



Fluctuations and interruptions in power supply

HOW PHARMACEUTICAL AND CHEMICAL COMPANIES CAN BENEFIT FROM **mtu** KINETIC POWERPACKS

Chapter 1 – The importance of uninterrupted power for pharmaceutical and chemical companies

In an era of increasingly frequent extreme weather events and a constantly aging grid infrastructure, the reliability of our power grids is under strain. This challenge is compounded by the growing reliance on intermittent renewable energy sources like wind and solar PV. As a result, the risk of power disruptions looms, whether from physical grid damage or fluctuations in grid frequency & power quality.

This issue hits industries hard, particularly those with high energy demands like pharmaceutical and chemical companies, where

operational integrity can mean everything. Processes requiring sterile environments, such as aseptic and biological manufacturing, are particularly vulnerable. These delicate operations demand tightly controlled conditions, where even minor voltage fluctuations can spell disaster, potentially ruining entire production batches.

To mitigate these risks, uninterrupted power supply (UPS) systems are indispensable. They ensure continuous, high-quality power, safeguarding against unplanned downtime and the large financial losses that can result from compromised batches.

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A Rolls-Royce
solution

Chemical and pharmaceutical companies face several challenges regarding uninterrupted power supply that are critical to their operations and regulatory compliance:

1. Process Sensitivity

Many manufacturing processes in these industries, such as pharmaceutical formulation and chemical synthesis, require precise and stable conditions. Even minor interruptions or fluctuations in power quality can disrupt these processes, leading to product quality issues or batch failures.

2. Regulatory Compliance

Regulatory compliance is critical in these highly regulated industries, where product quality, safety, and environmental standards must be met consistently. For companies operating globally, this challenge is magnified by the need to navigate diverse regulations and varying grid reliability. Deploying UPS systems that ensure continuous operation and meet both local and global regulatory standards is essential to avoid scrutiny or penalties.

3. Data Integrity, Security & Integration

Maintaining data integrity and security is crucial in industries like pharmaceuticals, where digital systems handle sensitive information. UPS systems protect this data during power disruptions. As advanced technologies like automation and IoT become integral to manufacturing, the need for stable, uninterrupted power grows, requiring UPS systems to seamlessly support these innovations.

4. Operational Continuity

Continuous operation is crucial for chemical and pharmaceutical companies to meet production schedules and supply chain commitments. UPS systems help mitigate the risks of unplanned downtime due to power failures, thereby ensuring operational continuity and minimizing financial losses.

5. Equipment Protection

The equipment used in these industries, such as reactors, centrifuges, and analytical instruments, are often sensitive to power quality variations. UPS systems provide protection against voltage spikes, surges, and other electrical disturbances that could damage expensive equipment and lead to costly repairs or replacements.

6. Emergency Preparedness

In the event of natural disasters, grid failures, or other emergencies, chemical and pharmaceutical companies must be prepared to maintain essential operations. UPS systems with backup power capabilities play a crucial role in emergency preparedness plans by providing a reliable source of power during critical situations.

7. Scale and Adaptability

As these industries evolve with advances in technology and production methods, UPS systems must be scalable and adaptable. Facilities may need to expand or reconfigure operations, requiring UPS solutions that can grow or be modified without significant disruption to ongoing activities.

8. High Energy Intensity

Both industries are known for their high energy consumption per unit of production. This makes them particularly vulnerable to the financial impacts of energy interruptions or downtime, as the cost of lost production time can be substantial.

9. Layout & operational complexity

Manufacturing facilities in these industries have complex layouts with multiple production lines, clean rooms, and specialized equipment, making it challenging to design and implement UPS systems that cover all areas. Additionally, the operation of UPS systems requires ongoing monitoring, maintenance, and testing, adding complexity to facility management and necessitating skilled personnel and resources.

10. Long-Term Reliability

Chemical and pharmaceutical companies operate on long planning horizons, often requiring investments in infrastructure with long-term reliability. UPS systems must demonstrate reliability over extended periods to justify investment and operational continuity.

Navigating these multifaceted challenges requires a comprehensive approach to UPS system planning, implementation, and management tailored to the specific needs and operational contexts of chemical and pharmaceutical manufacturing (Figure 1). By addressing these challenges effectively, companies can enhance resilience, reduce risks, and sustain operational excellence in a dynamic and demanding industry environment.

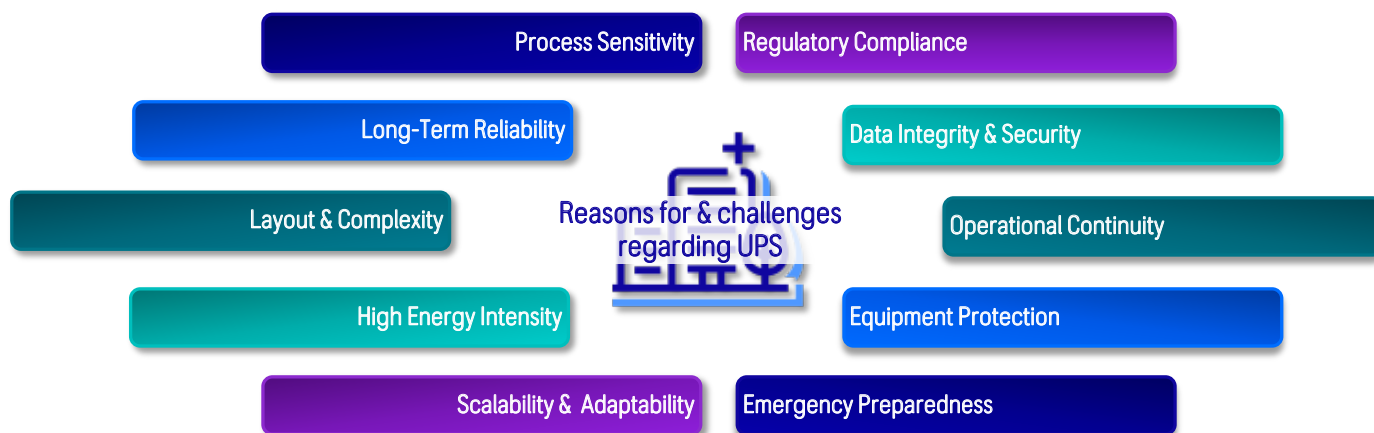


Figure 1: Challenges for chemical and pharmaceutical companies regarding uninterrupted power supply

Chapter 2: Different types of UPS: Static system vs. dynamic setup

UPS systems are crucial for ensuring continuous power during outages or disruptions. They come in two main types: Static (or Battery) UPS and Dynamic UPS, each designed to meet different needs and operational requirements.

Static UPS systems use chemical batteries to store energy, providing backup power for a limited period. They typically include a rectifier to convert incoming AC power to DC, which is then used to charge the batteries. When needed, an inverter converts this DC power back to AC for use. These systems are prevalent in installations with power requirements up to 1,200 kW and can be scaled by adding modular units to increase capacity. This modular approach not only helps in managing costs but also enhances redundancy and efficiency by allowing unused units to be turned off during low load periods.

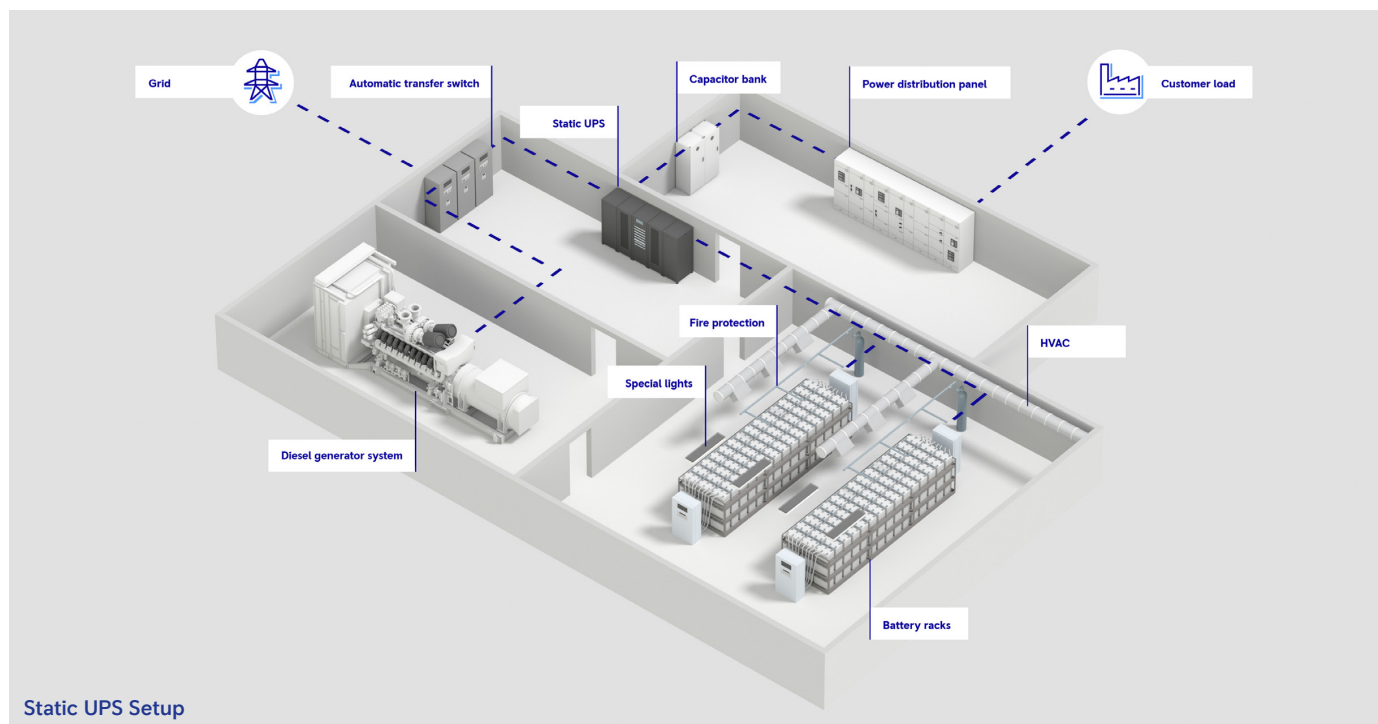
Dynamic UPS systems, on the other hand, store energy in a flywheel, which is a rotating machine that maintains power supply stability. This type of UPS features a diesel engine and a synchronous machine integrated with the flywheel, providing a robust solution for larger installations with power ratings typically ranging from 200 kVA to 3,000 kVA. Dynamic UPS systems are particularly beneficial for their high efficiency and durability in handling large and fluctuating loads preferable for medium voltage applications.

Each technology has its unique benefits, with Static UPS systems being favored for their modular scalability and cost-effectiveness, while Dynamic UPS systems offer superior performance for higher power demands and load stability. Understanding these differences helps in selecting the right UPS system to ensure reliable power protection tailored to specific operational needs.

But how do they compare?

Static UPS systems are highly dependent on their batteries, with battery failures being the leading cause of unplanned downtime. A single bad battery cell can lead to significant operational disruptions, and battery life, especially for VRLA batteries, typically ranges from 3 to 5 years, after which performance degrades. In terms of cost and investment, static UPS systems are generally cheaper for lower power ratings below 1.200 kW. However, costs increase with larger systems due to the complexity of parallel configurations. Operating costs for static UPS systems include ongoing energy and maintenance expenses, particularly due to the cooling and replacement needs of batteries.

On the other hand, dynamic UPS systems, which do not use batteries, are more robust in handling load fluctuations and voltage deviations. The space requirements for dynamic UPS are significantly lower compared to static UPS and the needed associated equipment, such as capacitors, backup generator sets and cooling systems (Figure 2). Dynamic UPS systems, with a longer lifespan, generally have a lower environmental impact due to no need for battery replacements. When it comes to electrical fault handling, dynamic UPS systems offer better fault-clearing capabilities due to their ability to generate high fault currents, unlike static UPS systems, which are more sensitive and rely on switching to mains power for fault clearance. Dynamic UPS systems are also better suited to handle mechanical loads like chillers because their inherent electrical inertia helps stabilize the power supply, while static UPS systems may struggle with such loads, potentially compromising protection. Additionally, static UPS systems are limited to low voltage (up to 400 V), requiring multiple installations in large sites, whereas dynamic UPS systems can operate at higher voltages, allowing for a more centralized and efficient power distribution (Table 1).



Static UPS Setup

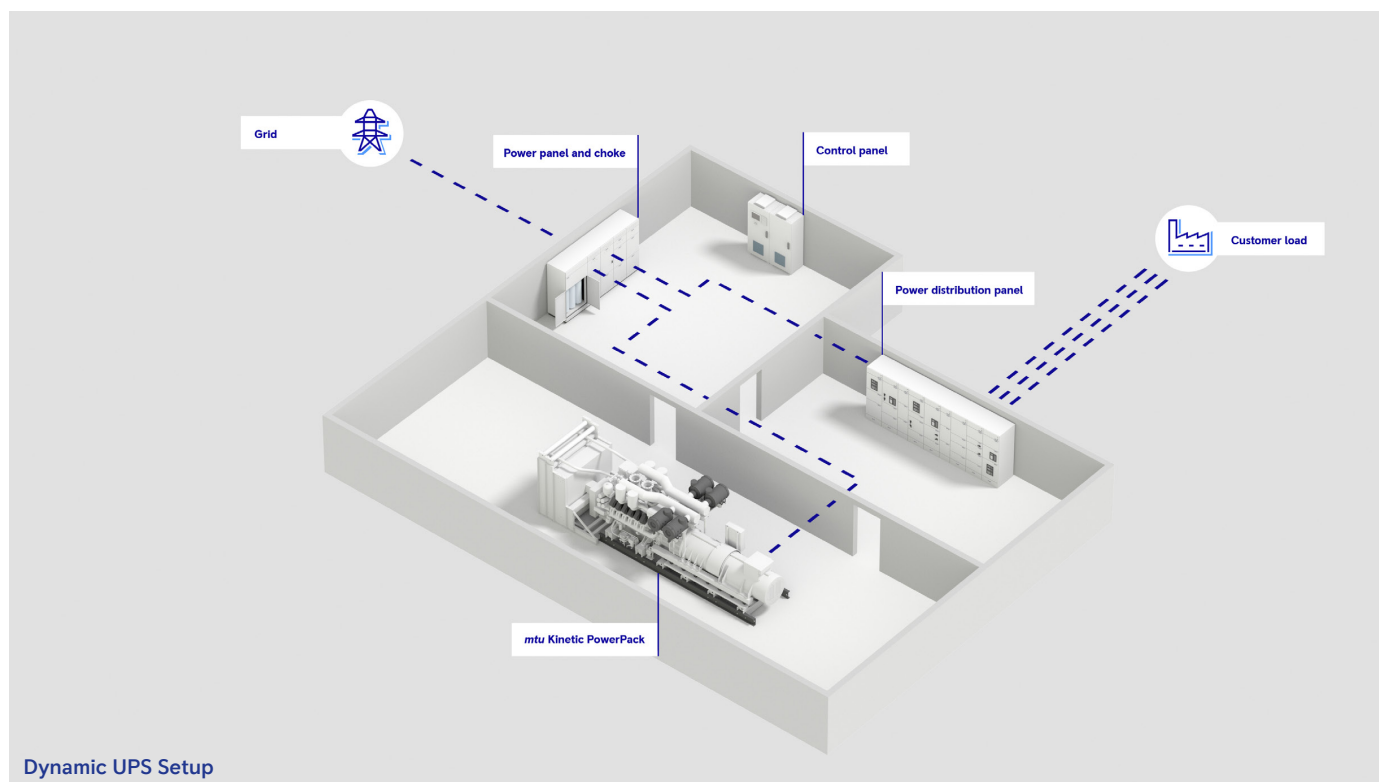


Figure 2: Footprint comparison:
Static UPS setup vs. dynamic counterpart

Table 1: Comparison of key differentiators between
static and dynamic UPS systems > 1.000 kVA

Comparison factor	Static UPS & Generator Sets	Dynamic UPS
Product reliability	+	+
Footprint	-	+
Component count	-	+
CAPEX	0	0
OPEX	-	+
TCO	-	+
Efficiency	0	0
Environmental impact	-	+
Fault clearing capability	-	+
Dealing with mechanical loads	-	+
Voltage options/flexibility	-	+
Lifetime	-	+
Operating temperature range	-	+

+ superior | 0 non-differentiating | - inferior

Chapter 3 – Our Solution, the *mtu* Kinetic PowerPack, explained

The *mtu* Kinetic PowerPack is a cutting-edge technology designed to deliver reliable, uninterruptible and conditioned power through kinetic energy. It offers a dynamic solution to power supply challenges, making it ideal for environments where reliability and sturdiness are crucial.

What is the *mtu* Kinetic PowerPack?

This advanced power system uses kinetic energy instead of batteries to ensure uninterrupted electrical power. It features a diesel engine connected to a kinetic energy storage module via an electromagnetic clutch. This setup not only provides consistent conditioned power but also contributes to a more robust and reliable solution compared to conventional static UPS systems (Figure 3).

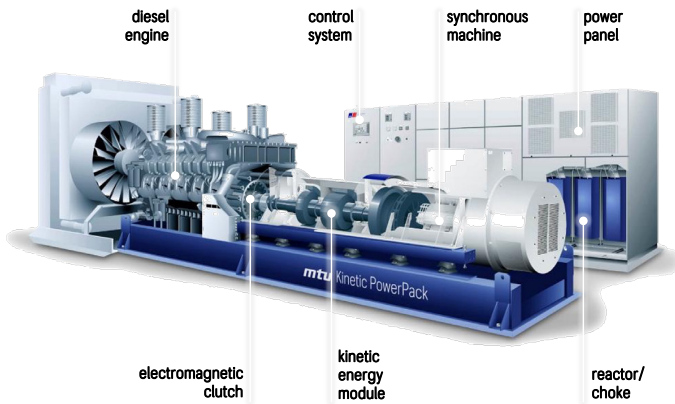


Figure 3: Design of a dynamic UPS system

The system offers a series of great benefits to industries in need of reliable and high-quality power:

a) Power Quality and Conditioning

The *mtu* Kinetic PowerPack enhances power quality, stabilizing voltage from the grid to ensure a clean and reliable power supply for critical loads. It integrates a choke and a low impedance synchronous machine, functioning as a dynamic filter to improve power factor and eliminate micro-cuts, resulting in smoother power transfer and a high-quality uninterrupted power supply. Additionally, the system provides harmonic filtering and voltage stabilization, correcting the power factor and filtering out voltage harmonics to deliver stable and high-quality power (Figure 4).

b) Footprint and Design

A dynamic UPS is designed to be compact and space-efficient, with a footprint that is up to 40% smaller than equivalent static UPS systems. This streamlined design not only reduces building construction costs but also maximizes space for other uses. Additionally, the system features a single base frame that houses all components, including the diesel engine, synchronous machine, and kinetic energy module, ensuring an efficient setup.

c) Reliability

The system features redundant engine start capabilities, incorporating independent starting systems for the diesel engine to ensure reliability and prevent downtime. Its robust synchronous machine generates a stable sine wave naturally, offering durability with its high rotational inertia, unlike static UPS systems that depend on delicate semiconductors. Additionally, the *mtu* Kinetic PowerPack boasts fewer components compared to traditional UPS systems, enhancing reliability and reducing maintenance needs.

d) Flexibility

The *mtu* Kinetic PowerPack is both modular and scalable, allowing it to be customized to fit various layouts and requirements. It features customizable containers and enclosures, options for sound attenuation, ventilation systems, as well as complete building installation. Being operational at low and medium voltage, the system supports both single and dual output configurations: single output for continuous power and dual output for separating critical and non-critical loads. This flexibility not only saves space but also optimizes power distribution and electrical discrimination of the installation.

e) Sustainability and Cost Efficiency

The KPP offers a competitive total cost of ownership (TCO), especially on power ratings above 1,000 kVA. Its design eliminates the need for batteries, minimizing associated production, recycling and exchange waste and making it an environmentally friendly option. Even in times the diesel engine is in operation, the environmental impact can be minimized using sustainable diesel fuels, like HVO. Additionally, the *mtu* Kinetic PowerPack boasts high power density, providing significant space savings compared to static UPS, offering to utilize the free space differently or simply reduce installation investment cost.

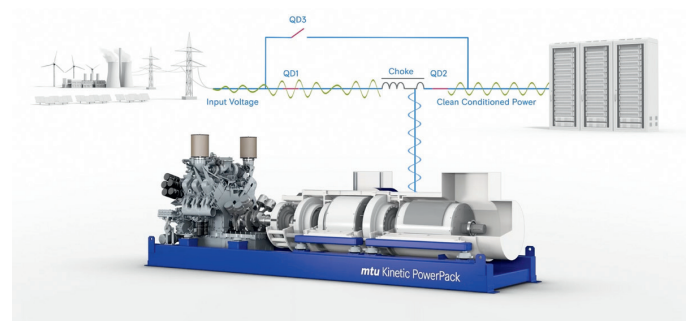


Figure 4: Conditioning mode of *mtu* Kinetic PowerPack:

- a) QD1 input breaker & QD2 output breaker are closed; QD3 auto by-pass breaker is open,
- b) power is supplied from mains,
- c) Synchronous machine running at target frequency,
- d) Accumulator running @3,000 rpm,
- e) clutch is open and diesel engine is stopped

The *mtu* Kinetic PowerPack is suitable for medium voltage systems, critical loads, and long distribution distances, making it a versatile choice for various industrial and commercial applications. Available in ratings from 630 kVA/500 kW to 3000 kVA/2160 kW, it can be scaled up by combining multiple units.

Chapter 4– Benefits of KPP systems for pharmaceutical & chemical companies

The **mtu** Kinetic PowerPack is specifically designed to support the high demands of the pharmaceutical and chemical sectors by delivering superior power quality and operational reliability. It tackles the critical need for stable power by enhancing power quality through advanced voltage stabilization, harmonic filtering, and power factor correction. This ensures that sensitive manufacturing processes, such as pharmaceutical formulation and chemical synthesis, remain unaffected by fluctuations or interruptions, protecting product quality and preventing costly batch failures.

Given the complex and space-constrained layouts typical of these facilities, the KPP’s compact design is a significant advantage. It offers a footprint that is up to 40% smaller than equivalent static UPS systems, reducing construction costs and optimizing space for other critical operations. All components, including the diesel engine, synchronous machine, kinetic energy module, and clutch mechanism, are mounted on a single base frame, simplifying installation and ongoing maintenance, which is crucial for maintaining continuous operations without extensive downtime.

Reliability is a cornerstone of the **mtu** KPP, particularly important in industries where unplanned downtime can have severe financial and operational consequences. The system’s robust synchronous machine, with its high rotational inertia, naturally generates a stable sine wave, ensuring consistent power delivery. Additionally, the KPP features a unique redundant engine start system, the KINstart. The inertia stored in the kinetic accumulator is used to start the diesel engine mechanically, guaranteeing a diesel engine start under any condition, which is reducing the risk of engine start failure and ensuring continuous operation even in the most demanding scenarios. With fewer components compared to traditional UPS systems, the KPP minimizes maintenance needs and enhances overall system durability, which is critical for long-term reliability.

The KPP’s flexibility is another key benefit, enabling it to adapt to various facility layouts and operational needs. It can be customized with modular and scalable configurations, supporting both single and dual output systems to manage critical and non-critical loads efficiently. This adaptability is crucial as these industries evolve, allowing the KPP to grow and adjust without significant disruption to ongoing activities. Further integration in medium voltage installation is easily possible, either by directly utilizing a medium voltage alternator on the system or with step up transformers for higher medium voltage ranges. Compared to static UPS, the **mtu** Kinetc PowerPack positions itself superior in terms of short circuit power contribution and handling of inrush and starting current, being an ideal choice to create centralized high-power installations with good selectivity of the electrical design.

Sustainability and cost efficiency are also integral to the KPP’s design. By eliminating the need for batteries and reducing space consumption, the KPP lowers the total cost of ownership while minimizing environmental impact.

Furthermore, the **mtu** KPP is well-suited for emergency preparedness, providing a reliable backup power source during natural disasters, grid failures, or other critical situations. Its robust design ensures that essential operations can continue uninterrupted, safeguarding the facility’s operational continuity (Table 2).

Table 2: How the **mtu** Kinetic PowerPack addresses the energy challenges of the pharmaceutical & chemical companies

Challenge	Solution Provided by KPP
Process Sensitivity	Stabilizes grid voltage, filters harmonics, and corrects power factor to protect sensitive manufacturing processes.
Regulatory Compliance	Ensures continuous, high-quality power to meet stringent local and global regulatory standards.
Data Integrity & Security	Provides stable, uninterrupted power, safeguarding digital systems and maintaining data integrity during disruptions.
Operational Continuity	Features unique redundant engine start system and robust components to minimize downtime and ensure continuous operations.
Equipment Protection	Filters out voltage spikes and provides consistent power quality, protecting sensitive equipment from damage.
Emergency Preparedness	Offers reliable backup power during critical situations, ensuring essential operations continue without interruption.
Scalability & Adaptability	Modular and scalable design allows for easy expansion and adaptation to evolving operational needs.
High Energy Intensity	Efficient operation in high power ranges and ratings above 1000 kVA, ability to be easily integrated into medium voltage installations.
Layout & Complexity	Compact, space-efficient design with a single-frame installation simplifies integration into complex facility layouts.
Long-Term Reliability	Durable design with fewer components ensures long-term reliability and reduced maintenance needs.

Chapter 5 – From theory into praxis – use case examples that demonstrate the value of KPPs

The **mtu** Kinetic PowerPack is a proven and trusted technology, with over 100 MVA installed globally in the pharmaceutical and chemical industries, sectors that rely on conditioned and protected power 24/7.

To illustrate this, two use cases are presented where **mtu** KPP solutions are successfully in operation, safeguarding companies against power interruptions and ensuring high-quality power for seamless on-site processes.



Use Case 1

Customer: Böhringer Ingelheim

Location: Vienna, Austria

Solution: 1x **mtu** Kinetic PowerPack with 2.444 kVA / 10 kV

The expansion of the production facility necessitated a secured power supply. Rolls-Royce delivered a KPP unit with a capacity of 2.444 kVA at 10 kV. The scope of delivery included a control system, MV-choke, transformer, LV auxiliaries and LV-voltage supply panel. It operates in parallel with the existing CHP units. The turnkey installation was carried out in collaboration with our local distribution partner, K&W Drive Systems.



Use Case 2

Customer: Vetter Pharma

Location: Rankweil, Austria

Solution: 1x **mtu** Kinetic PowerPack with 1.750 kVA / 10 kV → 20 kV

Vetter Pharma required a replacement genset for an old unit to be retired, however the decision was made to replace this genset with an **mtu** KPP instead. The current design of this unit is fit for 10 kV but will in later expansion be integrated into a 20 kV grid. Rolls-Royce service partner NEATEC was responsible for commission & delivery. The scope also included transformers, neutral earthing resistors and switchgear as a switchable 10/20 kV variant. As of mid-2025, Vetter Pharma will operate a total of 14 **mtu** Kinetic PowerPack units across various sites in Germany and Austria.

Closing Statement

In conclusion, the **mtu** Kinetic PowerPack dynamic UPS system offers a comprehensive, reliable, and adaptable power solution that directly addresses the challenges faced by the pharmaceutical and chemical industries. By ensuring superior power quality, operational reliability, scalability, and sustainability, the KPP supports these industries in maintaining operational excellence, regulatory compliance, and long-term resilience in a dynamic and demanding environment.

Get in touch to discover more
about our energy solutions:

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Rolls-Royce Power Systems is headquartered in Friedrichshafen in southern Germany and employs more than 10,350 people. The product portfolio includes **mtu**-brand high-speed engines and propulsion systems for ships, heavy land, rail and defence vehicles and for the oil and gas industry. The portfolio also includes diesel

and gas systems and battery containers for mission critical, standby and continuous power, combined generation of heat and power, and microgrids. With its climate friendly technologies, Rolls-Royce Power Systems is helping to drive the energy transition.

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