CHP Design Considerations for Cold Climates

Don't Stick Your Tongue on That Pipe!

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CampusEnergy2020
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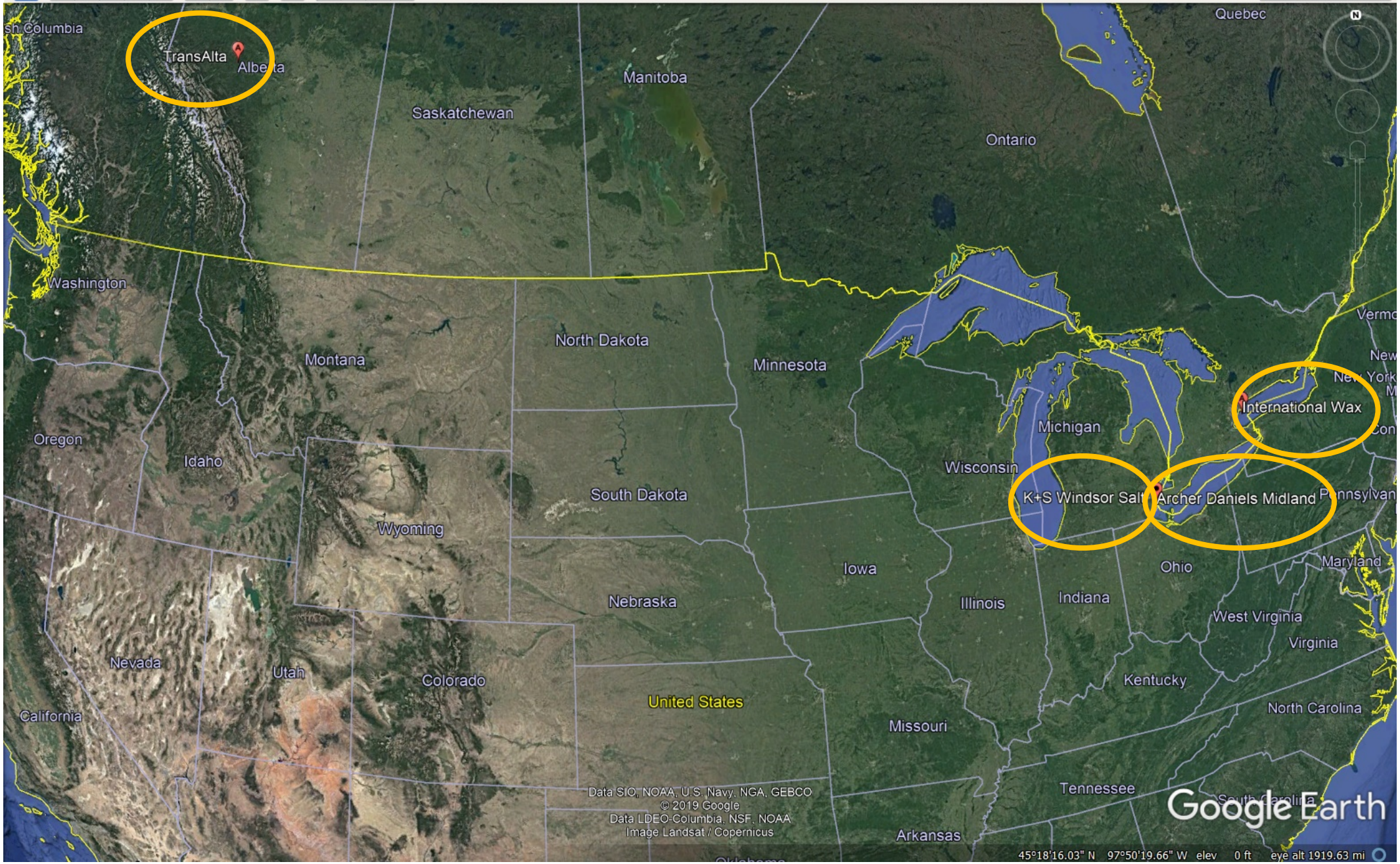
CEM ENGINEERING
COGENERATION & ENERGY MANAGEMENT

Solar® Turbines
A Caterpillar Company

INTERNATIONAL DISTRICT ENERGY ASSOCIATION


TransAlta
Manitoba
Saskatchewan
Ontario
Quebec
Washington
North Dakota
Montana
Minnesota
Oregon
Idaho
Michigan
International Wax
Wisconsin
K+S Windsor Salt
Archer Daniels Midland
South Dakota
Wyoming
Iowa
Ohio
Nebraska
Illinois
Indiana
West Virginia
Virginia
Nevada
Utah
Colorado
Kentucky
United States
California
North Carolina
Missouri
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Arkansas
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Data LDEO-Columbia, NSF, NOAA
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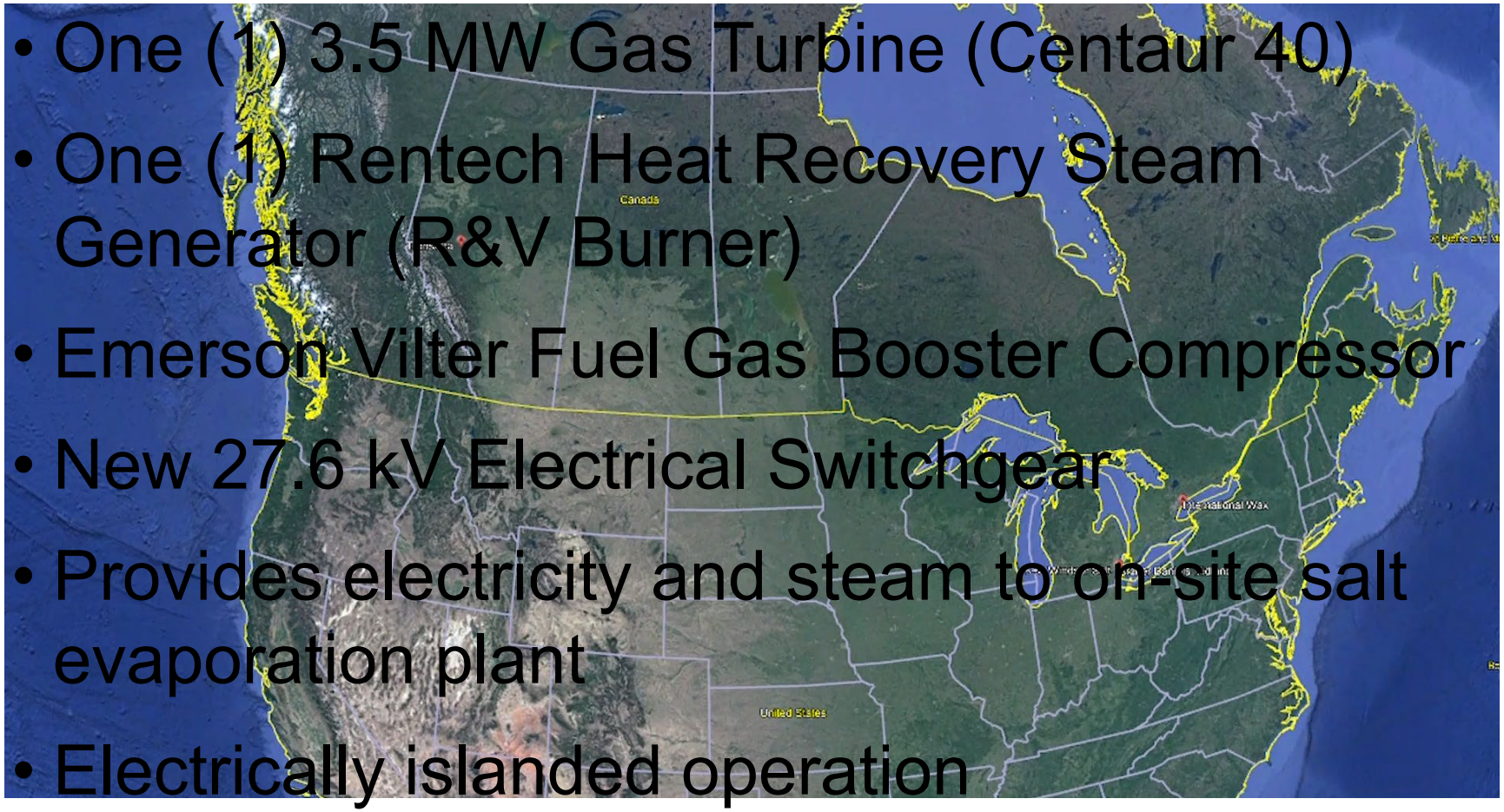
Google Earth
45°18'16.03" N 97°50'19.66" W elev 0 ft eye alt 1919.63 mi

Case Study: K+S Windsor Salt

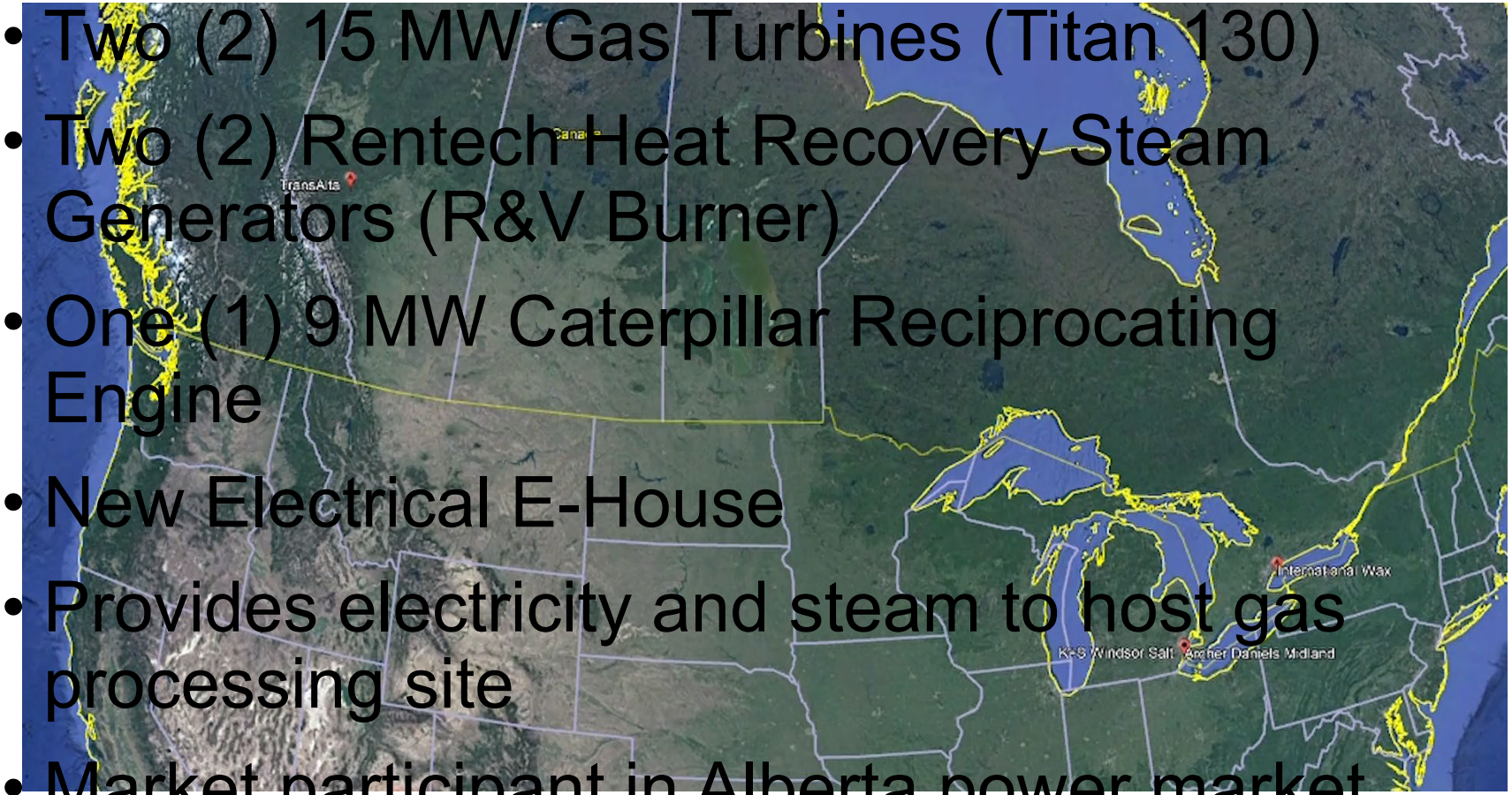


- One (1) 3.5 MW Gas Turbine (Centaur 40)
- One (1) Rentech Heat Recovery Steam Generator (R&V Burner)
- Emerson Vilter Fuel Gas Booster Compressor
- New 27.6 kV Electrical Switchgear
- Provides electricity and steam to on-site salt evaporation plant
- Electrically islanded operation

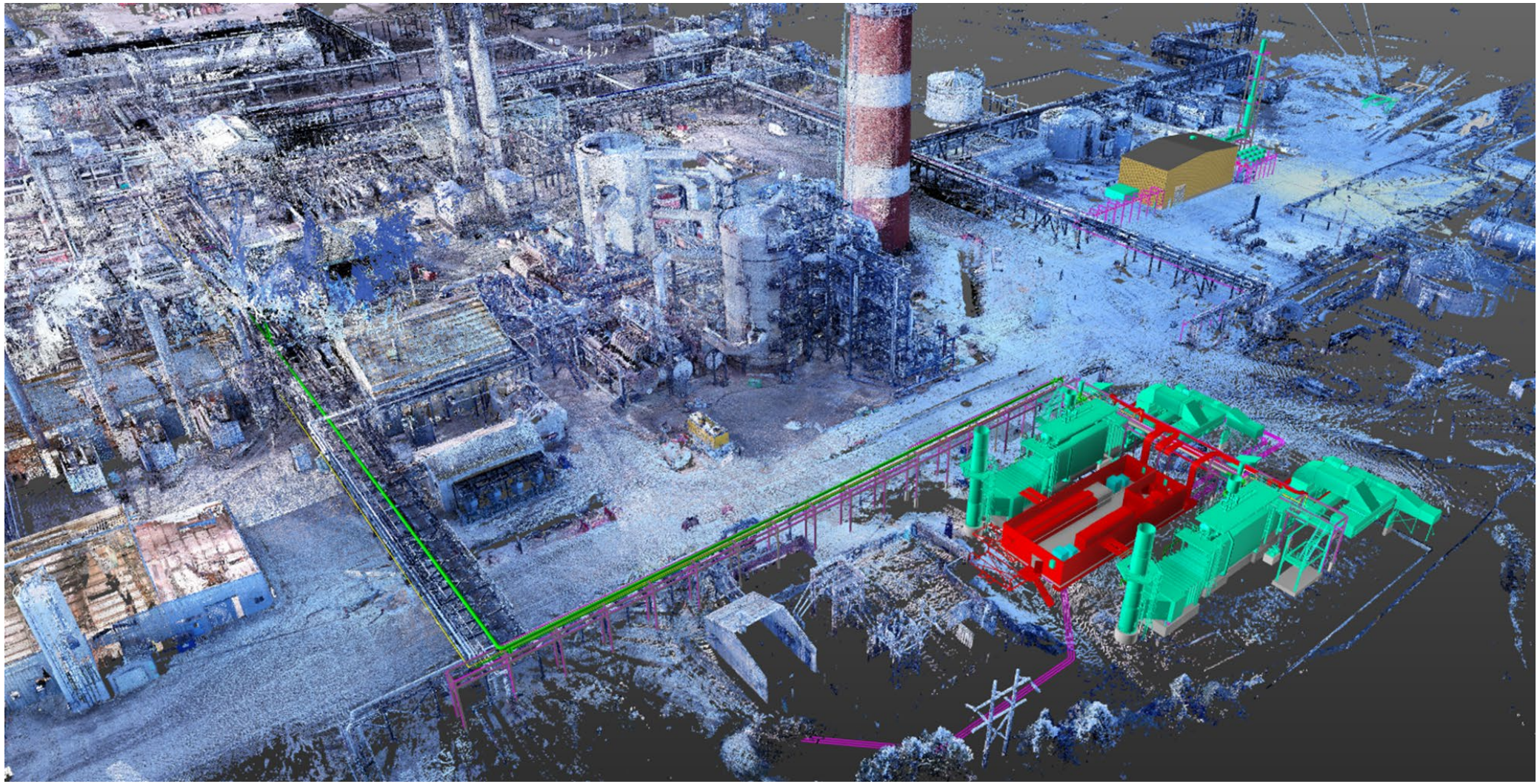
Case Study: K+S Windsor Salt

Case Study: TransAlta, Alberta

- Two (2) 15 MW Gas Turbines (Titan 130)
- Two (2) Rentech Heat Recovery Steam Generators (R&V Burner)
- One (1) 9 MW Caterpillar Reciprocating Engine
- New Electrical E-House
- Provides electricity and steam to host gas processing site
- Market participant in Alberta power market

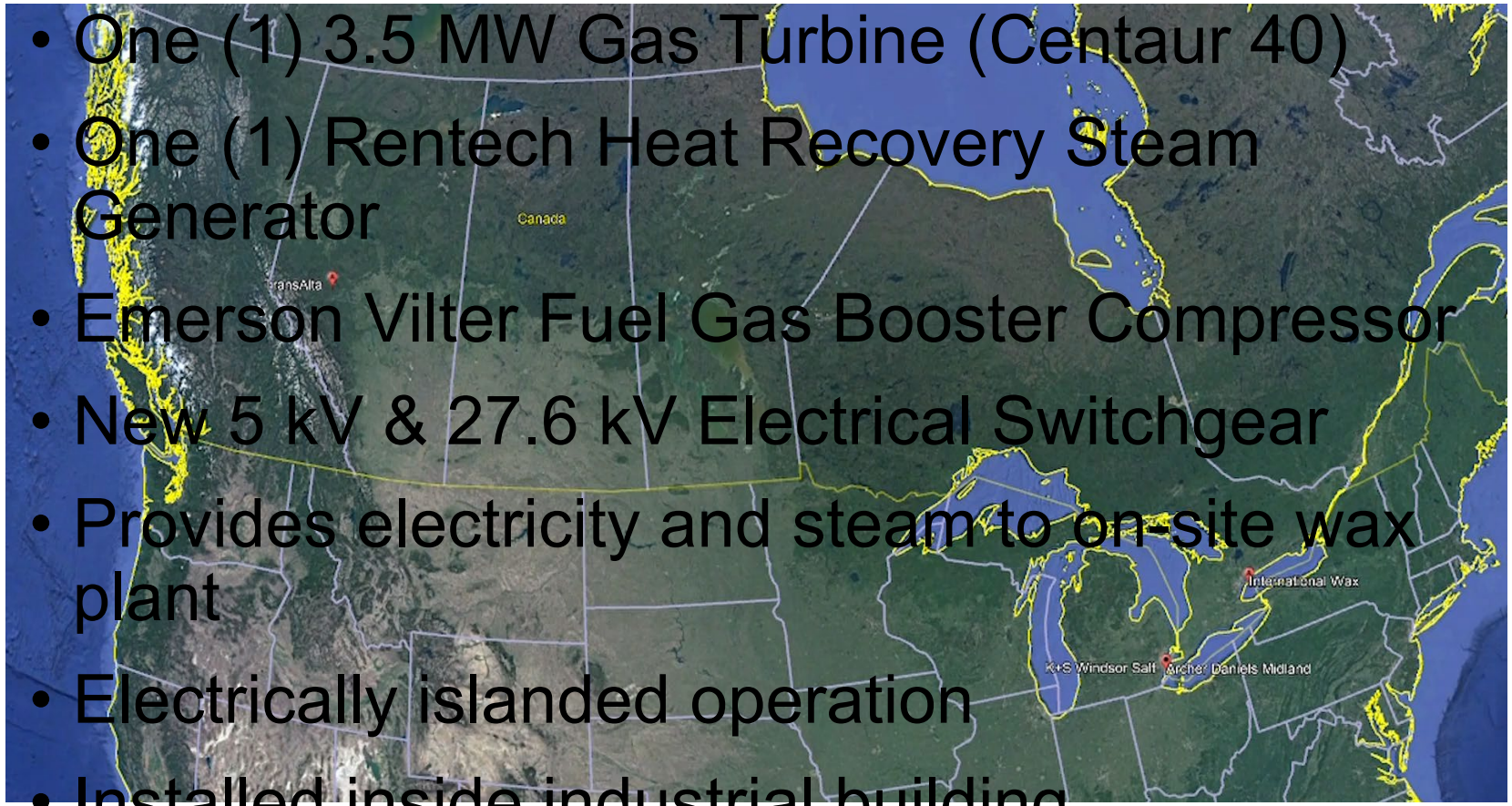


Case Study: TransAlta, Alberta



Case Study: International Wax

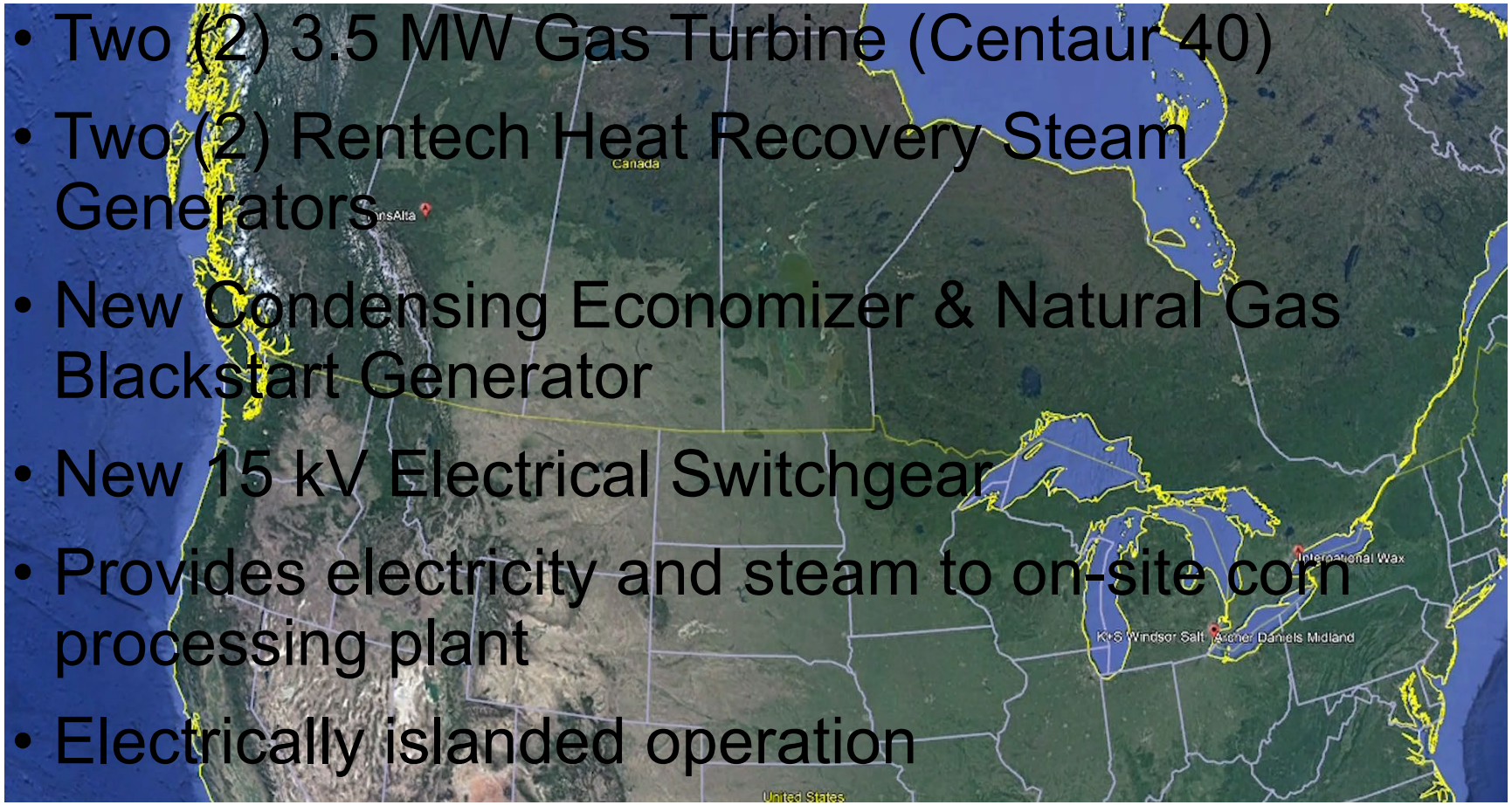
- One (1) 3.5 MW Gas Turbine (Centaur 40)
- One (1) Rentech Heat Recovery Steam Generator
- Emerson Vilter Fuel Gas Booster Compressor
- New 5 kV & 27.6 kV Electrical Switchgear
- Provides electricity and steam to on-site wax plant
- Electrically islanded operation
- Installed inside industrial building



Case Study: International Wax

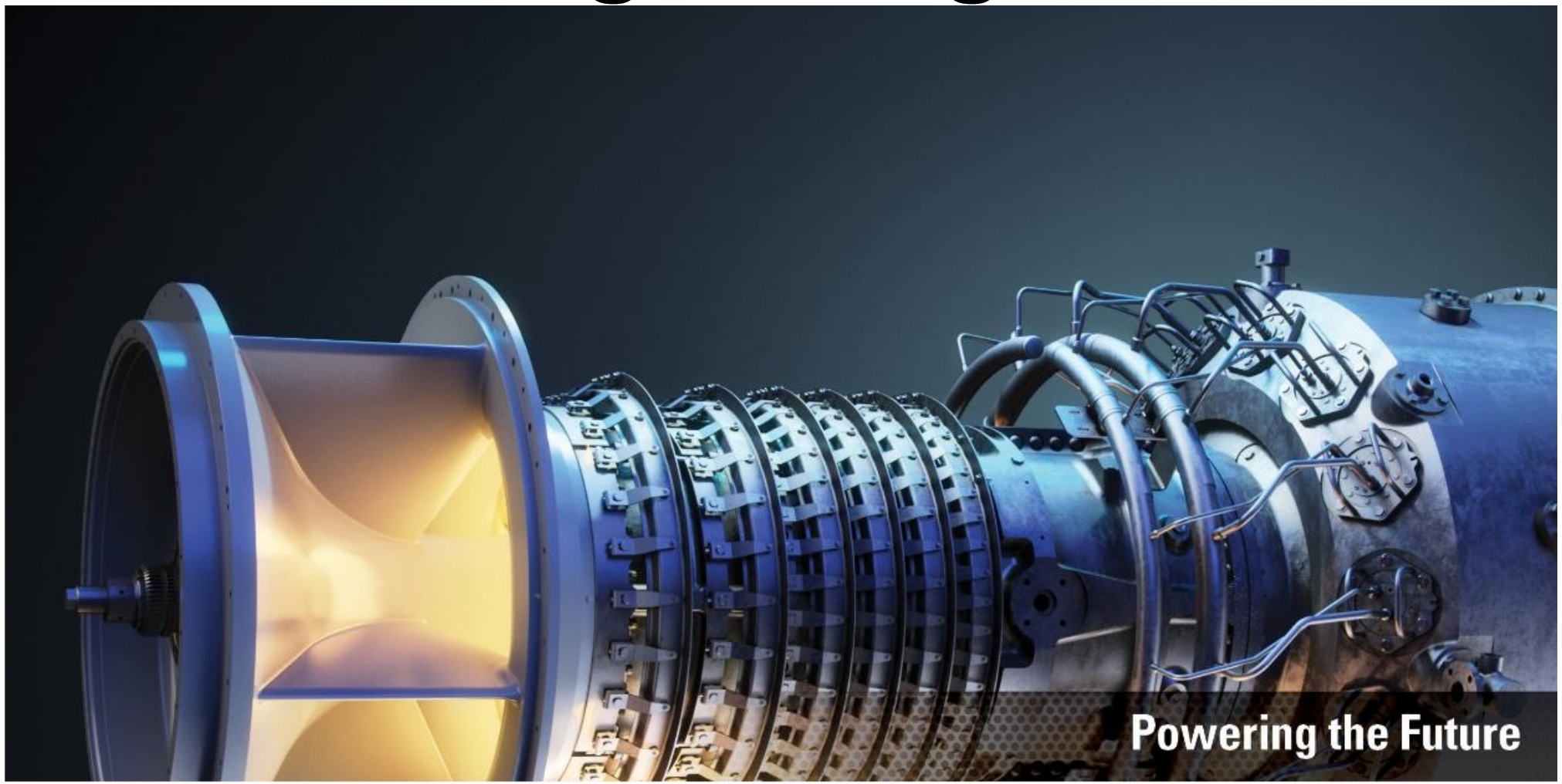
Case Study: Archer Daniels Midland

- Two (2) 3.5 MW Gas Turbine (Centaur 40)
- Two (2) Rentech Heat Recovery Steam Generators
- New Condensing Economizer & Natural Gas Blackstart Generator
- New 15 kV Electrical Switchgear
- Provides electricity and steam to on-site corn processing plant
- Electrically islanded operation



Case Study: Archer Daniels Midland

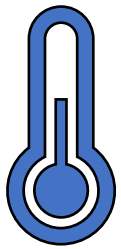
Cold Weather Package Design Options



Cold Weather Package Design

- Combustion power generation equipment is installed in many different geographic locations, some of which expose the equipment to temperature extremes.
- -4°F (-20°C) is the minimum temperature guideline for the standard Solar package. The following table lists the temperature limits for standard packages. Generally, packages can operate within these limits without any special modifications.

Temperature Range



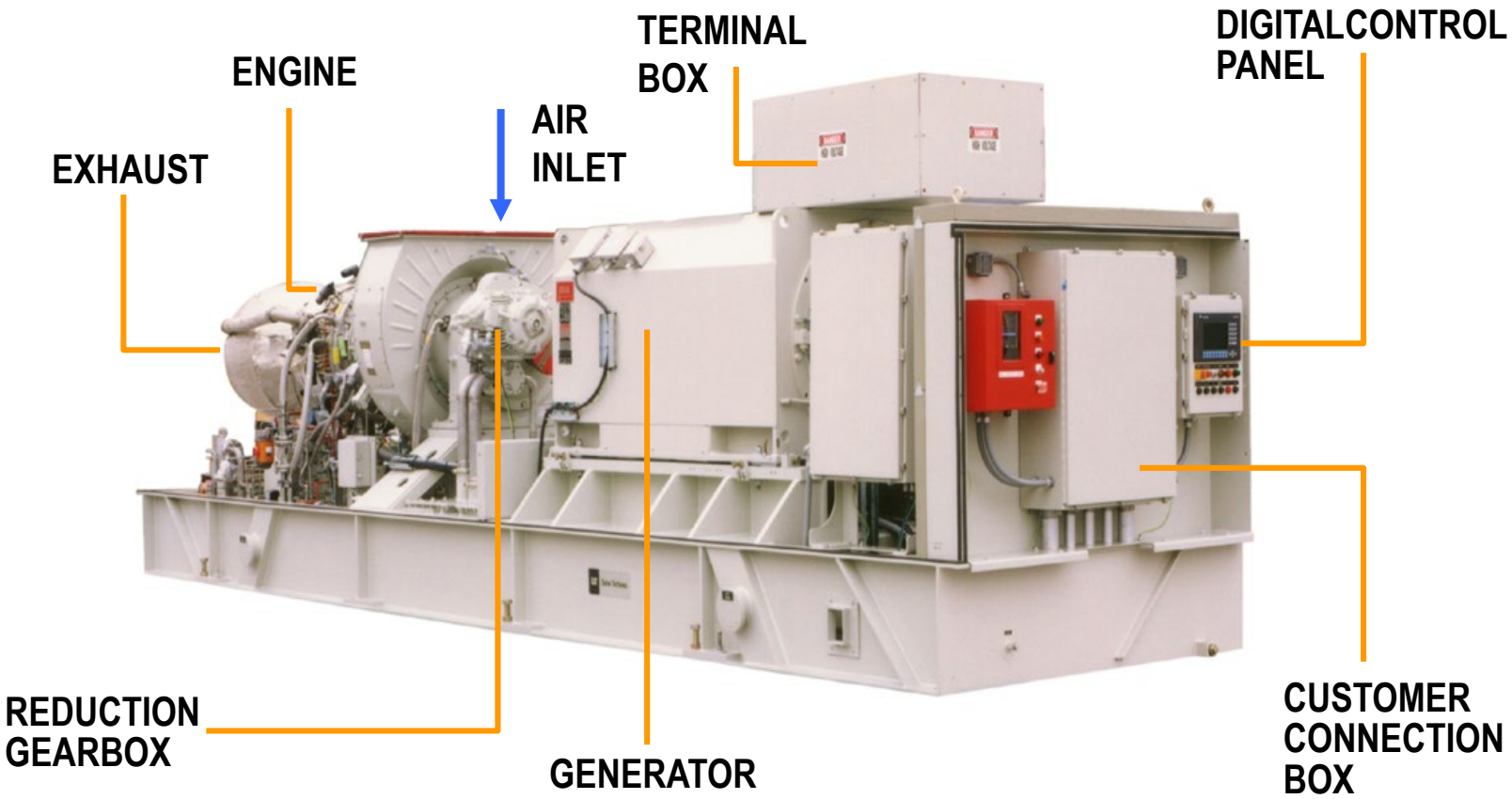
	Lower Limit		Upper Limit	
	°F	°C	°F	°C
Packages with Offskid Control Systems	– 20	– 29	120	49
Packages with Onskid Control Systems*	-4	-20	120	49
Control Console (Offskid and Onskid)	-4	-20	140	60

Standard Generator Package Scope of Supply

- Base Frame
- Driver, Gearbox & Generator
- Auxiliary Systems
- Combustion Air Inlet Filtration
- Control Panel & HMI

Typical Options

- Enclosure & Ventilation
- Fire Suppression
- Exhaust System

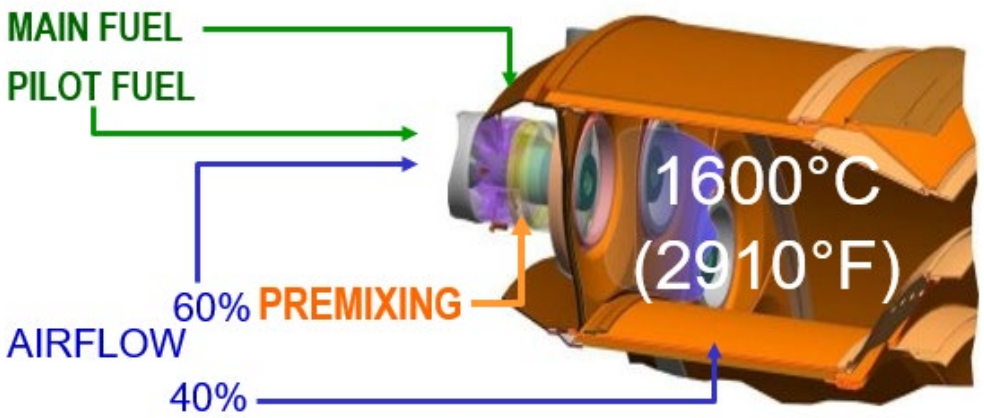


Cold Weather Requirements

STANDARD PACKAGE	40°C (104°F) to -20°C (-4°F)	-21°C (6°F) to -30°C (-22°F)	-31°C (-24°F) to -40°C (-40°F)	< -40°C (-40°F)
STANDARD PACKAGE	40°C (104°F) to -20°C (-4°F)	-21°C (6°F) to -30°C (-22°F)	-31°C (-24°F) to -40°C (-40°F)	< -40°C (-40°F)
ON SKID CONTROL PANEL	STANDARD	MODIFIED TO INCLUDE OVERATEMP STAT	VENTILATION LOUVERS CONTROL FOR OFF SEASON COLD WEATHER	
ENCLOSURE PACKAGE	STANDARD	HEATERS, THERMOSTAT SWITCH, FAN TO RECIRCULATE AIR, AND ADD DOOR HEATERS		< -40°C (-40°F)
HMI	STANDARD			
BASEPLATE	COLD WEATHER BASEPLATE			NO DYNAMIC OIL CIRCULATION AND INSTALLATION
ODP GENERATOR	STANDARD	ADD SPACE HEATERS FOR STATOR, EXCITER & TERMINAL BOX		WARM ROOM AIR MUST BE LOUVERED
CO2 CABINET	STANDARD			
ENGINE	LOW AMBIENT ENGINE	COLD WEATHER MATERIAL FOR SHAFT		ALL LOUVER SHOULD BE SUPPLIED
HANDLING KIT	HANDLING KIT	ADD SPACE HEATER		INSTALLATION
DUCTING	CARBON STEEL	OIL PRE-CIRCULATION FOR STARTUP		DURING STARTUP
TURBINE AIR INLET FILTER	STD FILTER WITH SPACE HEATER	NOT AVAILABLE	NOT AVAILABLE	
EXHAUST BELLOWS	STD A38X ALLOY STEEL	LOW AMBIENT SILICON SEALANT		ADD INSULATION & STAINLESS STEEL
LUBE OIL COOLER	RAIN/SNOW HOOD/VFD OPERATED LUBE OIL COOLER	OVERSIZED COLD WEATHER STAINLESS STEEL		WRAPPING TO HEAT TRACING TO COMPRESSED AIR
ENCLOSURE VENTILATION				AUTOMATIC LOUVER SYSTEM WITH BUILT-IN MANIFOLD HEATERS
CONTROL PANEL	STANDARD PANEL	LOW AMBIENT CONTROL PANEL		
FILTER	BARRIER FILTER	SELF-CLEANING UPDRAFT COLD WEATHER FILTER		OFF SKID CONTROL SYSTEM

Standard Cold Weather Logic Below 0°F (-18°C)

- Increased fuel pilot flow required for flame stability to prevent combustor rumble
- For DLE cold ambient emissions, the turbine must be configured with the appropriate combustion hardware and software.



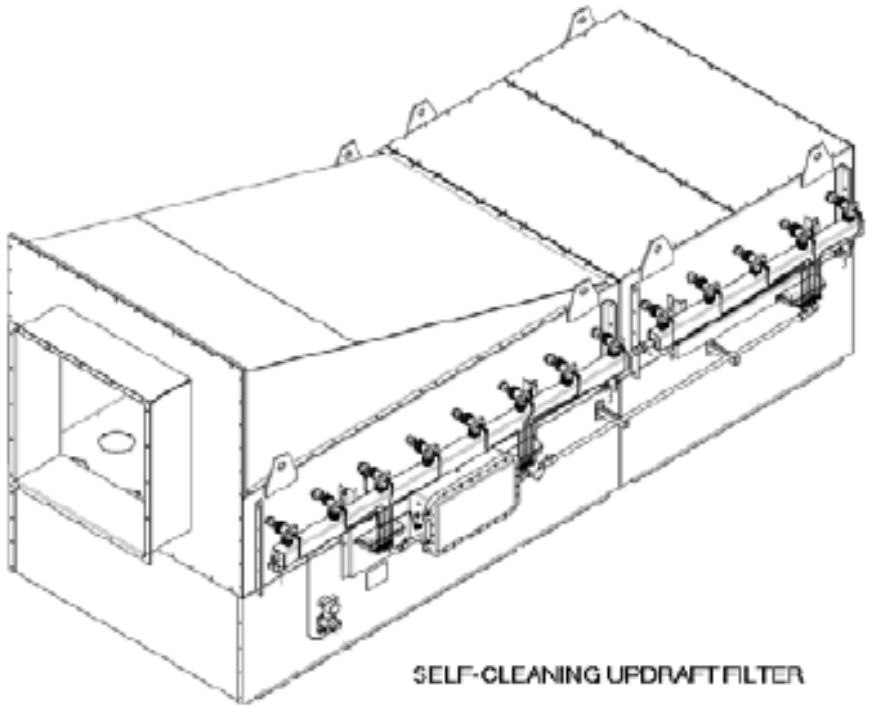
Gas Turbine SoLoNOx Combustion

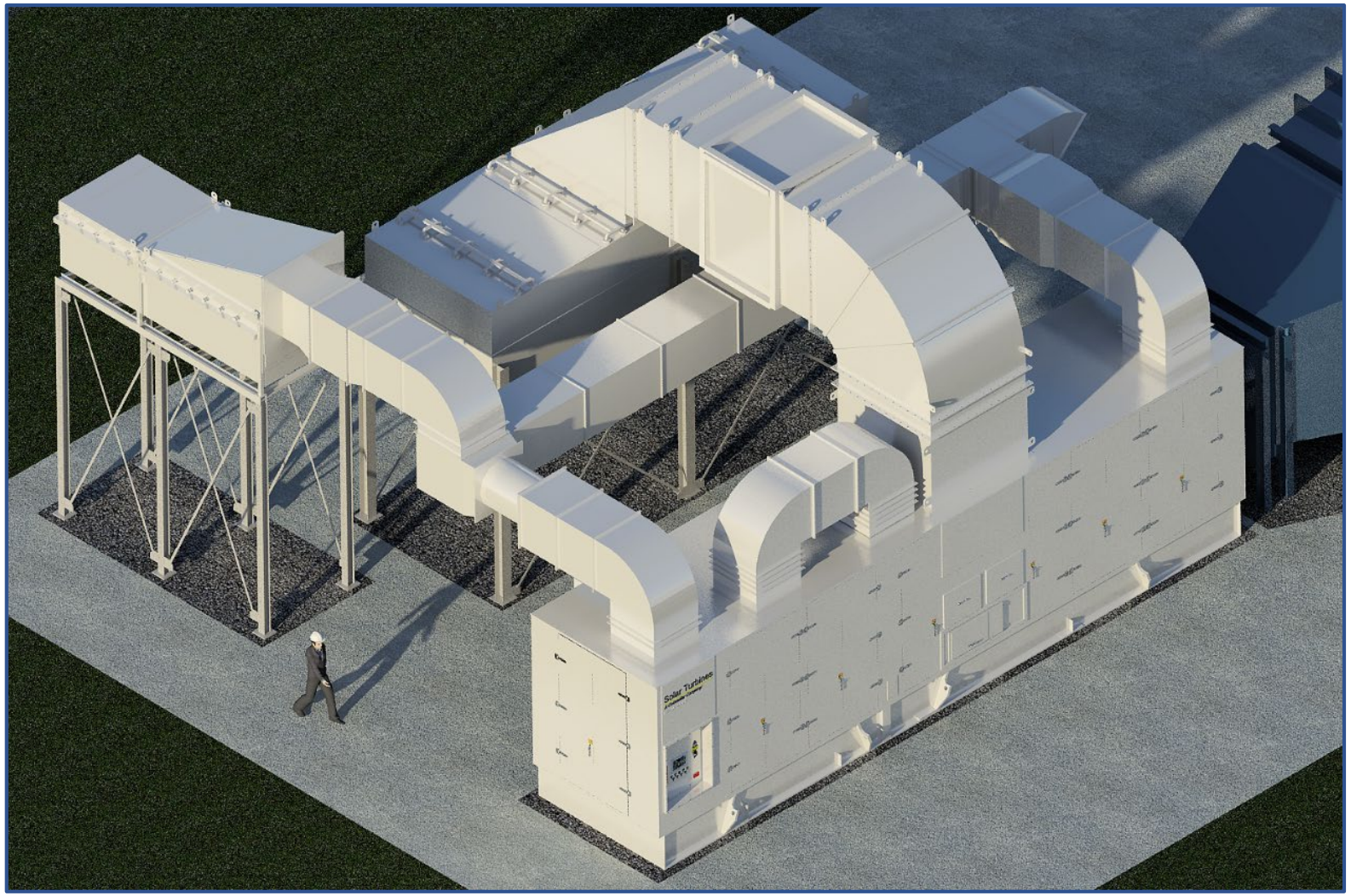
Pilot Active Control Logic

- Uses active oscillations feedback to increase pilot fuel & reduce oscillations
- Offered for DLE emission requirements of 42 ppm NOx on natural gas from below 0°F (-18°C) to -20°F (-29°C)
- Provides reduced emissions below -20°F (-29°C) on natural gas only

Air Flow Design Changes

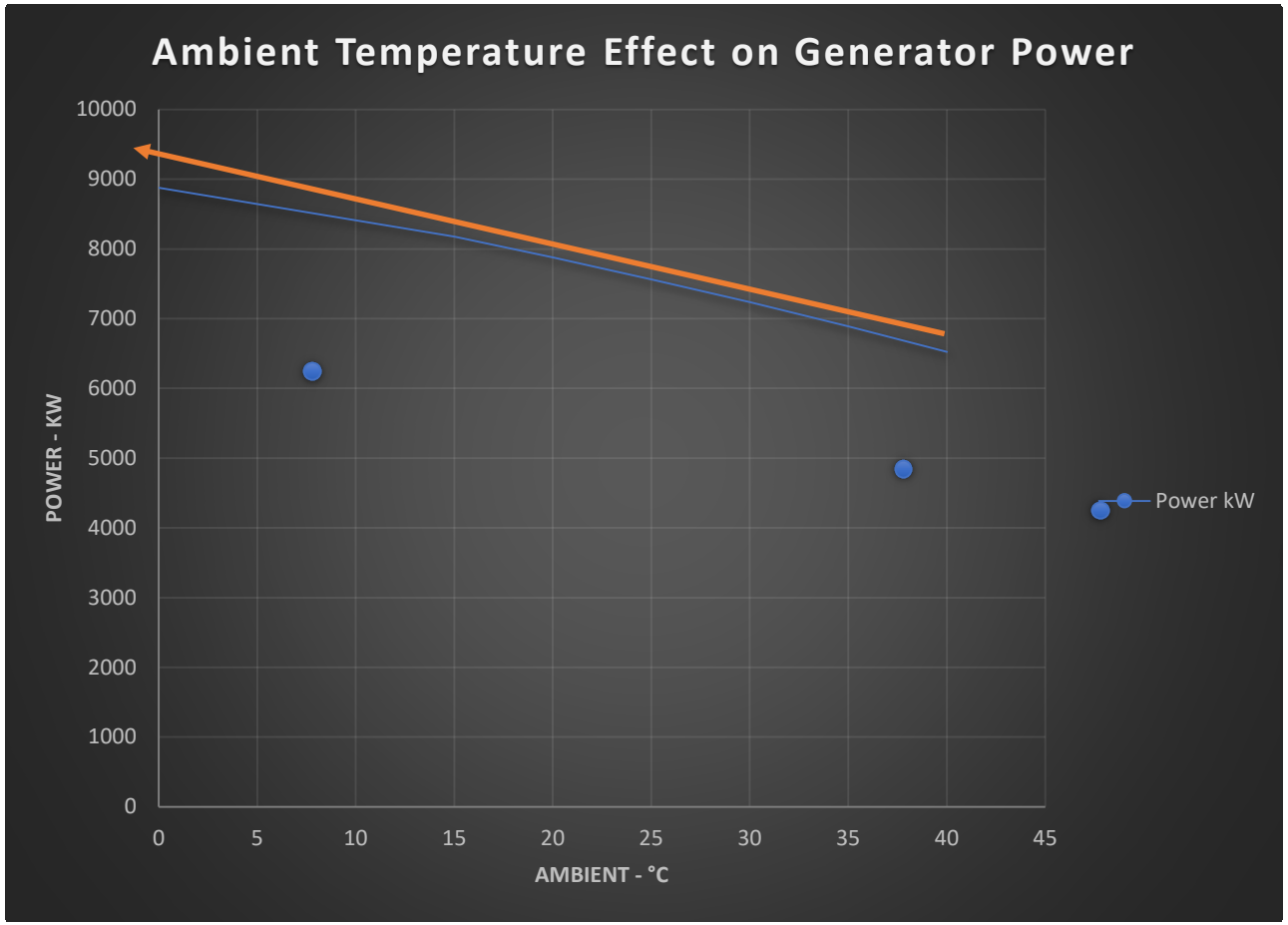
- Turbine Air Inlet
- Enclosure ventilation





Generator Design Changes

- Proper Generator Selection



Questions?

Thank You!

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