



Combined Heat and Power (CHP) NASA – Lyndon B. Johnson Space Center



2019 Federal Environmental Symposium

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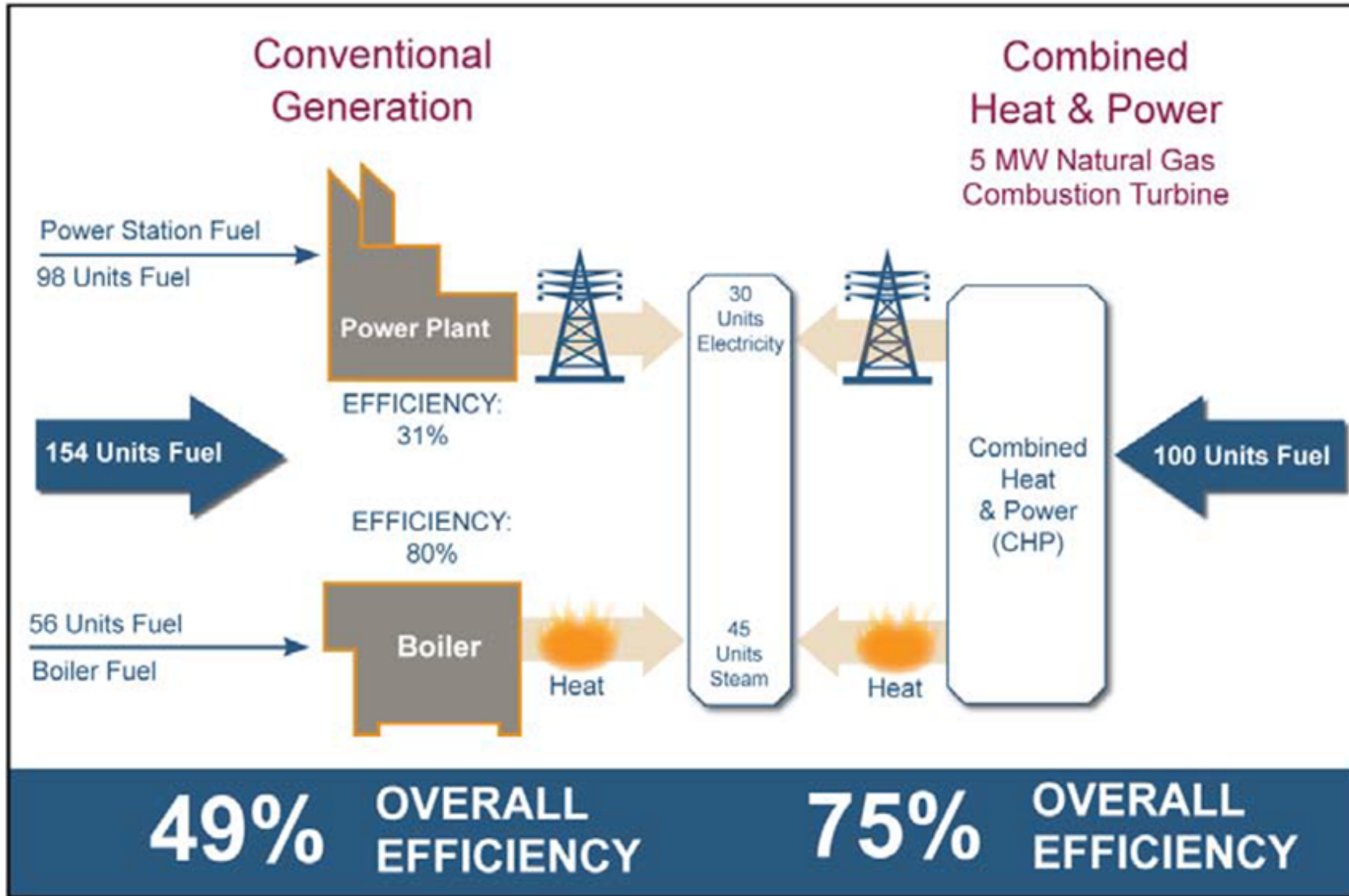
Overview

- Severe Drought Conditions Texas (State-Wide)
 - CenterPoint (Utility Provider) Electrical Grid Strained
 - Record Number of +100 degree days
 - Rolling Brown Outs
- Significant Event: December 14, 2012
 - One truck driver = JSC Site Electrical Outage
- Energy Goals
 - JSC was consistently “red” on the Agency metric for energy reduction and energy conservation

***Need for Enhanced Energy Security,
Cost Savings, and Reliability for Mission Support***



Why CHP?





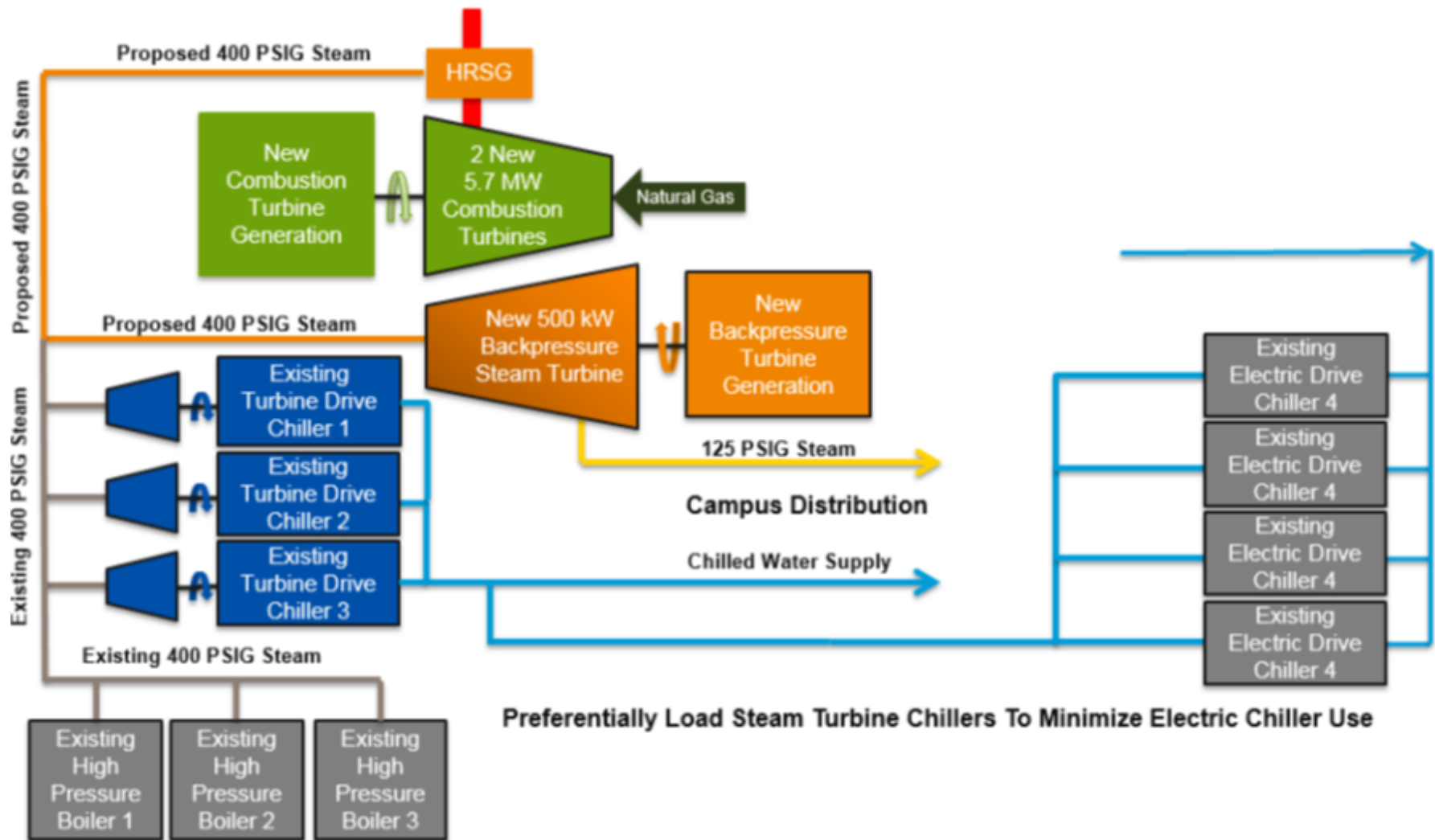
What is Combined Heat and Power?

- JSC's CHP uses natural gas to make electricity by powering two 5.7 MW Natural Gas Turbines
 - Heat is produced in that process
 - That waste heat is used to produce steam within two heat recovery steam generators
 - High pressure steam drives three existing steam turbine chillers to provide central campus air conditioning (chilled water distribution)
 - Sufficient low pressure steam produced for other uses

- Cost \$47 Million

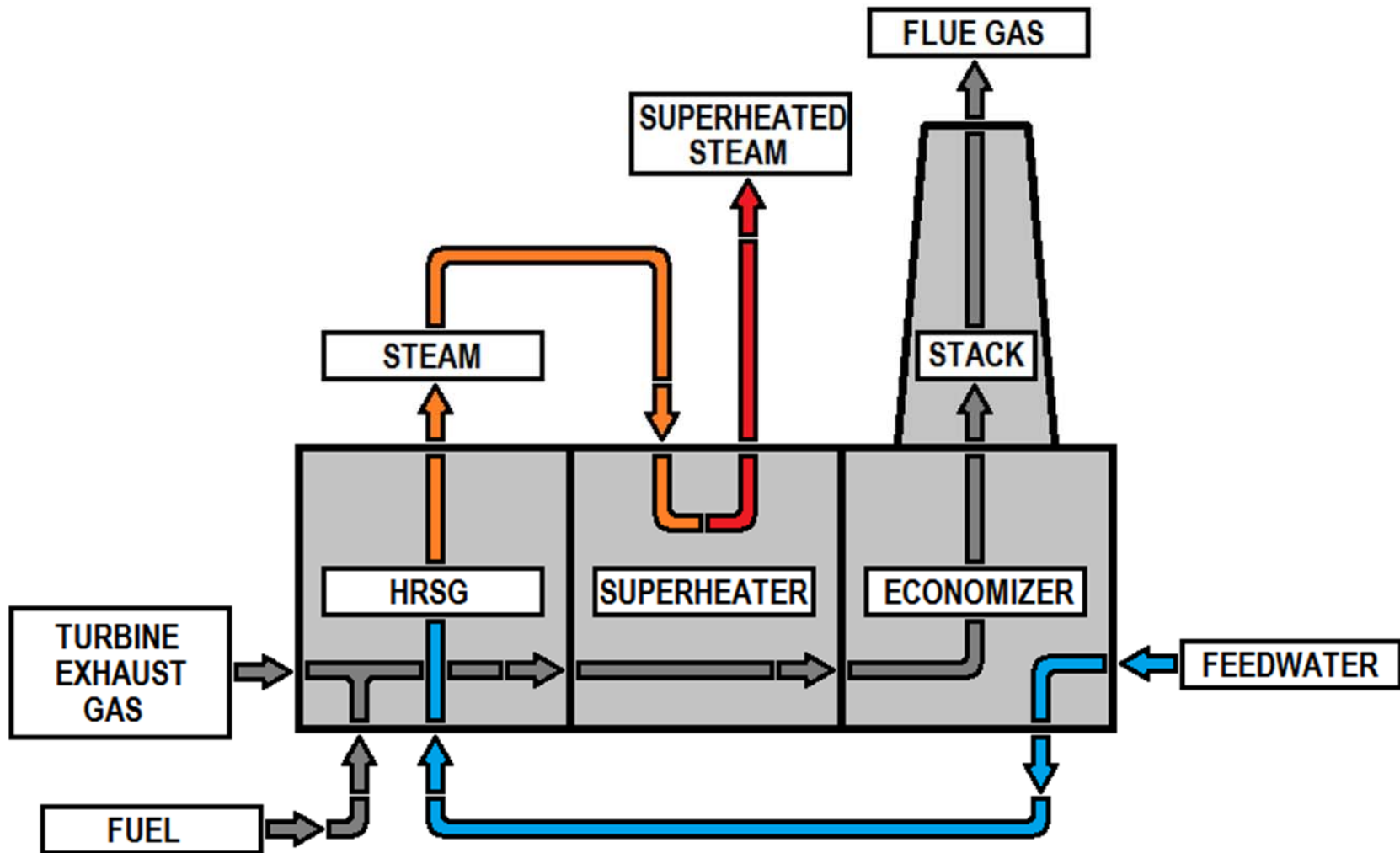


Natural Gas = Electricity + Steam + Chilled Water





Heat Recovery System Generator (HRSG) & Duct Burner





Energy Savings Performance Contract

- ESPC provides a viable funding alternative
 - Executive Order encourages use of ESPCs for Federal agencies
 - ESPC “finances” Capital equipment & installation cost + operations/maintenance cost; i.e., only minimal impact to O&M budget for term of the loan
 - 23 year term; capital and interest is paid through the realized cost savings accrued each year based upon market energy costs
 - Upon completion of the payout, the ESCO turns over the equipment with a minimum of 10 years remaining service life



Energy Savings Performance Contract

- Department of Energy served as a key partner
 - Contract awarded through the DOE Master Contract
- Additional \$1M AFFECT (Energy Conservation) Grant provided greatly assisted contract award
 - Very stringent cost targets in order to make the project viable.



Environmental Planning – A Success Story

- JSC sized the CHP turbines and ancillary equipment to conform to the following principles:
 - Avoid triggering of Prevention of Significant Deterioration (PSD) Review and avoid “netting”
 - Meet a substantial portion of JSC’s base electrical load
 - Be cost-effective and streamline the permitting process
- Environmental requirements, constraints, and costs were ***fully integrated*** into the design, as well as the construction and long term operations and maintenance of the systems.



Environmental Planning – A Success Story

- **Friendly Texas Regulatory Environment**
 - Meets the Requirements for a TCEQ New Source Standard Permit - no need for extensive air modelling
 - Standard Permit substantially reduces the need for NOx credits

- **Completed National Environmental Policy Act (NEPA) Environmental Assessment**
 - No significant adverse impacts identified
 - No adverse comments received during public comment period



Inside the Numbers

- Greenhouse Gas Combustion Emissions
 - Project results in a net **increase** of < 75,000 tons of CO_{2e};
Avoids Prevention of Significant Deterioration (PSD) trigger as a major modification
 - Net Change: 45,000 tons **increase** - Scope 1 Emissions
59,000 tons **decrease** - Scope 2 Emissions
 - Projected Net 12.5% **decrease** in GHG Emissions
- Significant reduction in operating hours for Central Plant Boilers (natural gas and diesel fuel)



Inside the Numbers

- NOx
 - Project results in a net increase **of less than 5 Tons of NOx**
 - JSC had previously banked sufficient NOx credits under the State Implementation Plan's Mass Emission Cap and Trade (MECT) Program for installation
 - Meets all State-specific NOx emissions limits and applicable reporting requirements that apply to Harris/Galveston/Brazoria (HGB) ozone non-attainment area



Emissions Monitoring / Controls / Reports

- Selective Catalytic Reduction (SCR) for NOx
- Continuous Emissions Monitoring (CEMS) for each Turbine / Heat Recovery Train
- Black Start Emergency (Standby) Generator
- Modified Facility's Spill Response Plan to address a potential release of 19.5% Aqua Ammonia



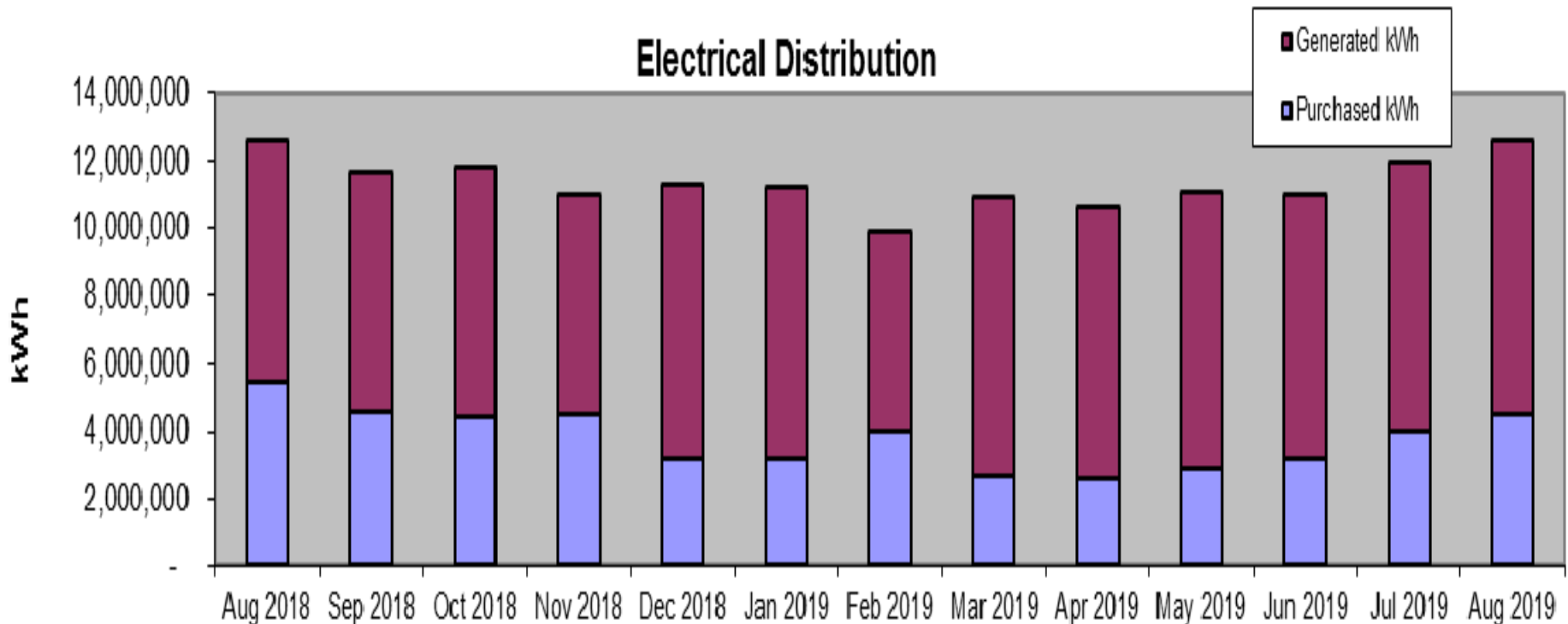
Emissions Monitoring / Controls / Reports

- Additional Environmental Compliance Reporting:
 - Relative Accuracy Test Audit (Annual) and Cylinder Gas Audit (Quarterly) for each CEMS
 - 40 CFR KKKK reporting (semiannual)
 - State-specific reporting for State Implementation Plan Compliance (semiannual)
 - Units Incorporated into the NASA-JSC Title V Clean Air Act Federal Operating Permit (FOP) compliance reporting (semiannual deviation and compliance certification)
 - 19.5% Aqua Ammonia 12,000 gallon double-walled tank triggers EPCRA Tier 1 (but not TRI) reporting (Annual)



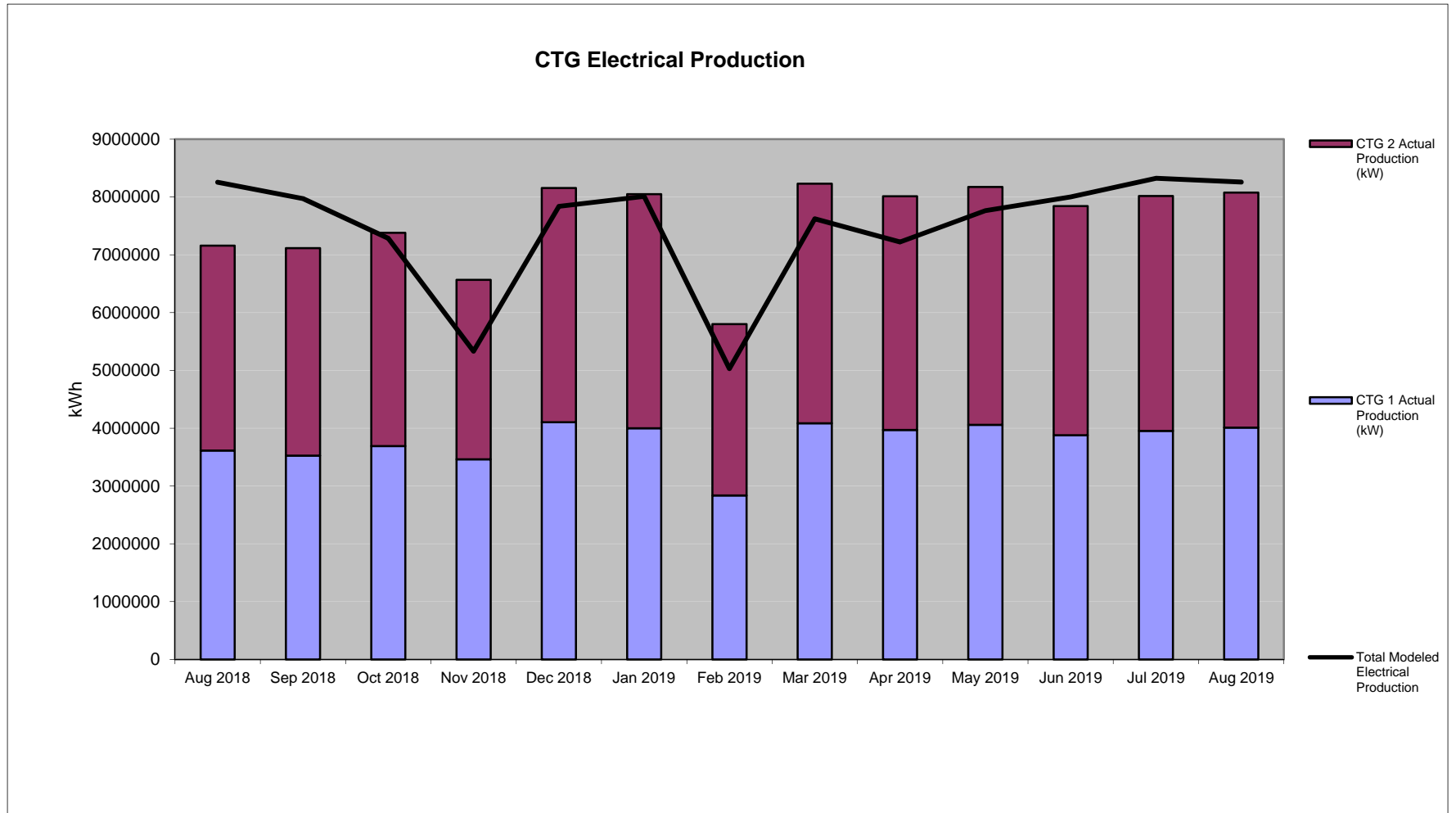
How are we doing – Energy Production?

- Began operation on July 1, 2018
- Supports 65% of JSC's electrical requirements
- Supports 55% of JSC's chilled water requirements



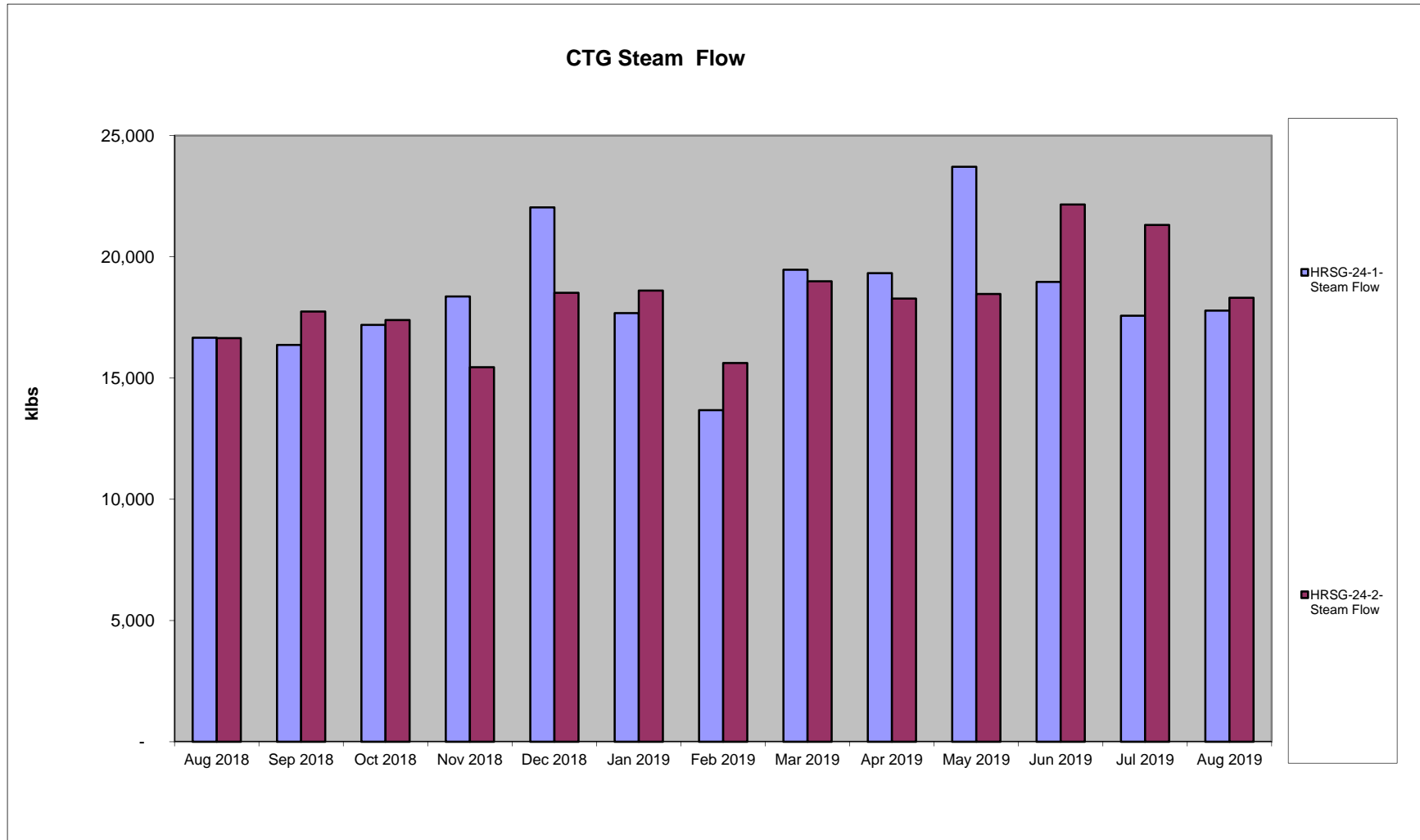


How are we doing – Energy Production?



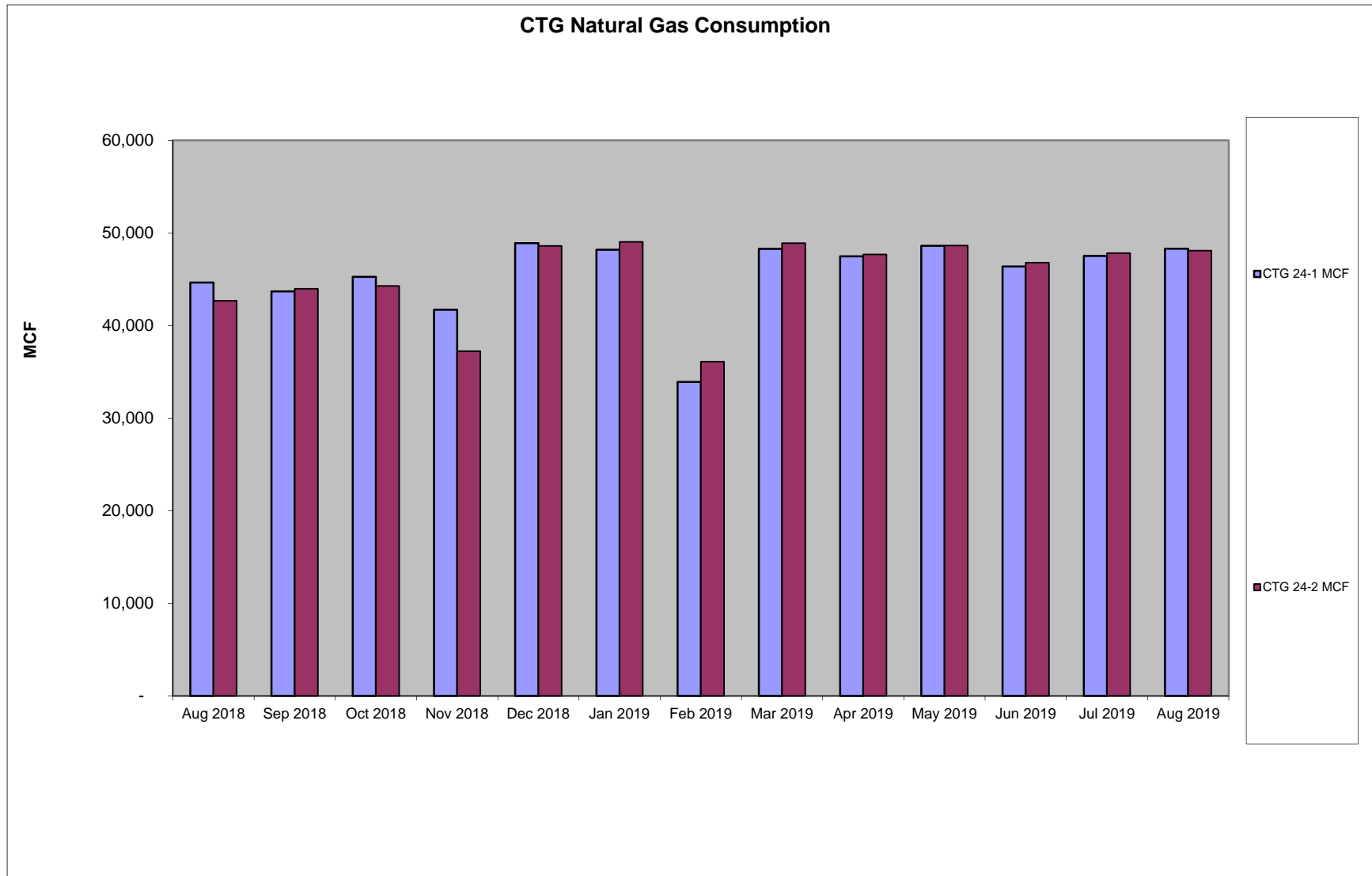


How are we doing – Steam Production?





How are we doing – Gas Consumption?





How are we doing – Emissions?

- CO and NOx hourly limit excursions occur occasionally during startup and shutdown following planned or unplanned maintenance (< 1.5% of operating hours since startup).
- CEMS reliability/operability (< 0.5% downtime)
- Remain on track for net 15% GHG emissions reduction for CY 2019 reporting year (based upon Scope 1 and Scope 2 emissions calculation factors).



How are we doing – Emissions?

AIR EMISSIONS REPORT
NASA - JOHNSON SPACE CENTER
Year To Date: August 2019

Month/Yr	FIN	EPN	Name	Contaminant		Emissions		
				Name	Code	Lb/Hr	TPY	PPD
August 2019	T-1	T-1	Turbine 1	Nitrogen Oxides	70400	0.42	1.22	11.43
August 2019	T-1	T-1	Turbine 1	Carbon Monoxide	90300	0.54	1.59	11.61
August 2019	T-1	T-1	Turbine 1	Carbon Dioxide	90100	7,885	22,993	195,694
August 2019	T-1	T-1	Turbine 1	Ammonia	70050	0.01	0.03	0.08
August 2019	T-2	T-2	Turbine 2	Nitrogen Oxides	70400	0.42	1.23	10.93
August 2019	T-2	T-2	Turbine 2	Carbon Monoxide	90300	0.46	1.35	11.45
August 2019	T-2	T-2	Turbine 2	Carbon Dioxide	90100	7,692	22,430	188,595
August 2019	T-2	T-2	Turbine 2	Ammonia	70050	0.01	0.03	0.16
				Nitrogen Oxides	70400	0.76	2.06	
T1/T2 PERMIT EMISSION LIMITS				Carbon Monoxide	90300	6.54	17.65	
				Ammonia	70050	0.48	2.09	
T1 Maximum 30-Day Rolling Average NOx Emissions for the month =					0.007	lb/MMBtu	0.032	lb/MWh
T2 Maximum 30-Day Rolling Average NOx Emissions for the month =					0.007	lb/MMBtu	0.033	lb/MWh



Key Take-Aways

- ESPC (DOE contract vehicle) made it possible!
- Enhanced Energy Reliability
 - CHP provides over 60% of JSC's base electric load throughout the year
 - Provides up to 60% of peak chilled water loads
- Energy Intensity Reduction
 - Reduces energy intensity in BTU/GSF by well over 50%
 - JSC now meets NASA's 2.5%/yr energy reduction goal for foreseeable future (well beyond 2030)



Key Take-Aways

- Environmentally Friendly Solution
 - Based upon FEMP guidelines, reduces JSC's carbon footprint by over 20,000 metric tons of CO_{2e}
 - Substantially decreases JSC's strain on the electrical grid

 - Economics likely to improve into the future
 - Electrical energy rates likely to increase while natural gas costs are expected to remain comparatively low

 - Demonstrated effectiveness of a multi-agency Government / Private Sector strategic partnership
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Questions?

