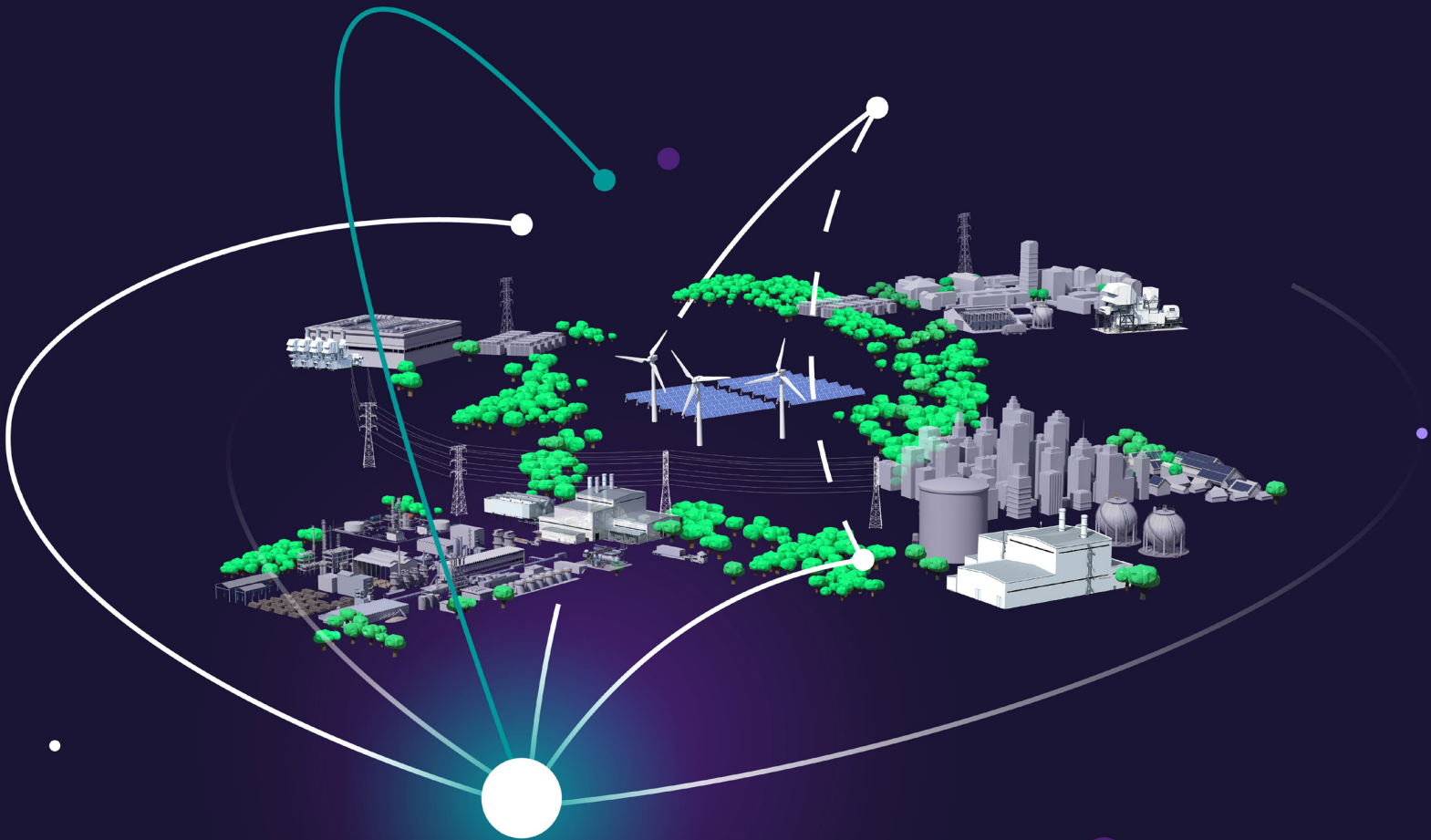


Decarbonization

Transitioning to a net zero future with
Omnivise Performance solutions



Preface

Climate change is the most urgent problem we face on planet Earth, yet the global demand for energy and electricity increases year after year. Navigating this fundamental challenge drives our quest to discover more sustainable solutions to meet net zero goals. With a proven history of turning ideas into reality, Siemens Energy is dedicated to helping our customers transition to a more sustainable world. Despite the rapid build-out of carbon-free and carbon-neutral power generation technologies and infrastructure, we cannot neglect the legacy fossil fuel assets that supply energy to the world today—they continue to play a crucial role in guaranteeing our energy supply while renewable sources are added to the mix and energy storage technologies evolve.

Our forward-leaning technologies and approaches help bridge the gap between fossil and carbon-neutral sources of power generation.

Omnivise Performance Portfolio. Realizing that existing fossil power plants were not built to accommodate the flexibility needs of modern-day power grids, Siemens Energy developed Omnivise Performance solutions. **The Omnivise Performance portfolio helps you advance toward your country's net zero goals by increasing efficiency and reducing emissions.** Even without full access to renewables, traditional plants and energy suppliers can take steps today to reduce emissions and decrease fuel use, all while increasing energy output to meet consumer demands. We see our energy customers and partners falling in one of three steps toward a net zero future: 1) Fossil-based power generation assets that can

reduce emissions and decrease fuel use with performance solutions, but have not done so yet, (2) Emissions-reduced, fossil-based power generation assets that have decreased emissions through performance solutions, and (3) Net zero energy systems that prioritize renewables, and retain access to emissions-reduced and performance-maximized fossil-based power generation when renewables are unavailable. Our solutions target the center of the net zero energy system journey, enabling traditional power plants to take steps now toward carbon neutrality.

The Omnivise Performance Portfolio helps reduce emissions of legacy fossil burning assets through a broad range of digital products, optimization solutions, and managed services. But Omnivise Performance also moves beyond these areas to address the increasingly complex market for energy management/dispatch planning and energy trading for hybrid fleets.

Omnivise Performance leverages new energy management hardware and software to lower the carbon footprint of your fleet while safeguarding profitability. By combining years of operational data from a global fleet of power plants with high-fidelity digital twins, we were able to develop detailed simulations that increase plant efficiency and flexibility under a large array of operational conditions.

Today, Omnivise Performance solutions are proven in real world applications and continue to help our customers efficiently meet their energy needs every single day as they begin their journey to support a net zero future.



Figure 1 Steps you can take towards a net zero future.

Efficient generation means less carbon emissions.

Our Omnivise Performance solutions have been deployed to more than 300 projects worldwide, involving 4,500 control systems, 7,000 gas turbines, and 1,000 steam turbines. No matter your plant's type, complexity or purpose, we have the know-how to help you achieve your decarbonization objectives. Our solutions span from reducing fuel use and CO2 emissions at start-up to full-scale energy system management to optimization energy dispatch and trading. These solutions enable more flexible operations that would otherwise be restricted to standard load requirements (see Figure 2). This paper will overview ways you can cut emissions, save costs and reach desired performance across energy operations.

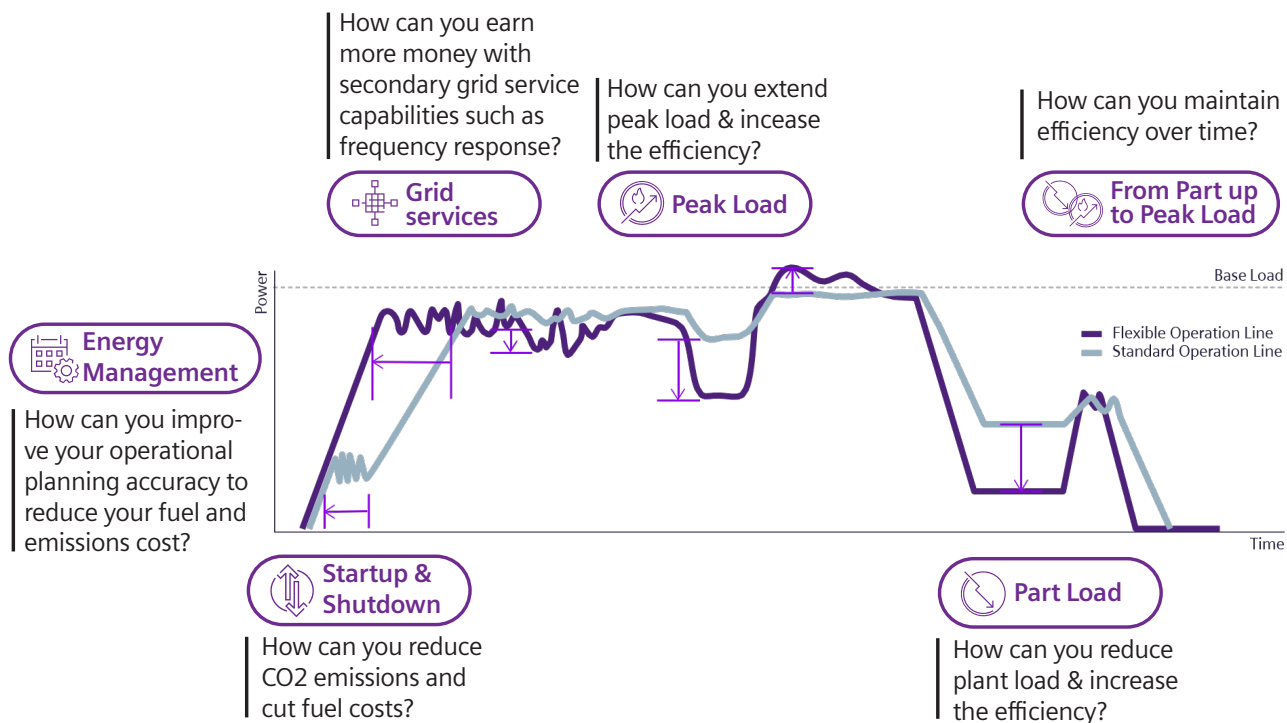


Figure 2 Omnivise Performance solutions can cut emissions for your fleet and optimize performance in many ways

Reduced emissions start with Startup.



Startup & Shutdown solutions for both combined-cycle and steam power plants can help reduce emissions. Starting up a power plant optimally is a challenging task, involving the consideration of various factors like fuel and electricity prices, design limits, and current plant conditions (e.g., cold/warm or hot start.)

Slow and non-linear control loops like steam temperature control make the automation of the optimal startup a complex control problem, one that often requires manual operator interventions.

Low Loss Start addresses these challenges in a way that reduces fuel consumption upon startup and thereby reduces emissions—ideal for plants also looking to cut fuel consumption costs.

Fast Start is a second solution that accelerates the time it takes to synchronize with the grid, enabling the plant to react more quickly to emergent power demands.

In both cases, these are turnkey solutions that incorporate a dynamic digital twin, adaptive open- and closed-loop controls, as well as server, software, and predictive controls to realize optimal set points for main control loops. These optimizations will improve your plant's efficiency while reducing fuel consumption.



Peak Load solutions for combined cycle power plants can improve power output and provide grid support to stabilize carbon-free, variable generating assets in your hybrid fleet.

Temperature Optimizer uses a dynamic digital twin to model the complex and non-linear interactions between gas turbines, heat recovery steam generators (HRSGs), and duct burners. By doing so, we better control steam temperature fluctuations. The result is the plant can increase steam temperature set points and improve overall efficiency.

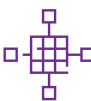
GT Auto Tuner improves part load efficiency by adjusting fuel staging and inlet guide vane (IGV) position to achieve a higher heat energy of exhaust gas for a given part load. The higher heat energy from the exhaust gas is then used to generate more steam from the boiler and thereby increases the steam cycle power output, which in turn boosts the overall efficiency. Additionally, the fuel staging lowers combustion temperatures, which results in reduced NOx emissions. Since the fuel staging is done in a continuous way, NOx output is always optimized.



Part Load can help steam power plants avoid shutdown during periods of low power revenue by reducing your plant's minimum power output limit.

Low Throttling increases efficiency thanks to lower throttling losses in main pumps like the feedwater or cooling water pump through the implementation of variable speed drives and proper valve staging.

Minimum Load Reduction improves open- and closed-loop controls to consume less energy and allow plants to continue operating at times of depressed electricity prices while keeping the impact on efficiency as low as possible. For one customer whose plant meets the energy needs of 2.5 million people per day, the minimum load reduction solution reduced fuel consumption by 30% during low demand times while increasing dispatch control capability four times.



Grid Services like Primary Frequency Control (PFC), Secondary Frequency Control (SFC) and Automatic Generation Control (AGC) are critically needed services that directly support the transition

to carbon-free generation. These solutions help ensure grid stability for grids with significant wind and solar generation.

Maximum Load Plus is both an efficiency and megawatt output improvement for plants that already employ the grid services described above. It works by incorporating the steam cycle into the frequency response. The benefit is that combined cycle plants can run their gas turbines at higher load while still delivering the frequency reserve. This enables the gas turbines to run more efficiently and produces more heat for the steam cycle.

Continuous improvement means staying efficient.



From Part up to Peak Load it's inevitable that power generation equipment will degrade with use and grow less efficient. Your equipment operates under extreme mechanical and thermal stress, which—combined with environmental factors—will eventually cause it to decline in power output. Over time, this also results in higher carbon release per megawatt generated.

Fortunately, Siemens Energy has a solution that helps your equipment run at a highly efficient state while minimizing the carbon output. Our use of equipment-specific, high-fidelity digital twins can model your power plant's performance at all operating loads while infusing our fleet engineering and operating experience into your plant's maintenance plan. This helps to ensure your plant continues to operate at a highly efficient state month after month.

Continuous Performance Optimization is a managed service that allows you to identify and understand all the areas that contribute to efficiency loss. We use high-fidelity digital twins combined with an intelligent rule base that continuously monitors your equipment's thermal performance. If a loss in performance efficiency is identified, a team of experienced performance engineers from Siemens Energy will evaluate. The team will deliver quantified evidence of the loss as well as a plan for how to address it. Siemens Energy will even follow up after the proposed maintenance is complete so you can see the performance improvements firsthand.

Economic dispatching means artfully integrating fossil assets with new carbon-free MWh production.

The biggest challenge facing power producers in the coming years will be how to determine the right dispatch plan, one that allows you to maximize your revenues while minimizing your carbon output.

Today's producers have a variety of power generation equipment available to dispatch. These bring different variables into play affecting the best time to dispatch. Power grids now ask power producers to submit bids for as little as 5-minute intervals, and those intervals are expected to get even smaller in the future.

Such a trading environment demands advanced AI simulation scenarios with virtual power plants that connect to integrated hybrid controllers that help determine the most economical dispatch decisions. With the help of AI, you can set an objective function for optimizing revenue within a target carbon output goal. Siemens Energy offers these solutions as part of our Energy Management suite so you can integrate new carbon-free power generating assets into your existing fleet.



Energy Management is a suite of solutions that enables you to optimize the dispatch of your hybrid fleet of power generation equipment towards a particular goal, such as maximizing your carbon-free generation. These solutions also facilitate forecasting and ultimately help you manage your energy trading. In essence, they offer a one-stop shop for virtual energy planning and dispatch, a key to success in the complex energy markets of the future.

Create the foundation for decarbonization.

The choices we make today will have a profound impact on the world's climate. Although it's important to act with urgency, we recognize that the change to a net zero world will not happen in the blink of an eye, but we can take the first steps to getting there. The Omnivise Performance portfolio will help decrease the carbon output of your fleet through reduced emissions, less auxiliary power consumption, and lower fuel consumption from existing fossil assets. Additionally, our solutions enable the creation of an integrated economic dispatch plan for your entire fleet.

With Siemens Energy at your side, you can implement solutions today to create the foundation for a deeply decarbonized world.

Contact your Siemens Energy sales representative to schedule a presentation or visit our website for more details <https://www.siemens-energy.com/global/en/offerings/services/digital-services.html>

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