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Power Management Systems

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In This Issue

Foreword

Chris Rush
Editor in chief

Distrelec is proud to announce its first edition of its eBook series focussing on product solutions for various industries. In this issue we are taking a look at **Power Management Systems** (PMS). Power management systems play an important role across many industries ensuring their day to day operations are uninterrupted using a combination of real-time data from industrial sensors within a system.

Better power management is useful to ensure smooth dynamic power demands. Smoothing out peak demands and low demands can often be very beneficial and lower in cost as the problem within energy systemsisoftenthattheoverall average power is too high.

Within this eBook we take a look at some of the solutions in the PMS category across a number of industries lead by our key suppliers who are leading experts in their field.

One industry that is being accelerated is the **electronic vehicle (EV)** market. The EV market has seen rapid growth in the last few years with battery technology improving and vehicle costs reducing. The EV design infrastructure also plays an important role in the overall uptake ensuring there is the supply of charging units to meet the demand from both a domestic and commercial point of view.

Energy saving is also on forefront of every government and business agenda. There is real potential to reduce the overall carbon footprint of every business by using sources of renewable energy such as wind, solar and hydroelectric. Sources of renewable energy aren't new per say but the technology has improved overtime with the introduction of artificial intelligence and IIoT. Energy must become more dependable and more cost effective. An important aspect to its sustainable growth is having the ability to remotely connect, monitor and control all types of assets from wind turbines, solar farms and hydroelectric generators. This is where data and IIoT services will play a vital role in ensuring maximum efficiency and rapid maintenance for continued operations.

Power management systems are not only considered for large scale projects but also for embedded discrete devices. We have seen in the last few years where semiconductors are getting much smaller and more energy efficient. This is most likely due to the demand of wearable devices and IoT devices as power is an integral part of any device's operation. In technology such as LoRa (Long range) it is a requirement for most applications to have sensors that can operate for a number of years without the need for constant power.

At Distrelec we are proud to offer our customers a range of PMS solutions to fulfil their needs. We are working with some leading experts in this field through a range of key suppliers.

EATON: Opportunities in electric vehicle charging at commercial and industrial sites

Along with NatWest and Lombard, and in partnership with the Renewable Energy Association, EATON has commissioned a new Aurora Energy Research report highlighting the scale of commercial opportunities for electric vehicle (EV) charging commercial and industrial sites.

Eaton's innovative products, solutions and technologies are designed to help customers manage power and conserve resources while working more productively, safely and sustainably.

The Whitepaper focuses on the problem surrounding home charging. In some cities and towns around Europe, EV users do not have access to private parking facilities, around 40% in the UK and Germany. It is expected that commercial and industrial sites will also play an essential role within the charging infrastructure for EV's. Aurora's forecasted that by 2040 there will be 17m and 23m EVs in the United Kingdom and Germany. This could be accelerated based on several factors: the depreciation of EV costs, manufacturing availability, and government schemes.

A large number of EV uptake will also transform the current electricity grid. As the deployment of EV's over the coming years will grow, so will the electricity demand, which will ultimately affect the pricing of electricity and carbon emissions.

The introduction of intelligent charging will also be a key factor where charging EVs when there is lower electricity demand (such as at night-time) or where there is also excess supply on the national grid will reduce the cost of charging significantly. The result will make EV's more affordable compared to traditional combustion engine vehicles. It is expected that the price range would fall by about a third between 2018 and 2040 in the UK with a high EV deployment scenario.

The Whitepaper also discusses the possibility of reducing the overall market share of petroleum vehicles by up to 90% by 2040, which would also reduce carbon emissions and, more importantly, each country will hit their EU targets for climate change.

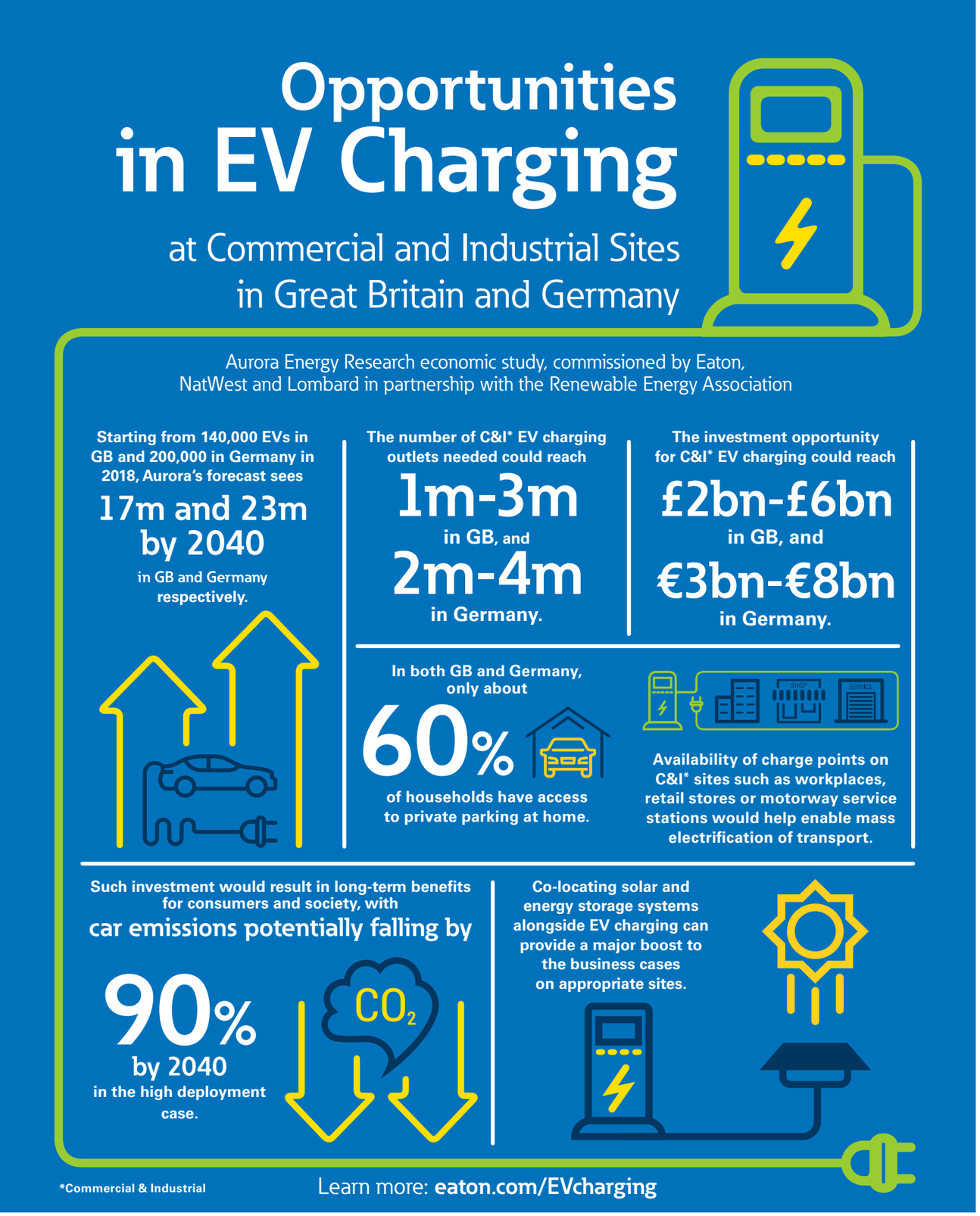
Size of opportunity within commercial and industrial

Commercial and industrial sites will play a significant role in the deployment of the EV infrastructure. In both the UK and Germany, only about 60% of households have access to private parking; the rest will have to rely on public charging, workplace, retail stores, car parks or service stations. The actual number of EV charging stations could reach up to 1-3m in the UK and 2-4m in Germany under a higher deployment rollout. This would also be spread across several applications such as fleet vans, workplace commuters, public car parks and motorway services.

The actual investment opportunity in these applications is enormous. Aurora energy research has estimated that it could reach £2bn to £6bn in the UK and 3bn to 8bn Euros in Germany. This investment cost is based on the total cost of equipment and installation outlets to support the projected growth in 2040.

Developing a profitable business case

Studying a business case for implementing EV charging stations has to be met with risks. Ultimately, whether this is directly charging customers for electricity or indirectly where having EV



EATON

charge stations is attracting business to retail outlets has to be a profitable action. Most EV charge stations will apply a Premium on top of the standard electricity rate to enable a positive investment return.

From a commercial point of view, light fleet vehicles in the UK and Germany could save companies up to 15% by switching to EVs compared to today's costs. Cost reduction trends could trigger an initial investment in fleets of EV. This is expected to happen in the next decade if it isn't already happening. Indeed, in the UK market and some European areas, Amazon delivers vehicles are now becoming all-electric. They already see the benefit of this throughout cost savings compared to an internal combustion engine's (ICE). Workplaces with charging points can improve their economics by sharing each point between several cars. Workplace charging can also be profitable if drivers and employees are prepared to pay slightly above the retail electricity price and share each charging point between 4 cars.

Car parks could charge a small premium above retail prices to reach a profitable business case. The examples analysed in the report presented a Net Present Value (NPV) per charging outlet at £8000 in the UK and 3000 E in Germany. These levels of margin would be sustainable over 12 years, assuming utilisation of 6 hours per day.

Services stations are, by far, the most attractive business model for investors. NPV per charging outlet could reach up to £66k in the UK and 25K in Germany at a sustainable level over 12 years in the examples analysed. This also assumes that outlets are used for 6 hours each day. Potential benefits from combining EV charging with other technologies Adding a vehicle to grid (V2G) capabilities, onsite energy or solar panels can enhance a business case for commercial & industrial EV charging. Each of these use cases would require further investment but could unlock further saving overall. There are already some EV charging companies across Europe investing in this technology, such as Fastned in the Netherlands. They have rolled out some solar charging stations on European highways.

V2G can improve the business case for commercial fleet charging. For overnight charging of a fleet of cans at a business within-site energy consumption like a refrigerated warehouse, using V2G technology could improve the NVP per charging outlet by up to 15%. Co-locating solar and energy storage systems alongside EV charging can significantly boost business cases on suitable sites. This would either improve profits, support lower consumer price of electricity or counter a possible fall in utilisation. i.e. in the motorway service station case in the UK, solar and energy storage can contribute almost as much to the NPV over 24 years as Premium sale prices. This could keep the investment profitable even if the usage drops to just 4 hours per day for each charging point.

Factors driving EV deployment

There are two main factors for EV deployment growth; EVs are becoming more attractive to consumers, and governments are supporting investment schemes. The rising consumer preference comes down to pricing to a comparable ICE vehicle and improvements such as battery range and more widespread charging options.

Price: The report suggests that battery electric vehicles would become cost-competitive with ICE cars within the next decade, thanks to the rising production scale and the fall in battery technology costs. Range: Range will rise further as battery sizes increase, reassuring consumer confidence. It is expected that the battery range for a £20k battery vehicle should achieve 400 miles by 2030.

Charging access:
Consumers, governments and industries each have their roles to play in the overall EV infrastructure. The report focuses on those opportunities offered by the infrastructure on commercial and industrial sites.

Government support is very much driven by issues such as pollution, global climate change and consideration of the industrial strategy. Pollution: Governments are under increasing pressure from consumers over the air quality within major cities and its impact on residents' health. Most cities are not working towards a zero-emissions target, with many banning the use of diesel vehicles.

Climate change:
EV's can be used to cut out emissions from transport systems. They have much lower emissions than ICE vehicles and will also accelerate the need for decarbonising power systems. Ban's on the sale of ICEs are planned in the Netherlands and India from 2030, Scotland from 2032 and France & England 2040. Industrial strategy: In the UK, the government has identified mobility as one of four significant challenges that will shape its industrial strategy. It hopes to improve public transport and to capitalise on the strengths of the existing transport sector.

Challenges
The following areas have been highlighted as some of the critical uncertainties for future development of business cases for

charging infrastructure within commercial and industrial sites:

Equipment costs:
The modelling assumes a 20% decline in charging equipment costs by 2030; this might be faster or slowed in practice. It is also estimated that there will be a decline in costs for solar generation equipment and energy storage systems.

Battery technology:
Continued battery technology improvements will lead to a decline in the annual power demand for EVs.

Revenue streams:
Over time, technical development and regulatory reforms could make new streams available to charging stations, in-particular those with V2G.

Government incentives:
As government come closer to meeting climate change goals, it is expected that any incentives may be withdrawn and funds directed elsewhere.

Charge point technology:
High levels of utilisation could enable new design for charge points. Charge points with more outlets can allow more vehicles to be charged simultaneously. Car parks could opt for a portable charger unit where a battery on a trolley could be wheeled to a vehicle, or a robot could be used to automate this. Could we also see wireless charging being employed for an effortless charging process?

Speed of EV deployment:
EV business models is much easier to achieve their goals if there is a high utilisation rate. The speed will ultimately affect how soon investors are ready to support this industry.

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Consumer behaviour:
Business cases will be affected mainly by the behaviour of the consumers. Some will be happy to charge their vehicles at home or only at work. Some will top up throughout the day whilst running errands, or others will charge en route over greater distances. The choice would be down to the cost of charging as one of the selling factors of EVs is the ability to save compared to ICE costs.

Case Study: Park@Sol solar carports by Schletter in Germany

Schletter is a manufacturer of solar mounting systems. It produces the Park@Sol mounting system for large-scale carports, in which small pre-cast concrete foundations are anchored onto micro-piles. This requires minimal construction works on the car park surface and is suitable for most types of subsoil.

For individual carports, it is possible to have double and single row parking, customised foundations and sub-decking for waterproofing; other optional accessories include advertising space, cable management, carport lighting, and drainage. The carports feature integrated charging pillars with multiple (2-4) outlets for electric cars, mopeds and bicycles.

Example projects
- Schletter GmbH company car park in Oberbayern: 260 parking bays, 500kW solar capacity; solar generation from the carport complements that from the PV installation on the factory roof, and is consumed onsite, with excess used for EV charging or exported to the grid.
- Sparkassen-Center bank in Bad Tölz: 0.3 MW solar capacity and 142 parking bays covering 2,000m2; free EV charging is provided to bank customers
- Eurospeedway in Lausitz: 1 MW solar capacity and 480 parking bays, with five EV charging stations

AURORA ENERGY RESEARCH

Opportunities in Electric Vehicle Charging at Commercial and Industrial Sites

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- Push button for PE Error (Earth Fault) simulation
- Rotary switch providing PP State simulation
- Rotary Switch providing CP State simulation
- Type 2 Charging Plug for charging points with panel mounted socket outlet or fixed cable with vehicle connector
- IP54 Rating
- Carrying Case
- CAT II 300 V Rating
- Comply with Low Voltage Directive LVD 2014/35

Included accessories: Type 2 Charging Plug, EVCA210 Carry Case, Instruction Manual

Can EV batteries really last a million miles?

By Chris Rush Editor in Chief at Distrelec

Perhaps you have already heard of the “million-mile battery” phrase? It is the latest in the electric vehicle industry to excite the public’s interest in investing in electric vehicles (EVs).

If you haven’t heard about it, don’t worry, most EV car manufacturers will be shouting with excitement about it soon, in particular Elon Musk at Tesla. Tesla is currently working on a “million-mile” battery project within their R&D section.

Internal combustion engines (ICE) in today’s market generally can last around 200,000 miles with some regular maintenance along the way. This is considered a good run for any vehicle, regardless of whether it is ICE or EV. The fact that we are talking about reports of a million miles powered by a long-lasting Lithium battery is astonishing on so many levels.

Who’s leading this race?

Recently, multiple EV battery makers have announced the arrival of a “million-mile” battery for EVs. In May 2020, General Motors (GM) released a statement claiming they are “almost there” to develop a battery. Not only this, but GM is working on the next generation of battery technology such as zero-cobalt electrodes, solid-state electrolytes and ultra-fast charging.

GM unveiled its Ultium advanced battery system in March 2020 to rival Tesla. It stated that its $2.3 billion battery production venture with LG Chem would be called Ultium Cells LLC. Its sole purpose is to find ways of reducing battery costs in EVs by investing in mines, hedging metal prices and partnering with metal refiners.

One of the biggest names in EVs is Tesla, and it is no surprise that Tesla will soon be able to power its EVs for more than a million miles over its lifespan. That’s double the mileage that current Tesla EVs can expect now. This project is being led by Contemporary Amperex Technology (CATL), who make batteries for Tesla and Volkswagen AG.

CATL is now going one further to produce a battery that can last 16 years or 1.24 million miles. The idea behind this is not only to reduce the battery waste disposal when it reaches its end of life but to also implement a battery recycling scheme. It is suggested that batteries could be swapped between vehicles, which would lower the cost of owning a brand new EV.

Battery technology

Most EV batteries in today’s market are all made up of Lithium Ion, using several different chemistries within the battery. When you purchase an EV today, it will come with a warranty period of 8-10 years or 100-200,000 miles. Some aspects of the warranty may differ from manufacturer to manufacturer. Still, some will guarantee that a battery will retain at least 70% of its original capacity over the warranty period.

In reality, it has been determined that EV batteries will last considerably longer with much less degradation. EV has been around for more than ten years, so experts are beginning to look at the data in much greater detail.

The data that experts have analysed has shown that it is doubtful that an EV will be removed from the road due to a fully degraded battery. This is sometimes the case for EVs used for business purposes such as deliveries and taxis; it certainly isn’t for consumer EVs.

The current concerns surrounding batteries are: how long will the battery last? How will the charge capacity and range decline over time? These are questions every EV buyer will be asking when investing in electric vehicles. A battery that could last

for over a million miles and will most likely outlive the car itself will undoubtedly answer those questions. Even with a 500,000 mile warranty period, it will go a long way to easing those concerned about replacing the battery at high costs in the future. This would be more so the case with fleets of vehicles for deliveries or taxi firms.

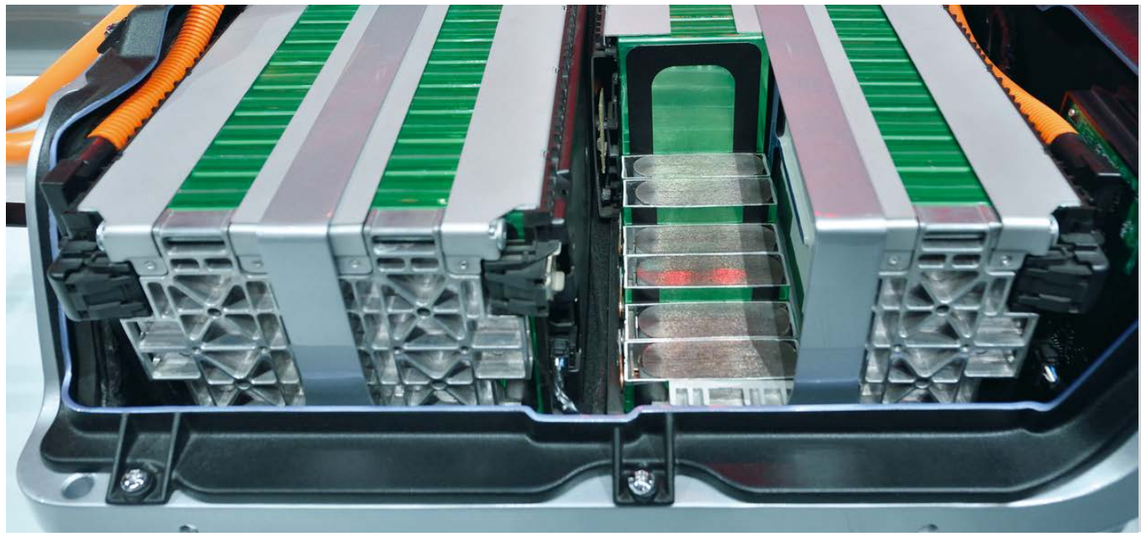
EV manufacturers currently use nickel-cobalt-aluminium (NCA) or nickel-manganese-cobalt (NMC) on passenger vehicles due to their higher density of energy, which is an essential factor when considering how far an EV can drive on a single charge.

The potential issue with cobalt batteries is the high cost of the metal and the enormous environmental cost of mining it. It is forecasted that the metal cost will rise, and the demand will also increase over the next ten years. To address this issue, there are several recycling schemes in place to recycle the batteries, but if they are expected to last half a million or one million miles, then this may not happen for 10-20 years. There are now calls for batteries to be recycled much earlier than the anticipated life span.

Another solution is to seek other materials and advance research in battery technology, which is what CATL is currently doing. CATL is working on a lithium iron phosphate (LFP) battery, which will lower its production costs and boost its battery density and safety. CATL has been working on this technology along with their cell-to-pack technology.

When are we going to see a million-mile battery in EVs?

Even though the technology is already there or "almost there", as others have claimed, we might not see them being implemented until 2030. This could be due to several factors, including current battery commitments and purchase orders. Some car manufacturers are still in that transition between ICE and EVs and could be playing catch up in the market.



Tested: charging stations for electric vehicles

Standards ensure clarity and high standards of quality. Flexible measuring instruments and connection adapters are required.
by Werner Käsmann, Beha-Amprobe

With the electric vehicle (EV) market becoming more significant in Europe over the past years, also the need for charging points is steadily increasing. Infrastructure and demand for EV's have a "chicken and egg" like relationship as the more vehicles that are on the road, the more demand there is for charging stations, but the amount of charging stations deployed can also hinder the adoption of EV's. With the EV market becoming more relevant, also the number of charging points has been steadily increasing, and according to association and media reports, there should be about 220,000 chargers by 2020 in western and northern Europe. There are numerous effects of faulty charging stations, including overloads of the power supply system, equipment and system failures and danger for people.

> "It is particularly evident from public charging stations how important initial testing and approvals as well as periodic testing are. After all, these are technical laymen who operate these systems"
>
> –Werner Käsmann, Technical Sales Manager at Fluke.

The relationship is quite simple: Each faulty charging station slows the demand for electric cars due to the unreliable supply infrastructure. If countries want to make progress on electromobility, there are no gaps in supply allowed.

Many cities throughout Europe are already responding to this with their own expansion plans as part of a balancing act in view of the shortage of parking spaces in urban areas. Each new charging station must comply with the relevant European standards for electrical systems. The general regulations that must be applied include HD 60364-6, HD 60364-7-722, HD 60364-5-54 and HD 60364-4-41 as well as HD 60364-5-52.

In accordance with HD 60364-6, all qualified electricians are obligated to perform an initial test on a low-voltage system after commissioning. The tests include measuring, inspecting and testing the different operating states of a charging station.

Standard measurement procedures include measuring the continuity of the protective earthing conductors (PE), the functionality of the RCDs and the insulation and earth resistance.

During the initial and subsequent periodic tests, it is important to know which charging mode is being used.

Four methods of charging A look into the current operating practice reveals four different wired charging modes based on system standard DIN EN 61851-1, referred to as charging modes 1, 2, 3 and 4.

EN 61851-1 describes charging mode 1 as charging with a maximum of 16 A using single-phase socket outlets with earthing contact (in most European countries Schuko-socket) or three-phase industrial sockets (e.g. CEE socket). Mode 1 is typically used to charge small electric vehicles such as e-bikes, e-motorcycles or e-scooters. In this mode a RCD (residual current device)

is stringently required.

Mode 2 describes single or three-phase AC charging with double current up to 32 A, also with household or industrial sockets. The main difference compared to mode 1 is that mode 2 uses a special charging cable with an integrated control and protective device. The IC-CPD (In-Cable Control and Protection Device) protects the user from an electrical shock caused by insulation defects if he has connected his vehicle to a power outlet that is not intended for charging.

Mode 3 covers permanently installed charging stations with a charging cable and specially designed vehicle connections of type 1 and 2. The system includes built-in safety functions, such as a residual current device (RCD). The Equipment is deployed in practice to provide a quick charge with a single or three-phase alternating current of up to 32 A for all commonly used electric vehicles.

In contrast to charging mode 3, mode 4 charges vehicle batteries with up to 400 A DC. For this purpose, the charger is integrated into the station. The other structural features are similar to mode 3: Permanently installed charging station with fixed charging cable, lockable plug-in connections (Combo 2 or CHAdeMO) as well as protective functions within the charging station.

> “It is advisable to add additional evaluation of the durability of plug-in devices”

explains Werner Käsmann.

Standards: ensure clarity and high standards of Quality In general, for electrical planning, connections with power ratings above 2 kW have their own circuit.

In assessments of single-phase charging stations, the diversity factor is 1. It should also be noted that socket outlets with earthing contact for household purposes use can only be used for short periods with a maximum current of 16 A. If continuous power up to 3.7 kW is required, socket outlets with suitable protections are used (e.g. CEE 16/3). The design of the supply cable must also comply with HD 60364-5-52. This also includes temperature evaluation after one hour of continuous operation. A maximum temperature increase of 45 Kelvin is tolerable. Possible fire loads can be easily identified using the latest technology. For these purposes Fluke has developed the new PTi120 thermal imaging camera. Its values can then be easily evaluated and assigned in conjunction with the new Fluke Connect asset tagging software.

Charging mode simulation
When testing charging stations, the results must accurately and repeatable represent the actual charging processes. Consequently, an electric vehicle must be simulated during testing at a charging station, as the charging station will not release a charging voltage without vehicle simulation. Fluke has developed the Beha Amprobe EV-520-D test adapter kit for this purpose. The kit simulates the vehicle as well as different charging cable cross sections for power outputs of up to 22 kW.

Once the charging voltage is released, the tests can be carried out at the charging station outlet using the measuring adapter and the installation tester. In addition, the initial test includes a visual inspection and low-resistance measurement of the protective earth (PE) and equipotential bonding conductor up to the charging station and to the charging connection.

Measuring adapter: it makes the real difference
The test Adapter kit Beha Amprobe EV-520-D differs from other products on the market by his adaptability. With the adapter, test single-phase charging stations can be tested with a type 1 socket in the same way as charging stations that have type 2 sockets installed. The EV-520-D can also be used for stations with permanently connected charging lines and type 2 charging interfaces. Despite the large number of charging station manufacturers, the kit can still offer this level of flexibility because it allows varying test simulations and cable cross sections to be set. Both connections for the control pilot signal output (CP) are used during commissioning. The pilot signal (PWM) is checked to ensure that it is communicating correctly with the vehicle to be charged.

Overall, the Beha-Amprobe solution can test a huge variety of charging stations with just one test adapter. To ensure durability and operational reliability, especially in outdoor areas, the EV-520-D is equipped with 4-mm dust and water-protected measuring sockets. The PE pre-test function is one of the highlights of the kit. It enables an initial assessment of a possible presence of voltage on the protective earth conductor (PE), which makes it especially useful during operation.

In practice: test sequence during commissioning
Once the visual inspection and low-resistance measurement have been completed and the charging voltage is switched off, an active measurement can be carried out on the test adapter using the Beha Amprobe Pro-Install 200 installation tester.

The sequence of test steps to be followed is defined by the standard HD 60364-6. A test always starts with a visual inspection. The continuity of the protective earth conductors (PE) and their connections must be carried out by measuring the resistance with a test current of at least 200 mA. The specifications for evaluating the measurement results are evaluated in accordance with HD 60364-6, Annex A, Table A.1 based on the cable length and the cross section. The insulation measurement can only be carried out after this measurement.

Depending on the design of the system, the fault loop impedance must be measured and evaluated in relation to the upstream protective device in order to be protected by automatic shutdown. Since the installation of charging stations involves a special type of system, the specification for the selection of an RCD given in HD 60364-7-722, which specifies the use of RCD type B when DC fault currents occur, should be observed.

This must then be checked for compliance with the shut-down conditions using the relevant test procedure. If counting devices are installed, the rotating field must then also be checked. A load can also be connected to the test adapter and the power socket on the rear. This can then be used to check that the energy detection system is functioning correctly.

Beha-Amprobe

In practice: periodic verification
Clause 6.5 of HD 60364-6 must be followed for periodic verification. If the periodic tests include electrical safety as well as the operating states of the pilot signal in accordance with EN 61851-1, then the PWM signal must also be measured using an oscilloscope. The graphical signal display provides the user with important information about possible faults in the communication between the vehicle and the charging station. If an external interference occurs due to a fault in the mains, the Fluke 125B ScopeMeter will accurately display the interference. This means that the existing measurement system, charging adapters, installation testers and portable oscilloscopes are a valuable investment for quickly finding and fixing faults in the charging infrastructure.

Conclusion
Electric vehicles are here to stay, but installing and commissioning the necessary charging stations requires electricians to have a suitable level of expertise. This applies to both the private and public sectors. Public charging stations especially demonstrate how important initial tests and regular periodic tests are, as public sites are operated by laymen. In the future, it will become increasingly important to be able to determine a fault in charging circuits safely and quickly using flexible measuring technology.

Compact Fluke PTi120 Pocket Thermal Camera

The bigger the problem, the faster you need to solve it. The new Fluke Pocket Thermal Imager puts the power to minimize downtime in everyone's hands with the right tool at the right time. As the first line of defense for easy troubleshooting, the PTi120 empowers you to stop fighting fires on the job and start preventing them.

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Test Adapter Kit for EV Charging Stations

The EV-500 Series Test Adapter Kits are designed to test function and safety of charging stations mode 3 for AC charging. The Adapter Kit allows you to conduct tests in combination with appropriate test instruments like an installation tester.

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Supercapacitors – the future of energy storage?

Benn Hodgkiss
Product Manager

By Benn Hodgkiss, Distrelec Product Manager for Passive components

Traditionally, when we think of storing energy we automatically look to batteries. Due to their chemical characteristics, batteries take time to charge up, and this is particular the case with Lithium Polymer batteries. Therefore, Lithium-Ion batteries are better suited for the EV market, with their high-power density and lack of memory effect, which is when batteries become harder to charge over time. However, despite these features, batteries are not always suited for some vehicles such as hybrids. This is where capacitors can be applied with great effect. As we already know from using capacitors in electrical circuits, they have the ability to rapidly charge and discharge as required. This is why they are best suited for hybrid vehicles that require a large amount of energy in the shortest time, and why this gap is being more commonly filled by supercapacitors.

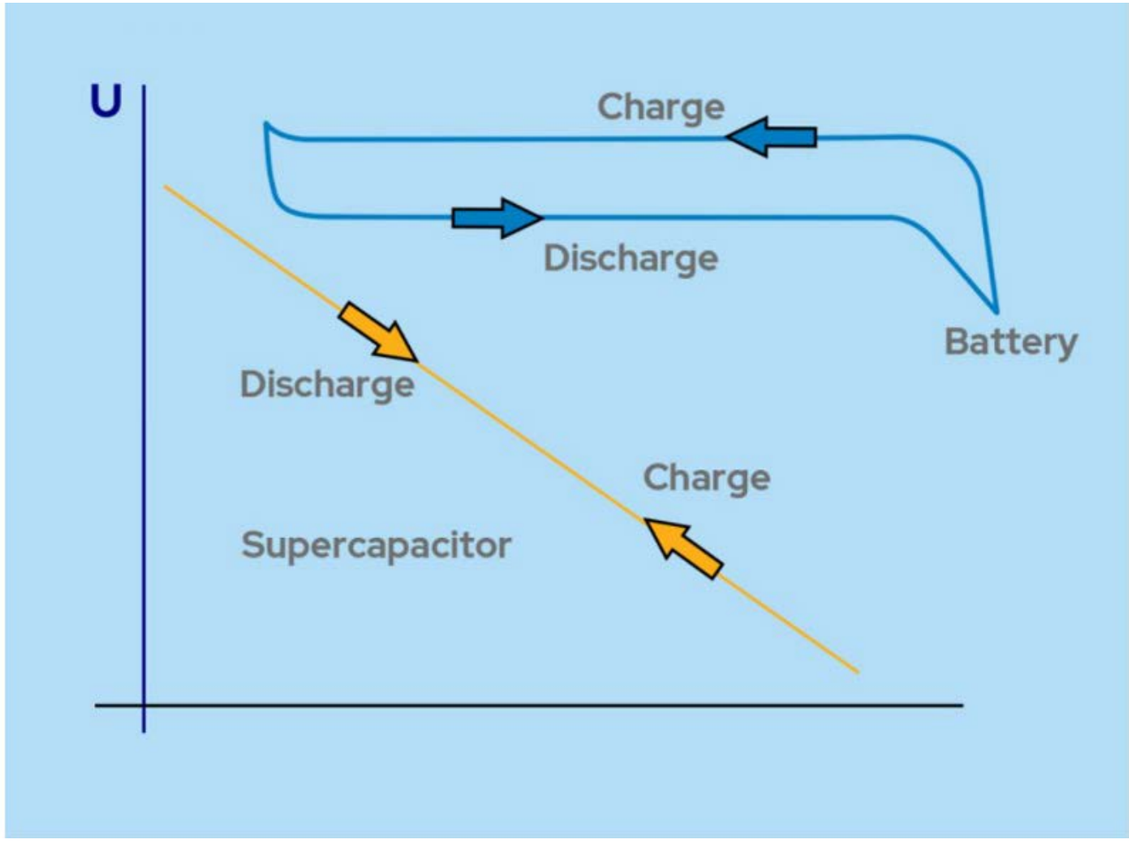
What are supercapacitors?
Supercapacitors (or ultracapacitors) are broadly different from traditional capacitors in two ways: they have a bigger plate area as well as a tighter gap between these plates because the separator behaves slightly differently from a standard dielectric. In an ordinary capacitor, there are two plates coated with a metal porous material to give a larger area for storing charge, separated using a thick plastic film or ceramic dielectric. As the capacitor is charged, the electric field is created from the positive charge forming on one plate and the negative on the other. This then polarises the dielectric and aligns the molecules in the opposite direction to the field, reducing its strength and allowing the plates to store more charge.

In a supercapacitor, there is no dielectric in the traditional way. Instead, there are two plates soaked in an electrolyte and separated by a much thinner inductor (usually plastic or paper). When the plates in a supercapacitor are charged, the opposite charge forms on both sides of the inductor. This has been referred to as an 'electric double layer', and for this reason you may also see supercapacitors referred to as double layered capacitors. The combination of the following features allows supercapacitors to achieve a much greater capacitance level:

- Plates with a bigger and more effective surface area
- Reduced distanced between the plates

Battery vs supercapacitor
Supercapacitors also have characteristics that are common to both batteries and traditional capacitors. The key difference between the two is that batteries have a higher density (storing more energy per mass) whilst capacitors have a higher power density (releasing and store energy more quickly).

Supercapacitors have the highest available capacitance values per volume and greatest energy density of all capacitors. The power



density of a supercapacitor is generally 10 times greater than a conventional battery, which means that they are capable of much quicker charge/discharge cycles, simplified charging circuitry, significantly longer cycle life, wider operating temperature range, and a high peak discharge rate for loads that require high power for a short duration. The technology is increasingly coming more in line with the properties of a traditional rechargeable battery and is forming a hybrid in the space between the standard capacitor and battery. This means they are also well suited to parallel connection with batteries to take the best features of both. If you need to store a reasonable amount of energy for a relatively short period of time (from a few seconds to a few minutes), you've got too much energy to store in a capacitor and you've not got time to charge a battery, a supercapacitor may be just what you need.

Current use and future
Supercapacitors are becoming ever present in general consumer devices as the cost has started to come more in-line with

Supercapacitors

batteries. They provide everything from back-up power for mobile phones to battery life extensions for devices that sometimes need quick bursts of power like a digital camera's zoom feature.

They are also becoming commonly used in more demanding applications for power and energy requirements such as:

Memory backup in electronic equipment to help manage low power input
Electric Vehicle applicationsthatoftenneed short, high current power
Recovery of braking energy for vehicles such as buses and train
Energy harvesting in wind and solar to help smooth out intermittent power supplies

However, their uses can go far beyond this and they are increasingly being seen as a genuine replacement for batteries as part of the Green Energy Drive in energy harvesting and electric vehicles.

SPSCAP are the forefront of this technology with their module series of capacitors. Already this technology is being widely used in hybrid buses, plug-in hybrid buses, dual-

source trolley buses, fuel cell buses, school buses and other commercial vehicles. The ultracapacitor modules can be used as efficient, highly reliable, safe, and intelligent energy storage units for starting, acceleration and braking energy recovery. These principles are also now being trialled in trams and trains to further fuel this conversion.

Furthermore, as the IoT continues to accelerate, devices that are a part of the network will most probably rely on some form of energy harvesting for their continuous use and power management. It is likely that supercapacitors, with their small form but powerful storage capabilities, will be integral to this. The development of a 'flexible' supercapacitor (with no loss of features) is also currently ongoing, promising endless applications. This could be crucial for the future of not only the IoT but wearables, portable consumer goods and medical tracking systems and devices.

Supercapacitors

Eaton Hybrid Supercapacitors

A new generation of energy storage components combining the benefits of Li-ion batteries with long life and reliability of symmetric supercapacitors.

Shop now

Vishay 196 HVC Series Energy Storage Capacitors

This series was created to give designers an energy storage solution that overcomes the limitations of rechargeable batteries and supercapacitors.

Shop now

KEMET FT Series Supercapacitors

These devices are best suited to embedded microprocessor systems with flash memory.

Shop now

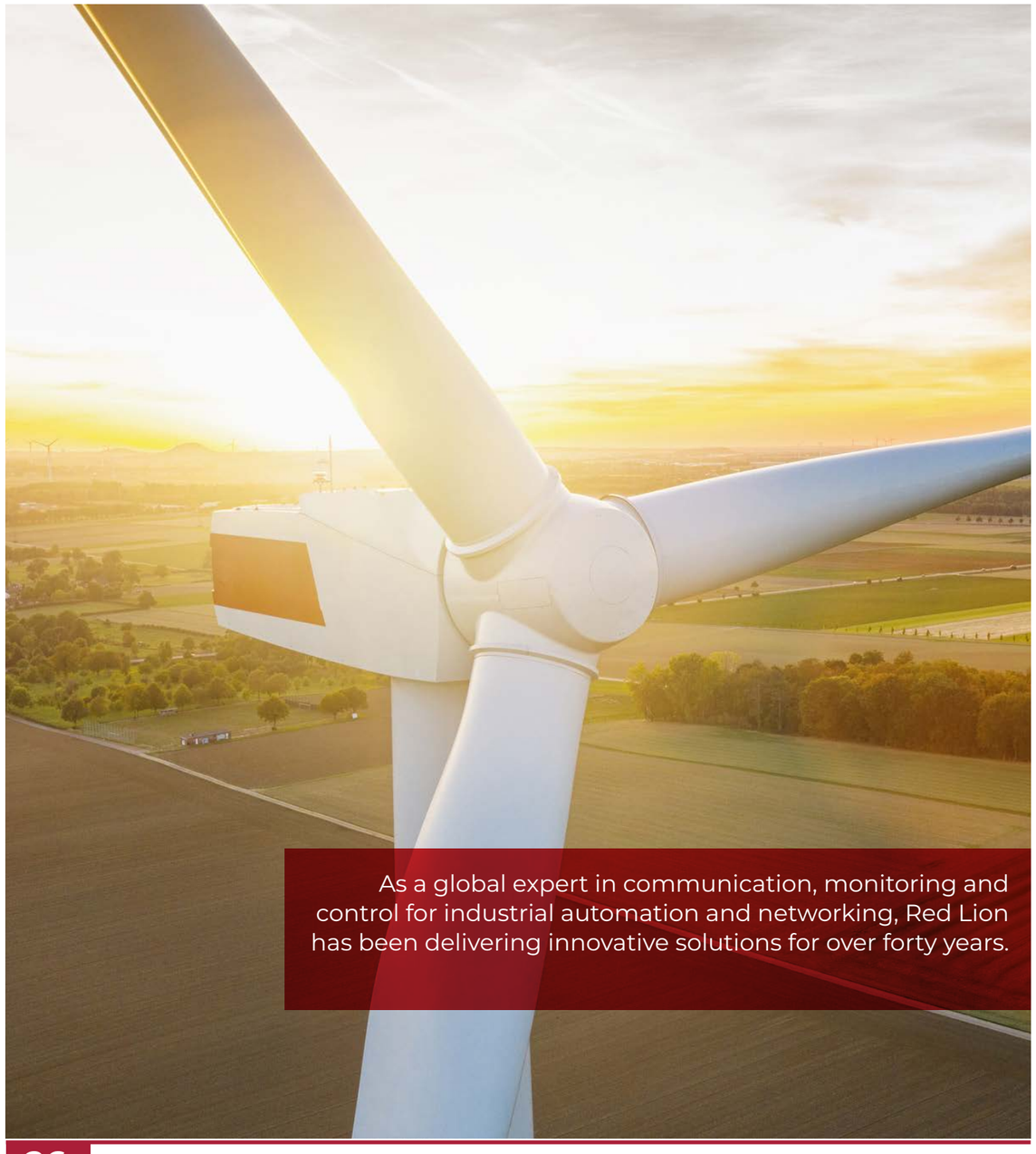
SPSCAP Module Supercapacitors

These devices offer supreme power and over 1,000,000 duty cycles at the forefront of the green revolution.

Shop now

Alternate Energy

Connect, monitor and control diverse remote sites and processes
by [Red Lion]



As a global expert in communication, monitoring and control for industrial automation and networking, Red Lion has been delivering innovative solutions for over forty years.

Alternate Energy

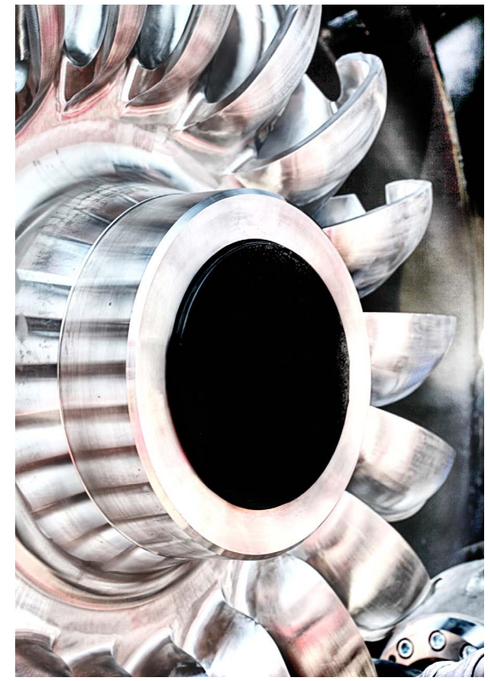
Alternative Energy
Alternative energy is a growing sector of the world's power supply. For wind, solar and hydro sources to reliably scale, production must become more dependable and cost effective. Energy sources of the future will require next-generation infrastructures. Red Lion Controls gives producers the ability to remotely connect, monitor and control all types of assets, from wind turbines to solar panels to submersible hydroelectric generators.

Because key production variables change by the second, operators need real-time data collection, communication and control systems. The controls used to run traditional power generation operations are giving way to more intelligent, powerful and standardized systems. Red Lion's industrial automation and networking solutions include Ethernet switches that quickly transfer and process data, Wi-Fi and cellular routers for wireless access to remote assets and HMIs that enable organizations to monitor status in real time.

Reliable data access and communications provide operators with the information they need to instantly adjust blades, turbines and valves to maximize power generation and monitor equipment health. Timely access to remote data is essential to predicting required maintenance and minimizing costly down time. Our software and configuration tools make it easy to integrate intelligent new equipment monitoring capabilities with existing SCADA, maintenance management and other systems.

Built for reliability and ease of use, our rugged industrial products deliver the performance required to help ensure infrastructures stay up and running. This is why Red Lion is considered as one of the industrial automation and networking leaders within the Alternative Energy industry. As a trusted partner, we help organizations worldwide develop systems that improve output efficiency and reduce downtime.

Companies worldwide rely on Red Lion to keep systems running safely and reliably around the clock, regardless of location. Red Lion offers intelligent industrial solutions that provide the connectivity, monitoring and control required to get the job done across Alternative Energy applications that include:



Wind Power
Building real-time intelligence, communication and control capabilities into wind turbines helps improve uptime and efficiency in several ways. Gearbox failures, for example, can be prevented by using programmable controls to continually monitor oil temperature, pressure and variables from other sensors. An application on the controller can automatically initiate corrective action as condition thresholds are reached. Turbine problems can be prevented and efficiency can be improved by monitoring and correcting for excessive vibration, over speed and braking, while optimizing

output by automatically adjusting pitch and yaw of the blades. Even bird strikes can be dealt with more efficiently by integrating Ethernet or wireless communications with video cameras, enabling blades to be inspected remotely without the need to send a technician to the site after sensors detect an event.

Solar Power
Proactively prevent problems by adding the ability to respond instantly to troubling changes in temperature or other performance indicators. Panels, transformers, inverters and other components can be monitored in real time. With the ability to receive and process input from multiple remote I/Os, operators can detect leaks, blocked panels and other problems and correct them quickly to minimize loss. Remote video surveillance can be integrated with control systems to see what is causing shade or other problems and determine if a technician needs to be dispatched. Control systems provide the data to accurately diagnose problems and plan the appropriate response to maximize labor efficiency.

Hydro Power
Remote monitoring and control capabilities can be extended to hydroelectric generators and the underwater components that power them. Tidal turbine blades can be automatically adjusted depending on the strength and direction of the tide using input from sensors connected through the network. The pressure and flow through various valves, pumps and pipes can also be monitored and controlled in real time to keep operations within safe and efficient parameters. Intelligent systems not only provide real-time control, but help long-term maintenance by collecting performance data via open protocols to provide data to other monitoring, predictive maintenance and M2M communication systems.

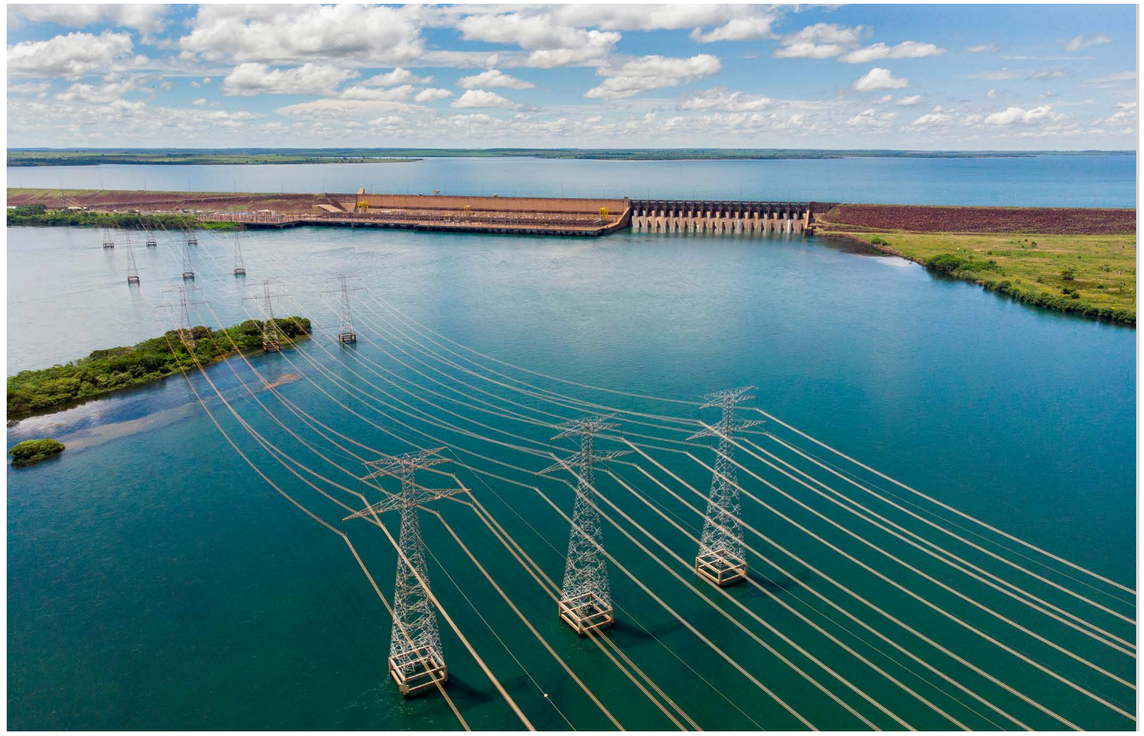
Red Lion can put you on the path to improved productivity and reliability with industrial automation and networking products that give you the ability to seamlessly connect, monitor and control your operations.

Connect
Connectivity is at the heart of what Red Lion does, from our industry-leading line of Ethernet, Wi-Fi and cellular M2M products to the extensive protocol support and connectivity options that are built into our RTUs and HMIs. You'll find secure reliable communications options that provide visibility into remote operations, collect performance data from critical assets, and enable complete remote maintenance and troubleshooting. Ethernet and cellular technology allow for the seamless connection of numerous I/O devices regardless of location. We offer industrial Ethernet switches, Wi-Fi radios, cellular routers and other communications products. Supported standards include Ethernet, USB, RS-232 and RS-485 communications, HSPA, GSM, GPRS and EDGE cellular, 802.11a/b/g/n Wi-Fi and others. Red Lion's feature-rich products include:

- N-Tron® and Sixnet® series industrial Ethernet switches available in managed, unmanaged, monitored and PoE models.
- Red Lion HMIs deliver the widest range of protocol support in the industry and have native drivers for hundreds of industrial control products used in Alternative Energy operations.

Many of our products offer security features that meet NERC CIP requirements, including 1024-bit encryption, 802.1x compatibility, VPN support and IP blacklisting. With products that enable the easy retrieval and logging of critical telemetry data, our industrial solutions provide real-time remote access to "always-on" monitoring equipment located in the field. The end result is streamlined data collection and improved network

Alternate Energy



uptime, which improves safety and productivity by reducing the need for site visits.

Monitor
The protocols that our HMIs, panel displays and other products support make it easy to monitor multiple devices whether you are at the point of activity or thousands of miles away. You can get a true picture of performance by using the native drivers that are built into our HMIs to get data and status information from equipment, without having to add a protocol converter. By using our flexible Crimson® software or programmable RTUs, you can seamlessly take advantage of real-time data to create new applications that optimize performance and uptime. Red Lion's comprehensive support and flexibility take time out of installation and integration and add new capabilities to existing equipment.

- Red Lion HMIs not only provide sleek displays, but can also double as data loggers to collect information for statistical analysis. And, with a built-in webserver, you can easily monitor your installations on mobile devices.
- Crimson HMI configuration software includes drivers for over 250 protocols, allowing complete integration with virtually any PLC, PAC, RTU or motor drive controller.
- Our products can even monitor themselves through self-diagnostic capabilities. For example, native support of the N-Tron® series N-View protocol allows our HMIs to monitor and display port-level status of N-Tron® series Ethernet switches.

The ability to process input from more sources

Alternate Energy

and integrate with more systems and applications gives Red Lion customers the unmatched ability to monitor operations in real time and benefit from increased visibility.

Control

Red Lion's powerful control features for valves, pumps, gearboxes, solar panels and other equipment have already been highlighted. But controlling equipment and processes is only one requirement for RTUs and other industrial automation products. They should also help operators control costs. Red Lion products do that with features that minimize deployment, integration and support.

First, our products help reduce capital equipment costs by performing multiple roles:

- Red Lion HMIs serve as protocol converters;
- HMIs and Sixnet® series RTUs provide data logging functionality;

Because our products fulfill multiple roles, our customers have fewer devices to install, power, monitor and maintain. Second, we make our products easy to integrate by providing flexible configuration options, supporting open standards and leading protocols, and simplifying application development through software tools and preconfigured drivers. A product sampling follows:

- Sixnet® series RTUs feature a Linux operating system so there are no proprietary operating systems and development environments to learn, and support multiple communication options, including Modbus and DNP3 for tight integration with enterprise systems.
- Our process control product line includes RTUs, distributed I/O modules and controllers that can enhance existing PLCs or form the foundation of advanced new control systems.
- Multifunctional capabilities plus various wireless and Ethernet connectivity options enable our products to play key roles in M2M systems.

While wind, sun and the flow of water are all variable, Alternative Energy producers can ensure there is a steady flow of data to keep their operations running at peak efficiency. By building intelligence, control and communications capabilities intocomponentsandsystems, organizations can break free from the constraints of weather conditions or limited technician availability. Red Lion has the tools and expertise to allow you to connect, monitor and control assets even in the most remote and challenging environments. We can help produce the uninterrupted flow of data that is essential in keeping production consistent and reliable.

Red Lion

NT4008 Industrial managed switches

Red Lion's NT4008 gigabit managed industrial ethernet switches are certified to met PROFINET PNIO V2.34 conformance Class B (CC-B), RT Class 1 standards to ensure seamless integration into PROFINET networks using standard PLC configuration and managment tools.

Shop now

DAx0D Protocol convertor

The DA10D and DA30D Data Stations provide powerful protocol conversion and data acquisition capabilities to unlock valuable data from orphaned or legacy equipment and share with plant floor, enterprise or cloud platforms with ease.

Shop now

ST-IPM-8460 Remote terminal controller unit 30V

The SIXTRAK® ST-IPM-8460 Industrial RTU provides powerful control for many automation applications. With many serial and Ethernet ports, the ST-IPM-8460 reliably controls processes in harsh environments.

Shop now

Indoor HMI Operator Panel, 24V 10" 640 x 480 IP66

The Graphite® operator panels are the industry's first rugged HMI touchscreens to combine I/O modules with protocol conversion, data logging, web-based monitoring and IEC 61131 control capabilities.

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Honeywell Launches First Autonomous Building Sustainability Solution To Fight Rising Global Energy Consumption

Machine learning autonomously adjusts building energy settings to deliver up to double-digit energy savings and a seamless occupant experience

Honeywell announced the launch of Honeywell Forge Energy Optimization, a cloud-based, closed-loop, machine learning solution that continuously studies a building's energy consumption patterns and automatically adjusts to optimal energy saving settings without compromising occupant comfort levels. Honeywell Forge Energy Optimization, the first autonomous building solution focused on decreasing energy consumption, may deliver double-digit energy savings, decrease a building's carbon footprint, and can be implemented without significant upfront capital expenses or changes to a building's current operational processes.

System Agnostic Optimization and Advancing the Latest Building IoT Technologies

During a pilot at Hamdan Bin Mohammed Smart University (HBMSU) in Dubai, United Arab Emirates, Honeywell Forge Energy Optimization demonstrated an initial 10% energy savings. HBMSU is the first accredited smart university in the UAE and is known for its technology and innovation programs.

Honeywell Forge Energy Optimization was applied to HBMSU's existing building management system, which uses competitor technology to demonstrate the platform's open architecture and hardware-agnostic capabilities. The additional energy savings is especially significant because HBMSU is regarded as a highly smart, energy efficient building with fully connected lighting, cooling, building management, power and efficiency control that is optimized based on real-time occupancy. The pilot also uncovered local control issues with the chiller plant and fresh air handling unit that were not adjusting to set points.

"As a smart university, we look to deploy the latest technology across our campus and ensure our buildings are efficient. We were pleasantly surprised by the results we saw from Honeywell Forge and its ability to drive further energy savings beyond our achievable optimization with the techniques we have,"

Dr. Mansoor Al Awar, Chancellor of Hamdan Bin Mohammed Smart University.

"Our further partnership with Honeywell will help to support the advancement of artificial intelligence (AI) modeling for building automation and provide our students with first-hand applications of how AI and machine learning (ML) will drive operational efficiencies in buildings. Our goal is to collaborate with leading organizations like Honeywell that support our vision of educating the innovators of tomorrow."

"Buildings aren't static steel and concrete – they're dynamic ecosystems and their energy needs fluctuate based on ever-changing variables like weather and occupancy,"

David Trice, vice president and general manager, Honeywell Connected Buildings.

"With Honeywell Forge Energy Optimization, we're evolving building operations far beyond what would be possible even with a robust team of engineers and the rules they code in their building management system. By employing the latest self-learning algorithms coupled with autonomous control, we can help building portfolio owners fine-tune their energy expenditures to drive efficiencies and create more sustainable practices for our customers."

Achieving Energy Savings Beyond Standard Techniques

Energy consumption in commercial buildings is a significant issue because these buildings account for more than 36% of global final energy consumption and nearly 40% of total direct and indirect CO2 emissions.1 Additionally, heating, ventilation and air conditioning (HVAC) often presents the largest opportunity for energy savings in a commercial building.2

Honeywell Forge Energy Optimization autonomously and continually optimizes a building's internal set points across hundreds of assets every 15 minutes to evaluate whether a building's HVAC system is running at peak efficiency. When Honeywell's solution finds a need to make an adjustment, it analyzes factors such as time of day, weather, occupancy levels, and dozens of other data points to determine the optimal settings per building and makes calculated decisions 96 times per 24-hour period for every building in a portfolio, 365 days a year across the system of assets. Repeated results have shown double-digit reductions of HVAC-related consumption while not impacting customer comfort.

Traditional HVAC control solutions incorporate varying levels of sophistication. The most basic involve static set

points that don't account for variable factors such as occupancy or weather. The second, and most common, rely on scheduled set-point adjustments using estimated occupancy and climate conditions. Finally, set points can be managed by a certified energy manager; however, most facilities have not found this solution to produce a viable return on investment due to the sheer volume of variables involved and the difficulty in producing accurate calculations in any scalable manner.

Honeywell Forge Energy Optimization is simple for building portfolio owners to deploy with plug-and-play capabilities. No changes to business mechanics are needed and there's no need to rip and replace systems to add Energy Optimization to a building.

Ultra-High Wattage Power Supply System for Synchrotron Light Source Facility

By Mean Well

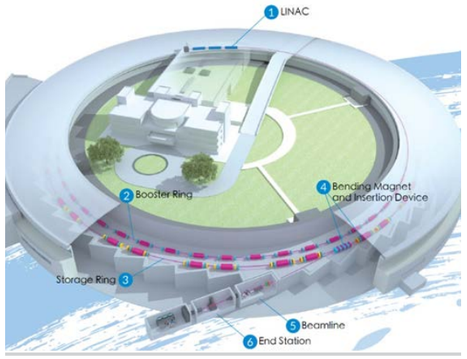
Proven Case Study

In 2020, MEAN WELL's system power solution successfully won one government tender contract for Taiwan Photon Source (TPS) Synchrotron, as DC power supply system for the RF amplifier system within the synchrotron. This power system provides ultra-high energy for electrons to be accelerated to near light speed. Figure 1 shows a common ring structure of a synchronous (electron) accelerator. The inner side is booster ring, and the outer side is storage ring from which multiple experimental stations branch out.

Synchrotron Applications

The ultra-high brightness and wide bandwidth spectrum of light source (far-infrared to hard X-ray) generated by the synchrotron can be widely used for experiments in the fields of physics, chemistry, materials, chemical engineering, biology, medicine, geology, archaeology, environmental protection, energy, electronics, micro-electromechanical systems (MEMS), nanoscale devices, and etc. It is an indispensable tool for leading-edge fundamental scientific research, biomedical technology and industrial applications in the 21st century. It has contributed to the study of lithium materials achieving long-lasting battery which is essential to the global electric vehicle market nowadays. Additionally, it further helps the deep understanding at research of nanotechnology for which is key element of semiconductor materials and biomedical relevant products development.

Figure 2 shows the illustration of the synchrotron



of TPS for which it mainly consists of Linear Accelerator (LINAC), Booster Ring and Storage Ring. The source produces the particles which are propelled up to speed in a LINAC before they are injected into a booster ring to be accelerated further. The particle beams then enter the storage ring, which maintains their speed. In case particle beams are diverted at speeds close to the speed of light, it emits part of the energy as synchrotron radiation in the form of electromagnetic waves. Depending on requirements,

the super bright beams are then diverted into the beamline to perform the experiment or application in the end station. RF amplifier system is to compensate the power loss of the particle beams in the storage ring due to the emission of synchrotron radiation by which a signal picked up on ring can be amplified and fed back in on the opposite side of the ring at a dedicated phase angle. The feedback loop helps to reduce the size and energy distribution. MEAN WELL system power solution is installed and applied as the DC power source for the RF amplifier system in the storage ring.

The plan of project is to use multiple sets of 96kW high-power power supply system shown in Figure 3. The output from the power system is for driving solid-state RF power amplifier clusters shown in Figure 4 which generates high-frequency energy for boosting electrons to travel at nearly light speed shown in Figure 5. The maximum output DC power of whole system is up to 800kW!

Figure 3

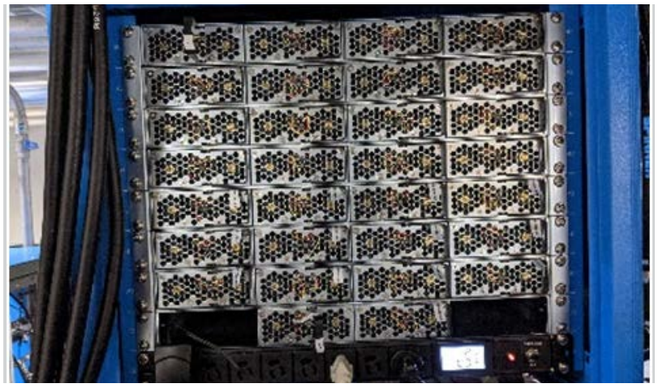


Figure 4

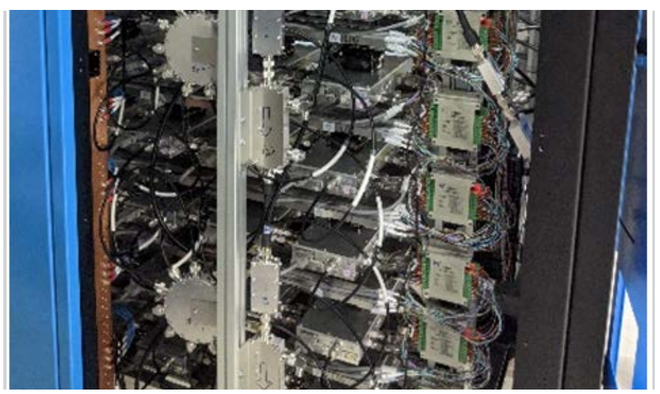
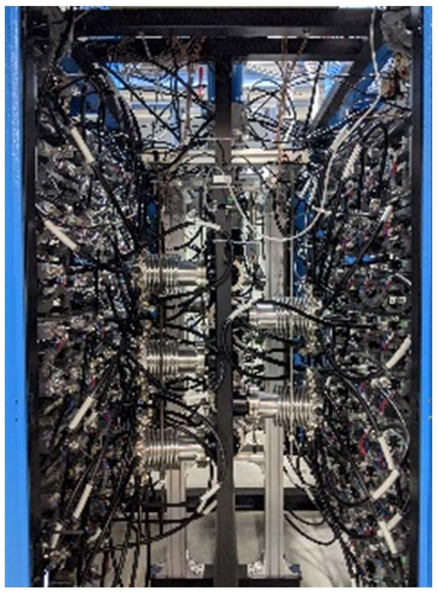


Figure 5



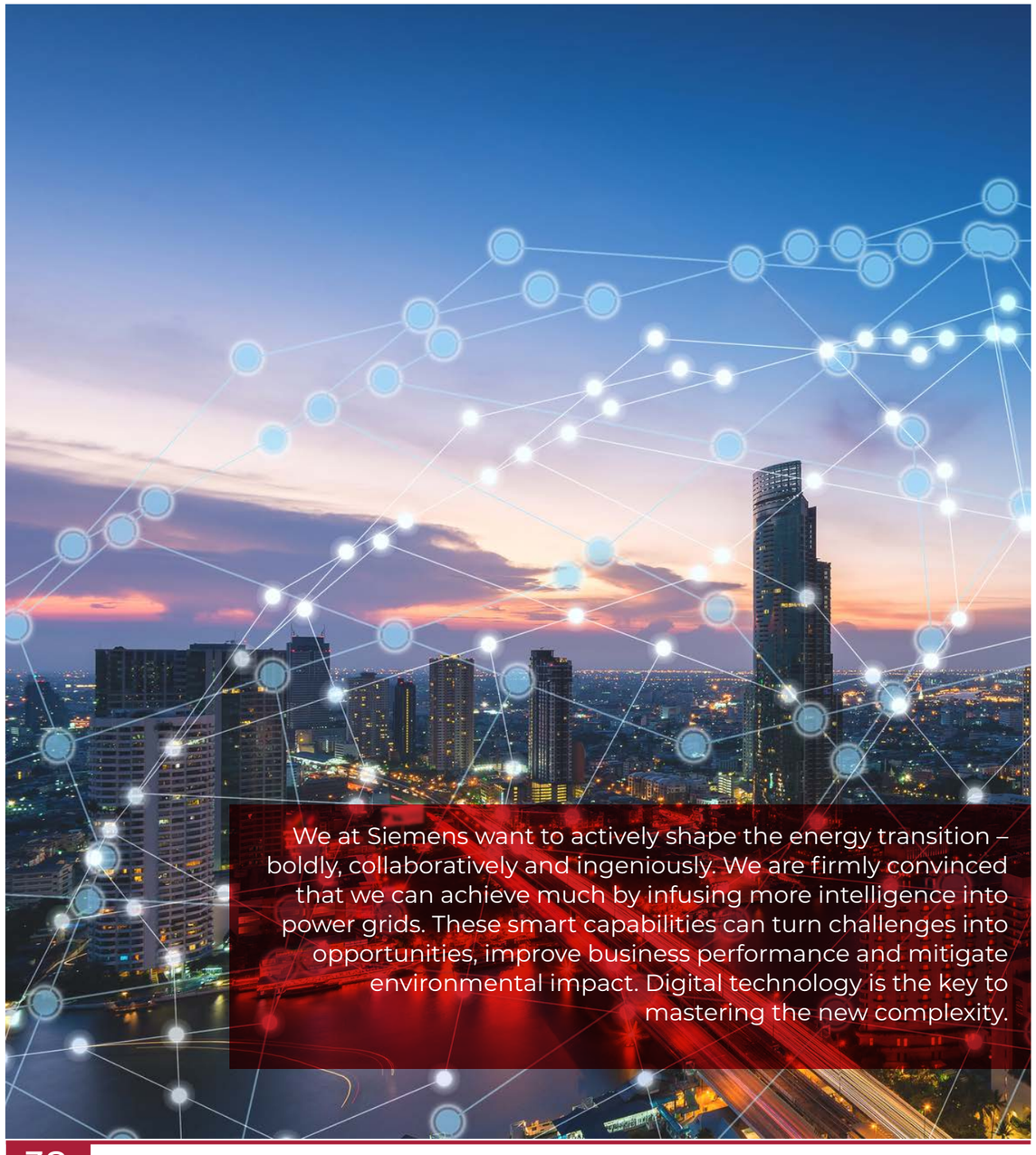
To match RF power required by the storage ring and best power efficiency, the output voltage of the power system must be adjustable between 42Vdc to 54Vdc modulation range for each operating point with specific RF power level to achieve best result. The DRP-3200 series equipped with CANbus, digital communication protocol, can achieve the requirement on precise voltage trimming.

Furthermore, the bus voltage of each set of power system needs to be adjusted synchronously during experiments provided they are not connected in parallel. To achieve it, the external controllers are implemented for remote control. Another challenge is that the accuracy of output power is limited to +/- 1% after trimming. To accomplish it, power supply with fully digital design and communication protocol makes it possible for control and monitoring the system remotely through Ethernet!

Another important factor that DRP-3200-48 being selected is because of its extremely high efficiency which is in line with international trends for energy saving and environmental protection. An increased 0.5% on efficiency of every single power supply in an 800kW system, it will bring substantial economic result and benefit in the case of long-term operation.

Energy intelligence – Tapping the potential of a smart energy world

By Siemens Switzerland



We at Siemens want to actively shape the energy transition – boldly, collaboratively and ingeniously. We are firmly convinced that we can achieve much by infusing more intelligence into power grids. These smart capabilities can turn challenges into opportunities, improve business performance and mitigate environmental impact. Digital technology is the key to mastering the new complexity.

As a result of social and economic developments such as urbanization and climate change, electricity will have to account for an increasing share of our general energy consumption. This is leading to a radical transformation of the energy landscape that is shaped by three major trends: decarbonization, decentralization and digitalization. A deep understanding of each of these trends is essential so that every market player can take the right decisions and actions to maximize value creation.

Decarbonization

The commitment towards a green future has never been stronger. Political agendas, new regulations, industry initiatives and a broad societal consensus support the significant reduction of CO2 emissions. This can be achieved by further electrifying all major energy-consuming sectors – transportation, buildings, and commercial as well as industrial facilities. But we must ensure that this electricity is generated by renewables like wind or solar and that energy efficiency potential is used to the fullest extent. Several examples show that this development is already underway: · The European Commission has raised the ambition to reach net zero emissions by 2050. From 30 % today, renewable generation is expected to meet over 80 % of the EU's future energy needs.1 · In the US, 11 states and over 200 cities have already committed to 100 % renewable energy targets, and major utilities have pledged to reduce their carbon emissions by 80 % in 2050.2 · Large companies like Walmart, Apple, and Microsoft have contracted more than

19.5 GW of clean energy to achieve their 100 % renewable goals.3 Decarbonization will be driven by the growing share of renewables in the energy mix, advances in storage technologies and changes in demand patterns. Connecting renewable generation and loads like power2heat, e-mobility or buildings, which are responsible for 40% of global energy consumption4 alone, will change the traditional load and production profiles (e.g. residual duck curve) or could overload the current infrastructure. The resulting voltage and frequency balancing as well as congestion management require new investments into the grid, but also new ideas and principles relating to system planning and operation. Although this makes grid operations more complex, it offers attractive business opportunities like providing energy management services, smart hardware for consumers (e.g. smart thermostats, intelligent HVAC, private storage) or new flexibility solutions for the grid. Private and commercial consumers can actively contribute to climate protection and capitalize on lower energy consumption or the active participation in energy markets.

Decentralization

An inherent effect of decarbonization is the dramatic transformation of the energy system into a heterogeneous, interconnected network of large- as well as small-scale generation sites, storage facilities and other flexible

loads (e.g. electric vehicles, smart buildings). Driven by more data, bi-directional communication and smart devices, the focus of attention moves further to the edge of the grid, where intelligent prosumers play an increasingly important role. The economic benefits (e.g. ease of financing and faster time-to-grid of small-scale, decentralized assets) and the positive effects on the environment as well as a higher degree of independence from the grid are strengthening the robust position of distributed energy resources (DERs). It is estimated that the vast majority of all distributed energy resources are and will most likely continue to be connected at distribution grid level, in the form of many small-scale installations from commercial and industrial (C&I) and private households.5 In Germany alone, the approximately 245 fossil power plants (with over 50 megawatts each) are offset by over 31,000 wind power plants and 1.7 million PV plants.6 This enables new market roles and business models. Aggregators can pool and manage these DERs to ensure a secure, cheap and reliable power supply. The combination of generation, storage and loads in a microgrid can help developing countries to

leap-frog centralized energy systems and electrify rural areas with local value added efficiently and sustainably. In a next step, the availability of DERs may lead to peer-to-peer-trading solutions. The electrification of our society and the rise of DERs directly create the urgent need to balance demand and production more actively than ever before. Large-scale, fossil and pumped-storage hydro power generation resources will focus on providing backup power and stabilizing the grid. Close collaboration and a seamless exchange of information between transmission and distribution system operators will play a key role in successfully managing the grid. A modern digitalized infrastructure and intelligent software solutions are cornerstones for a future-proof, decentralized and decarbonized electricity grid.

Digitalization

The rise of smart devices and the utilization of the billions of data points has already disrupted many industries and the energy world will not be excluded. Just imagine that the amount of data from one million smart meters, which collect data every 15 minutes, accumulates to over 2,900 terabytes per year.7 A networked system of smart energy infrastructure (e.g. generation units, storage, buildings, electric vehicles, automated distribution equipment) is often referred to as the “Internet of Energy (IoE)”. The aim of IoE is to collect and organize the information from individual devices at the edge of the grid across the network and make it available to all relevant participants. On a grid level, a digital representation of the physical infrastructure, advanced data analysis and forecasting (e.g. weather, traffic, consumption patterns) can be leveraged to plan and use the infrastructure more efficiently, defer grid investments, manage constraints, detect faults, minimize outage times, and enhance flexibility. Together with operational data from the substation, condition monitoring and predictive maintenance can prolong

the lifespan of the equipment and reduce maintenance costs. Connected, controllable actuators allow the coordination of supply and demand autonomously, perfectly leveraging the available resources. The combination of data and automation even enables new business models (e.g. energyas-a-service) and revenue streams. But with more and more connected devices, the energy systems become susceptible to cyber-attacks. Ensuring the highest security standards regarding systems and customer data is a huge challenge, which requires the collaboration of all involved parties from regulators to system operatorsaswellasprosumers and device manufacturers.

Grid edge – the main stage of transformation

The effects of these trends vividly manifest at the grid edge, as we move from a centralized energy system to one that is more decentralized, decarbonized, intelligent, local and efficient. When we speak of the grid edge, we refer to the many connected technologies that exist at the interface between the energy supply side (grid) and the energy demand side (industry, buildings and consumers). These technologies include those for local consumption and production as well as for the storage of energy. A recent study of the World Economic Forum quantifies the magnitude of the grid edge in one, impressive number: US $ 2.4 trillion. This will be the economic value created through investments, new jobs and new revenues through the adoption of grid edge technologies in the OECD countries over the next ten years.8 A prime example of this is a microgrid across a whole community or facility (e.g. energy village Wildpoldsried). It features a high penetration of DERs such as solar, energy storage, demand response and electric vehicle charging infrastructure. It provides secure power to critical infrastructure, helps to reduce overall energy costs, minimizes investments in new distribution infrastructure, and provides valuable services to the overall grid (e.g. peak load shaving, voltage and frequency balancing, and demand response). As the boundaries between consumers, producers and distributors become increasingly blurred, the grid will evolve into a platform that allows decentralized sources of all kinds to use it to their best advantage. A mind-shift towards consumer-centric strategies, cooperation at all levels, new business models and the creation of intelligent management systems for the diverse assets at the grid edge will help all players to tap into potential new revenue streams.

Siemens

SIMATIC S7-1200 Ethernet PLC CPU Modules

The SIMATIC S7-1200 compact controller is the modular, space-saving controller for small automation systems that require either simple or advanced functionality for logic, HMI and networking.

Shop now

LOGO! 8.3 PLC CPU Modules IOT

LOGO! 24CE, logic module, display PS/I/O: 24 V/24 V/24 V trans., 8 DI (4 AI)/4 DQ, memory 400 blocks, modular expandable, Ethernet integrated web server, data log, user-defined web pages, standard microSD card for LOGO!

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SINAMICS V20 Frequency Inverters

The compact SINAMICS V20 is the frequency converter for simple motion sequences. It is characterized by its short commissioning times, easy handling, and energy-saving functions. The converter with its nine sizes covers the power range from 0.12 kW to 30 kW.

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SIRIUS 3RW5 Soft Starters

SIRIUS soft starters are the best solution when direct or star-delta starting doesn't apply to three-phase motors, because problems can often arise due to mechanical impact in the machine or voltage drops in the line supply.

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Control Station Switches, 3SU1

SIRIUS ACT 3SU1 is our modular, tried-and-tested complete range of pushbuttons and indicator lights in round design.

Shop now

Improving Solar Energy Efficiency With Artificial Intelligence

by **Moxa** & **thingario**

Many solar power plants pay significant attention to their operation and maintenance (O&M) mechanism. The companies often experience bottlenecks around personnel and interruptions to operations. Moxa and thingnario combined their technological advantages to jointly promote the first intelligent solar energy monitoring system “Photon”. The main benefit of this solution is that it uses durable industrial-grade devices and artificial intelligence (AI) to greatly improve solar power efficiency in challenging outdoor environments.

At a glance

The Taiwanese government has set a goal for its renewable energy policy, that by 2025, 20% of power generated will be by renewable energy resources. It is predicted that solar energy will supply 20 GW annually to help meet this target, which will be fifteen times more than the 1.3 GW that is currently produced. However, before the Taiwanese government reaches their target, there are many obstacles that need to be overcome. In reality, many solar power plants lack a good operation and maintenance (O&M) mechanism, which often results in losing power that has been generated. Furthermore, when operations are interrupted, companies have to fork out significant amounts of money to dispatch personnel to fix machines. It is in response to these issues that Moxa and thingnario combined their technological advantages to jointly promote the first intelligent solar energy monitoring system “Photon” to enhance efficiency.

Recurring Operational Expenditure for O&M

The owner of the plant shared some of the complex operations that take place when generating solar energy across large areas. Each solar station transmits between 20,000 and 50,000 pieces of field data per minute. It was too time consuming to use the traditional operating system to manage these vast quantities of data, and data loss was a serious problem. In addition, the previous maintenance system was hardware-based and relied heavily on the capability of the inverter. Operating under these circumstances, the operators did not have a holistic view of the entire solar power operation status through one single platform. Furthermore, there were other system integration issues, and it was difficult to determine whether the power being generated was being lost. In fact, even when it was determined that power was being lost, it was almost impossible to determine the root cause of the loss.

When abnormalities occurred, the solar plant owners had to dispatch maintenance personnel to perform troubleshooting. This problem was magnified as the owners have a large number of sites around Taiwan. As personnel resources were limited, it resulted in problems being identified and rectified too late. In fact, there were sites where 20% of power was lost due to bird droppings covering the panels. In order to solve this issue, the maintenance personnel had to travel to the remote area where the problem occurred to determine what went wrong, return to pick up the necessary equipment and parts to fix the problem, and then return to make the necessary repairs. All in all, the process from discovery to rectification took six months. Mr. Zhang, the chairman of thingnario, realized this was a significant pain point for the customer and took steps to make the owners feel at ease.

20% of power was lost due to bird droppings covering the panels.

Enabling Artificial Intelligence to Improve Operational Efficiency

Mr. Zhang said that thingnario identified all of the problems and worked out how to find a solution utilizing AI technologies. Conceived by design thinking, the Photon system incorporates intelligent monitoring functions and intelligent operational mechanisms to ensure that equipment is monitored effectively. By providing maintenance personnel with more information earlier, they were able to increase the overall operational efficiency of the solar station.

The technology produced by thingnario was designed to capture all of the data from the inverter as well as weather data from their self-developed Sky Camera, which provides information about cloud coverage and how the solar panels will be affected. Photon has five key features:

(1) Artificial Intelligence (AI) Capabilities: The AI engine analyses large volumes of historical and real-time sensor data to recognize patterns and predicts how much power will be generated in the next 5 to 30 minutes. When there is a large discrepancy between how much power was predicted to be generated and the actual amount generated, the system will send an alert to notify the solar plant operators to allow them to perform preventative maintenance.

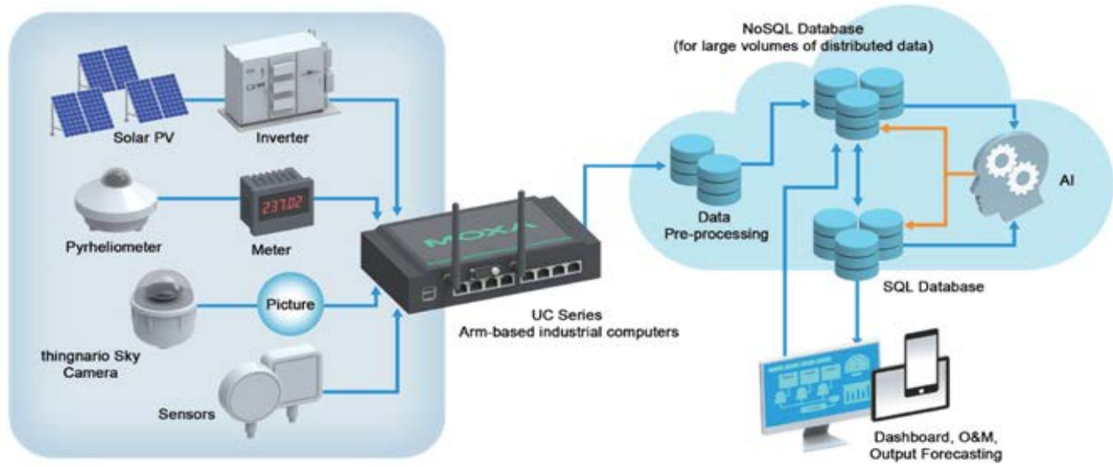
(2) Highly Scalable: Photon handles timestamp data and business data separately in the backend database. This ensures that for every solar plant, irrespective of size, all the data is processed quickly.

(3) O&M Task Management System: Manage all records including maintenance, attendance, and expenses. The digitalization of operational costs along with the AI system are helping new operators get started quicker and reduces the amount of time, and therefore the cost of, troubleshooting.

(4) Easy Setup in Three Steps or Data Acquisition: First, set the solar station information on the software page, second, configure the network settings, and third, conduct field deployments.

(5) Dashboard for Instant Data Analysis: The single-line diagram, system configuration map, and real-time data make the operational status clear.

The AI engine analyzes large volumes of historical and real-time sensor data to recognize patterns and predicts how much power will be generated in the next 5 to 30 minutes.



Moxa

Ensuring Durability, Reliability, and Longevity

Before the company was able to accurately acquire huge amounts of data, they had to ensure the industrial computer they selected met all of the project requirements. After careful analysis, Moxa's UC Series Arm-based industrial computers were deemed the most appropriate. Mr. Zhang required that the computers were capable of withstanding harsh environments, maintain stable operation for many years, and have a good brand reputation in order to win the trust of customers. Moxa's UC Series of fanless industrial computers not only provide efficient and stable data acquisition functionality, but are also equipped with multiple serial ports to simplify connections with inverters, pyrheliometers, and other meters. The low power consumption also helps to reduce maintenance complexity.Furthermore,they can withstand temperatures from -40 to 70°C and meet all of thingnario's expectations.

"Moxa's UC Series of fanless industrial computers not only provide efficient and stable data acquisition functionality, but also help reduce power consumption and maintenance complexity."

Mr. Zhang Chairman of thingnario

Moxa has opened multiple offices around the world and has distributors in over 70 countries. This localized expertise is expected to greatly contribute to the expansion of overseas operations and facilitate RMA policies in multiple countries for the solution being offered by thingnario and Moxa. Furthermore, Moxa's five-year product warranty allowed thingnario to sign a five-year contract with their customers making it possible for thingnario to accurately calculate the initial acquisition cost, which is a key factor in the partnership.

Gaining Real-time Insights to Increase Productivity

In addition to the AI analysis that was used to predict the amount of power that would be generated by the solar plant, the real-time alerts (that were not available in the previous system) helped the operator to increase the power generated by 10% and reduce labor costs by almost 30%. The EPC (engineering, procurement, and construction) contractor who was responsible for maintenance of the plant, also saw the benefits of a good monitoring and operation system that presented useable information on a one-page dashboard.

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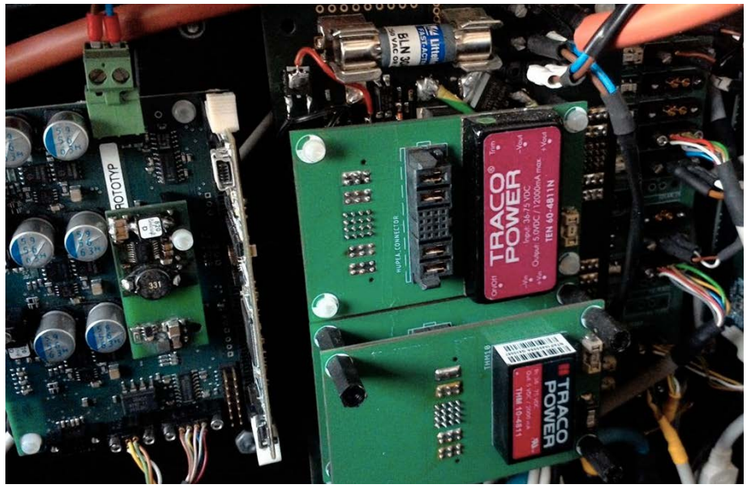
The challenge of powering industrial IoT applications

By Traco Power

The hype around IoT devices nowadays is not surprising. IoT engineering kits and the appropriate technologies for designing IoT prototypes are widely available and affordable for creative technology enthusiasts. Consequently, there are no limits for enabling ideas and possible business models based on these technologies.



Also in the industrial environment, there has been an rapidly increasing demand for professional IoT applications. Common characteristics include the ability to distribute intelligence by connecting various sensors and actuators with decentralized control. The ability to make them smart is that these sensors and actuators can collect and communicate data and are designed to be managed with intelligence. The market for industrial IoT applications will continue to expand as more applications evolve, including (home) healthcare, infrastructure, utilities, home automation and smart homes, vehicle, mobility and more. These professional IoT trends will undoubtedly involve miniaturization, mobility, robustness, efficiency (degrees of effectiveness) and the networking of electronic devices.

In contrast to hobby IoT applications, such safety-relevant industrial IoT applications are subject to strict regulations, both, for the engineer and for the components being used. This poses a great challenge for developers of industrial IoT applications. The use of certified, reliable and long-term available electronic components is critical, as they are often used in safety and function-critical applications. The professional support of component suppliers is playing a very important role.

Requirements for powering professional IoT applications

Critical modules within professional IoT devices are without a doubt the power converters and the power supply. Miniaturization, low power consumption, size and a high efficiency are playing an increasingly important role for those products. Semiconductors are probably the components which offer the highest level of innovation. As a second key technology I'd mention the power transformation and isolation devices used in the products. Additionally, since these mostly battery-powered IoT systems spend most of their time in standby mode and only a small part is in active mode, the built-in DC/DC converters must cover a wide load range with high efficiency.

Size and efficiency matter- what else?

In order to design, certify and market such professional IoT devices, not only these technological product features matter. If these professional IoT devices want to be certified and sold, they have to be fully compliant with increasingly stringent regulations through globally harmonized standards and guidelines, which bring a big challenge to today's IoT electrical engineer. If IoT functionalities are required for critical applications such as in medical technology, the electronic components must be designed in such a way that they can be used accordingly, meeting industry specific regulations.

As an example, let us take a medical approved, wireless, battery-powered control panel with Internet access to the patient file. Wirelessly connected to this control panel is another device, which may can come into contact with the patient (e.g. a blood pressure monitoring device). One of the key safety concerns with respect to medical devices is that the patient is often electrically connected to the device. As a consequence, the power supply and the DC/DC converter of this IoT application must meet safety critical regulation such as BF compliance and 2XMOPP standards within IEC/EN 60601-1 3rd Edition.

Another good example are industrial IoT applications for "smart" homes and buildings. High efficiency & low no-load power consumption (ErP compliant), small size, high reliability and an affordable price are key elements to all these home/building IoT automation applications, and the ever-increasing compliance & standards including IEC/EN 60335-1.

Careful planning is required, with the entire supply chain

We know the use of new

Traco Power

technologies in security-sensitive and functionally critical applications requires increased reliability, quality, service life and certifications and - last but not least - seamless traceability of electronic key components.

Manufacturers are more and more in the need to use tools that have been established and perfected in the automotive industry for years, such as failure mode analysis, Corrective actions, 8D Reports, DFMEA, PFMEA, Total Quality Management and continuous improvement).

Today Total Quality has to find its way into the earliest phase of almost every development. To achieve this, a developer today has to do more than just provide a functioning solution. Where a mobile telephone used to be a useful accompanying instrument, today we are increasingly dispensing with redundancy from other means. Cash, camera, address book, subscribers are all integrated into the smartphone. Smartphones are therefore critical life companions today. The product designer today bears much more responsibility for the quality of his development than he did 10 years ago. We all know that this trend not only continues but will continue to develop rapidly. Moreover, suppliers should regard the digital transformation in the individual components' supply channels as a highly significant development. By establishing, analyzing and processing relevant data, a fast, reliable and economic availability of the components can contribute to increased productivity at the customer's facility

In summary: This means that in IoT applications in critical applications, for example in medical technology, building automation or mobility, not only need to be efficient, miniaturized with an ultra-low standby power consumption, they also need to be available for decades, trackable and fully compliant with the relevant standards and regulations.

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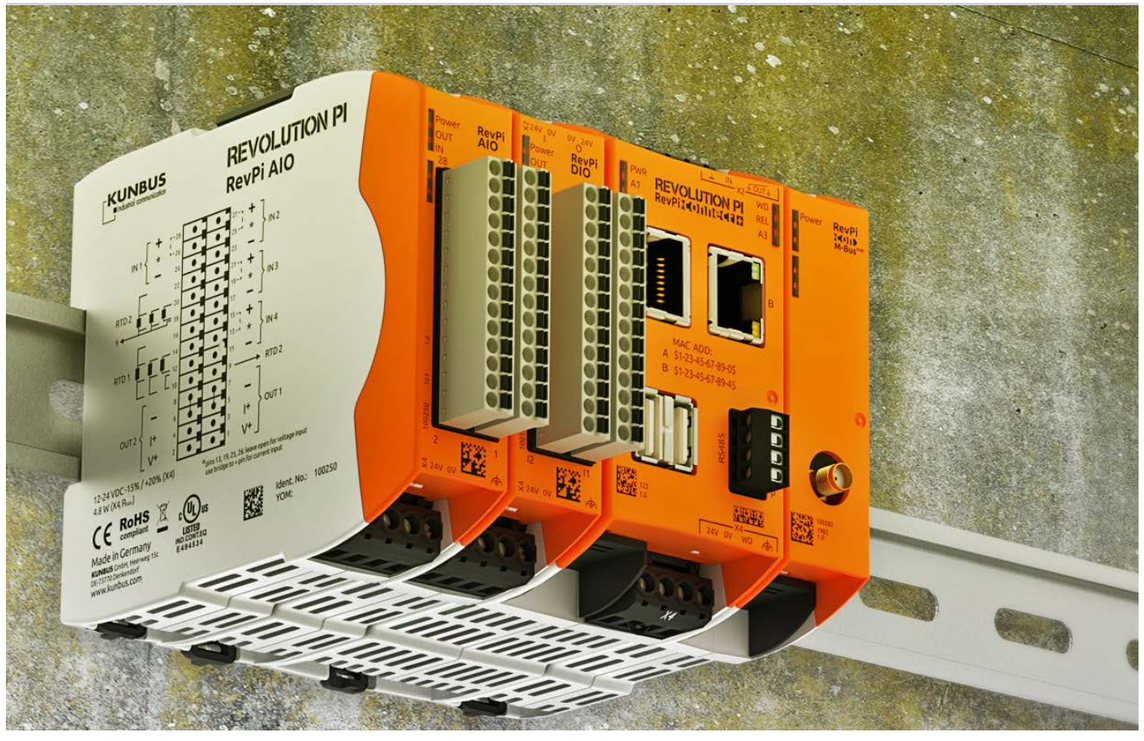
Revolution Pi: Open Source IPC based on Raspberry Pi

Open source, modular, cost-effective. Your tool of choice for implementing your IIoT & automation projects



Meet the Revolution Pi family

Revolution Pi is an open, modular and inexpensive industrial PC based on the well-known Raspberry Pi. Housed in a slim DIN-rail housing, the three available base modules can be seamlessly expanded by a variety of suitable I/O modules and fieldbus gateways. The 24V powered modules are connected via an overhead connector in seconds and can be easily configured via a graphical configuration tool.

No lazy compromises when it comes to industrial suitability

To achieve a real industrial suitability according to EN 61131-2 or IEC 61131-2, the rather unknown Raspberry Pi Compute Module was used as a basis. The module, which looks like a notebook RAM bar, is limited to the essentials and does not have any external interfaces. With the Raspberry Pi Compute Module the foundation has been laid for equipping the Raspberry Pi with a robust and industry-compatible periphery developed by us, which meets all important industrial standards. On the software side, the Revolution Pi has a specially adapted Raspbian operating system, which is equipped with a real-time patch. The use of Raspbian ensures that most

of the applications developed for the Raspberry Pi can also be used on the Revolution Pi.

IIoT Gateway RevPi

Connect
The open source IIoT gateway RevPi Connect gives users maximum freedom when implementing IIoT projects due to its open platform concept (including full root rights). RevPi Connect is based on the Raspberry Pi Compute Module 3/3+ and features a 1.2 GHz quad-core processor, 1 GB RAM and up to 32 GB eMMC flash memory. A Real Time Clock (RTC) with 24 h buffering ensures that the device always knows what time it is, even in the event of a power failure. A specially modified Raspbian version with a real time patch is available as an operating system. Common IIoT protocols like MQTT and OPC UA are supported to transfer machine data directly to the Cloud.

Individual applications can be programmed via, amongst other things, Node-RED, Python or directly in C. The modular design of the RevPi Connect enables the 45 mm wide base device to be fitted with suitable expansion modules such as digital and analog IOs, fieldbus gateways and radio modules like for example ones for Bluetooth. The expansion modules can be joined up – plug and play – with the base device via a socket positioned at the top and can be easily configured using a graphical user interface.

Real industrial suitability
One of our key goals was to give the Raspberry Pi real industrial capability to turn it into a true IIoT gateway. For this reason, the top-hat rail housing of the RevPi Connect is fitted with robust 24 V industrial hardware that complies with the EN61131-2 standard.

- Power supply: 12-24 V DC -15 % / +20 %
- Operating temperature: -40 °C to 55 °C
- ESD protection: 4 kV/8 kV according to EN 61131-2 and IEC 61000-6-2
- Surge/Burst tests: applied according to EN 61131-2 and IEC 61000-6-2
- EMI tests: according to EN 61131-2 and IEC 61000-6-2
- UL certified (UL-File-No. E494534)

Open Source IPC RevPi Core
RevPi Core is an industrial computer based on the Raspberry Pi Compute Module 1/3/3+. The RevPi Core is a combination of open hardware and software meeting the EN61131-2 standard. It has a modular structure so depending on the customer requirements it can be expanded with a range of additional modules such as digital or analog I/O and a number of network interfaces, all on a DIN rail mounting.

Full power
The power supply circuit is one of the most important parts of the RevPi Core. In order to get low heat from power dissipation it uses state-of- the-art high-efficiency DC-DC-converter (efficiency over all is greater than 80 %). These converters use 24 VDC

input (which is the usual case in industrial applications) to produce all supply voltages needed for the Core.

But the Core module does not only run on the standardized supply range of 20.4 V to 28.8 V but also runs on as little as 10.2 V input voltage. That means you can even use car batteries or solar panels as power supply. At 24 V input any power loss of up to 10 ms will not influence operation of RevPi Core (drawing full current from both USB ports) and even up to 25 ms without USB load. Input voltage and functional earth is connected to RevPi Core using heavy duty connectors at the bottom side.

A sophisticated protection circuit guarantees continuous operation even under massive electrical or electro-magnetic interference on the input power lines (provided that functional earth is connected properly). Lightning strikes and nearby welding machines have been simulated in test laboratories but could not impress RevPi Core modules.

In addition, the Revolution Pi has a Real Time Clock with 24 h buffering, which ensures that the device always knows what time it is, even in the event of a power failure.

Highly modular
The data highway connecting all RevPi modules is called PiBridge. The modules are physically connected to each other, using a system connector on the top side. Three signal types are exchanged via this connector: 4 pins of the PiBridge are used for automatic module detection during start up phase. After this phase RevPi Core exactly knows which modules are connected and in which physical position they are. 4 pins of the PiBridge are used for rapid data exchange of small data packages using RS485 signals. This channel is also used for module configuration during start up phase. After configuration this channel is used for cyclically exchanging data between RevPi Core and all IO modules connected. 8 pins of the PiBridge are used for rapid data exchange of large amount of data using Ethernet signals. Up to now this channel is only used by the modular gateway modules which may collect up to 512 Byte data cyclically from nearly all relevant field busses.

Open Source Software
Despite the fact that Revolution Pi is an open system on which everyone can install their own apps and software, we have tried to equip Revolution Pi with software and apps that cover most applications.

The operating system used is a customized version of Raspbian, which includes a real-time patch of the kernel. This is the best compromise to stay as close as possible to the original development environment of a Raspberry Pi and still get a high level of control over the priorities of the tasks managed by the scheduler. The scheduler,

Revolution Pi

which controls the execution of tasks by the operating system, can be extensively configured with this modified kernel, so that delays usually caused by network and other I/O accesses are avoided. Suitable drivers for the expansion modules are of course already pre-installed.

Modbus capabilities
Revolution Pi comes with master and slave capability for the popular Modbus RTU and Modbus TCP network protocols. External gateways are therefore in most cases no longer necessary when using these two network protocols.

Modbus TCP works with the Ethernet interface available on the RevPi Core (i. e. via the RJ45 socket on the front panel) or any other Ethernet connection (e. g. USB WLAN adapter) that is supported by the TCP/IP protocol.

Modbus RTU requires a TTY device under Linux. Since the existing UART interface of the compute module is already reserved for the PiBridge and therefore not available, a USB to serial converter such as an RS485 converter is required (not included in scope of delivery).

The configuration is done via the browser-based, graphical configuration software PiCtory.

Node-RED
The pre-installed open source software Node-RED is an excellent tool for the realisation of simple automation tasks and rapid prototyping. With the specially developed RevPi Nodes the Revolution Pi modules are seamlessly integrated into Node-RED.

Case Study: IoT for Energy Revolution Pi

Everyone is talking about decentralised energy supply today. But it can only work with the help of intelligent energy management. With increasing networking and integration into IoT, however, the demands on the hardware to be implemented are also growing rapidly.

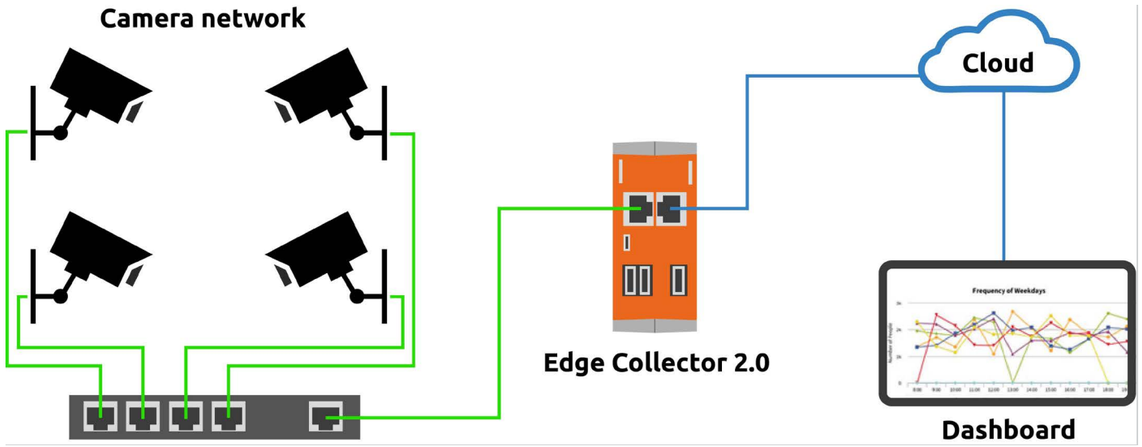
This is what happened to OXYGEN TECHNOLOGIES. The German company provides municipal utilities, energy supply companies and measuring point operators with IT solutions for electricity products. Its IT platform ELEMENTS offers a flexible trading and control system for decentralised energy plants of any size.

Suitable hardware is required to connect such systems, for example inverters for photovoltaic systems, electrical storage devices, digital electricity meters, combined heat and power plants, charging stations for electric vehicles, etc. In addition to a wide range of communication interfaces for linking as many systems as possible that are important for energy supply and consumption, field bus, Ethernet as well as digital/analog interfaces should also be integrated. The communication with the plants is cyclical. The data is then transferred to the cloud via an internet connection.

It quickly turned out that RevPi Compact as ELEMENTS Gate perfectly meets these requirements. The DIN rail module can easily be installed in the distribution cabinet of the prosumer households (prosumer = combination of producer and consumer). The energy technology systems available in the respective household are connected to the device via Modbus TCP, Modbus RTU, a serial interface or via a digital/analog port. The data exchange with the cloud is carried out via a secure connection. Once the ELEMENTS Gate has been installed, the energy service provider is networked and has the possibility to monitor and control all important functions via the ELEMENTS Modules running on the platform. The basis for electricity trading on a peer-to-peer basis has been created, producers and consumers can join together to form so-called energy communities and benefit equally.

Thanks to Revolution Pi's open source approach, OXYGEN was able to create a software image tailored to its needs. In addition, we adapted the colour of the front cover as well as the device labeling according to their wishes.

Case Study: Smart Retail Revolution Pi



Measuring and analyzing visitor flows and drawing the right conclusions from them has been an important component of successful online business for years. However, the recording of customer frequencies and flows is also essential for stationary retail in order to optimise the placement of new products or goods on offer, for example. What can be implemented quickly online by adding a few extra lines of code, requires the use of extensive hardware such as cameras or light barriers in stationary trade, as well as the ability to evaluate the data locally or in a cloud.

The company Security-Max Analytics GmbH specialized in in-store analysis offers a new, simplified solution, which convinces by low hardware & software requirements, fast setup as well as easy handling and is therefore affordable even for smaller companies. With the Edge Collector 2.0, which is based on the RevPi Connect, metadata from the edge analysis cameras is collected and sent to a cloud every 15 minutes. While the Edge Collector is connected to the cloud via one of its Ethernet interfaces, it is simultaneously integrated into the local network in which the cameras are also connected via its other Ethernet interface. If the upload is temporarily interrupted, the Edge Collector can cache the data and thus prevent data loss. Once in the cloud, the data is automatically processed and displayed in user-specific dashboards or made available in compiled reports. In order to better interpret the information, it is possible to display peak times automatically or to include weather data, for example.

RevPi Connect/Connect+

RevPi Connect is based on the Raspberry Pi Compute Module 3/3+ and features a 1.2 GHz quad-core processor, 1 GB RAM and up to 32 GB eMMC flash memory.

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RevPi Flat

The RevPi Flat forms a versatile, Raspberry Pi and LINUX-based and freely programmable platform for process optimization, more efficient data handling and the implementation of new marketing strategies in the energy industry.

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RevPi Core/3/3+

For all those who need plenty of performance & storage, the RevPi Core family with the fast Raspberry Pi Compute Module is exactly the right choice.

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Expansion Modules

Build your Revolution Pi system with a variety of expansion modules to suit your needs from Digital I/O, Analog I/O, CON modules and gateways.

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RevPi Compact Programmable Controller

The RevPi Compact is an open source compact controller based on the Raspberry Pi. Equipped with the Raspberry Pi Compute Module 3+, the control system has a quad-core processor with 1.2 GHz, 1 GB RAM and 8 GB eMMC flash memory.

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SenseCAP LoRaWAN Deployed in Environmental Monitoring Projects in Stockholm, Sweden

By SeeedStudio, Violet

This is a global leading company that designs and manufactures outdoor power products such as chainsaws, trimmers, garden tractors, and mowers, etc. In the company's 300+ years' journey of inventing and innovating, they have always embraced emerging technologies in creating great product experience for their customers.

Because most of their products are used in parks, gardens, forests and other environments where humans interact with nature, the company strives to explore methods to reduce its products' impact on the environment and to enhance the ability of its products to positively affect people's lives and the environment. Apart from adopting new battery technologies and renewable energy sources, they also apply IoT technology in monitoring the environmental data to provide insights for guiding corporate operations as well as providing better services to customers.

Seeed is very happy that their partner applies SenseCAP industrial wireless IoT products including LoRa gateways and sensors in their pilot projects of environmental monitoring. Currently, two sets of IoT devices have been deployed in the industrial park and a public park respectively in Stockholm, Sweden, to collect the following environmental data:

- CO2
- Barometric Pressure
- Light Intensity
- Air Temperature
- Air Humidity

The data is collected and monitored with the following IoT sensors and gateways.

- SenseCAP Wireless CO2 Sensor – LoRaWAN
- SenseCAP Wireless Barometric Pressure Sensor LoRaWAN
- SenseCAP Wireless Light Intensity Sensor LoRaWAN
- SenseCAP Wireless Air Temperature and Humidity Sensor LoRaWAN
- SenseCAP LoRaWAN Gateway

SeedStudio's partner is very satisfied with the stable and precise data collected in these IoT applications. They envision to have data-driven solutions for their daily operations at workplaces to integrate sustainability across the company. And at the same time, with data collected at the public park and other environments where their products are used, they can provide suggestions and better services to their customers for collectively building a better living environment.

We are looking forward to cooperating more closely in the future to empower businesses to create great experience and services to their customers and at the same time create a more pleasant environment for all.

This project also contributes to the following Sustainable Development Goals:

- SDG 9 Industry, innovation and infrastructure
- SDG 13 Climate action
- SDG 15 Life on land
- SDG 17 Partnerships for the goals

What is SenseCAP?
SenseCAP is an industrial wireless sensor network that integrates easy-to-deploy hardware and data API services, enabling low-power, long-distance environmental data collection. SenseCAP includes several versions, such as LoRaWAN, SensorHub-LTE, etc.

SenseCAP LoRaWAN version products include LoRaWAN Gateways and Sensor Nodes. Based on LoRaWAN protocol, it can realize one-to-many, long-distance networking, and bilateral communication. The LoRaWAN gateway supports Ethernet and 4G. The sensor node is powered by a high-capacity battery that lasts up to 3 years (uploading data once per hour). It also supports hot-swap, making it easy for maintenance and upgrading.

SeeedStudio SenseCAP

LoRaWAN Gateway, IP66, 868MHz

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LoRaWAN Wireless Barometric Pressure Sensor, IP66, 868MHz

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LoRaWAN Wireless CO2 Sensor, IP66, 868MHz

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LoRaWAN Wireless Air Temperature and Humidity Sensor, IP66, 868MHz

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LoRaWAN Wireless Soil Moisture and Temperature Sensor, IP66, 868MHz

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LoRaWAN Wireless Light Intensity Sensor, IP66, 868MHz

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