Important Note

This presentation contains statements relating to the future business and financial performance of and future events or developments involving SGL Group or its businesses, including statements with respect to SGL Group’s outlook, targets and business development, expected customer demand, expected industry trends and expected trends in the business environment. You can generally identify these statements by the use of words like "may", "will", "could", "should", "project", "believe", "anticipate", "expect", "plan", "estimate", "forecast", "target", "potential", "intend", "continue" and variations of these words or comparable words. These statements are not historical facts, but rather are based on current expectations, estimates, assumptions and projections about SGL Group's businesses and future financial results, and readers should not place undue reliance on them. Forward-looking statements do not guarantee future performance and involve risks and uncertainties. These risks and uncertainties include, without limitation, changes in political, economic, legal and business conditions, particularly relating to SGL Group’s main customer industries, competitive products and pricing, the ability to achieve sustained growth and profitability in SGL Group’s businesses, the impact of any manufacturing efficiencies and capacity constraints, widespread adoption of carbon fiber products and components in key end-markets of the SGL Group, including the automotive and aviation industries, the inability to execute additional cost savings or restructuring measures, availability of raw materials and critical manufacturing equipment, trade environment, changes in interest rates, exchange rates, tax rates, and regulation, available cash and liquidity, SGL Group's ability to refinance its indebtedness, development of the SGL Group’s pension obligations, share price fluctuation may have on SGL Group’s financial condition and results of operations and other risks identified in SGL Group’s financial reports. Should one or more of these risks or uncertainties materialize, or should underlying expectations not occur or assumptions prove incorrect, actual results, performance or achievements of the SGL Group may (negatively or positively) vary materially from those described explicitly or implicitly in the relevant forward-looking statement. These forward-looking statements are made only as of the date of this document. SGL Group does not undertake to update or revise the forward-looking statements, whether as a result of new information, future events or otherwise.

This document includes supplemental financial measures that are or may be alternative performance measures (non-IFRS or alternative performance measures). These supplemental financial measures should not be viewed in isolation or as alternatives to measures of SGL Carbon’s net assets and financial positions or results of operations as presented in accordance with IFRS in SGL Carbon’s consolidated financial statements. Other companies that report or describe similarly titled alternative performance measures may calculate them differently.

Due to rounding, numbers presented throughout this and other documents may not add up precisely to the totals provided and percentages may not precisely reflect the absolute figures.
Agenda

1. Connecting the dots
   • Integration and completion of the value chain
   • Strategy evolution

2. Making markets
   • Automotive
   • Aerospace
   • Energy
   • Industrial applications

3. Our path to sustainable and profitable growth
   • Leveraging capabilities
   • Improving profitability
Carbon fiber composites industry still in its infancy.

### Aluminum industry

<table>
<thead>
<tr>
<th>Year</th>
<th>Industry</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1936</td>
<td>Aerospace</td>
<td>Douglas DC-3</td>
</tr>
<tr>
<td>1959</td>
<td>Industrial Applications</td>
<td>Introduction of aluminum cans</td>
</tr>
<tr>
<td>1961</td>
<td>Automotive</td>
<td>Land Rover V8 engine blocks</td>
</tr>
<tr>
<td>1994</td>
<td>Automotive</td>
<td>Audi Space Frame</td>
</tr>
<tr>
<td>2015</td>
<td>Automotive</td>
<td>Ford F-150</td>
</tr>
</tbody>
</table>

### Carbon fiber industry

<table>
<thead>
<tr>
<th>Year</th>
<th>Industry</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late 1960s</td>
<td>PAN-based carbon fibers</td>
<td>First high-performance carbon fibers</td>
</tr>
<tr>
<td>1980s</td>
<td>Aerospace</td>
<td>US military aircraft</td>
</tr>
<tr>
<td>2009/13</td>
<td>Aerospace</td>
<td>Boeing 787, Airbus A350</td>
</tr>
<tr>
<td>2013/15</td>
<td>Automotive</td>
<td>BMW i3 and 7 series</td>
</tr>
</tbody>
</table>

- It took the aluminum industry 40 to 50 years from selected use in aerospace to serial use in automotive
- Carbon fiber industry trails 30 years behind aluminum
- Driven by environmental legislation, serial use of carbon fibers and composites in general just begins
Evolution of SGL Carbon's composites activities.

SGL Carbon

1997: Acquisition
RK Carbon Muir of Ord, UK
Carbon fibers
Acquisition Hitco Gardena, US
Aerospace components

2007/08: Acquisition
epo Willich, DE
Prepregs
Joint Venture with Benteler
Automotive components
Inception SGL Kümpers Lathen, DE
Textile materials

2007: Acquisition
RK Carbon Muir of Ord, UK
Carbon fibers
Acquisition Hitco Gardena, US
Aerospace components

2009: Acquisition FCT, AT
CFRP components
Joint Venture with BMW Group
Automotive carbon fibers
Joint Venture with Brembo
Carbon ceramic brake discs

2010: Joint Venture
MSP with Mitsubishi
Rayon Co. Ltd., JP
Precursor

2012: Acquisition Fisipe Lavradio, PT
Acrylic Fibers
Divestiture Rotec Lemwerder, DE
Rotor blades

2015: Partial divestiture
Hitco Gardena, US
Aerospace Components

2017: Full consolidation of the Benteler SGL Joint Venture
Announcement of acquisition SGL ACF (JV with BMW)
Start of precursor production in Fisipe Lavradio, PT
Divestiture Kümpers Lathen, DE

1997–2018
Experience and market changes required a refocus of our composite activities.

<table>
<thead>
<tr>
<th>Evolution</th>
<th>Today</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbon Fibers</strong></td>
<td></td>
</tr>
<tr>
<td>- Kelheim:</td>
<td>No own precursor</td>
</tr>
<tr>
<td>+ Moses Lake:</td>
<td>Large volume production</td>
</tr>
<tr>
<td>+ Muir of Ord:</td>
<td>Refocused on specialties</td>
</tr>
<tr>
<td>- Evanston:</td>
<td>Too small, sold</td>
</tr>
<tr>
<td><strong>Composite Materials</strong></td>
<td></td>
</tr>
<tr>
<td>+ JV BMW:</td>
<td>Materials competence for automotive</td>
</tr>
<tr>
<td>- JV Kümpers:</td>
<td>Textile materials</td>
</tr>
<tr>
<td><strong>Composite Components</strong></td>
<td></td>
</tr>
<tr>
<td>+ JV Brembo:</td>
<td>Forward integration into foundation brakes</td>
</tr>
<tr>
<td>+ JV Benteler:</td>
<td>Serial production competence</td>
</tr>
<tr>
<td>- HITCO:</td>
<td>Not backward integrated</td>
</tr>
<tr>
<td>- Rotec:</td>
<td>Business model was swing capacity for our customers</td>
</tr>
</tbody>
</table>

**Fully integrated value chain**

**Engineering capabilities**

**Serial production capabilities**
Agenda

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   - Industrial applications

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   - Leveraging capabilities
   - Improving profitability
In-depth understanding of composites industry led to strategic shift.

- Carbon fiber composites industry still in its infancy
- Substitution of metals in aerospace and automotive applications just started
- Automotive market penetration slower than expected in early 2010s
- Successful where cost benefit ratio favorable, e.g. hybrid solutions
- Gap between materials and customer applications
- Supply risks need to be mitigated therefore backward integration vital

Derived consequences:
- Bridging the gap requires engineered solutions and serial production capabilities
- Acquisition of necessary capabilities (remaining interest in former JVs with Benteler and BMW)
- Build-up of Lightweight and Application Center
Our unique value chain and engineered solutions set us apart from competitors.

Our differentiators

- Engineered solutions
- Leading composites serial production
- Unique value chain from carbon fibers to components
- Industrial carbon fiber competence

Competitors

- Carbon fiber producers focused on providing materials, not components
- Focused on expensive carbon fiber not suitable for automated production processes
- Component producers not backward integrated
- Geared to expensive, time consuming and not scalable hand lay-up
Agenda

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   • Strategy evolution

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   • Automotive
   • Aerospace
   • Energy
   • Industrial applications

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   • Leveraging capabilities
   • Improving profitability
CFM expected to grow ...

### Market Segment

<table>
<thead>
<tr>
<th>Market Segment</th>
<th>Automotive</th>
<th>Aerospace</th>
<th>Wind Energy</th>
<th>Industrial Applications</th>
<th>Acrylic Fibers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sales 2017</strong></td>
<td>30%&lt;sup&gt;1&lt;/sup&gt;</td>
<td>6%</td>
<td>12%&lt;sup&gt;2&lt;/sup&gt;</td>
<td>23%</td>
<td>29%</td>
</tr>
<tr>
<td><strong>Sales 2018</strong> (pro forma)</td>
<td>51%</td>
<td>6%</td>
<td>2%</td>
<td>17%</td>
<td>24%</td>
</tr>
<tr>
<td><strong>CFM midterm growth expectation</strong></td>
<td><img src="#" alt="Up Arrow" /></td>
<td><img src="#" alt="Up Arrow" /></td>
<td><img src="#" alt="Up Arrow" /></td>
<td><img src="#" alt="Right Arrow" /></td>
<td><img src="#" alt="Diagonal Arrow" /></td>
</tr>
</tbody>
</table>

<sup>1</sup> Automotive sales 2017 proportion before effect from full consolidation of joint ventures with Benteler and BMW

<sup>2</sup> Wind energy sales including full consolidation of SGL Kümpers, sold end of 2017
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Automotive

SGL Carbon acts as full service and solution supplier to the automotive industry by offering engineering, prototyping and large-scale serial production for materials and components. Together with our global customers we develop new and innovative composite automotive applications, hence transforming the existing material world into a more dynamic one and introducing flexible ways of using high-tech composite materials for diverse customer needs.
Still in early adoption phase, automotive already accounts for 22% of the total carbon composite market.

Total: 126,700 t

Aerospace 30%
Industrial Applications 35%
Automotive 22%
Energy 13%

Revenue growth (in € billion)

Source: CCeV (September 2017)
Source: CompositesWorld, JEC, MarketsandMarkets.com, internal analysis
Global carbon composites business growing in automotive market, driven by similar trends across the regions.

**Americas**
- Confrontation with US fuel economy and emission standards leading to increasing pressure on industry for more radical lightweight solutions
- Huge truck/SUV market expected to drive growth in lightweight construction to meet emission regulations

**Europe**
- Electric vehicle initiatives by Daimler, Porsche, Audi, and other European OEMs may drive growth of lightweight materials – battery cases huge potential for composites
- Reinforced thermoplastics continue to gain in areas once thought to be the province of thermoset composites

**Asia**
- EV market driven by Chinese OEMs paving the path for huge composite use in automotive, especially for composite battery cases
- Stricter emission standards given high level of pollution in Asia anticipated to lead to increasing composite use to reduce weight of vehicles

Source: CompositesWorld, JEC, MarketsandMarkets.com, internal analysis
We offer solutions for any ICE and BEV market share scenario.

Global LDV and EV annual sales 2015–2040

While BEV are expected to show sustainable growth, ICE are expected to continue to dominate sales in next 10–15 years.

Source: Bloomberg New Energy Finance
LDV = Light Duty Vehicles; EV = Electric Vehicle
ICE + HEV = Internal Combustion Engine and Hybrid Vehicles; BEV = Battery Electric Vehicles; PHEV = Plug-in Hybrid Electric Vehicles
CO₂ targets drive lightweight construction in the automotive industry.

**OEM fleet target development (EU)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
<th>Expected Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>119</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>68</td>
<td></td>
</tr>
</tbody>
</table>

**Relative component weight (in %)**

<table>
<thead>
<tr>
<th>Material</th>
<th>2016</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>100</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Aluminum</td>
<td>60</td>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td>CFRP quasi-isotropic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFRP uni-directional</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. status as of 10/10/18
2. with same functionality

Source: ICCT, SGL estimates
Weight does matter – materials and components for electric vehicle batteries.

Lower vehicle weight

- Reduces energy consumption and extends the range for electric vehicles
- Compensates for the added mass by integration of batteries and electronics into electric vehicles
- Reduces consumption of resources by using less material

Source: „Lightweight spiral“, after “FOREL – Chancen und Herausforderungen im ressourceneffizienten Leichtbau für die Elektromobilität 2015“ // paulbr75, pixabay.com
Materials and components are suitable for various automotive parts.

Source: SGL Carbon, based on Volvo XC 90 chassis model
SGL Carbon is already well-positioned in the automotive industry.

Existing projects in different automotive vehicle segments

- Rear bench for performance sports cars
- Structural components for electric vehicles (EV)
- Leaf springs for light commercial vehicles and passenger car suspension systems
- Hybrid designs for large series passenger vehicles
- Friction materials for modern gear boxes

Source: Audi AG, BMW AG, Volkswagen AG, Volvo CC, SGL Carbon
Example: Composite trunk lid for Porsche GT.

Source: Porsche AG, SGL Carbon
Customer testimonial. Porsche AG.

- Porsche AG is the largest and most traditional sports car manufacturer and the most profitable automobile company in the world
- Dr. Oliver Humpert, Director Procurement – Commodity Exterior, Porsche AG:

“We need a reliable and flexible partner who is willing to support us in such innovative technologies as fiber-reinforced plastics. For us, SGL Carbon is a competent partner in this field.”
Example: SGL Carbon manufactures the volume-wise largest composite order in the market today.

Significant weight-savings through glass fiber-based lightweight leaf spring

Volvo SPA¹ platform

- Structural component for axle module, from simulation-assisted product design up to parts delivery in large series
- Fully automated production lines
- Peak volume over 550,000 pieces p.a.
- Weight saving combined with dynamic driving advantages

¹ Scalable Product Architecture
Source: Benteler, SGL Carbon
Customer testimonial. Volvo Car Corporation.

• Since 2015 SGL Carbon produces the transversal leaf spring for VCC’s Scalable Platform Architecture (SPA)

• The project started 2 years earlier for SGL, when the leaf spring was designed and validated in responsibility of SGL Carbon

• It is the first time that VCC uses fiber reinforced plastic for more than 500,000 units per year

• Erik Johannson, responsible engineer for SPA springs:

“SGL’s combination of technical expertise in the field of automotive series production, R&D and the use of the entire value chain is a great advantage for us.”

Source: Volvo Car Corporation
Our materials and components contribute to EV battery performance.

Applications for CFM’s products:

1. Battery management system (BMS) cover
2. Battery top cover
3. Battery frame with internal struts
4. Battery bottom cover

Photo source: Daimler EQC Battery
Carbon composites are the right material for EV battery cases.

- Lightweight cost for actual automotive composite applications between €10/kg and €50/kg
- For EVs with 200 km range (and with battery capacity of 200–300 Wh/kg) the allowable cost of weight saving is around €7/kg\(^1\)

In comparison to other applications, battery case components show superior lightweight costs

\(^1\) Source: “Verfahren zur parameterbasierten Gewichtsabschätzung neuer Fahrzeugkonzepte”; \(^2\) “Lightweight costs depend on design and requirements”; Dipl.-Ing. Stephan Fuchs M. Sc. Source: SGL Carbon
Thermoplastic materials and components offer new flexibility and increase efficiency for the automotive industry.

New possibilities for serial production

- Composites can be readily shaped, repaired, and recycled
- Production of components in short cycle times
- Facilitate integration into body-shop by making components weldable
- Depending on component cost-parity with aluminum achievable

Source: MAI Carbon
By 2030 most cars expected to have fiber-reinforced polymer (FRP) parts and thermoplastic components.

Source: RedBull F1, Daimler AG, Audi AG, BMW Group
Latest new project wins.

**Our leaf spring concept shows clear potential to open up further applications in the automotive industry**

- Important order received from North American automobile manufacturer for full composite leaf springs for deliveries from 2019 onwards
- Flexible component design enables integration into multiple models of one platform in passenger cars as well as commercial vehicles
- Our lightweight construction concept of fully automated serial production of fiber-reinforced leaf springs positions us as a Tier 1 supplier in automotive chassis components

**We will supply carbon fiber materials for the newest generation of electric vehicles**

- Order awarded by a major German automobile manufacturer for the complete supply of carbon fibers and textile semi-finished products for various components
- Deliveries of fibers and material solutions consisting of various innovative textiles to start in 2021 and last for the entire vehicle life cycle
- Involves various stages of our value chain
Automotive growth is expected to be driven by ...

Local reinforcements
- A- and B-pillar reinforcements
- Roof rail

Leaf springs for passenger cars
- Pick-up trucks, SUVs, Vans
- New BEV vehicle concepts

Thermoplastic components
- Structural parts
- Easy to integrate into OEM assembly plants

Battery cases for BEVs
- Hybrid material solutions
Agenda

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   - Automotive
   - Aerospace
   - Energy
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Aerospace

Materials and components must be reliable and safe under extreme conditions. Fuel consumption must be reduced through lightweight design. These demands can be met with our carbon fiber reinforced composites. We offer the right solutions for primary and secondary structures, sub-systems or internal fittings.
The aerospace industry consumes 30% of the total carbon composite supply.

**Total: 126,700 t**

- **Aerospace**: 30%
- **Industrial Applications**: 35%
- **Automotive**: 22%
- **Energy**: 13%

**Revenue growth (in € billion)**

- 2017: 11.6
- 2018e: 12.5
- 2020e: 14.6
- 2022e: 17.0

CAGR 8%

Source: CCeV (September 2017)
Source: CompositesWorld, JEC, MarketsandMarkets.com, Internal analysis
Global carbon composites business is growing in the aerospace market with regionally varying grades of maturity.

**Americas**
- B787 and B777X driving growth in commercial aircraft sector
- Big Falcon Rocket (SpaceX) to be designed in large proportions with carbon fiber composites

**Europe**
- Establishment of the A350 XWB, A380 programs
- Ariane 6 (ESA/ASL) designs feature carbon fiber structures
- In addition to traditional aircrafts, UAVs and launchers also gaining momentum

**Asia**
- New large-scale activities in India and China are particularly promising
- Comac C919 driving growth in the commercial aviation sector

Source: CompositesWorld, JEC, MarketsandMarkets.com, internal analysis
CFM growth in the aerospace industry based on proven competence in automated serial manufacturing.

Limitations in today’s aerospace composites manufacturing prevented further penetration beyond Boeing 787 and Airbus A380 and A350
• Low annual production volume allow labor intensive production processes
• Composites for aerospace are by far the most expensive.

Aerospace industry likely to further increase composites penetration rate
• Requirement: higher use of automation to produce composite parts at lower manufacturing costs and increased production volumes

We are ideally positioned to address exactly these issues based on our carbon fiber and composites competence acquired while working for the automotive industry
• Integrated value chain from precursor to components
• Materials (e.g. fabrics) for secondary structures and interior applications
• New aerospace projects for materials and aircraft components
The high production volume of narrow body commercial aircrafts requires serial production competency.

### Airbus monthly production volume forecast

<table>
<thead>
<tr>
<th>Model</th>
<th>2016</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>A350 (wide body)</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>A320 (narrow body)</td>
<td>46</td>
<td>60+</td>
</tr>
</tbody>
</table>

### Boeing monthly production volume forecast

<table>
<thead>
<tr>
<th>Model</th>
<th>2016</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>B787 (wide body)</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>B737 (narrow body)</td>
<td>42</td>
<td>58</td>
</tr>
</tbody>
</table>

Remark: “Narrow body” typically describes single aisle aircrafts, “wide body” aircrafts with double aisles.

Source: Airbus, Boeing
The use of carbon fiber composites in commercial aircrafts is continuously increasing.

Remark: “Narrow body” typically describes single aisle aircrafts, “wide body” aircrafts with double aisles.

Source: SGL Carbon
Smart solution for narrow body wing production.

High investments into autoclaves required - uneconomical

Production time per wing [%]

- Metallic
- Composite today (Prepreg + Autoclave) - Capable of 60+ aircraft per month
- Composite tomorrow (Non Crimp Fabric + Out Of Autoclave)

Source: SGL Carbon
Composite materials and components for commercial aircraft parts.
Market growth and focus on operating cost efficiency.

- Airline industry extremely competitive, constant battle over cost reduction
- Composites address this key customer requirement as lightweight construction reduces fuel consumption
- Strong commercial aircraft **CFRP market growth (CAGR > 8%)**\(^1\) driven by aircraft programs (e.g. A350, B787, B777X)
- Besides Boeing and Airbus in the field of commercial aircraft other aerospace markets are accelerating – launcher, UAV, etc.
- The aerospace industry has a clear incentive to use composites, as their customers are willing to pay for reduced weight

\(^1\)Source: CompositesWorld, JEC, MarketsandMarkets.com, internal analysis
Example: Helicopters and potential additional markets.

Helicopters

Example: AIRBUS Helicopters

• Cutting and stacking of fabrics for production of A350 doors

Potential additional markets:

Unmanned Aerial Vehicles (UAV)

• Professional UAVs, Military UAVs, Human transportation UAVs

Small aircraft business

• E.g. textiles for Pipistrel and Diamond Aircraft

Source: Airbus Helicopters, Diamond Aircraft Industries
Customer testimonial. Airbus Helicopters.

• Airbus Helicopters is the largest helicopter company in Europe, offering a portfolio of rotary wing aircrafts for civil and defense missions.

• Matthias König, Strategic Procurement, Airbus Helicopters:

  “Reflecting on our long term relationship based on reliability and trust, we are convinced that developing innovative solutions with SGL Carbon will continue to fall in line with our common future goals. This will offer a high degree of competitive advantage.”
Aerospace growth expected to be driven by …

**Non-crimp fabrics for primary structures**
- Automated textile preforming processes based on lay-up technologies
- Liquid resin infusion and out-of-autoclave curing

**High-performance insulation**
- Spare parts business for aero-engines, e.g. thrust reverser heat shield
- Fuselage insulation components

**TowPreg materials in combination with fiber placement processes**
- Fast curing pre-impregnated carbon fiber tow materials
- Automated material deposition by fiber placement processes

**Next generation aircraft brakes**
- 3D carbon fiber based preforms
- Dedicated carbon fiber for dry friction applications
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Energy

Energy companies must ensure a reliable, flexible supply of energy to consumers. At the same time, cost pressures are increasing, and so are greater demands on efficiency. Genuinely high-performance materials are needed – in different sectors of the energy industry.
Energy accounts for 13% of global carbon composites mainly in the wind energy industry.

Total: 126,700 t

### Revenue growth (in € billion)

- **2017**: 1.6
- **2018e**: 1.8
- **2020e**: 2.2
- **2022e**: 2.7

Source: CompositesWorld, JEC, MarketsandMarkets.com, Internal analysis
Global carbon composites business is growing especially in the wind energy sector with China as major driver in the future.

**Americas**
- Continued large investment by carbon fiber manufacturers for expansion of existing plants and opening of new sites
- As of 2017, 28,668 MW of wind power capacity under construction, a 34% year-over-year increase

**Europe**
- EU must meet the 20% renewable energy share target by 2020
- Wind energy a growing market in both offshore and on shore technologies
- 26% of renewable energy share in EU dependent on offshore and onshore wind power

**Asia**
- Growing willingness particularly in Asia towards comprehensive implementation of climate change objectives
- In this context, renewable energies will play an important role in the future

Source: CompositesWorld, JEC, MarketsandMarkets.com, internal analysis
Wind energy is the key driver for the energy segment.

Key benefits of composites in the wind energy industry:

- Corrosion resistance
- Strength-to-weight ratio

Efficiency requirement for rotor blade design leads to potential for composites:

- The growing demand of efficient wind energy plants has led to interesting developments in wind turbine designs
- Plants with a large number of wind turbines with short rotor blades are being upgraded with a smaller number of wind turbines with longer rotor blades
- This has led to a reduction in demand of rotor blades in volume but the requirement of longer rotor blades has resulted in a huge potential for composite use in rotor blade construction

1Source: Globaldata
Customer testimonial. Vestas Wind Systems A/S.

- Vestas is the energy industry’s global partner on sustainable energy solutions
- SGL is supplying carbon fibers for rotor blades
- Jan Rietdijk, Senior Vice President Global Sourcing Vestas:

"Carbon fiber will become more and more important to the wind industry. Carbon fiber helps to further increase the efficiency of wind turbines and helps us maintain our leading market position and high quality standards."
Keeping up with the evolution of rotor blade production technologies in the wind industry.

Carbon fiber spar caps usually manufactured out of CF pultruded profiles, CF non-crimp fabric or CF prepreg

Multiaxial glass fiber non-crimp fabric

Source: vivis.de
Energy growth expected to be driven by …

Supply of carbon fiber to growing pultrusion market
• Technology change from prepreg/textile to pultruded profiles
• Pultrusion provides better mechanical properties

Increasing carbon fiber need for on- and offshore wind turbines
• Increased blade length possible
• Reduced levelized cost of energy by using longer blades

Political driven need to reduce CO₂ emission
• Countermeasure against global warning
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Industrial Applications

SGL Group is the only company to master all types of production processes, manufacturing everything from carbon fibers to composites. Our unique expertise allows us to tap the full potential of new materials. We offer solutions that fully meet our customers’ expectations in many different industrial sectors.
More than one-third of the global carbon composites supply is sold to various industrial applications.

Total: 126,700 t

- Aerospace: 30%
- Industrial Applications: 35%
- Automotive: 22%
- Energy: 13%

Revenue Growth (in € billion)

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018e</th>
<th>2020e</th>
<th>2022e</th>
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<tbody>
<tr>
<td>Value</td>
<td>3.6</td>
<td>3.9</td>
<td>4.7</td>
<td>5.6</td>
</tr>
</tbody>
</table>

Source: CCeV (September 2017)

Source: CompositesWorld, JEC, MarketsandMarkets.com, internal analysis
Global carbon composites business growing in industrial applications with civil engineering as strong driver across regions.

**Americas**
- Multiple rehabilitation work on bridges, post natural disaster repair work and innovation in the civil engineering industry driving use of composites
- The Americas were the leading region for global medical composite materials in 2017

**Europe**
- EU growth driven by corrosion/chemical resistance demand in construction and pipe & tank industry as well as electrical resistance/high flame retardant demand in electronics industry
- Huge potential in Scandinavian marine industry

**Asia**
- China particularly strong in the pipe & tank industry (42% of global composites production), electronics & electrical (39%) and wind (44%)
- Rest of Asia dominant industries are consumer goods (30%) followed by E&E (27%) and others (27%)

Source: CompositesWorld, JEC, MarketsandMarkets.com, internal analysis
Market shares estimated for 2022.
Approaching the civil engineering industry with composites.

Carbon composite demand in civil engineering industry estimated at 6,300 tons and valued at €379 million (2016)

- **SGL’s products relevant for civil engineering:** Fibers and materials
- **Processes:** Grid and textile layup, spray carbon reinforced concrete and hybrid construction
- **Potential customers:** Q. Zementol, Acciona, Pultrall, S&P Reinforcement, Hanson
- **Civil engineering applications:** Bridges and structural repair, reinforcement of new structures for extended life span
- **Markets:** European market is very mature with Americas following the same growth path. Asia has more of glass fiber penetration but is expected to follow in a couple of years

Source: Compositesworld, JEC, Internal Research.
Industrial applications analysis shows variety of applications, customers, regions and thus actions.

Industry progression

- Diversity in markets across industries in Americas, Europe and Asia
- Huge potential visible for fiber intermediates in injection molding process technology
- Opportunities identified in civil engineering in synergy with glass/aramid reinforced composites
- Progress in usage of carbon composite materials in serial as well as high performance boat building practices

SGL in action

- Approaching uncharted markets such as Middle East, Central America, civil engineering, marine, etc.
- Strengthening and expanding sales force in every region – own employees as well as distributors
- Targeting increased penetration of fiber intermediate products with high added value
- Developing new products and applications for end of life-cycle materials
- Increasing environmental friendliness and sustainability of products/processes
- Digitizing sales activities
- Improving efficiency and effectiveness of customer service and adapting to regional disparities in expectations
Customer testimonial. Saint-Gobain Abrasives.

• Saint-Gobain Abrasives, the world’s leading manufacturer of abrasives, offers powerful, precise and user-friendly solutions enabling customers to shape and surface finish all types of materials even in the most complex and challenging applications across a diverse range of markets

• Andreas Witsch-Bade, Market Director Automotive EMEA, Saint-Gobain:

“SGL Carbon and Saint-Gobain Abrasives have been working together for many years in the field of CFRP base body technology for CBN high-performance grinding tools. Right from the start, SGL Carbon was able to anticipate the special features of this special technology environment and translate them into technically complex and well-founded solutions. In particular, SGL Carbon was able to convert the ideas for further weight reduction of large grinding wheels into application-suitable technology within a short period of time. Since then, a trusting technology partnership with an open communication culture has grown between the two companies. The value-adding cooperation with SGL Carbon is highly valued by us and thus forms the basis for further projects and joint technology developments.”

Source: Saint-Gobain Abrasives
Industrial Applications growth expected to be driven by …

**Industrial grade carbon fiber for civil engineering**
- Carbon fiber materials to be used e.g. for infrastructure repairs
- Usage for concrete reinforcement in renovation and new buildings

**Fiber intermediates for compounding applications**
- Chopped carbon fibers within applications for consumer electronics
- Milled carbon fibers as anti-static coatings

**Tailor-made pre-impregnated materials for component manufacturing**
- Material basis for professional sports gear

**Small series components for engineering solutions**
- Lightweight applications within machining/tooling parts
- Customized parts for highly stressed applications
Agenda

1. Connecting the dots
   • Integration and completion of the value chain
   • Strategy evolution

2. Making markets
   • Automotive
   • Aerospace
   • Energy
   • Industrial applications

3. Our path to sustainable and profitable growth
   • Leveraging capabilities
   • Improving profitability
Capabilities tailored to serve market needs.

**Product toolboxes**

- **≤5 min. cycle time**
  - Dry Textiles Material Toolbox
    - Textiles
    - Various dimensions and sizes
    - Commercially proven
  - thermoelectrical

- **≤3 min. cycle time**
  - Thermoform Material Toolbox
    - Composites
    - Thermoforming
    - Various shapes and sizes
    - Commercially proven
    - Commercially proven
    - Various shapes and sizes
  - Fiberform
  - Thermoplastics
    - Various shapes and sizes
    - Commercially proven
    - Various shapes and sizes

- **≤1 min. cycle time**
  - Thermoplastic Material Toolbox
    - Composites
    - Various shapes and sizes
    - Commercially proven
    - Various shapes and sizes
    - Commercially proven
    - Various shapes and sizes

**Engineering (LAC)**

- Concept development
- Product design
- Process simulation
- Structural analysis
- Virtual prototyping
- Prototyping
- Product testing
- Virtual factory

**Component processes**

- Placement
- Pressing
- Injection molding

**Market needs**

- Mass production
- Automated processing
- Hybrid design (e.g. GF/CF)
- Load path adapted design
- Minimum scrap and waste
Lightweight and Application Center (LAC) offers a full engineering service and process value chain.

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- Virtual factory
Computer Aided Manufacturing enables factory simulations. Serial production of CFRP parts planned for various manufacturing processes

- Layout depended on cycle time, volume and process
- Virtual factory needed for manufacturing study

Source: SGL Carbon
Fiber placement to enable load-path oriented composite designs.

**Working principle**
- Direct application of rovings onto a 2D or 3D surface, no semifinished fabric needed
- Buildup the layup in every direction which is requested by the product design or process needs (e.g. overlaps for grippers)
- Start the conventional press process

**Customer benefits**
- Intelligent material mix and functionalization (e.g. hybrid metal/CFRP)
- Production costs optimization
  - Application of cost-effective materials
  - Scrap and cycle time reduction
  - Combination of technologies to implement an efficient processing route for a given composite component
- Tailor-made solutions for serial production

**Fiber placement**

- Increase productivity
- Ressource efficiency
- Optimization concepts
Fiber Placement Center to strengthen technological competence.

<table>
<thead>
<tr>
<th>Coriolis Composites TS Automated Fiber Placement</th>
<th>AFPT – TP Automated Fiber Placement</th>
<th>Cevotec SAMBA Prepreg – Fiber Placement</th>
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<tr>
<td>Composiente RoboMAG Fiber Placement</td>
<td>FiberForge Relay 2000 Tapelaying</td>
<td>Coriolis Composites Fiber Placement</td>
</tr>
<tr>
<td>Tape Slitter Thermoplastic</td>
<td>BA Composites STAXX 1700 Fiber Placement</td>
<td>Fraunhofer IGCV Continuous Fiber Tailoring</td>
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Variety of measures designed to improve profitability.

Utilization of existing capacities leading to cost absorption, e.g. carbon fibers for wind energy

Short term: Lavradio site restructuring and development of higher margin acrylic fibers
Long term: Gradual conversion of acrylic fiber lines to precursor

Forward integration into components

Development of high-margin products for next generation commercial aircraft

Improving global marketing & sales coverage

Project driven extension of production footprint (materials and components) in the USA and China
New and long-term partnerships supporting our future growth.