Duke Energy Dual Fuel Program

The Why, The Where and The How



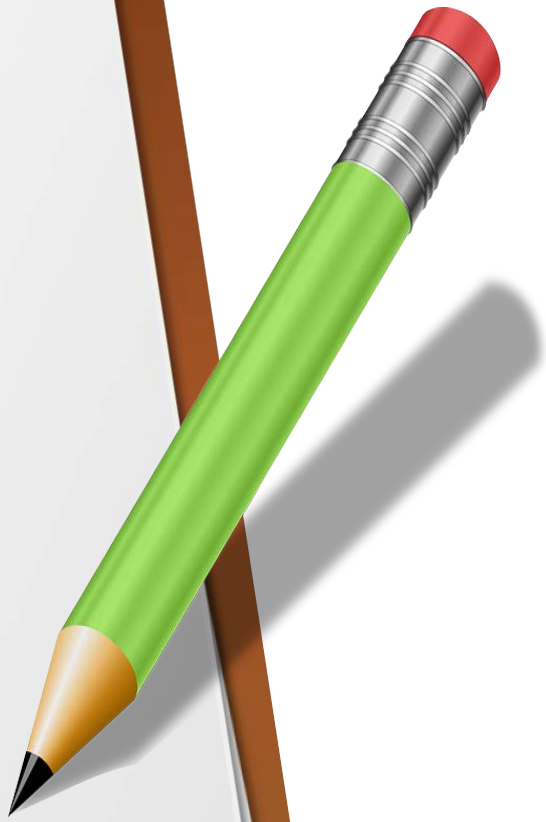


Brad Rudolph – PE
Dual Fuel Program Manager

DUKE ENERGY®

AGENDA

- SHEEN Moment
- What is DFO / Co-firing?
- The Why at Duke Energy?
- The Where at Duke Energy
- Program History
- The How at Duke Energy
- Program Status



SHEEN moment – Natural Gas Safety

- Naturally occurring mixture of hydrocarbon and non-hydrocarbon gases
  - Methane is the largest component
- Non-visible, Odorless, Tasteless gas in the natural state
- Explosive range is between 5% and 15% volume in air
- Odorant (Mercaptan) added to aid in detection
  - Do not rely on smell to determine if there is a leak

- Natural gas is lighter than air
  - Outdoors will travel upward into atmosphere
  - Indoors it will collect near ceilings or overhead structures
- Use caution with all ignition sources around potential leak points
  - Open flames, static charges

What is DFO / Co-firing?

Dual Fuel Optionality (DFO) is the ability to generate electricity using 1 of 2 fuels.

- For this program we are using Coal and Natural Gas

The DFO Program is taking existing coal generating sites and adding the capability of using Natural Gas to generate electricity without changing the ability to utilize Coal to generate

Co-Fire Ratio – this defines the amount of generation that can come from either of the 2 fuels

- 40% ratio – On a 600 MW unit, the first 240 MW's can be from either Coal or Gas but the remaining 360 MW's is always from coal

Dual Fuel Optionality and Gas Co-firing are used interchangeably

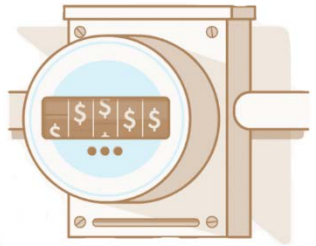
Why Gas Co-firing at Duke Energy

Reduce environmental footprint

- Reduced CO_2
- Reduced NOx, SOx, Hg
- Reduction in Fuel Oil usage and handling

Deliver savings to our customers

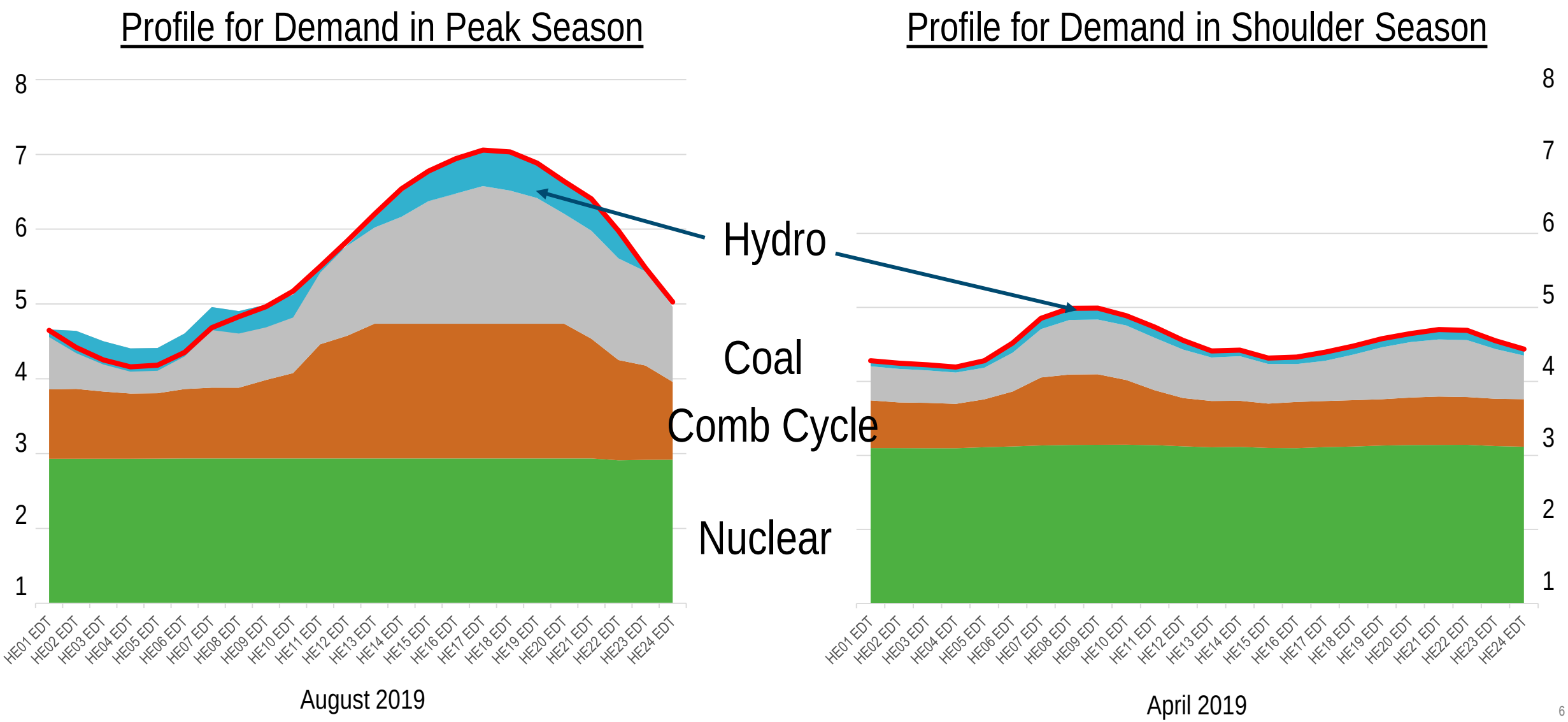
- Option to utilize lowest cost fuel on a daily basis
- Drive competition



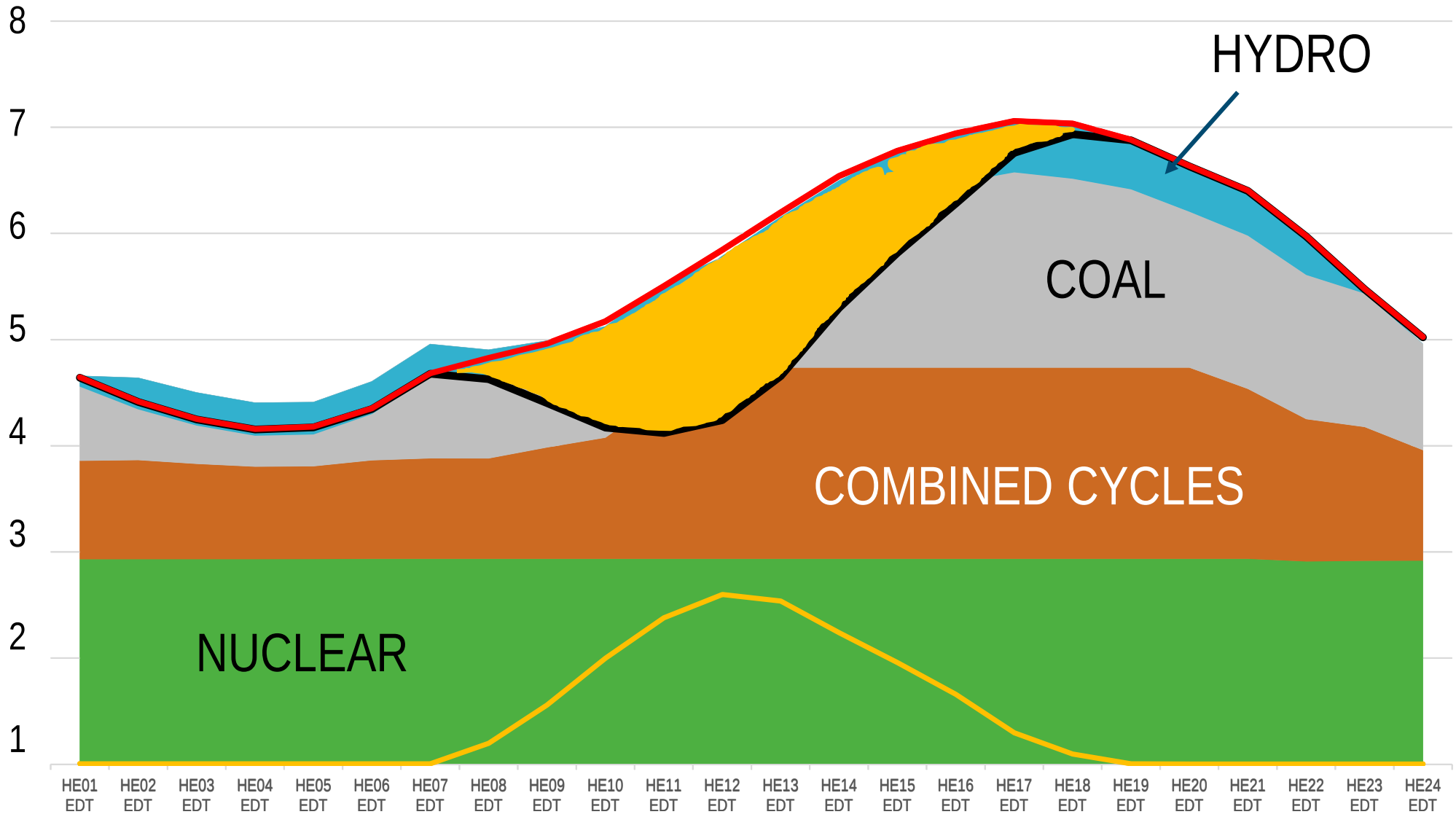
Increase unit flexibility to adapt to renewables

- Lowered Unit Minimum Load
- Increased Unit Ramp Rates

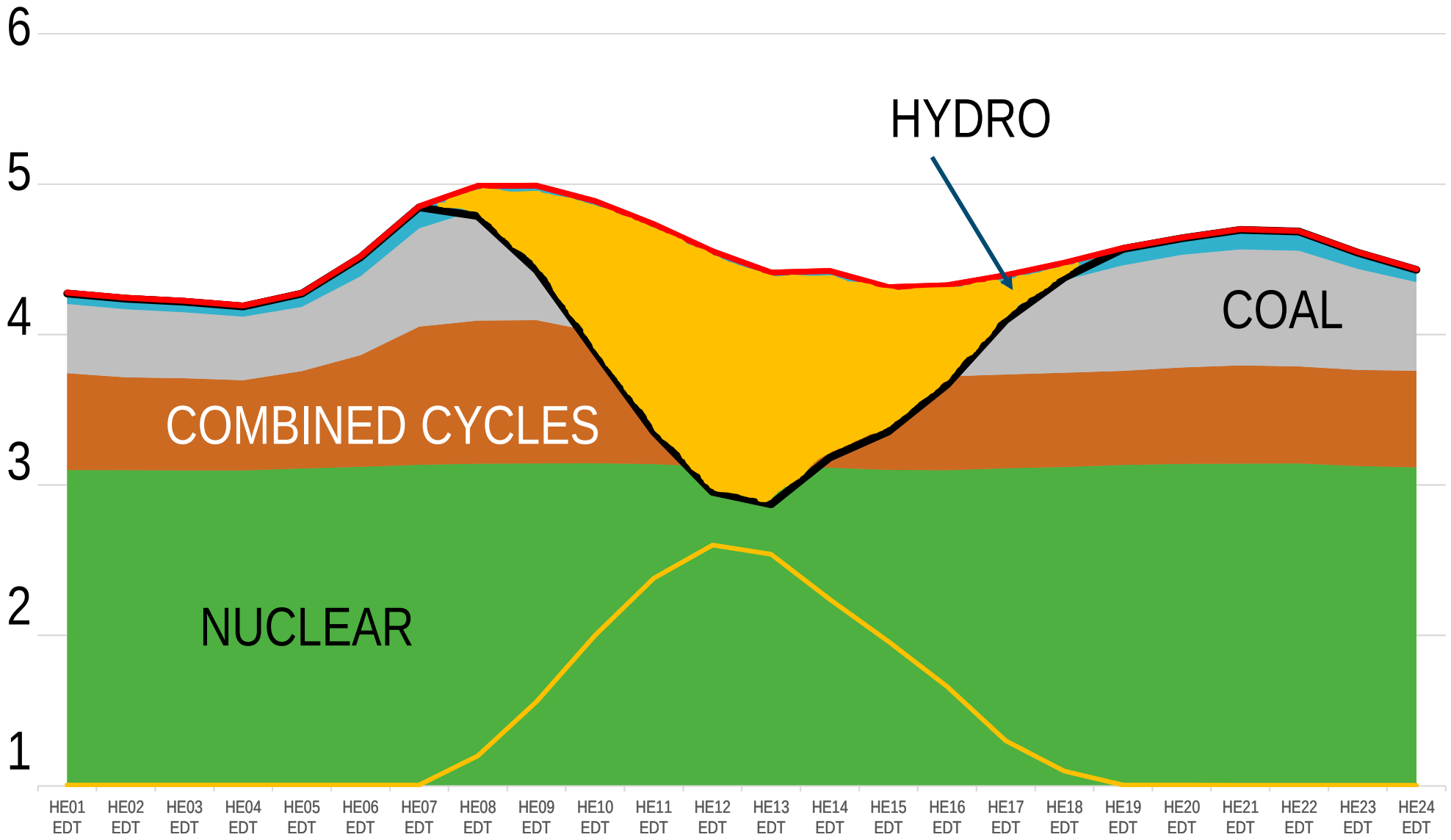
Comparison of Demand by season



Solar Impacts – High Demand Summer Day

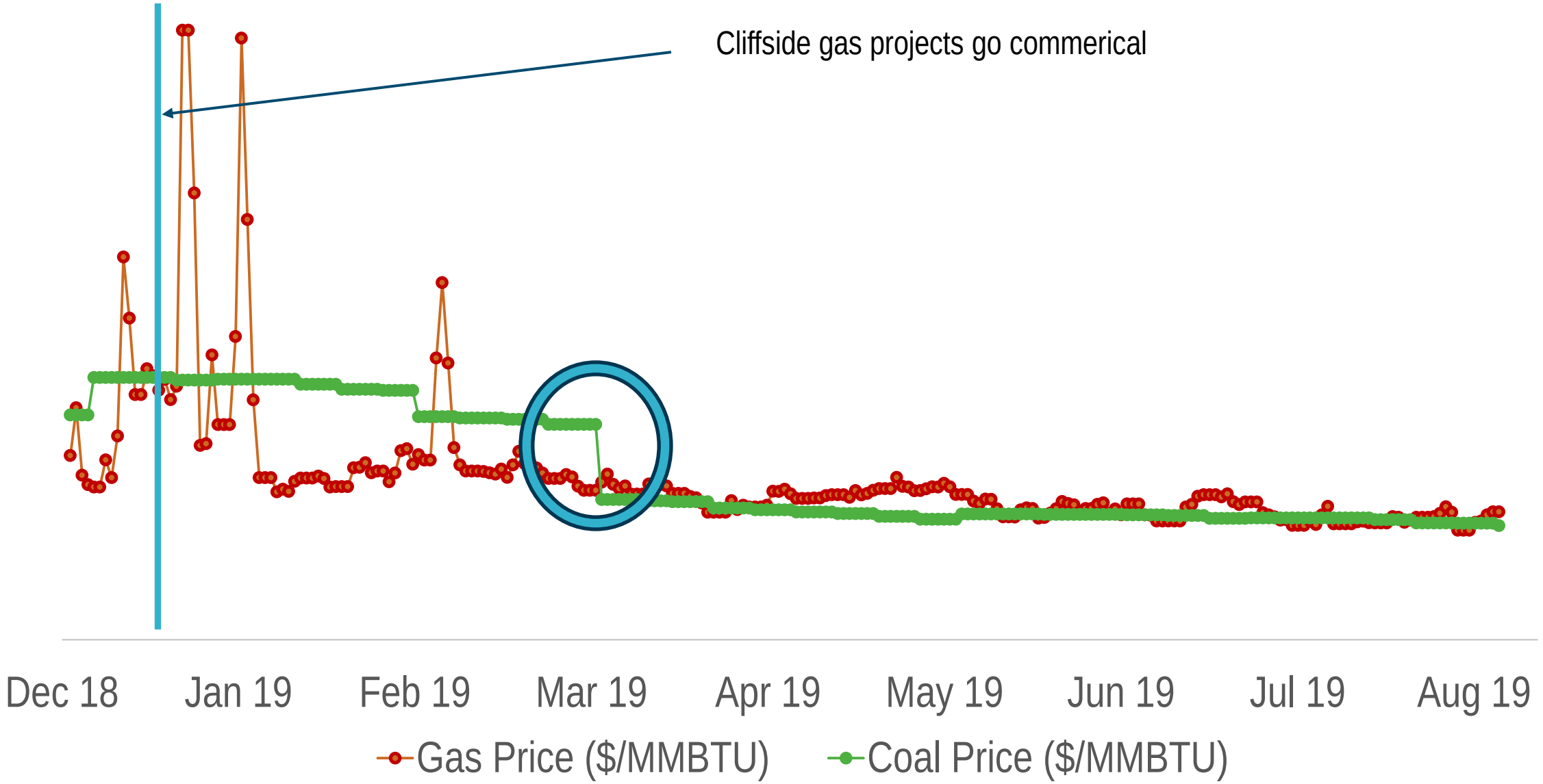


Solar Impacts – Low Demand Spring Day



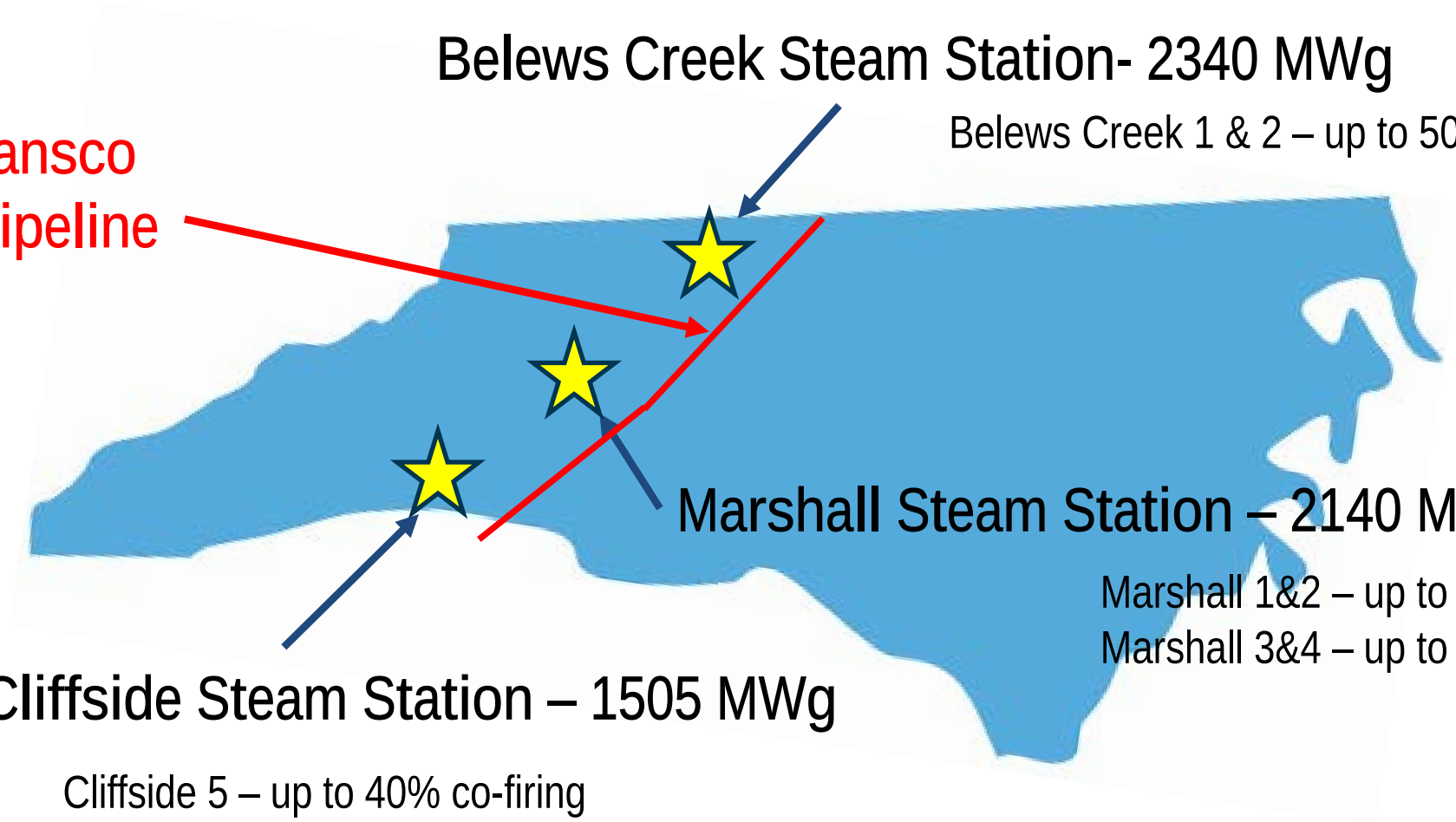
Duke Energy Announces: Net Zero CO_2 by 2050

Delivering Customer Savings




AGENDA
✓ SHEEN Moment
✓ What is DFO / Co-firing?
✓ The Why at Duke Energy?
❑ The Where at Duke Energy
❑ Program History
❑ The How at Duke Energy
❑ Program Status

Where Gas Co-firing at Duke Energy



Belews Creek Steam Station- 2340 MWg

Belews Creek 1 & 2 – up to 50% co-firing each

Williams Transco
Interstate Pipeline

Marshall Steam Station – 2140 MWg

Marshall 1&2 – up to 40% co-firing each
Marshall 3&4 – up to 50% co-firing each

Cliffside Steam Station – 1505 MWg

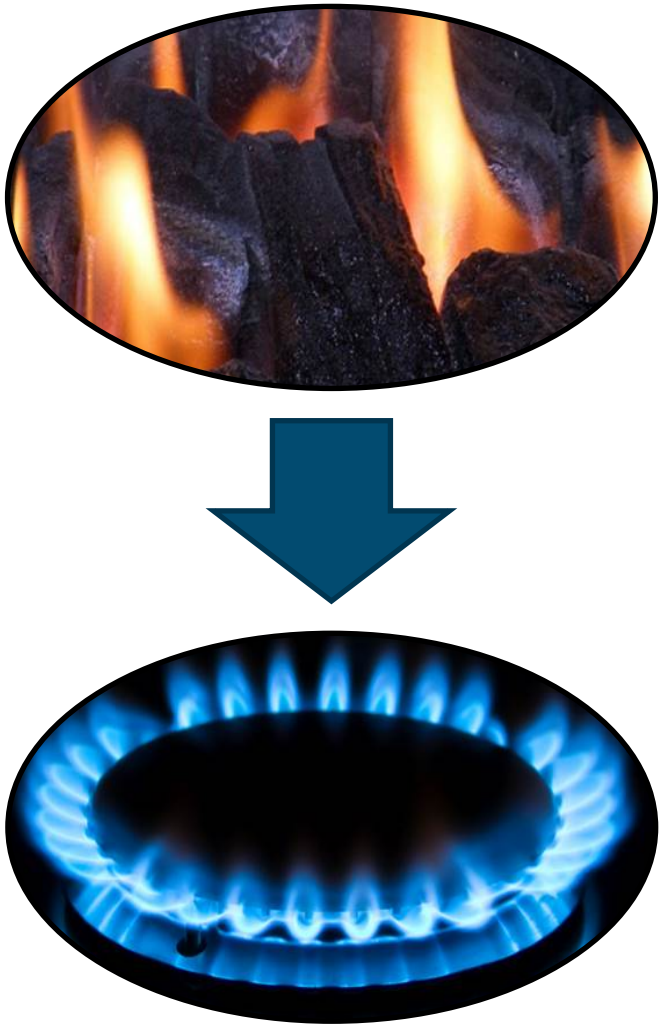
Cliffside 5 – up to 40% co-firing
Cliffside 6 – 100% Dual Fuel

Program History

2015

Company begins to plan response to Clean Power Plan legislation

- Evaluated multiple scenarios of adding or converting coal plans to gas
- Solicited budgetary costs from gas suppliers and boiler OEM's for financial screening
- Developed list of high potential sites for potential gas co-firing projects

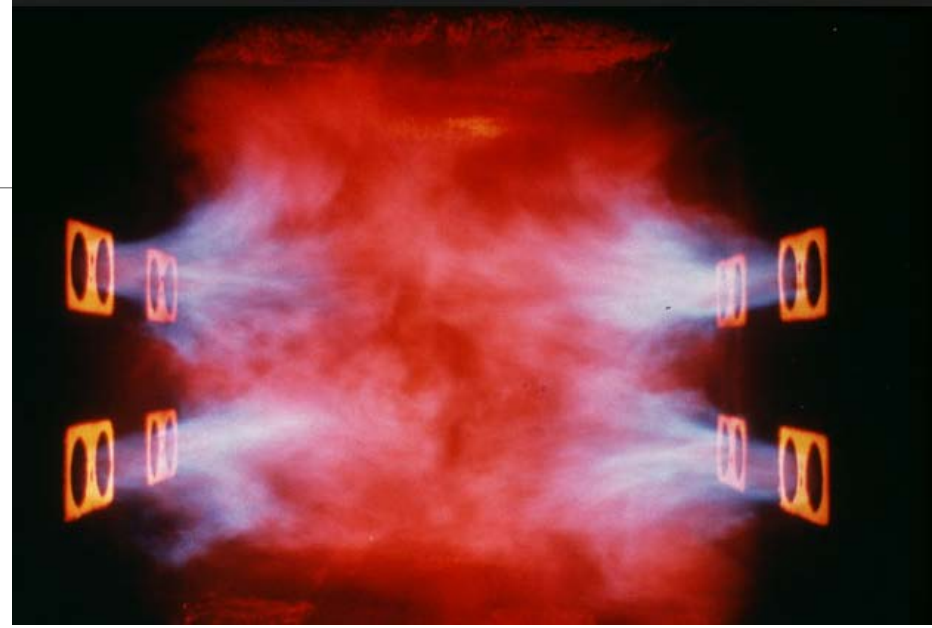


2016

Cliffside site selected to be first project developed.

- Received approval in July to proceed
- Engineering began in August
- Burner supplier selected in Nov

Program History - continued



2017

- Cliffside project engineering continues
- Further review of high potential sites
  - Narrowed down to Belews Creek and Marshall
- Projects at Belews Creek and Marshall developed further
  - Received approval for Belews Creek in Aug
  - Belews Creek engineering began in Sept
  - Received approval for Marshall in Dec

2018

- Cliffside construction begins in March
- Cliffside units put in service Nov (Unit 5) and Dec (Unit 6)
- Belews Creek engineering continues
- Marshall engineering begins in January and continues

Gas Co-firing Projects 2019 Status

- Cliffside Steam Station
  - Unit 5 and Unit 6 in Service Q4 2018
  - Finished commissioning Q1 2019
- Marshall Steam Station
  - Engineering complete Q2 2019
  - Construction to start late Q3 2019
  - First unit target in service Q3 2020
- Belews Creek Steam Station
  - Engineering complete Q1 2019
  - Construction to start early Q2 2019
  - First unit target in service Q1 2020


AGENDA
✓ SHEEN Moment
✓ What is DFO / Co-firing?
✓ The Why at Duke Energy?
✓ The Where at Duke Energy
✓ Program History
❑ The How at Duke Energy
❑ Program Status

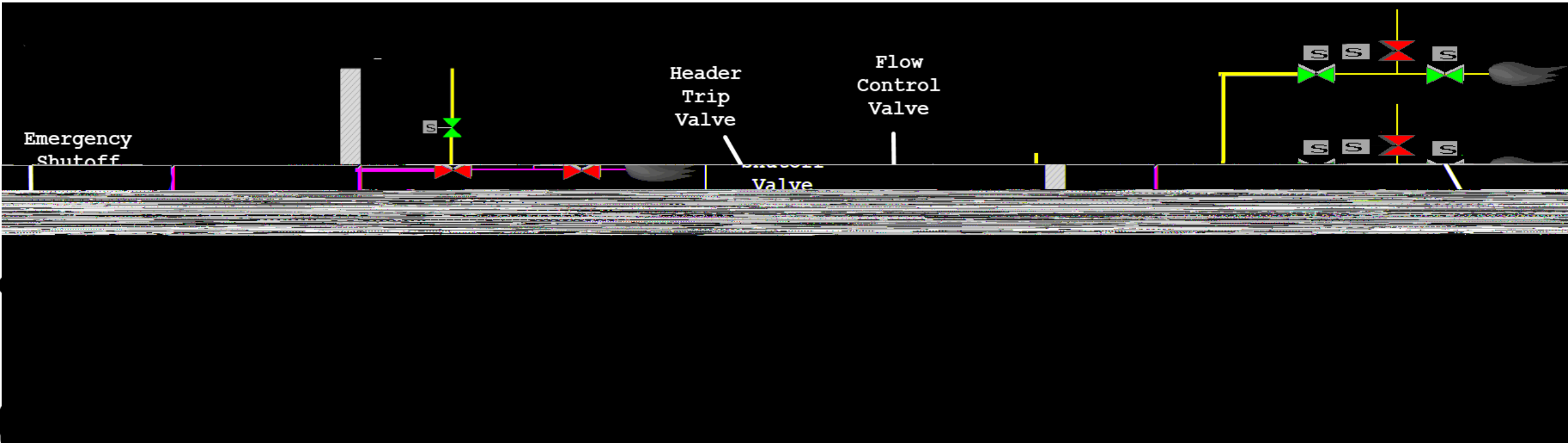
Site Project Details

Unit	Boiler Style	# Coal Brnrs	MW Capacity	Co-fire Ratio	# Gas Burners
Cliffside 5	4 corner T-fired Sub-Critical	24	600	40%	16
Cliffside 6	Wall Fired Super Critical	30	905	100%	30
Belews Creek 1 & 2	Wall Fired Super Critical	80	1170	50%	32
Marshall 1 & 2	8 corner T-fired Sub-Critical	40	370	40%	16
Marshall 3 & 4	8 corner T-fired Super Critical	48	670	50%	16

The co-fire ratio was determined through financial and production cost modeling efforts to balance the cost of construction (includes constructability), cost of gas supply, future cost of coal and gas commodity, future generation forecasts working to maximize customer benefits.

The co-fire ratio shown was determined to be the best scenario of those evaluated at the various sites

Gas Process Overview



T-Fired Concept

Wafer Style Gas Burners Located in Auxiliary Air Ports between coal burners

High Energy Spark Ignition of Main Gas burner

Wall Fired Concept

Cane style gas burners installed in periphery around coal burner

High Energy Spark Ignitor on Main Gas burner

Main Gas Burner built with retract mechanism

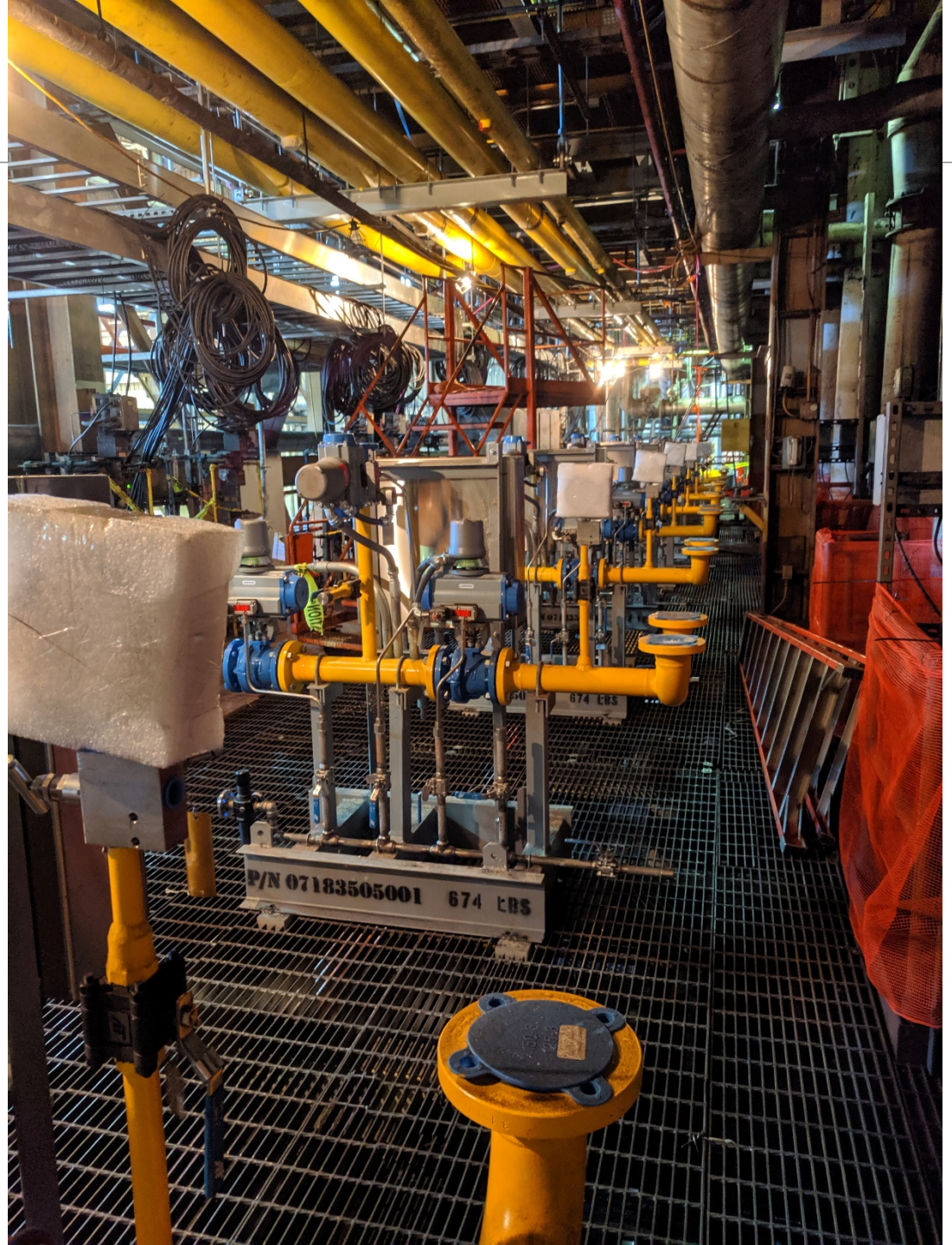
Construction Photos from Belews Creek

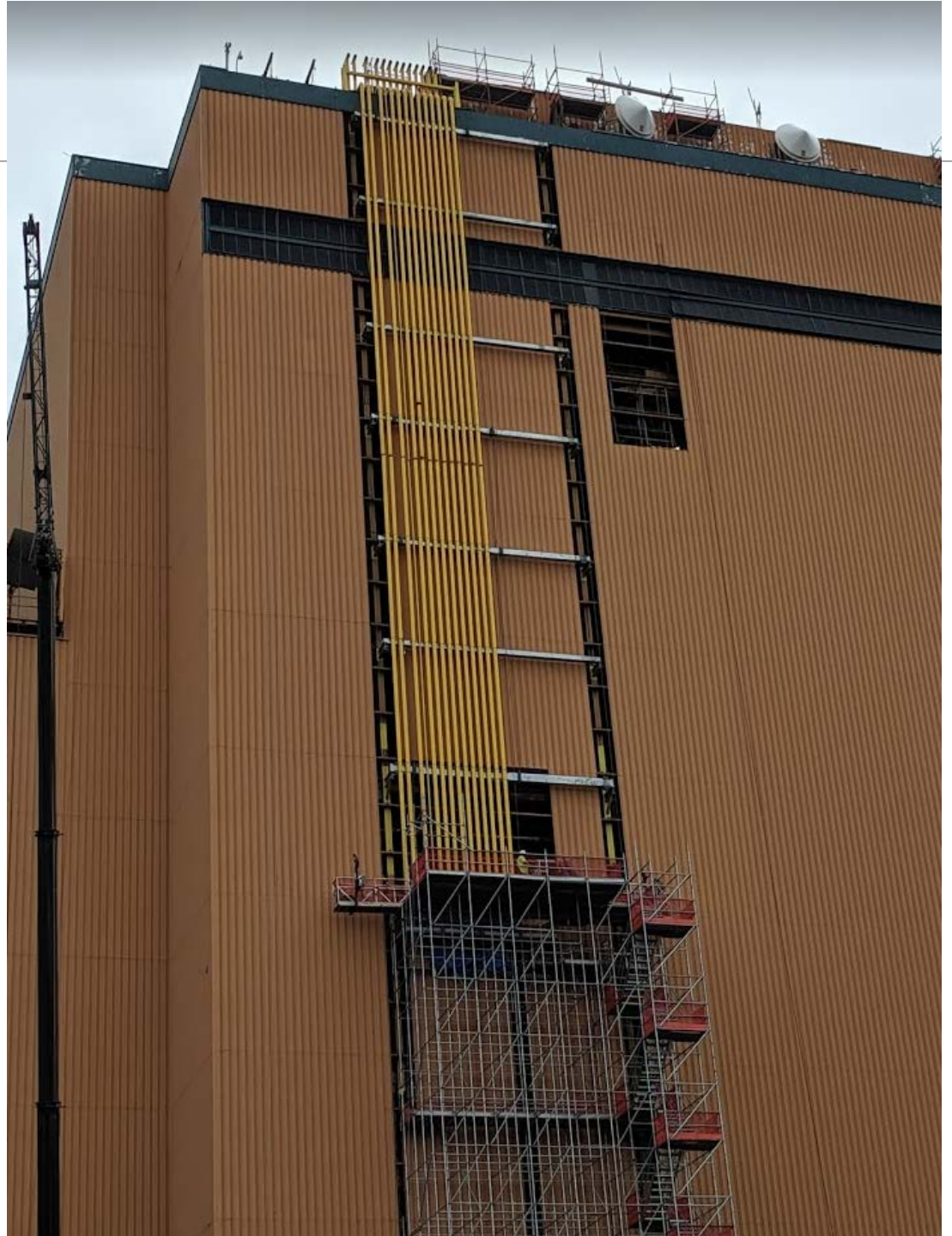

CAT


STOP
THE
DROP
20
MINUTES
20
SECONDS


GRAYBAR
WILLSCOT


7 1/2 TON CA
2800 LBS


P/N 0718350500I 674 EBS




DUKE
ENERGY®