Appendix A

Standalone Memo Refinery Electrification

Subject: Technical and Cost Barriers to Electrification – Illustrative Case Study

Overview

This memorandum provides an illustrative example of the complexity and cost associated with attempting to electrify even relatively low-temperature refinery equipment. The purpose is to demonstrate why electrification, while often discussed as a decarbonization pathway, presents significant technical and economic barriers that cannot be overlooked when evaluating policy options for emissions-intensive, trade-exposed industries (EITEs).

Case Study Example

Within the last few years, one facility conducted a screening exercise to identify potential “low-hanging fruit” opportunities to replace steam-based heating with electric heating. A heat exchanger was identified as a potential candidate for a straightforward conversion.

- The exchanger was a modest unit (~9 MMBtu/hr duty) with a relatively low steam requirement.
- Because it operated at lower temperatures and only performed sensible heat duty (no vaporization), it appeared to be a good test case for electrification.
- The initial concept was to remove the existing tube bundle and replace it with an approximately 2.7 MW electric heating element while retaining the existing shell, with the expectation that this would keep costs down.

In practice, the retrofit proved infeasible. The number and size of the required electric rods made the bundle unable to fit within the existing shell due to required rod spacing to address electrical impendence concerns. This requirement dictated an increase in the shell to effectively double its original size and weight then creating both structural concerns and significant piping rework to proceed.

The redesign dramatically increased the overall cost of conversion — more than 300 percent above the original estimate. This outcome occurred despite the fact that this was considered one of the “simpler” and lower-temperature electrification opportunities available. This project is estimated to deliver a value in the range of $400–$600 per metric ton of CO_2 reduced. However, it should be noted that the realized value depends on where within the steam system boiler network the project is implemented. In some cases, the benefits may be offset by how decarbonization and offsets are measured under the CCA framework, and at certain points in the system network no directly measurable reductions would occur for the refinery.

Implications

This example highlights the real-world engineering and cost challenges of electrification:

- Even relatively small, low-temperature units pose significant feasibility hurdles.
- Conversions often require major redesigns of equipment rather than simple component swaps.
- The associated costs can increase severalfold beyond initial estimates, undermining economic viability.
- Scaling such approaches to larger, higher-temperature refinery equipment would be even more complex and costly.

Conclusion

While electrification is frequently raised in policy discussions as a potential decarbonization strategy, this example demonstrates the need for caution. Technical feasibility and cost barriers remain substantial even for modest applications, and policymakers should avoid assuming rapid or low-cost electrification pathways in Washington's EITE sectors.