



GE Energy

# FlexEfficiency\* 50

## Combined Cycle Power Plant

Advanced power with a new standard of high efficiency and operational flexibility



\* Trademark of General Electric Company

# Innovation for the new energy future

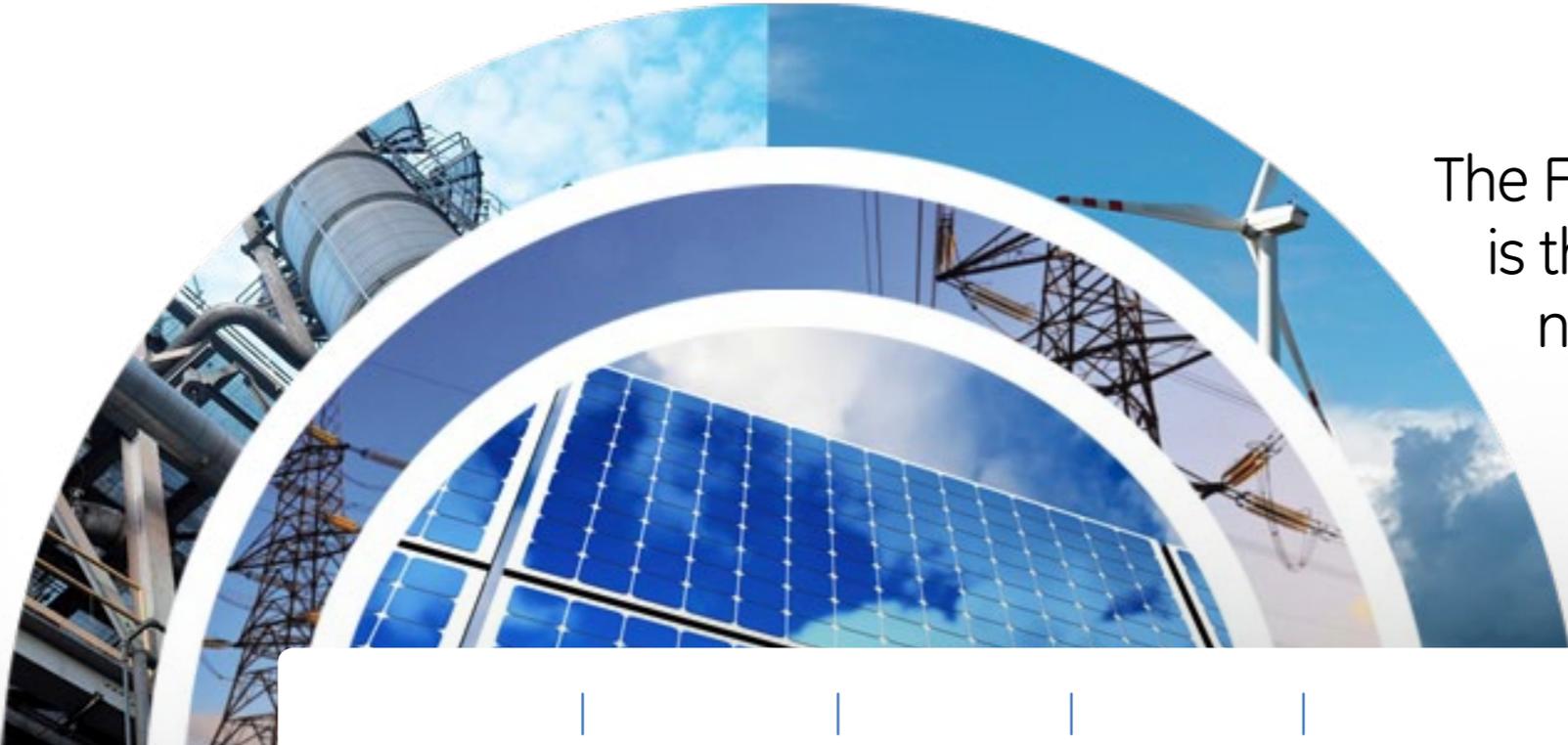
The growing realities of producing cleaner energy as intelligently and efficiently as possible, put today's global power providers in a complex and challenging position

From the increasing penetration of renewable energy resources to evolving emissions standards, utilities are in greater need of enhanced efficiency and flexibility to effectively and profitably navigate the fluctuating energy landscape.

In response, GE Energy has developed the new **FlexEfficiency 50 Combined Cycle Power Plant**. As a product of ecomagination, this innovative 510-megawatt (MW), block-size plant is engineered to answer the current and evolving energy production needs of the globe.

Drawn from GE's proven F-class legacy, this advanced single-shaft platform features an innovative total plant approach that defines a new standard for higher efficiency and operational flexibility.

Next generation gas turbine, steam turbine and generator components combine with digital control capabilities, power island integration and a turnkey plant design. The result is advanced power generation that helps reduce fuel costs, creates additional revenue sources, improves dispatch capability and reduces emissions compared with prior technologies.



The FlexEfficiency 50 plant  
is the catalyst to the  
new energy future

# Total Plant fully integrated

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Rollover for information 

GE Energy has specifically engineered the FlexEfficiency 50 plant to give customers a total plant design that is simple and cost effective to install, control and maintain.

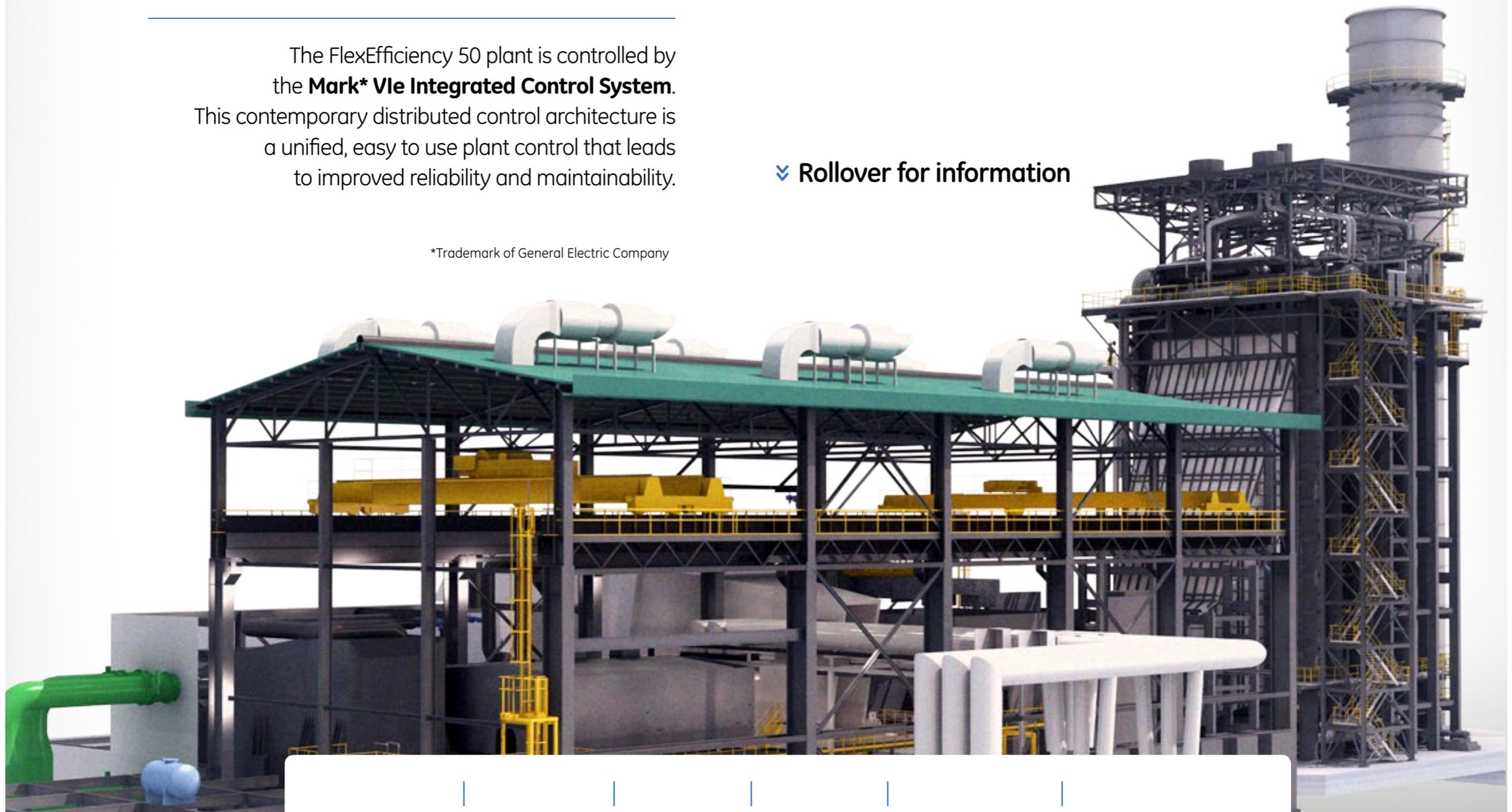


# Simple, yet advanced control platform

The FlexEfficiency 50 plant is controlled by the **Mark\* V1e Integrated Control System**. This contemporary distributed control architecture is a unified, easy to use plant control that leads to improved reliability and maintainability.

\*Trademark of General Electric Company

∨ Rollover for information



# The limitless possibilities of flexible operation

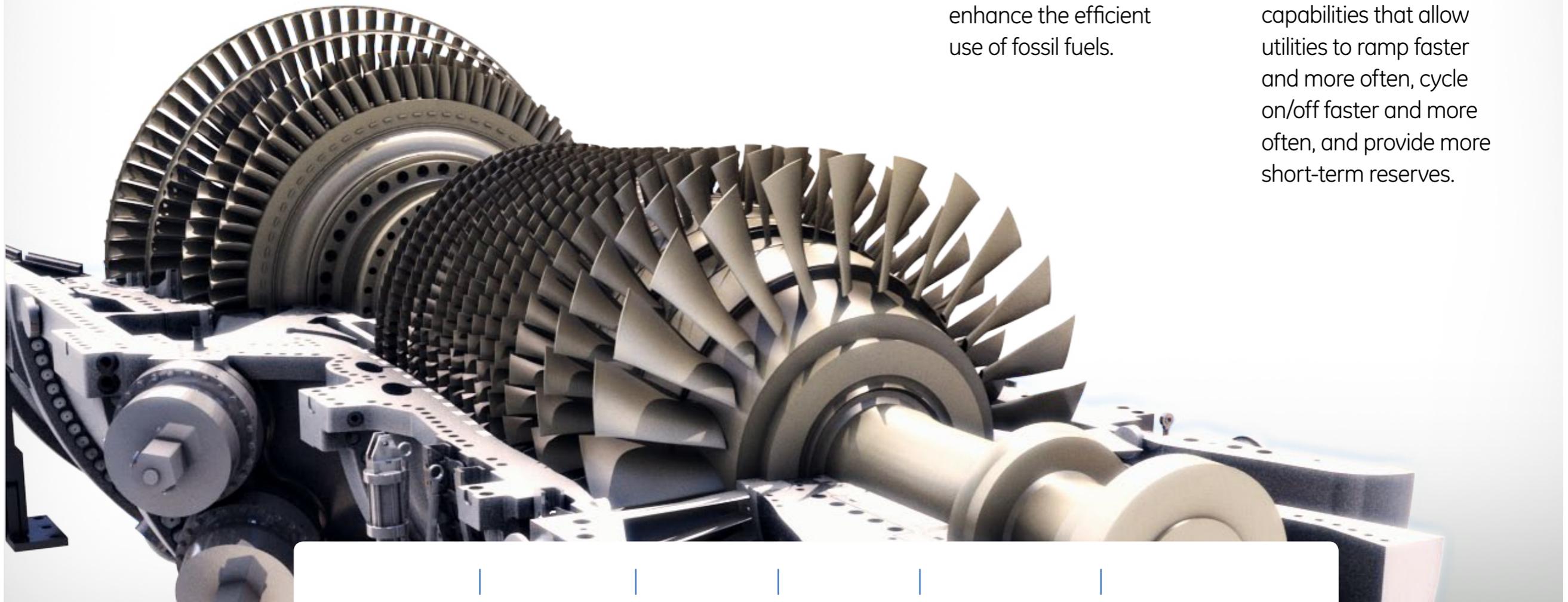
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At GE Energy, we understand the significant impact renewable energy sources like wind and solar have had – and will continue to have – on the power generation industry.

The environmental implications are exciting. But finding the right technological balance, while ensuring the viability of these abundant resources, is a challenge that requires innovation.

Leveraging a rich history in gas turbine technology, the revolutionary FlexEfficiency 50 plant delivers industry-leading flexibility that will encourage further penetration of renewables onto grids, as well as enhance the efficient use of fossil fuels.

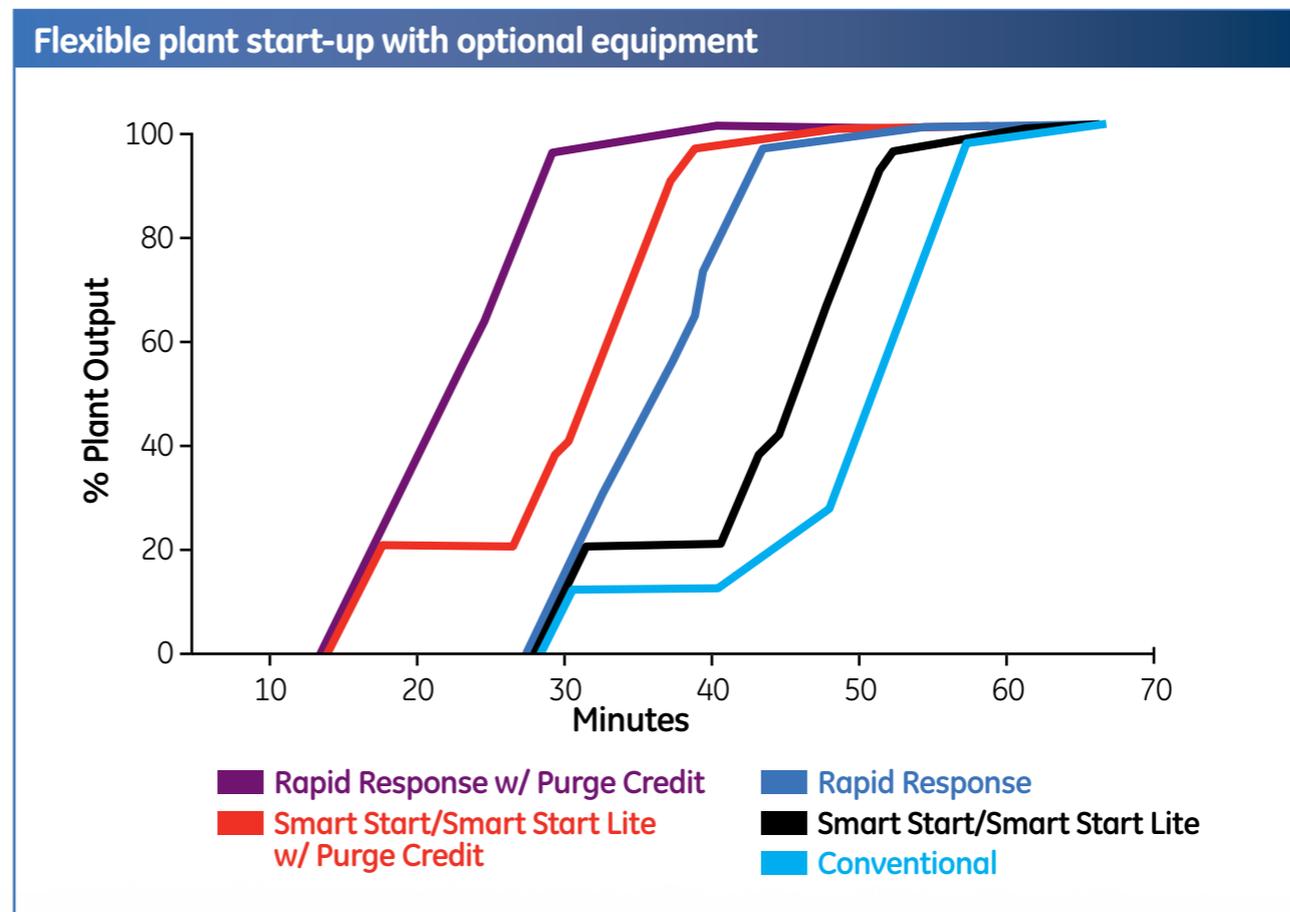
In support of fluctuations in renewables, fossil fuel prices, and energy demand, fewer plants will be operating in baseload mode. That's why GE technologies are engineered to deliver enhanced cyclic capabilities that allow utilities to ramp faster and more often, cycle on/off faster and more often, and provide more short-term reserves.



# Unique start-up options

With the FlexEfficiency 50 plant, operators will have the choice of four unique start-up options that allow them to rapidly respond to electrical industry conditions, limits on air emissions and power demands—all while improving their bottom line. After completion of pre-start conditions, all options are initiated with one-button push-start, enabling automatic plant start-up.

GE start option	Customer need
<b>Conventional</b>	Baseload plant, no cycling concern, higher start-up emissions acceptable
<b>Smart Start Lite</b>	Some cycling need but low cost concern predominate, low start emissions on hot starts
<b>Smart Start</b>	Reducing start cost for negative spark spread, low start emissions on all starts
<b>Rapid Response</b>	Maximum flexibility, lowest start-up emissions, best daily starts and stops with positive spark spread



**Rapid Response offers hot start capability in less than 30 minutes!**

# Measuring the true cost of energy

Given today's shift to more cyclic operation of plant assets, fewer plants are operating in baseload mode. At GE, we believe owners and operators can generate electricity more cost effectively if they include flexibility and efficiency considerations in their evaluation models.

Accounting for both the profitability of power production and the annual fuel consumption for cyclic operation, GE has defined the term FlexEfficiency as:

$$\frac{\text{Profitable annual MW-hrs}^{\dagger}}{\text{Annual fuel consumption}^{\ddagger}} = \text{FlexEfficiency}$$

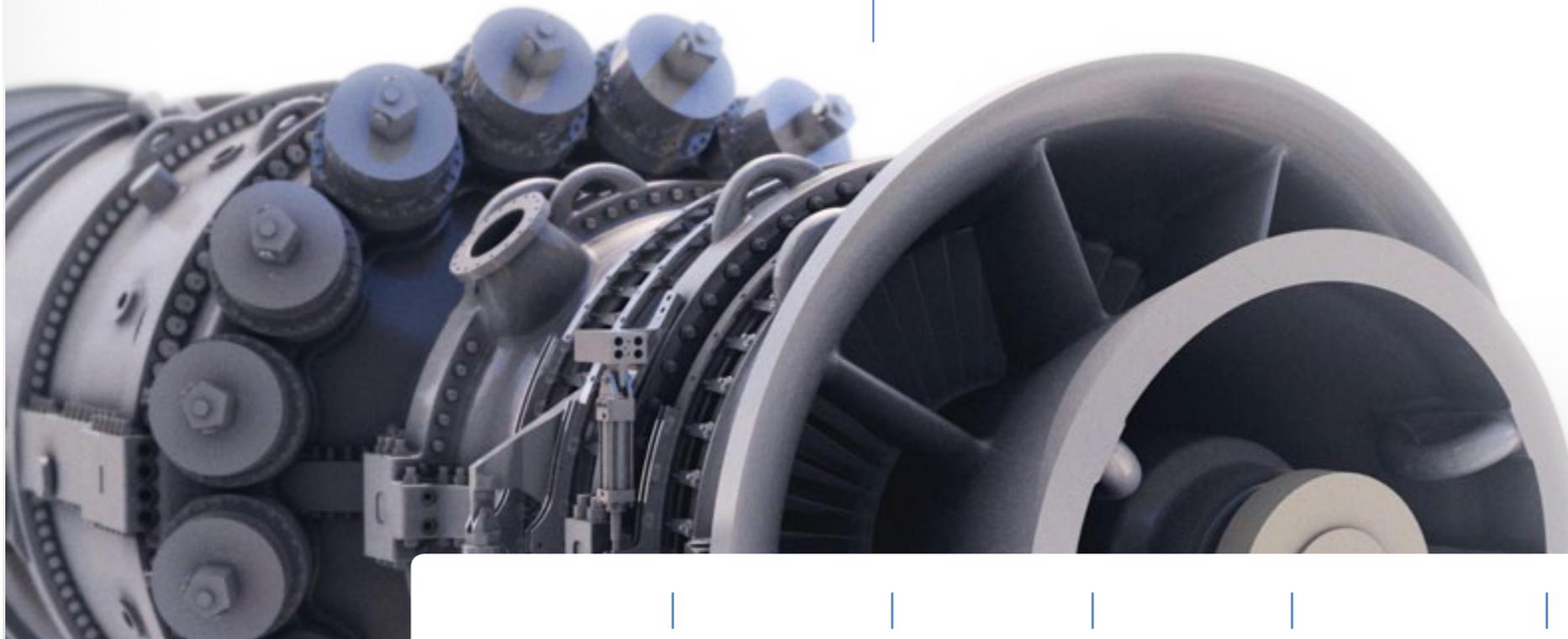
By evaluating the total annual fuel consumption across a highly variable operating profile, customers will be capturing the fuel costs the way the plant will actually run.

With this metric, and an operating profile that includes 250 starts per year and a mix of baseload, part load and minimum turndown hours, typical advanced combined cycle power plant FlexEfficiency is 54%.

The FlexEfficiency rating for the FlexEfficiency 50 plant is greater than 58% on the same basis including plant part load efficiency greater than 60% down to 87% of the plant baseload power output.

<sup>†</sup>Excludes MW-hrs. during minimum turndown

<sup>‡</sup>Includes fuel consumption during start-up



# Achieving a new standard of efficiency

With advanced gas turbine technology and the integration with innovative plant components and the Mark VIe Control System, the FlexEfficiency 50 plant achieves industry-leading baseload and part load efficiency.

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**61%** baseload efficiency

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**>60%** efficiency down to 87% load

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**>70%** Integrated Solar Combined Cycle (ISCC) baseload efficiency

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**40%** turndown while maintaining guaranteed emissions profile

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**>50** MW per minute ramp rate while maintaining guaranteed emissions profile

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a product of  
**ecomagination**

With its ability to operate at a new standard of fuel efficiency, while lowering annual CO<sub>2</sub> and NO<sub>x</sub> emissions by significant margins, the FlexEfficiency 50 plant has been named a product of ecomagination. This rigorous third-party certification validates the significant environmental and economic benefits of the new power plant.

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**Rollover for economic benefits >>**

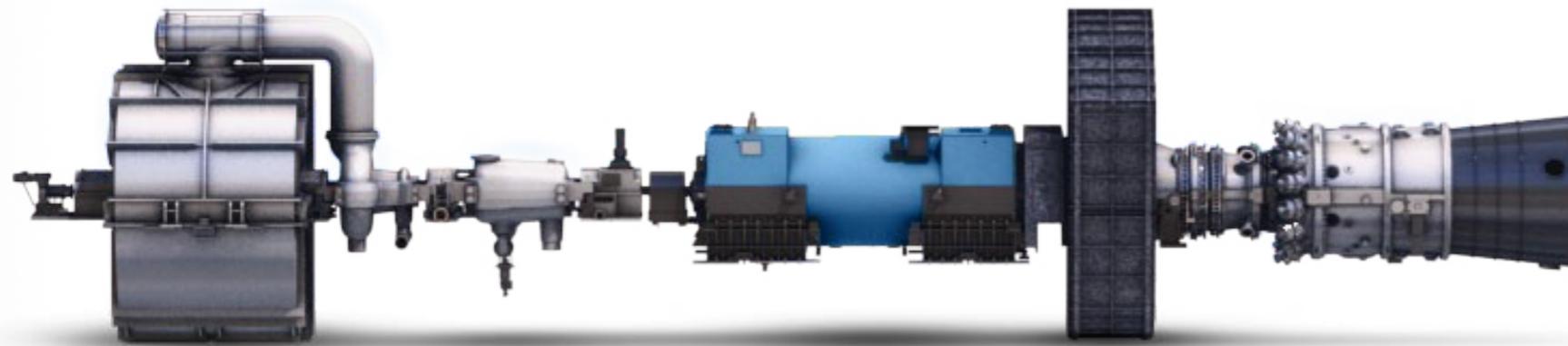
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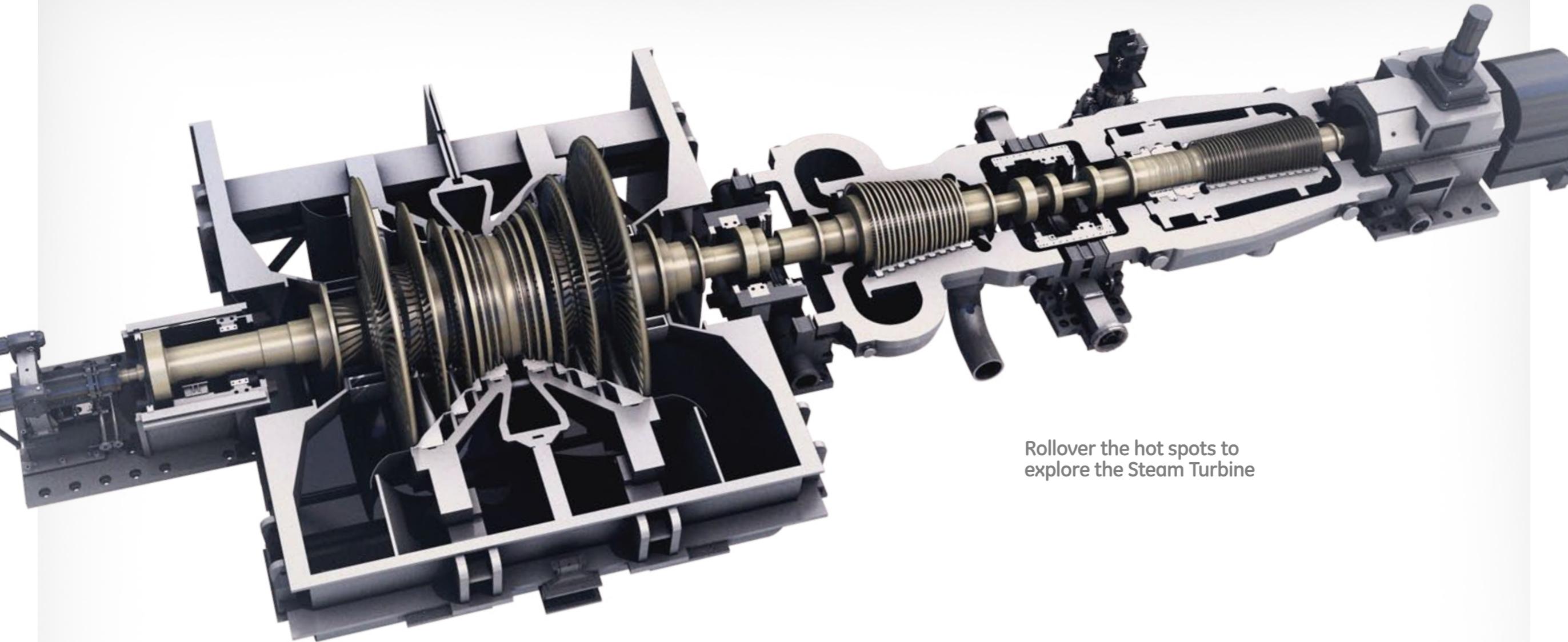
**Rollover for environmental benefits >>**

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# Advanced power generation technologies

Roll over the hot spots to explore the advanced technologies featured in the innovative FlexEfficiency 50





Rollover the hot spots to explore the Steam Turbine

# The new 109D-14 Steam Turbine

GE is one of the world's leaders in the design, development and application of steam turbine technology. And the new 109D-14 Steam Turbine represents GE's next evolution of enhanced technology. Uniquely engineered for the FlexEfficiency 50 plant, the 109D-14 Steam Turbine delivers a new level of performance and efficiency with enhanced operational flexibility and improved ease of maintenance — compared with prior technologies.

\* Trademark of General Electric Company

Shaft efficiency of greater than 40%.

Rated at 180 megawatts

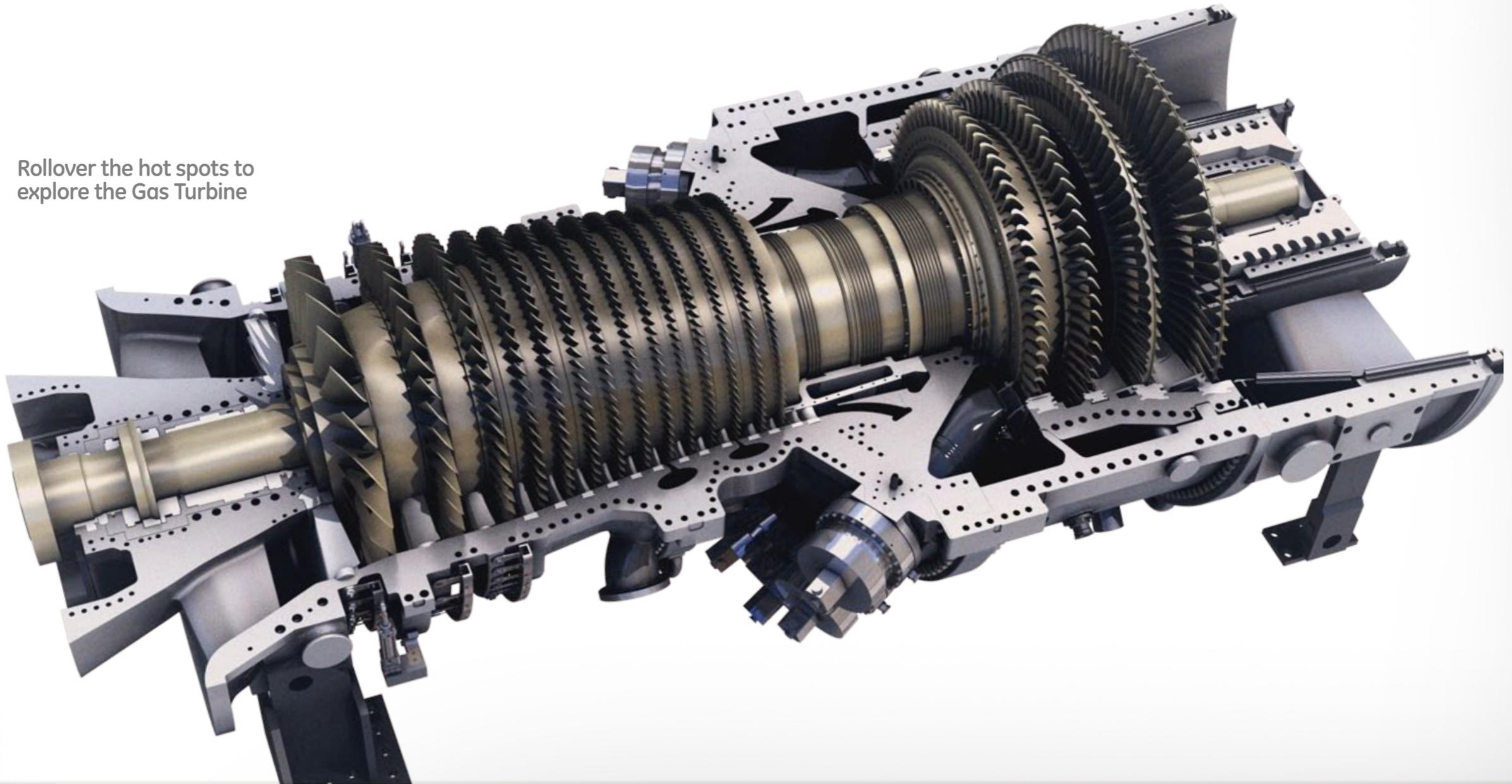
HEAT technology expanded into double flow LP configuration

# The new 9FB Gas Turbine

GE Energy's fleet of F-class gas turbines, the largest in the world, has a proven record of performance with more than 35 million hours of operation. The new 9FB Gas Turbine – the core of the FlexEfficiency 50 plant – is the product of this rich history, offering power generation that excels in performance, efficiency, reduced emissions and operational flexibility.

Compared to the 9FB Gas Turbine predecessor, its improved efficiency and higher output will result in less fuel consumption and lower emissions on a MW-hr. basis. In addition, the ability to start up quickly, change load rapidly and run at low loads allows customers to respond to varying grid needs.

Rollover the hot spots to explore the Gas Turbine



Gas turbine efficiency over 40%

Extended turndown to 30% gas turbine load, an industry leader in lower emissions

GE turbines average 98% reliability and achieve 96-98% availability in baseload performance

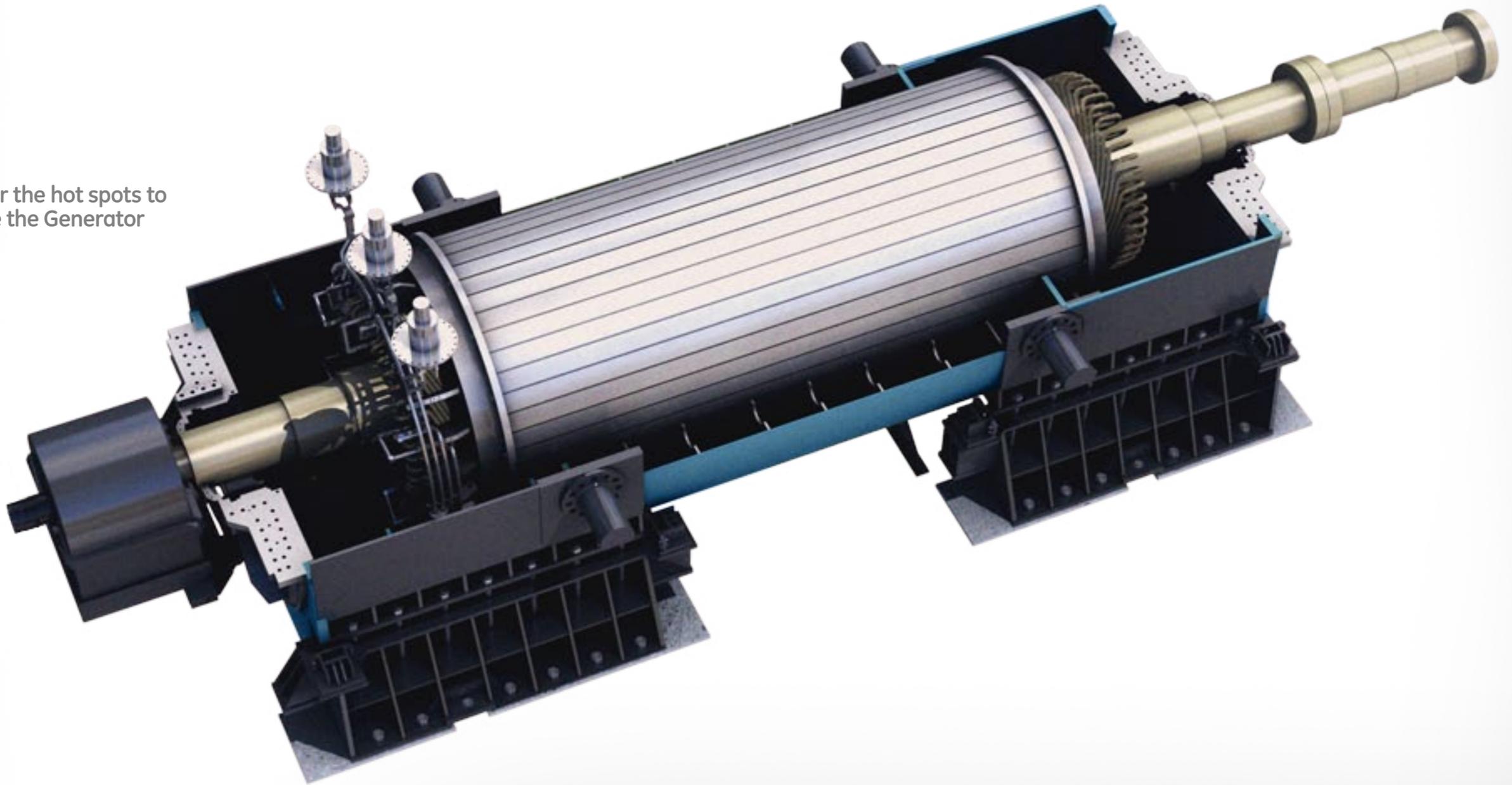
GE gas turbines, steam turbine-generators and controls implement proven technology

Full load validation prior to first fire

# The new W28 Generator

The W28 Generator for the FlexEfficiency 50 plant features an enhanced, compact design for placement between the steam and gas turbines. Featuring a water-cooled stator, this 550 MW generator offers improved cooling capability, as well as increased reliability and high efficiency — compared with prior technologies.

Rollover the hot spots to explore the Generator



Overall generator efficiency exceeds 99% at 0.9 power factor

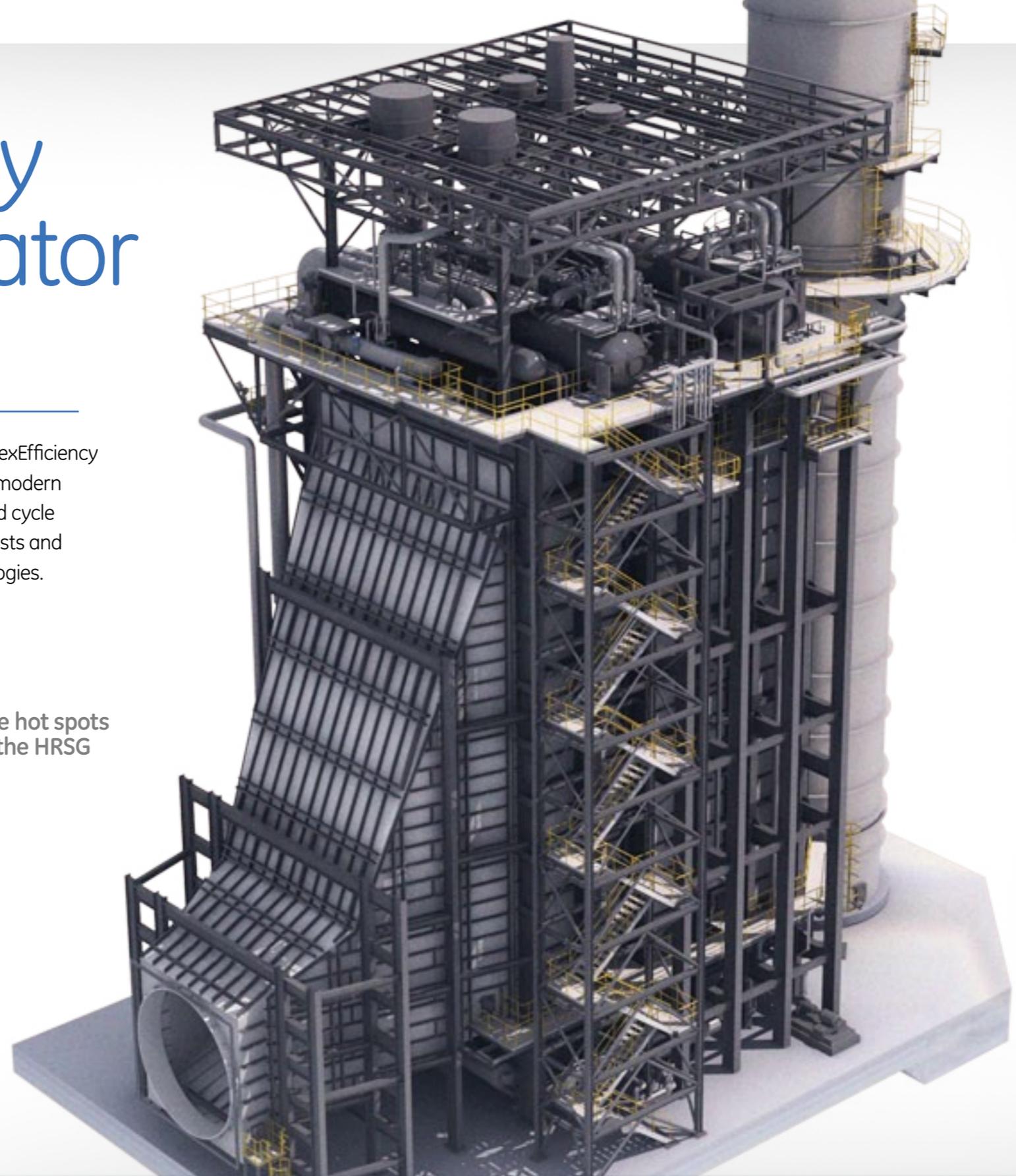
Packaged static excitation and static starter ensures optimum starting conditions

Facilitates removal of the patent pending lateral generator from between the turbines for maintenance or repair

# Heat Recovery Steam Generator (HRSG)

The Heat Recovery Steam Generator (HRSG) featured in the FlexEfficiency 50 plant is built to a rigorous and proven GE specification. Its modern engineering contributes to the improvements of the combined cycle system, helping maximize performance, minimize life cycle costs and deliver a lower cost of energy — compared with prior technologies.

Rollover the hot spots to explore the HRSG



Designed for daily start-stop mission

Condensate polishing not required

Designed to international standards

# Setting a standard in gas turbine validation

Located in Greenville, South Carolina, GE's full-speed, full-load test stand facility is the largest and most thorough gas turbine system validation in the world.

With over \$170 million invested, this robust facility will validate the new 9FB Gas Turbine – the core of the new FlexEfficiency 50 plant – at full capacity and under “real world” plant conditions.

This sophisticated level of testing will enhance the reliability of GE's new technology advancements and increase insurability.

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**Rollover for information >>**

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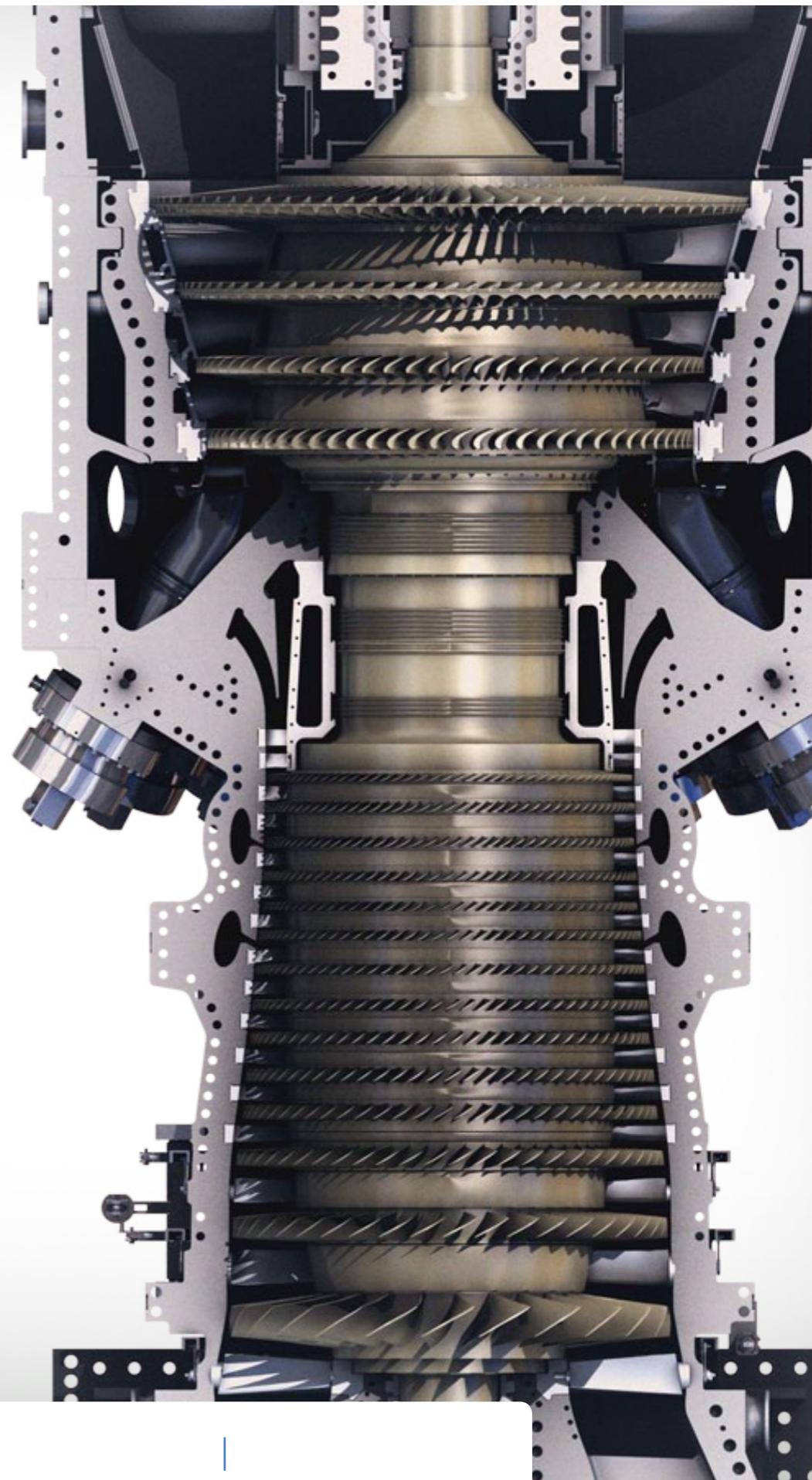
# Building on a distinguished history of innovation

As represented by the FlexEfficiency 50 plant, GE Energy is focused on developing more flexible products—to act as the throttle that balances intermittent power from renewables. GE's history in aviation, with gas turbine innovation that outperforms under rigorous cyclic duties, provides a solid foundation for the advancement of combined cycle engineering.

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**Rollover for a list of  
F-Class platform Firsts** »

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# Technical excellence

With a long-standing record of innovation, GE Energy is staying one step ahead of the rapidly evolving energy landscape with solutions that master the delicate balance of power generation. With current and emerging technologies, GE is addressing evolving life-cycle demands like stricter emissions, additional performance, operating flexibility and asset life extension.

Since GE's first steam turbine in 1901, our installed base of steam and heavy-duty gas turbines has grown to over 10,000 units. This represents over a million megawatts of installed capacity in more than 160 countries.





imagination at work