WHITEPAPER

Omnivise T3000 SCADA

Your bridge into the future for renewables and decentralized power generation

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The Changing Energy Landscape

Rethinking the power generation market

The power generation market is changing fast. It's not just that there are changes in the types of power generation technology being used, there is something even more fundamental taking place. We are moving from centralized to distributed generation, and that leads both to major challenges and some new opportunities. There are three main reasons for these changes.

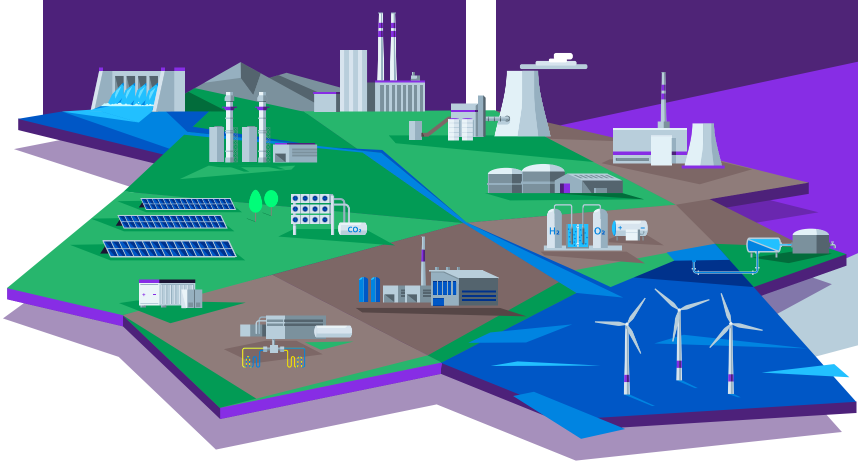
The first is **environmental**. There is a growing realization that power generation needs to decarbonize fast to address the negative impacts of climate change. The industry is already moving more quickly than most experts would have predicted even as recently as ten years ago and, in most developed countries, wind, solar and water are becoming normal power sources for our economies.

The second is **technological**. As our societies move to an all-electric future, where the grid is the only source of power, so the very nature of distribution grids is evolving.

Multi-directional functionality is becoming a reality, as virtual power plant companies (which aggregate energy from many different sources, such as solar panels on thousands of houses) and private corporations sell power as well as buying it, while the spread of smart sensors through IoT arrays enables greater flexibility in power management.

The third is **commercial**. Many energy markets are liberalizing (or have already liberalized), with trading now a basic part of electricity supply markets, and competition intensifying across both generation and distribution sectors. Availability is the key to success for all power generation businesses, and the old days of steady long-term running are long gone. There are now more players in the market, and they compete with each other in different ways, as markets change.

Once monolithic structures are now being replaced by a fragmented, constantly changing, and hard to manage new reality. This presents a serious challenge to every participant in the market, and has major political and economic implications, too.



Top-level view of the many different potential sources that must now be managed to deliver reliable services across the distribution grid.

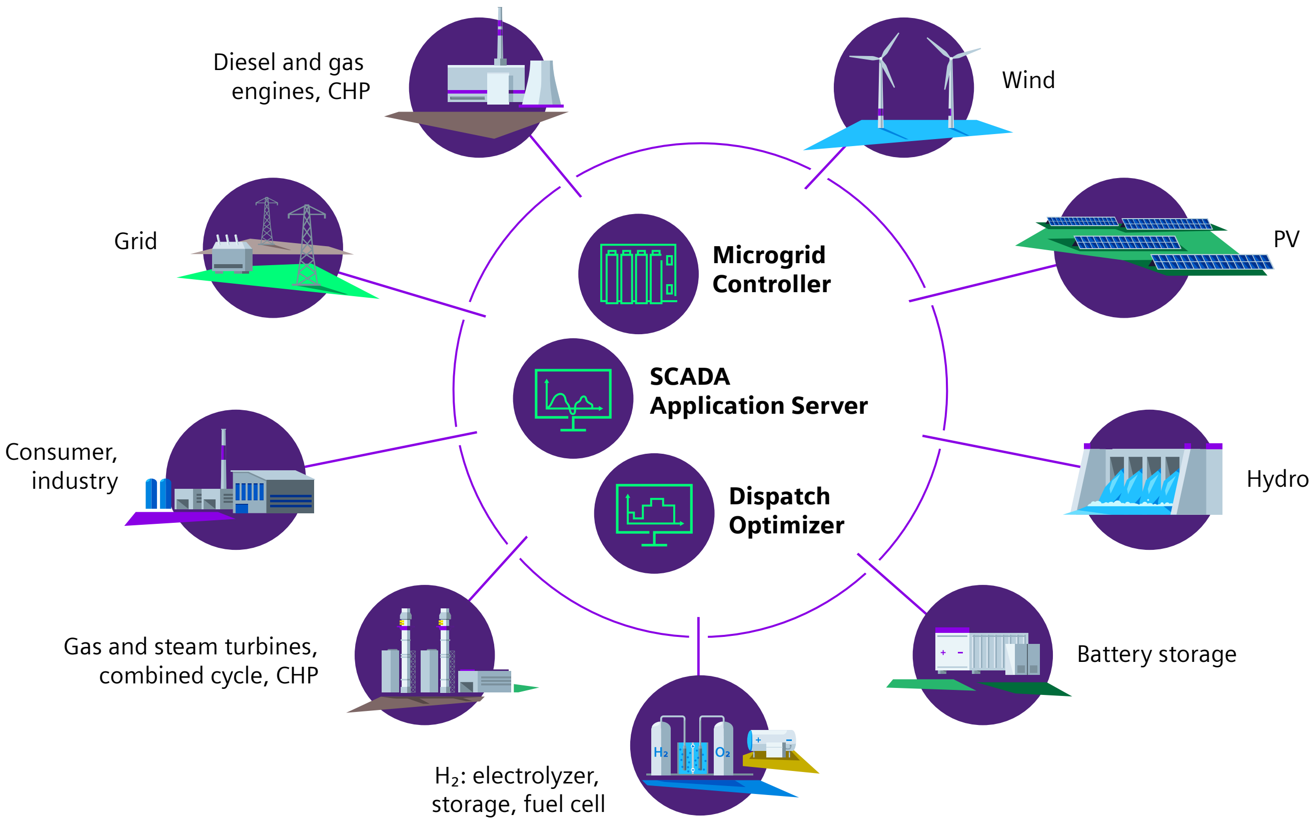
A more complex market

Today, power is generated in different ways, at different times and by different organizations, using different forms of technology. The result is great complexity within any national or large regional network: complexity that must be carefully managed, with outputs balanced so that the distribution grid can deliver the required energy to customers without unwanted interruptions or downtime.

The power generation mix still includes traditional large plants: combined cycle gas, industrial gas turbines, hydro and biomass. Alongside these we now have fluctuating power sources (available only at certain times and under certain conditions), including wind power and photovoltaic installations, together with other options that are relatively new for distribution grids: battery storage, biogas and small-scale combined heat and power.

Also just entering the picture are hydrogen, still at a comparatively early stage of development, and the new concept of Power to X. This allows power to be decoupled from the grid at times of surplus (such as when fluctuating sources are working with high efficiency) and applied to industrial processes or other non-grid related uses.

Quite apart from the increasingly complex mix of technologies now used for power generation, we must also deal with many different forms of commercial intermediary. These include virtual power companies or industrial and commercial campuses (which can sell surplus power to the grid on an hourly or minute by minute basis).



Staying in control

As we have also learned from recent events, we cannot always depend on current sources of supply from fossil fuels which are still needed when fluctuating sources, such as wind and solar, are not available. The absolute requirement at all times is to make sure that the power supplied to the grid is optimized to be as stable as possible, which is ultimately a function of the control systems.

In grids as they once were, where power was supplied by a relatively small number of very large plants, grid control was comparatively simple. Today, however, grids are managing inputs from a huge range of sources and the task of balancing supply and demand is granular, continuous, and very complex. This is especially important now, when the locations where power is generated may well be a long distance from where it is required. Power may come from a wind farm in the North Sea, for example, but it may be consumed in cities many hundreds of kilometers away. This adds an extra layer of management difficulty.

Now it is necessary not just to have visibility end to end across the entire energy landscape, but to have the means of understanding what is happening at all times, in all power generation locations, together with the ability to intervene as needed. That is a new concept for management and control. It depends on real or near real time data flows, in massive quantities, together with analytics, proactive management, distributed intelligence to enable instant responses as needed, all managed from a single point of authority.

Data, therefore, is at the heart of control systems, and the key source for the data used in virtually all industrial controls is SCADA.

Let’s take a closer look at it.

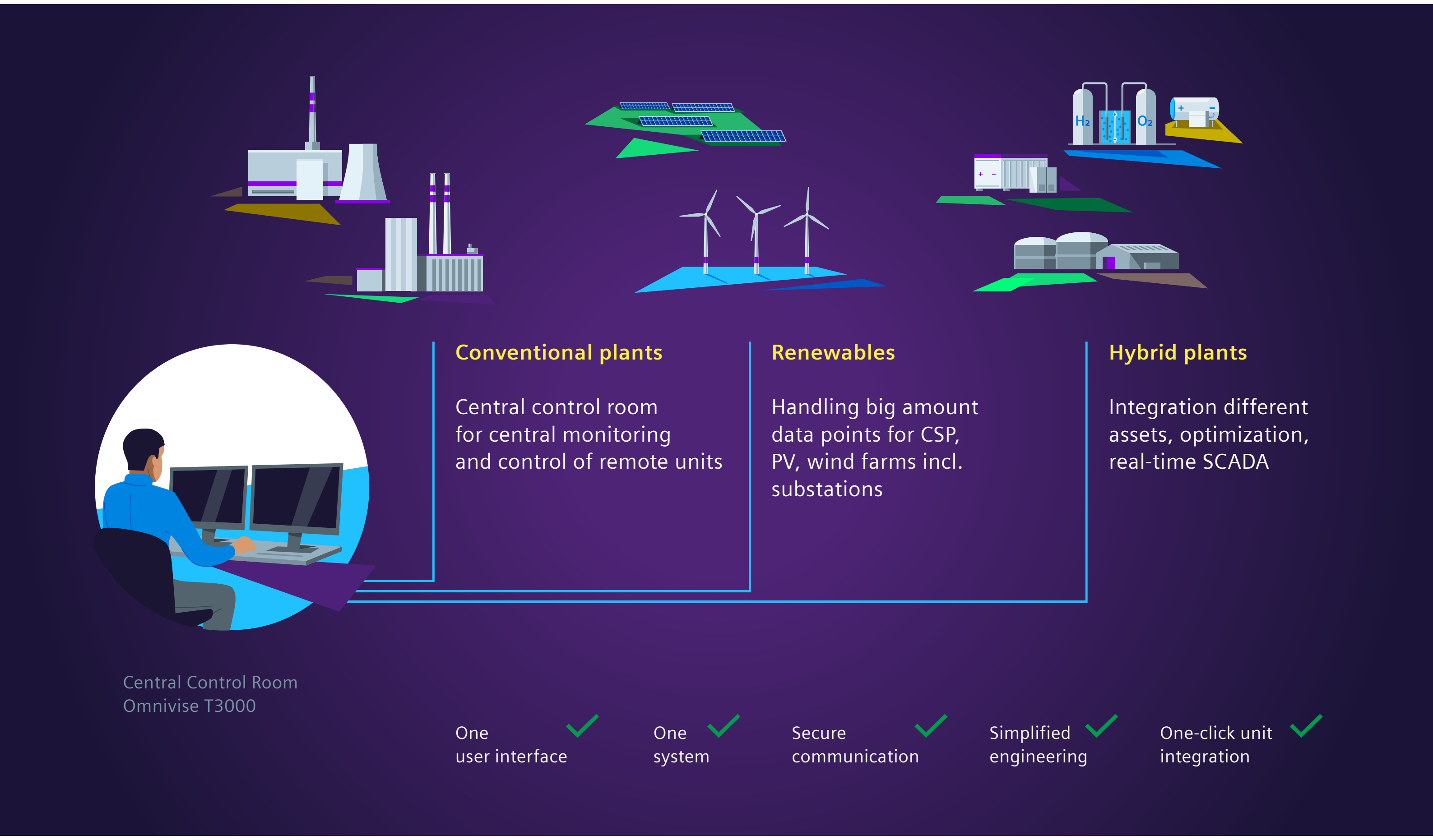
SCADA stands for Supervisory Control and Data Acquisition and is a set of software applications designed to collect data that originates in sensors and transmit these data to an agreed location.

The role of SCADA

The location can either be a server that is physically close to the power generation assets or based on a remote site, depending on connectivity. SCADA has important functionality, but there is a gap between what is increasingly required for effective control and what SCADA is able to deliver. A SCADA system has only limited intelligence, so it is in no way synonymous with Industrial Internet of Things (IIoT), while, in addition, the sensors used for different production assets can vary greatly. SCADA solutions simply ensure that data is collected and presented to a Distributed Control System (DCS) for active management of the network. This is where we encounter real issues in moving into a world of distributed power generation.

In the "old" world, of large central power plants, each location will have its own control solution (Siemens Energy is the world's largest provider of DCS solutions). In the new world of multiple power sources, some fluctuating, some not, the range of variations is extremely large. Most assets will have their own specific SCADA components, which may be incompatible with both other asset types and many different control solutions.

There may be variations in data security capabilities, while visualization options, response times and the ability to carry out autonomous actions may also be very different. A modern control solution will normally require an object-related single data source, with data consistency across a complex landscape, supported by data back-up and archiving, diagnostics, ample redundancy, and fail-over options.



None of these requirements are built into most SCADA solutions, so although SCADA still has an important role to play, its functionality is not sufficient for the challenges faced by power generation and power grids today. In fact, the existence of multiple SCADA solutions increases fragmentation in the network and wider grid. The effort required to collate information, analyze it, and then take appropriate action causes unacceptable delays and brings a good deal of risk into energy management, at generation and distribution level.

Distribution networks must be capable of managing considerable variety in power sources, while coping with fluctuations in output, multi-directional power flows and complex patterns of demand, yet always stay firmly in control. Output needs to remain steady and predictable, with the end goal of keeping lights on, heating operational, vehicles moving and manufacturing systems always running.

In other words, we need to take disparate and fragmented inputs and translate these into steady and reliable output. How to do that? The answer is through coordinated and managed control systems. That's where the Siemens Energy Omnivise T3000 control solution comes in, as we will see in the next part of this paper.

Integrated Control for Decentralized Energy

The importance of distributed operations

We have seen that power generation has evolved into a complex landscape of interconnected power plants, using a wide range of different power sources, which distribution networks must transform into reliable power, delivered to millions of users via distribution grids. To ensure energy security, the key as always, lies in management and controls. The mission is to deliver:

- A **single view of the truth**, so that operators and engineers can see end to end across the power generation landscape and understand precisely what is happening in detail, everywhere.
- A **single workbench**, with every relevant engineer able to take action as and when needed, knowing they can intervene to deal with faults and emerging issues in a timely way, ensuring that concerns do not turn into major problems.
- Assured **end to end cybersecurity**, so there are no points of weakness where malicious code can enter and there are adequate safeguards to identify cyber problems and respond fast.
- Effective use of **distributed intelligence**, enabling automated responses within agreed limits to happen without having to wait for intervention from the center.

How do we ensure these outcomes? It all comes down to the control solution in place.

The role of Distributed Control Systems (DCS)

In the old world of large-scale central power plants, the DCS solution would normally be related to an individual power generation facility and would comprise a constantly evolving combined hardware and software solution, designed to maintain and optimize normal operations at all times. Over the years, DCS solutions, such as the Siemens Energy Omnivise T3000, have become more responsive, proactive, and comprehensive in their scope. Today, such solutions will be able to carry out all the following actions:

- Gather data from a sensor array, providing very detailed insights concerning operation of the overall system and the different components within it.
- Analyze the data received from sensors to identify signs of potential issues or any likelihood that operations will move beyond defined tolerances or normal parameters.
- Review alerts automatically to reduce the number of human touchpoints. This means ensuring it is no longer necessary for an engineer to look at all alerts to decide which must be actioned and which can be discounted.
- Manage the maintenance schedule, interfacing with specialized solutions that optimize use of human expertise and make maintenance activities more proactive.
- Interface and support other relevant production management solutions, including PLM and trading platforms to ensure extension to asset life and availability for market needs.

Control systems, in other words, will provide the functionalities needed to manage production assets effectively. As technology platforms develop and become more capable, so solutions are becoming more effective at managing power generation in an agile and responsive manner.

The challenge of managing decentralized systems today, however, is orders of magnitude more complex and demanding than the traditional role. Why is that? One major factor more than any other is driving complexity across the entire system: the need to manage multiple distributed sources. Of course, a major distribution grid always does and always has taken power from many different sources. Yet as we move to a reality where many or most of these sources will of necessity continuously fluctuate, and where grids, themselves, permit two-way transmission, the level of complexity rises exponentially.

Equally important is the fact that the new generation of renewables do not come equipped with the standard sensor formats and controls that have been developed over many decades in the world of centralized power plants. So now we are dealing with greater complexity in the number of power generation suppliers, complexity in the forms of power supply (which are much less predictable in their operation), and complexity in the forms of data gathering and transmission software (and sometimes hardware, too) being employed.

Yet the requirements of society for reliable energy are rising fast, as we move to an all-electric future. All complexity comes together at one operational point: the control suite, where power flows are monitored, data analyzed and continuous adjustments made, moment by moment, without a break. Control solutions, therefore, can no longer be focused only on the individual power plants themselves: we need a distributed solution (DCS), as well.

Core requirements for control systems

SCADA remains the key to providing control and efficient management of distributed, decentralized power generation in large-scale distribution grids. That's because SCADA offers a standardized format for collating data coming from multiple generation units and systems, enabling rapid analysis of data gathered (in real or near real time). These functionalities make it possible to deliver a single view of the truth to distribution management.

Effective controls for distributed energy production will therefore include all the following capabilities as a minimum:

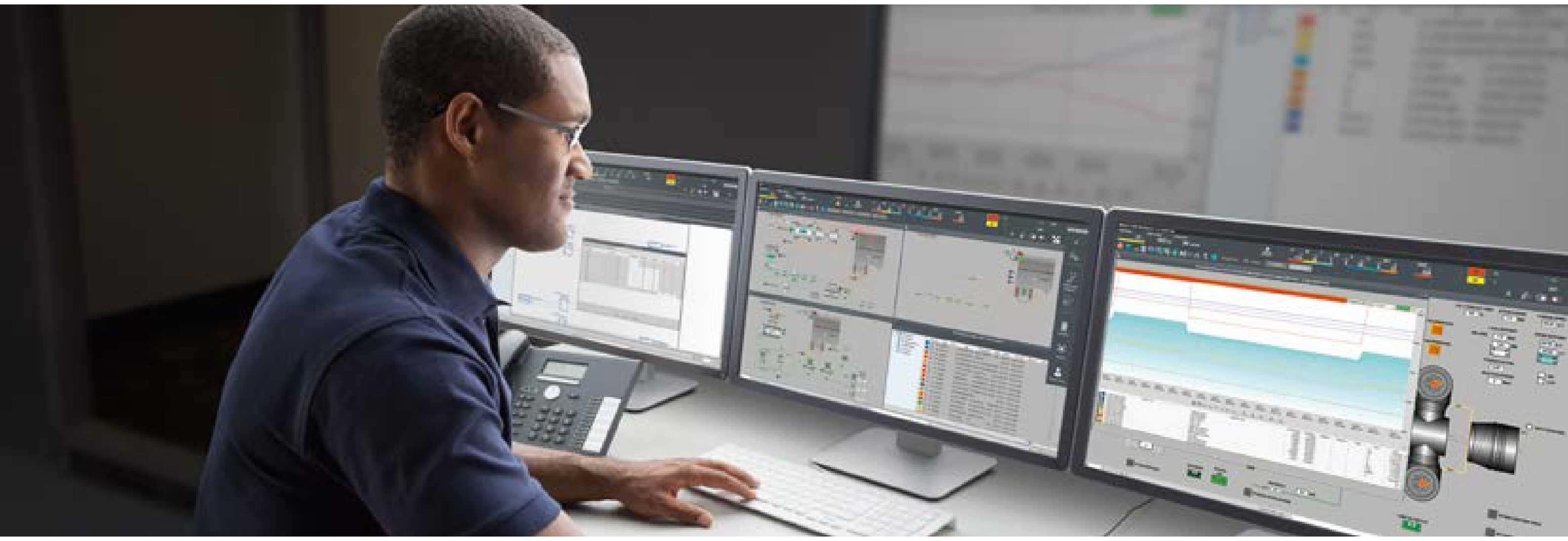
- Import SCADA data from remote units, sited at every production location. Ensure that any temporary communication interruptions are synchronized as soon as connections are restored.
- Enable central management of remote units, combined with manual input (if required due to communication loss) and a central archive for rapid search and analysis.
- Input engineering data from all systems, solutions, and software types, enabling comprehensive data access in the most complex and diverse engineering landscapes.
- Carry out root cause analysis to pinpoint issues, with full event list and applied analytics to identify emerging problems.

This approach means that distributed power generation and distribution systems can be managed in an integrated manner, bringing central oversight and control even to the most apparently fragmented energy landscapes. This entire new approach rests on the ability to access comprehensive performance data from every production asset in every location, based on secure data flows and efficient analytics.

DCS solutions in the future cannot afford to be reactive. It is not enough to ensure steady running and regular maintenance of production assets. Now the control system is tasked with constantly balancing an inherently unstable system, in which inputs may fluctuate, variations in energy flows are normal and the number of players in the market is increasing.

It's a new concept for a new reality.

That is the thinking behind Siemens Energy's Omnivise T3000, explained in the final section of this paper.



The Omnivise Approach

The starting point

The T3000 series of DCS solutions is already the most widely used control system within a large area of Operational Technology, and in particular for power generation. The scale of the current installed base makes it easier for Siemens Energy to build new developments on the solid foundation of experience gained from several thousand installations, in widely varied operational environments, all over the world.

The current solution provides key SCADA related functions as standard already. These include:

Central control room, where inputs from multiple remote units are gathered, collated, and analyzed. This is the basic requirement for effective control of distributed production assets.

Ability to manage the **massive quantities of data points** created by large renewable production arrays, and in particular for offshore wind farms. Given the variability of operation and the sheer scale of such facilities, data flows are of unprecedented scale and require specialized systems to enable remote collation and systematic transmission to the central control rooms. Most current systems cannot handle such a data challenge.

Data storage for later recovery and analysis, should a connection be interrupted. In current SCADA solutions, such data is likely to be lost, and that will be a major problem in future distributed energy environments. Omnivise T3000 stores all data for later synchronization, even in the event of major loss of connectivity.

Management of hybrid systems, including Virtual Power Plants. In a complex, distributed landscape, the control systems must be able to optimize and manage inputs from many different types of system, provided by many different vendors. They must also handle two-way flows across the distribution system and manage capacity in substations. Once again, this is not a normal function of most current DCS solutions.

A real-world example will show why exactly the Omnivise solution is currently viewed as the being more fit for purpose than other alternatives in this emerging energy environment. The new 900 MW He Dreiht wind farm (90 kilometers from the North German coast) announced in late 2022 will use a Siemens Energy Omnivise control solution, which can provide the capacity, system intelligence and assured cybersecurity performance to manage consistent output from this large renewable power solution.

This project breaks new ground in some ways but, in others, is becoming more and more typical of what will be seen as "normal" renewable power solutions for the future. Others are already operational in the North Sea and many more are planned for this region and other regions worldwide.

A wind farm of this type is physically large and geographically remote. To reach the assets requires a five-hour trip by sea (if major work is required) or an hour by helicopter (for less intrusive maintenance).

It is also potentially vulnerable to assault, and recent events have reminded us that hacking is not the only security concern for renewable power supplies: old-fashioned sabotage is also a real possibility.

The Omnivise approach offers integrated cybersecurity, linking Siemens Energy and other OEM equipment into a single solution, covering an entire installation, from turbines to substation automation, auxiliary systems, and direct marketing into the grid. These issues are covered in greater detail within our T3000 Cybersecurity white paper.

To ensure effective management of power supplies, therefore, control systems must be able to monitor in real time and in great depth, with assured security and failsafe communication options.

The solution must also include intelligence and smart algorithms devolved to the production site, itself. There must be enough intelligence on the local Edge server to maintain normal functions in abnormal conditions.

This implies robust, intelligent networks and a control solution that is not only inclusive (gathering SCADA data from every device and every location) but predictive and intuitive in its design. Services can be delivered remotely, which is extremely important for distributed sources (such as wind farms out at sea, where normal access is via ship only). This is an efficient control solution, to be sure, but on a different scale and sophistication when compared with today.

New developments, new functions

The new vision for control solutions pioneered by Siemens Energy includes several significant changes when compared to existing control systems. All of these are designed to optimize working in complex, distributed environments, delivering assured power outputs from sometimes unreliable, intermittent generation sources. Key factors include:

Integration. Omnivise T3000 SCADA connects wind turbines substation automation, auxiliary systems, and access to the energy market through a single platform with a centralized, integrated view. Integration covers Substation Automation Systems (SAS), with data and underlying logic from files applied for external (non-Siemens Energy) systems and platforms. This provides a single view and integrated approach for an entire extended network of production and distribution assets. The T3000 solution is also fully capable of remote working, enabling a high level of automation, self-diagnosis, and correction, with remote adjustments to reduce the need for costly and difficult on-site visits.

Testing. One core requirement for future power networks will be the ability to plan in more detail, removing the need for "trial and error", enabling scenarios to be examined, run in virtual machines, evaluated, revised and tested again. The Omnivise T3000 solution includes the ability to create digital twins and test them exhaustively. This is already speeding up development, identifying potential hazards and making these networks safer and more efficient.

Scalability. This is perhaps the most important characteristic of all, when applied to complex power generation landscapes. Traditional DCS solutions are normally fixed in scale: there is one controller for each site. That way of operating is no longer appropriate, and the T3000 design approach reflects the need to scale in ways that reflect the changing nature of energy generation.

The graphic on the next side illustrates how this works. This schematic view shows how the T3000 DCS capability sits at the heart of a scalable network of connections. Secure tunnels move data from all installed systems, no matter what their design or who provides them, combining such data with T3000 inputs to create a single view of performance realities from a growing number of remote locations.

The current design specifications allow for multiple remote sites to be connected to a single T3000 controller, enabling a consolidated view over an energy environment that is in many cases national in scale.

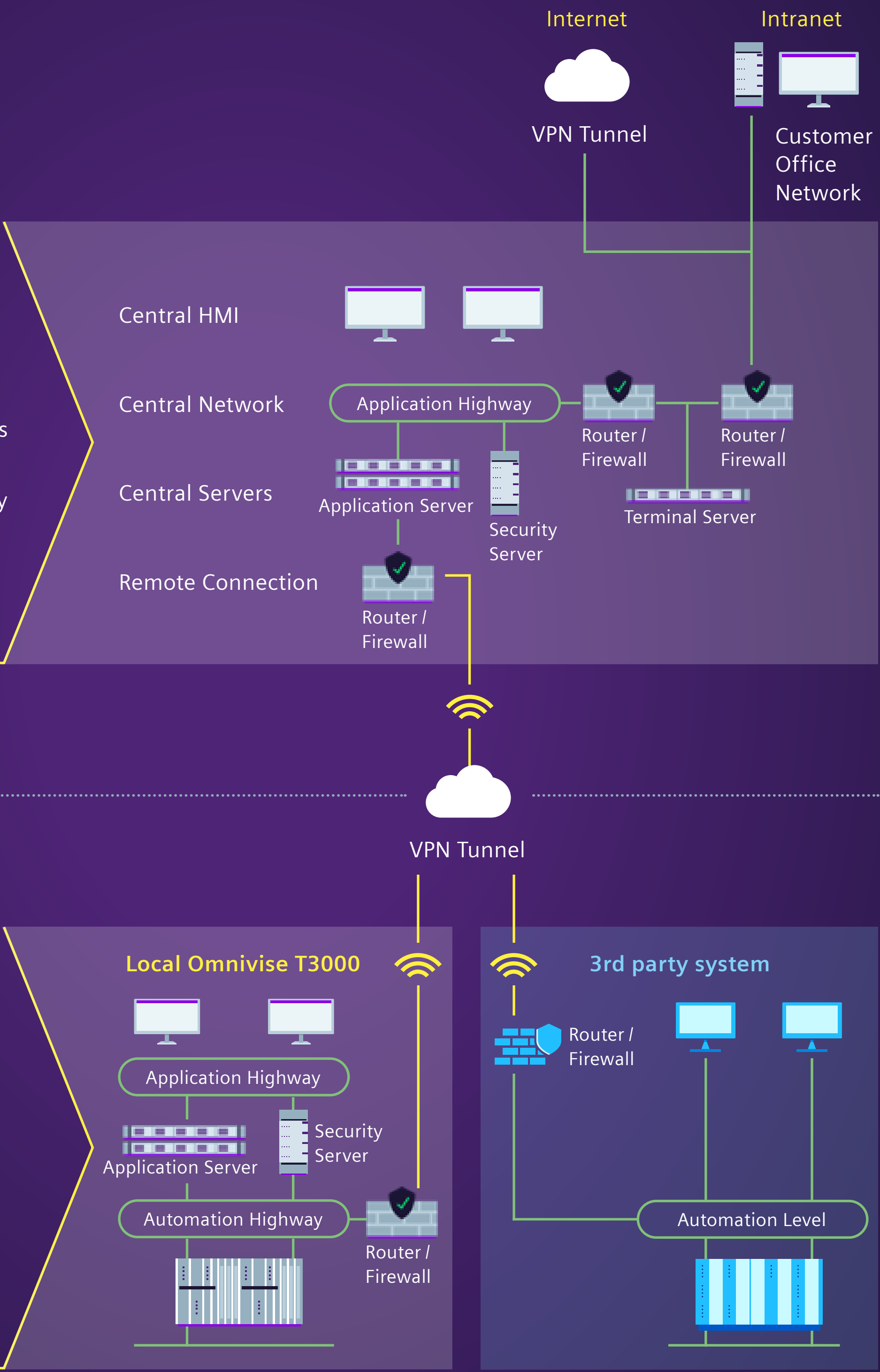
Adding modules to the installed system is now simple and cost-effective because this is a fundamental design characteristic and does not require bespoke engineering.

T3000 SCADA architecture

Benefits of proven T3000 and integrated cybersecurity

Central operation

- Benefits of T3000 can be applied
- One Workbench for connected remote units
- Secure connection of remote units via WAN
- Communication interfaces directly at Application Server



central

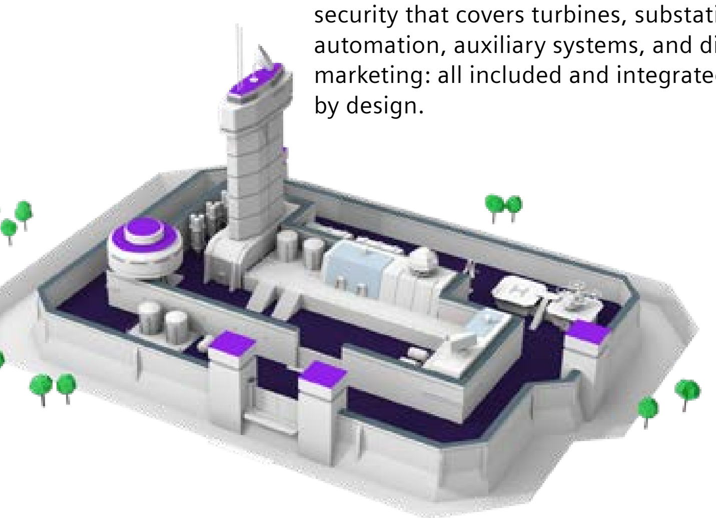
remote

Remote units

- Integration of T3000 - and 3rd party remote units
- Integration of 3rd party remote units via standard communication protocol (e.g. OPC UA, IEC 60870-5-104)
- Independent local and remote monitoring
- Local / remote interlocking for control

Local Network   WAN

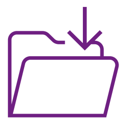
Security. This topic is covered in a separate paper so we will not go into detail at this stage. The key points are simple enough. Distributed environments can potentially include many different points of weakness, both providing attack vectors for malicious external actors and multiple options for technology failure. Because Omnivise T3000 enables simple and efficient integration with non-Siemens Energy systems, it is possible to provide a single, highly effective cybersecurity solution for an entire production environment. Within a large-scale windfarm, for example, this means integrated cybersecurity that covers turbines, substation automation, auxiliary systems, and direct marketing: all included and integrated by design.



Omnivise T3000 has been designed for compliance with the internationally recognized standards for cybersecurity, including the two most important: IEC 62443-3-3 and IEC 62443-4-1. This makes the solution, itself, extremely robust in operation, highly effective in detecting and repelling cyber-attacks and constantly evolving as new information becomes available. It is also supported by the Siemens Energy security methodologies and practices, which provides additional safeguards to the entire network.

This emphasis on security becomes more important as our power generation options become increasingly diverse. Local power sources, such as large-scale battery installations, solar arrays, and wind farms, may not have been designed with security and resilience in mind and may form potential weak spots when integrated into a wider system.

The T3000 is designed to monitor the entire integrated network and can identify potential issues rapidly before systematically driving problem resolution. In this way, T3000 can oversee the whole landscape and can make the generation and distribution environment more secure.



Central Archive. One key issue for small scale, local control systems is archiving, with historical data often stored only on remote sites, with the need to carry out specialized work in data transfer and forensic analysis in case of failures and other issues.

By networking remote T3000 units to the central control rooms, we can now archive data in parallel, in remote sites and at the center. If there is a communication failure between remote and central servers, synchronization will automatically take place as soon as connections are restored. This means that the best and most current information can rapidly be made available to control room management at the center. Any disconnections will be short-lived and temporary, so the normal operational reality is that all necessary data will always be available where it is most needed.

Novel monetization methods. The new world of multi-directional distribution grids opens up the potential for new methods for selling (and sometimes aggregating) power for direct marketing into the grid. Virtual Power Plants enable specialist businesses to aggregate energy from a range of sources (some of them very small in scale- such as large housing developments with solar panels) and sell power to the grid via the spot market. This can offer new commercial opportunities to generation businesses.

Direct Marketing to the grid is now a normal activity which, in many national and regional markets is a required facility for renewable power companies. This approach permits energy to be sold via a Direct Marketer into the grid to meet demand requirements. The Omnivise T3000 solution makes it simple for power generation companies that focus on renewables to ensure that power generated on an intermittent basis is fully monetized, maximizing ROI while helping to meet power requirements in the grid.

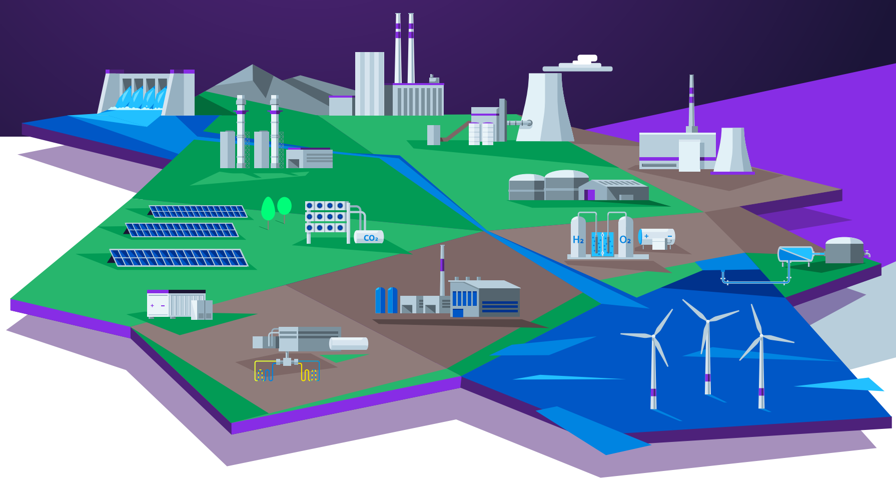
Facing the future

As a society, we are now moving fast to a world of distributed, decentralized services, and this includes the most important service of all: generating the electricity that will keep our cities, businesses, homes and all the systems we depend on operating successfully. In place of central power generation from a relatively small number of large-scale plants, we are now dependent on hundreds, eventually many thousands of small-scale generation options. These need to be networked together, supervised, monitored, managed, kept secure from both operational failures and cyber-attack, and deployed as a single, reliable power source to users of every kind.

This is a new reality, and we need new systems to manage it. From secure data communications from locations far out at sea to smooth interconnections between multi-directional power flows across grids, we are dealing with a complex and potentially fragmented environment. As with the Internet, itself, our task is to turn complexity from being a potential weakness into a strength. The goal is to engineer possible points of failure out of the system, while enabling the multiplicity of supply options to deliver greater resilience to the system as a whole. In this new environment, the role of control solutions is paramount and absolutely central. That is why Siemens Energy has rethought and redesigned its proven T3000 solution to bring scalability, central control and management certainty to a complex new reality.

Siemens Energy is a global team of more than 91,000 dedicated employees. Together, we're responsible for meeting the world's growing demand for energy while ensuring our climate is protected. We build on our 150-year legacy and push the boundaries of what is possible. We strive for sustainability in our decarbonization journey, innovation centered on future technologies, and transformation among future focused offerings, portfolio and mindset. Together as one team across 90 countries, we are committed to making sustainable, reliable and affordable energy possible. This is how we shape the energy of tomorrow.

For more information, please visit our website
www.siemens-energy.com/omnivise-t3000
or contact your local Siemens Energy representative.



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