



Solutions for electromobility

Innovative joining solutions that enable
lightweight design and electromobility

Atlas Copco



The world is shifting away from fossil fuels and carbon emissions, towards smart grids and electric vehicles.

These changes create a need for automotive manufacturers to look for suppliers with innovative joining solutions that enable lightweight design and electromobility.



SCA dispensing

Adhesive bonding and dispensing is a highly versatile joining technology for body shop, paint shop, powertrain and final assembly. From structural bonding, hem flange joining and sealing – to sound dampening, insulating and thermal conduction – the SCA line from Atlas Copco ensures precision and uptime, saving material and costs even at high volumes.



Henrob self-pierce riveting

Self-pierce riveting is a joining method that doesn't introduce heat and leaves no welding splatter, while preventing harmful fumes. Different materials can be joined, allowing freedom in design. With the Henrob line, Atlas Copco offers flexible, reliable joining with high repeatability and short cycle times.



K-Flow flow drill fastening

Flow drill fastening technology ensures a reliable joint for multi-material design entered from one side, yet enabling disassembly later on. With high durability and short cycle times, flow drill fastening ensures high repeatability and high process reliability.



Atlas Copco tightening

Tightening with Atlas Copco tools ensures a high-quality process – for simultaneous tightenings or tightening in a sequence. Reducing cycle times while performing a consistent and homogeneous tightening, it is well-proven in various industries. The systems minimize operator influence while performing with high repeatability, process reliability and full traceability.

Industrial Assembly Solutions

– Your global partner for innovative joining technology

Industrial Assembly Solutions is a division within Atlas Copco's Industrial Technique business area. We offer multiple joining technologies from a single source and are a competence partner in innovative joining for the automotive and general industries worldwide.

We market dispensing solutions, self-pierce riveting and flow drill fastening under the product brands SCA, Henrob and K-Flow. The division is headquartered in Sweden and we manufacture in the US, the UK, Germany and China. And we take special pride in the fact that we have the competence to support our customers in every step of the process.

Did you know that a modern car could be assembled with:

2500

Self-pierce rivets

500

Safety critical bolts

160

Meters of adhesive

200

Flow drill fasteners

What makes us the preferred global joining partner

16

... Customer Centers worldwide ensure that we are close to our customers, wherever they are.

550+

... customer training days are carried out by our training department every year. This is how we share our know-how with our customers.

400+

... customer trials are run by our Innovation Centers worldwide every year. This is how we drive your innovations and tailor our solutions to your needs.

180+

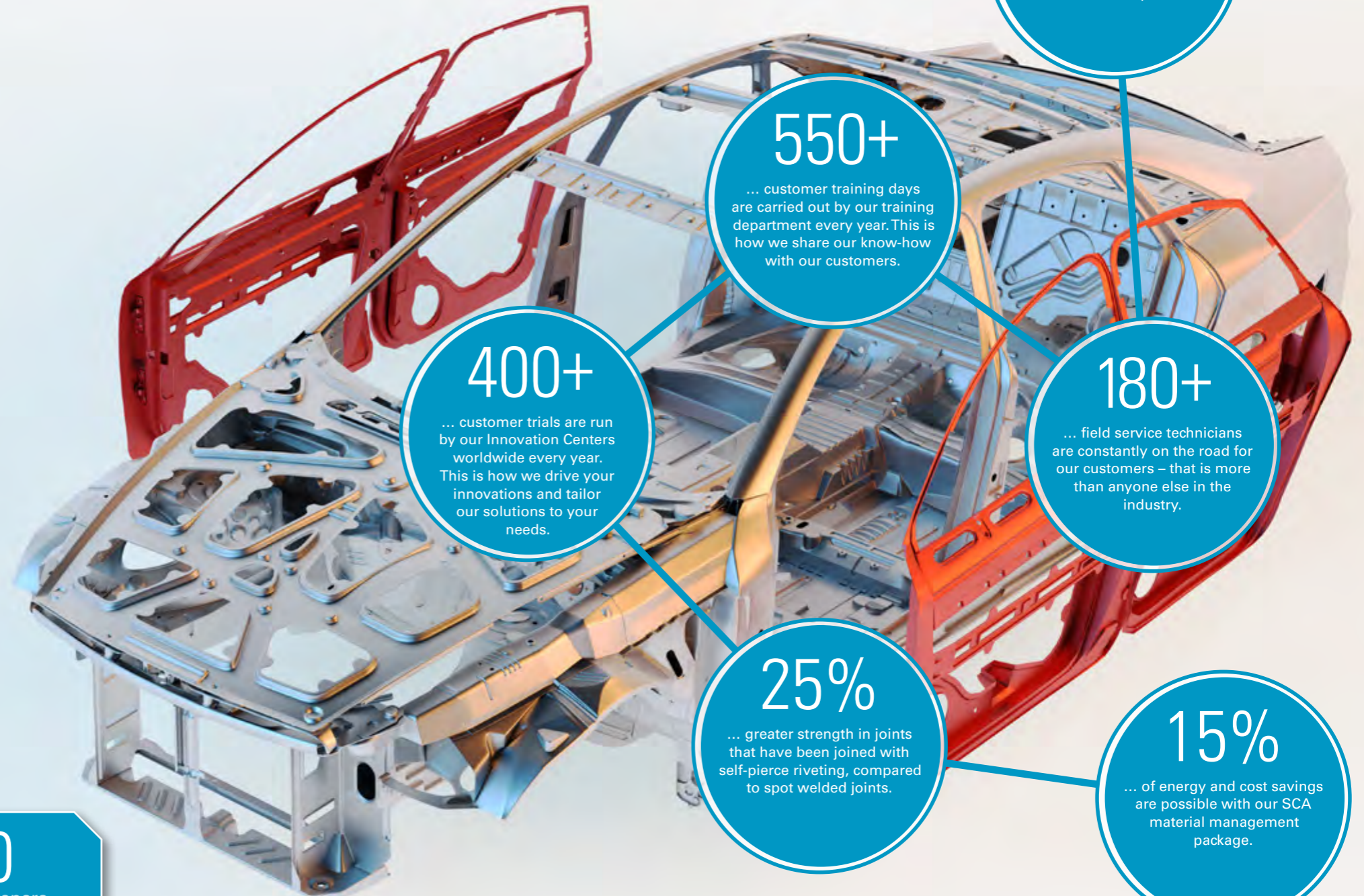
... field service technicians are constantly on the road for our customers – that is more than anyone else in the industry.

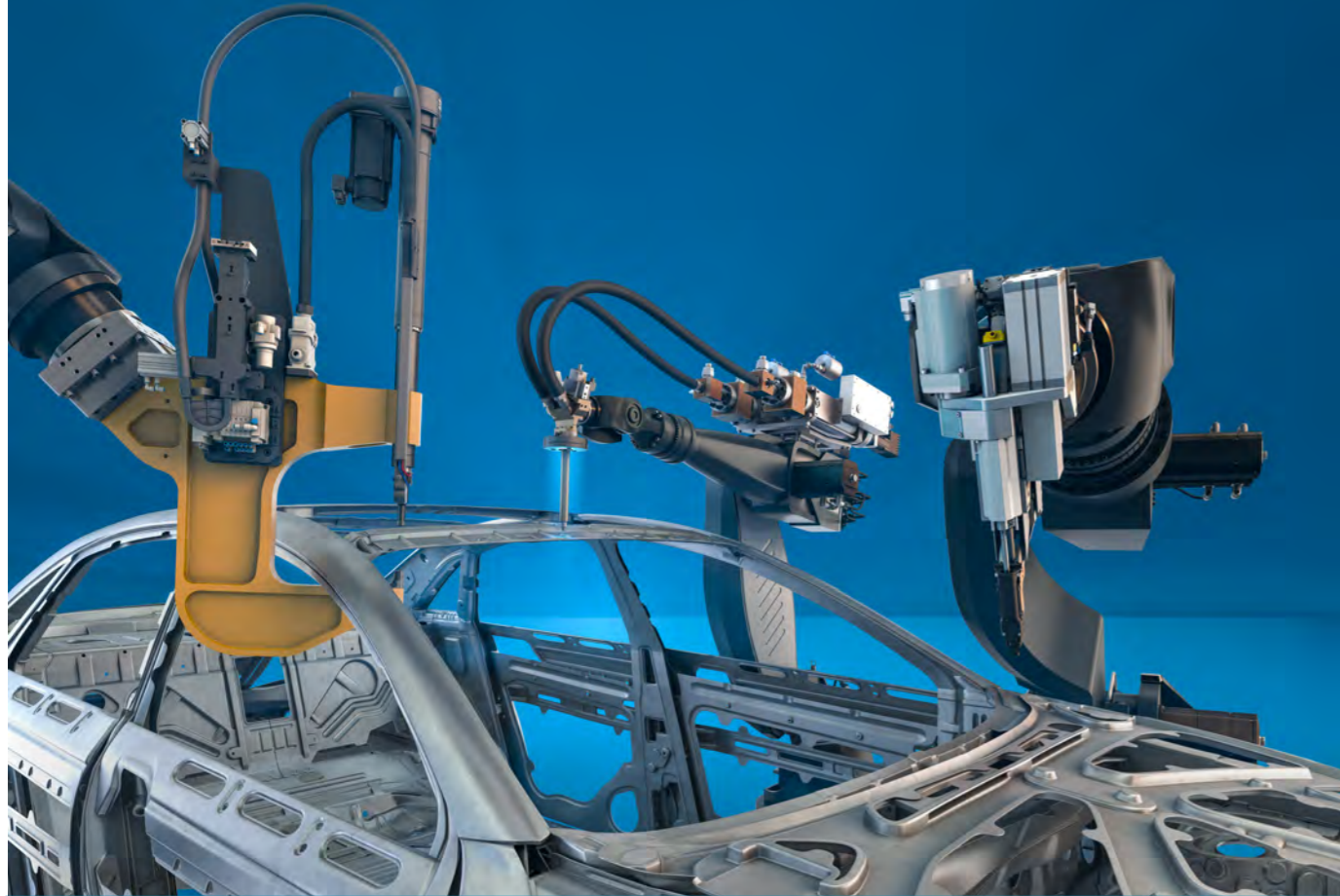
25%

... greater strength in joints that have been joined with self-pierce riveting, compared to spot welded joints.

15%

... of energy and cost savings are possible with our SCA material management package.





Innovations that enable electromobility

In today's economic climate, quite frequently we hear about trends like globalization, emerging markets, early adopters, disruptive innovation and Industry 4.0. To maintain your competitive edge, you need suppliers that don't just understand these philosophies, but also take a market leading role in their areas of expertise.

At Atlas Copco, we combine the full spectrum of innovative joining solutions. This includes adhesive dispensing technology, self-pierce riveting systems, flow drill fastening and tightening. But no matter what the customer challenge is – we always look at the big picture when it comes to our customers' processes. We are at your side and develop tailor-

made solutions that meet the highest demands concerning productivity, quality and sustainability. We want to be an extension of your innovation department.

Today, with the largest global network of sales and service experts in the field, and innovation centers in major countries, we can help. Let us show you how fast we can innovate!

1 500 000

Electric vehicles will be sold in 2018

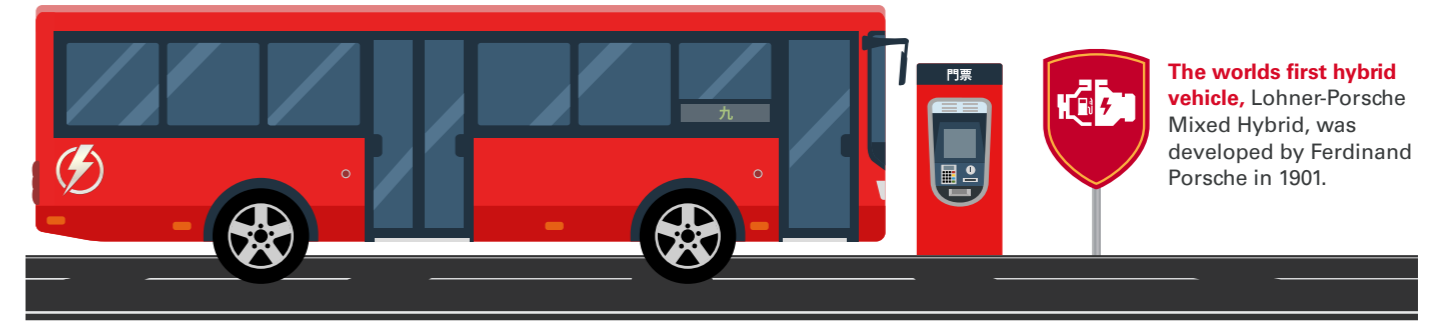
(Bloomberg New Energy Finance)



16 359

The city of Shenzhen, China has the world's first 100 percent electrified bus fleet. With its 16 359 electrical buses it is bigger than New York's, Los Angeles's, New Jersey's, Chicago's and Toronto's electric bus fleets combined. (wri.org)

In January 2018, BP invested in the US mobile electric vehicle charging company FreeWire to deliver rapid charging at retail sites in the UK and in Europe during 2018. (bp.com)



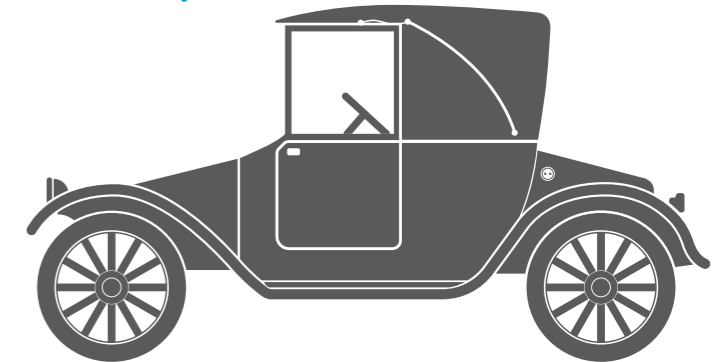
The world's first hybrid vehicle, Lohner-Porsche Mixed Hybrid, was developed by Ferdinand Porsche in 1901.



China will represent more than half of the global electric vehicle sales until 2030.

(South China Morning Post scmp.com)

Did you know?



Electric vehicles are not a modern day invention. In fact, 100 years ago they dominated the roads. British inventor Thomas Parker, who was responsible for electrifying the London Underground, built the **first production electric car in 1884.**

Speed and distance became an issue as infrastructures evolved. In the 1920's large petroleum reserves were discovered making gasoline available and affordable. Europe attempted to revive the electric vehicle during World War II due to fuel rationing, although this was not successful, then the war ended the fuel crisis. It took another war - the current one on environmental threats - to give the electric cars a true revival. This time the future looks brighter than ever.

More people – less old fashioned cars

Increasing urbanization means an additional 2.5 billion people will be city folks by 2050. Energy and mobility will drive necessary transformations, to meet demographic growth and economic in a sustainable fashion. The charging infrastructure available for the public needs to be optimized as the number of electric vehicles increase.

(World Economic Forum www.weforum.org)

Joining with a strategic partner

– Atlas Copco enables future mobility

The automotive industry is radically changing to fulfill the high global environmental goals. One major trend is decreasing vehicle weight through new multi-material designs – enabled by hybrid joining technologies. The other success factor for higher sustainability in transportation is the use of new drive concepts, such as the purely electrical or hybrid drive.

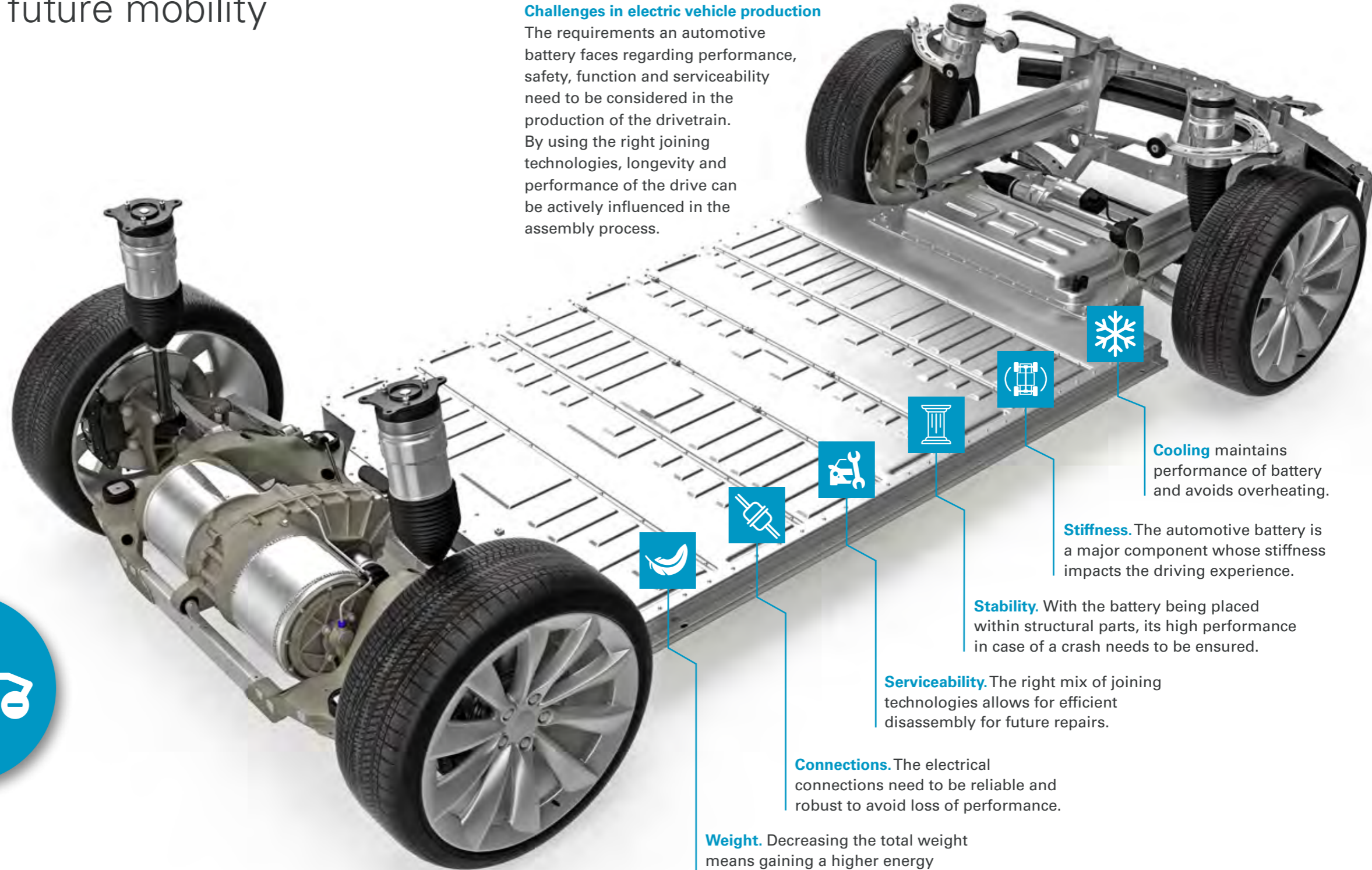
Partially or fully electric driven vehicles rely on rechargeable batteries to store and supply power. The various types of batteries which are used in automotive drivetrains need to be optimized for longevity, performance and safety.

These revolutionary changes in automotive production ask for joining technologies that help to realize the high-performance assembly processes of the future. Atlas Copco accepts the challenge and is meeting these demands with innovative and efficient solutions.



Challenges in electric vehicle production

The requirements an automotive battery faces regarding performance, safety, function and serviceability need to be considered in the production of the drivetrain. By using the right joining technologies, longevity and performance of the drive can be actively influenced in the assembly process.



Cooling maintains performance of battery and avoids overheating.

Stiffness. The automotive battery is a major component whose stiffness impacts the driving experience.

Stability. With the battery being placed within structural parts, its high performance in case of a crash needs to be ensured.

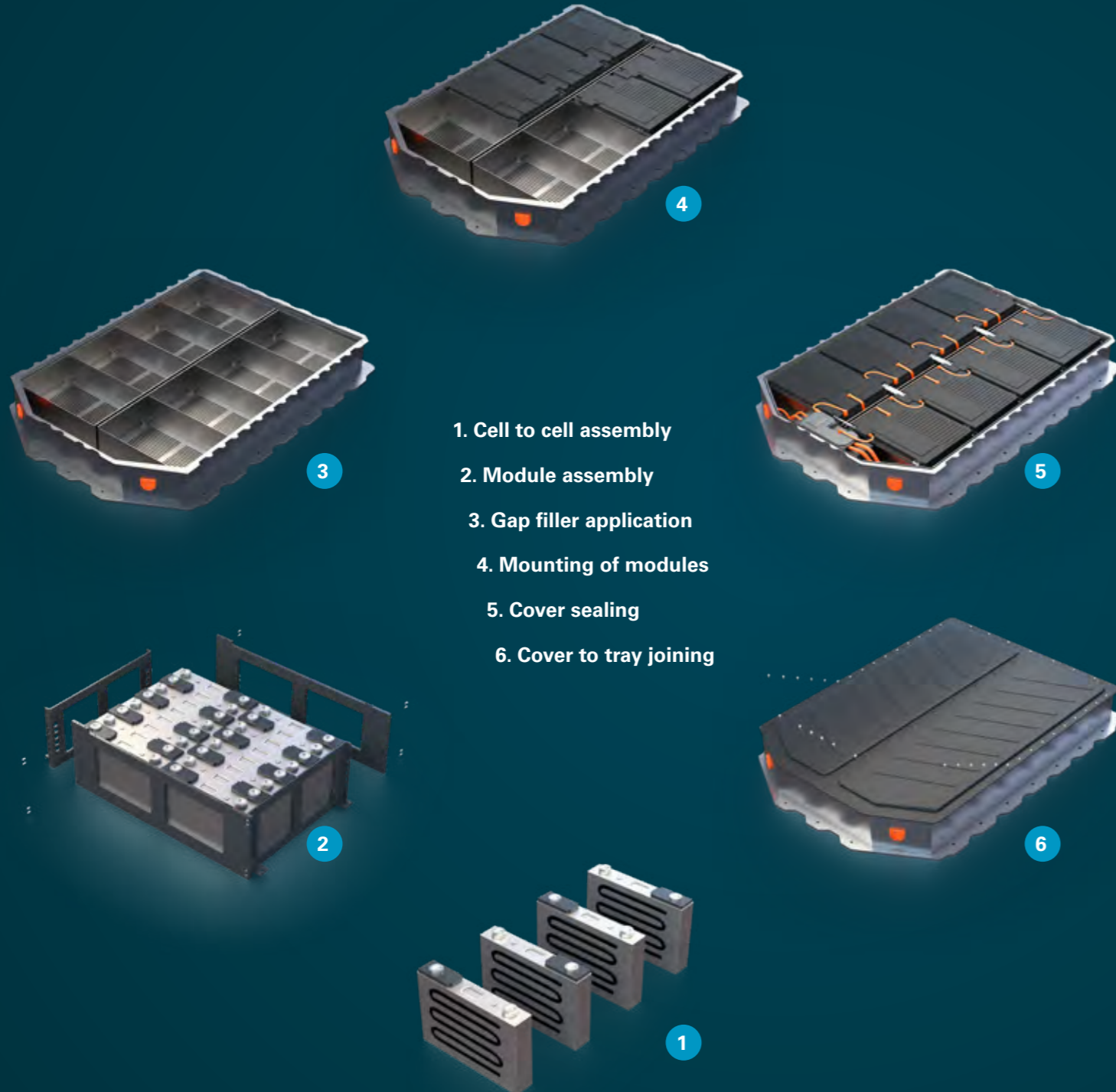
Serviceability. The right mix of joining technologies allows for efficient disassembly for future repairs.

Connections. The electrical connections need to be reliable and robust to avoid loss of performance.

Weight. Decreasing the total weight means gaining a higher energy efficiency, Therefore a higher range on a single charge.

Step by step to the perfect result

When it comes to battery assembly, our innovative joining technologies take action. Take a look at this showcase of what a complete solution from Atlas Copco could look like:



1. Cell to cell assembly
2. Module assembly
3. Gap filler application
4. Mounting of modules
5. Cover sealing
6. Cover to tray joining

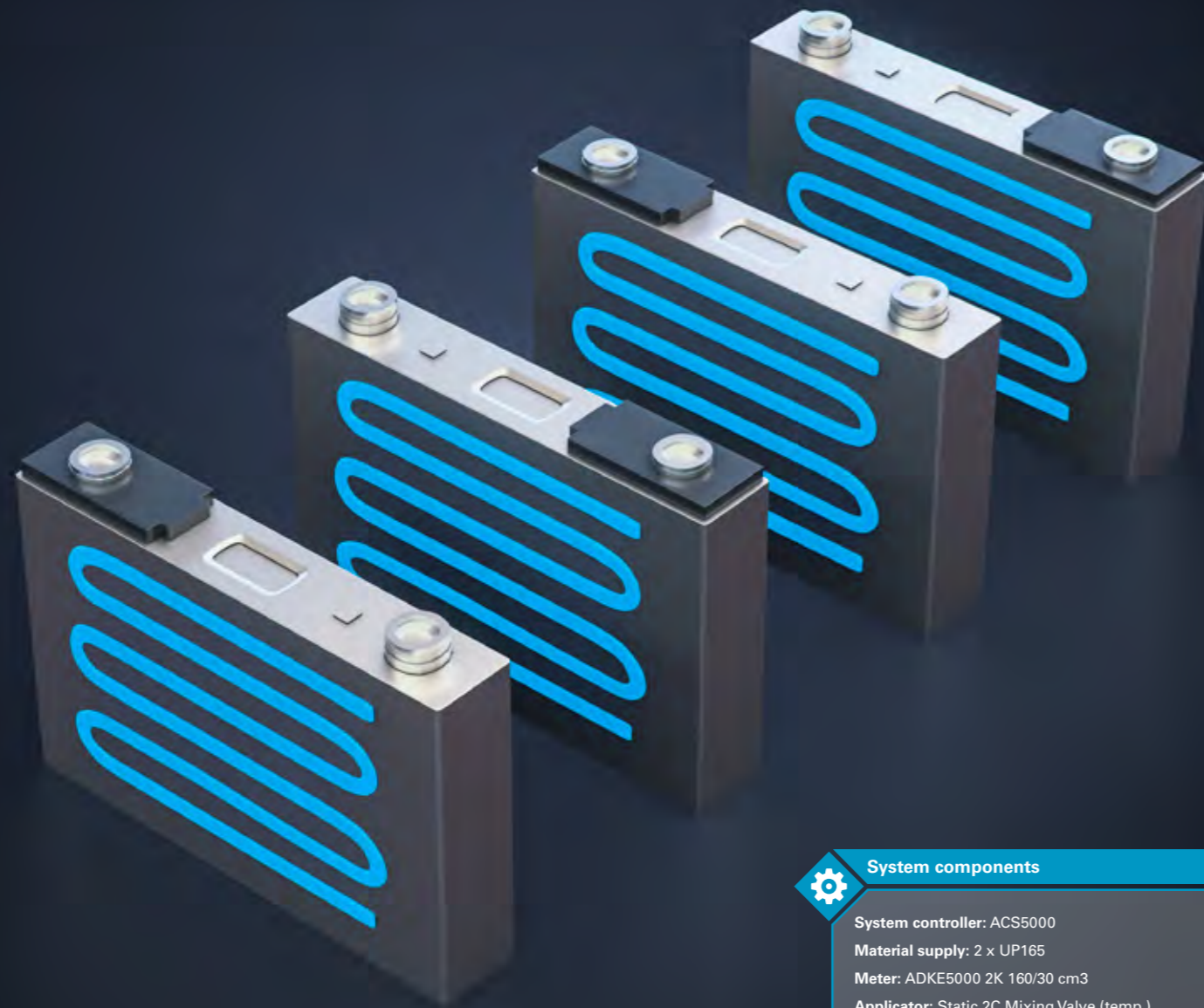
Challenges

Solutions

- | | |
|---|--|
| <p>① → Cells need to be stacked reliably to deliver power – a huge challenge with these sensitive cells. All while keeping productivity as high as possible.</p> | <p>Our SCA dispensing solutions handle 2C bonding and applications with high speed while ensuring a high process reliability. ✓</p> |
| <p>② → The cell modules need efficient joining and maximized crash performance at the same time.</p> | <p>Our Henrob self-pierce riveting solutions make sure that rivets reinforce the modules with a highly efficient joining process – flexible and non-intrusive. ✓</p> |
| <p>③ → Gap filler is crucial for effective thermal conductivity. However the filler material is expensive and very difficult to process.</p> | <p>SCA dispensing provides an extremely robust, precise, self-monitored gap filler application that saves material and quality costs. ✓</p> |
| <p>④ → The longevity of the battery stands and falls with the gapless contact between filler material and modules.</p> | <p>With our tightening solutions, we provide a clean, homogeneous and controlled joining process that can handle soft joints. ✓</p> |
| <p>⑤ → Humidity is a threat to safety and performance. This is just one of the reasons why the battery needs perfect isolation.</p> | <p>Our SCA solutions provide a well proven uninterrupted sealing application that boosts productivity and stands the test of time. ✓</p> |
| <p>⑥ → You only have one sided access for safe and firm final assembly of cover to tray joining. The tray needs to be easy to disassemble later on for servicing.</p> | <p>Our flow drill fastening technology ensures a fast and reliable joint entered from one side – yet enabling disassembly later on. ✓</p> |

High application speed and process reliability

Battery cells are the core of the complete battery. To provide the power that is required, prismatic cells need to be stacked. Therefore, you need precise adhesive bonding.

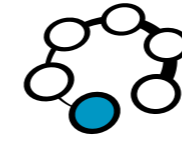


System components

- System controller: ACS5000
- Material supply: 2 x UP165
- Meter: ADKE5000 2K 160/30 cm3
- Applicator: Static 2C Mixing Valve (temp.)
- Material: 2C Polyurethane (Dow Betaforce 9050M)

Additional:

- Hybrid Peltier Conditioning System (PCS)
- RtVision.QT (Offline Vision System)



Step 1: Cell stack assembly with 2C bonding and quality monitoring

When stacking prismatic cells there are a lot of challenges. Battery cells are very temperature sensitive, so the joining process must not introduce heat. Furthermore, the cells must be fixed very quick and firmly, so they do not lose their position during further assembly or due to the vibrations of driving.

Bonding with 2 component material

For those reasons, 2C bonding is the optimal joining technology for this step. By using a 2-component material, no heat is needed for curing. This joining technology also increases stiffness and crash performance. The material is elastic, absorbs vibrations and improves the durability of the battery.

As lots of cells need to be stacked, uptime as well as fast dispensing is required – while keeping quality on a high level. With the SCA product line, Atlas Copco offers dispensing solutions that handle 2C applications with efficiency and constant quality. SCA solutions allow high application speed along with the high process reliability realized by features that perfect flow, pressure, temperature and mixing ratio.

Joining technology benefits

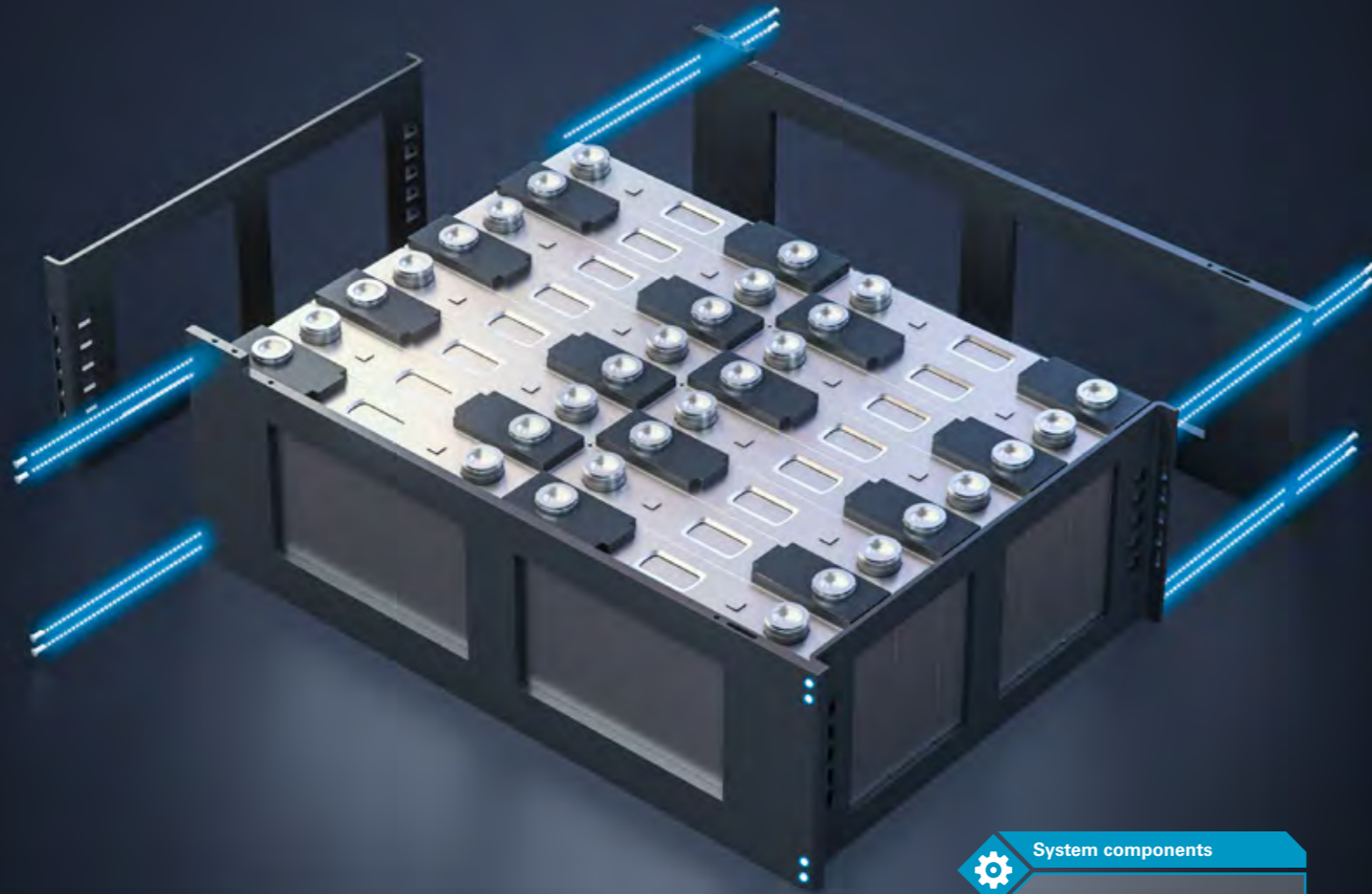
- Bonding provides area force which makes it the best method to minimize vibrations or loosening during operation
- No heat insertion to battery that might damage battery or change properties
- Quick curing fixes cells immediately – allows direct handling or further processing in production

Solution benefits

- High process reliability thanks to various software features allowing to perfectly adjust process parameters (flow, pressure, temperature, mixing ratio)
- High mixing quality based on
 - High metering accuracy
 - Competence in choosing best mixer appropriate to application
- Less purging thanks to perfect adjustment of dispensing process properties according to material properties
- High application speed (up to 250 mm/s)

Protective reinforcement of cell stacks

The reinforcement of the cell stacks is assembled by joining cover plates to braces. One of the favored joining technologies for this task is self-pierce riveting.



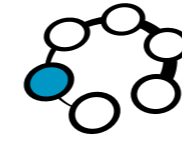
System components

System controller:
HenrobEco-controller

Feed: 4 Feeder Supply cubes with poka-yoke bottle supply

Setter: 85 kN

Additional: Henrob 7-die die changer, Henrob Rivware



Step 2: Module assembly with self-pierce riveting

The EV battery is an important part of the car, which is also prone to be damaged in the event of a crash. Therefore, the most vulnerable parts need to be reinforced to reduce the risk of damages and injuries.

Joining with self-pierce riveting

Joining the braces is done properly with self-pierce riveting. A joining method that doesn't introduce heat generates no harmful fumes and especially doesn't create welding splatter. A rivet is pushed through the material layers with a high force stroke, in short cycle times. The reinforcement structure can be made up of different materials

and material stacks – allowing for high freedom in design for safety.

With our Henrob product line, we offer highly reliable and productive solutions for self-pierce riveting. Rivet-joined batteries fulfill the high requirements in mechanical crash performance while being unintrusive to the vulnerable battery cells at short cycle times: No heat input, no harmful fumes and no welding splatter.

Joining technology benefits

- ❑ User-friendly and non-intrusive technology: no heat input, no harmful fumes, no welding splatter
- ❑ Freedom in design: joining of different materials, multi-layer stacks, coated or painted materials
- ❑ High crash performance through high structural stiffness and rigidity
- ❑ No preparation and rework of surfaces is required

Solution benefits

- ❑ Short cycle time due to fast rivet insertion and shortest rivet feeding time
- ❑ Highly flexible system that can handle four different types and lengths of one rivet diameter
- ❑ Efficient energy use with only 4 bar operating pressure
- ❑ Long term durability / Little maintenance due to robust system design
- ❑ Wide range of rivets available (geometries, dimensions, variants) for various applications

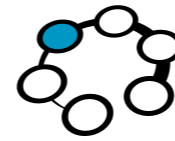
Effective thermal conductivity

To ensure that the cells operate in their optimal temperature range, a thermal conduction layer is applied to the cooling device.



System components

- System controller: SYS6000
- Material supply: UP1200
- Meter: ADKE6000 470 cm³
- Applicator: AK700 heated
- Material: Gap filler (Polytec VP 2106-408)
- Additional: Vision 3DVision.SC, Vision RtVision.T



Step 3: Gap filler application with in-line quality monitoring

A battery is only as safe and performant as its thermal management enables it to be. To ensure the effective thermal transfer the thermal conduction paste, which typically contains filler particles – needs to be placed with high precision in an optimized pattern, avoiding any air pockets.

Volume, position and continuity

The thermal conductivity and the longevity of the battery is achieved by closely monitoring the dispensed adhesive in volume, position and continuity during application (in-line). As high volumes of abrasive material are being used, the process demands tools that are optimized for a long service life, keeping uptime high and the need for servicing at a minimum.

With the SCA product line, Atlas Copco has solutions that ensure precision and productivity of the application process. In this case, by choosing the right pumping and metering components, you can reach low cycle times and a high throughput.

Quality control during application

An inspection system allows you to gain continuous quality control. Vision Systems RtVision.t and 3DVision.SC, are completely integrated into the production process detecting dispensing errors in width, continuity and position during the application. This effectively reduces quality costs while maintaining high productivity. It doesn't add cycle time and it allows for a fast reaction to any irregularities.

Joining technology benefits

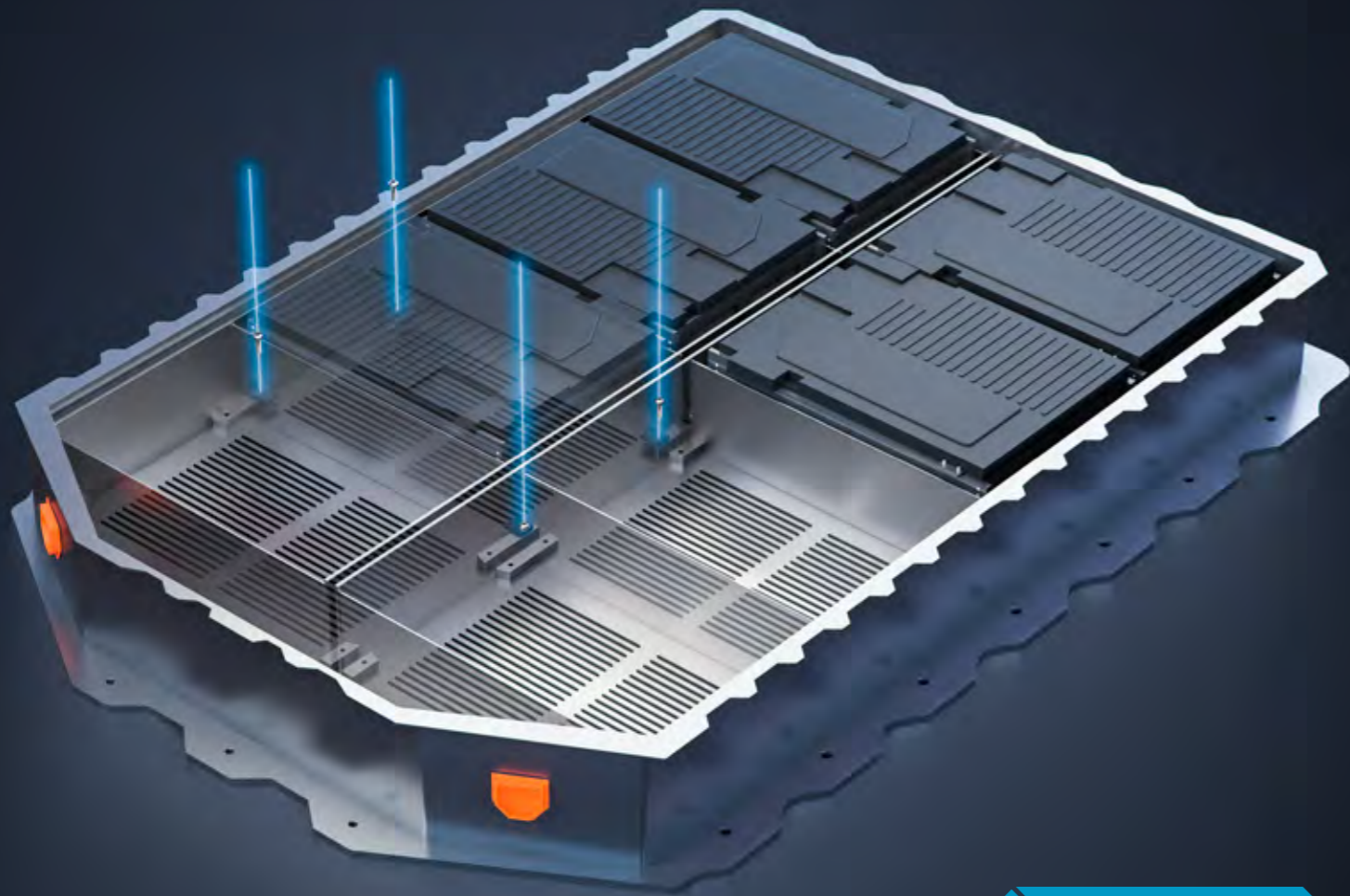
- Effective thermal conductivity for battery cells to ensure performance
- Short cycle time and less labor cost due to automated application

Solution benefits

- Highest uptime while handling abrasive materials through high-durability components
- Low cycle times with high volume applications
- Low quality cost with in-process quality monitoring
- Lower total cost of ownership and running cost compared to prefabricated mats

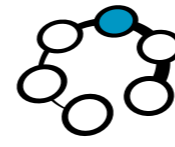
Clean, precise and easy to service

Thermal conduction is highly important for safety and performance of the battery. This is why a close contact between the battery module and gap filler is crucial.



System components

- Controller: PF 6 FlexSystem
- Joining tool: 4 x QST42-20CT
- Fastener: M6 x 20
- Materials: Aluminum + Steel



Step 4: Mounting of modules into tray

In battery production, it is crucial to keep a close contact between the battery module and the gap filler. Tightening is the preferred technology to mount battery modules as it allows for the soft joint behavior of the gap filler material, ensuring the best contact.

Simultaneous tightening

During mounting it is important not to introduce heat or contaminate the tray. Furthermore, the construction

needs to be reversible to allow service. Atlas Copco offers a multi-spindle solution that is well proven and ensures that you can tighten all bolts simultaneously and reduces cycle times.

Joining technology benefits

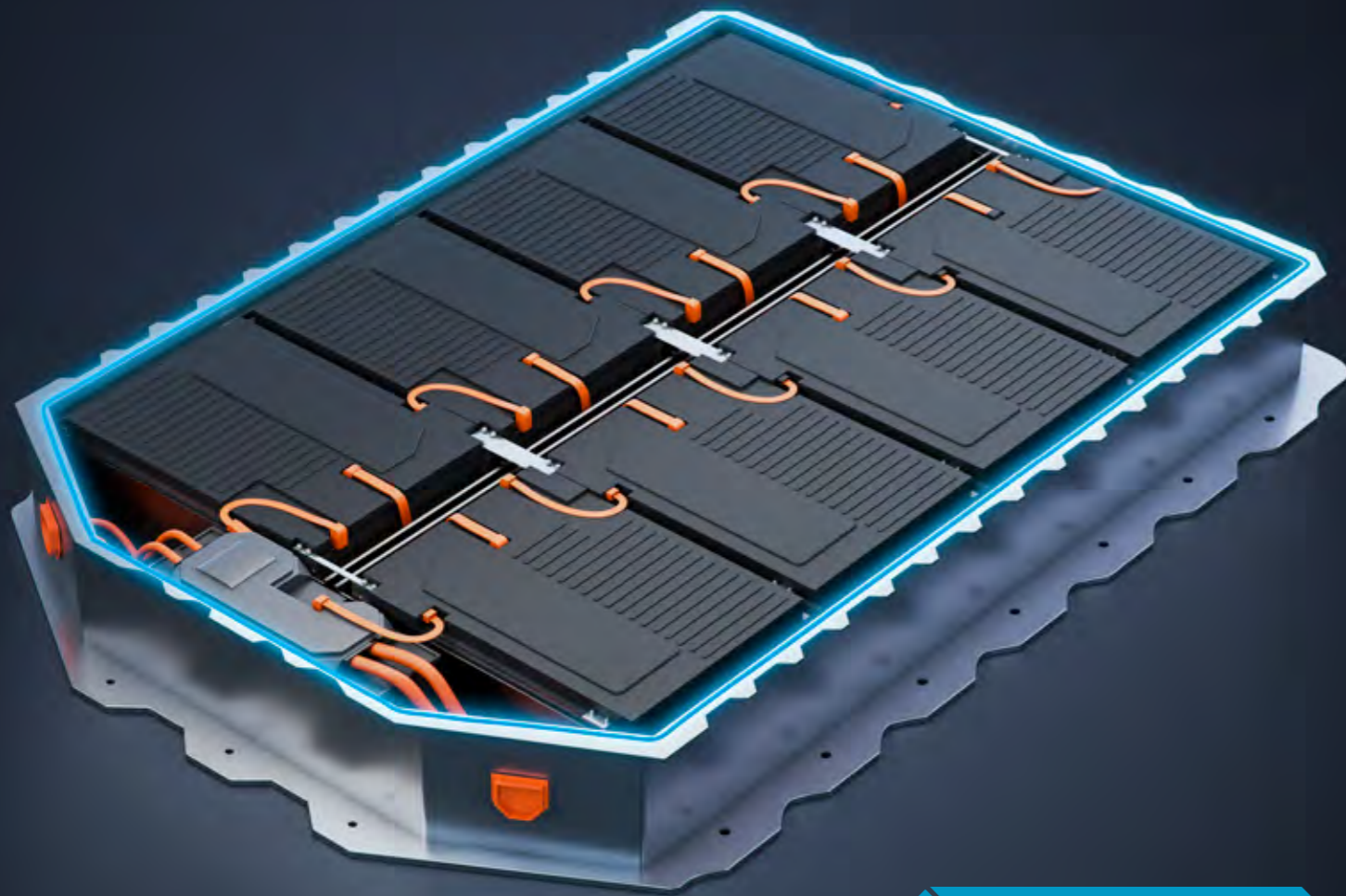
- Ability to handle soft joints
- High serviceability – easy to disassemble
- Only one-sided access needed
- Joining different materials and material thickness

Solution benefits

- Consistent and homogeneous tightening
- New controller weighs 88% less and needs up to 97% less space
- Documentation of tightening results

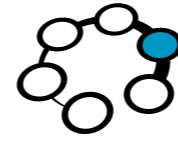
Protecting from humidity and gases

Protecting batteries from humidity is crucial. In addition, we need to prevent emission of harmful gases. A challenge that needs our attention.



System components

- System controller: SYS6000
- Material supply: UP301
- Meter: ADKE 6000 160 cm³ (180°C)
- Applicator: AK 313
- Material: Hot butyl (Henkel Teroson RB 81VA)



Step 5: Cover sealing

Entry of humidity dramatically decreases the performance of the battery and could lead to damage and corrosion as well as emitting gases that are a health hazard. This demands a solution that provides total isolation, both to the inside and the outside.

High performance liquid gasket

With years of experience and expertise in high performance adhesive dispensing technology, Atlas Copco with the SCA product line, offers automated sealing applications for the battery assembly process. Before mounting the cover to the

assembled tray, a liquid gasket is applied in a very fast, precise and uninterrupted application. This sealing can be applied either on the tray or on the cover. As the assembled battery pack must not be exposed to any heating process, typical materials are 1C Hot Butyl, 2C Polyurethane or 2C Silicon. The gasket does not need to cure in the oven.

Joining technology benefits

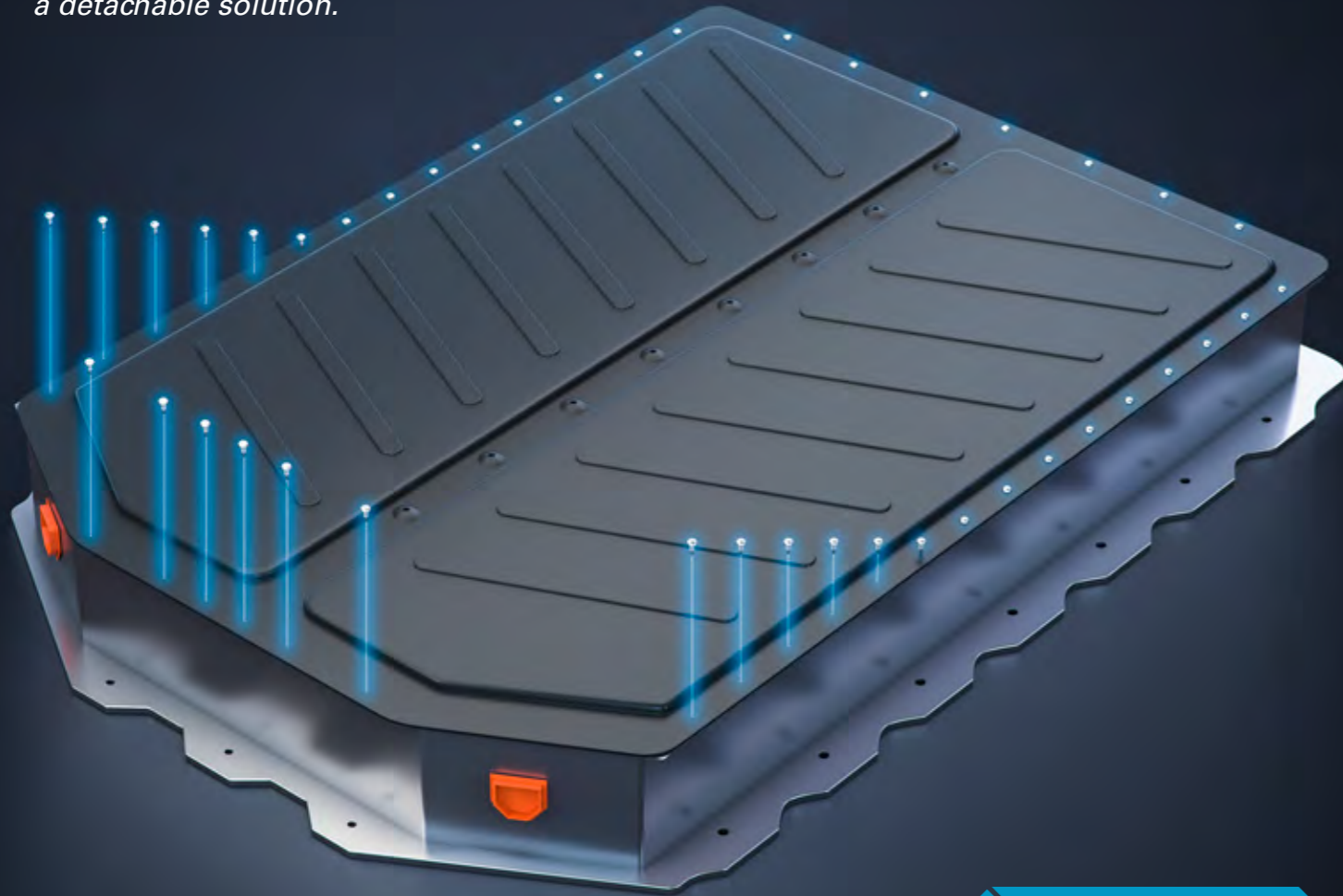
- Reliable prevention against entry and leakage of humidity and gas
- Automatic application
- Highly flexible application

Solution benefits

- Reliable and validated SCA automatic dispensing technology
- Uninterrupted application of beads
- High application speed for short cycle times

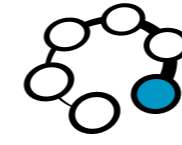
Serviceability drives sustainability

The easier it is to repair and disassemble the battery pack, the more sustainable the electric vehicle becomes. In this showcase production we assemble the cover tray with a detachable solution.



System components

Controller: Genius FLS
Joining tool: Robot-based tightening system KFLOWT20 (20Nm)
Fastener: Arnold Flowform
Materials: Aluminum (EN AW-6060) & Steel (HX220)



Step 6: Joining cover to tray with flow drill screws

When the inner parts of the battery are assembled, the lid needs to be fastened to the tray. Therefore you need a joining technology, that offers one side accessibility. Furthermore, access to the modules and electric components might be required. A detachable solution should always be favored.

Flow drill fastening

One joining method which ensures a reliable joint entered from one side, yet enabling disassembly later

on, is the flow drill fastening technology. With flow drill fastening you achieve fast rotation of the fastener, combined with high pressure to the cover sheet. This makes sure that the material heats up locally – just enough to become soft, allowing the fastener to push through the material stack, cutting the thread in the process. This joining technology also means a reduced electromagnetic interference risk – together with the fasteners, the cover and tray build a Faraday cage.

Joining technology benefits

- High serviceability – easy to disassemble
- No surface preparation needed
- Cold (compared to spot welding)
- Multi-material design and multi-material stacks possible

Solution benefits

- Short cycle times due to two independent strokes (down hold stroke and main stroke)
- Long-term durability based on best alignment of screw head and K-Flow system
- Easy to integrate into customer networks, i.e. central control center
- Immediate feedback on the joining application due to the large mobile touch panel
- Best selection of fasteners with K-Lab and immediate integration of test results into controller

Smart Connected Assembly

Bringing Industry 4.0 to life

New challenges are emerging, and new benefits of Smart Connected Assembly are arising. This evolution of the assembly process is driven by Industry 4.0 –the fourth industrial revolution: digitalization of manufacturing and assembly.

Discover the six pillars of value

The potential value of the benefits with Industry 4.0 are summarized in a framework we call “the six pillars of value.” They are all about improving quality, increasing up-time and productivity, and reducing the use of energy and costs. All achieved by smart integrated products and software solutions and a data driven approach.



Increased uptime: Data driven predictive maintenance is determined by the actual condition of the equipment. Thanks to the dramatically improved data analytics capability and the sophisticated maintenance models, repair can be scheduled at a time that minimizes the impact on production.



Human Interaction: The operator guidance application visualizes all process steps and data to direct the operator through the assembly process. When introducing a new model or changing the assembly process – there is a reduced amount of operator training required.



Reduction in defects: By integrating applications for part verification and documentation, such as operator guidance and pick-to-light solutions, you can achieve a significant reduction in defects and rework.



Product introduction cost: The use of virtual stations makes it easy to add new products to your existing layout without re-allocating or commissioning of new hardware.



Improved productivity: Problems are identified and rectified by systematical and regular check of the most frequent “not OK” applications – analyzing the trace information, speed and windows.



Reduction in energy use: Multiple wireless tools running on one virtual assembly process controller leads to a significant reduction in energy use.

We call it Smart Connected Assembly.

Product Design

Design for premium product experience

Truly understanding customer needs is the only way we succeed in designing products that meet highest demands in productivity and ergonomics in body and mind.

Atlas Copco has been listed as one of the world's 50 most innovative companies on Forbes list. The design language of our products and software is developed to work in a complex industrial environment. It reflects the innovative customer solutions developed from extensive user research and understanding true customer needs.





Committed to Sustainable Productivity

www.atlascopco.com

Atlas Copco