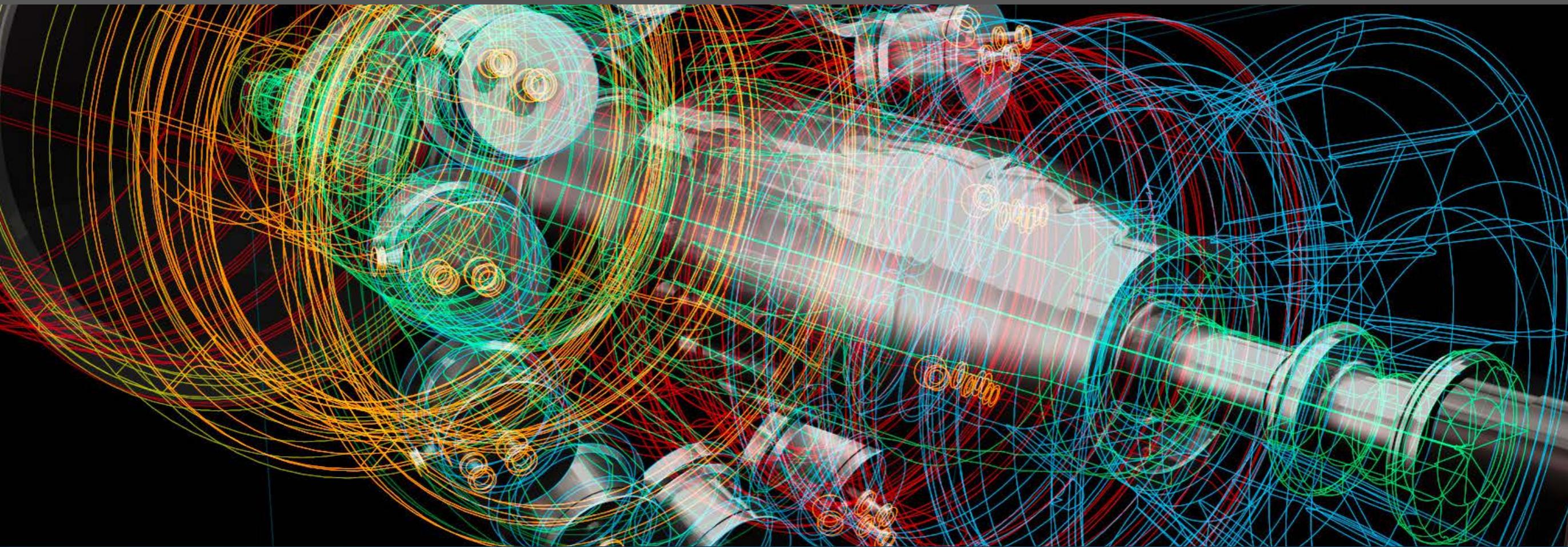




ON THE RECORD:
Stories of Customer
Success with OpFlex*
Advanced Controls
Solutions





GE Customers Speak

E.ON
Platt River
Mainova
TransCanada
Kospo
Dubal Aluminium

“ Gathering and analyzing massive quantities of machine data is the starting point for delivering meaningful insights. However, helping customers take action on those insights toward greater profitability is what sets GE apart. Now that’s the true value of the Industrial Internet. ”

Ganesh Bell, Chief Digital Officer, GE Power Digital Solutions





E.ON Achieves Faster, Lower Cost Combined Cycle Plant Starts with GE's OpFlex Solutions



40% faster combined cycle plant starts

50% less costly combined cycle starts

60% more operating hours and starts over plant without OpFlex solution

Challenge

E.ON is one of the UK's leading power and gas companies — generating electricity, and retailing power and gas.

Many gas-fired combined cycle power plants in Europe are unable to be economically dispatched due to high gas prices, low power demand, and low power sale prices.

Plants that ran 4,000+ hours per year, now see fewer than 1,000 hours of profitable operation. Even that is often only possible in real-time power markets and only when spark spreads are high, such as when intermittent renewable power (wind, for example) needs to be quickly replaced).

Successful operation in this time-sensitive environment requires combined cycle plant starts that are fast, reliable, and low-cost, similar to what is possible with simple cycle plants.

Solution

GE, in partnership with E.ON, developed an OpFlex Advanced Controls technology retrofit package that enables agile and robust combined cycle starts. This package consists of OpFlex Variable Load Path (VLP) solution, which enables GT load and exhaust conditions to be customized to best match bottoming cycle needs, plus OpFlex AutoTune MX solution, which provides fully automated combustor tuning to ensure robust GT operation across the full load range and whole VLP operating space.

Results

With Variable Load Path and AutoTune MX, E.ON demonstrated 40% faster and 50% less costly combined cycle plant starts, resulting in up to 60% more operating hours and starts compared to non-upgraded plants.

The solution has been proven in operation on more than 10 units at 5 different sites since 2013, with more than 20,000 cumulative hours and 1,000 starts through December 2015.

Power On Demand — Fast and Efficient



Platte River Power Authority

Over **100 MW** on grid in less than
10 minutes from start signal

30% less fuel burn during start up

50% less CO₂ emissions

Challenge

Platte River Power Authority is a not-for-profit wholesale electricity generation and transmission provider in Colorado.

Platte River's 668 MW Rawhide Energy Station consists of a primary coal fired unit with four GE 7EA gas turbines as peaking and backup units. Additional power sources include coal, hydro and wind.

Platte River required a backup of its primary unit as well as a backup for any other operating sources. Additionally, they wanted a hedge against short term market pricing fluctuations, while maintaining strict emissions controls.

Solution

To achieve Platt River's goals, GE installed OpFlex Fast Start software solution on two of the four GE 7EA, 65 MW gas units.

This software-only modification allows for rapid starting and loading of the gas turbines, with a guarantee of 90% base load within 10 minutes, while reducing fuel burn and start up emissions.

Results

Platt River is now able to quickly start and load two 7EA gas turbines for approximately 117 MW in 10 minutes. These GTs can now realistically act as a backup for Rawhide's primary unit and for system emergencies.

A More Profitable Market Position with Flexible Operations, Enabled by OpFlex Solution



60% turndown to 40% load

110% emissions compliant peak load

2% fuel savings during part load operation

Challenge

Mainova AG is one of the largest regional energy suppliers in Germany, providing electricity, gas, heat and water.

In Germany, cogeneration using gas fuel is competing in a landscape where electricity sells on a daily basis and purchases are mainly driven by the price of fuel. Other less costly fuel sources, such as solar, wind, coal and nuclear take precedence, leading Mainova to take an innovative step to drive production efficiency.

Mainova was interested in lowering its minimum part load, reducing fuel costs, and improving maximum power output — all while maintaining emissions compliance.

Solution

The GE unit in Frankfurt was the first 6B gas turbine in the world to receive OpFlex control software technologies: AutoTune, Turndown, Variable Peak and Smart Inlet Bleed Heat (IBH).

This Advanced Controls solution is designed to deliver broad operational flexibility across all modes of plant operation by expanding the operating envelope, while enabling significant performance improvement.

Results

Mainova is now able to run their gas turbine at competitive levels, leading to a more profitable position in the market. They also now have the ability to set emissions limits and let the turbine control maximum performance within those limits.

One of the biggest benefits Mainova saw was the ability to expand their emissions-compliant operating range from 60-100% load to 40-110% load.



Hardware and Software Upgrade to Existing Turbines Boosts Power Output for TransCanada



Mackay River

10% increase in output capacity

2% increased fuel efficiency

Ravenswood

5% increase in output capacity

1% fuel efficiency increase

Results from combined AGP & OpFlex Solutions

Challenge

TransCanada is a leading energy infrastructure company in North America. As their GE turbines were nearing end of life at their Ravenswood and Alberta locations, they required cleaner, more viable solutions to meet the growing power demands of their constituency, with the Ravenswood location serving over 20% of New York City.

Solution

In 2012, TransCanada, purchased GE's Advanced Gas Path solution for the Ravenswood power plant in New York City and the Mackay River cogeneration facility in Alberta replacing key turbine parts with new components made from advanced materials developed for GE jet engines — essentially extending the life of their existing equipment.

As part of the upgrade, OpFlex AutoTune DX and OpFlex Cold Day Performance were installed to obtain even more performance from the hardware, and to ensure robust turbine operation and emissions compliance at the increased output levels even as weather and fuel supplies vary.

Results

TransCanada projected efficiencies from the engagement with GE would total approximately \$900K in annual fuel cost savings or 223,440 decatherms of fuel for the company, as well as new revenue opportunities for Ravenswood in bidding into the area's power market. The more efficiently produced power displaced less efficient megawatts on the market with cleaner power, thus reducing overall emissions for the same amount of power generated.



Kospo Met Increasing Market Demands with Existing Turbine Upgrade and Software Solution



Shin-Incheon

180 MW capacity increase

4.3% efficiency improvement

Busan

35 MW capacity increase

2.6% efficiency improvement

Results from combined AGP & OpFlex Solutions

Challenge

Kospo, South Korea's largest electric utility, needed a way to provide a higher reserve margin, which had dipped as low as 4% during peak demand periods.

Given the rise in demand due to a positive economic environment, Kospo looked to upgrade their fleet of 7F gas turbines to provide additional capacity while controlling emissions.

Solution

Kospo upgraded two 7F gas turbines with the Advanced Gas Path (AGP) hardware upgrade and the OpFlex software solution, marking the 100th of these systems sold to date. The combined solution offered Kospo industry-leading gas path upgrade performance and operational flexibility by increasing gas turbine output, efficiency and availability. The upgrade was installed on two units at its Busan plant in Incheon to support the region's population growth and economic expansion.

Results

The results of the upgrades were compelling for Kospo, who had weighed the economics of building a new plant versus upgrading existing facilities with the GE AGP and OpFlex solutions.

Both the Shin-Incheon and the Busan plant locations experienced greater power production capacity and operating efficiencies. Combined, these two locations are now producing an additional 215 Megawatts of power — enough to energize 160,000 homes.



Greater Output, Lower Emissions and Ability to Manage Varying Fuel Quality for Power-Intense Dubal

dubal
Dubai Aluminium

6% increase in output capacity

1.8% heat rate improvement

32K hour hardware inspection interval

Results from combined AGP & OpFlex Solutions

Challenge

Dubai Aluminium (Dubal), the world's second largest aluminum smelter site running a 2350 MW plant, has relied on GE 9E gas turbines since the 1980's. With electricity accounting for 30%-40% of aluminum production cost, Dubal wanted the most efficient and reliable operation, especially for the smelting process, where interruptions in power can be disastrous.

As a technology leader in the aluminum smelting industry, Dubal was looking to infuse technology into their operations. Gas turbine efficiency, availability and increased capacity are critical value drivers for Dubal, especially during hot days.

Solution

To support Dubal in meeting its goals, GE installed Power LifeMax, consisting of 9E Advanced Gas Path (AGP) turbines, DLN 1+ combustion system and OpFlex Advanced Controls software.

The OpFlex software allows Dubal to expand the capability of the gas turbine hardware. GE tailored OpFlex for the 9E GE turbines, applying Variable Peak Fire solution to increase output within emissions limits, AutoTune solution

to maintain the best combustion, and AutoRecover solution to automatically detect, and recover from primary reignition without impacting load reduction on operations. To enhance long term reliability, GE is providing Dubal with monitoring and diagnostic services.

Results

With GE's solution, Dubal is realizing several operational benefits. With Variable Peak Fire, Dubal can choose between 3 modes of peak fire operation, which can deliver as much as 6% increased output on hot days while maintaining NOx as low as 9ppm.

With AutoTune, Dubal can use a wider range of fuels and cope with fluctuations in fuel quality. The system automatically adjusts fuel-air mix to help the unit operate efficiently while maintaining required emissions levels.

AutoRecover improves emissions compliance and reduces hardware combustion wear by automatically detecting primary re-ignitions within 15 seconds, recovering to emissions compliance within 3.5 minutes and minimizing load reduction in the process.

GE OpFlex Advanced Controls Solutions Analytics and Actions at the Edge

GE's OpFlex Advanced Controls Solutions are designed to help customers take action on insights gained from massive machine data, physics based analytics and logical human interfaces. Whether from analytics on-premise or in the cloud, Advanced Controls gives customers the ability to operate their assets more profitably, reducing operating costs and increasing revenue.

OpFlex solutions are organized into four categories for customers of GE gas turbines, steam turbines and combined plants:

- **Start-Up Agility:** Fast, reliable, repeatable starts with low emissions
- **Combustion Versatility:** Robust operation during weather, fuel and grid variations
- **Load Flexibility:** Load range expansion, efficiency, responsiveness and customization
- **System Reliability:** Enhancements for reliability, cost effective operations

OpFlex Advanced Controls Solutions are part of GE Power Digital Solutions for the Industrial Internet



BUSINESS OPTIMIZATION

Profitability and Growth



OPERATIONS OPTIMIZATION

Productivity and Flexibility



ASSET PERFORMANCE MANAGEMENT

Reliability and Availability



Predix

Cloud Platform for the Industrial Internet



Advanced Controls

Analytics and Actions at the Edge

Cyber Security

Defense for Industrial Operations



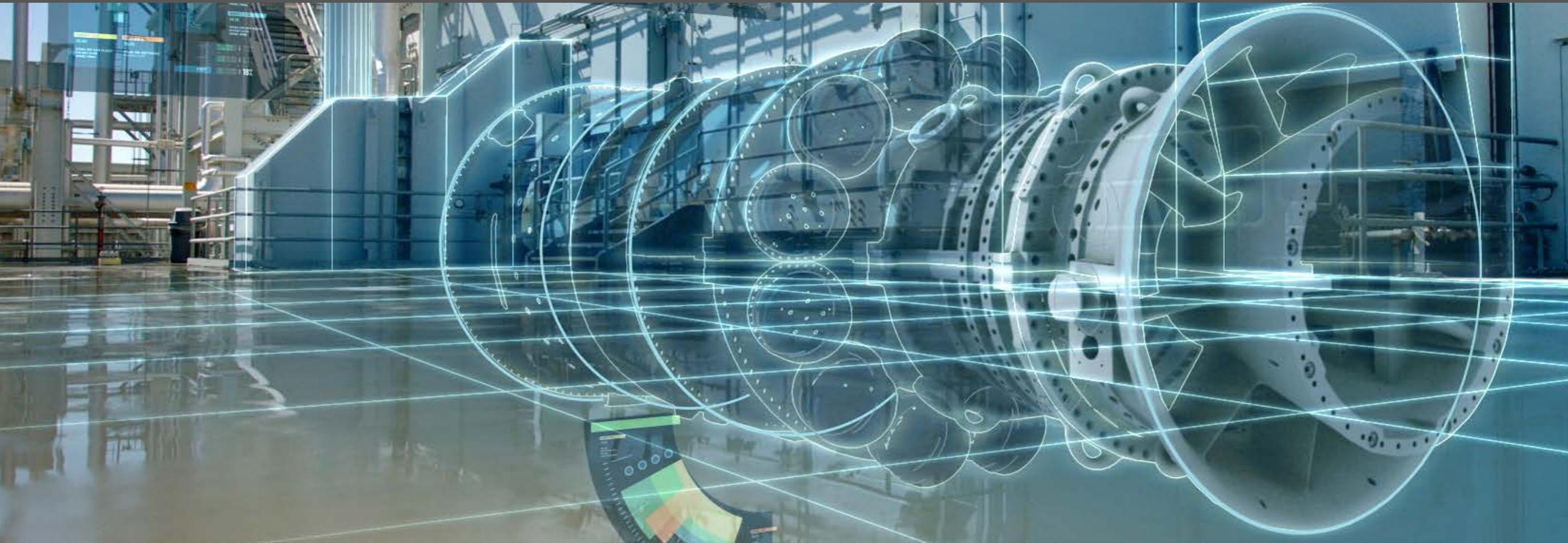
Real Customer Results

F-Class

- **40%** reduction in start up fuel consumption (for combined cycle plant hot start)
- **50%** reduction in start up time (for combined cycle plant hot start)
- **3x** increase in fuel variation handling capability
- **+2.5%** increase in peak output to meet short term demands
- **50%** reduction in start-up NOx emissions
- **2.5x** increase in loading/unloading rate — up to ±50MW/min

E-Class

- **8%** potential increased output to meet short term demands
- **10** minute starts for 7EA (<15 min. for 9E) vs. 30 minutes normally
- **50%** trip avoidance
- **50%** reduction in start-up CO emissions
- **40%** per minute fast ramp to base load



For more information, visit
www.ge.com/digital/power

“ OpFlex AutoTune provides continuous data on temperatures, pressures, flows; all critical to the overall performance of the machine. GE’s control system is constantly looking at these critical variables and fine-tuning the machine to ensure that it’s always running at it’s optimal level. ”

John McWilliams, VP of Energy Operations, TransCanada Ravenswood Power Plant