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IMPULSE

A WHITE PAPER FROM VINCORION ON ENVIRONMENTAL PROTECTION AND MILITARY

WHAT YOU NEED TO KNOW ABOUT GREEN DEFENSE

Armed forces can increase their tactical advantages through environmental protection.
Part 2: Approaches to climate change mitigation in Europe, the UK and Germany.

Dr. Stefan Stenzel
Managing Director
at VINCORION

TAKING THE RIGHT PATH TO "GREEN DEFENCE"

Climate change is one of the most pressing challenges of our time and affects all areas of society. The defense sector is also faced with the challenge of making a contribution to combating climate change. In 2023, we published our first white paper on this topic, in which we discussed the basic underlying contexts and relationships.

In this paper, we now look at efforts at both the European and national level to make the defense sector more climate friendly. We examine the initiatives undertaken by the European Union and the approaches in countries such as the UK and Germany, which have both initiated important measures towards green defense.

When it comes to their practical implementation at the local level, industry innovations are absolutely essential. VINCORION believes it has a responsibility to make a contribution with its cutting-edge technologies. If we use technology wisely and focus on the requirements of our soldiers, we can even deliver additional tactical advantages for greater effectiveness in the missions of the future.

The progressive integration of environmental concerns and defense is a sign of the times.

The progressive integration of environmental concerns and defense is a sign of the times. Through technological innovations, pragmatic solutions, and a coordinated approach, we can go down this path without abandoning our values.

I hope you enjoy reading this report.
Dr. Stefan Stenzel

The European Union

THE GREEN TRANSFORMATION OF ARMED FORCES IN EUROPE

As a result of climate change, the European Union wants to make the defense sector "greener." Initiatives based on the latest studies and strategy papers reflect this trend. Within the framework of the European Green Deal, which aims to make Europe the first climate-neutral continent by 2050, the defense sector also plays a key role in the implementation of innovative measures.

The European Defence Fund (EDF) is funding investments in the research and development of sustainable technologies, which is driving a green transformation of the military while strengthening Europe's strategic autonomy and security. "We cannot choose either green or strong armed forces. We need strong and green at the same time," explained NATO Secretary-General Jens Stoltenberg.

In its study "Enhancing EU Military Capabilities beyond 2040," for example, the European Commission has set the goal of significantly reducing the greenhouse gas emissions of the armed forces by 2030 and 2050, but has not yet specified any concrete milestones. The research paper "Greening the Armies" from January 2024 emphasizes that the military sector has long been neglected in the debate on emissions reductions, but the urgent challenges of climate change require change in every sector. The study shows that the environmental transformation of the armed forces is not only possible, but can, in fact, also be beneficial in terms of defense capabilities.

It is important to emphasize, however, that the operational suitability of equipment is the top priority for military decision-makers, especially in view of the worsening security situation in Europe. The Council of the European Union has emphasized that climate targets must meet the "highest military standards without compromising operational readiness." Realistically, it must be noted that in view of limited budgets and the urgent need to improve defense capacities, only limited resources are available for an environmental transition. In addition, this development creates "asymmetric capabilities" – the EU is aware that competitors such as China and Russia will be less committed to the environmental transformation of their armies.

ENERGY EFFICIENCY AND ENVIRONMENTAL CHANGE

The European Defence Agency (EDA) is actively addressing the impact of climate change on European security and defense. Issues related to energy efficiency in military operations were discussed at an EDA conference in Malaga in November 2023, for example. During the conference, energy was highlighted as a strategic factor. A particular focus was on the "electrification of military transportation" and increasing energy efficiency in military buildings. These initiatives aim to reduce dependence on fossil fuels and cut operating costs while maintaining the operational readiness of the armed forces.

Recent geopolitical events demonstrate the importance of energy independence. The resilience of energy infrastructure, both military and civilian, was also a key topic of discussion. In an era of increasing cyber threats and physical hazards, ensuring that energy systems are robust and responsive is of paramount importance.

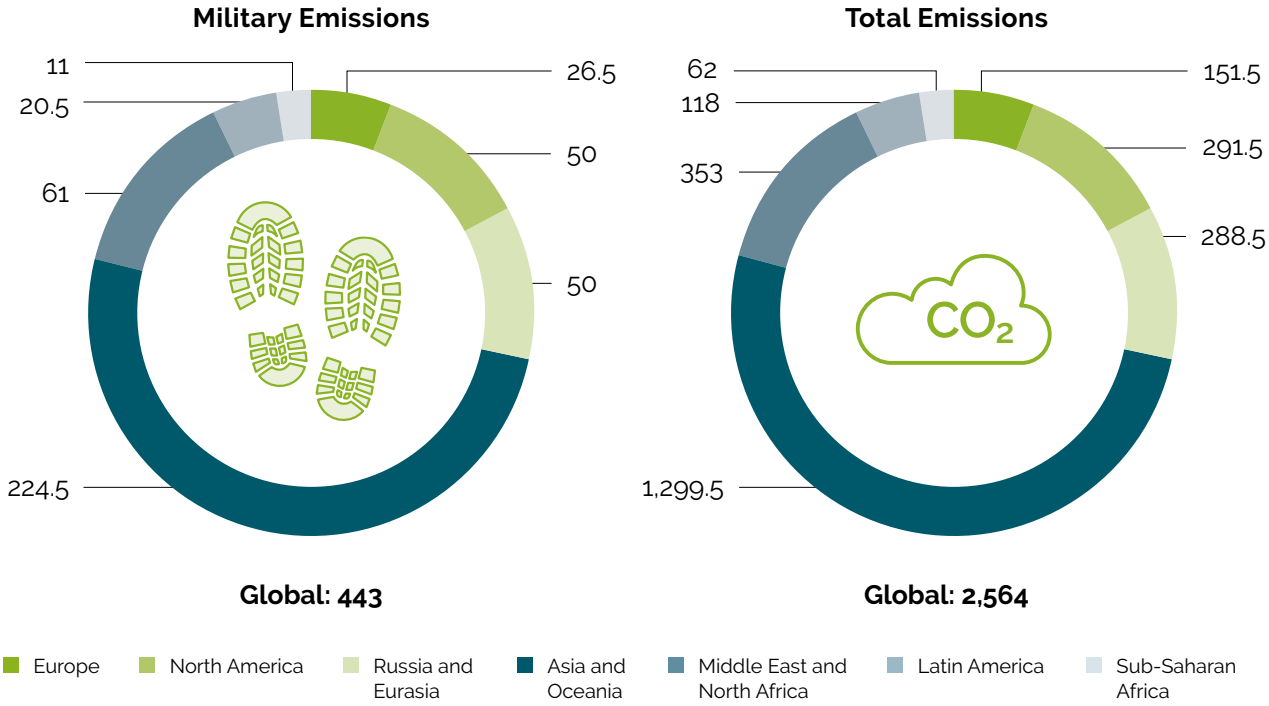
The integration of advanced energy storage technologies and alternative energy sources was deemed essential in order to compensate for fluctuations in renewable energies and guarantee a reliable energy supply. The EDA is also tackling the challenges posed by the high costs of infrastructure investment and wants to support innovative financing models.

The resilience of our energy infrastructure is significant.

For example, the EDA wants to promote industrial partnerships in which the defense industry makes joint investments with governments possible. Through these partnerships, the costs can be spread across several different stakeholders, which reduces the financial burden. In addition, the EDA also aims to support public-private partnerships (PPP). Furthermore, it is considering launching innovative financing instruments such as issuing bonds or using funds to close the financing gap.

Whether increased environmental awareness – coupled with digital technologies – will truly lead to a "significant change" in warfare by 2040, as predicted by the EDA, is likely to be the subject of debate.

THE MILITARY'S CARBON BOOTPRINT



Unit:

millions of tons of CO_2, these figures do not include carbon emissions from direct acts of war and reconstruction.

Source: Stuart Parkinson (Scientists for Global Responsiblity, SGR) and Linsey Cottrell (Conflict and Environment Obervatory, CEOBS); data represent averages of the highest and lowest estimates extrapolated for the world based on data collected from the United States, United Kingdom, and EU countries.

THE EU'S DEFENSE AND CLIMATE CHANGE STRATEGY

A study by the European Commission and the EDA found that the defense sector in the EU contributes significantly to greenhouse gas emissions.

In Europe, the main drivers of emissions are the energy production and consumption sectors, the transportation sector, particularly road transportation, industrial production, agriculture, and the building sector, which also contributes to greenhouse gas emissions, particularly through energy consumption for heating, cooling, and lighting buildings. In the case of the military, it accounts for a large percentage – in the French armed forces, for example, buildings account for over 40 percent of total emissions.

The study sets goals for the EU defense sector:

- The EU's armed forces should achieve a reduction in greenhouse gas emissions of at least 55% by 2030 compared to 1990 levels.
- By 2050, the EU's armed forces should be climate neutral and reduce their greenhouse gas emissions to net zero.
- Although no specific percentage figures were provided, the EU defense sector should gradually increase the share of total energy consumption from renewable sources.
- Energy efficiency in military buildings and vehicles should be continuously increased.

The measures recommended by the EU include:

- The development of an overarching EU strategy for defense and climate change.
- Climate-friendly modernization of military buildings and infrastructure.
- Greater consideration of sustainability in procurement and research.
- Expansion of renewable energies on military installations.
- More exercises focused on dealing with climate impacts and energy crises.
- Establishment of an EU center of excellence for defense, energy, and climate.
- Development of standards for climate-neutral defense.

30 MEASURES IN THE ROADMAP

The EU's Climate Change and Defence Roadmap, an integral part of the 2020 European Green Deal, includes over 30 measures covering operations, capability development, and partnerships. The measures are often formulated in general terms and without specific targets, however. When it comes to operations, the emphasis is on the integration of climate aspects into military operations and advice from environmental experts. In capability development, the focus is on the creation of training modules, the promotion of environmentally friendly innovations such as microgrids, and the consideration of climate targets in the transportation infrastructure. In terms of partnerships, the focus is on collaborating with NATO, the United Nations, and bilateral partners in the areas of climate and defense.

The roadmap provides important input, but the actual implementation depends largely on the EU member states and their military, and here a reluctance to follow guidelines from Brussels is apparent, particularly in national procurement issues. Nevertheless, the EU is making progress towards green defense and promoting the exchange of information and ideas between member states. The systematic continuation of these efforts, supported by coordinated strategies, EU funding programs such as the EDF, ambitious targets, and accelerated innovation, is crucial.

Finally, it should be noted that the most recent research paper on green defense also tends to reflect existing approaches and offers few new approaches to solving the complex challenges of an environmental transformation in the military. The harmonization of the various European armed forces and their procurement processes remains a challenging and lengthy task. ■

Armored vehicles on military training grounds – the transformation to "green armies" must maintain their capabilities.

The Measures: The United Kingdom's Approach

THE UK'S THREE-EPOCH DECARBONIZATION PLAN

As a pioneer in the transition to a more climate-friendly defence policy, the UK has presented a strategy for decarbonizing the armed forces. The "Climate Change and Sustainability" concept outlines a transformation process that aims to lay the foundations for reducing emissions, integrate new technologies and achieve the UN sustainability goals.

In the United Kingdom, the Ministry of Defence presented a strategy for climate change and sustainability in 2021. The officer in charge, Lieutenant General Richard Nugee, says that climate change poses a threat to global security that is comparable to conventional military threats. He is convinced that the ministry is making steady progress in pursuing a more sustainable approach. Nugee believes that by changing the way we operate on land, at sea, and in the air, the defense sector can make a significant contribution to the fight against climate change.

In its publication "Climate Change and Sustainability: A Strategic Approach," the British Ministry of Defence explains that it plans to gradually implement climate targets by 2050. To this end, it developed a "three epochs" approach.

THE THREE "EPOCHS" OF THE UK PLAN

2021 to 2025

EPOCH 1

Laying the foundations for reducing emissions, particularly in the supply chain, and integrating carbon emissions and sustainability targets into annual defense plans. Objectives include reducing emissions from properties by a third by 2025, establishing guidelines for new buildings, and creating a "register for natural capital" to document biodiversity in military properties.

2026 to 2035

EPOCH 2

Reducing emissions through new technologies and improving the ability to respond to global threats, which will require additional financial resources from the Ministry of Defence.

by 2050

EPOCH 3

Complete utilization of new technologies to increase resilience and reduce emissions with the aim of achieving UN Sustainable Development Goals.

CRITICAL ANALYSIS OF THE UK STRATEGY

The Royal United Service Institute for Defence and Security Studies (RUSI) has examined the ambitious goals of the United Kingdom's Ministry of Defence set out in the "three epochs." The experts Dr. Sarah Ashbridge and Lieutenant Colonel Alistair emphasize that although the plan for a greener defense points the way forward, it still lacks crucial details.

The development and integration of industry innovations are key elements in enabling the defense sector to act as a "fast follower" and adapt technologies such as heat pumps and solar cells. Financial incentives from the ministry are necessary to promote green technologies in the military and prevent a shortage of skilled workers.

RUSI sees considerable potential for reducing emissions, particularly in the armed forces' properties. Investments in renewable energies, as envisioned in "Project Prometheus," an initiative to promote environmentally friendly and sustainable practices within the defense sector, could lead to savings. Energy efficiency measures in buildings, although less visible, enable the rapid implementation of existing technologies and contribute to a rapid reduction in emissions. RUSI emphasizes that these initiatives represent a solid foundation, but urges that the importance of climate change in a military context be brought further into focus. ■

EXAMPLES OF ENVIRONMENTALLY FRIENDLY INITIATIVES BY THE UK MILITARY:

- **Renewable energy:** Installation of solar panels on the roof of the Ministry of Defence in London to reduce carbon emissions.
- **Vehicle fleet:** Switch to hybrid and electric vehicles for logistics and transport-related tasks.
- **Microgrid technologies:** Research by the Defence Science and Technology Laboratory (Dstl) to improve the self-sufficient energy supply on military bases.
- **Energy-efficient infrastructure:** The Future Defence Infrastructure Services (FDIS) program improves the energy efficiency of buildings and infrastructures.
- **Waste management:** Introduction of a comprehensive recycling program at the Catterick base to increase recycling rates and reduce landfill waste.
- **Alternative fuels:** Royal Air Force (RAF) experiments with biofuels for military vehicles and aircraft to reduce greenhouse gas emissions.

The Measures: Germany's Approach

THE GREEN TRANSFORMATION OF THE GERMAN ARMED FORCES

Germany wants to reduce the greenhouse gas emissions of its armed forces. With a series of innovative initiatives, the Bundeswehr is striving for a sustainable transformation that reconciles ecological responsibility with the necessary operational capability.

In an effort to achieve a climate-neutral government by 2030 and a climate-neutral German Armed Forces by 2045, Germany has launched a series of climate action initiatives. Despite relatively low carbon emissions per capita within the German Armed Forces compared to other countries, the need for a sustainable transformation is obvious, especially in light of the geopolitical tensions caused by the Ukraine conflict.

Germany's Federal Ministry of Defense has made sustainability an integral part of its operational and structural planning. This is reflected in the German Armed Forces' fifth sustainability report from 2022. A central aspect of the transformation is the integration of environmental protection measures in all areas and the inclusion of climate issues in security policy considerations.

Environmental protection and climate issues are central aspects.

As part of the "Green Barracks" project, the German Armed Forces are experimenting with renewable energies and alternative heating systems such as heat pumps and district heating in order to reduce their carbon footprint. The "Infrastructure" expert group is supporting these efforts by focusing on improving energy efficiency and self-sufficiency, including the electrical operation of military properties.

The German Armed Forces are also striving to replace fossil fuels with renewable alternatives in the area of mobility, both for use at home and on foreign missions. A "Mobility" expert group set up by the ministry identified areas of action back in 2019, including the development of an integral system architecture and research into synthetic fuels.

One aim is to increasingly supplement the energy supply of the deployment infrastructure, which to date has mainly been provided by fuel-powered generators, with renewable energy sources such as solar and wind energy. Changes in user behavior and technological innovations are also part of the strategy to reduce the consumption of fossil fuels. These efforts serve both to mitigate climate change and to ensure operational sustainability, whereby the mission requirements of the German Armed Forces are to take priority.

TOTAL EMISSIONS BY SECTOR

In addition to the German Armed Forces' properties at home and abroad, military mobility is a significant factor in overall emissions. The German Armed Forces' sustainability report describes the operational profile as being characterized by energy-dense fuels, whereby the potential use of alternative drive systems under current military requirements remains limited. Direct electrification and gaseous energy sources such as hydrogen have been ruled out due to the high energy density required by the military. E-fuels – liquid, synthetic fuels from sustainable sources – are being considered as a potential alternative to fossil fuels. The production of e-fuels is still in its infancy, however, and requires significant investment and consumes a great deal of electrical energy. Furthermore, it is already foreseeable today that civil aviation, in particular, will be directly competing for every liter of production capacity for green e-fuels in the short term.

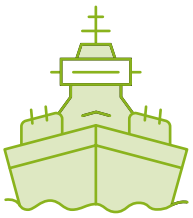
TOTAL EMISSIONS OF THE GERMAN ARMED FORCES

2021

Aviation fuel is the largest contributor with

471,660

tons of CO_2 units.



Marine diesel accounts for

163,676

tons of CO_2.

"normal" diesel for

129,700 tons of CO_2

gasoline for

11,028 tons of CO_2

2020

German Armed Forces:

0.79 Mio.

tons of carbon emissions from mobility

Germany as a whole:

146 Mio.

tons of carbon emissions from mobility

German Armed Forces share:

0.54 %

2021

German Armed Forces:

0.78 Mio.

tons of carbon emissions from mobility

Germany as a whole:

148 Mio.

tons of carbon emissions from mobility

German Armed Forces share:

0.53 %

GERMAN ARMED FORCES' PROJECTS

- **Use of renewable energy:** : The German Armed Forces operate several solar energy projects, such as the solar array on the grounds of the University of the German Armed Forces in Munich, which is one of the largest photovoltaic installations in Bavaria.
- **Hybrid and electric vehicles in logistics:** The German Armed Forces are increasingly integrating electric and hybrid vehicles into their non-tactical fleets in order to reduce carbon emissions and improve operational efficiency.
- **Use of microgrid technologies:** As part of the Smart Energy Networks initiative, which is part of the German Armed Forces' armaments innovation program, research is being conducted into the use of microgrids to optimize the self-sufficient and efficient supply of energy during foreign missions.
- **Energy efficiency in buildings and infrastructure:** The German Armed Forces are aiming to reduce their buildings' energy requirements through energy-efficient modernization measures such as improved insulation, energy-efficient heating and cooling systems, and lighting.
- **Improved waste management and recycling:** The German Armed Forces are implementing concepts to optimize waste separation and recycling, such as the waste separation system at the Baumholder military training area, as part of their environmental management activities.
- **Development of biofuels and alternative fuels:** In order to reduce dependence on fossil fuels and cut carbon emissions, the German Armed Forces are funding research projects into the use of alternative fuels, including biofuels.
- **Modern gensets:** Germany's Federal Office of Bundeswehr Equipment, Information Technology, and In-Service Support (BAAINBw) engaged VINCORION to develop and produce advanced power generators and corresponding battery storage modules. These are due to be delivered in the 200 and 50 kilowatt power classes starting in 2026, following successful troop testing and pilot production.

The government plans to achieve climate neutrality by 2030, which includes all civilian areas. Savings are expected from low-emission vehicles, increased use of telephone and video conferencing, teleworking, reduced paper consumption, and more organic products in cafeterias. There are also plans to expand "Natura 2000" protected areas on military training grounds, which already account for 59 percent of the total area.

CRITICAL ASSESSMENT: GERMANY CAN DO MORE

The German Armed Forces are striving to achieve a sustainable position, although they still need to define more specific goals and measures. This was how Sören Hellmonds assessed the situation in the magazine Internationale Politik. He emphasized that the military should be involved in global climate change mitigation efforts, but criticized the fact that the Kyoto and Paris climate agreements do not include a reporting obligation for military emissions. He pointed to the USA, where emissions from the armed forces are already tracked, and to EU armies, whose emissions are lower but still significant.

Hellmonds believes that investments to reduce emissions are crucial, emphasizing innovative approaches such as new battery technologies, synthetic fuels, and renewable energies. This is where European companies could play a leading role and transfer civilian technologies to the military.

When looking at Germany, Hellmonds sees a "mixed picture." Although the German government has issued general guidelines on climate action, no specific targets have been set for the Ministry of Defense. The only requirement for the German Armed Forces is to make its administrative buildings climate neutral. This is why Hellmonds is calling for the "transparency gaps" to be closed and a dedicated climate strategy to be developed for the German Armed Forces. He also believes that industry has a duty to minimize greenhouse gas emissions in the production of military equipment and calls for government investment in research.

The German Armed Forces are also making progress, however, particularly through the procurement of the aforementioned gensets and energy storage modules and the introduction of advanced technologies – which lead to lower emissions and greater safety by reducing consumption. Furthermore, Germany recognizes the importance of European harmonization and is actively involved in European dialogues and research projects in the field of energy technologies, supported by the European Defence Fund (EDF). ■

The contribution of the industry

HOW VINCORION SUPPORTS THE ARMED FORCES ON THEIR GREEN PATH

The defense industry faces the challenge of reconciling efficiency and environmental protection. The technology company VINCORION has taken up this challenge and developed modern energy solutions that can significantly reduce the ecological footprint of the armed forces.

The defense technology industry in Germany is moving towards more environmentally friendly solutions that not only increase efficiency but also reduce the carbon footprint. The technology company VINCORION has therefore made developing modern energy solutions for the aerospace and defense industry its core strategy. Dr. Stefan Stenzel, managing director of VINCORION, emphasizes that the company has focused on environmentally friendly and resource-saving energy production. These technical solutions can significantly reduce armed forces' carbon emissions.

VINCORION has around 800 specialists working on its innovative concepts. The company, which considers itself a partner on the path to climate-neutral national and alliance defense, would welcome concrete, measurable climate targets for the German Armed Forces.

Daniel Zeitler, head of product management at VINCORION, refers to the joint European efforts on green defense. "We need to increase the effectiveness of the military and at the same time reduce our dependence on fossil fuels," explains Zeitler. This is where VINCORION can make an important contribution with its innovative power systems.

VINCORION generators are equipped with state-of-the-art technology that optimizes both performance and sustainability. Key features include:

- **High-performance engines:** These are designed to offer an optimum power-to-fuel consumption ratio, which reduces operating costs.
- **Intelligent control systems:** The gensets have advanced control mechanisms that enable adaptive power output and maximize efficiency under fluctuating load conditions.
- **Rugged design:** Designed for durability under harsh operating conditions, our gensets guarantee a reliable supply of power even in critical situations.
- **Emission-reducing technology:** By using the latest technologies in exhaust gas aftertreatment, the gensets exceed current and expected environmental standards.

Modern energy solutions can increase efficiency.

SAVINGS POTENTIAL:

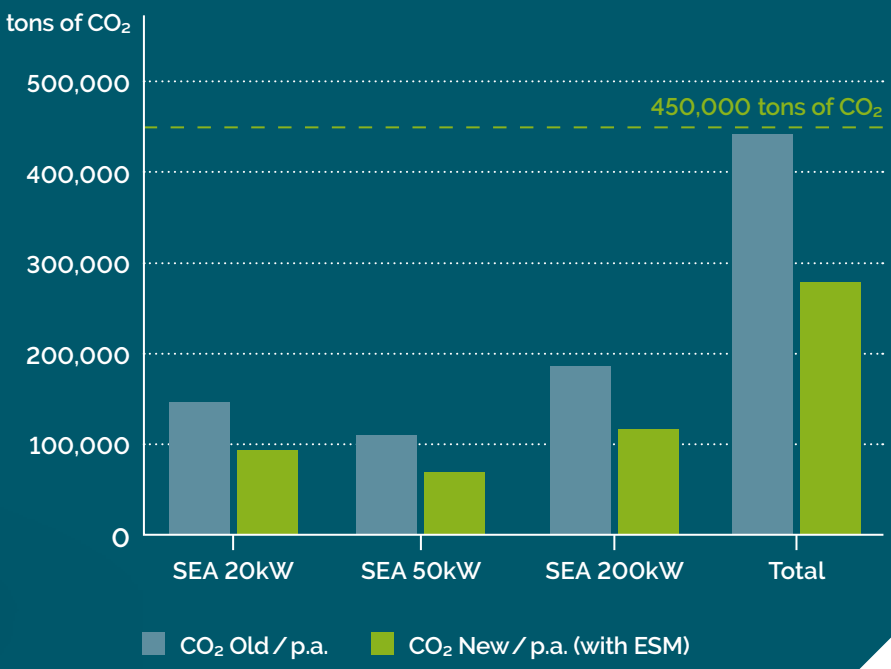
VINCORION's gensets offer significant savings in terms of both fuel consumption and maintenance costs. By using the units, users can expect the investment to pay for itself quickly due to the increased efficiency and lower operating costs. In this context, it is important to emphasize that the genset technology was designed to minimize the total cost of ownership (TCO).

POWER FOR GROUND-BASED AIR DEFENSE

VINCORION's solutions are not only perfect for powering mobile field camps, but also for critical defense applications such as powering air defense systems. The intelligent power management systems guarantee a high degree of flexibility and allow the power supply systems to be expanded modularly. Reliability is particularly important in the field of GBAD (ground-based air defense). In this area, VINCORION utilizes redundant power sources – gensets, storage units, and grid connections – to guarantee uninterrupted availability and maximum operational reliability, even under the most demanding operating conditions. State-of-the-art diesel engines form the backbone, supplemented by storage systems and renewable energies. According to Zeitler, it is possible to reduce carbon emissions by 33 percent.

The importance of this rugged and reliable power supply becomes particularly clear in the context of state-of-the-art air defense systems such as the PATRIOT and the IRIS-T SLM. These systems are crucial for fending off threats from the air and ensuring that critical infrastructure is protected. The events in Ukraine have highlighted the importance of such systems and the need for a reliable, uninterrupted power supply. VINCORION's technology helps to safeguard the performance of these defense systems in crisis situations.

LESS CO2 WITH VINCORION POWER GENERATORS PGM LOW EMISSIONS[V]



Source: Calculations by VINCORION

THE NEXT GENERATION OF GENSETS

Modern energy systems can significantly reduce emissions, Zeitler continues. This would also be possible in the context of military vehicles. VINCORION supplies powerful generators and other components for the LEOPARD 2 main battle tank and the PUMA infantry fighting vehicle. An innovative start-stop system could reduce consumption and increase operating time. Experts are confident that considerable carbon emissions could be saved through optimization.

VINCORION is a partner in European research and development initiatives, such as the "NOMAD" project funded by the European Defense Fund (EDF). With a total budget of around 20 million euros, the project is being supported by a European consortium and is developing energy storage systems for forward military operating bases – which will result in functional modules and technology demonstrators.

The EU funding share, together with co-financing from the BMVg, will enable VINCORION to expand its expertise in storage technology and drive forward the development of cutting-edge power supply systems. NOMAD underscores VINCORION's role in the European innovation landscape and the importance of collaborative projects for defense policy. The participation of nine countries, including Spain, France, Greece and Norway, promotes a strong network for the implementation of advanced energy solutions.

These projects contribute to the reduction of fossil fuels and increase energy efficiency on missions. VINCORION's activities in the development of new technologies are crucial for the future security and sustainability of the energy supply.

Managing Director Dr. Stefan Stenzel summarizes: "Our approach is to get more value out of every liter of fuel." Lower consumption not only has environmental benefits, but also reduces dependence on external sources. As a final note, Stenzel reaffirms VINCORION's goal of focusing on environmentally friendly energy production. With over 30 years of experience, he emphasizes that VINCORION's solutions support the climate goals of the defense sector and support customers on the road to climate neutrality. ■

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VINCORION is a technology company with a focus on innovative energy systems in safety-critical applications, including generators, electric motors and drives, gensets, power electronics and hybrid energy systems.

As a partner to the aviation, security and defense industries, VINCORION develops and manufactures solutions for the specific requirements of its customers based on intensive dialogue. An efficient customer service offers support and service for the use of own and third-party products throughout the entire product life cycle.

Would you like to know more? Just get in touch with us. www.vincorion.com

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