Fully Burdened Cost of Energy –
A Computational Framework for Acquisition Tradespace Analyses

Summary

In the acquisition process, the Fully Burdened Cost of Energy (FBCE) estimates the energy-related costs to sustain specific pieces of equipment, including procurement of energy, the logistics needed to deliver it where and when needed, related infrastructure, and force protection for those logistics forces directly involved in energy delivery. FBCE shall be applied in trade-off analyses conducted for all developmental Department of Defense (DoD) systems with end items that create a demand for energy in the battlespace. FBCE does not identify savings for programmatic purposes. It is an analytic input to business case analysis designed to identify the difference in total energy-related costs among competing options. Consistent with 10 USC 138c and DoDI5000.02, FBCE estimates shall be made and reported for all acquisition category (ACAT) 1 and II systems that will demand fuel or electric power in operations, and will be applied to all phases of acquisition, beginning with the preparation of the Analysis of Alternatives. FBCE is also required as part of Total Ownership Cost calculations (See DAG Chapter 3.1.6. “Fully Burdened Cost of Delivered Energy”). FBCE is not additive to Total Ownership Costs, but rather, is reported beside it. While TOC estimates are based on total (“peace-time”) life of a system, FBCE estimates are based on short combat scenarios. They provide different, but complementary insights.

Introduction

The energy required to field and sustain forces with current deployed systems poses significant operating costs and imposes several operational constraints on the larger force structure. First, growing logistics footprints can impede force mobility, flexibility, timing and staging, especially for anti-access and irregular conflicts. Reducing the need for energy can have significant benefits for force deployability and the timeline of operations. Second, this logistics footprint presents a target for conventional, irregular, and catastrophic threats, creating demand for force protection and transportation forces. In the conflicts of the past decade, for example, adversaries have targeted U.S. fuel supply convoys, putting our forces and their missions at risk and redirecting combat power and dollars to fuel delivery.

Conversely, reducing system energy demand can make operational forces more agile and lethal by extending their range and reducing their dependence on logistics lines. These reductions can be achieved through different, better informed tradespace choices, design alternatives, technologies and force structure concepts.

As outlined in the 2011 DoD Operational Energy Strategy, DoD is instituting procedures, frameworks, analytic tools and reporting requirements to better understand and manage how this energy demand affects force capability, vulnerability and enterprise costs.

One of these frameworks, FBCE, is used to inform the acquisition tradespace by quantifying the per gallon price of fuel (or per kilowatt price of electricity) used per day for two or more competing materiel solutions. The FBCE estimate includes apportioned costs of the energy logistics forces needed to deliver and protect the fuel in a scenario. Calculating the FBCE gives DoD decision makers a way to more accurately consider the cost of a system’s energy logistics footprint when making trades between cost, schedule, and performance. It has the added benefit of informing decisions on the size and focus of DoD investments in science and technology programs that affect the energy demands of the force such as engines and propulsion, light-weight structural and armor materials, power efficiency in electronics, mobile power production and distribution, and more innovative system design approaches.

FBCE includes the cost of the fuel itself and the apportioned cost of all of the fuel logistics and related force protection required beyond the Defense Logistics Agency-Energy (DLA Energy) point of sale. While most planning scenarios generally employ military forces for fuel delivery and protection, in some cases, contractor logistics and protection may be presumed. The cost estimation method is the same, though the data sources required may vary. As a decision tool, FBCE is meant to inform technological and design choices as it is applied in requirements development, acquisition trades and technology investments. Successful implementation will, over time, help DoD manage larger enterprise risks such as high and volatile fuel prices.

The FBCE will be applied in trade-off analyses conducted for all deployable DoD systems with end items that create a demand for energy in the battlespace. This FBCE methodological guidance applies to ACAT I and II developmental systems as well as mid-life upgrade or modernization choices.

FBCE estimates will be prepared concurrently with the Analysis of Alternatives (AoA) for each materiel solution being considered. The AoA should develop those estimates to sufficient fidelity to determine if the differences in energy demand and resupply costs are significant enough to meaningfully influence the final choice of alternatives. For developmental system with delivered energy requirements (i.e., most systems), the AoA shall examine alternative ways to reduce operational energy demand as a significant system capability factor. Even if FBCE does not significantly differ between alternatives, but shows sensitivity to change between sub-component or design choices within all alternatives, the Service sponsoring the program shall continue FBCE efforts after completion of the AoA to inform trades in the subsequent acquisition phases. This includes technology development, systems engineering, design decisions, or even to incentivize bidders to offer more efficient systems. In all cases, FBCE should be developed for all alternatives remaining in the trade space at the end of the AoA and not just for the alternative favored/chosen by the Service sponsor.

FBCE has a wide range of applications beyond system design. For example, it can be used for site specific investments, such as efficiency improvements at a contingency base to reduce fuel deliveries.

Commercial vehicles such as buses or cars used in support of routine fixed base operations normally should not be regarded as “deployable”, and are addressed in other regulations and guidance.

Fully Burdened Cost of Energy Computational Framework

This section of the Guidebook outlines a basic framework developed by the Office of the Assistant Secretary of Defense for Operational Energy Plans and Programs (OASD (OEPP)) and the OASD(CAPE), to calculate the FBCE. This framework is oriented towards liquid fuels, but extends to other forms of energy demands (e.g., fuel cells, hybrid-electric engines, nuclear and solar energy sources). The specific analytic tools and methods to estimate FBCE are being refined within the analytic, acquisition and costing communities. This approach was informed by analytical work started by a Defense Science Board task force in 2001, applied by PA&E in 2006 and 2007 in a ground system case study, and revisited by OSD while assessing several Major Defense Acquisition Programs (MDAP) and their approach to fuel issues. This framework is intended to give DoD Components flexibility in developing methodologies tailored to their various domains and force planning methods. Alternative methods or interpretations may be allowed, but DoD Components should consult iteratively with appropriate OSD offices, especially the Office of the Assistant Secretary of Defense for Operational Energy Plans and Programs (OASD(OEPP)), before delivering a “final” product at a milestone review or similar decision point.

Calculation of the FBCE differs from most other cost factors in two main ways. First, it is scenario-based. The FBCE analysis should be based upon a range of operational scenarios or use conditions from those specified in the program’s AoA guidance, or in the approved program’s analysis base, to ensure comparability within program tradespace discussions. Further, in order to estimate operationally realistic costs, all scenarios will have to be of sufficient duration to account for demanded logistics and force protection. In addition, its calculation requires participation from Component force planning and analytic organizations to appropriately calculate FBCE estimates. The appropriate organizations vary by Service.

There is no definitive, “correct” answer for a given system’s FBCE estimate, however, DoD Components should present a realistic and analytically defensible scenario and cost elements. The proponent’s scenario assumptions for fuel logistics must be consistent with Service future force plans and Concepts of Operation. Consistency enables the Services and DoD to evaluate their assumptions relative to strategy and doctrine, and make better informed risk decisions. DoD Components should use existing analytic tools, planning data, and costing methodologies where possible to develop FBCE values. If Components find their analytic tools are inadequate to make the necessary estimates, Components should approach OASD (OEPP), at the earliest opportunity to help identify potential solutions.

There are two key analytical components essential to developing a FBCE value:

1. **Scenarios.** Services decide upon a representative set of future operational scenarios or vignettes. However, to ensure the results of the FBCE calculations are comparable to other analytic measures, the same scenarios used in the program’s AoA or its analysis base shall also be used in calculating the FBCE. The DoD’s approved joint Defense Planning Scenarios (or Integrated Security Construct scenarios) and the Components’ supporting future force plans should provide the general guidance and analytic assumptions needed to identify appropriate scenarios. For purposes of computing the FBCE, scenarios must be of sufficient duration to require logistical re-supply of energy. Once the FBCE is calculated for the chosen scenarios, a simple mean average of the results will be computed.

2. **Apportionment.** Services determine what proportion of the fuel logistics footprint identified in the selected scenarios is attributable to the platform or system in question. Is it drawing 5% of the fuel from the fuel logistics units in the scenario, or 20%, or 50%? This percentage should inform how one attributes the logistics footprint to this one developmental system. Because no single system in any operation takes 100% of the fuel, it would be inappropriate to attribute 100% of the logistics tail cost to one system when calculating FBCE.

DoD Component organizations with responsibilities for scenario-based force planning, campaign model development, and force structure analysis should collaborate with responsible acquisition organizations to agree on a manageable subset of operational scenarios from the AoA that best represent the missions or duty cycles the system is being built to support. In the process of selecting scenarios, the force structure will determine the proper level of apportionment. Component organizations are encouraged to prepare fuel logistics and logistics force protection baselines for each common scenario to provide a starting point for AoAs and other acquisition trades that follow. As more acquisition programs perform these analyses and expertise builds, refinements to guidance and oversight criteria will be developed.

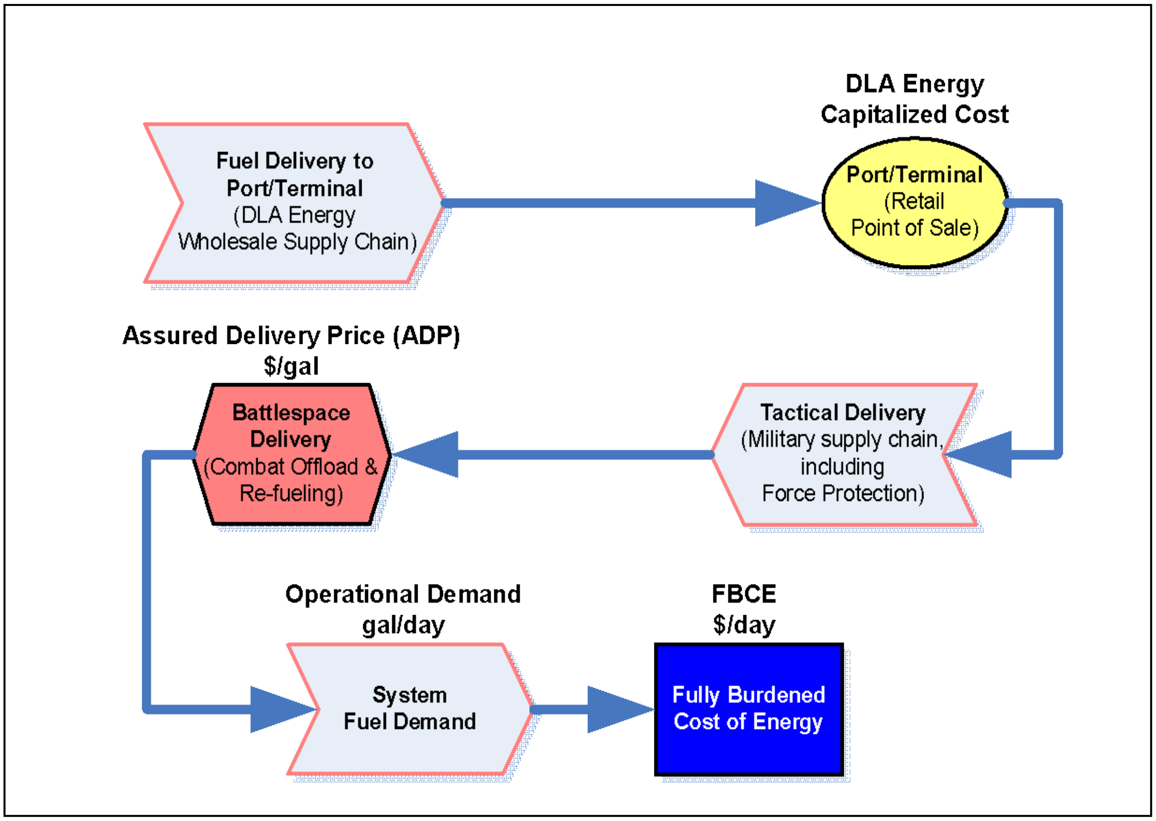

Figure 1. FBCE – Scenario Fuel Delivery Process Diagram

Assured Delivery Price Computation

The first item needed to compute the FBCE is the Assured Delivery Price (ADP). The price elements described in Figure 2 (below) provide a framework for determining the ADP of fuel within a given scenario. It is a measure of the burdened cost of the fuel, in $/gallon or $/barrel, and all the tactical delivery assets and force protection needed to assure the fuel is safely delivered out to a given location. The ADP is the same for all users of fuel in that location using a given source of fuel and delivery method.

Price Elements to Determine Assured Delivery Price

Element #	Price Element	Burden Description
1	Fuel	Most recent DLA Energy ”standard price” plus OMB-direct price inflation to the fiscal year of the scenario. In some cases, one may substitute a location-specific contract delivery price.
2	Tactical Delivery Assets*	Includes all of the following:
	Fuel Delivery O&S Price	Per gallon price of operating service-owned fuel delivery assets including the cost of military and civilian personnel dedicated to the fuel mission.
	Depreciation Price of Fuel Delivery Assets	Captures the decline in value of fuel delivery assets with using straight-line depreciation over total service life. Combat losses due to attack or other loss (terrain, accident, etc.) should be captured as a fully depreciated vehicle.
	Infrastructure, environmental, and other miscellaneous costs over/above and distinct from the DLA Energy capitalized cost of fuel	Per gallon price of fuel infrastructure, regulatory compliance, tactical terminal operations, and other expenses as appropriate.
3	Security*	Potential per gallon price associated with delivering fuel, such as convoy escort and force protection. Includes the manpower, O&S, asset depreciation costs, and losses associated with force protection.

* These prices vary by Service and delivery method (ground, sea, air).

Figure 2. Summary of Price Elements to Apply within Each Scenario to Determine the Assured Delivery Price

Although this figure provides a framework for calculating ADP, the elements must be tailored to a selected supply chain, system or platform type, and larger force structure context. In all cases, the results are scenario or unit-type-specific, and are not applicable for all situations. Each of the elements is discussed further in the following sections.

Fuel

The first price element for consideration is the fuel itself. DLA Energy serves as DoD’s single supply center for petroleum products worldwide and for coal, natural gas, and electricity services within the continental United States. DLA Energy not only procures the energy products, but serves as DoD's Integrated Materiel Manager for all petroleum products. DLA Energy charges the military Services for the fuel delivered through a reimbursable arrangement known as the Defense Working Capital Fund.

The 'standard price,' established by DLA Energy, is the rate that is charged to military customers at the retail point of sale worldwide. To simplify cost planning and accounting, the 'standard price' for a given fuel is the same globally and does not represent the full capitalized costs DLA Energy incurs to deliver the fuel out to the point of sale. For purposes of calculating ADP, the 'standard price' shall be used, referencing the most recent price update from DLA Energy. The standard price should then be inflated, using the most recent Office of Management and Budget inflation factors for fuel prices, to the year in which the (AoA) scenarios in this analysis are set (e.g. 2018 or some future year at or after Initial Operational Capability).

In certain circumstances, particularly for current-day, site-specific calculations, DoD Components can use actual contracted delivery price where available, instead of the 'standard price'. DLA Energy maintains a database of capitalized costs to purchase and deliver fuel at various supply points around the world. Site-specific fuel prices should only be used to inform rapid fielding and related procurement choices, as they represent market pricing in a specific operational situation. It is DLA Energy's responsibility to provide this data to DoD Components for these analyses as required. Since the FBCE is used for business case analyses and not to inform programming and budgeting for operation of platforms, the Services should not be concerned that this capitalized cost does not match the standard price it will be charged during actual operation of the platform under consideration.

Tactical Delivery Assets

The second price element captures the burdens associated with the tactical delivery assets used by the Services to deliver fuel from the point of sale to the system that will consume it. It includes the Operating and Support (O&S) costs, the cost of depreciation of the actual delivery assets, and any significant infrastructure costs needed to operate these assets.

Once the Services take over possession of fuel from DLA Energy at the point of sale, they must employ Service-owned delivery assets. For the purposes of ADP estimates, 'fuel delivery assets' means major items of fuel delivery equipment, such as Navy oilers (T-AOs), aerial refueling aircraft (KC aircraft) for fixed-wing and rotary-wing aircraft, and tanker trucks and trailers for ground vehicles. It also includes C-130s airdropping palletized fuel and rotary-wing aircraft carrying fuel by sling load for delivery.

The O&S cost for the fuel delivery assets consist of the costs of operations and maintenance (O&M) of the vehicles and equipment and the costs for military and civilian manpower dedicated to the fuel delivery mission divided by the gallons of fuel delivered, to arrive at the $/gallon price. For fuel delivery systems that are major systems in their own right, such as oilers or aerial refueling aircraft, actual O&S cost history is collected and made available to registered users of the Air Force's and Navy's Visibility and Management of Operating and Support Cost (VAMOSC) data systems. For other classes of equipment, cost and manpower data is found in planning factors used to develop O&M budgets and tables of organization and equipment associated with fuel delivery units. If the planning scenarios/missions being used for this calculation requires another Service's assets to delivering fuel in the battlespace, Services may need share data.

The cost of depreciation of the primary fuel delivery assets is also part of the second price element. Normally, depreciation is not used in DoD analyses, since most studies tend to deal with equipment recapitalization costs explicitly. However, in this case, depreciation provides a measure of the decline in capital value of the fuel delivery assets over time from use. The standard method is to use straight line depreciation over the anticipated service life of the primary fuel delivery asset. For example, for an ADP calculation for an aerial system that requires air-to-air refueling as part of its mission profile/duty cycle, this step would require inclusion of a depreciation value for the system's air refueling tanker.

An additional part of the cost of depreciation is the potential loss of delivery assets due to hostile attack or other attrition. Based on the scenario chosen, there is a definable probability that the associated logistics platforms will be interdicted and destroyed. If destroyed, the entire remaining value of the platform is immediately amortized and this cost is added to this price element. Depending on the quantity of fuel being carried by the delivery asset, an adjustment to the amount of fuel obtained from the point of sale will be required to account for this potential loss, if appropriate. Many cost and attrition factors related to fuel resupply convoys are available through existing combat models and historical databases.

Finally, miscellaneous infrastructure costs may be added if they significantly add to the cost of supporting the delivery assets and if the scenarios in the AoA involve energy infrastructure. These items may include the price of O&S and recapitalization for the facilities (such as fueling facilities and fuel storage sites) and related ground system equipment (such as pumps, fuel storage bladders, hose lines, and other refueling equipment to include maintenance and parts for refueling vehicles and other related ground refueling equipment). The costs to deploy the delivery assets may also be included, if the assets need to be transported to the theater of interest. This applies only to infrastructure that is operated by the military Services in the theaters of interest, and does not apply to infrastructure that is operated by DLA Energy and incorporated into the DLA Energy capitalized cost of fuel.

For DoD infrastructure, data sources and associated cost factors are centrally managed by the Office of the Deputy Under Secretary of Defense (Installations and Environment) and available to authorized users. Data on all DoD world-wide facilities is stored in the DUSD(I&E) Facilities Assessment Database. A four digit number known as the Facility Analysis Code (FAC) classifies each facility. For example, there is a unique code for each facility category such as marine fueling facility, POL pipeline, pump station, or fuel storage facility. For each four digit code, the DoD Facilities Pricing Guide (http://www.acq.osd.mil/ie/fim/programanalysis_budget/tool_metrics/FPG/fpg.shtml) provides cost factors used in DoD facilities cost models. Cost factors are expressed as annual costs per unit of measure (e.g., square foot) and are provided for facilities sustainment, modernization, and operations.

Security

The third and final price element includes the costs of escort protection of the fuel supply chain in hostile environments. In the case of DoD force protection assets allocated to the fuel delivery forces, the O&S costs, direct fuel costs and the depreciation cost of those forces will also have to be estimated and included in the overall calculation. In essence, all of the costs considered in the second price element should also be considered for security assets. This includes the possibility that some security assets will be destroyed due to hostile activity while protecting the fuel supply chain. In some high-risk scenarios, force protection costs may be the largest factor in the FBCE estimate.

Fully Burdened Cost of Energy Computation

To arrive at the FBCE, the ADP is multiplied by the apportioned amount of fuel demanded by the system of interest. The FBCE is computed for each scenario being considered. Programs then have the option of reporting out the FBCE for each of the scenario they've assessed separately, or to provide their mean or weighted average, depending on anticipated usage of the system. To arrive at a single FBCE for the program, average these estimates based upon the relative amount of time that the system is expected to operate in each of the chosen scenarios.

Other Considerations

The FBCE, which is based on a simplified activity based costing framework, is meant to provide the acquisition process with a realistic, financial proxy for the fuel burden our forces will incur in the future battlespace. It is not meant to capture the operational impacts and capability gained or lost by changes in the logistical burden or in the unrefueled range of the system due to fuel consumption. The DoD force planning process and the analyses conducted to inform requirement development, the Joint Capabilities Integration Development System (JCIDS) process, are evolving to consider these variables. Because acquisition is governed by "cost, schedule, and performance", the requirements developer and approving authority should consider those fuel-related variables as part of the performance tradespace relative to the capability gap they are trying to fill.

The use of FBCE estimates do not normally identify near-term savings that can be identified in a budget. Choices made during an acquisition program to reduce the fuel demand will not begin to show an effect until after the system is fielded. Further, actual usage may vary considerably from the planning scenarios used in the AoA. This is often 10 to 20 years following an initial ICD for a major program, well beyond the FYDP. Readers interested in this subject should periodically check this section of the Guidebook for future updates to this framework.