

FRIWO

FRIWO

Company profile

2021

Agenda

1. About FRIWO
2. Vision & Mission
3. Value Proposition
4. Innovation
5. Our range of services
6. FRIWO manufacturing facilities
7. Portfolio highlights
8. References
9. Use Cases

01

About FRIWO

FRIWO at a glance - 50 years of success in the market

4 locations

Headquarters: Ostbevern (DE)

Vietnam, India, China

99,4 €

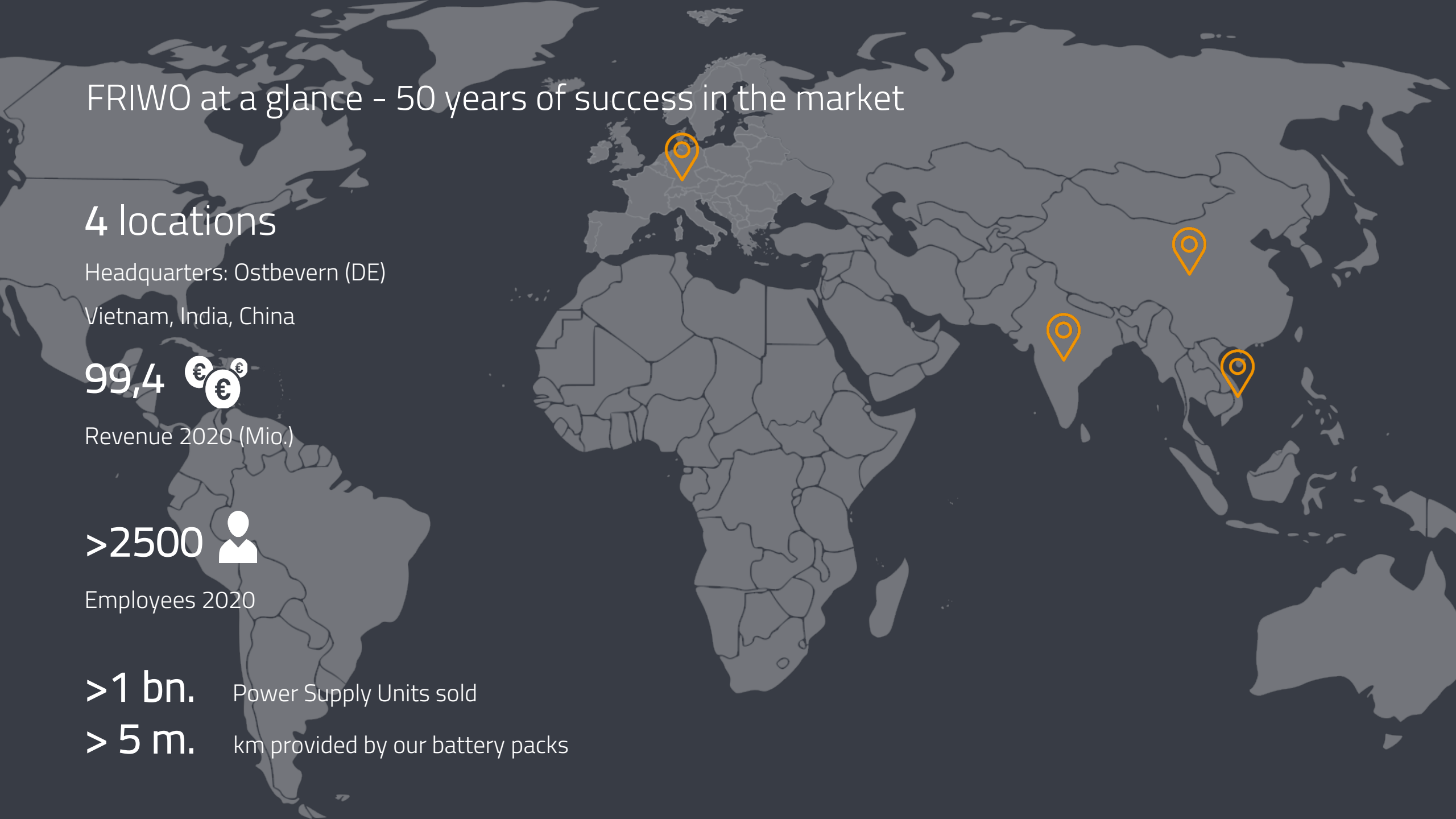
Revenue 2020 (Mio.)

>2500

Employees 2020

>1 bn. Power Supply Units sold

> 5 m. km provided by our battery packs



The FRIWO AG

International system provider with **worldwide** manufacturing facilities

Development and **production** of digitally controllable power supply and drive solutions for future-oriented industries such as medical technology, mobile tool technology, industrial applications or electromobility

The **product portfolio** includes platform products and **OEM** solutions, as well as **technologically leading chargers, battery packs and power supplies**, and **intelligent components** for **electric drive trains**

The **range of solutions** extends from the display to the motor control and the drive unit to the control software

Modern manufacturing and production cost advantages

- Production in three state-of-the-art manufacturing facilities in Vietnam
- Production for smaller series and prototypes at the company headquarters in Ostbevern, Germany

50 years of success in the market

- 50 years of experience stand for innovation, safety, quality and efficiency worldwide.

The company is certified according to:

- DIN ISO 9001 (quality management)
- DIN ISO 14001 (environmental management)
- DIN ISO 13485 (quality management for medical devices)

02

FRIWO Vision & Mission



FRIWO Vision & Mission

Vision

"Our passion is what fuels us in our bid to become the most recognized company in the industry."

Mission

"FRIWO is the first choice when it comes to sophisticated and innovative power supply solutions."

FRIWO

03

FRIWO Value Proposition



FRIWO Value Proposition

We want to use our products and services to supply our customers' applications with the necessary power and also give their products that little bit extra every day.

To meet this promise, we stand by our four core competencies: reliable premium quality, absolute customer orientation, smart intelligence, and innovative strength.

04

FRIWO Innovation



High-Tech provider with a global footprint

Implementation of the innovation focus within FRIWO's long-term strategy by:

- Establishment of a pre-development department at the innovation site in Dresden.
- Early introduction of new technology standards in prototyping
- Application of innovation methods to standard portfolio and customer products
- Establishment of a regular knowledge exchange with academic institutions on technology trends and other future topics

05

The company today: Our range of services



Our product portfolio

Power supply systems

- Power Supplies
- Chargers
- Battery Packs
- LED Drivers

EMS (Electronic Manufacturing Services)

- THT assembly
- SMD assembly
- Test engineering (SPI, AOI, ICT, Function)
- Boxbuilding

Drive systems

- Motor Controls
- Service Software
- Drive Units
- Vehicle Control Units
- Displays
- Chargers
- Battery Packs

Our T.I.M.E.-markets:



Tools & Garden

Shortest possible charging times
for constant availability



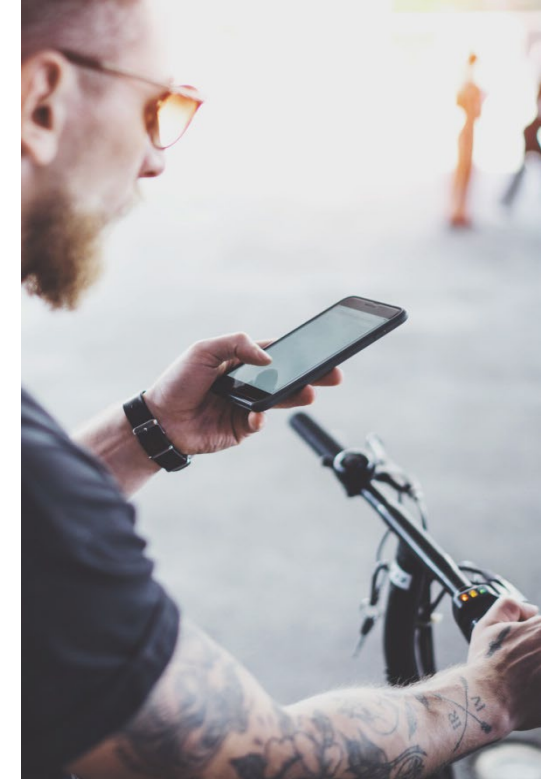
Industrial

Outstanding performance in the
most challenging environments



Medical

Complete security of supply
for critical applications



E-Mobility

Innovative power supply units and
drive systems for limitless mobility

These clients trust in FRIWO



4 of the 5 largest manufacturers of robotic lawn mowers and power tools

2 of the 5 largest manufacturers of professional garden tools

TOP 3 of the largest manufacturers for hedge trimmers



2 of the 5 largest manufacturers of gate operators

3 of the 5 largest manufacturers of home automation

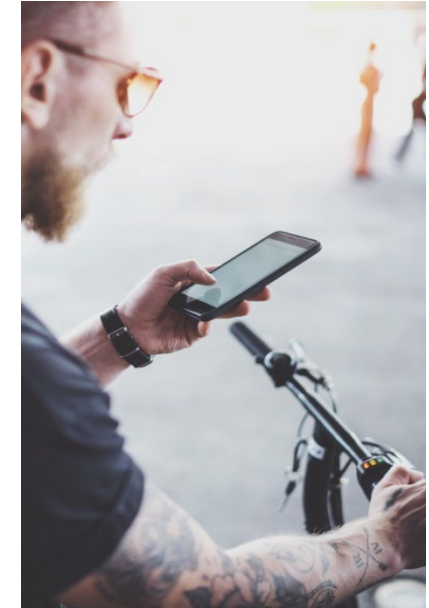
3 of the 5 largest manufacturers of Automation technology



3 of the 10 largest manufacturers of Medical technology

2 of the 5 largest manufacturers of infusion pumps

2 of the 5 largest manufacturers of inhalers



5 of the 10 largest manufacturers of E-Bike drive systems



Electronic Manufacturing Services (EMS)

Full service from a single source

As an experienced EMS service provider, we offer end-to-end contract manufacturing of electronic assemblies and equipment. You provide technical documentation, such as component lists and drawings, and we do the rest – supplying everything you need from a single source.

Your advantages:

- You can concentrate on your core competencies (synergy effect).
- You obtain additional capacities and thus avoid capacity bottlenecks or capacity overhangs.
- Reduction of entrepreneurial risk and the need to invest in new technologies due to state-of-the-art equipment and manufacturing standards.




Original Equipment Manufacturer (OEM) All first hand

From scope and specification to prototyping, testing and customizing your product – with our years of experience as an OEM service provider in a wide range of industries and our leading know-how, we reliably stand by your side as an expert in customized power supplies throughout the entire order!

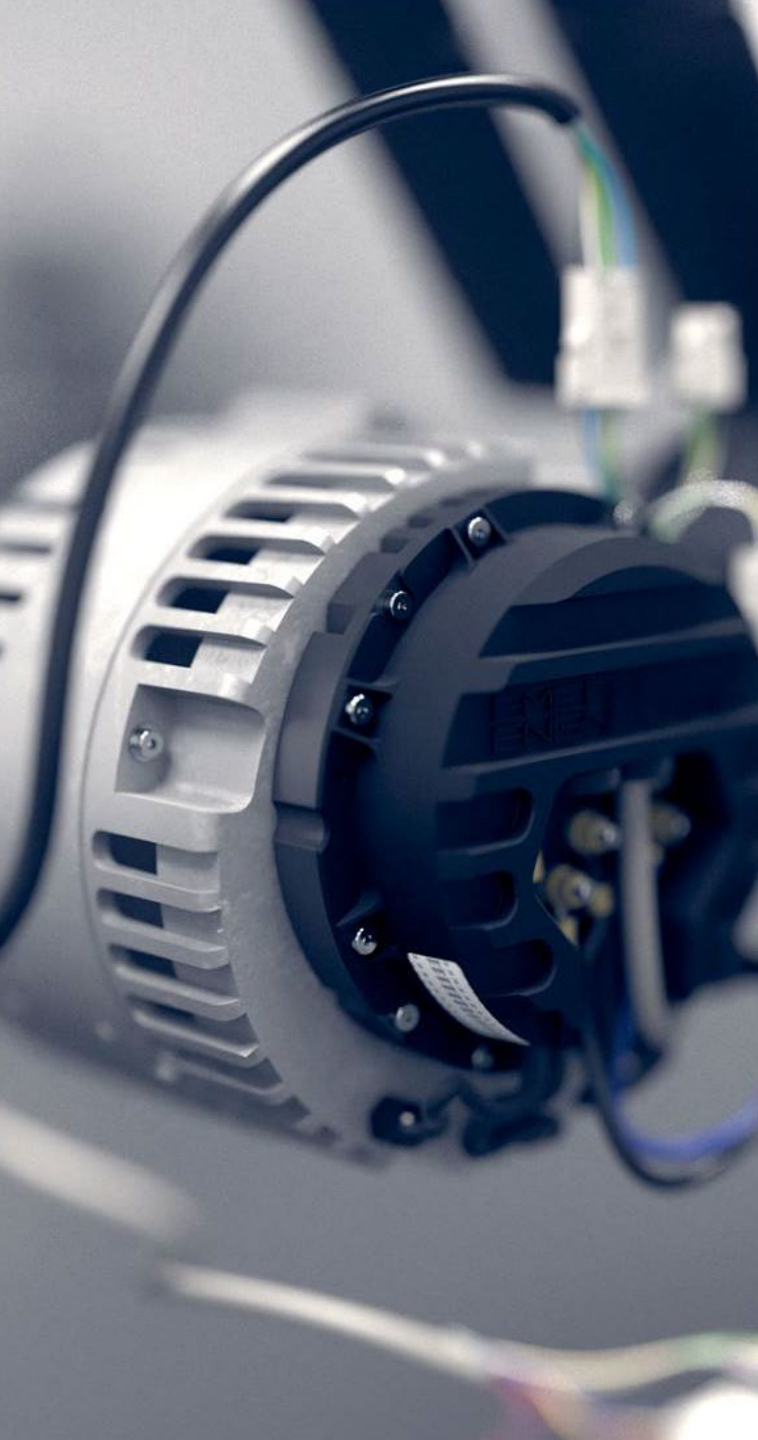
Your advantages:

- You will get electronics, mechanics and software from a single source! FRIWO has many years of expertise in all these areas.
- German contact persons and our own in-house development guarantee close coordination throughout the entire order process.



Our development know-how: Power supply systems

- Highly efficient power supply solutions with up to 1,000 W power output
- Microcontroller operated charging systems with up to 500 W output power
- Medical technology solutions with $\sim 0 \mu\text{A}$ leakage current
- CAN-Bus (Communication interfaces)
- IPX protection classes (depending on requirement environment, e.g. IP67)
- Efficient circuit concepts for highest efficiencies
- Use of ICs for protection against product piracy



Our development know-how: Drive system solutions

- Solutions for 48 V drive systems with up to 12 kW power output
- Modular system for individual electrification of drive units
- Highly efficient control algorithms for hybrid synchronous machines
- State-of-the-art communication interfaces
- Robust solutions for continuous outdoor use under all climatic conditions



“Quality first”

- In-house FRIWO laboratory
- In-house approval department
- State-of-the-art development instruments
 - EMC-Cabin
 - 3D prototyping
 - X-ray inspection
 - Drip water test
 - Climatic test
 - Drop test
 - Tensile test
 - Vibration test
 - DFMEA

06

Our manufacturing facilities: The best of both worlds

Ostbevern: Modern research and development center and manufacturing "made in Germany"

FRIMO

FRIMO



FRIWO Germany

- Focus on flexible production of power supplies and chargers with smaller quantities
- Production center for battery packs
- Modern production facilities with the highest level of automation
- Last minute assembly of standard products:
Shortest delivery times for European customers
- Certifications according to ISO 9001, ISO 13485 and ISO 14001

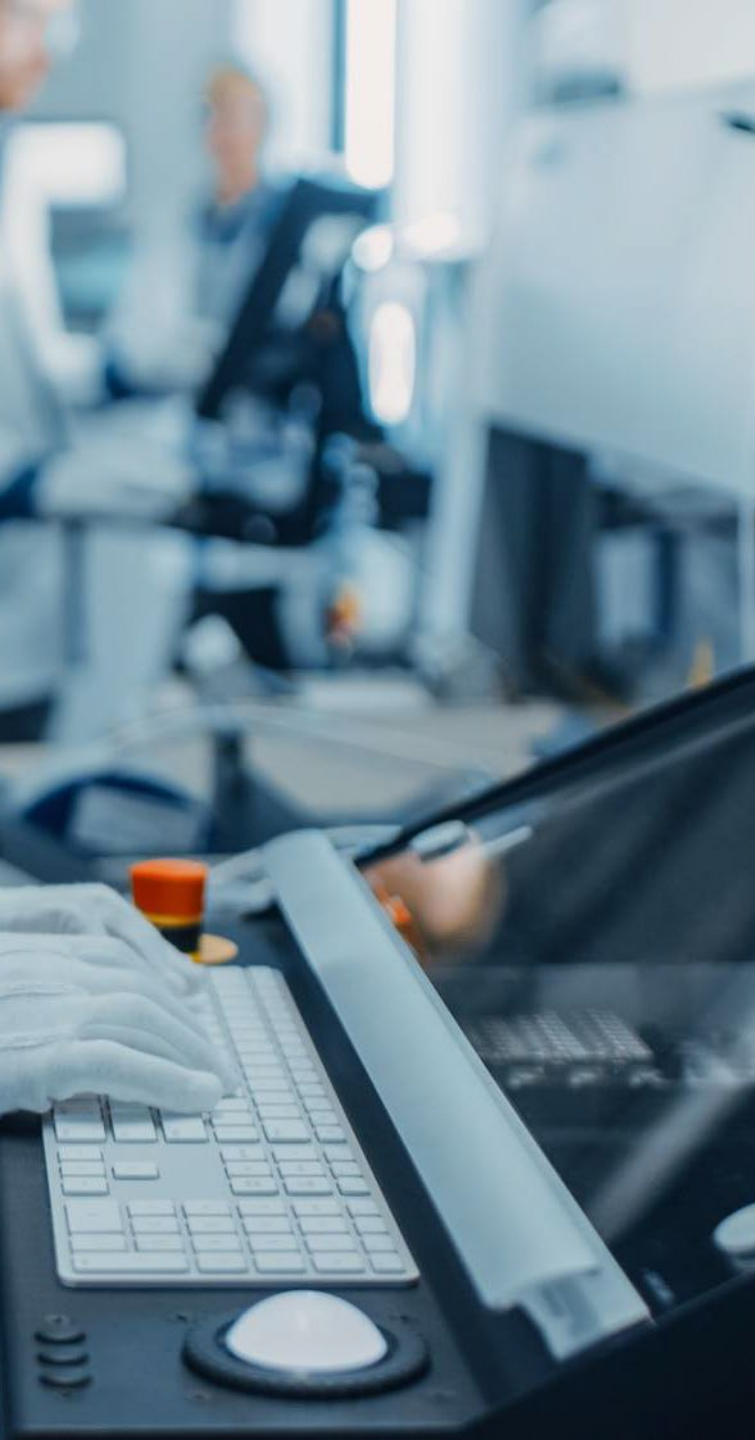
Dong Nai: European manufacturing know-how meets attractive
production conditions in Asia





FRIWO Vietnam

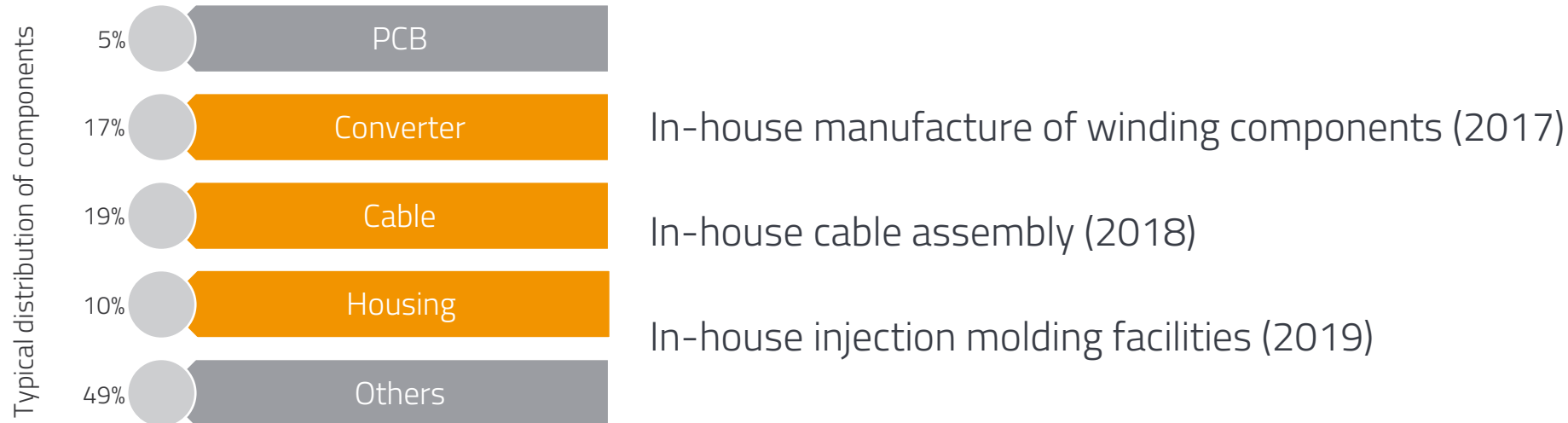
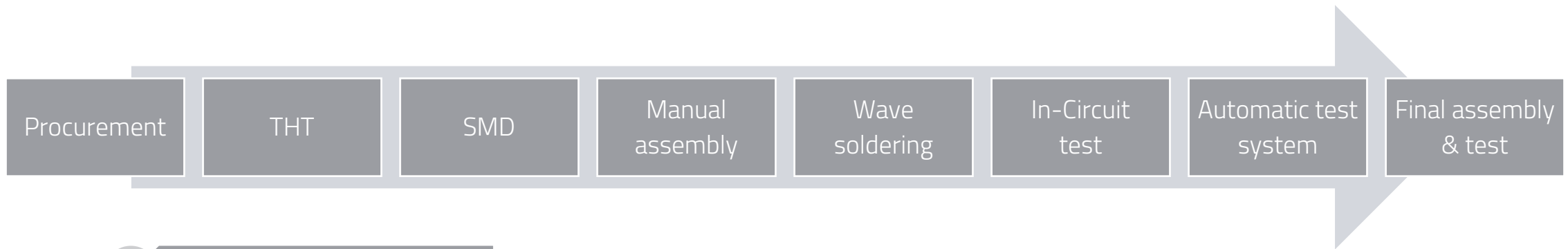
- Competence center for the production of complex chargers and power supplies
- Focus on the production of higher volumes
- Production according to European standards under German management
- Modern quality department on site
- Own training center for employees
- Certifications according to SA 8000, ISO 9001 and ISO 14001



Highest quality standards thanks to European equipment

- Modern nitrogen wave soldering machines from German manufacturer
- Own nitrogen generator and air compressor from German manufacturer
- Fully automatic painting system
- Potting of assemblies
- Full temperature and humidity control in warehouse and production
- ESD floors in the whole production
- High level of value added in the areas of winding goods, injection molding and cable assembly

Vertical integration in Vietnam: Maximum security of supply and highest quality control



Our manufacturing facilities in Vietnam

Plant I

- Production of power supplies and chargers
- THT & SMD
- Competence center for wave soldering
- Total area 10.827 m²
 - Production 3.000 m²
 - Warehouse 1.000 m²
 - Office 1.025 m²
- Available production hours per month: *
 - Single shift system: 140.000 h
 - Two shift system : 270.000 h

Plant II

- Production of transformers, chokes and coils
- Total area 7.500 m²
 - Production 5.000 m²
 - Warehouse 1.000 m²
 - Office 400 m²
- Available production hours per month: *
 - Single shift system: 180.000 h
 - Two shift system : 320.000 h

* Maximum possible hours in case all lines are installed and set-up

Plant III

- Production of DC cables and wires
- Production of housings and plastic bobbins
- Warehouse for raw materials and finished products
- Total area 11.000 m²
 - Production 3.200 m²
 - Warehouse 4.000 m²
 - Office 400 m²
- Available production hours per month: *
 - Single shift system: 100.000 h
 - Two shift system: 170.000 h

07

Extract:

Current portfolio highlights

Design meets technology: FOX**NEO**
A standard product that sets new standards



FOXNEO

- Flexibility thanks to high configurability
- Unique design
- Wide range of interchangeable adapters
- Conformity:
 - EN/IEC 62368-1
 - Medical 4th edition
 - VO EG 278/2009
- Customization by laser printing
- 3 years warranty





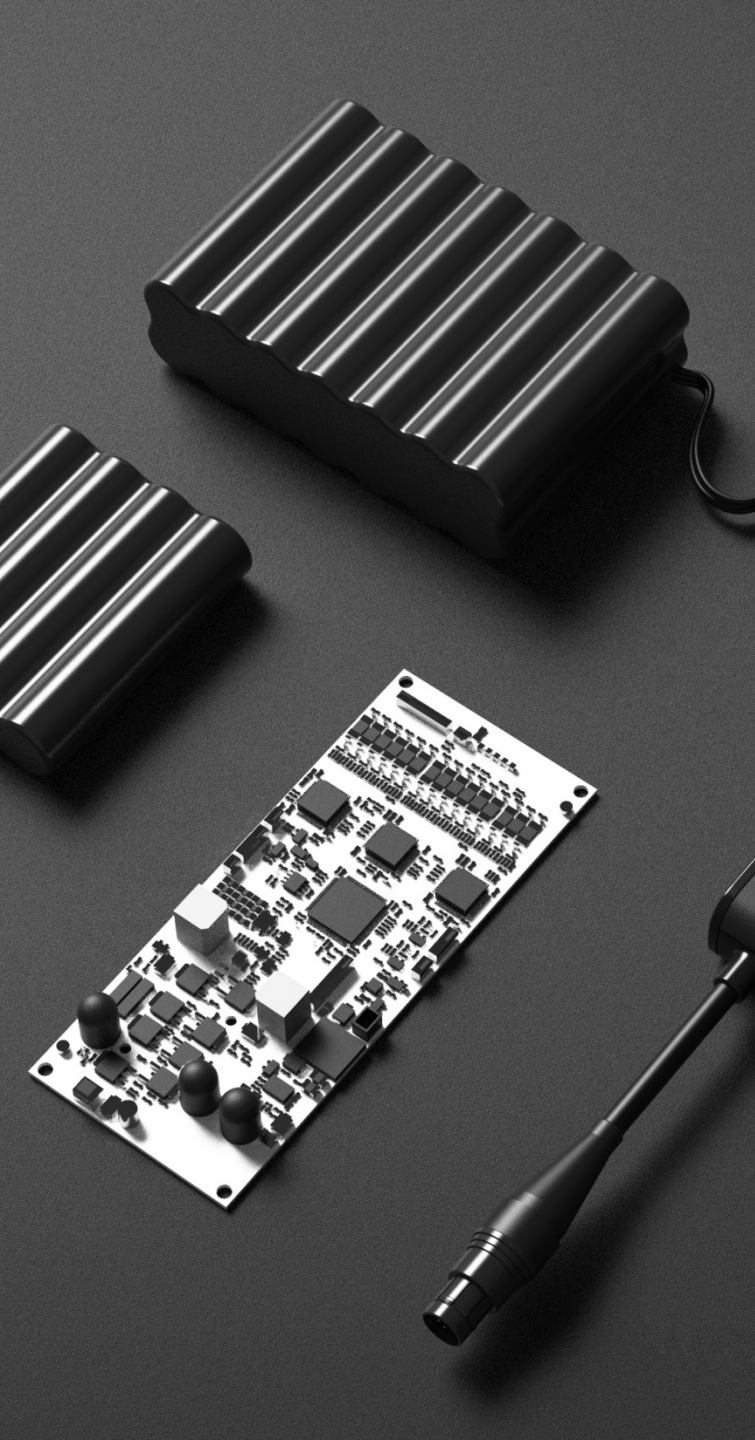
Li-Ion Charger LEV500

- Extremely quiet
- IP65
- Can be used as on-board device
- Device status via LED indication
- Customer-specific scalable (Customizing)
- Safety structure according to IEC60335-1, IEC60335-2-29
- Overvoltage protection & continuous short-circuit proof
- Unique, compact design

UP USB C 27W PD – the next UP USB Generation

- USB C PD power supply with up to 3A charging current
- Max. Output power 27W
- Qualcomm Quickcharge 4+ and latest PD standard
- AC Input Range 90-264VAC
- DC Output:
 - 5V3A
 - 9V3A
 - 12V2.25A
 - 15V1.8A
 - 5V_programmable (3.3-5.9V/3A),
 - 9V_programmable (3.3-9V/3A)
 - 9V-11V/CP_27W)





Battery Packs: Li-Ion technology for a wide range of applications

- Standard product portfolio from 1S1P to 13S3P
- Approval according to UN38.3
- Selected packs already approved to IEC62133
- SMBus interface
- Gas gauge function
- Available as "shrinking tube" variant in standard version
- Customer-specific extension of approval possible via in-house approval department and specific parameterization of Battery Packs



Compact E-Bike charger as perfect travel companion

- Shortest charging times thanks to high currents:
Two power classes available with 4 A or 6 A
- 5 V / 50 mA output for battery electronics
- Variety of communication options, e.g. CAN-Bus
- With PFC and resonant circuit
- Fanless design for noiseless charging
- Closed housing without any ventilation slots
- Surface temperature of max. 65°C
- Safety: integrated temperature protection, timer, current limiting

FRIWO Systems

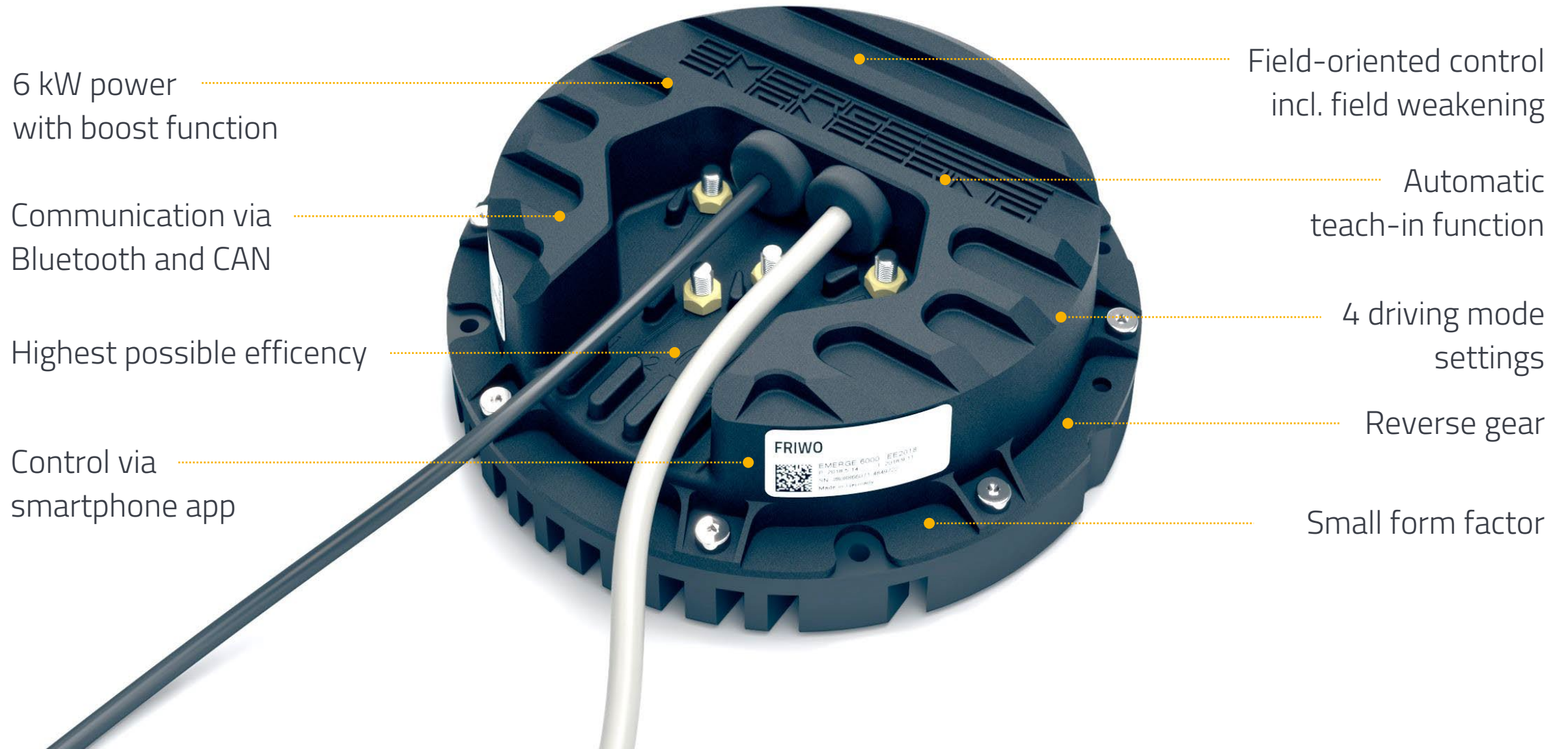
Digitally controllable
power supply and
drive system solutions
from one source

Example: E-Scooter

- 1 – Display
- 2 – Vehicle Control Unit
- 3 – Drive Unit
- 4 – Motor Controller
- 5 – Battery Pack
- 6 – Charger
- 7 – Service Software



Emerge 6000: best-in-class motor controller





Our standard Battery Pack in detail

- Samsung INR 18650 35E cells
- 14S/12P cell layout
- Nominal voltage 50.4 V
- Energy 2216 Wh
- Continuous current 50 A
- Peak current 65 A
- Standby < 0.1 mA
- CAN bus communication
- Diagnostic interfaces: USB, CAN



The alternative: Our High Power Pack

- Samsung INR 18650 30Q cells
- 14S/12P cell layout
- Nominal voltage 50.4 V
- Energy 2200 Wh
- Continuous current 140 A
- Peak current 180 A
- Standby < 0.1 mA
- CAN bus communication
- Diagnostic interfaces: USB, CAN

08

References



FRIWO Success Story – E-Mobility

E-Mobility startup Brekr combines smart design with radical E-Mobility innovation.

Goal: Developing of an sophisticated E-Mobility vehicle with the highest level of ride comfort.

Support by FRIWO:

Technical support in the design and development of an efficient powertrain (2,500 - 4,000 W)

Design of a powerful battery for maximum capacity (2.0 kWh Li-Ion)

Support for system integration

Optimization and adaptation of system components to the vehicle



FRIWO Success Story – E-Mobility

The Institute for Software Technology (IST) of the University of Technology in Graz researches methods for navigation in unstructured environments.

Goal: further development of robots for practical use in transport logistics.

Support by FRIWO:

Technical support in the design and development of an efficient drive train (2,500 - 4,000 watts)

Support for system integration and customer-specific software adaptations

Optimization and adaptation of system components to the vehicle

Holistic technical support of the development team

09

Use Cases



FRIWO Use Case – Tools

Innovative solution – Fast and effective work without losing time

Industry: Development, manufacturing and sales of engine driven equipment for forestry, gardening, landscaping & construction.

Customer Challenge: Development of a user-friendly solution to be able to charge as many battery packs as possible with one charger.



FRIWO Use Case – Tools

Innovative solution – Fast and effective work without losing time

FRIWO Product: Interaction of an existing charger of the customer (270 watt charger AL300) with a new development of the charging electronics of FRIWO.

Support by FRIWO: FRIWO developed a multi-charger that allows sequential charging of up to four battery packs. This multiple charger drew on many years of know-how in the field of FRIWO charging technology and at the same time implemented the customer's electronic components.

Customer Value: Despite a complex project, the customer has only FRIWO as a central contact and thus does not have to talk to different suppliers.



FRIWO Use Case – Tools

Customized Heart Supporting Device - Battery Pack & Charger

Industry: Medical technology

Customer Challenge: The customer is currently running its application on a power supply. Now they would like to convert the application to battery operation. For this they need batteries and a charging station. The charging station should have 4 bays. The battery comes in a sterilizable device.

Support by FRIWO: FRIWO offered and developed a complete solution for the customer. Charger and battery pack from one source.

Project Duration: The project duration was approx. 12 months.

FRIWO Use Case – Tools

Customized Heart Supporting Device - Battery Pack & Charger



Battery

- 4S1P Battery Pack
- 14,54V / 3500mAh
- IP 67 housing
- Gas pressure measurement with LED display
- Communication with SMBUS
- 2. protection with self-control protector
- Housing complies with ISO 10993- 5 (cytotoxicity requirements)
- Type approval: UN 38.3, EN62133, UL2054

Charger

- 4 separate chargers (one housing)
- Integrated power supply
- LED status display
- Type approval: EN60601-1-2





FRIWO Use Case – Tools

Desktop charger concept

Industry: Manufacturer of power tools in the construction, renovation and metal industry business segments. The company has a wide range of powerful tools for use in the toughest conditions.

Customer Challenge: Development of a "low-cost" 3-cell charger for optimal market development in Eastern Europe.

FRIWO Use Case – Tools

Desktop charger concept



FRIWO Product: New electrical and mechanical development in Vietnam.

Support by FRIWO: Originally, the product was to be implemented with a plug-in charger and a separate charging adapter. FRIWO presented a very good desktop charger concept, which is similar to the company's existing chargers.

Customer Value: The customer received a low-cost desktop charger that is compatible with the company's other charger systems in a very short development time.



FRIWO Use Case – Tools / E-Mobility

Industry: Premium E-bike manufacturer

Customer challenge: The customer was looking for a competent partner for the development and production of charger systems for its E-bike systems and for the parent company (largest European purchasing cooperative for the bicycle industry with own brands / trade brands such as Bulls, Pegasus, Hercules, Kettler).

FRIWO Use Case – Tools / E-Mobility



FRIWO Product: New electrical and mechanical development (independent housing design).

Support by FRIWO: FRIWO was able to present very good charger concepts for the use of Panasonic E-bike motors:

Fanless | Small design | Closed housing without ventilation slots | Very good energy efficiency.

Customer Value: FRIWO not only supplies this component, but also covers an entire system series with these chargers. With FRIWO as a competent and central contact at hand, the customer can save an otherwise time-consuming communication.



LED Power Supplies for Ovens & Stoves

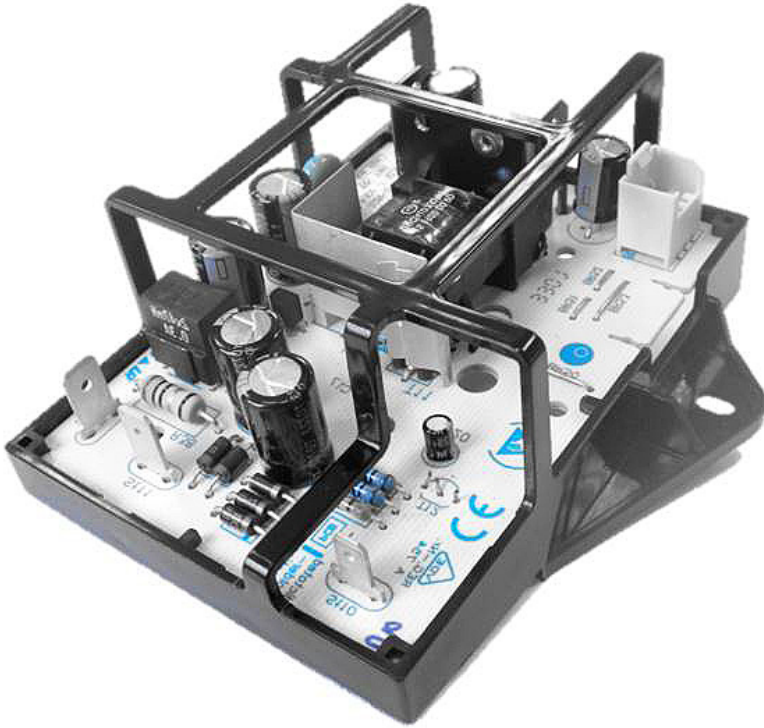
Industry: Household appliances / White goods

Customer Challenge: The customer was looking for a partner who could simulate the high temperature requirements for the product in operation and test it in the end application.

FRIWO Product: FRIWO developed a sophisticated manufacturing process, including inspection and test concept, to test the product within the production chain under extreme conditions (temperature oven).

Customer Value: FRIWO supplies the customer with a durable product that has already been tested under real conditions for use in the end application. This ensured the achievement of a high quality standard.

LED Power Supplies for Ovens & Stoves



- Input: Single range (162 to 264 VAC) or
Wide range (90 to 264 VAC)
- Models for 2 LEDs (Output: 8.5 VDC $\pm 5\%$ / 350 mA $\pm 5\%$)
or 3 LEDs (Output: 12 VDC $\pm 5\%$ / 350 mA $\pm 5\%$)
- Operating temperature +10° to +45° C
- High voltage test $\geq 3,75$ kVAC
- Power consumption in Stand-by $\leq 0,15$ W
- Leakage current ≤ 250 μ A
- Low voltage conformity: EN 60335-1, EN 60335-2-24
- EMC conformity: EN 55014-1, EN 55014-2



Technically leading high-end Power Supplies for laboratory equipment

Industry: Laboratory and Analysis Equipment

Customer Challenge: The customer was looking for a partner who could offer and promptly implement a technically demanding, customer-specific solution.

FRIWO Product: FRIWO developed a customized OF power supply with 700W power, multiple outputs and I²C bus.

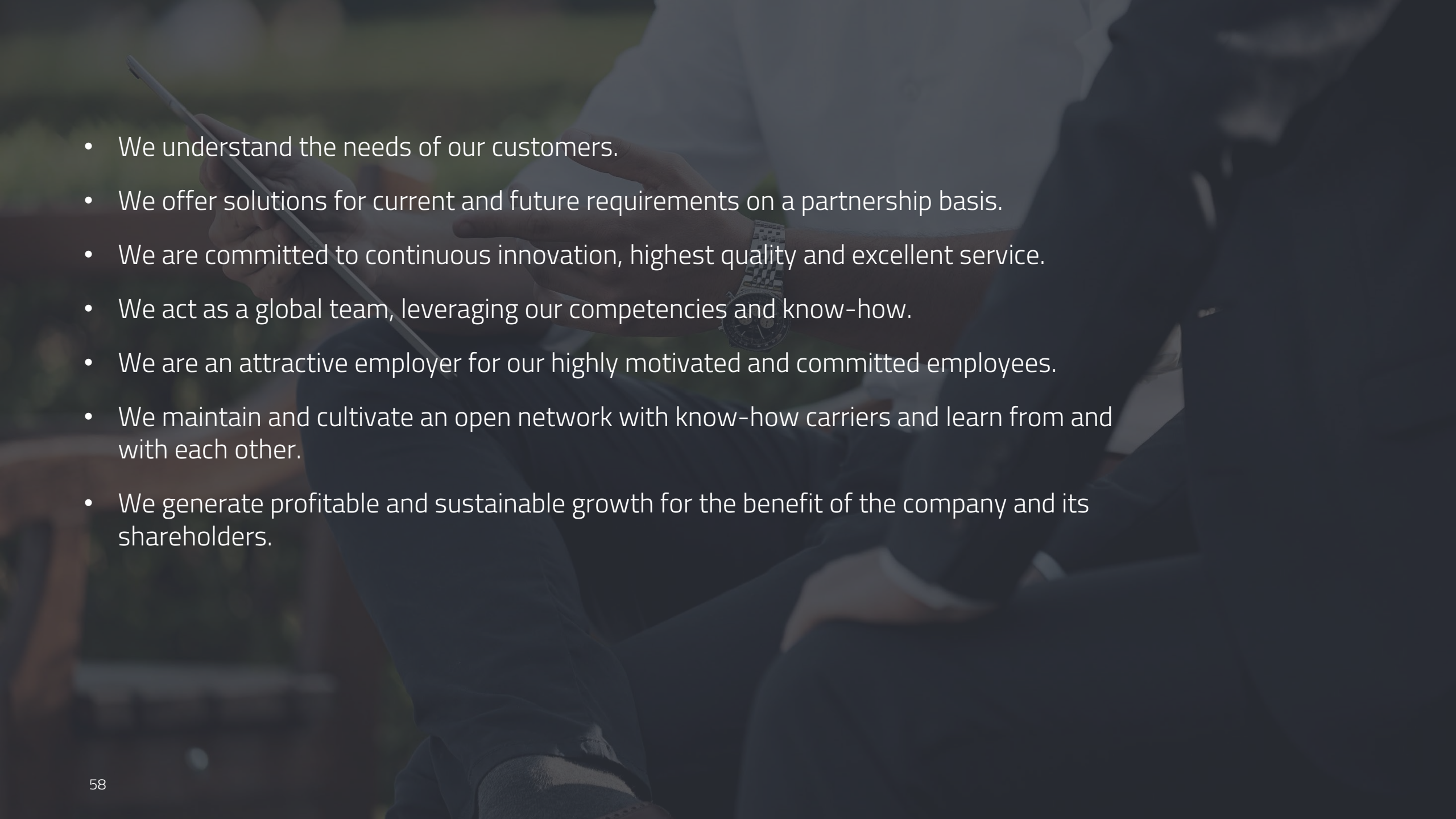
Customer Value: The closeness between the customer and FRIWO enabled a highly efficient implementation in terms of technical challenges and the timely execution of the project.

Technically leading high-end Power Supplies for laboratory equipment



- Protection class I
- 700 W OEM
- I²C bus communication
- MTBF 800.000h
- Multi-output up to 700W
- Approval for laboratory use - UL 61010-1
- PFC with leakage current < 500 μ A
- Efficiency 94,5%

Why FRIWO?

- 
- We understand the needs of our customers.
 - We offer solutions for current and future requirements on a partnership basis.
 - We are committed to continuous innovation, highest quality and excellent service.
 - We act as a global team, leveraging our competencies and know-how.
 - We are an attractive employer for our highly motivated and committed employees.
 - We maintain and cultivate an open network with know-how carriers and learn from and with each other.
 - We generate profitable and sustainable growth for the benefit of the company and its shareholders.

FRIWO

FRIWO Gerätebau GmbH
Von-Liebig-Straße 11
48346 Ostbevern
Germany
Tel +49 (0)2532/81-0
hello@friwo.com
www.friwo.com