Powering wireless networks

Contents

Introduction

Putting power in context

Every year, our reliance on always-on technology grows. We expect to be able to place a call or surf the internet with our cell phones at any time, under any circumstances. However, the electrical infrastructure that powers our wireless networks has not kept pace with the demand for more macro cells and small cells.

The challenge goes deeper than powering additional cell sites. The architectures of cellular access are changing dramatically. Customer demand is pushing 5G rollouts which, in turn, require more RF equipment. Additional radios, more frequencies and increasing use of remote radio units, plus an entire small cell layer that still needs to be built out are pushing outdated power systems to the brink.

What's at stake from a business perspective? Plenty. A reliable power infrastructure has significant implications for both cost and revenue. Running power to thousands of small cells will be expensive. Cutting cost by even a point or two can generate major savings, as can reducing deployment times by a day or two. On the revenue side, we know the effect that network outages have on churn rates. With the vast majority of cell sites relying on older power grids for primary power, the need for reliable backup power is more important than ever.

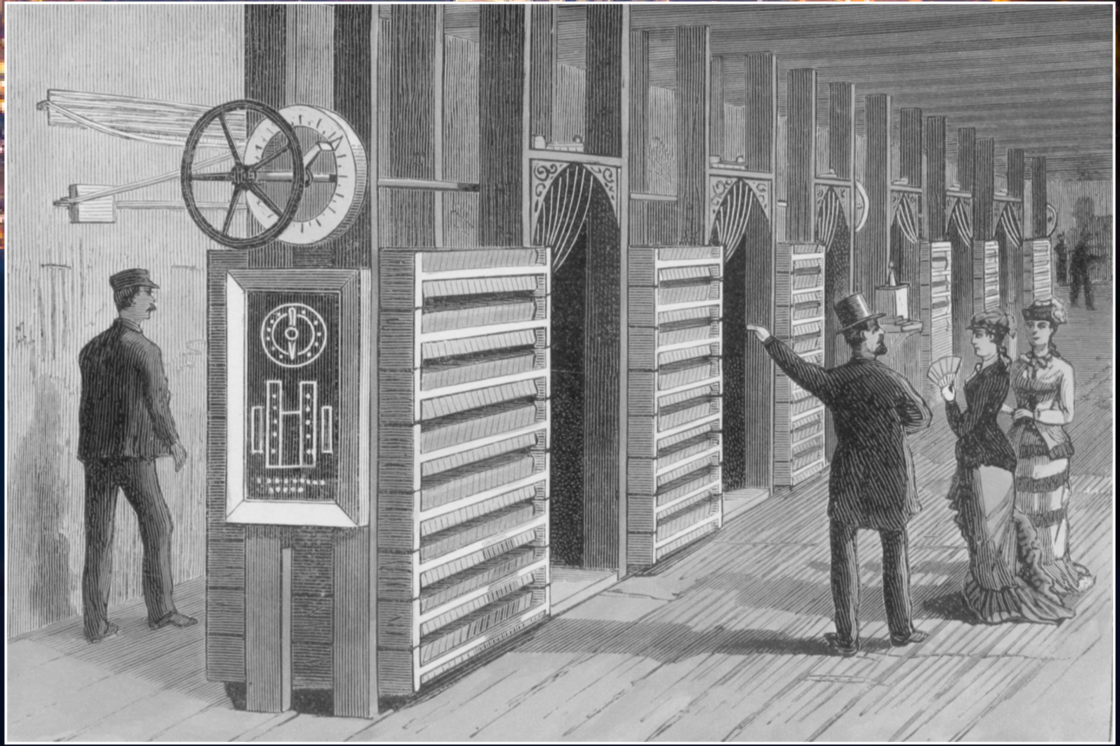
Welcome to the intersection of now and next

To keep pace with the changes and, more importantly, to satisfy user expectations of 24/7 availability, mobile operators need to re-evaluate all aspects of their power infrastructure. That means taking stock of where we are from a solution standpoint, where we need to be, and developing a cohesive, future-capable strategy to get us from here to there.

That's why CommScope has developed this ebook, to help keep you out in front. Here, you'll find the "what," "why" and "how" to help guide your power decisions as you navigate what's next. We've broken it down into easy-to-digest chapters and sections that walk you through the key issues of powering your macro and small cell networks. Along the way, we added the CommScope innovations designed to help you realize the more efficient, future-ready power solutions needed to keep you and your networks moving forward.

Elements of power

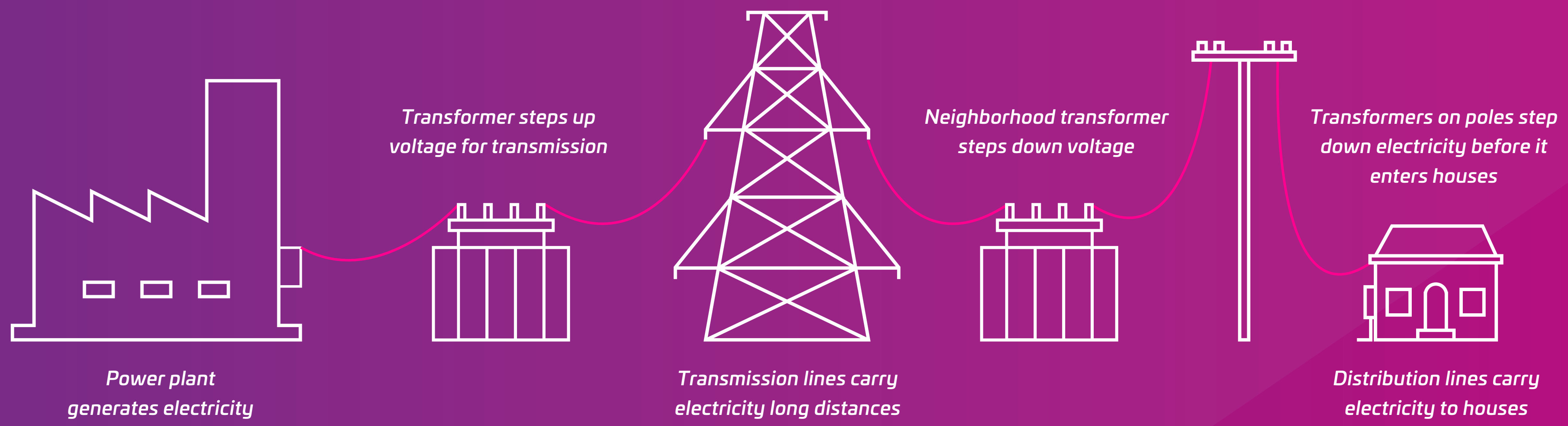
To understand how wireless communication networks are powered, you need to begin with the basics—which really haven't changed all that much since Thomas Edison lit up Manhattan's Financial District (NYC) on September 4, 1882. Sure, we've seen a lot of refinements, improvements and safety measures since then, but the principles of power generation and distribution still apply.



Thomas Edison's Pearl Street Station was the first commercial central power plant in the United States. It was located in the Financial District of Manhattan (New York City). Fired by coal and powered by six dynamos, it came on line September 4, 1882 and served an initial load of 400 lamps at 82 customers.

Electricity generation, transmission and distribution

Source: adapted from National Energy Education Development Project (public domain)



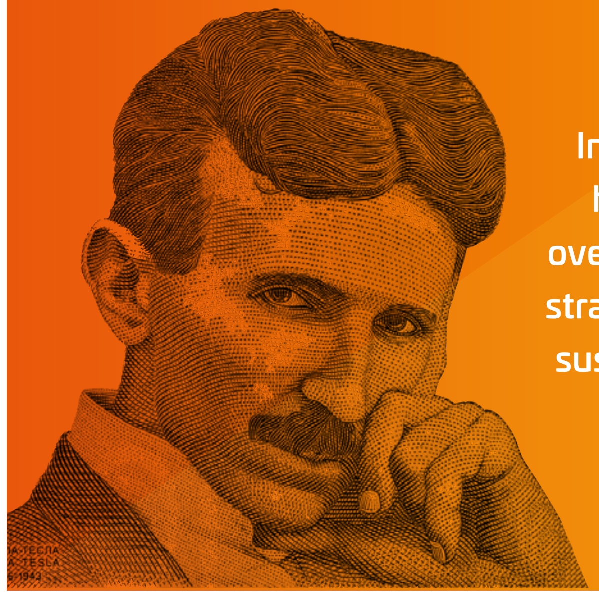
The power generation and distribution chain

Whether it's your home, workplace or wireless network, there's more to turning on the power (and keeping it on) than flipping a switch. *A lot more!* Delivering and maintaining just the right amount of electricity needed to power the myriad devices we rely on is as complex as it is fascinating.

For example, consider the public power grid that feeds most homes and businesses. It begins with a power source that generates the raw electrical power in the form of alternating current (ac). Public power utilities use a wide diversity of renewable and non-renewable power sources, including natural gas, coal, nuclear, solar, water and wind.

The energy generated must then be transported from the power source to the home. That's where high-power transmission lines (either overhead or underground) come in. The copper power conductors in a high-voltage line carry about 800,000 volts of ac current. So, before it enters the home, which is designed to handle only about 240 volts, the power needs to be stepped down using a transformer. Finally, a management/control system is needed to ensure the safe and efficient availability and use of power.

To take a deeper dive into the power generation and distribution chain and see how they're being adapted for use in outdoor wireless networks, read the other chapters in this section.



DID YOU KNOW?

In the late 1800s, Nikola Tesla was sure he could transmit electricity wirelessly over long distances—either via a series of strategically positioned towers (above) or suspended balloons. He obviously failed, but that's a story for another time.

Power sources for wireless networks

When the grid isn't enough

It's important to note that, in most cases, outdoor wireless networks use the public power grid as their primary source of electricity. Access to power drops is readily available and the cost per kilowatt is reasonable.

The challenge with the public power grid, however, is age and reliability. Each year, power outages affect every city in every country across the globe. When the grid is down, so is everything attached to it, including macro cell sites, small cells and DAS systems. Outages don't affect just personal and business communications. They cripple public safety and first responder providers and they affect smart city services and a host of other critical applications.

So, while tapping the power grid for your primary source of power is usually fine, it is not enough. Provisioning your networks with a safe, reliable and cost-efficient power backup system is vital. The following overview highlights some of the most common and emerging technologies for supplying backup power to wireless networks.

There are critical cases, especially with small cell networks and DAS networks, where tapping into the power grid may not be the safest or most cost-effective solution. We discuss an alternative solution for those instances later on.

Lead-acid batteries

These are commonly used as backups for telecom power systems. They are compact relative to their output and are similar to the kind you would find under the hood of your car. They are available in vented and valve-regulated forms.

Vented (also known as wet or flooded) batteries

Vented batteries maintain a charge for up to 20 years or longer. However, they demand a lot of costly maintenance such as water treatment, spill containment and forced-air ventilation. These drawbacks make them less suited to remote cell base stations.

Valve-regulated lead-acid batteries (VRLAs)

VRLAs are recombinant batteries, which means oxygen and hydrogen can recombine to prevent water loss. Because they don't need added water, they are easier to ship, maintain and install, making them the preferred choice for cell site base station use.

Lithium-ion batteries

These batteries are relatively new for wireless telecom applications. They are highly compact, about 50 percent the volume of a comparable VRLA battery. Unlike VRLA batteries, which are composed of four 12 Vdc batteries per string, lithium-ion batteries are packaged in a single rack-mounted module that provides –48 Vdc output. Should an individual module fail, the remaining modules will continue to provide backup power.

NiCad batteries

These are becoming popular as backups for telecom power systems. In general, NiCad batteries have a lower temperature operating range and have fewer (or no) battery cooling requirements, lighter weight and longer life.

Battery strings

Power capacity is directly related to the size of the battery; but, rather than spending more on larger batteries, we can achieve the same boost to capacity by adding more battery strings in parallel, as opposed to adding them in series. This safeguards against the failure of an individual battery, which would remove its string from the system altogether. By connecting in parallel, the spare capacity is already online and ready to maintain the current for its rated length of time. This configuration also provides a convenient means of maintaining the batteries. Often, these strings will be installed with separate disconnection breakers—making it easier to locate failures and isolate problems that could otherwise cripple the entire system.

Generators

Batteries alone can maintain operations for only a few hours. Longer ac service interruptions require a longer-term solution. Unlike batteries, generators provide power by burning fuel, typically diesel. Like batteries, there are different types and configurations available. Which one you install depends on factors like space, cost and service expectations.

Since they operate outside the cell station's internal dc system, generators aren't considered part of that system. Because they supply the dc system's rectifiers with the ac power they need, however, they're a vital link in assuring reliable operation. In the event the station must switch from external power to generator-supplied ac power, an electrical device called a "transfer switch" shunts the load to the generator.

What about renewables?

The international energy agency (IEA) in its latest global energy projection, the World Energy Outlook 2018 (WEO2018), has reported that global energy demand is expected to grow by about 27 percent, or 3,743 million tons oil equivalent worldwide from 2017 to 2040.[1] At the same time, the annual energy consumption by the mobile industry has increased from 219 TWh in 2007 to 519 TWh in 2019, and it is speculated that the demand will rise at a yearly rate of 10 percent.[2] Consequently, the electricity bill of telecom networks globally amounts to above US$10 billion per year.[3]

The importance of estimating future energy requirements and their consequent carbon emissions cannot be ignored when developing an effective energy policy for the future.[4] And, in fact, the industry is gradually moving toward the use of renewable sources such as wind, water and solar power. The table on the right shows where the world's major wireless providers are in their efforts to transition to greener energy and reduce their carbon footprints.

To accommodate the shift toward renewables, wireless infrastructure partners have begun to introduce solutions that enable service providers to integrate alternative energy sources into their overall power infrastructure. One such solution is a more flexible rectifier, discussed in the next chapter.

1 World Energy Outlook 2018, Aug. 2020
2 Sustainable power supply solutions for off-grid base stations, Energies, Sep. 2015
3 Towards Energy Efficient Load Balancing for Sustainable Green Wireless Networks Under Optimal Power Supply; IEEE Access, vol. 8, 2020
4 Analysis of Renewable Energy Usage by Mobile Data Network Operators; Sustainability Journal; 9 Feb. 2021

	Current status		Future targets			
Network operator	**Renewable energy utilization (%)**	**Reduction in emissions (%)**	**Renewable energy utilization (%)**	**Reduction in emissions (%)**	**Target year**	**Baseline year**
Deutsche Telecom	52%	2%	100%	90%	2021 [1], 2030 [2]	2017
Telefonica	81%	18%	100%	70% [3]	2030	2015
Telstra	Negligible	40% [4]	Not stated	50%	2030	2017
T-Mobile	100%	9%	Already 100%	Not stated	N/a	N/a
Verizon	N/a	28% [5]	50%	50%	2025	2016
Virgin Media	100%	22%	Already 100%	Not stated	2020	2014
Vodafone	15%	3%	Not stated	50%	2025	2017

Source: Sustainability Journal; 9 Feb. 2021

Green energy solutions taking shape

To meet their ambitious energy green goals, the world's cellular network operators are getting creative in how they power their systems.

In some European countries, for example, energy costs vary throughout the day depending on supply and demand for power. Using strategies like peak shaving, MNOs run their macro sites via the grid when prices are low and switch to battery power during peak rate hours.

Operators are also employing PID (proportional–integral–derivative) controllers to boost energy efficiency. PIDs use special scripting, automation or artificial intelligence to power RRUs up and down based on traffic. This reduces energy consumption, thermal loading and their associated costs.

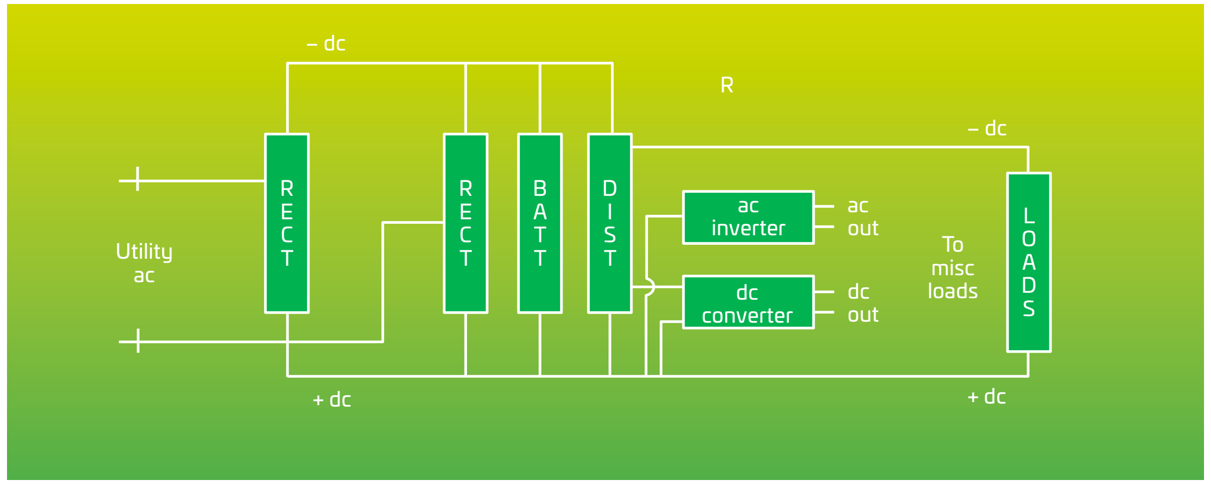
To learn more about minimizing power consumption with PID controllers, download CommScope's white paper, **"Potential energy savings using PID."**

Rectifiers: the ac-dc interface

Nearly all modern communication networks (wired and wireless) run on direct current (dc) electricity. But, because homes and offices are powered by alternating current (ac), the electric grid is ac. Rectifiers are used to convert an ac power feed to dc. In both macro sites and small cells, the rectifiers' output is connected to the radio and its transmission equipment—the "load" for the current—as well as the backup battery equipment.

The rectifier provides enough dc voltage level to maintain the charge in the backup batteries. This level, called "float voltage," supplies the equipment load as well as a trickle charge to the battery. In the event of an ac power interruption, the rectifiers go off-line and the batteries automatically kick in. When external ac power is restored, the rectifiers re-engage and the batteries return to their trickle-charging state.

Multiple rectifier modules are usually required to supply power for the base station's load. Modules are connected in parallel, enabling them to share an equal part of the load. This load sharing allows operators to design in a degree of redundancy to guard against individual rectifier module failures.



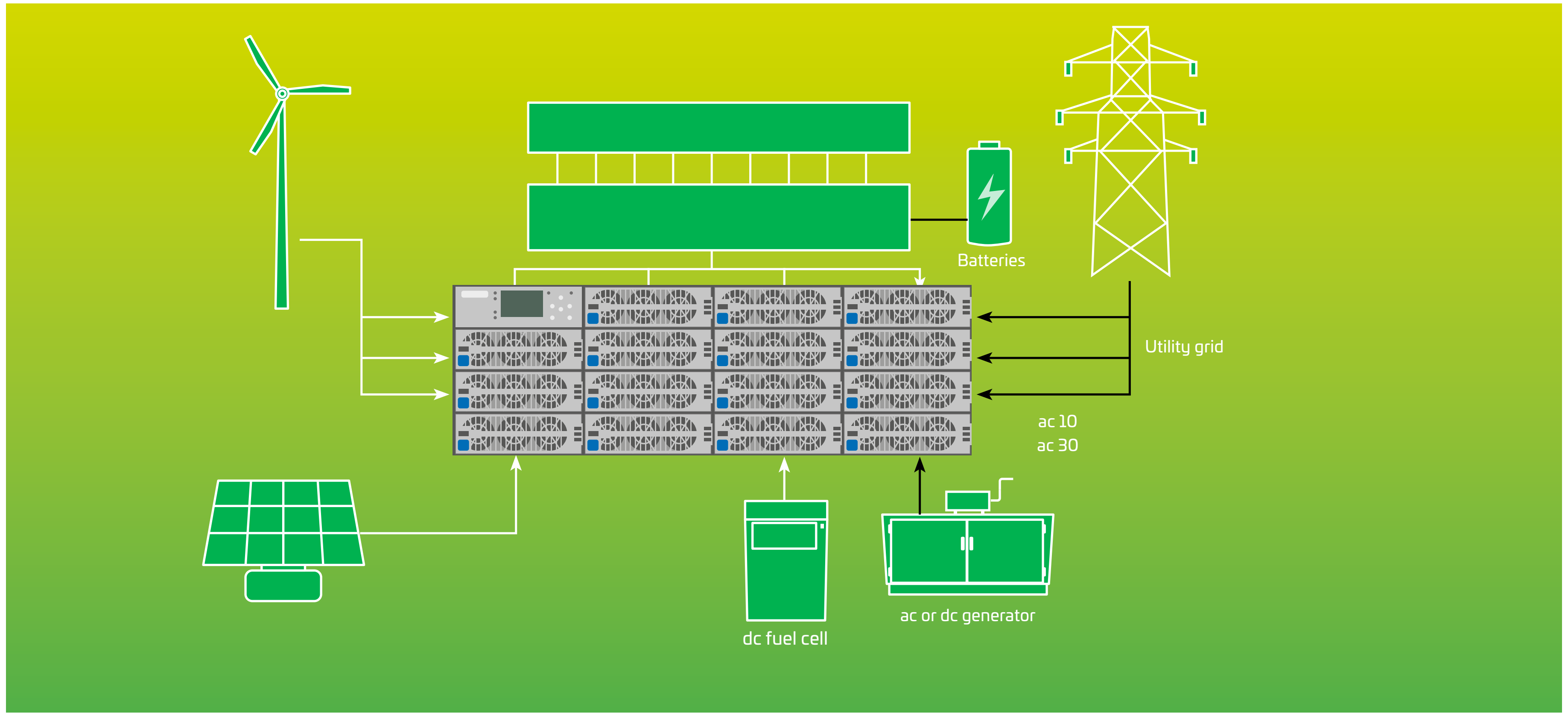
A block diagram of a basic telecommunications power system

ac power sourcing flexibility

With ever-increasing utility costs, the ability to combine power from renewable sources with utility power is another aspect of power flexibility. To address this, some rectifiers can accept ac power from attached solar panels or wind turbines just as easily as they can draw it from the utility's transmission lines.

Choosing the right rectifier

The first consideration in deciding which rectifier will best suit a given installation is the kind of ac power it will receive. Switchmode rectifiers are the preferred choice for cell and microwave sites since they can support multiple ac inputs and have a broader operating range—from single-phase to three-phase inputs. This flexibility means fewer rectifiers are required—saving money, space and maintenance.



Power source flexibility lets rectifiers draw from conventional or renewable sources

Power distribution

The rectifier is merely the first stage in the power system. Once converted, the power must be distributed to the many component loads within the system. As mentioned above, these loads include core elements like the radio, transmitter and battery backup, but they can also include secondary systems like lighting, security networks and HVAC systems. In the most complex installations there may be so many components that up to 80 circuit breakers are required to manage them.

Bus bar conductors

In the macro layer, the cell site's distribution system is supported by the bus bar conductors, which physically connect the rectifiers to the batteries and dc loads. There are two bus bar connectors: the charge bus and battery return bus.

The charge bus is a current-carrying conductor that connects the rectifier's output to the battery string. For instance, in a –48 V system the negative rectifier lead would terminate on the charge bus along with the corresponding negative lead of the battery. The battery return bus provides a common return point for the loads connected to the power system. This common point is grounded to provide a low-impedance path for transients and noise and offers a ground reference to all connected equipment.

Within the power distribution system there are a number of sub-systems designed to prevent overloads, overheating and other unsafe conditions. These sub-systems include fuses and circuit breakers and surge protectors.

Fuses vs. circuit breakers

While both fuses and breakers provide overcurrent protection, they do it in different ways. Fuses are designed to melt under unsafe currents—physically breaking the connection between the power source and the load. Circuit breakers have internal switches that pop to the "off" position under unsafe conditions—again providing a physical break in the circuit.

Sensitive wireless equipment requires "fast blow" fuses or short delay curve breakers to provide the needed protection. Fuses are generally used for lower loads and offer the advantages of lower cost, greater flexibility and fast action. Circuit breakers are preferred for larger loads and do not require replacement every time they are tripped.

Surge protection

Typical variations in ac power are not the only threat to a cell site. Electrical events like lightning can also produce excessive voltages and currents—events known as "electrical surges." Surge protection devices (SPDs) are incorporated to reduce the effects of these surges on sensitive electronics.

An SPD features a non-linear voltage-current characteristic that reduces unsafe voltages by increasing the conducted current. In this case, a cell site's SPD operates on the same principle as a surge protector does in your home—safeguarding expensive electronics from lightning-induced surges.

Power safety, maintenance and management

Modern telecommunication power plants are equipped with electronic monitoring and control systems, generally called “controllers.” They keep track of system voltages, currents, temperatures and other key indicators. They also allow operators to make adjustments from a central monitoring point—usually on the power plant itself, on the distribution cabinet or in a rectifier slot.

The following are some of the key functions and capabilities that controllers provide:

Plant control

Control functions are extended from the supervisory panel to control other power system components. These panels communicate directly with the rectifiers and, in some cases, can coordinate the sequenced restart of all rectifiers to prevent power surges during switchovers from external ac to a backup power source.

Manual equalizing

This allows a user to engage all rectifiers in equalize mode at once. This is useful for maintenance on VRLA batteries—equalizing cell voltage within a battery string.

High-voltage shutdown/ overvoltage protection (HSVD/OVP)

Controllers can automatically shut down rectifiers when dc output overvoltage conditions are detected—avoiding costly damage to load components.

Low-voltage disconnect (LVD)

If a low-voltage condition is detected in the backup batteries, the controller can open additional contacts to equalize voltage and close them again when levels equalize. This helps prevent damage to sensitive electronics and protect the battery from over-discharging. LVDs also enable the operator to prioritize which components are disconnected, and in which order—preserving limited function when necessary.

Battery disconnects

Switches installed on a battery string that allow easy disconnection for maintenance or replacement. Some disconnects incorporate safety measures such as overcurrent fusing or breakers.

Power conversion

dc to dc power conversion

Some wireless sites require multiple dc voltage outputs. Installing a second rectifier plant is one solution, but requires a second battery backup array. Instead, many operators use a dc-dc converter that changes a dc input voltage to a different dc output voltage. The solution consists of multiple dc converters arranged in parallel and may feature many of the same functions as the primary dc power system, such as distribution. It also has dedicated fuses or circuit breakers isolating it from the rest of the system.

Since a dc-dc converter system does not have an associated battery connected to its output, it isn't bound by a battery system's requirement for precise output voltage. However, since it is necessarily energized by the primary dc power system, that demand must be figured into the power system's initial design.

Advantages of converting voltage

Modern dc-dc converters are essentially "plug and play" devices designed to fit in the racks alongside rectifiers and other converters. This approach offers communications providers the greatest flexibility in adopting next-generation technology—offering new services while maintaining older standards.

Disadvantages of converting voltage

On the downside, converting to a given voltage is inherently less efficient than drawing that voltage directly from the rectifiers, so losses increase as more and more dc power is converted away from the primary voltage.

Mapping the positions

Since a single power plant can generate varying amounts of both primary and secondary voltages, the need arises to assign numbers to the distribution positions of each voltage. A selectable voltage distribution panel makes this organization possible.

Powering today’s macro site

How your macro site is powered has a lot to say about how profitable it is. Site architectures are quickly changing, with more active and passive RF components being moved to the top of the tower. This shift is affecting tower loads and creating additional congestion at the top. At the same time, user expectations are increasing as everyone assumes their mobile service will be available 24/7, regardless of the weather or problems with the local power grid. All of this has an immediate impact on the network’s bottom line.

In this section, we discuss some of the ways your power infrastructure can either help or harm your efforts to improve site efficiency, availability, and your OpEx and CapEx spend.

Power needs move to the top

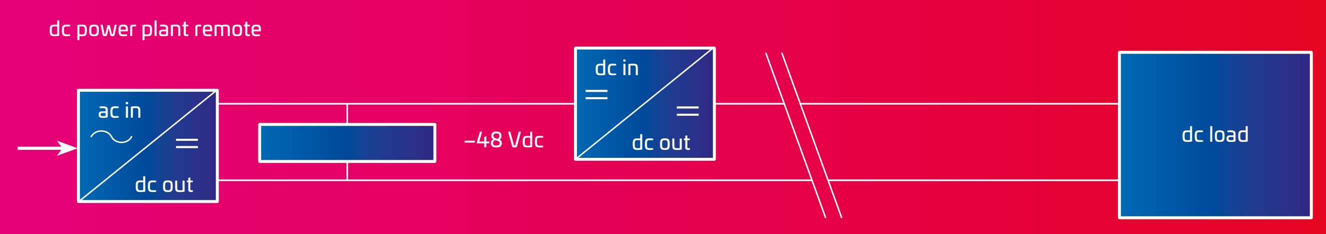
One of the most significant architectural changes in cell site design has been an explosion in the number of passive and active RF components at the top of the tower. The main drivers behind the change are the increasing number of remote radio heads being deployed and the ramp-up of 5G services.

Remote radio heads (RRHs) have become one of the most important subsystems of today's distributed base stations. In an RRH deployment, the baseband equipment remains on the ground while the remote radio head, containing the base station's RF circuitry, analog/digital and up/down converters, is positioned on the tower. This frees up more space in the base station shelter and reduces cooling costs. At the top of the tower, the RRHs make MIMO operation easier and increase base station efficiency.

In addition to the optical fiber connecting it to the base station, the RRH also requires a power feed. Herein lies the challenge.

Each RRH needs a battery backup to ensure operation in case of a power failure. Locating the battery on the tower isn't feasible because of weather risks, so it must be housed in the shelter, far away from the RRH. Therefore, a heavier gauge of power transmission line is needed to sustain the voltage required to operate the RRH. This adds a significant weight onto the already-overloaded tower.

Alternatively, you can convert the power feed, based on its voltage drop, to a higher voltage at ground level to ensure the correct voltage at the RRH.This would enable operators to deliver the right amount of power to the RRHs without having to substantially increase the conductor gauge and risk exceeding the tower's loading capacities. This alternative has, in fact, been developed and is being used successfully. For more, see the next section in this ebook on PowerShift.

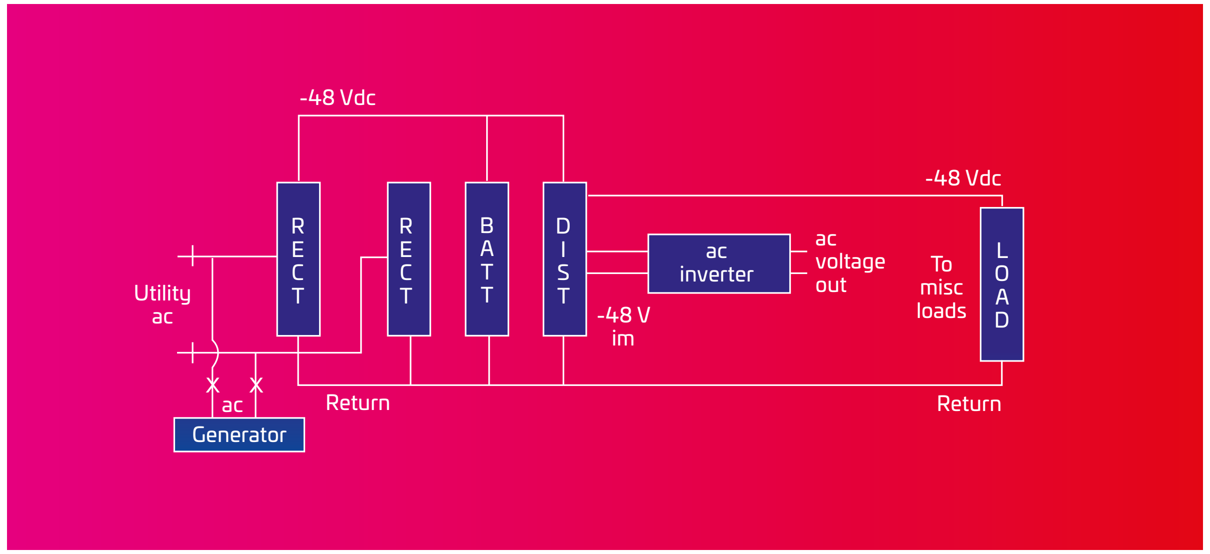


Typical power feed for a remote radio head

Saving space and cost in the shelter

While relocating the RRH from the base station to the top of the tower saves space inside the shelter, the number of additional radio units required for today's advanced 5G deployments threatens to outgrow the shelter. Additionally, it compounds the challenge of managing the thermal load inside.

In response, infrastructure providers such as CommScope have developed new, more compact power solutions that enable operators to save space and cooling costs inside the shelter.



A dc-ac inverter system connected in series to a cell site's power system

An integrated rectifier, dc distribution and controller power system

Integrated power systems

To address these space limits, CommScope produces integrated power systems with several components built into a single device and suited for installation in a single rack. This approach is increasingly common in modern cell sites.

A typical integrated cell site power system includes one or more shelves of rectifiers along with one or more shelves of dc-dc converters. This integrates power conversion and power distribution functions, connecting them with bus conductors. The distribution system contains an integrated dc bus, fuses or breakers and cabling tie-downs to distribute power to the load.

dc-ac inverters

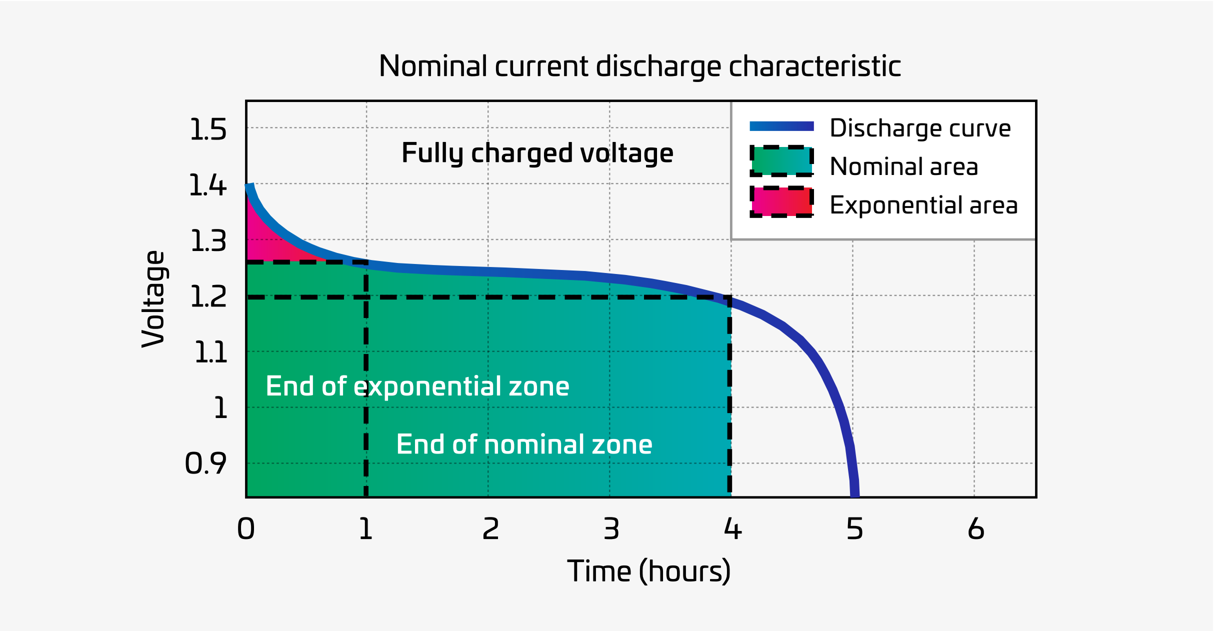
Some of the equipment operating at a cell site may require ac current from battery backup supplies. Since the entire system is built around DCD-A power, a dc-ac inverter is needed to provide the necessary ac voltage. There are two basic types of inverters.

Offline inverters feature an ac input and an ac output with a standby dc line connection available. This is the type generally used in cell site applications. Online inverters feature a dc input and an ac output with an optional ac standby line available.

Like dc-dc converters, the input for a dc-ac inverter is supplied by the primary power plant. Like converters and rectifiers, inverters are often installed and configured for redundancy. A static switch maintains equalized voltage to the load by switching automatically between external ac power and the inverter's ac power. This switching is done instantaneously—assuring no interruption in operation.

Right-sizing the power conductor

As wireless networks evolve, dc power consumption levels at the cell site are approaching two kilowatts of demand. A key question for network designers is: “How much copper is really needed to support the power needs of the site? There is no single standard for determining the right size of conductors to use when connecting dc power to tower-top electronics; so, to make a good selection, consider the following factors.



Voltage drop

Due to the resistance of the cable itself, tower-top electronics will always have a lower voltage than the power plant or the ground-mounted equipment. The lower the input voltage the higher the current needs to be to maintain the output power level. Voltage delivered at the tower-top will depend on the power plant voltage and the size and length of the conductors.

Design case

The critical factor when sizing conductors is knowing the voltage of the power source when the cell site switches to backup battery power. The battery starts at 48 volts and will drain until the battery disconnect is triggered or the electronics reach their low-voltage drop-out value.

Battery backup time

Depending on the required cell site reliability, the battery backup should last until the technician can reach the site and ensure the generator has successfully started. This can range from one to eight hours.

Power line losses

Power loss is a function of the cable’s resistance multiplied by the square value of the current. Use 54 volts to calculate the current for efficiency since the rectifiers provide 54 Vdc power to the RRUs when primary power is connected.

Electrical codes

As the power requirements at the top of the tower have increased to 1600+ watts, electrical codes have become a factor since the amperages in conductors can be exceeded. In the U.S., reference the latest NEC table 400.5(A)(1) and 400.5(A)(3) if using SO type cables and Table 310.15(B)(16) and 310.15(B)(3) (A). Outside the U.S., reference the applicable standard for flexible cable ampacity.

Cost

The initial cost of the cable and installation should be weighed against battery backup time, tower loading, permit costs, etc., in order to select the optimum conductor size.

Future proofing

Consider the site evolution over the next few years so an upgrade is not needed soon after the cell site cabling is completed.

Rule of thumb

Size the conductors for a five-volt drop when the cell site is on battery (48 volts). When the battery powers the cell site, it will provide 48 volts, so the tower-top electronics will initially receive 43 volts and the tower-top electronics will remain powered until it sees about 38 volts (which means the battery has drained down to 43 volts). If the conductors are sized based on voltages supplied by the rectifiers while the primary power is connected, it is likely the tower-top electronics will either drop out when the battery is engaged or there will be little backup time.

Here are some links to tools that will help properly size conductors.

FTTA Power Calc ™

PowerShift® Macro

Today's high-performance remote radio units (RRUs) consume more power, and operators are installing more of them to keep up with exploding data traffic. Radio equipment is also increasingly moving to the top of the tower, requiring more energy to deliver the right power level to the units.

To handle the increased power requirements, higher-wattage RRUs require additional power cables or larger power conductors, which use more copper. The increase in copper adds more weight on the tower—as do the thicker, more expensive cables required to support these new RRUs. Add higher installation costs and rising copper prices, and operators are feeling the financial squeeze of upgrading their network.

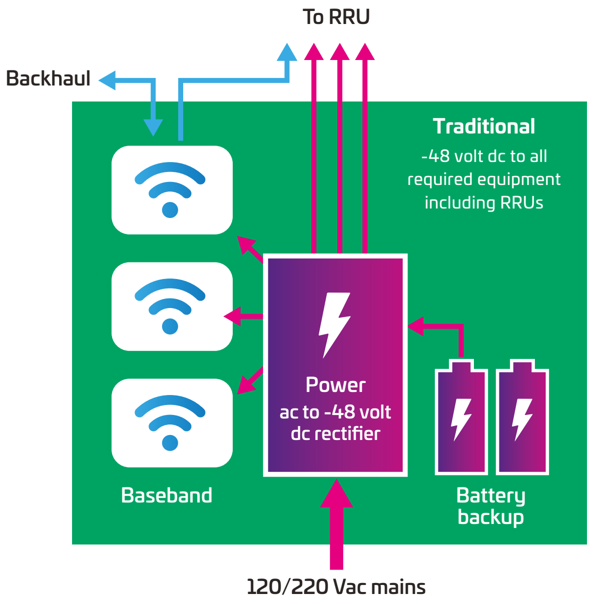
Take back the power with PowerShift®

With PowerShift, CommScope shatters the old paradigm for delivering dc power to the tower, opening new opportunities for efficiency and performance. With PowerShift, operators can:

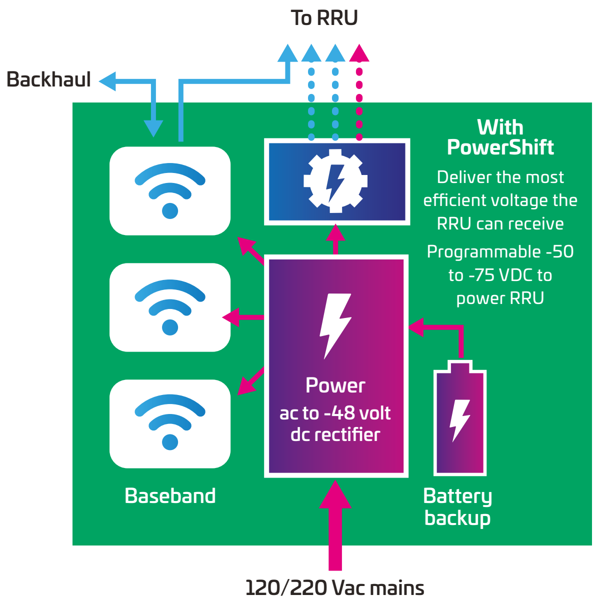
- Reduce CapEx
- Extend RF battery uptime by up to 50 percent
- Achieve 97.7% power efficiency
- Build future-ready infrastructure to accept higher-powered radios
- Improve cost effectiveness of RRU upgrades

All while evolving their macro layer network to support and deliver 5G-enabled services and beyond.

Traditional setup



Setup with PowerShift



How it works

PowerShift gives you back the balance of power by delivering the most efficient voltage to your RRUs in real time automatically—regardless of power supply, distance, conductor size or RRU power requirements. That optimization enables you to decrease the cost of network rollouts and upgrades and start earning a greater return on investment from day one. PowerShift also offers the system design flexibility you need to create an agile, future-ready network.

PowerShift works by optimizing backup battery power by solving the voltage-drop challenge discussed in the previous section. PowerShift is inserted between the battery plant and the trunk cable at the base of the tower. The battery output is fed into PowerShift, which adjusts its output voltage (VPS) to compensate for the cable voltage drop (VC), providing a regulated, programmable voltage to the RRU input (VL).

As the battery discharges down to 42 volts, PowerShift continues to boost its output to maintain the programmed input voltage to the RRU. This effectively eliminates the RRU dropout voltage as a major concern, ensuring full utilization of backup battery runtime by the RRU.

PowerShift also eliminates having to oversize the power plant and battery backup to handle a worst case scenario. So, MNOs can save cost and accommodate higher-power RRUs in the future.

Watch this brief video to learn more about the CommScope PowerShift Macro solutions

PowerShift® Macro portfolio

Engineered to provide the most efficient and reliable power feed for your remote radio units, the PowerShift Macro family can support multiple RRUs per circuit and maximize existing power infrastructue and power cable design

PowerShift
High Density & Capacity

Where cell capacity is critical, you can now power up to 12 RRUs in 1-RU of rack space with 1,460 watts and -54 Vdc per RRU.

- 4 modules, 3 RRUs per module
- Manual or Automatic setup for any power level or conductor length
- Pulsar® controller (optional) to manage performance
- All active electronics are centralized
- Extended battery backup life for service continuity
- Dynamic voltage regulation at the RRU

PowerShift
Total Redundancy

Get the highest level of reliability with two independent, redundant circuits per RRU with bypass redundancy in a 3-RU chassis.

- 12 hot-swappable modules for full redundancy
- 12 dedicated 2,000 watts circuits (1 per RRU)
- Manual or Automatic setup for any power level or conductor length
- Pulsar® controller to manage performance
- Easy wiring, open accessible design
- Extended battery back up life for service continuity
- Dynamic voltage regulation at the RRU

PowerShift
Modular High Power

Four 2,000-watt, -54 Vdc circuits in a 1-RU chassis deliver the power and agility to support future network growth.

- Modular from 1-RU to 3-RU (4-12 RRUs)
- 4 dedicated 2000W output circuits (per 1-RU)
- Ganged front input and output connections for easy installation in tight spaces
- Pulsar® controller to manage performance
- Extended battery back up life for service continuity
- Dynamic voltage regulation at the RRU

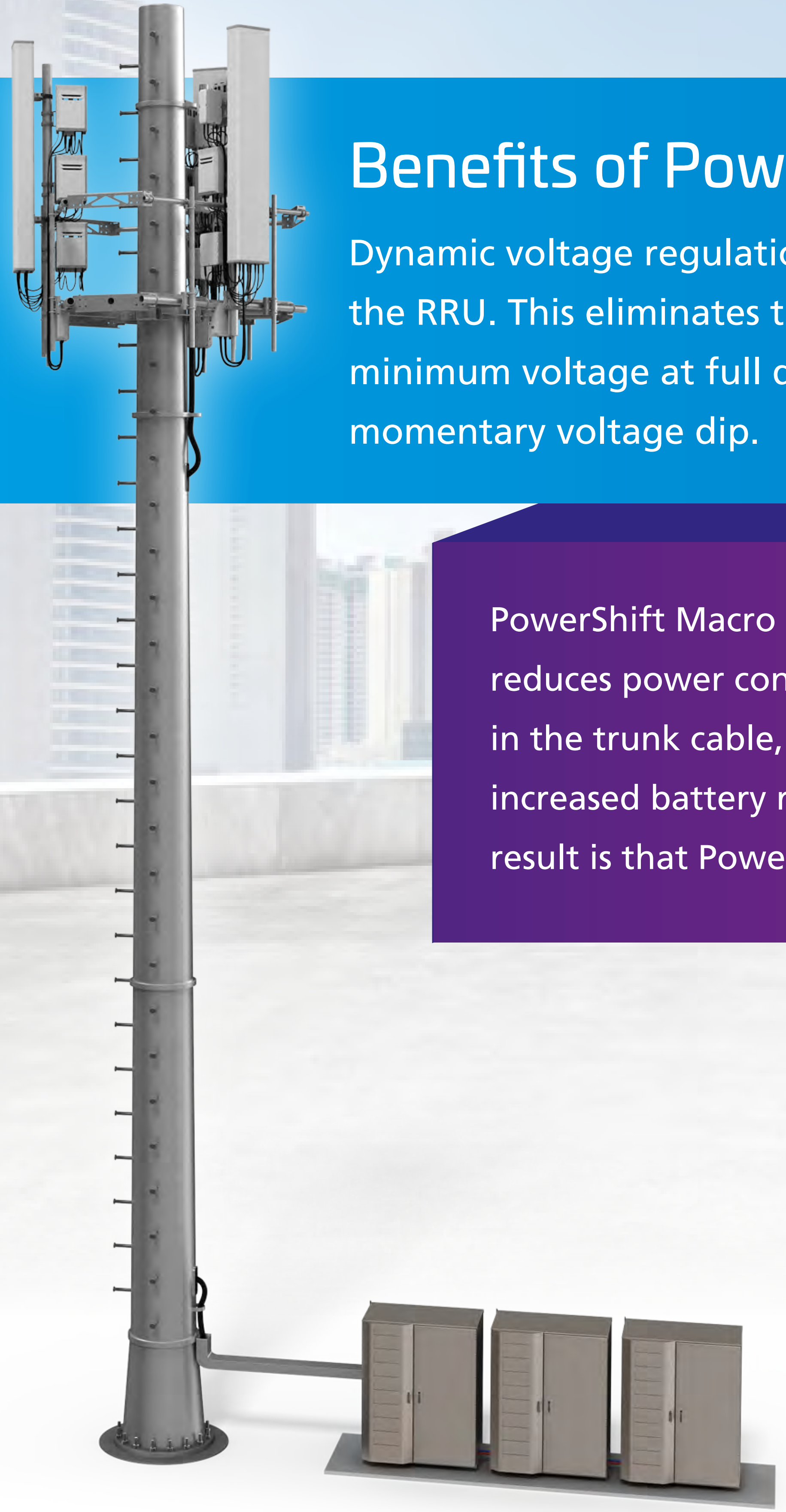
PowerShift
Constant Boost

Designed to meet budget constraints for applications involving a low number of high-power RRUs, where deployment speed is key.

- 3 high-power circuits in 1-RU chassis
- 2,166 watts per circuit, 6,500 watts per shelf
- Ability to gang the output circuits
- Front access for quick connectivity to input and output connections
- Plug & play requires no configuration or training

Benefits of PowerShift Macro

Dynamic voltage regulation ensures delivery of optimal input voltage to the RRU. This eliminates the risk of RRU dropout when batteries reach minimum voltage at full discharge and when older batteries suffer a momentary voltage dip.



PowerShift Macro also reduces power consumption in the trunk cable, resulting in increased battery runtime. The result is that PowerShift Macro:

- Minimizes the cable gauge needed to support high-power RRUs
- Enables the reuse of existing cell site cables
- Minimizes the need for additional battery strings
- Ensures the maximum utility and service life of older battery strings

The trend of increased power demand by remote radio units will continue, with RRUs approaching 2,000 watts already on the drawing board and even higher power radios expected in the future. CommScope continues to expand and evolve the capability of the PowerShift Macro portfolio to keep pace with these demands and support our customers' need to maximize cell site reliability.

Powering small cell metro networks

Demand for wireless data is exploding, with 5G deployments increasing daily. Increased data traffic requires more computational power. As a result, networks must increase cell density, adding thousands of small cells, up to 10 for every LTE macro site. And they all need power. How do you run reliable power to every small cell—quickly and affordably? Your solutions are as limited as your time and budget. What's your strategy?

Powering small cells is a whole new challenge

The advanced capabilities of today's 5G small cells create added power requirements. A typical three-sector small cell can require 200–1,000 watts of power. With thousands of small cells, the challenge is how to run power to each one in a way that's fast, efficient and repeatable. The first step is realizing the vast differences between powering macro cells versus small cells.

Macro cell deployment is a deliberate and structured process of permitting, building and provisioning; each tower location represents a unique, carefully planned project. With small cells, operators don't have that luxury. They must accelerate rollouts using processes that are agile enough to adapt to siting, backhaul and power configurations on the fly. The following are some of the key differences between powering macro and small cell networks.

Operational power

The long lead time for deploying a macro site enables the operator to assess the power requirements and schedule a power drop from the public utility long in advance. The hectic pace of small cell installation doesn't allow for this. Often, it's not until after the site survey that engineers discover there is no electrical power close to some of the proposed small cell locations. Tapping power from existing buildings and/or getting municipal approval involves negotiations with building owners, tenants and local agencies, and takes time.

Backup power

Battery backups can be added to a macro site without affecting permitting issues, which is not the case with small cells. In some instances, the power backup solution can take up more space than the small cell itself; if that backup solution involves a diesel generator, there are additional permitting and environmental issues to overcome as well.

Space constraints

A macro tower site is pre-designed with the power cabinet and power meter typically housed in a dedicated space within the shelter. In deploying urban small cells, mobile network operators must work within the constraints of the available space. On lamp posts or utility poles, for example, there may not be room for a dedicated power source, meter or backup power supply. Small cell solutions that can integrate with street furniture or are available pre-assembled for faster turn-up can help operators deal with these challenges.

Options for powering your small cell networks

When it comes to tackling the various issues of powering small cells, there are a few existing options and each has its opportunities and obstacles.

Power from the grid

For the vast majority of mobile network operators, tapping the utility grid is the go-to solution for powering wireless networks. However, the process requires intense planning and project management. This method becomes less attractive as mobile network operators shift from deploying fewer and larger-capacity macro-based cell sites to thousands of smaller capacity small cells. Challenges include the cost and time involved in getting a power drop (metered or un-metered) to each individual node. Additionally, network engineers must solve the issue of equipping each site with battery backup in space-constrained urban locations and satisfying tougher aesthetic regulations.

Hybrid fiber coaxial (HFC)

HFC networks are now the mainstay of the cable television industry. HFC's power-carrying capability can also provide an alternative solution to the small cell power challenge. As operators push HFC deeper into the network, they're upgrading their 60/90 Vac power plant, adding more power injection points and deploying remote distributed-access architectures. This allows them to use coaxial cable, running in parallel with the fiber, as a back-feed from an optical node to deliver power for small cells. The challenges with HFC networks are that it is still not ubiquitous and, where operators do not own their own backhaul networks, they must lease from other providers.

Twisted pair

A second possibility involves tapping the power-carrying capability of the legacy copper telephone networks, also known as remote feed telecommunications (RFT) circuits. There are essentially two approaches to this solution. RFT-C is a current-limited technique, whereas RFT-V is voltage-limited; both enable you to re-use the existing copper plant. However, the small-diameter copper pairs provide limited power under the current standard and exhibit high power losses over extended distances. At a length of 3,000 meters, the 100 watts of injected power drops to about 60 watts of effective power. Additionally, there is a general lack of documentation regarding available copper wires within the public-switched telephone network (PSTN). So, identifying the right power injection points is also a challenge.

Power over Ethernet (PoE)

The latest power over Ethernet standard, IEEE P802.3bt (PoE++), supports up to 71.3 watts (dc) per device port. As such, its use in a small cell environment is limited to very low-powered Wi-Fi access points. In addition, PoE is also distance limited, with PoE++ rated for a maximum distance of 100 meters, although solutions like CommScope's Powered Fiber Cable System extends PoE use up to three kilometers. While it removes the distance limitations, the power limitation remains. Moreover, the speed and latency requirements for small cell backhaul dictate the use of fiber, which further weakens the business case for power over Ethernet.

The importance of getting it right from Day 1

Due to the accelerated pace of small cell deployment and more extensive power infrastructure required, there will be a high price to pay by not getting it right from the beginning. Meeting the large demand in a compressed timeframe will be hard enough without having to switch strategies six months down the road.

This is where having a go-to solution that has already been field-tested and vetted can be a major help. As noted earlier, a fast, flexible and repeatable process that enables operators to deploy quickly and efficiently—regardless of backhaul needs, power requirements or proximity to the grid—is essential to a successful small cell rollout.

CommScope has developed a solution that checks all the boxes. To learn more about PowerShift Metro for small cell networks, go to the next section. >>>

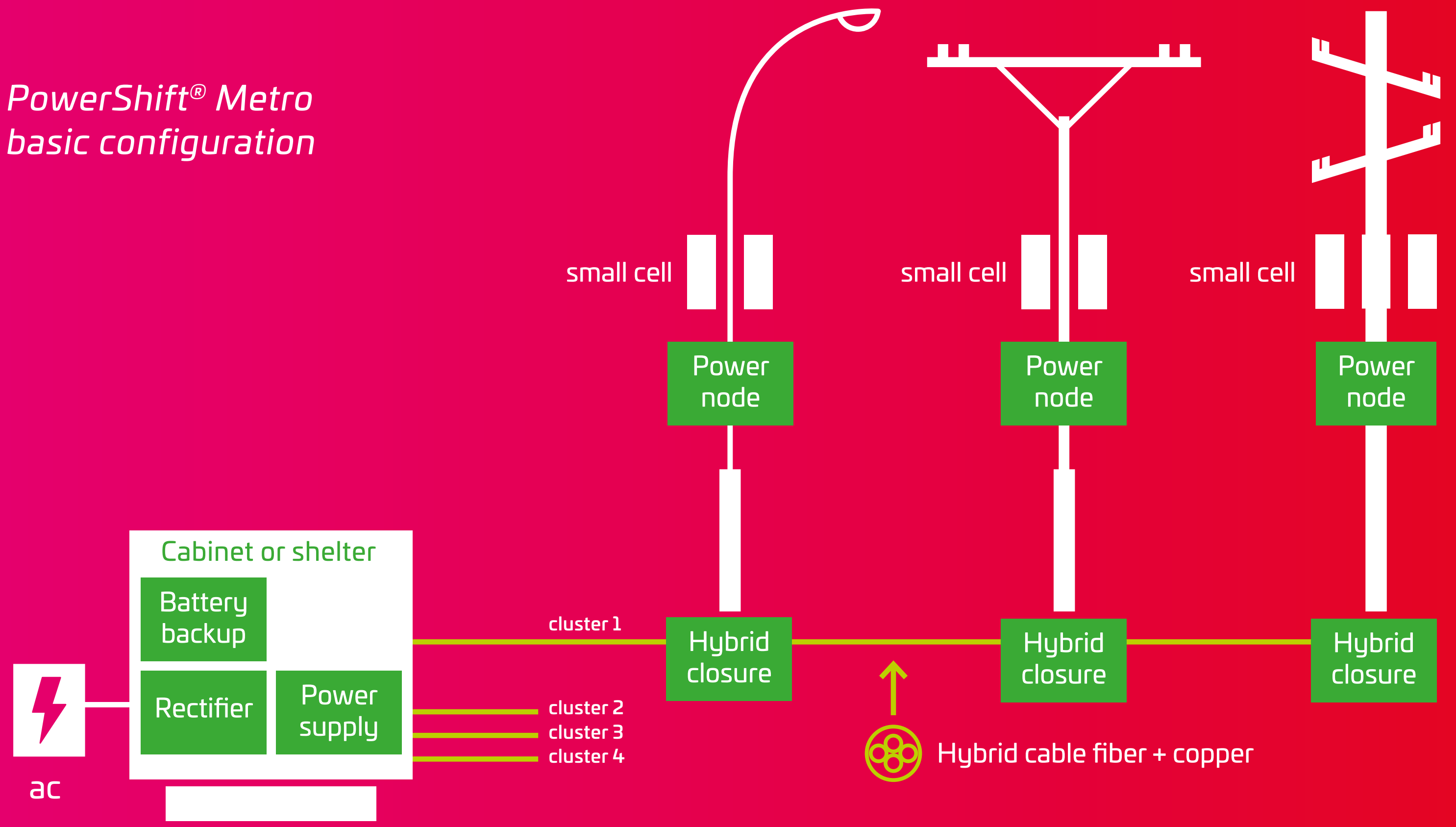
PowerShift® Metro

Until recently, powering small cells required separate ac power drops for each site. Operators often have to reconfigure their network to stay on schedule and within budget. Then there's the question of backup power. When the grid goes down, most small cells don't have the backup power infrastructure that macro sites do. And power's only half the problem. You still need to run fiber.

Introducing PowerShift® Metro from CommScope: Distributed power and fiber for your outdoor small cell network.

CommScope's PowerShift Metro is a more agile, reliable and cost-effective alternative to grid power. Controlled by the mobile operator, it provides a separate power feed from a central location, eliminating the need for an onsite power rectifier and meter, and relieving equipment congestion at the small cell pole.

PowerShift® Metro basic configuration



With PowerShift Metro, CommScope transforms its engineering expertise into an end-to-end, best-in-class power and fiber solution. One that gives you more control of your evolving small cell network—just in time.

PowerShift® Metro: How it works

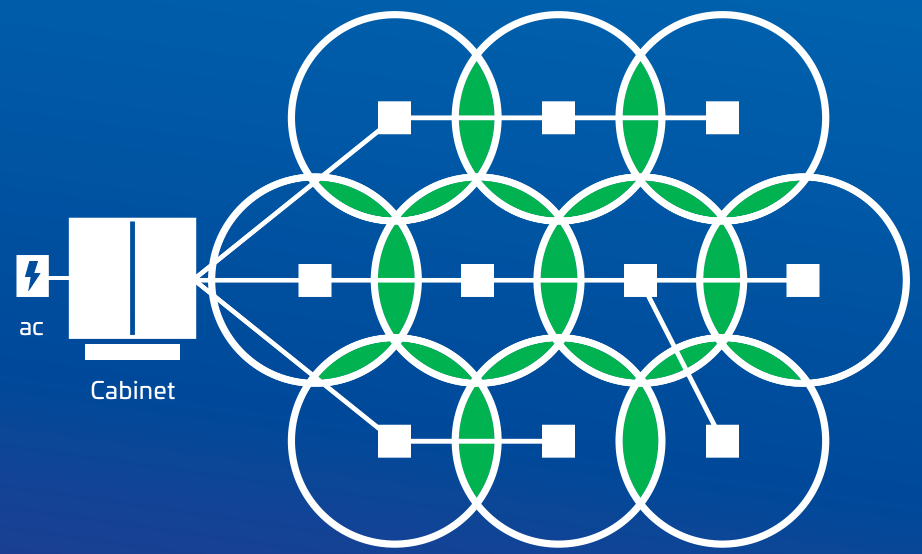
PowerShift® Metro is an innovative patent-pending solution that delivers cost effective power, fiber and battery backup to clusters of small cells, up to two miles away.

The heart of the PowerShift Metro solution is the power hub—ac power supply, rectifier and battery backup—that can be deployed from any central location or macro site. Grid power feeds the power hub, which distributes the power and fiber to clusters of small cells arrayed in a "spoke and hub" architecture. Each hub provides power and data connections to as many as four small cell clusters and supports a variety of topologies. The power hub also contains enough battery backup to fully power the small cells should the grid power fail.

Power cabling and fiber connections are integrated and routed together, in full compliance with the latest standards for distributed power connectivity. PowerShift Metro delivers kilowatts of power and up to 144 fiber strands in a single composite cable.

Built-in safety features enable non-certified electrical personnel to install the solution. In most cases, the cable can be co-routed with other communications cabling. PowerShift Metro can also be leveraged to supply various types of infrastructure such as fixed-wireless access points, mobile edge computing, hybrid fiber coaxial cabinets and smart city installations.

Planning and provisioning for next-generation applications like smart city, IoT and edge computing is easier, too. A unique, expandable bus structure lets you add edge nodes or additional power, often without cable upgrades. Real-time monitoring delivers a wide range of data—like voltage, current, and operating temperature—onsite or from any web browser.



CommScope's PowerShift Metro, an integrated, end-to-end solution, delivers power and backhaul from one central location—which can be anywhere that has access to power and the optical network—to clusters of neighboring small cells.

PowerShift® Metro: The benefits

By eliminating the excessive time and costs required for a utility drop, mobile network operators can deploy power to their small cells faster and less expensively in places where power is not quickly and easily available. It also allows for battery backups or generators at the centralized location to support busy or mission-critical small cells.

By reducing the number of uncontrolled variables—scheduling delays, electrician availability, additional meters—the distributed power connectivity solution gives operators full control over how, when and where to add small cell coverage. This enables mobile network operators to swiftly respond to new market opportunities and increase speed to revenue—capabilities that are critical in an increasingly competitive marketplace.

The variable-voltage power supply also reduces OpEx by enabling peak shaving across small cell sites. When the demand and cost for grid power are highest, MNOs can avoid spikes in power consumption by leveling out peak use of electricity. This not only reduces the amount of energy purchased, but it also improves power grid stability.

Key benefits:

- Reduce operating costs and dramatically lower installation costs
- Accelerate time to market
- Ensure service continuity
- Prepare your power infrastructure for the future
- Reduce congestion at the pole

Learn more

To learn more about the CommScope PowerShift Metro solution, watch this brief video and see how PowerShift Metro can help you take control of your small cell networks.

Conclusion

At home, work and play, the world relies on wireless networks like never before. But the demands on your network are quickly increasing. A relentless appetite for more bandwidth, fast-changing technologies, slowing subscriber growth and the arrival of 5G are causing massive disruptive shifts in the wireless landscape.

In response to these changes, outdoor networks are growing in scope and complexity. But what about the power distribution systems that enable them? As public power grids age, the always-on wireless services customers rely on become less reliable.

Your outdoor network is evolving. Your power distribution solutions must evolve as well.

Hopefully, this ebook has provided valuable information and inspiration to help you improve the operational resiliency of your power distribution system. But we've only skimmed the surface. For a deeper dive into how to develop a more reliable and efficient outdoor wireless power strategy, contact us.

Always prepared, always pushing ourselves to do it better and smarter, keeping you ready for whatever is next.

That's the value of CommScope.

www.commscope.com

Visit our website or contact your local CommScope representative for more information.

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