



Commercial Air Conditioners and Heat Pumps

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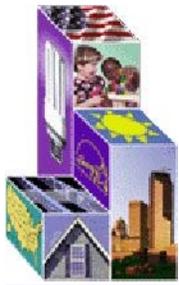
# ENGINEERING ANALYSIS

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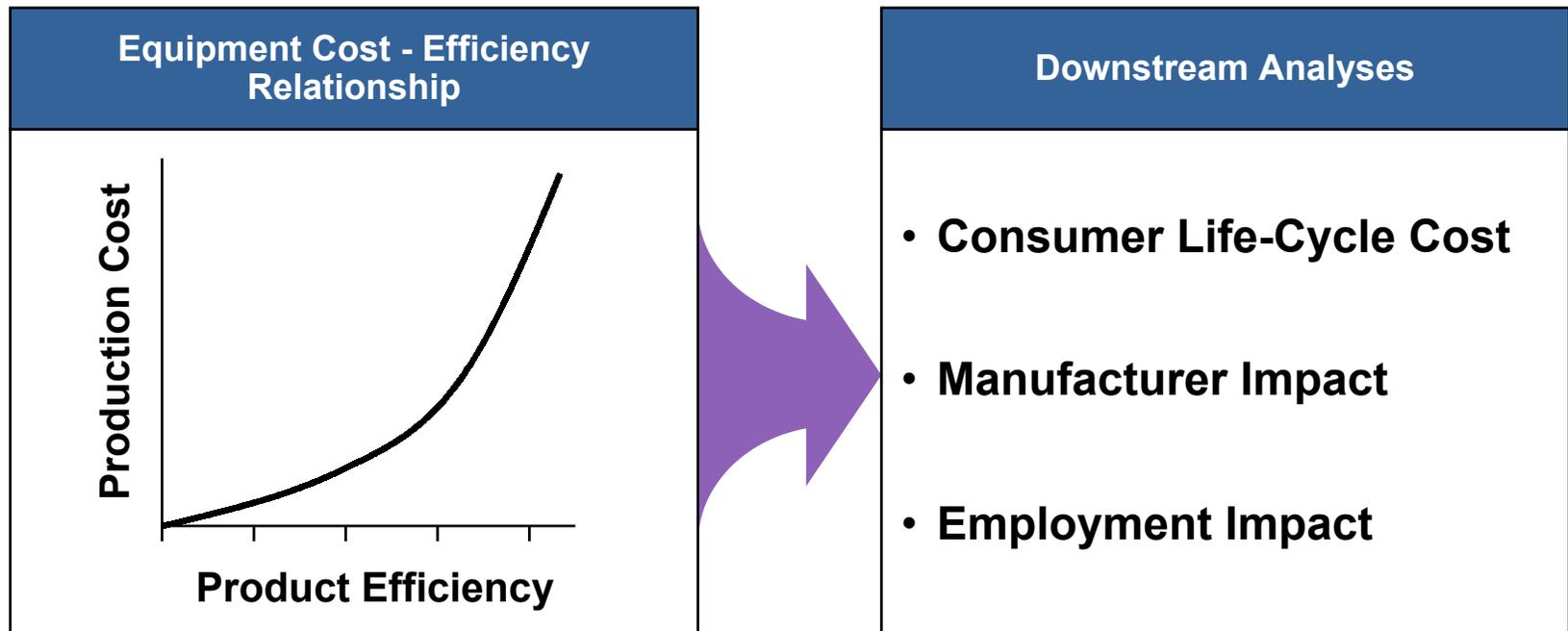
Arthur D. Little, Inc.

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for Commercial Air Conditioners and Heat Pumps  
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## Engineering Analysis Overview

The Engineering Analysis defines the relationship between equipment cost and equipment efficiency for use in downstream analyses.





## Engineering Analysis Characteristics

**DOE desires that the cost/efficiency relationships used in the analysis possess certain characteristics.**

- Credible
  - based on acceptable estimation techniques
  - incorporates and reconciles available data from multiple sources
- Transparent
  - publicly accessible
  - protects proprietary information
- Specific
  - sufficient detail to reduce ambiguity or misinterpretation
  - a single set of cost-efficiency estimates
  - quantified uncertainties
- Timely
  - available prior to scheduled deadlines



## Engineering Analysis Sources of Efficiency Data

There are several potential sources of efficiency/performance information, when applied to commercial air conditioners.

### Primary advantage . . . disadvantage

	Primary advantage	Disadvantage	
Manufacturers and Suppliers	Direct source of performance data	Detailed data is often the most sensitive	✓
Testing/Rating	Objective and accessible	Products are concentrated near only a few efficiency levels	
Technical Literature	Freely available	Inconsistent topical coverage	✓
Engineering Estimates	Efficient	Scope depends on personnel availability	✓
Simulation Modeling	Flexible	Questionable applicability for larger equipment	✓
Prototyping	Direct observation	Resource intensive	✓

✓ *Can provide direct insight into performance of future equipment under more stringent standards*



## Engineering Analysis

### Sources of Manufacturing Cost Data

Similarly, there are several potential sources of manufacturing cost data each with advantages and disadvantages.

### Primary advantage . . . disadvantage

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Manufacturers and Suppliers	Direct source of cost and market info	Detailed data is often sensitive	✓
Teardown Analysis/ Engineering Evaluation	Direct product observation	Products concentrated near only a few efficiency levels	✓
List Prices	Readily accessible wholesale prices	Indicates overall value, not efficiency-related cost	
Public Data (e.g. Census)	Freely available	Highly aggregated	

✓ ***Can provide direct insight into future costs under more stringent standards***

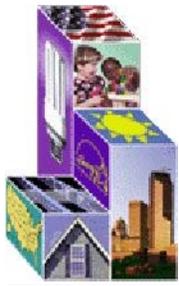


## Engineering Analysis Proposed Approach

**Based on the Department's past experience using approaches such as the Design Option and Efficiency Level approach, we propose to combine data sources for this rulemaking.**

- Gather publicly available information on cost, price, and performance
- Work with manufacturers to obtain design data for appropriate equipment samples and perform a cost estimate based on that data
- Conduct computer simulations and perform engineering estimates to supplement the design data
- Obtain reviews by stakeholders
- Reconcile results and characterize uncertainty

***Based on their advantages and disadvantages, are all these steps necessary, or are others warranted?***



## Engineering Analysis

### Questions Related to Proposed Approach

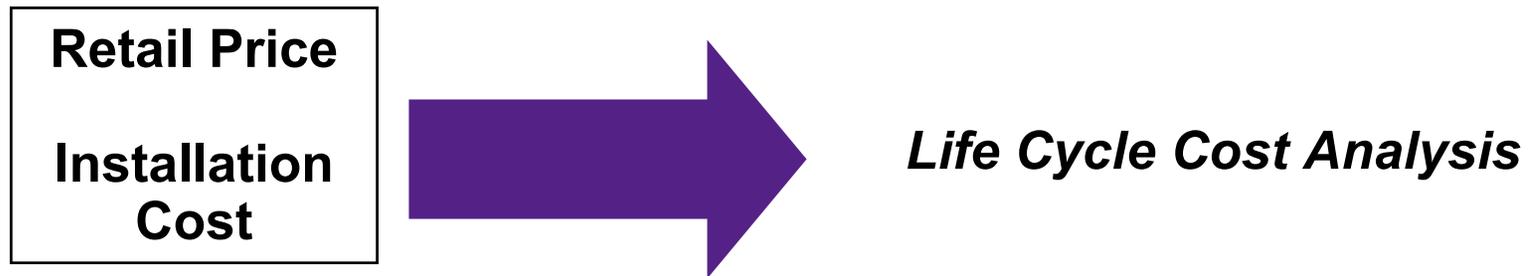
**Depending on which approach we take, there are some questions to be answered.**

- *What role should manufacturers and other stakeholders have in providing data and reviewing assumptions, methods and results?*
- *What performance modeling tools should be used, if any?*
  - PUREZ -- formerly referred to as MODCON (Oak Ridge National Laboratory simulation model)
  - HPSIM (National Institute of Standards and Technology simulation model)
  - ACMODEL (Ray W. Herrick Laboratories, Purdue University simulation model)
  - Spreadsheets (based on engineering expertise)
- If we draw on multiple sources of information, what guidelines should we use for reconciling them and integrating them into a single set of cost-efficiency data?
- How should the Department consider improvements that impact part-load efficiency (e.g. IPLV) but not EER?



## Retail Price and Installation Cost Overview

Retail prices and installation costs at various efficiency levels are needed to estimate consumer life cycle costs.



- *How will standards impact equipment price, installation cost (and maintenance/service costs)?*
- *What are the drawbacks, if any, of inferring equipment retail prices by applying a series of markups to our production cost estimates?*
- *Given that the equipment price is just one component of the price of the installed system, is it likely that information gathered through a survey could help determine retail prices or markups?*