The Rise of Renewable Energy: Accelerating Change Through Better Power and Testing Solutions

Going "green" is no longer just a buzzword. In both the private and public sectors, the energy transformation is not only happening, but accelerating at a rapid pace.

A mix of consumer and regulatory pressure, along with long-term energy reliability, is causing companies across industry lines to seek out renewable energy as a means of differentiation over their competitors. To fuel that transformation, companies require better power and testing equipment, including advanced programmable power solutions.

This white paper will focus on the power and energy sector as it stands today, key considerations for power and testing, and what's driving future innovations.

What the Power and Energy Sector is Doing Today

According to the U.S. Energy Information Administration (EIA), renewable energy sources accounted for about 11% of the total energy consumption in the United States in 2019. By 2021, the EIA projects that electricity generation from renewable sources such as wind and solar will surpass nuclear and coal. By 2045, they project that it will also surpass natural gas.

The top renewable energy sources that are experiencing growth include:

- Solar
- Geothermal
- Wind
- Hydropower

While these and other sources of renewable energy present new opportunities, changing over to a more renewable future is not as simple as flipping a switch. The main challenges involve:

Energy Availability

Renewable energy sources are not always available 24/7. When the sun sets or the wind dies down, we start to lose out on major sources of renewable energy. Unfortunately, the world does not stop working just because the sun is down.

This means that if we ever want to rely solely on renewable energy, then we need to have proper means of energy storage. Only then can we keep powering the world during the sun and the wind's "off" hours.

Reliability

If there is one thing we have come to expect in the modern world, it is our devices and machines staying up and running. From the convenience of having consistent power in our daily lives to the absolute necessity of it within industrial and medical settings, reliability is key.

Maintaining a reliable supply of energy can be broken down into three main parts:

- Designing equipment that mitigates the chance of failure
- Having the ability to accept a wider range of outputs and/or integrate with other technologies
- Providing redundancies for when one source fails or goes offline

If your power fails, your system goes down – it is as simple as that. Assuring the reliability of the devices that convert power from renewable sources is of the utmost importance. Companies offering devices such as grid-tied inverters over decades of warranty coverage cannot afford to field products that do not match that coverage.

Power Redundancies

Redundant power sources allow you to keep systems up during an outage or whenever your main source of power is offline.

Making sure that you have adequate redundancies is a challenge for any power and energy system, including renewable ones. Not only must there be adequate backup power, but the transition between a primary power source and a second one needs to be as quick and as seamless as possible.

Key Power and Testing Considerations

An idea is only worth as much as it can be acted upon and realized. For the energy sector to continue its forward momentum and achieve a higher energy utilization, advanced power and testing equipment are required to validate power conversion designs.

Power Solutions

Not every energy source works the same. The power conversion equipment that was designed for oil and gas cannot simply be put into a system meant to capture and make use of renewable energy.

Take solar power, for instance. The fatal flaw of using the sun as an energy source means that you can only collect energy when the sun is shining. Not only are your efforts stemmed at night, but even a cloudy day can drastically reduce function. It is estimated that cloudy days only provide about 10 to 25 percent of the energy that you would get on a clear day.

The difficulty here is that it is not just as simple as some days generating less power. Solar energy collection can greatly vary even from minute to minute from a brief stint of cloudy overcast.

The power you get from the solar panel is DC power, which cannot directly be tied to the utility grid. It must be processed through a device called an inverter that converts the DC power to AC power in a manner that the utility grid will accept. Test equipment like AC grid simulators are designed to provide the means to behave like the utility grid and able to simulate things like brownouts and blackouts. Other equipment like terrestrial solar array simulators (TerraSAS) are designed to behave like a solar panel. These can simulate different real-world scenarios like how the angle of the sun changes from the morning to the evening and how clouds passing over the panel can create localized shadowing.

To complicate things even further, solar panel arrays are not a single, uniform entity, but rather made up of individual solar panels. These are what collect the photons from the sun and convert them into electrical power. When a cloud passes by or the shadow of a tree is projected on a solar panel, it often will not cover the entire solar panel at once. Some cells will still have direct sunlight while others are in the shade, meaning that it is not just about if the panel is getting sun, but how much sun it is getting.

The same logic applies to other variable renewable energy sources, such as wind energy. As air currents speed up or slow down, a test system must be able to provide the same power behavior as that experienced by the energy source.

If you want to validate the design of the fielded equipment that converts power from these renewable energy sources, one needs to be able to create a test platform that provides power simulation behavior that matches each use case.

Programmable power allows you to tweak electrical characteristics—voltage, current, frequency, slew rate, transient response, etc.—to fit the needs of whatever test system you have. They are flexible and adaptable and can handle the demanding power transitions or any other unique electrical properties. Through an analog input, digital interface, or resident user interface, you can design the appropriate test methodology and sequences that match the validation requirements.

For example, Maximum power point tracking (MPPT) is a method that grid-tied inverters use to increase efficiency when converting power from solar panels. When using a solar array simulator to emulate the solar panel power, it has to react very quickly to minute changes introduced by the inverter's MPPT algorithm. If it is too slow, the inverter will not be able to accurately optimize its output. With inferior test equipment, the design engineer will need to determine if the sub-standard efficiency resides in their MPPT design or in the test equipment. This takes time and could waste significant resources to determine.

AMETEK Programmable Power's TerraSAS™ series photovoltaic (PV) simulators are specifically designed to emulate the dynamic electrical behavior of a terrestrial PV solar array. The TerraSAS offers a high-performance solution in a small form factor, combining an agile power supply with an innovative I-V curve generator – all in a single standalone unit. Their low output capacitance and high closed loop bandwidth also allow them to keep up with advanced MPPT algorithms for higher power testing.

Regenerative power supplies – those which can both supply and accept power – are also important to certain applications, especially when energy storage and overall efficiency are key factors.

While typical electronic loads will convert energy to heat, regenerative power supplies can safely return that energy to the grid. This saves on energy that can be then be stored for later while also eliminating any additional costs that come along with heat management. Energy storage is critical for renewable power sources due to their variability, so regenerative power supplies can help maintain a consistent supply of power.

Developing more compact power supplies is also a major consideration. Smaller designs allow you to reach the same power output without taking up as much space or weighing your systems down. The bulky nature of conventional power supplies is the primary reason that certain life-changing technologies such as powered exoskeletons have yet to take off.

Advanced Testing

Having precise and reliable testing equipment is critical to the success of the power and energy sector. Only by validating our designs can we ensure that they are ready for commercial and industrial use.

Just as power supplies and electronic loads need to handle the variable nature of renewable energy, so must our testing equipment. Proper testing equipment should be able to adequately simulate real-world scenarios that cause dips or spikes in energy, such as a shaded solar panel or a pickup in wind.

While the input of renewable energy is variable, you cannot have any significant variation in the electrical monitoring of that energy or you risk invalidating a test. That is why you need ultra-high precision monitoring equipment.

AMETEK Programmable Power: Fueling the Change

As a global leader in electronic instruments and electromechanical devices, AMETEK Programmable Power specializes in developing highly-differentiated power and testing equipment for the world's leading markets.

The team at AMETEK Programmable Power designs, manufactures and markets precision AC and DC programmable power supplies, electronic loads, and application specific power subsystems, as well as advanced testing solutions. We make better equipment so that the shift to more renewable energy can be as seamless and beneficial as possible.

Beyond our advanced power and testing technology, AMETEK Programmable Power works closely with you to develop custom equipment that best fits your application. Our experience is your experience.

For decades, AMETEK Programmable Power has served as a world leader in developing next-level energy solutions for various markets and industries. That expertise allows us to know what works and what does not based on what we have already accomplished. Even if you need an entirely new product, chances are that we have done something similar enough in the past that we will not need to start from scratch.

We combine that experience with our innovative product offerings for a full-service approach to power and testing. Have an idea that you think might be beyond what can be done with modern technology? We will let you know if it is feasible, and if not, what the next best alternative would be. With the right approach, you will find that most things are possible, even if the path to get there is different from what you originally thought.

As your power partner, AMETEK Programmable Power is ready to take that journey with you. That way, we can work together toward a circular economy fueled by renewable energy.