Making Adjustments to Survey Data When Collected Data do not Meet Expectations

Stan Kaplan, Team Leader
Electric Power Division, EIA

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Data collection for fuel consumption

- EIA collects data on fuel consumption from electric power generators. This is some of the most basic and important electric data collected and published.
- EIA collects fuel consumption (and other data) from:
  - Traditional power plants, whose only business is the production of electricity for sale on the power grid, and
  - From industrial and commercial combined heat and power (CHP) plants.

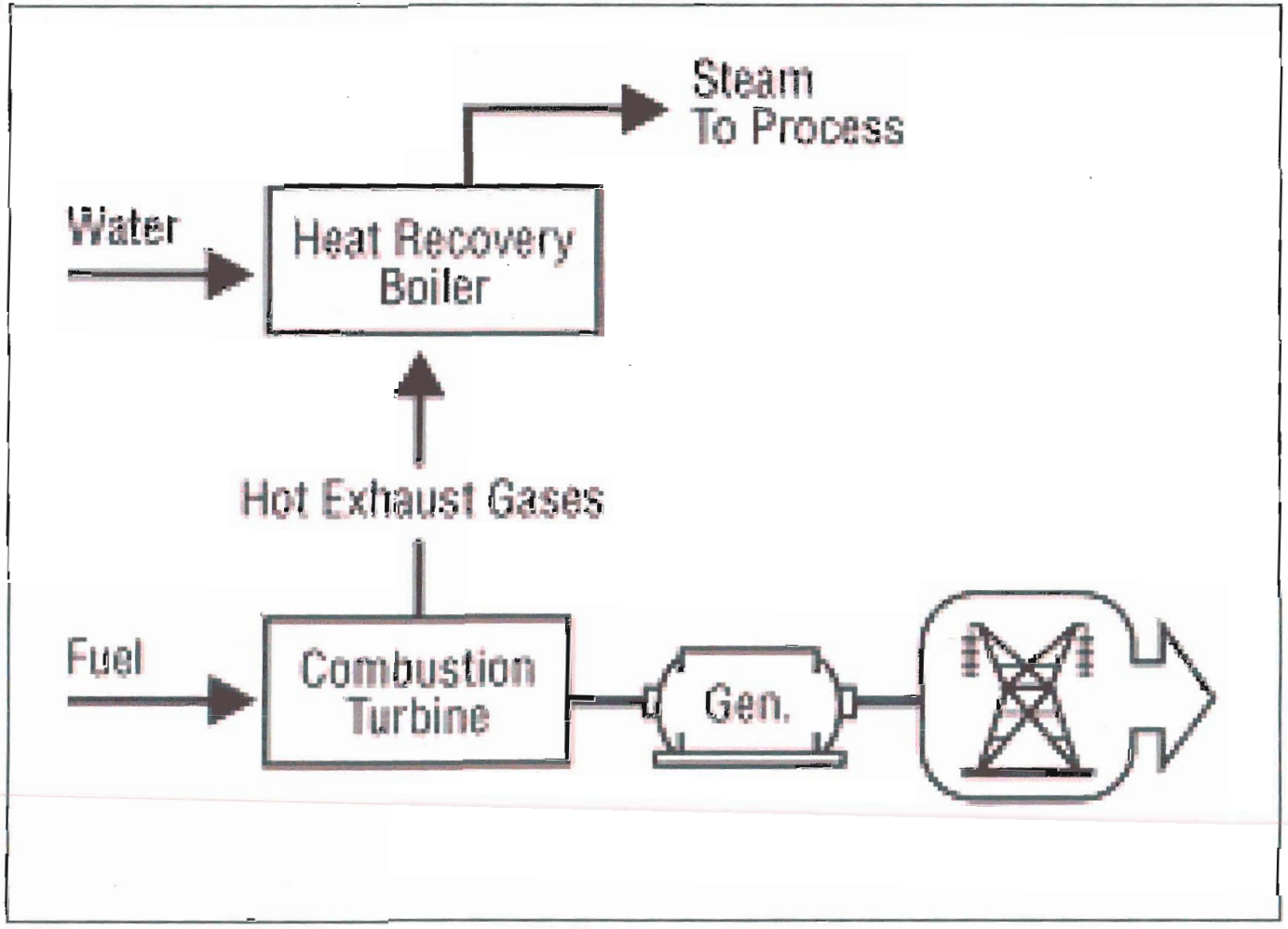
Combined Heat and Power Plants (1)

- CHP plants are typically industrial facilities whose primary business is manufacturing (e.g., paper mills, chemicals plants).
- Commercial CHP plants include universities, hospitals, other institutions, and large commercial enterprises.
- These plants produce electricity as a secondary business. The electricity they produce is largely used to meet their own needs; any excess can be sold on the grid.
- Heat for the manufacturing or commercial process is usually referred to as "process steam" or as useful thermal output (UTO).

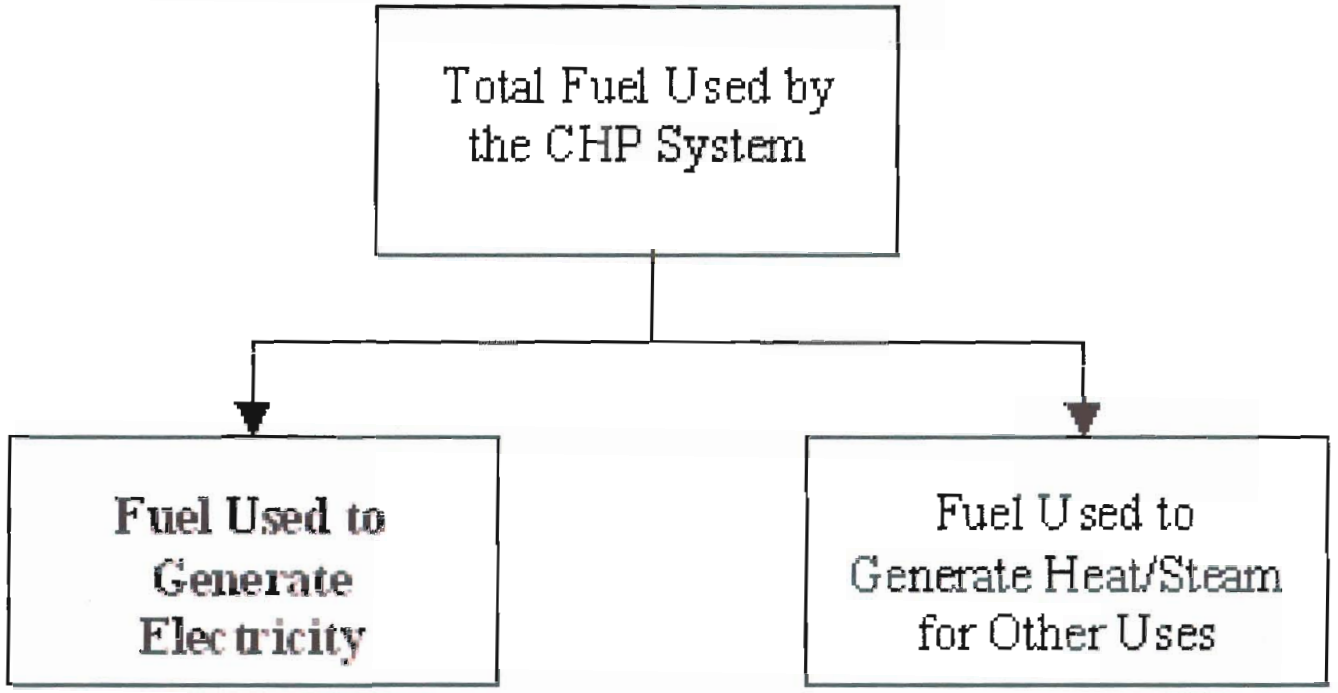
Combined Heat and Power Plants (2)

- CHP plants achieve high efficiencies by using more of the heat produced by fuel consumption than standalone power plants and factories. Heat that is wasted in conventional power plants and factories is used to make electricity or process heat in a CHP plant.

Typical CHP Plant Configuration



Allocating fuel consumption for CHP plants



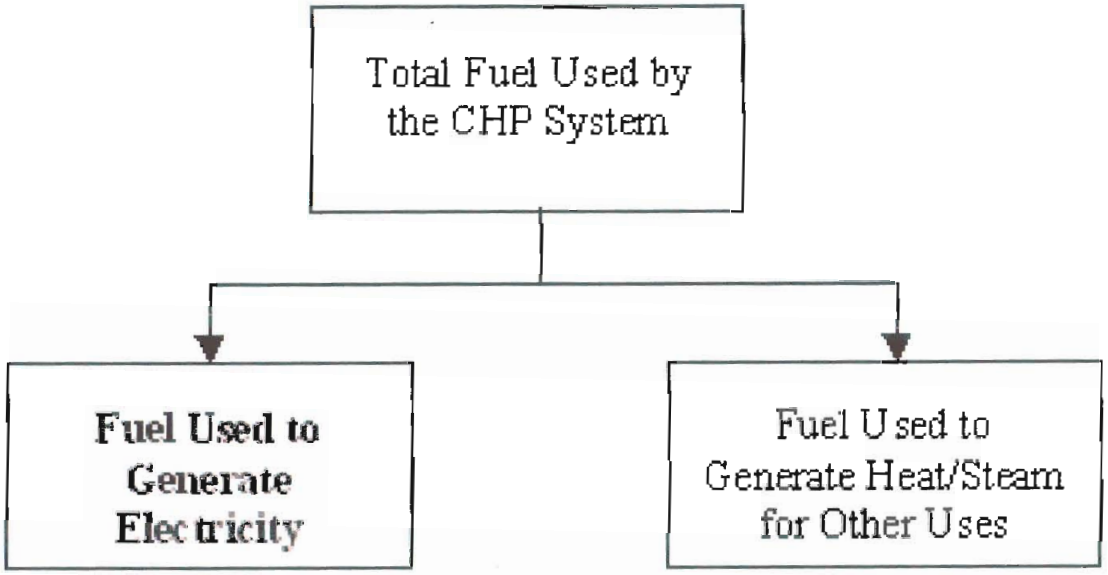
- The issue EIA has struggled with is how to collect accurate allocations of total fuel consumed between fuel used for electricity production versus fuel used to produce process heat.

Why is it difficult to collect data on fuel for electricity versus fuel for UTO?

- Collecting reasonable fuel allocations for CHP plants has been a continuing problem for two main reasons:
  - First, unlike total fuel consumption or electricity generation, most respondents are indifferent to the allocation of fuel between electricity and UTO. They do not estimate the allocation for their own purposes.
  - Second, there is no single standard methodology -- or single theoretically "correct" methodology -- for estimating the allocation of fuel.

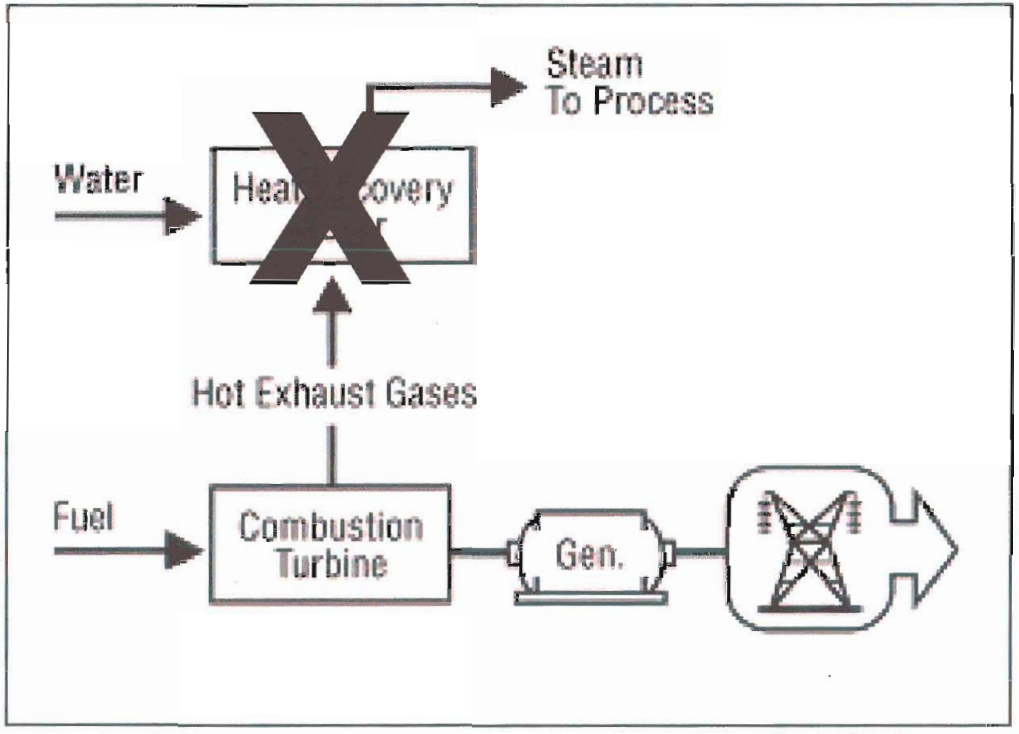
Methods for estimating the fuel allocation at CHP plants (1)

- **Compute the fuel allocation by first determining UTO**. Fuel for electricity can then be calculated as Total Fuel – Fuel for UTO.
- **Compute the fuel allocation by first determining fuel for electricity**: Once fuel for electricity is determined, fuel for UTO can be calculated as Total Fuel – Fuel for Electricity.



Methods for estimating the fuel allocation at CHP plants (2)

- *Thermal displacement.* estimate how much fuel would have been used to produce electricity (or UTO) in the absence of the CHP system, and subtract this value from the total fuel actually consumed to estimate fuel for UTO (or electricity).



Data collection approaches used by EIA (1)

- Prior to 2004, EIA used the "*Compute the fuel allocation by first determining UTO*" method. Respondents were asked to report only their UTO, and EIA made the rest of the calculations to estimate the fuel allocations.

- This method presumed that respondents had a estimate of how much UTO they produced, and that a standard combustor efficiency value of 80% could be applied to most respondents. Both of these presumptions were false, and consequently EIA had to spend a tremendous amount of time resolving survey responses that showed either improbably large or impossibly small amounts of fuel being used to produce electricity.

Data collection approaches used by EIA (2)

- Beginning with 2004 data collection, EIA adopted the "*Compute the fuel allocation by first determining fuel for electricity*" method. Respondents no longer reported UTO, just their estimate of fuel for electricity. This change in approach was based on an extensive series of interviews with respondents, discussions with industry and the ASA Energy Statistics Committee, assistance from EIA's Statistics and Methods Group, and tests of a new survey instrument (the Form EIA-920, "Combined Heat and Power Plant Report").

- The old approach asked respondents to focus on how much UTO they produced. The new approach asked respondents to focus on much fuel they used to produce electricity. The change in focus produced radically different survey results.

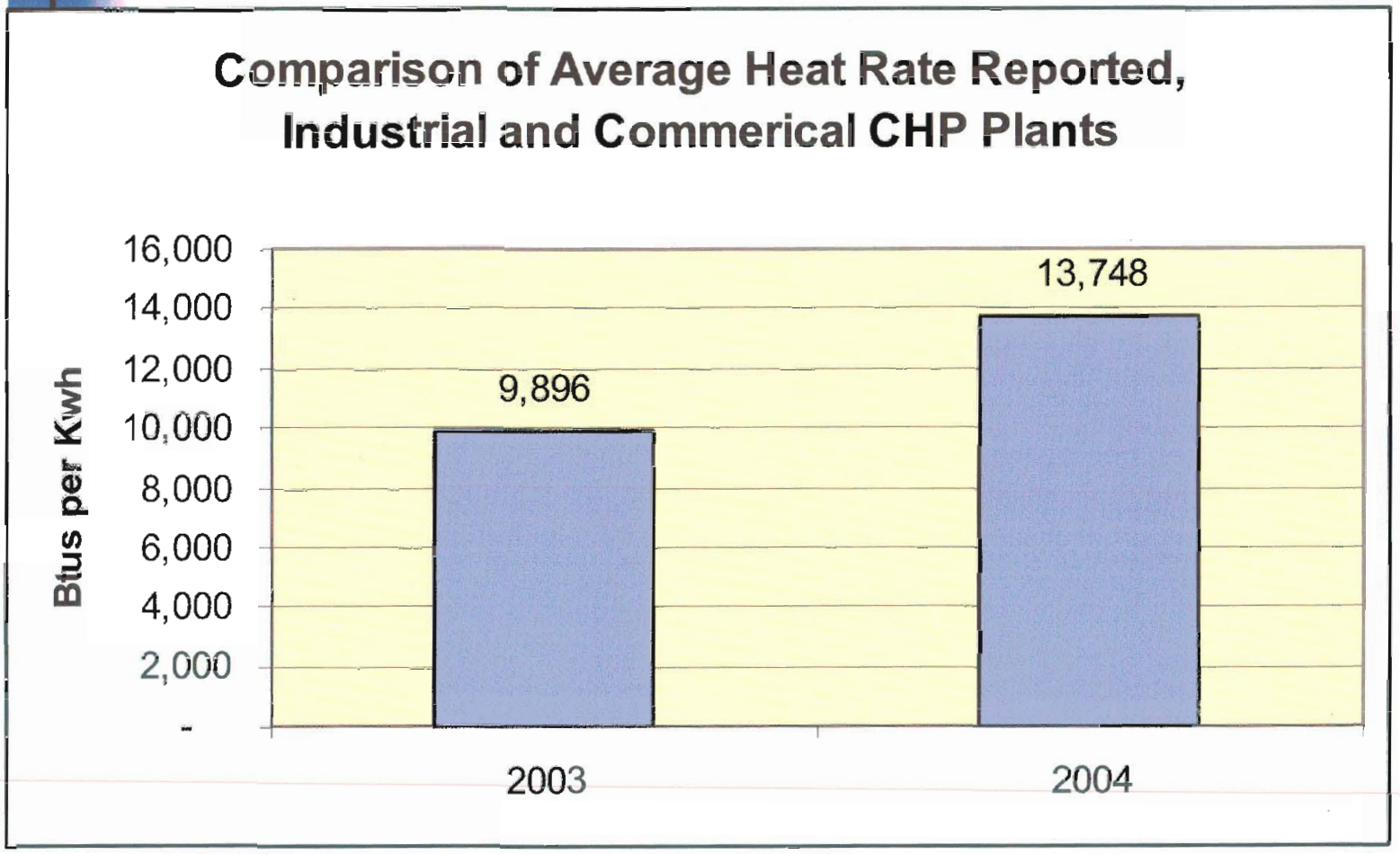
Measures of CHP Plant Efficiency

- *Heat rate*: Btus of fuel input required to produce a kilowatthour (kwh) of electricity.
- *Power to Steam Ratio (PS Ratio)*: the ratio of the heat content of electricity produced (computed as 3,412 Btus per kwh) to the heat content of the UTO produced.
- *Thermal efficiency*: ratio of the sum of the heat content of the power and steam produced to the total fuel input.

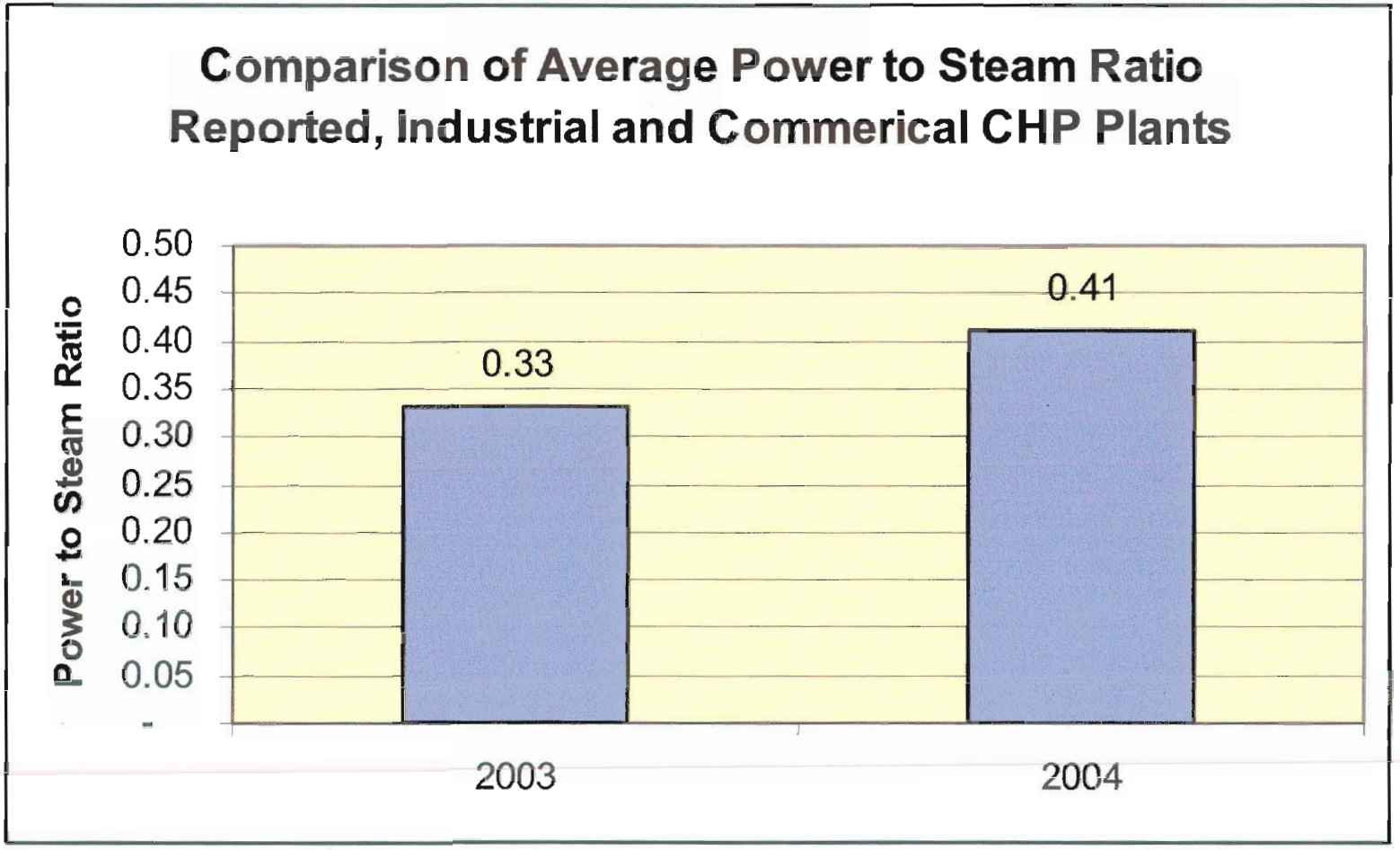
Respondents allocated much more fuel to electricity in 2004 than in 2003

- The new survey form asked respondent to focus on fuel used to produce electricity instead of the amount of UTO produced.
- Consequently, data reported for 2004 showed much more fuel allocated to electricity than in 2003 or past years. This is indicated by sharp increases in the heat rate and the power to steam ratio.
- Thermal efficiency declines because electricity production is less efficient than production of UTO, and in 2004 respondents allocated much more fuel to electricity production.

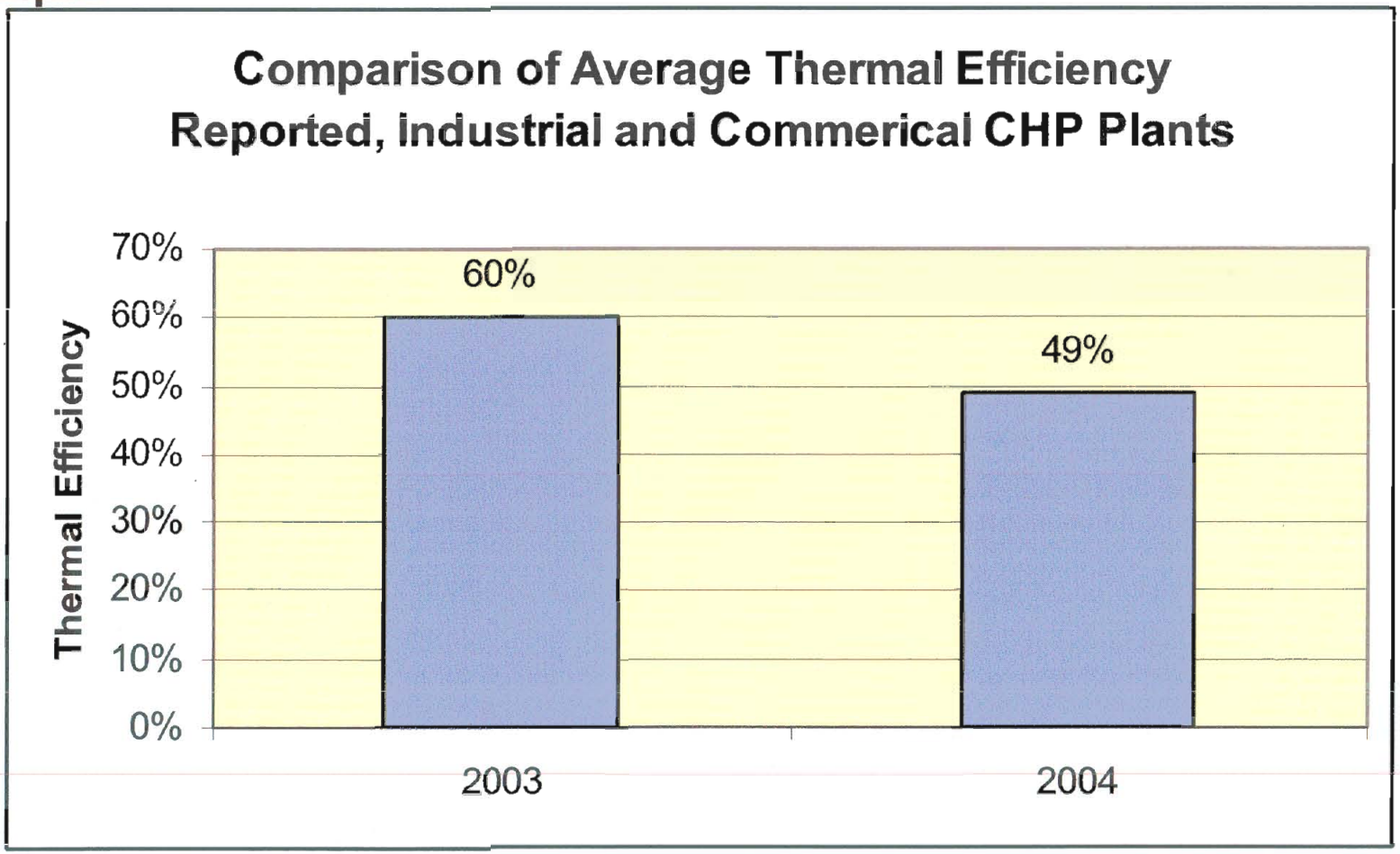
Change in Heat Rate, 2003 vs. 2004



Change in Power to Steam Ratio, 2003 vs. 2004

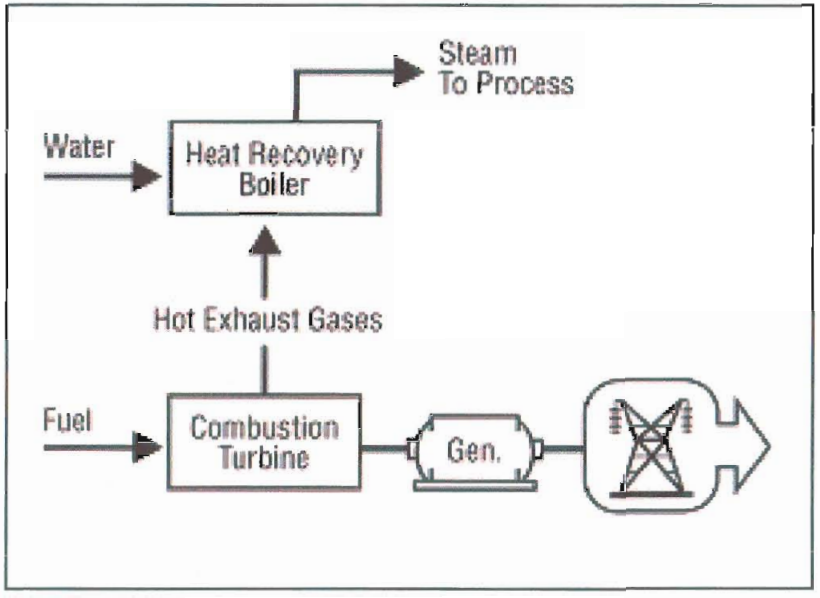


Change in Thermal Efficiency, 2003 vs. 2004



Many respondents allocated zero fuel to UTO in 2004

CHP Plant Using a Combustion Turbine



Out of 610 industrial and commercial CHP plants reporting in 2004, 177 (29 percent) reported zero fuel for UTO in 2004. All but 31 of these plants had reported UTO in 2003.

Many of these zero-UTO plants operated combustion turbines. The operators viewed the hot exhaust gases used to produce process heat as a "free" byproduct of power generation, or they believed they would have run the generator regardless of whether the industrial process had a demand for steam. In these cases the operator allocated no fuel to UTO.

The 2004 allocations of fuel for CHP plants were not credible

- The reported efficiencies were often comparable to operating stand-alone power generation and process steam plants. This defied logic since CHP plants capture more of the energy of each unit of fuel burned and therefore should be more efficient than combinations of stand-alone plants.
- Responses that showed zero fuel for UTO, although the plant produced UTO, were incorrect. The allocation must take into account the energy used to produce the process steam.
- Because of these problems the data had to be corrected, but the time and resources were unavailable to contact hundreds of respondents and assist them in changing their data. Therefore EIA needed to adjust the reported data.

Summary of the Adjustment Process

- The object was to bring the aggregate measures of efficiency for the CHP category into line with historical trends.
- We would change as little reported data as possible. Total fuel reported was never adjusted, just the allocation of fuel. Out of 610 plants 184 were adjusted.
- Each CHP plant was evaluated against a maximum acceptable value for the Power to Steam ratio, based on 2003 data. If the plant exceeded the maximum the allocation of fuel for the plant was adjusted to:
  - Match the 2003 PS ratio if that value was in the acceptable range; or.
  - Match the 2003 average for the plant type.
- Final checks made sure that the allocation did not result in impossibly low heat rates.

Adjustment process details (1)

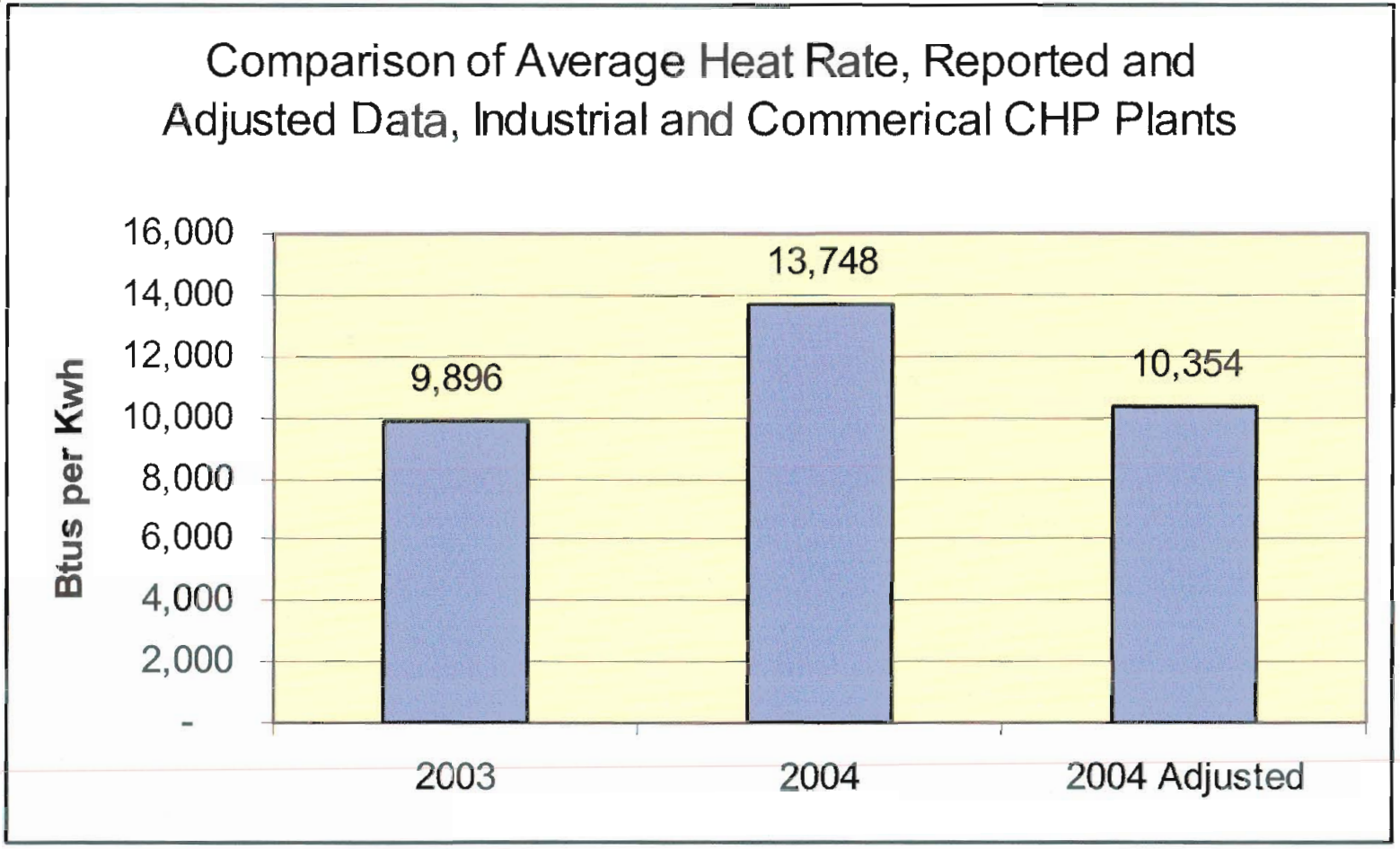
- Adjustments were made only to plants with one prime mover type, either combustion turbines or steam turbines. Plants with multiple prime mover types or plants using less common prime movers (e.g., large diesel engines) were not adjusted because it was more difficult to determine whether the reported data was bad or if the plant's configuration was the cause of unusual but accurate reporting.

- Adjustments were made only to industrial and commercial CHP plants. There is also a category of "independent power producer/CHP plants" for whom power production is the main business and the manufacturing process is a sideline. In these cases the great majority of the fuel should properly be allocated to electricity production.

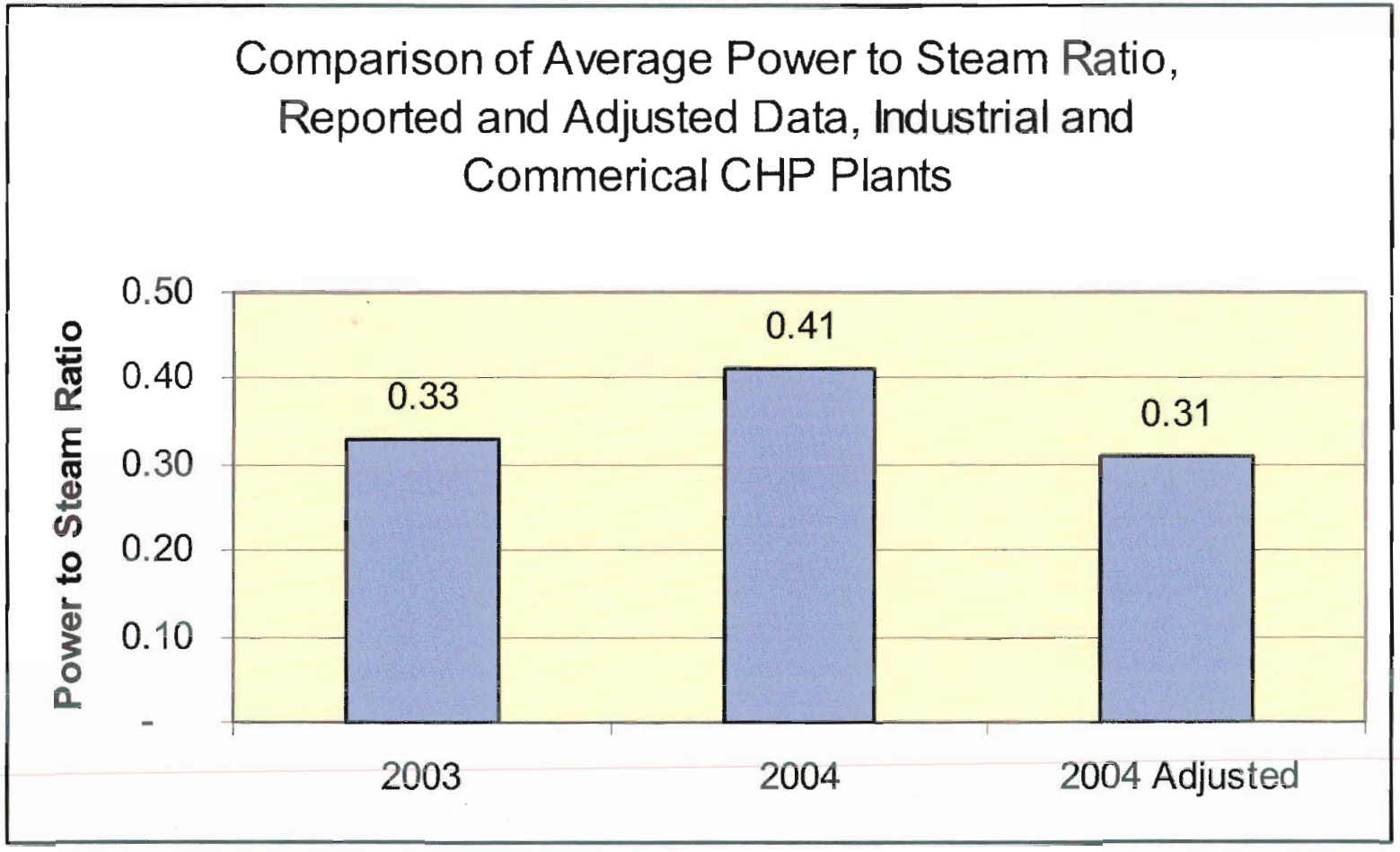
Adjustment Process Details (2)

- A maximum acceptable PS ratio was established for the two types of plants to be adjusted (steam turbine and combustion turbine plants). The maximum acceptable values selected were the 2003 national averages for each plant type
- If a plant's reported 2004 data yielded a PS ratio that exceeded the maximum acceptable values, the 2003 value for the PS ratio was substituted if that value was within the acceptable range. Otherwise, the industry-wide average for 2003 was substituted.
- Fuel for UTO was recomputed using the substituted PS ratio. The system then checked to make sure that 1) fuel for UTO did not exceed total fuel, and 2) the calculated fuel for electricity (computed as total fuel minus fuel for UTO) resulted in a heat rate of at least 5,000 Btus per kwh. If either of these criteria were violated, the system recalculated the fuel allocation to ensure that the heat rate was at least 5,000 Btus per kwh.

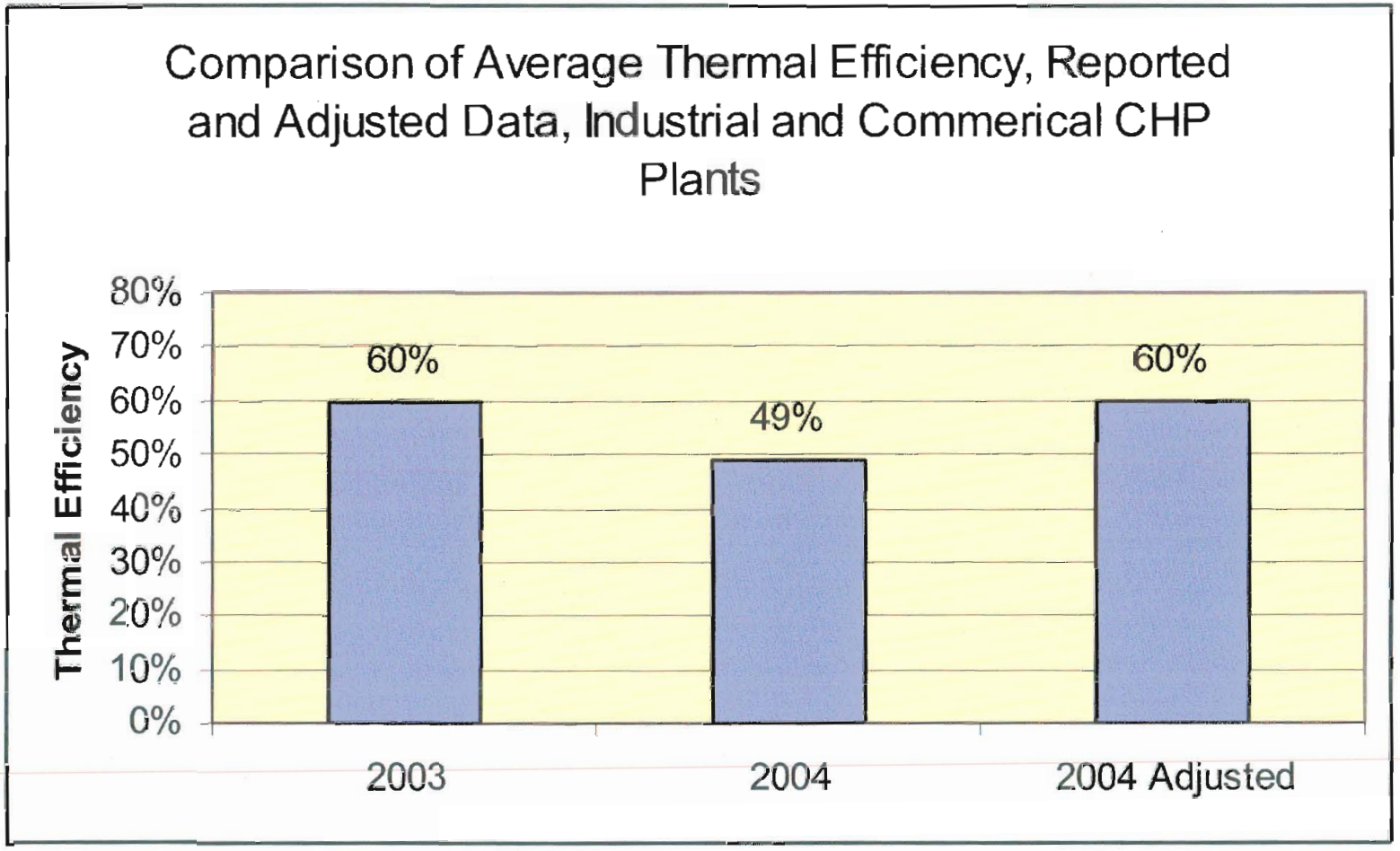
Heat Rates for Collected and Adjusted Data



Power to Steam Ratios for Collected and Adjusted Data



Thermal Efficiency for Collected and Adjusted Data



Next Steps (1)

- The data collected for 2005 is showing the same over-allocation of fuel to electricity as in 2004, and will have to be adjusted before the data is finalized later this year.

- EIA is currently testing with respondents supplemental instructions for completing the EIA-920 survey. However, issuing new instructions is unlikely to solve the problem of inconsistent and questionable data reporting.

Next Steps (2)

- The basic problems are:
  - EIA is trying to collect data – the allocation of fuel between electricity and UTO production – that is not of interest to most respondents or captured in their normal course of business.
  - There is no single standard or "correct" method for estimating the allocation of fuel.
- This is a fundamentally different problem than collecting power plant data that the operator views as an important measure of its business operations and is metered using standard procedures (such as total fuel consumed or electricity generation).

Next Steps (3)

- The new approach EIA is considering is to end the ambiguities and data gaps that have plagued its efforts to collect the allocation of fuel for CHP plants by:
  - 1) Specifying the estimation method that must be used, and
  - 2) Specifying typical values for key inputs into the method (e.g., boiler efficiency) that must be used when the respondent does not have reasonable data.

Next Steps (4)

- Two means of implementing this approach are in the earliest stages of consideration:
  - Build into the EIA's Internet Data Collection system a "CHP calculator" that the respondent would use to allocate fuel.
  - EIA would make all the estimates itself. The respondent would provide only basic operating data that can be accurately reported, such as total fuel consumed. EIA would then compute the allocation of fuel using the reported information and typical industry values.

Next Steps (5)

- Considerations in implementing these approaches include:
  - Is more research is needed into the typical ranges for key parameters, such as the PS ratio and boiler efficiency?
  - Will EIA need to collect additional information on plant configurations?
  - What is the development time and cost for implementing different approaches?
- EIA currently hopes to implement a new process for data collection starting January 2008.