

# Net Energy Analysis

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**Prepared for:**

**Connecticut Energy Advisory Board**

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## **Net Energy Analysis (NEA) Context**

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- **Part of 2007 Revisions to CEAB RFP Process Statute**
  - Section 54 g of Public Act No. 07-242
  - *“An Act Concerning Electricity and Energy Efficiency”*
  
- **Adds “Net Energy Analysis” Requirement to CEAB RFP**
  - Beginning December 1, 2007
  - CEAB to conduct NEA in RFP Process

## Net Energy Analysis (NEA) Applicability

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- **Part CEAB RFP Evaluation Process**
  - To be conducted by CEAB for any RFP Conducted
  
- **Applies only to Generation Projects in excess of 65 MW**
  - **Excludes:**
    - Smaller generation proposals
    - Transmission facilities
    - Natural Gas facilities

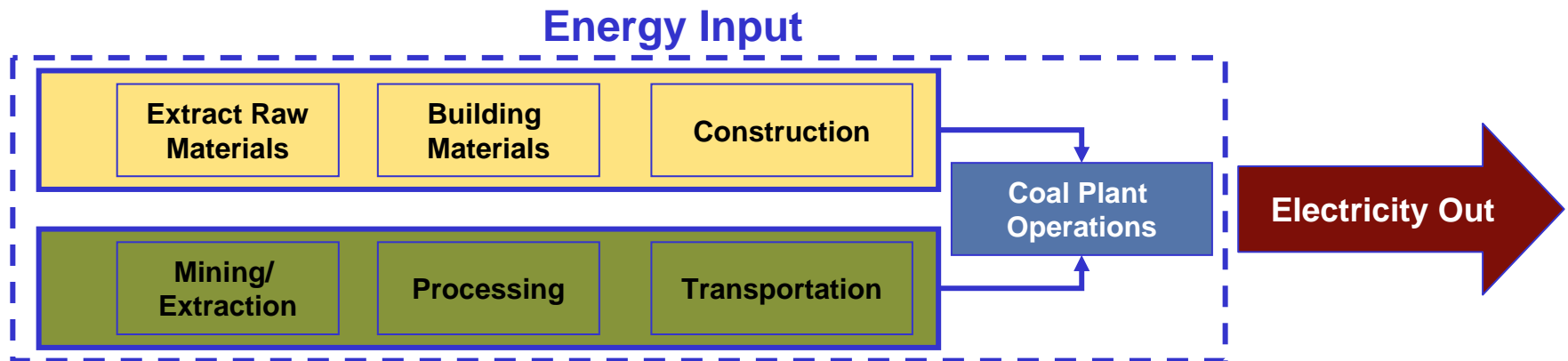
## Net Energy Analysis (NEA) – Statute Definitions

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- ***“embodied energy requirements used in the materials for initial construction of the facility over its projected useful lifetime”***
  - To be expressed as an ***“Energy Profit Ratio”***
  - To include ***“the energy consumed through the entire supply chain”***
- ***“Facility Net Energy”*** means the heat energy delivered by the facility contained in a fuel minus the life cycle energy used to produce the facility
- ***“Fuel Net Energy”*** means the heat energy contained in a fuel minus the energy used to extract the fuel from the environment, refine it to a socially useful state and deliver it to consumers
- ***“Embodied Energy”*** means the total energy used to build and maintain a process

## What is Net Energy Analysis (NEA)?

- An energy accounting framework that estimates the energy input versus output of a system over its entire life cycle.
  - NEA relies on energy as the unit of measure.
  - All the direct and indirect energy associated with the entire supply chain is taken into account.
  - For example, electricity generated from a coal plant may include the following:



## What is Energy Profit Ratio?

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- Energy Profit Ratio is formulated as follows

$$\frac{\sum \text{Energy Out}}{\sum \text{Energy In (EXCEPT FUEL)}} > 1$$

- The final output must be **GREATER** than the sum of the inputs to be a “profitable” system.
- In the case of electricity, the **FUEL** fired in the boiler/combustor is **NOT** considered an input fuel.
  - Otherwise, the system would not be “profitable”.
  - The fuel fired in the boiler is an intermediate form of the final energy output, which is ultimately electricity.

## What Is NEA Used For?

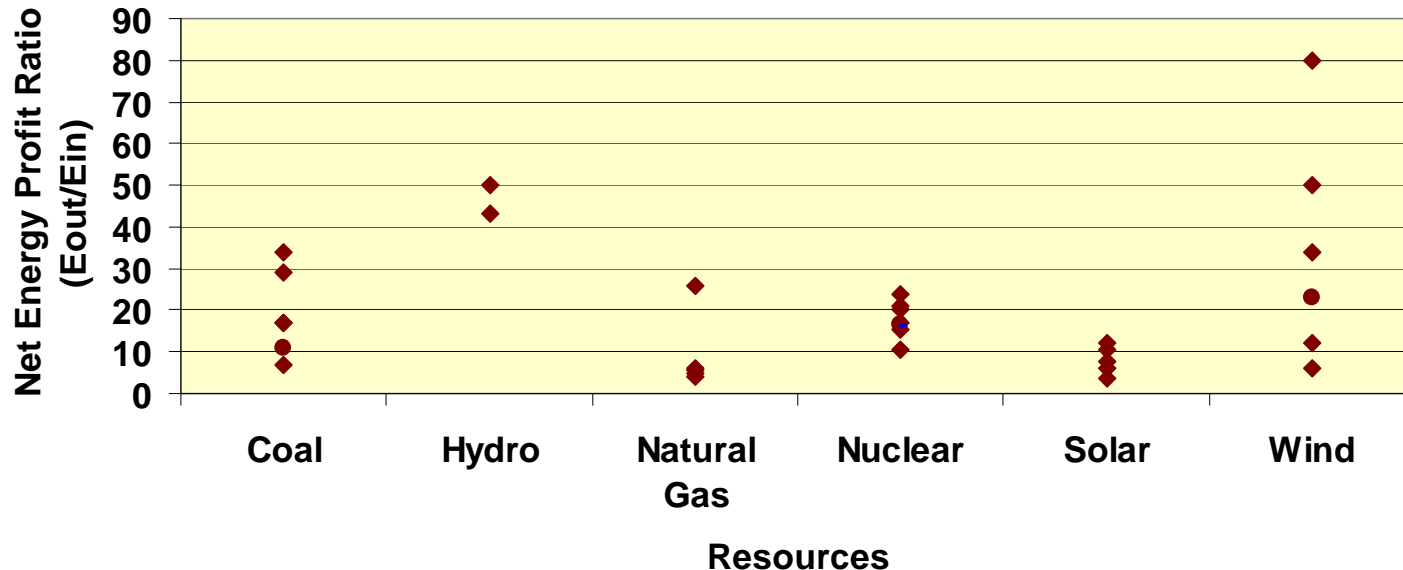
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- **Historically, Energy Profit Ratio helped determine the profitability of an energy system. For example:**
  - **Nuclear energy:** accounting for the full life cycle of the fuel extraction, processing, and ultimate waste treatment.
  - **Biofuels:** accounting for the energy to grow, harvest, process, and transport the biofuel to the ultimate consumer.
  - **Solar cells:** accounting for the energy needed to grow silicon, make wafers, transform into modules, transport and install.
  
- **Today, NEA has been supplanted by Life Cycle Analysis (LCA)**
  - **LCA examines the total energy and environmental impacts over the life-cycle of a product.**
  - **LCA accounts for non-energy related impacts, such as emissions and greenhouse gases, that is not accounted for using NEA.**

## How Should NEA Be Used?

- To compare different technologies using similar fuel sources such as supercritical coal vs. pulverized coal technologies
  - It would be inappropriate to compare a renewable technology versus a fossil-based technology, because the fuels used have very different characteristics.
- If comparing multiple fuel sources, results vary dramatically depending on assumptions and technologies. See sampling of past studies below.

Compilation of Net Energy Profit Ratio for Different Resources



## What Steps Are Needed to Conduct a NEA?

1. Establish system boundaries (e.g. fuel extraction, construction materials, transmission lines, labor, capital, etc...)
2. Create list of data needs associated with power generation to include (detailed vs. simplified, may vary by technology)
3. Determine data sources to use (e.g. EIA, NREL, economic data, input-output models, LCA databases, etc...)
4. Sum up total energy inputs (specific to project or generic to technology)
5. Calculate Energy Profit Ratio

*\*Note that the steps laid out above appear to be simple, but the data needed and calculations involved are quite complex because multiple linked systems must be developed and data may not be readily available.*

## What Are Some Issues Associated with NEA?

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- **Calculated results (Energy Profit Ratio) do not provide sufficient information to compare between different fuels, especially with respect to environmental impact.**
  
- **Since “energy” inputs from a variety of sources (coal, oil, natural gas, electricity) are converted to the same units and summed together, the qualities and characteristics of the different sources are not easily distinguished.**
  - **For example, the qualities of electricity and the qualities of oil are quite different, but in NEA, one unit of electricity is converted from kWh to a btu equivalent and treated the same as one btu of oil.**
  
- **The two key aspects of NEA is the quality, vintage, and source of data used and the methodology in utilizing the data. Problem is that there is **no standard** methodology or database for NEA available.**

## Observations

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- **We have not found any state entities that are actively using NEA in resource planning decisions.**
- **The issues described are not easily resolved as they are inherent to NEA.**
- **While an NEA can be conducted, the results should be viewed with full understanding of such issues.**
- **If there is a need to examine the life-cycle impact of various generation facilities in a non-economic context, an alternative approach is Life-Cycle Analysis where more environmental factors are examined.**

## **Process**

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- **Complete a White Paper (with bibliography) and Methodology Proposal.**
- **Solicit Written Comments on White Paper and Proposal.**
- **Conduct a Public Hearing**
- **Modify Methodology, considering input, for CEAB Consideration**