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Reducing Electrical Energy Usage during Curing with a Variable Frequency Drive

51st Tobacco Workers' Conference

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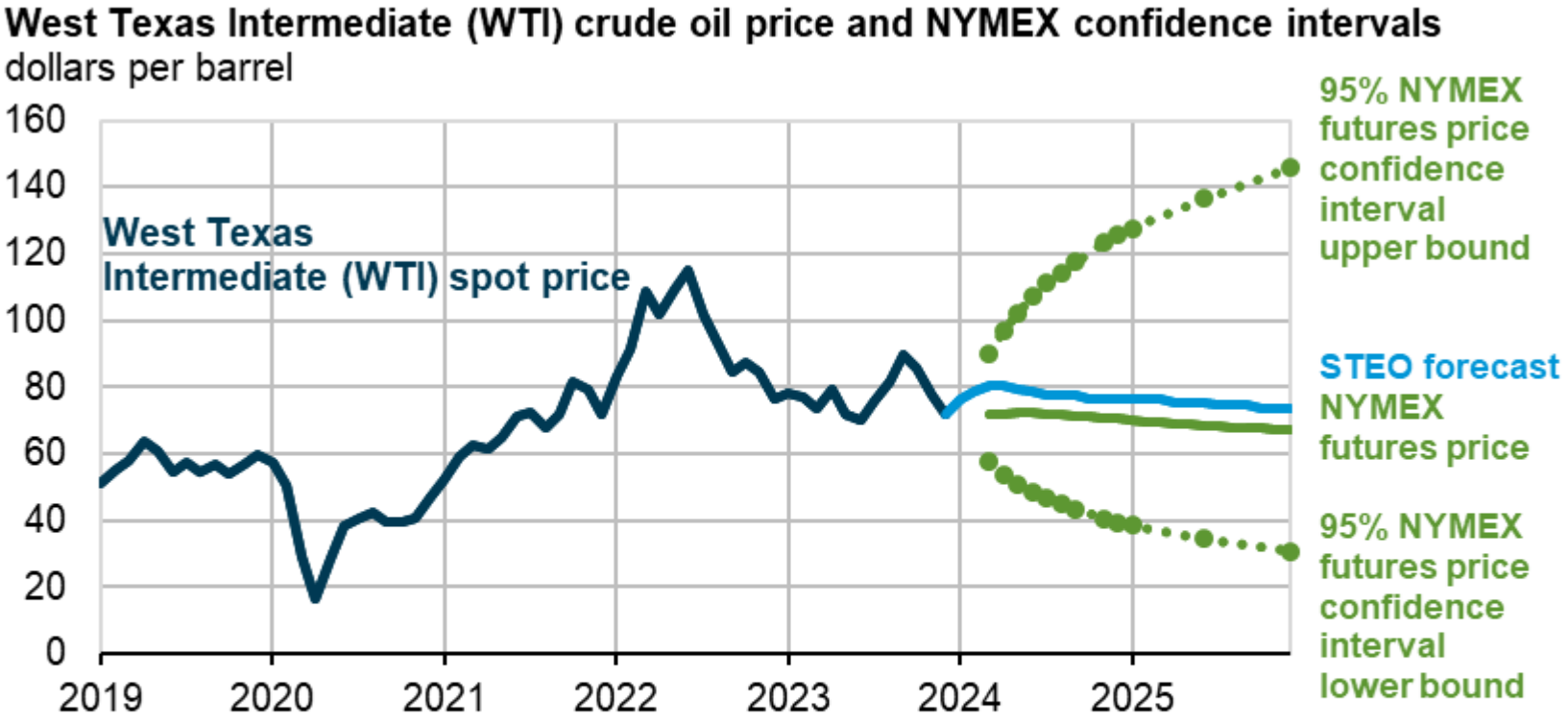
U.S. EIA Short-Term Energy Outlook
(Crude Oil)

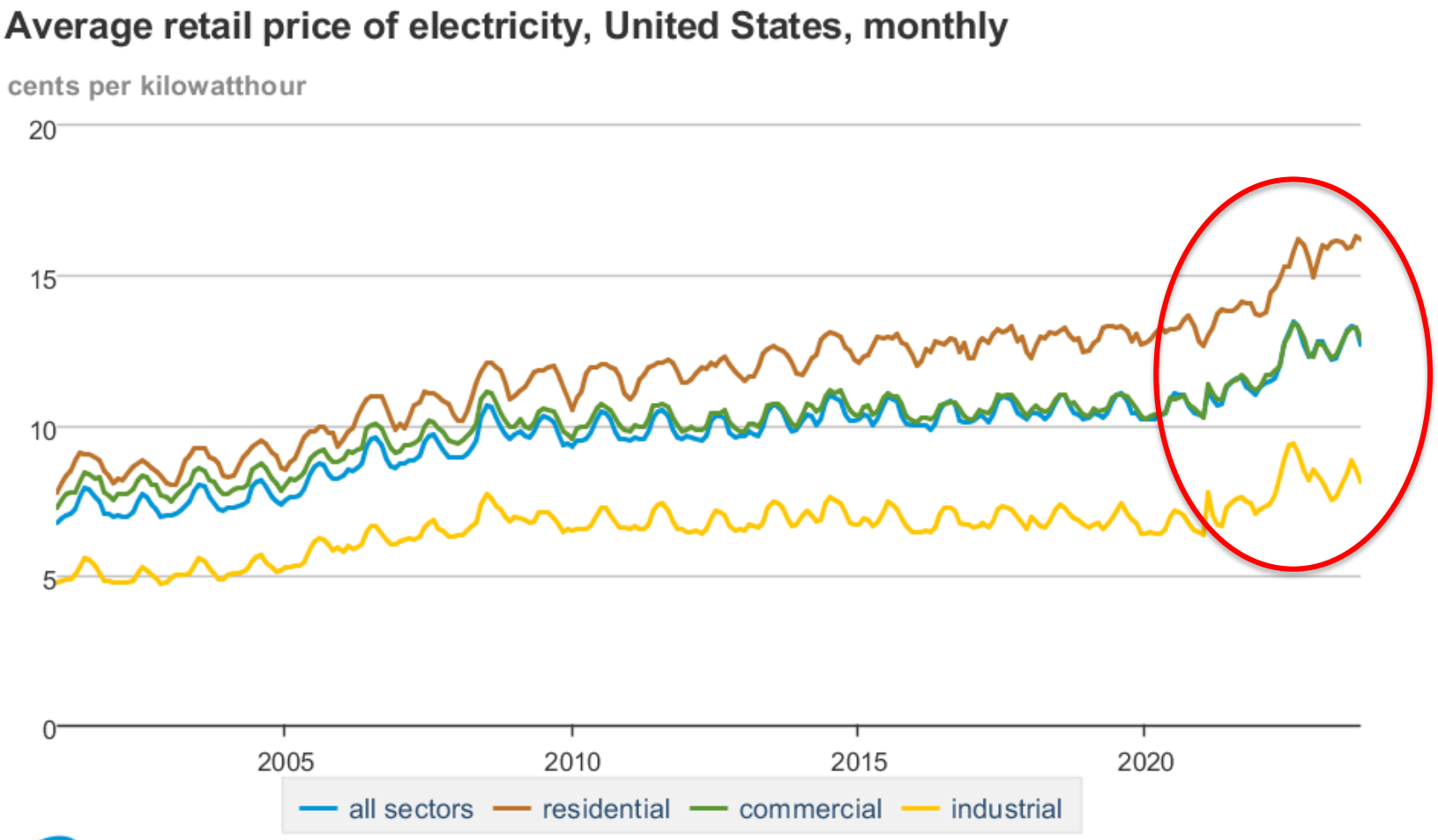


Data source: U.S. Energy Information Administration, Short-Term Energy Outlook, January 2024, CME Group, Bloomberg, L.P., and Refinitiv an LSEG Business

Note: Confidence interval derived from options market information for the five trading days ending January 4, 2024. Intervals not calculated for months with sparse trading in near-the-money options contracts.

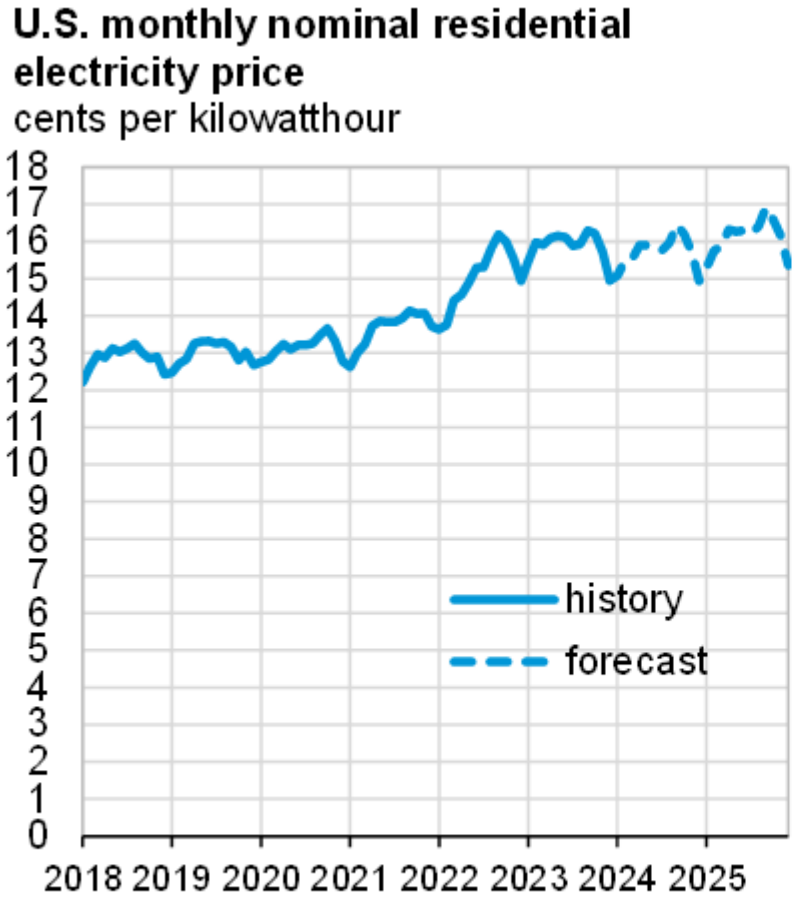
eia

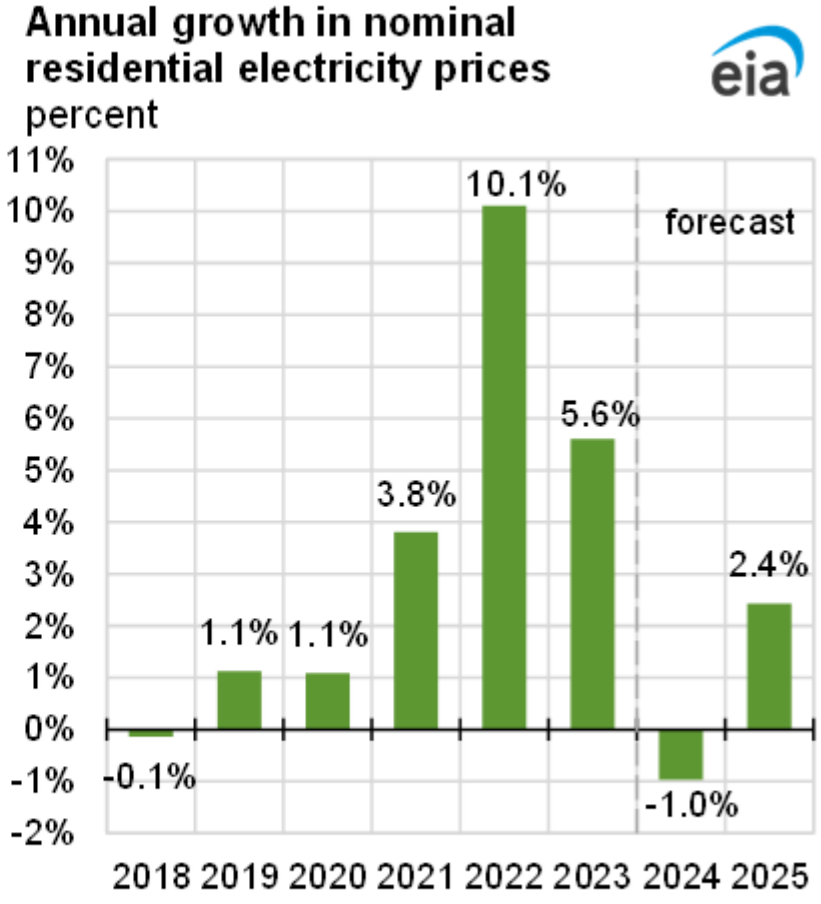
U.S. Average Electricity Cost



¢/kWh

U.S. Average Electricity Cost – cont.





Data source: U.S. Energy Information Administration, Short-Term Energy Outlook, January 2024

Total Curing Energy Usage, Wilson County 2023

(Long 10-box, 10 hp fan; $1.00/gal, 13¢/kWh)

Cure	LPG (gal)	Heating Cost ($)	Electricity (kWh)	Electrical Cost ($)	Total Energy Cost ($)
1	315	315	1,699	221	
2	290	290	1,651	215	
3	241	241	1,513	197	
4	266	266	1,520	198	
5	285	285	1,530	199	
6	299	299	1,574	205	
7	274	274	1,503	195	
8	285	285	1,306	170	
9	323	323	1,513	197	
	2,578 (235.92 MMBTU)	***$2,578***	***13,806 (47.11 MMBTU)***	***$1,795***	***$4,373 (283.03 MMBTU)***

Fan Electrical Energy is approximately <u>17% of Total Energy</u>, but approximately <u>41% of Total Costs</u>

Variable Frequency Drives (VFDs)

- VFD technology is utilized to change the speed of an electric motor
- Strategically decrease fan speed during curing to reduce electrical energy usage
- VFD output is always 3-phase power
- Electrical energy rates vary across NC (*$0.09 to $0.14 per kWh)*
- Duke Energy rates will increase 15% - 20% from 2023 to 2025
- Cured leaf quality benefits from reduced fan speed and CFM output during yellowing?
- Soft start limits in-rush of current during fan motor startup
  - *Extend motor life*
  - *Reduced generator capacity required per barn*
  - *Decreased demand charge during peak hours of electrical consumption?*

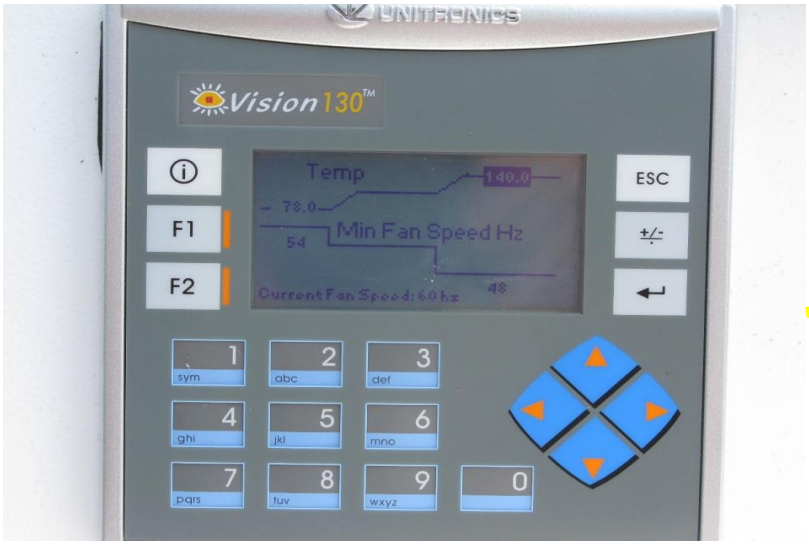
Fan Motor Speed and Power Reduction

Motor Frequency (Hz)	Fan Speed (RPM)	Speed Reduction (%)	Power Reduction (%)
60	1750	0	0
57	1663	5	14
54	1575	10	27
50	1458	17	42
48	1400	20	49
45	1313	25	58
42	1225	30	66

On-farm VFD Evaluation

- Past studies investigated reducing the fan output during the stem drying phase
  - *fan was cycled ON / OFF during stem drying*
  - *curing time and cured leaf quality did not change*
  - *Utility companies interested in reducing peak demand during summer months*
- VFD technology was utilized to change the speed of the fan electric motor (2010 – 2012) at multiple locations
- Strategically decrease the fan speed during curing to reduce electrical energy usage
- kWh and fuel consumption monitored

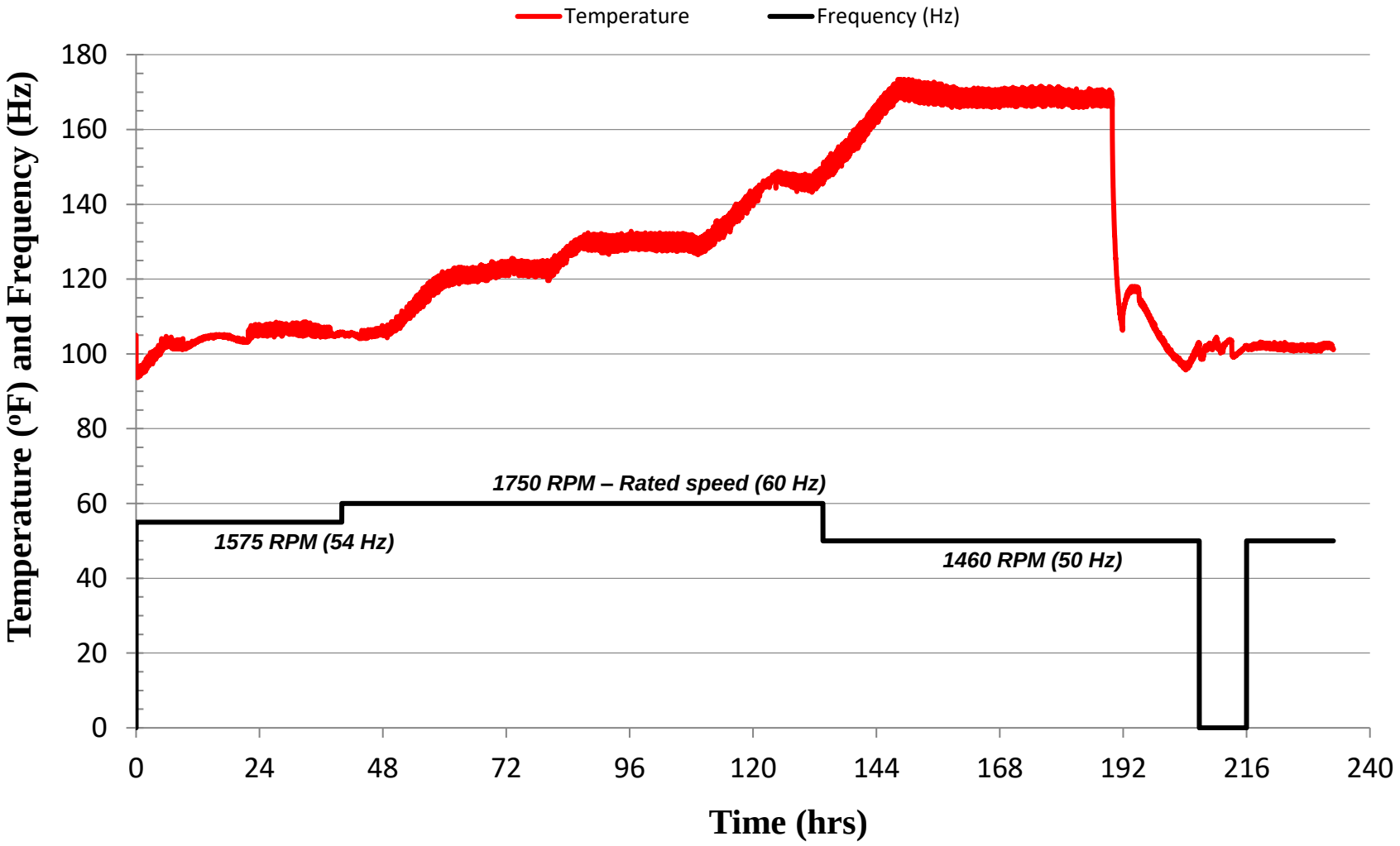
2010 – 2012 VFD System



PLC Utilized to Automate the Change in Fan Speed

Temperature and Fan Speed Profiles

(Cure 2, Wilson County – 2011)

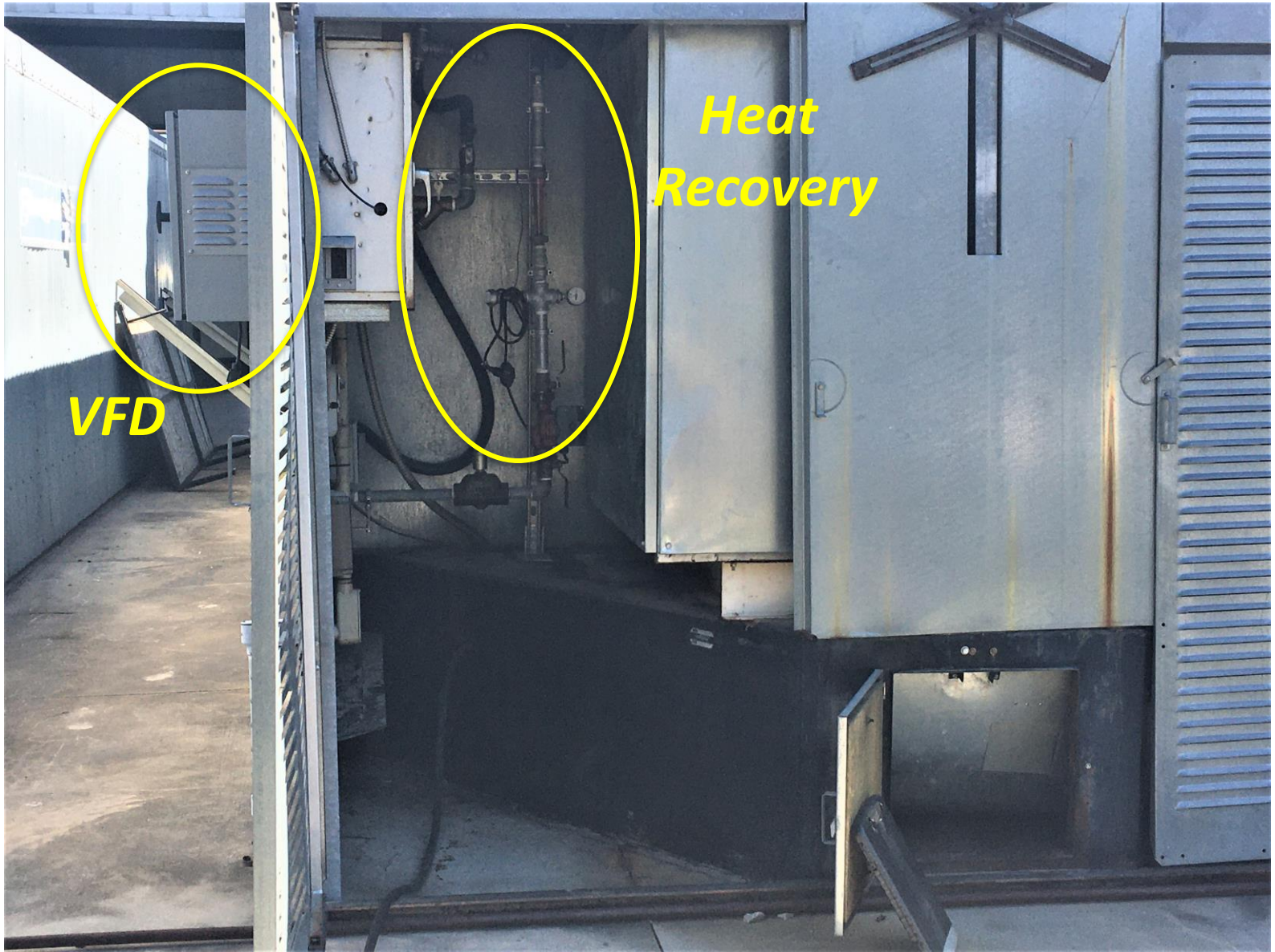


Electrical Energy Summary – 2011

Location	*Motor Hp and Phase*	*# of Cures @ Reduced Speed*	*AVG. kWh*		*AVG. Savings*		
			Check	*VFD*	*kWh*	*%*	**$*
Harnett	10, 1-phase	7	1745	1391	354	20	42
Wilson	10, 3-phase	4	1596	1312	284	16	34
Johnston	10, 3-phase	4	1872	1553	347	19	42

** 0.12 / kWh*

Wilson County Location, 2023



VFD System Results – Wilson County, 2023

Cure	Green Wt. (lb)	Cured Wt. (lb)	LPG (gal)	Energy (kWh)	(kWh)	% (kWh)
			Combined Systems - Barn 50			
*1	18,000	2,010	321	1,738	-39	-2.29
2	18,000	2,400	318	1,665	-14	-0.87
3	20,000	3,460	255	1,514	-2	-0.10
4	20,000	3,600	263	1,541	-22	-1.43
5	22,000	3,270	277	1,440	90	5.90
6	24,000	3,950	274	1,489	85	5.40
7	24,000	3,870	290	1,258	244	16.27
8	24,000	3,970	323	1,182	124	9.49
9	24,000	4,210	367	1,411	102	6.72
		Total (gal)	***1,532***	***Avg. Savings***	***129***	***8.8***
		Total (kWh)	***6,780***			
			Control - Barn 49			
*1	18,000	1,940	315	1,699		
2	18,000	2,440	290	1,651		
3	20,000	3,690	241	1,513		
4	20,000	3,500	266	1,520		
5	22,000	3,370	285	1,530		
6	24,000	4,210	299	1,574		
7	24,000	4,480	274	1,503		
8	24,000	3,930	285	1,306		
9	24,000	4,390	323	1,513		
** = Baseline*		***Total (gal)***	***1,466***			
		Total (kWh)	***7,425***	***Avg. (kWh)***	***1534***	

2023 VFD Application Summary

- No decrease in cured leaf quality observed
- Curing time was not extended with fan speed reduction
- Limited time at reduced speed due to heat recovery system
- Maximum electrical energy savings was approximately 16%
  - *32% (545 kWh), 2011*
- Savings will vary with electrical cost ($/kWh) and fan motor size
- VFD cost is approximately $1,200 per barn for 10 hp fan motor
  - *@ 20% (300 kWh), 14¢/kWh, 3 to 4 year payback*
- Electrical energy cost are going to increase
- On-farm evaluation will continue in 2024

Acknowledgements

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