LIGHTEnUp Tool & Analysis Framework
Lifecycle Industry GHgas, Technology and Energy through the Use Phase

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Analysis Support for U.S. DOE, EERE, Advanced Manufacturing Office (AMO)

Collaborative Research From:
U.S. Department of Energy, EERE, AMO
Lawrence Berkeley National Laboratory
National Renewable Energy Laboratory
Oak Ridge National Laboratory
Argonne National Laboratory
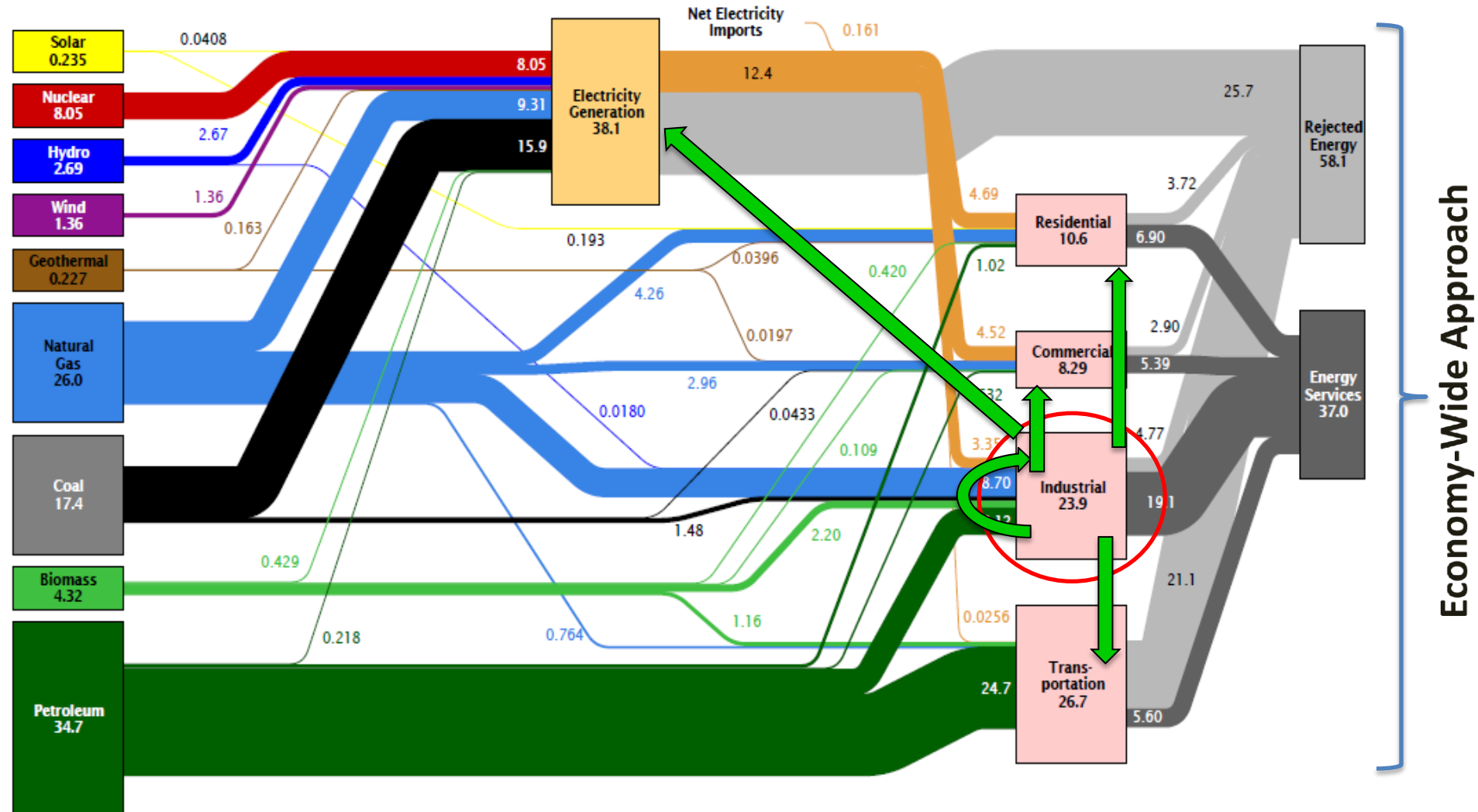*Northwestern University*

AMO Analysis Review
May 28th & 29th
Washington D.C.

Flow of Energy through the U.S. Economy

Estimated U.S. Energy Use in 2012: ~95.1 Quads

Lawrence Livermore National Laboratory

Economy-Wide Approach

Presentation OVERVIEW

- WHAT DOES THIS ANALYSIS GIVE US?
  - A consistent foundation for comparing prospective impacts of technology deployment within the U.S.
  - Predicated on publically available DOE Datasets

- WHAT QUESTION DOES THE ANALYSIS ANSWER?
  - How technology deployment scenarios might impact future U.S. energy consumption.
  - Scenario uncertainty bounded by existing DOE datasets and forecasts

Presentation Outline

- ## LIGHTEnUP Analysis Objectives
  - What THE LIGHTEnUP Tool is & what it is not
  - Datasets

- ## Developing Scenarios
  - Distilling analysis to key variables

- ## Scenario Examples
  - Illustrative
  - Detailed

- ## Conclusions

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Development Objectives

Substantive yet Intuitive:

- Prospective Technology Life-Cycle Analysis
- Intuitive
- Transparent
- Publically Available Datasets

Resilient:

- Evolves
- Harmonizes
- Repository
- Guide

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Advanced Manufacturing Office (AMO) LIGHTEnUP Tool
Lifecycle **I**ndustry **GH** gas & **En**ergy through the **U**se **P**hase

What it is:
- Prospective analysis tool (projections out to 2050)
- Estimates energy and CO_2 impacts of technology deployment across the U.S. economy
- Simple spreadsheet (Intuitive & Transparent)
- Based on publically available DOE Datasets

What it is not:
- Optimization
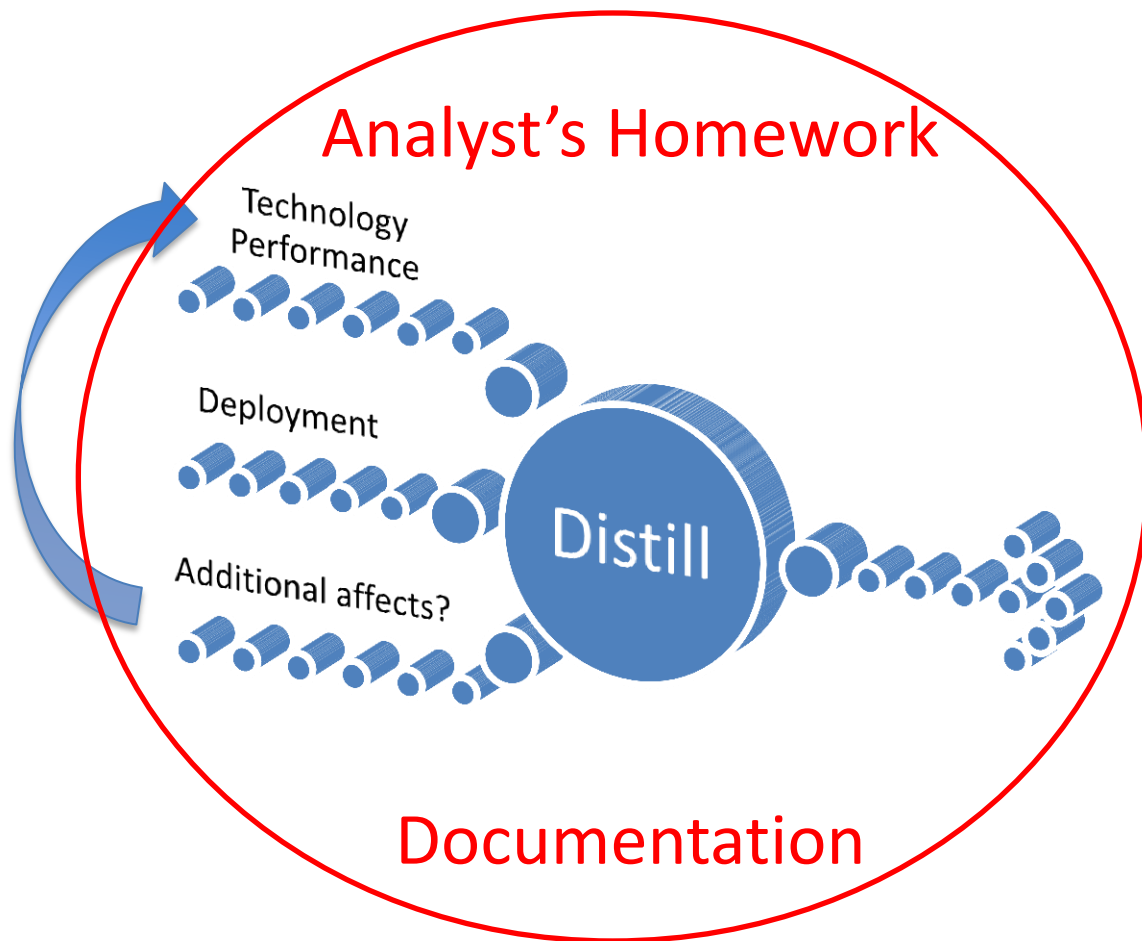- General Equilibrium
- Crystal Ball (Sadly)

What it is best at:
- Developing scenarios
- Documentation & communication

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Developing Scenarios

Analyst's Homework

Technology Performance

Deployment

Additional affects?

Distill

Documentation

Three Key Scenario Variables

Where?
(Sector & end-use)

What?
(Energy Impact)

When?
(Start & End years)

LIGHTEnUP

Publically Available U.S. Energy Consumption Data

Legend: ☐ Industrial ☐ Commercial ☐ Residential ☐ Transportation

Y-axis: All Primary (Quad BTUs), scale 0 to 100

X-axis: 2010, 2015, 2020, 2025, 2030, 2035, 2040, 2045, 2050

20 AEO† Tables covering 17 Modes x 13 Energy Sources

2 AEO† Tables covering 3 Building Types, 6 Energy Sources x 14 End-Use Types

2 AEO † Tables covering 11 Building Types, 5 Energy Sources x 10 End-Use Types

12 AEO† Tables
83 MECS†† Manufacturing Classifications, 6 Energy Sources x 22 End-Use Types
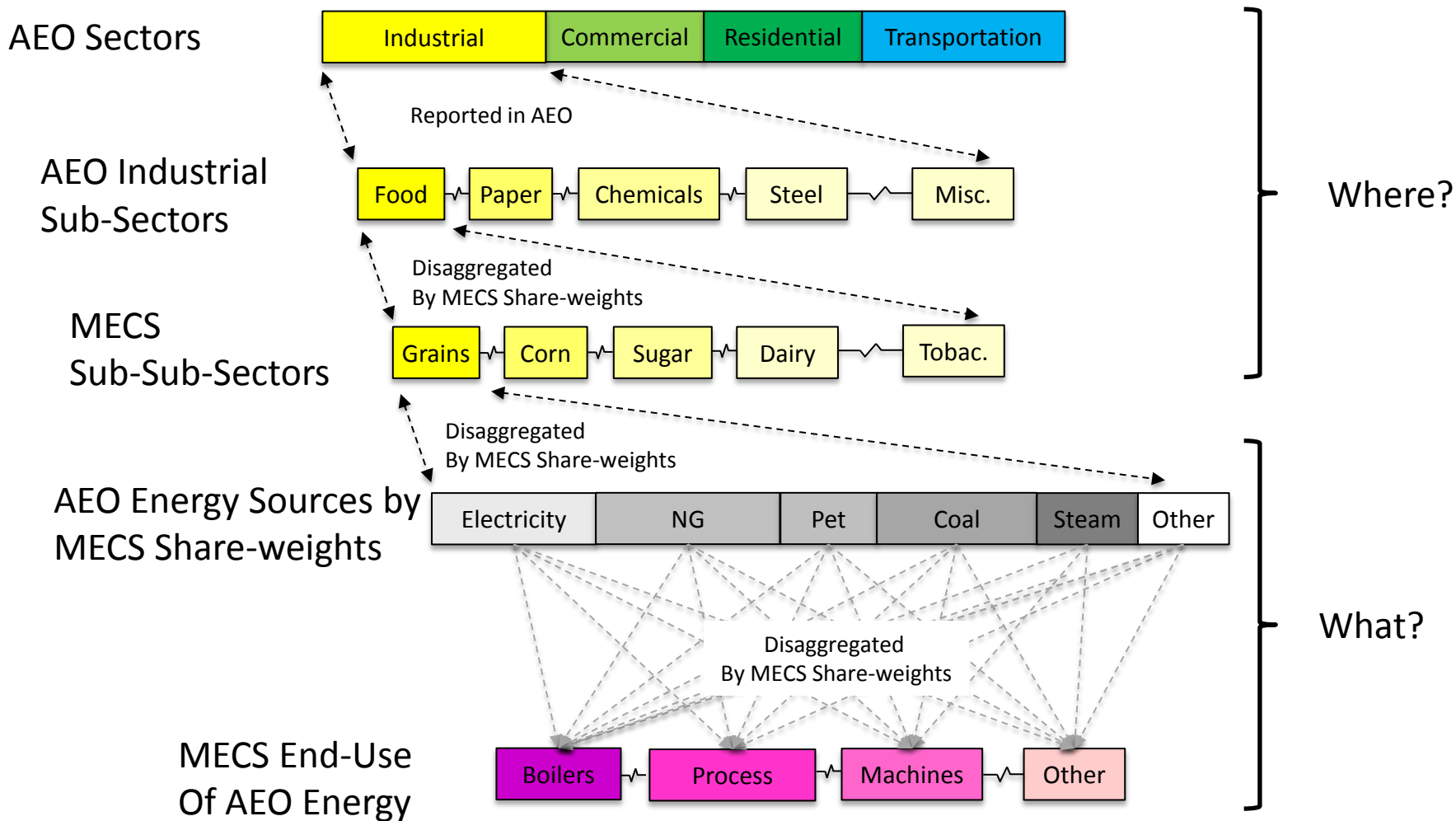
† Annual Energy Outlook (AEO) Tables
†† Manufacturing Energy Consumption Survey

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Where? What?
Industrial Energy to End Uses

What Sector & End-Use?			What Impact at End Year			When?	
Industrial Commercial Residential Transportation	Sub-Sector	End-Use	Technical Adoption Potential %	Relative Energy Impact %	Growth Rate Assumption	Start Year	End Year

Energy

Technical Adoption Potential (%)

Relative Energy Impact (%)

Growth

Energy Impact

Eq. 3

Eq. 2

Eq. 1

Where?

Sector & Sub-Sector & End-Use

Equations:

1) $E_{t=EY} = E_{t=0} \times GR$

2) $E(TP)_{t=EY} = E_{t=EY} \times TAP\%$

3) $E(RI)_{t=EY} = E(TP)_{t=EY} \times REI\%$

Time

Base Year (2011)   Start Year (SY)   End Year (EY)

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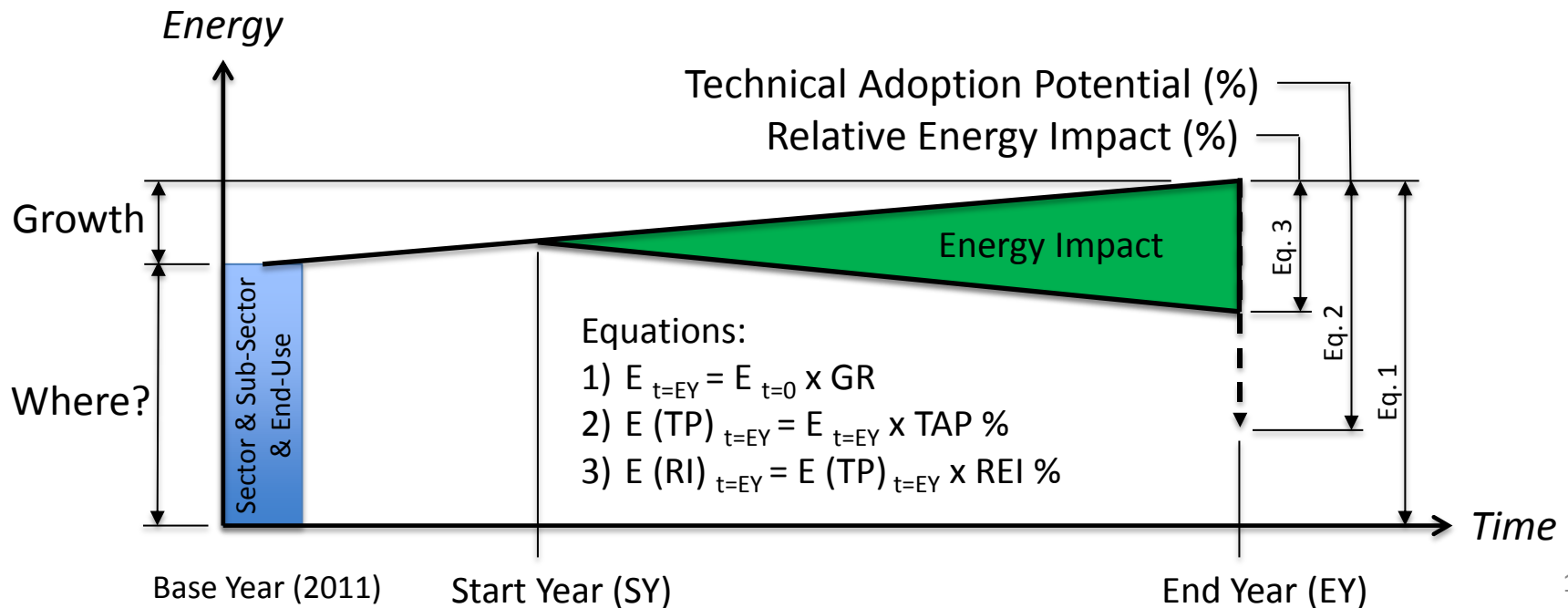
Replace all non-LED Lightbulbs with LED lightbulbs
In the Residential, Commercial, and Industrial Sectors in the U.S.

LIGHTEnUP tool LED inputs

| Impact Component	Sector	Modeled End Use	Technical Adoption Potential %	Relative Energy Impact %	Start Year	End Year
Traditional light bulb manufacturing	Manufacturing Electrical equipment, appliance, and component manufacturing	Fuel	100%	-1.2%	2010	2030
	Manufacturing Electrical equipment, appliance, and component manufacturing	Electricity	100%	-1.2%	2010	2030
LED manufacturing	Manufacturing Semiconductor Sector Fuel Impact	Fuel	100%	66.2%	2010	2030
	Manufacturing Semiconductor Sector Elec Impact	Electricity	100%	66.2%	2010	2030
Transportation	Transportation for LEDs – Freight Trucks	Diesel	100%	0.15%	2010	2030
Buildings	Use Phase LED lighting in Residential buildings	Other	70%	-60%	2010	2030
	Use Phase LED lighting in Commercial buildings	Lighting	98%	-48%	2010	2030
	Use Phase LED lighting in Manufacturing buildings	Facility Lighting	100%	-44%	2010	2030

Analyst's Homework

Detailed Example: LED Lighting replacement
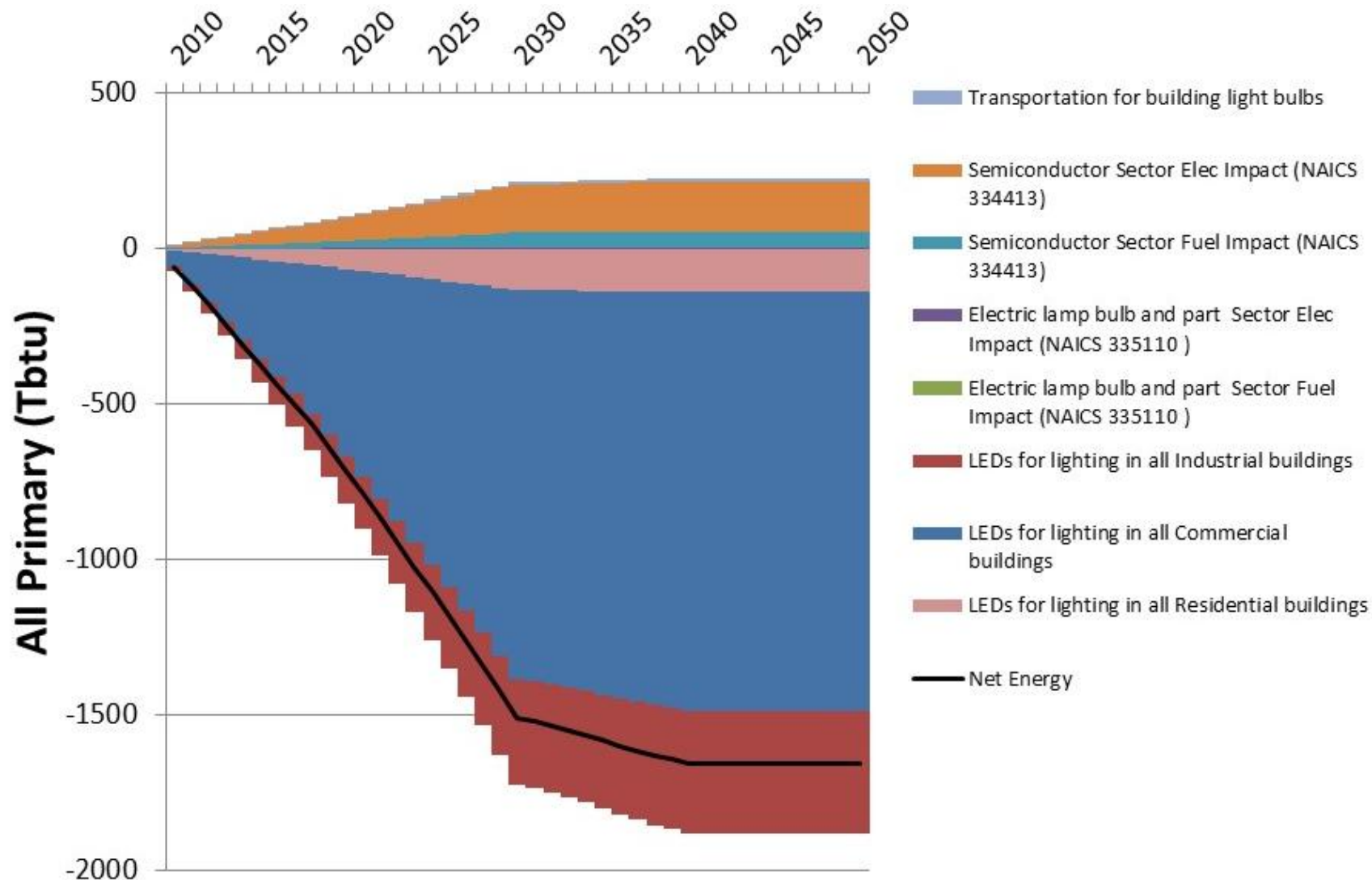
Replace titanium with Ultra-High-Molecular-Weight polyethylene (UHMW-PE)
for U.S. Export LNG seawater heat exchangers

U.S. LNG export sea water heat exchangers: UHMW-PE displaces titanium
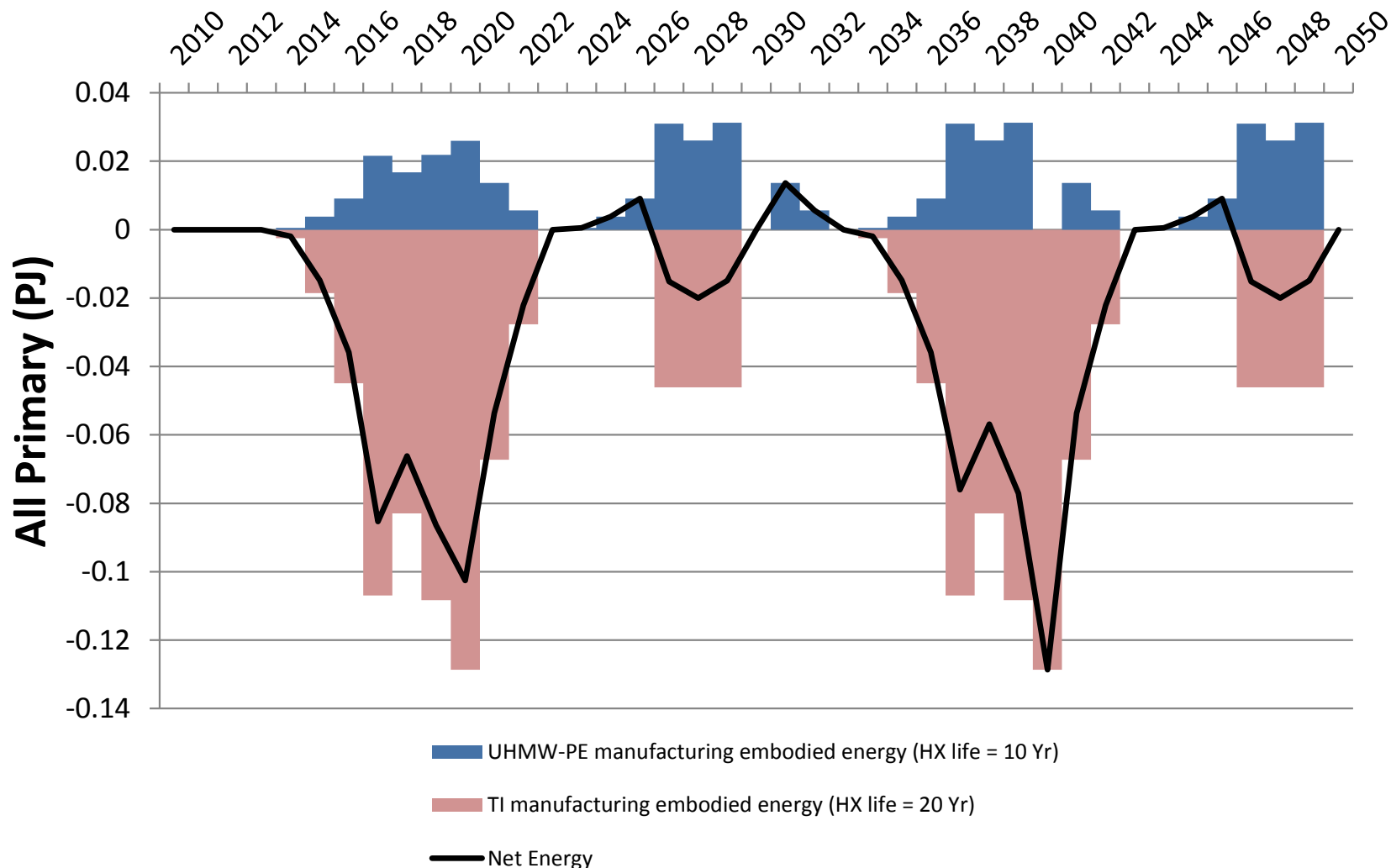
Conclusions

- Objective is to have a consistent method for analyzing and projecting the energy impacts of emerging and advanced technologies.
- This requires careful attention to details
  - The LIGHTEnUP Tool is designed to help guide scenario development

- The MFI & LUP Tools where developed in tandem and they cover different parts of the LCA perspective, but are designed to be integerated

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Thank You!