Small Electric Motors
Energy Conservation Standards
Preliminary Analyses

Public Meeting

Building Technologies Program
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

January 30, 2009

http://www1.eere.energy.gov/buildings/appliance_standards/commercial/small_electric_motors.html

Welcome

- **Introductions**
- **Role of the Facilitator**
- **Ground Rules (norms)**
  - Listen as an ally
  - Use short, succinct statements/keep to the point
  - Hold sidebar conversations outside the room
  - One person speaks at a time (raise hand to be recognized; state your name for the record)
  - Set cell phones to silent/vibrate
- **Housekeeping Items**
- **Agenda Review**
- **Opening Remarks**

Agenda

9:00 – 9:20 am	Welcome, Introductions, Opening Statements
9:20 – 9:30 am	Statute and Context
9:30 – 10:15 am	Market & Tech; Screening Analysis
10:15 – 10:30 am	Break
10:30 – 11:15 am	Engineering Analysis
11:15 – 12:00 pm	Energy Use & End-Use Load; Markup Analysis
12:00 – 1:00 pm	Lunch
1:00 – 1:30 pm	Life-Cycle Cost And Payback Period Analysis
1:30 – 2:00 pm	National Impact Analysis
2:00 – 2:30 pm	Preliminary MIA and other NOPR Analyses
3:00 – 3:30 pm	Final Questions / Discussion
3:30 pm	Closing Remarks and Adjourn

Purpose of the Public Meeting

- Review statute and DOE actions for small electric motors
- Present DOE's preliminary analysis
- Clarify any questions about DOE's approach
- Seek comment from participants on the analysis to date
- Discuss next steps for the rulemaking

Issues for Comment

Issue Box DOE welcomes comments, data, and information concerning its preliminary analysis on small electric motors. Throughout this presentation, issues that correspond to issues raised in DOE's published material from this preliminary analysis are raised for discussion in boxes like this one. Nonetheless, comments are welcome on any part of DOE's analysis.

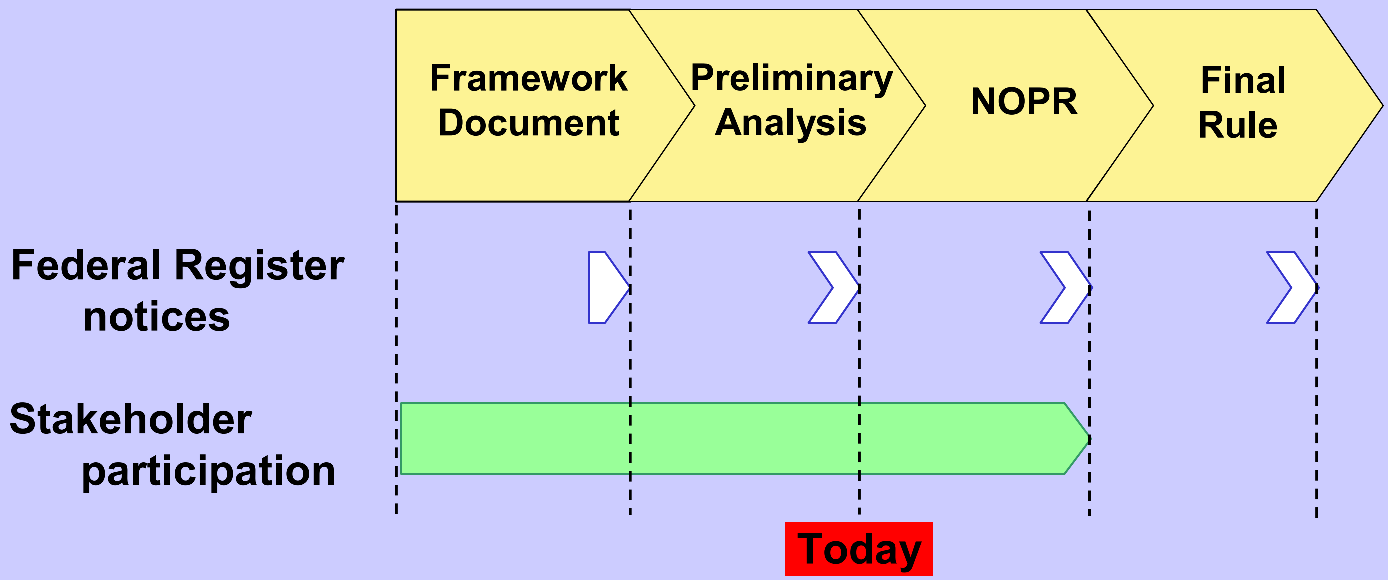
Public Meeting Agenda

1. Statute and Context
2. Market & Tech; Screening; Engineering
3. Energy Use; Markup Analysis
4. Life-Cycle Cost and Payback Period Analysis
5. National Impact Analysis
6. Preliminary MIA; NOPR Analyses

Small Electric Motors

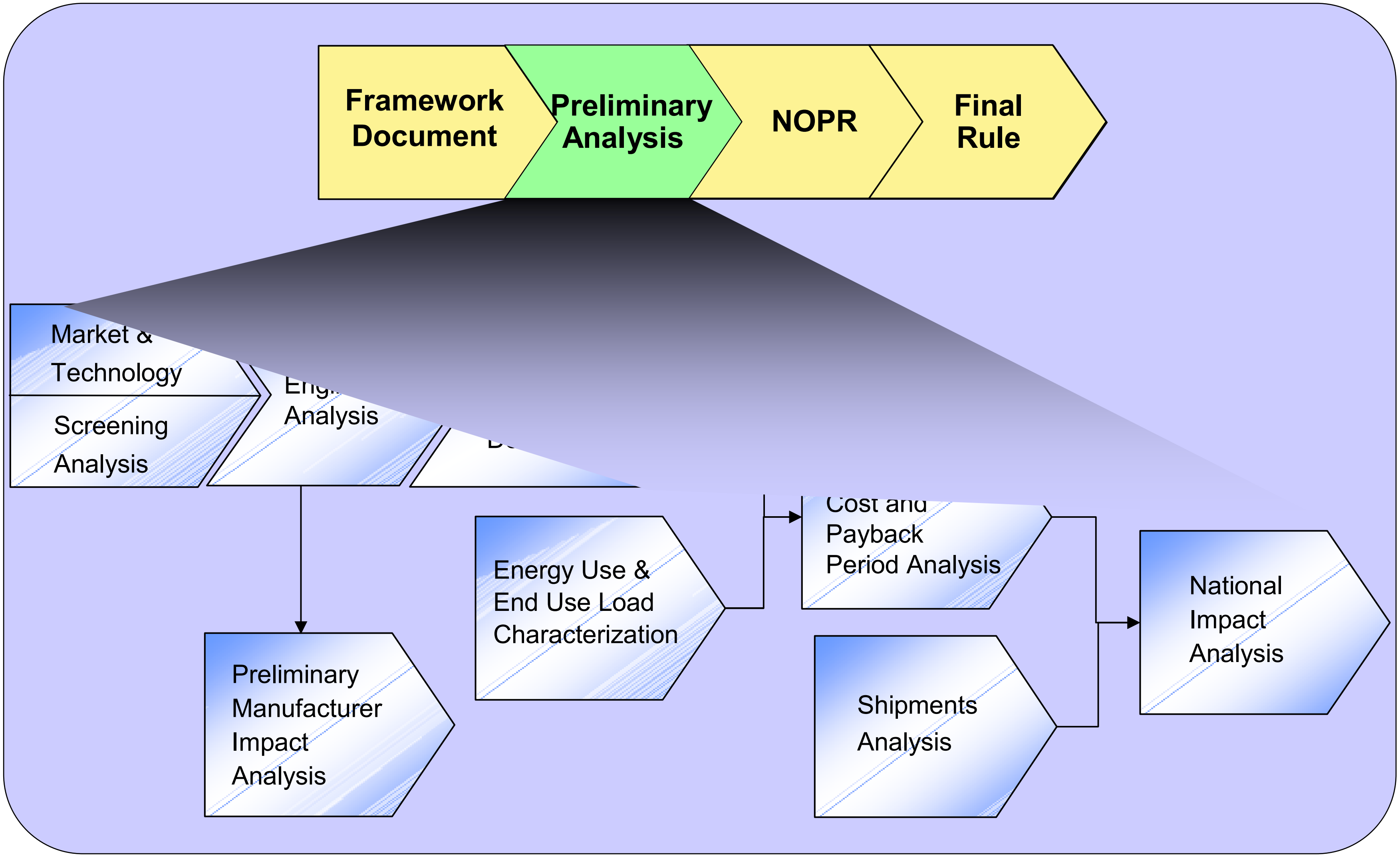
- **The Energy Policy Act of 1992 amended the Energy Policy and Conservation Act to direct DOE to prescribe energy conservation standards for those small electric motors for which the Secretary determines that standards ‘‘would be technologically feasible and economically justified, and would result in significant energy savings.’’ (42 U.S.C. 6317(b)(1)).**
- **DOE conducted analysis and published a positive determination on July 10, 2006. 71 FR 38799.**
- **DOE initiated its energy conservation standards rulemaking by publishing a framework document soliciting comment on its methodology on August 10, 2007. 72 FR 44990.**
- **DOE is conducting a separate rulemaking to establish test procedures for small electric motors.**
  - NOPR published on December 22, 2008. 73 FR 78220.
  - Comment period is open until March 9, 2009.

Stakeholder Participation in the Rulemaking Process

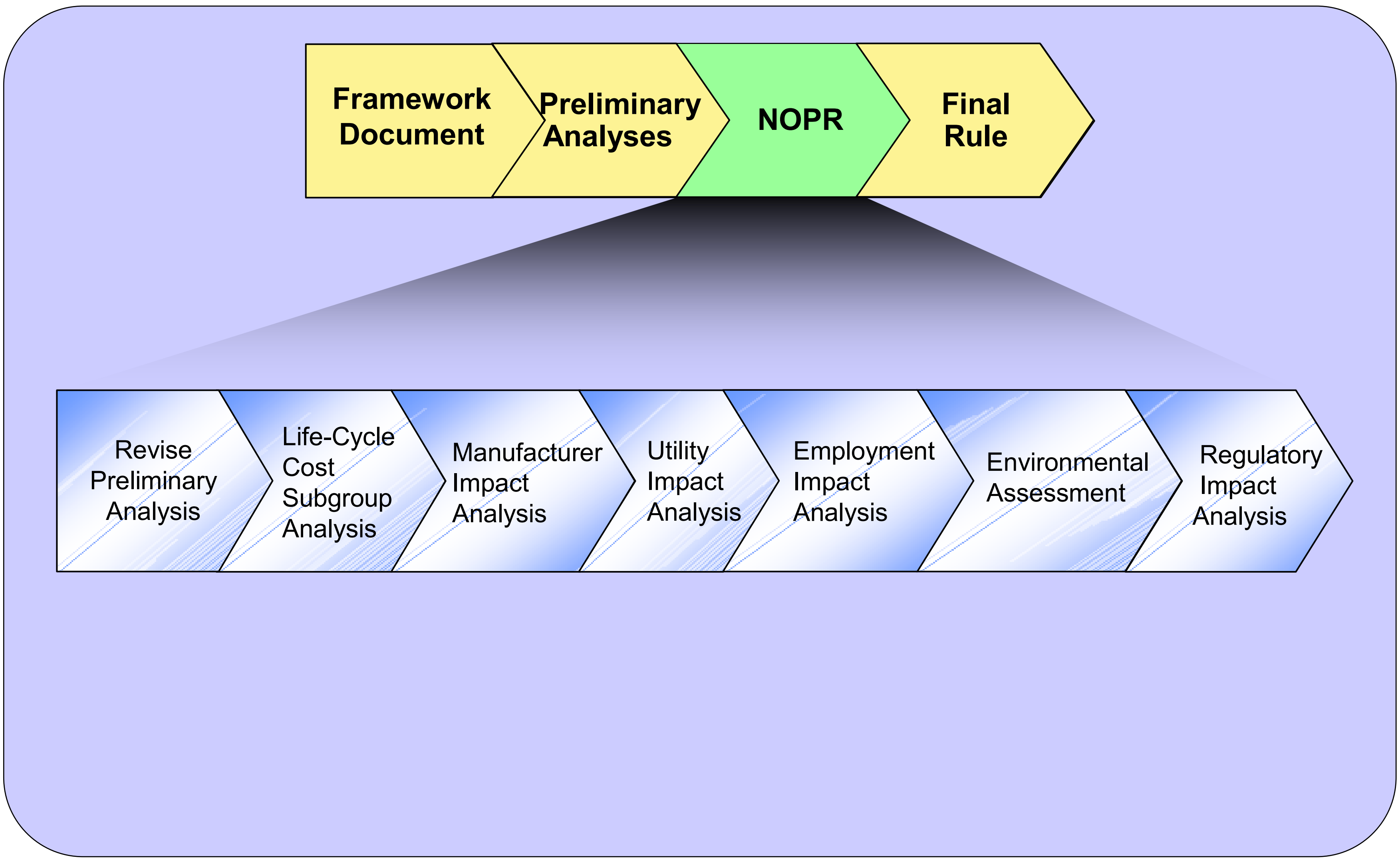


- Public meetings and oral comments
- Written comments on Federal Register notices, Technical Support Documents and Analytical Spreadsheets
- Data input from manufacturers and other interested parties.

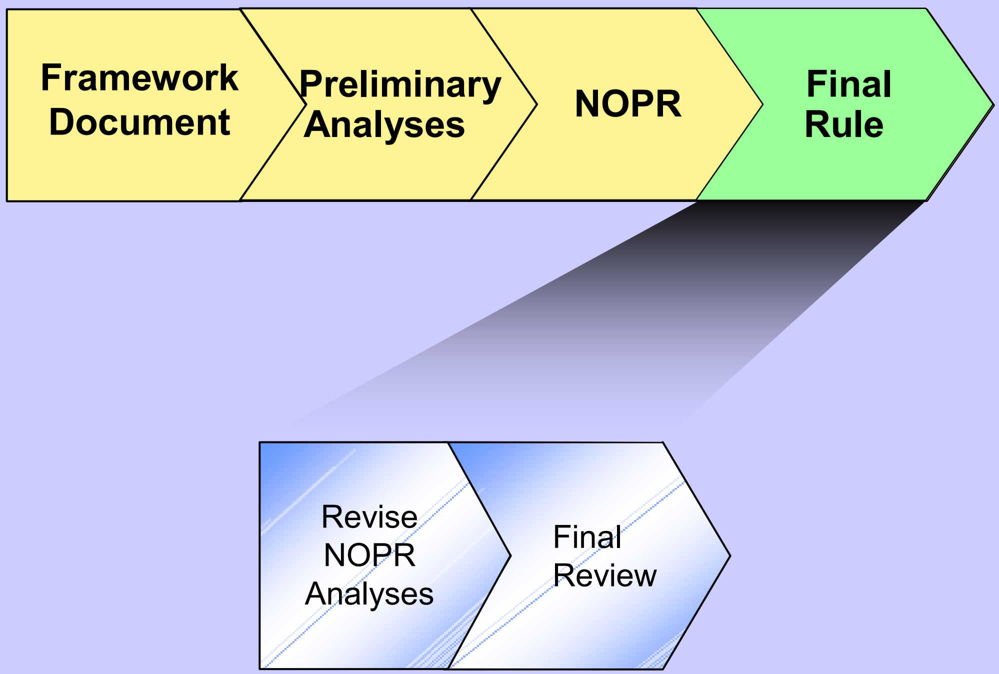
Preliminary Analysis Rulemaking Stage



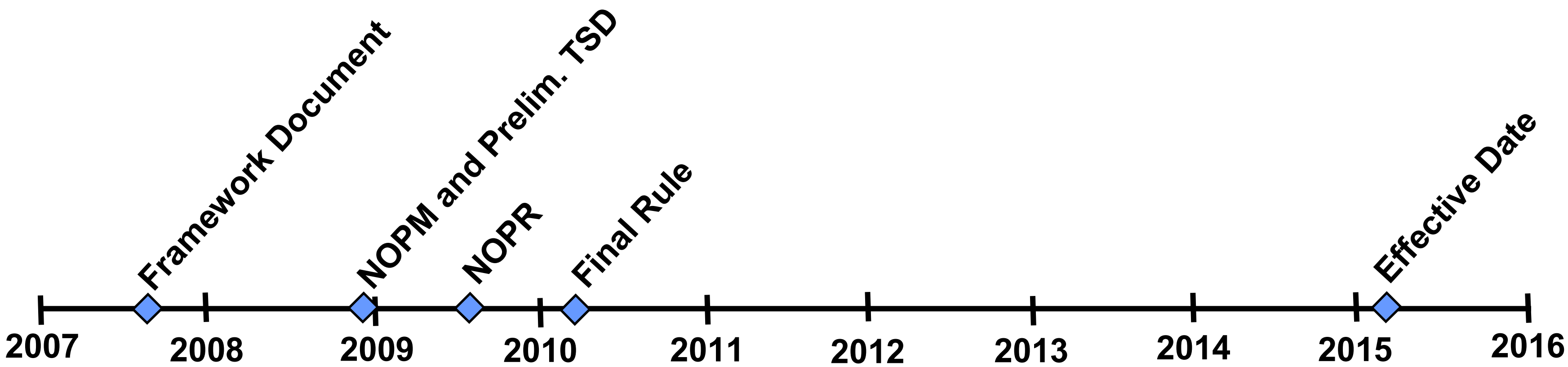
Analyses for Notice of Proposed Rulemaking (NOPR)



Analyses for Final Rule



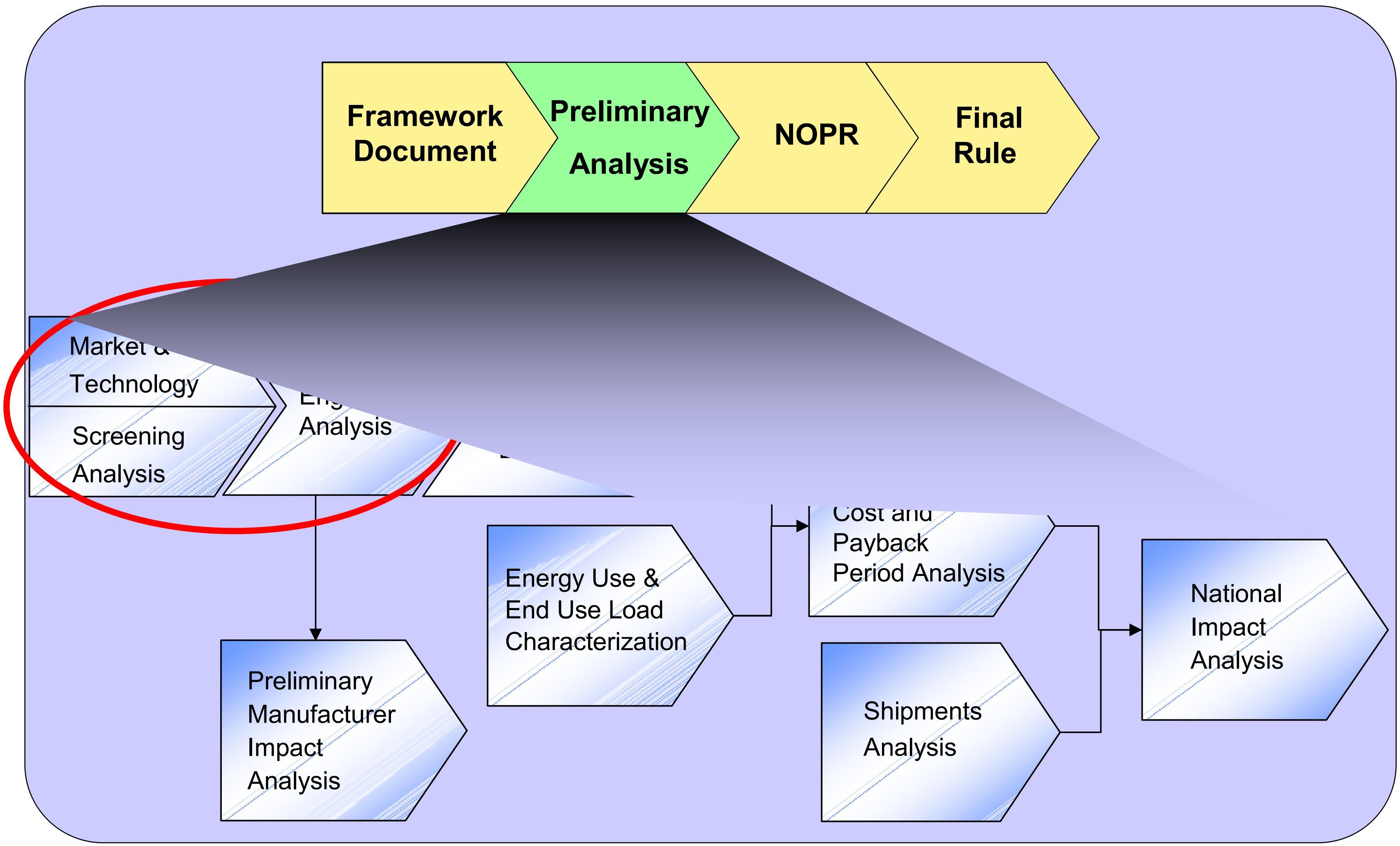
Small Electric Motors Rulemaking Schedule



Milestone	*Date*
Framework Document Published	*August 10, 2007*
Federal Register Notice of Public Meeting and Availability of the Preliminary Technical Support Document	*December 30, 2008*
Issue NOPR	*~July 2009*
Issue Final Rule	*February 2010*
Effective Date (5 years minimum, 42 USC 6317(b)(3))	*February 2015*

Public Meeting Agenda

1. Statute and Context
2. **Market & Tech; Screening; Engineering**
3. Energy Use; Markup Analysis
4. Life-Cycle Cost and Payback Period Analysis
5. National Impact Analysis
6. Preliminary MIA; NOPR Analyses


Framework Document
Preliminary Analysis
NOPR
Final Rule
Market &
Technology
Screening Analysis
Analysis
Payback
Period Analysis
Energy Use & End Use Load Characterization
National Impact Analysis
Preliminary Manufacturer Impact Analysis
Shipments Analysis

Market Assessment

Purpose

- Characterize the small electric motors market and manufacturers
- Determine appropriate equipment classes

Method

- Clarify scope of coverage based on NEMA MG1-1987
- Identify and characterize manufacturers of small electric motors
- Classify covered products into appropriate equipment classes
- Use historical NEMA shipment data provided for the Determination Analysis, estimate current sales

Scope of Coverage

- **Statutory Definition of Small Electric Motor**
  - "a NEMA [National Electrical Manufacturers Association] general-purpose alternating-current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1–1987. " (42 U.S.C. 6311(13)(G))

- **In order to more clearly understand scope, DOE sought to clarify the following terms in this definition:**
  - "general-purpose alternating-current"
  - "induction motor"
  - "two-digit frame number series"

Scope of Coverage

- **"General-purpose alternating-current"**
  - a NEMA term used in MG1-1987 for alternating-current motors that are not designed with a specific application in mind.
  - Paragraph MG1–1.05 defines this term as:
    - A general-purpose alternating-current motor is an induction motor, rated 200 horsepower and less, which incorporates all of the following:

      (1) open construction,

      (2) rated continuous duty,

      (3) service factor in accordance with MG1-12.47, and

      (4) Class A insulation system with a temperature rise as specified in MG1-12.42 for small motors or Class B insulation system with a temperature rise as specified in MG1-12.43 for medium motors. It is designed in standard ratings with standard operating characteristics and mechanical construction for use under usual service conditions without restriction to a particular application or type of application.

Scope of Coverage

- **"induction motor"**
  - Converts electrical power into rotational mechanical power using electromagnetic induction for its operation and has one or more component members capable of rotary movement.
  - Statute requires that small electric motors are built in accordance with NEMA MG1-1987, which has five categories of induction motors: split-phase, shaded-pole, capacitor-start (both CSIR and CSCR), permanent-split capacitor (PSC), and polyphase motors.
  - DOE comes to a preliminary conclusion that the CSIR, CSCR, and polyphase motors are the only categories that meet the statutory requirements.
    - Split-phase motors are designed for specific purposes and applications. DOE is unaware of any general-purpose split-phase motors.
    - Shaded-pole and PSC motors fail to meet the torque requirements for general-purpose motors, under NEMA MG1–1987 (MG1-12.32).

Scope of Coverage

- **"two-digit frame number series"**
  - A motor's standard system of numbers in combination with letters for designating the size and mounting dimensions of a motor.
  - For small electric motors, it is the "D" dimension in inches multiplied by 16.
  - The "D" dimension is measured from the centerline of the shaft to the bottom of the mounting feet.
  - For example, a 48 frame motor would have a "D" dimension of 3.00 inches (16 x 3.00 = 48). Standard dimensions enable ease of replacement.
  - Covered motors are 42, 48 and 56 frame motors
    - MG1-1987 only gives standard dimensions for these three frame sizes
    - Other two-digit sizes, e.g., 66 frame, are likely to be definite-purpose or special-purpose and are not used in general-purpose applications

Request for Comment:
Coverage of Small Electric Motors

Issue: The scope of small electric motors covered under the current rulemaking activity is slightly narrower than that considered for the determination analysis. In the determination analysis, coverage of small electric motors was interpreted to mean open and enclosed construction. DOE now understands the statutory definition of "small electric motor" as being applicable only to motors with open construction. DOE invites interested parties to comment on its understanding of coverage for the preliminary analyses. In particular, DOE requests specific legal bases and detailed supporting evidence for an alternative viewpoint. Please refer to section 2.2.1 of chapter 2 of the preliminary TSD.

Manufacturers of Small Electric Motors

- **Four manufacturers account for more than 90% of the domestic market share of all categories of covered equipment.**
  - A.O. Smith Electrical Products Company
  - Baldor Electric Company
  - Emerson Motor Technologies
  - Regal Beloit Corporation

- **All are members of NEMA**
- **All have diverse portfolios of products, including many other categories of electric motors, other related electrical equipment, and switchgear.**

Equipment Classes

- **DOE divides covered equipment into classes by**
  - (1) the type of energy used;
  - (2) the capacity of the equipment; and
  - (3) any other performance-related features that require different standard levels, such as features affecting consumer utility. (42 USC 6295(q))
- **Different energy conservation standards may apply to different equipment classes**
- **DOE determined that it would classify:**
  - CSIR, CSCR, and polyphase small electric motors separately
  - Horsepower - rated power capacity of the motor, has a direct impact on small motor efficiency
  - Number of poles - impacts the both the rated speed and torque characteristics of the motor
- **72 equipment classes – each a unique combination of horsepower, number of poles, and motor category**

Equipment Classes

- **Proposed table of equipment classes**
- **One table like this for each motor type – polyphase, CSIR, CSCR**

Motor Horsepower/Standard Kilowatt Equivalent	Six Poles	Four Poles	Two Poles
1/4 hp/0.18 kW			
1/3 hp/0.25 kW			
1/2 hp/0.37 kW			
3/4 hp/0.55 kW			
1 hp/0.75 kW			
1½ hp/1.1 kW			
2 hp/1.5 kW			
≥ 3 hp/2.2 kW			

Small Electric Motors Unit Shipments

- **Methodology:**
  - Shipment estimates were prepared using the shipment data NEMA had provided to DOE for the determination analysis in 2006.
  - DOE used publicly available shipment data from the U.S. Census Bureau to calculate an annual growth rate and project the NEMA data to a shipment estimate for 2007.
  - As discussed earlier, DOE only projected open construction motors.
- **Approximately 6,286,000 covered small electric motors shipped in 2007.**
  - Polyphase – approximately 557,000 or 8.9%
  - CSIR – approximately 5,443,000 or 86.6%
  - CSCR – approximately 286,000 or 4.5%

Technology Assessment

- **Purpose: to develop a preliminary list of technology options that could improve the efficiency of small electric motors.**
- **Method: DOE identified technology options from:**
  - Literature review, including manufacturer marketing brochures
  - Determination analysis rulemaking technical reports
  - Comments and input from stakeholders, including DOE technical contractors
- **DOE classified losses into four different groups:**
  - conductor losses (I^2R)
  - core losses
  - friction and windage losses
  - stray-load losses
- **DOE did not identify any technology options that reduce stray-load losses.**

Technology Options

- **Conductor losses (I^2R) - measures DOE considered to reduce:**
  - using copper die-cast rotor cages
  - removing skew on the conductor cage
  - increasing the cross-sectional area of the rotor conductor bars
  - increasing the end-ring size
  - changing gauges of copper wire in the stator
  - manipulating slot size geometry
  - decreasing the air gap between the rotor and stator

Technology Options

- **Core losses – measures DOE considered to reduce:**
  - adding stack length to the motor;
  - changing grades of electrical steel (i.e., improved conventional grades and exotic steel types)
  - annealing laminations
  - thinning laminations
  - using plastic bonded iron powder (PBIP) as a core material
  - using a permanent magnet electric motor

Technology Options

- **Friction and Windage losses – measures DOE considered to reduce:**
  - improving mechanical components and design (e.g., bearings and bearing lubricant)
  - improving the efficiency of the cooling system

Technology Options

- **DOE received comment that improving efficiency can impact the performance / operation of an electric motor. DOE therefore kept the following motor characteristics in mind:**
  - rotor forces and stresses
  - bar shapes and fits
  - aluminum versus copper cages and other alloys
  - rotor skew and air gap
  - the cooling circuit
  - length to diameter ratios
  - speed torque characteristics and slip
  - end ring forces
  - unbalanced magnetic forces and noise
  - application requirements
  - stator core design factors
  - winding elements
  - stator and frame construction
  - rotor design and construction

Request for Comment:
Technology Options for Small Electric Motors

Issue: DOE invites comments on the list of technology options developed in the technology assessment. DOE invites comment on the completeness and description of these technology options. Please refer to section 2.2.3 of chapter 2 of the preliminary TSD.

Screening Analysis

- **Purpose**
  - To apply screening criteria to determine which technology options to evaluate and which to screen out

- **Technology options are screened using the following criteria:**
  - Technological feasibility
  - Practicability to manufacture, install, and service
  - Adverse impacts on product utility or availability to customers
  - Adverse impacts on health or safety

(10 CFR Part 430, subpart C, appendix A at 4(a)(4) and 5(b))

Technology Options Screened Out

- **Three technology options were screened out:**
  - radial air gaps less than 10 thousandths of an inch
  - plastic bonded iron powder
  - permanent magnet electric motors
- **The screening of these options are discussed on the following slides**
- **Preliminary TSD Chapter 4 provides detail on the screening analysis.**

Screened Out: Radial Air Gap <10 Thousandths

- **Reducing the radial air gap between rotor and stator improves efficiency, but at some point exceeds practicability to manufacture.**
- **DOE screened out radial air gaps below ten thousandths of an inch because it is not "practicable to manufacture, install, and service."**
  - Problems in manufacturing and service, because the rotor could come into contact with the stator
- **Also screened out due to adverse impacts on consumer utility and reliability**
  - May experience higher failure rates when manufactured with air gaps are less than ten thousandths of an inch, particularly for motors with taller and heavier rotors.

Screened Out: Plastic Bonded Iron Powder

- **An iron powder alloy suspended in plastic and shaped into motor components, eliminating a number of manufacturing steps. Further, researchers claim this technology option could cut core losses by as much as 50 percent.**
- **DOE screened out PBIP because it has never been incorporated into a working prototype of a small electric motor**
  - DOE is uncertain whether the material has the structural integrity to be formed into a small electric motor
- **DOE is also uncertain whether PBIP would be practical to manufacture, install, and service**
  - Insufficient information available on the ability to manufacture this technology

Screened Out: Permanent Magnet Electric Motors

- **A rotating machine whose stator has surface-mounted permanent magnets, thus the air gap magnetic field is produced by permanent magnets.**
- **DOE screened out permanent magnet electric motors because these motors cannot be manufactured as small electric motors, as defined in EPCA.**
  - Necessary controls to start and operate the motor may make it impractical to install the electric motor in certain equipment

Technology Options Selected for Further Consideration

- Use a copper die-cast rotor cage
- Remove skew on conductor cage
- Increase cross-sectional area of the rotor conductor bars
- Increase end ring size
- Manipulate stator slot size
- Decrease the air gap between rotor and stator (no less than 10 thousandths of an inch)
- Use improved grades of electrical steel
- Use thinner steel laminations
- Anneal steel laminations
- Add stack height (i.e. more electrical steel)
- Use high-efficiency lamination materials
- Install better bearings and lubricant
- Install a more efficient cooling system

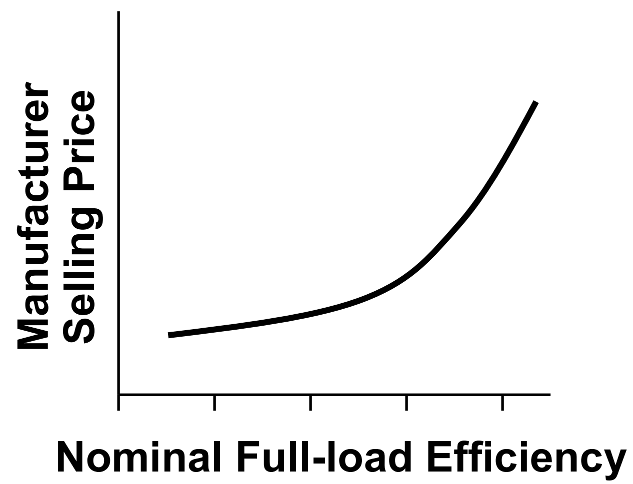
Request for Comment:
Screened Out Technologies

Issue: DOE invites comments on the three technology options that were screened out of the analysis—radial air gaps below ten thousandths of an inch, plastic bonded iron powder, and permanent magnet electric motors. Please refer to section 2.3 of chapter 2 of the preliminary TSD.

Purpose of the Engineering Analysis

- To evaluate design options that improve efficiency relative to the baseline units
- To characterize manufacturer selling price versus nominal full-load efficiency relationship for higher efficiency small electric motors

Manufacturer Selling Price – Efficiency Relationship



Downstream Analyses

- **Life-Cycle Cost and Payback Period**
- **National Impact Analysis**

Selecting Representative Units to Analyze

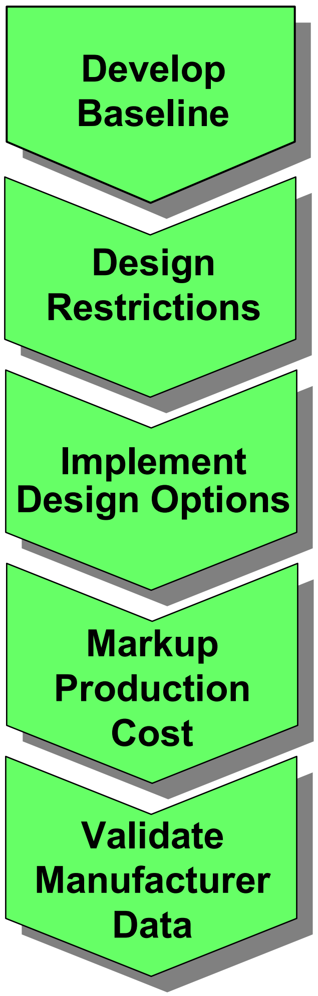
- **Selecting the representative motors to analyze**
  - Reviewed the small electric motor determination analysis
  - Reviewed manufacturers' sales catalogs
  - Considered three variables:
    - motor categories (three categories)
    - horsepower rating (eight rating categories)
    - number of poles (three configurations)
- **Motor Categories - ensure each motor category was represented: CSIR, CSCR, and polyphase.**
- **Horsepower - ratings commonly available in several manufacturer catalogs and scalable to other equipment classes.**
- **Number of poles - selected four-pole motors because 1) highest 2007 shipment volume and 2) falls between 2 and 6 poles, minimize any error from scaling from 4 to 2 and 6 poles.**

Engineering Analysis Representative Units

- **DOE selected four motors from three equipment classes for its analysis:**
  - Polyphase, 1 hp, 4 pole, 56 frame motor
  - Capacitor-start, induction-run, ½ hp, 4 pole, 56 frame motor
  - Capacitor-start, induction-run, ½ hp, 4 pole, 48 frame motor
  - Capacitor-start, capacitor-run, ¾ hp, 4 pole, 56 frame motor

- **Two-Pronged Approach**
  - Efficiency curves for each motor listed above using a subcontractor's proprietary design software.
  - Software outputs bill of materials, coupled with labor estimates and mark-ups to arrive at a manufacturer's selling price.

Engineering Analysis Methodology



- Defined baseline specifications for each equipment class analyzed.
- Design criteria set to ensure that the resulting designs would be both reasonable and manufacturable.
- Design option combinations ordered from shortest payback to longest payback.
- Bill of materials, labor estimates and estimated manufacturer mark-ups to convert production cost to selling price (MSP).
- Curves and slopes compared with data provided by a few manufacturers under confidentiality agreements.

Small Electric Motor Design Analysis – Manufacturability (1 of 3)

- Peak slot fill – the maximum value this parameter should reach is 75 percent for an assumed high volume simultaneous insertion process. (Note: DOE considers "slot fill" to be the area of the wire (including insulation) divided by the total slot area available for winding.)

- Air gap between rotor and stator – the air gap between the rotor and stator should not be less than 0.010 inches. Having air gaps tighter than this minimum could be problematic and may cause contact between the spinning rotor and the stator, especially as shaft length increases.

- Stator slot opening – the opening in combination with the copper wire gauges used should graph to a point in the "Level Wind Area" of the "Blade Gap Chart" taken from Alliance Winding. Without this restriction, DOE is concerned there may be too many issues with wire breakage and jamming of manufacturers' winding tools.

Small Electric Motor Design Analysis – Manufacturability (2 of 3)

- Stack height – the stack height (or length) may change by up to 100 percent relative to the baseline height (i.e., the stack height may double the original value). This design option enables motors to regain induction when steel grades are improved.

- Locked rotor torque – the torque must be kept within 10 percent of the baseline motor, and be within the specifications set forth by NEMA MG 1-1987 in Section 12.32.2. (e.g., for a 0.5 hp, four-pole motor the minimum is 85 oz-ft., [7.2 Newton meters]). Maintaining the locked rotor torque within 10 percent of the baseline motor will help preserve the utility of the more efficient motor designs.

- Locked rotor current – the current should not exceed the values of NEMA MG 1-1987 Section 12.33.2 (Design N) (e.g., 45 amperes for a 115-volt, 0.5 hp motor).

Small Electric Motor Design Analysis – Manufacturability (3 of 3)

- Breakdown torque – the breakdown torque must fall within NEMA MG 1-1987 Table 10-5 limits for all ratings (e.g., for 0.5 hp, four-pole small electric motor greater than 40.5 oz-ft, but not to exceed 58.0 oz-ft [3.43-4.91 Newton meters]).

- Cooling system – the parameters directly related to the motor's cooling system, such as ventilation openings in the laminations, should not be modified in a manner that will increase the operating temperature of the motor.

- Rotor skew – the rotor skew may be altered, but it cannot be raised or lowered to a point that will introduce harmonics that adversely affect motor performance or introduce cusps in the acceleration curve. (Note: this design limitation relies on the expertise of the motor designer).

Cost Model Inputs

- **Full production costs**
  - Material and component costs derived from a Bill of Materials generated by third-party design software and input from industry experts
  - Labor costs estimated, based on industry experts

- **Direct material**
- **Direct labor**
- **Factory overhead**
- **Depreciation**

- **Sales & marketing**
- **Research & development**
- **Interest**
- **Profit**

Cost Model Inputs - Material

- Bill of materials is calculated from three types of material costs: fixed costs, variable costs and semi-fixed costs.
- Fixed cost materials are those parts and components that are constant across all designs and do not vary with efficiency, e.g., switches or ball-bearings.
- Variable costs are those based on the cost of the material and the amount of that material used in the design. E.g., stator and rotor lamination costs are variable because the material price for the different steel grades changes as does the volume of steel needed in each design.
- Semi-fixed costs are those with a constant price per pound, which vary in cost from design to design as a function of the amount used in the motor designs. E.g., die-cast aluminum or copper used in the rotor bars. The price per pound for aluminum or copper is the same from design to design; however, the cost per design is different because the amount varies with each design.

Cost Model Inputs - Material

Steel	$/lb
M36 24 gage	0.65
M36 29 gage	0.70
M19 24 gage	0.75
M19 29 gage	0.80
M15 29 gage	0.90

Metal	$/lb
Copper	3.49
Aluminum	1.11

Wire Gauge	$/lb
19	3.83
19.5	3.84
20	3.85
20.5	3.86
21	3.87
21.5	3.88
22	3.90
22.5	3.91
23	3.92

- **Steel costs, metal costs, and copper wire gauge costs used as inputs to the engineering analysis**
- **Prices were estimated after conversations with industry experts and DOE technical consultants, as well as comments received at framework public meeting**

Cost Model Inputs - Labor

Table 5.4.1 Labor Markups for Small Electric Motor Manufacturers

Item description	Markup percentage	Rate per hour
Labor cost per hour*		$ 13.55
Indirect Production**	33 %	$ 18.02
Overhead***	30 %	$ 23.43
Fringe†	28 %	$ 29.99
Assembly Labor Up-time††	43 %	$ 42.88
Non-Production Mark-up†††	37%	$ 58.75
Cost of Labor Input to Spreadsheet		**$ 58.75**

* Cost per hour is from U.S. Census Bureau, *2002 Economic Census of Industry*, published December 2004, Table 5, page 5. Data for NAICS code 3353121 "Fractional Horsepower Motors" Production workers hours and wages.
** Indirect Production Labor (Production managers, quality control, etc.) as a percent of direct labor on a cost basis. Navigant Consulting, Inc. (NCI) estimate.
*** Overhead includes commissions, dismissal pay, bonuses vacation, sick leave, and social security contributions. NCI estimate.
† Fringe includes pension contributions, group insurance premiums, workers compensation. Source: U.S. Census Bureau, *2002 Economic Census of Industry*, published December 2004, Table 3, page 3. Data for NAICS code 335312 "Motors and generator manufacturing," total fringe benefits as a percent of total compensation for all employees (not just production workers).
†† Assembly labor up-time is a factor applied to account for the time that workers are not assembling product and/or reworking unsatisfactory units. The markup of 43 percent represents a 70 percent utilization (multiplying by 100/70). NCI estimate.
††† Non-production markup reflects non-production costs, including sale and general administrative, research and development, interest payments, and profit factor markups. Source: SEC 10-K reports for A.O. Smith, Baldor, Emerson, and Regal-Beloit.

Cost Model Markups

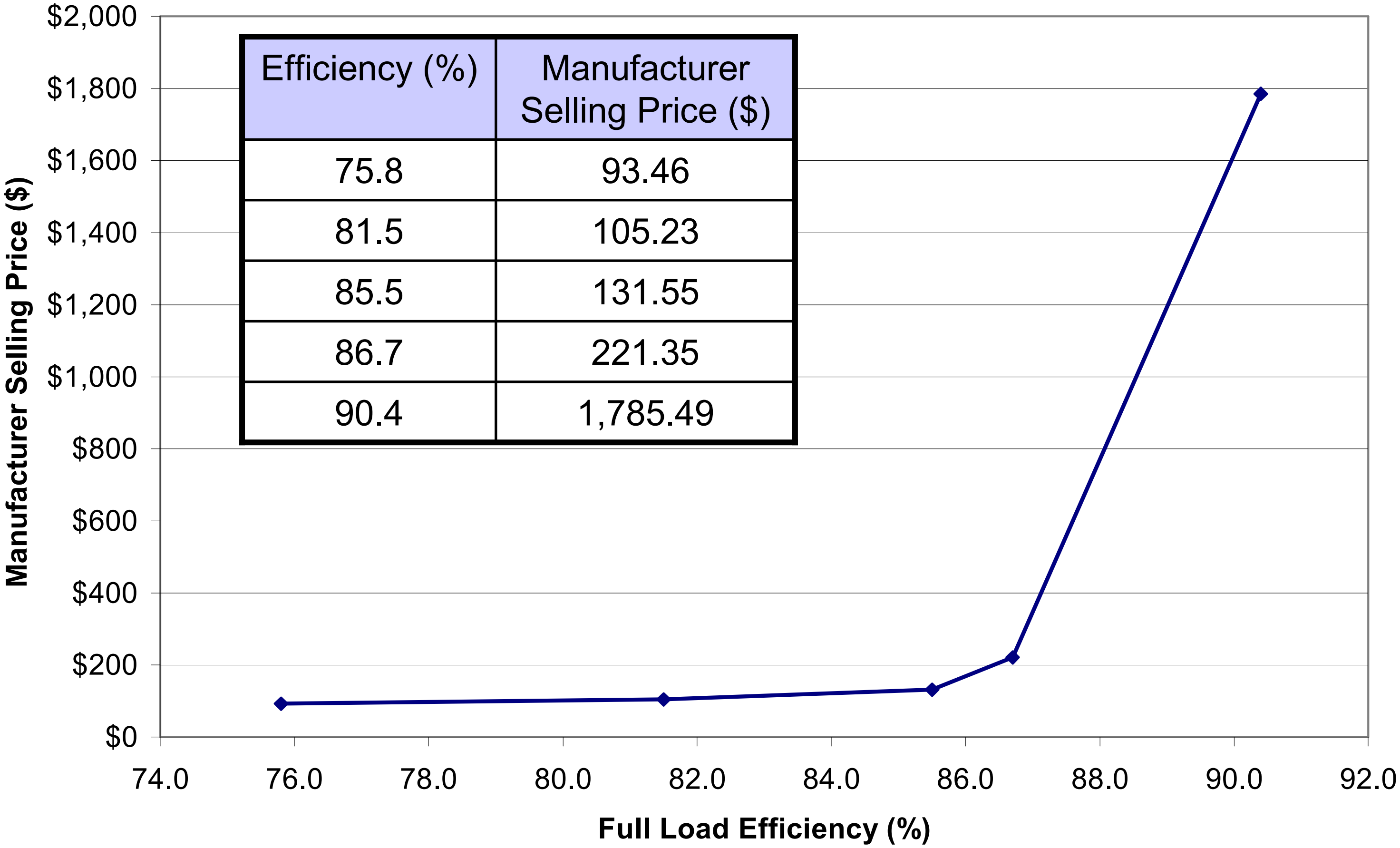
- **DOE developed manufacturer markups**
  - Scrap factor: 2.5% – handling of material in the factory and scrap material that cannot be used (i.e., short wire lengths)
  - Factory overhead: 12.5% – indirect costs associated with production, indirect materials, energy use, taxes & insurance.
  - Non-production: 37% – sales and general administrative costs, R&D, interest payments and profit.

Full Production Cost **+** Manufacturer Markups (Non Production Costs) **=** Manufacturer Selling Price

Full Production Cost:
- Direct material
- Direct labor
- Factory overhead
- Depreciation

Manufacturer Markups (Non Production Costs):
- **Sales & marketing**
- **Research & development**
- **Interest**
- **Profit**

Results for Polyphase, 1 hp, 4 Pole, 56 Frame Motor



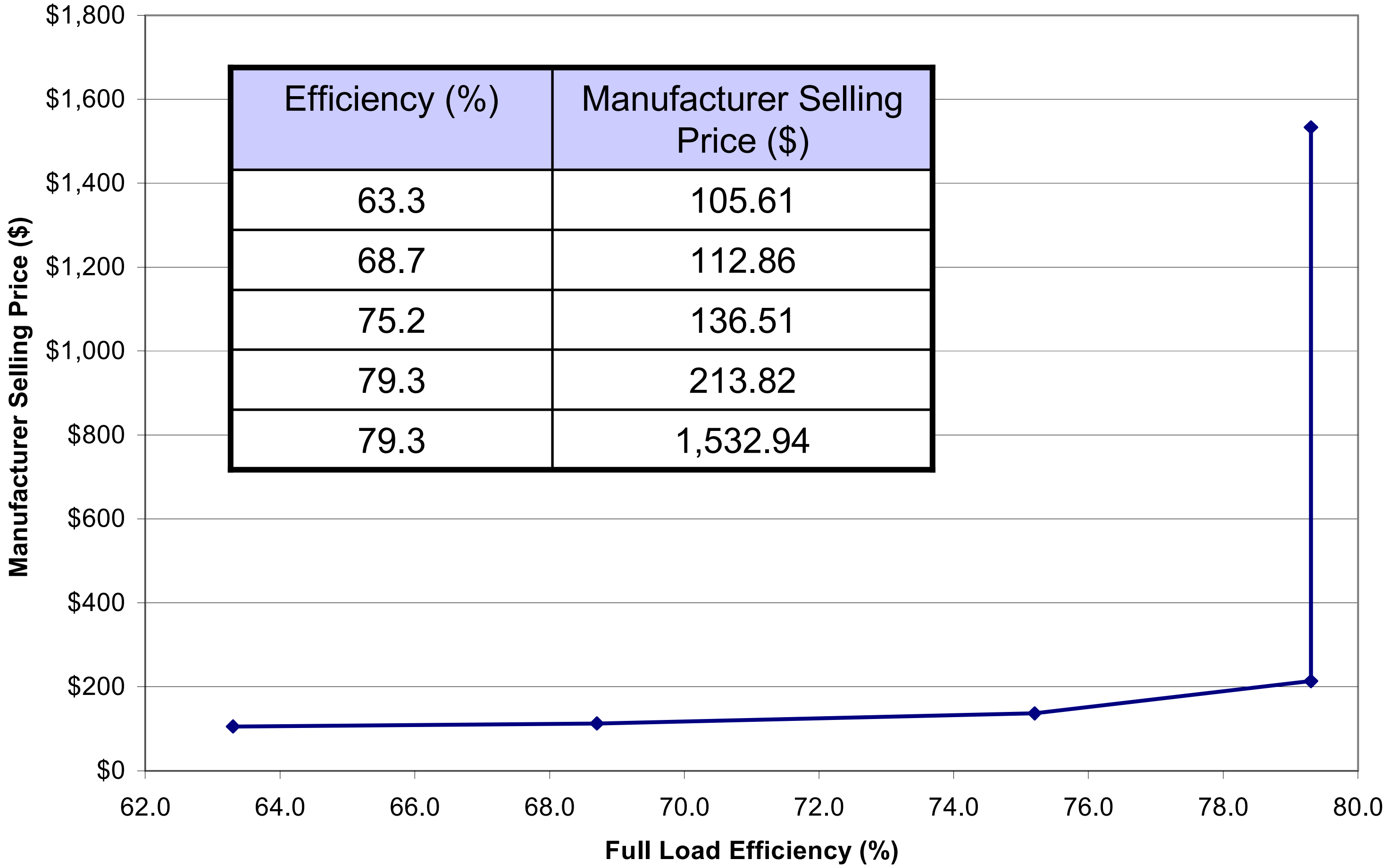
Efficiency (%)	Manufacturer Selling Price ($)
75.8	93.46
81.5	105.23
85.5	131.55
86.7	221.35
90.4	1,785.49

Results for Polyphase, 1 hp, 4 Pole, 56 Frame Motor

Table 5.5.2. Polyphase, 1 Horsepower, 4-Pole, 56-Frame Motor Designs

Parameter	Units	Baseline	Energy Efficient	Premium	Premium Plus	Max Tech
Efficiency	*%*	75.8	81.5	85.5	86.7	90.4
Line Voltage	*V*	230	230	230	230	230
Speed	*RPM*	1714	1703	1709	1719	1729
Torque	*oz-ft*	49.6	51.2	49.8	51.4	48.3
Current	*A*	4.5	4.0	4.0	3.9	3.1
Steel		24M56	24M56	24M19	29M15	Hiperco 50 0.006
Rotor Conductor Material		Aluminum	Aluminum	Aluminum	Copper	Copper
Main Wire	*AWG*	19.0	20.0	19.0	20.5	19.0
Main Wire Weight	*lbs*	2.530	4.250	5.480	5.850	9.584
Rotor Conductor Weight	*lbs*	1.069	1.078	1.174	1.900	4.890
Peak Slot Fill	*%*	32.0	55.0	68.4	74.6	73.9
Locked Rotor Torque	*oz-ft*	125.0	128.0	125.0	127.0	124.0
Locked Rotor Current	*A*	18.5	17.5	17.5	18.6	18.2
Stack Length	*in*	2.75	2.85	3.00	3.00	3.50
Laminations per Stack	*#*	110	114	120	215	584
Housing Weight	*lbs*	6.41	6.50	6.60	6.60	7.56
Slot Liner	in^2	126.186	130.818	137.522	137.522	160.440
Slot Peg	in^2	16.319	16.917	17.795	17.795	20.640

Results for Capacitor-start, Induction-Run, ½ hp, 4 Pole, 56 Frame Motor



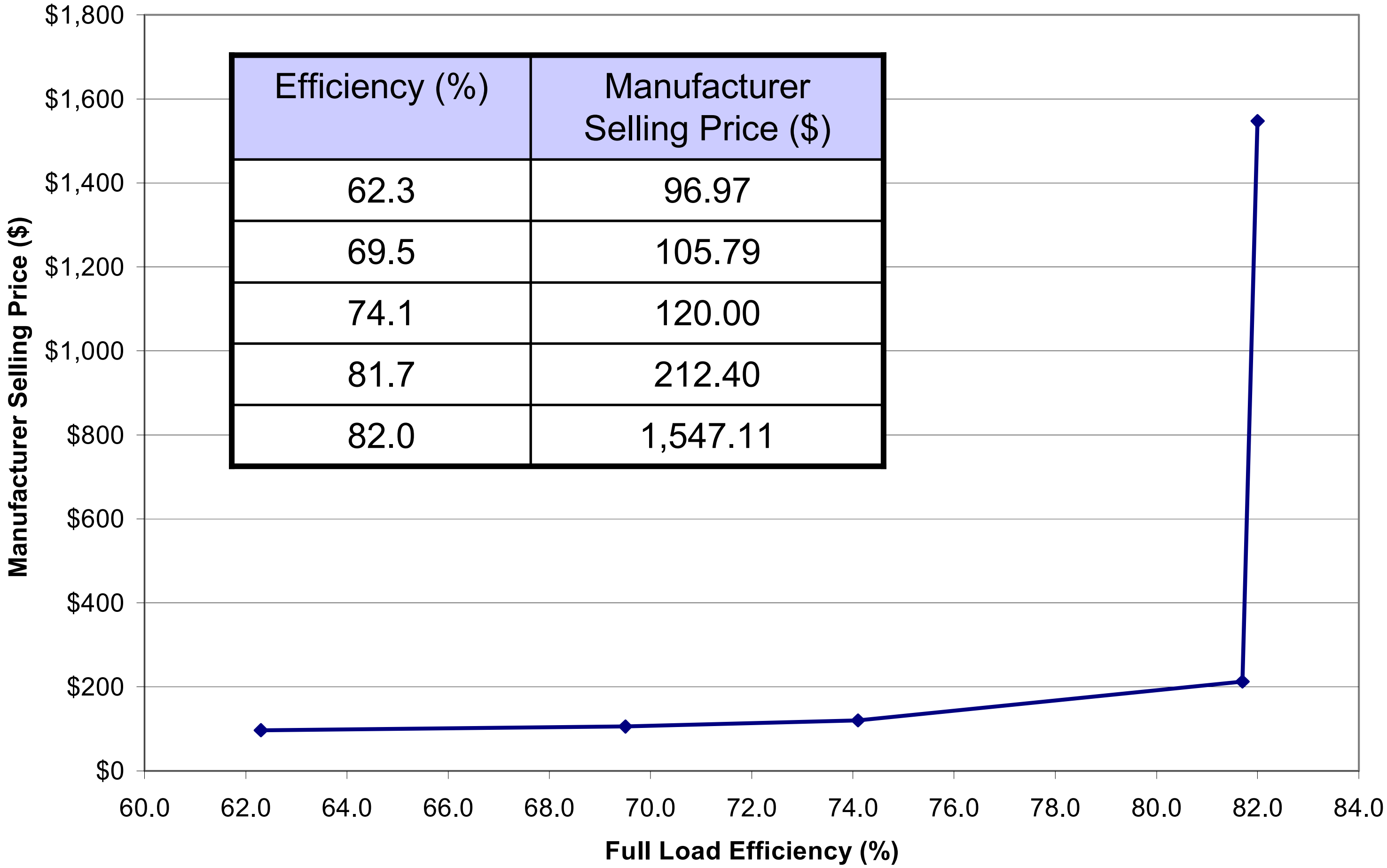
Efficiency (%)	Manufacturer Selling Price ($)
63.3	105.61
68.7	112.86
75.2	136.51
79.3	213.82
79.3	1,532.94

Results for CSIR, ½ hp, 4 Pole, 56 Frame Motor

Table 5.5.4. Capacitor-Start, Induction-Run, 1/2 Horsepower, 4-Pole, 56-Frame Motor Designs

Parameter	Units	Baseline	Energy Efficient	Premium	Premium Plus	Max Tech
Efficiency	*%*	63.3	68.7	75.2	79.3	79.3
Line Voltage	*V*	115	115	115	115	115
Speed	*RPM*	1727	1727	1727	1760	1760
Torque	*oz-ft*	24.37	24.44	26.41	24.13	24.13
Current	*A*	9.17	7.98	8.48	8.18	8.18
Steel		24M56	24M56	24M19	29M15	Hiperco 50 0.006
Rotor Conductor Material		Aluminum	Aluminum	Aluminum	Copper	Copper
Main Wire	*AWG*	20.5	20	19	19	20
Auxiliary Wire	*AWG*	20.5	20	19.5	19	19
Main Wire Weight	*lbs*	2.586	3.063	3.777	3.777	5.117
Auxiliary Wire Weight	*lbs*	0.955	1.101	1.327	1	1.068
Rotor Conductor Weight	*lbs*	0.723	1.06	1.09	1.71	2.67
Start Capacitor	*μF*	300	300	300	450	450
Peak Slot Fill	*%*	58.82	65.97	74.95	74.12	74.7
Locked Rotor Torque	*oz-ft*	85	85.2	87.08	90.22	93.78
Locked Rotor Current	*A*	36.1	34.6	37.5	41.16	38
Stack Length	*in*	2	2.3	2.6	2.6	3
Laminations per Stack	*#*	80	92	104	186	500
Housing Weight	*lbs*	6.1	6.15	6.3	6.3	7.245
Slot Liner	in^2	91.71	105.56	119.17	119.17	137.3
Slot Peg	in^2	11.86	13.66	15.42	15.42	17.71

Results for Capacitor-Start, Induction-Run, ½ hp, 4 Pole, 48 Frame Motor



Efficiency (%)	Manufacturer Selling Price ($)
62.3	96.97
69.5	105.79
74.1	120.00
81.7	212.40
82.0	1,547.11

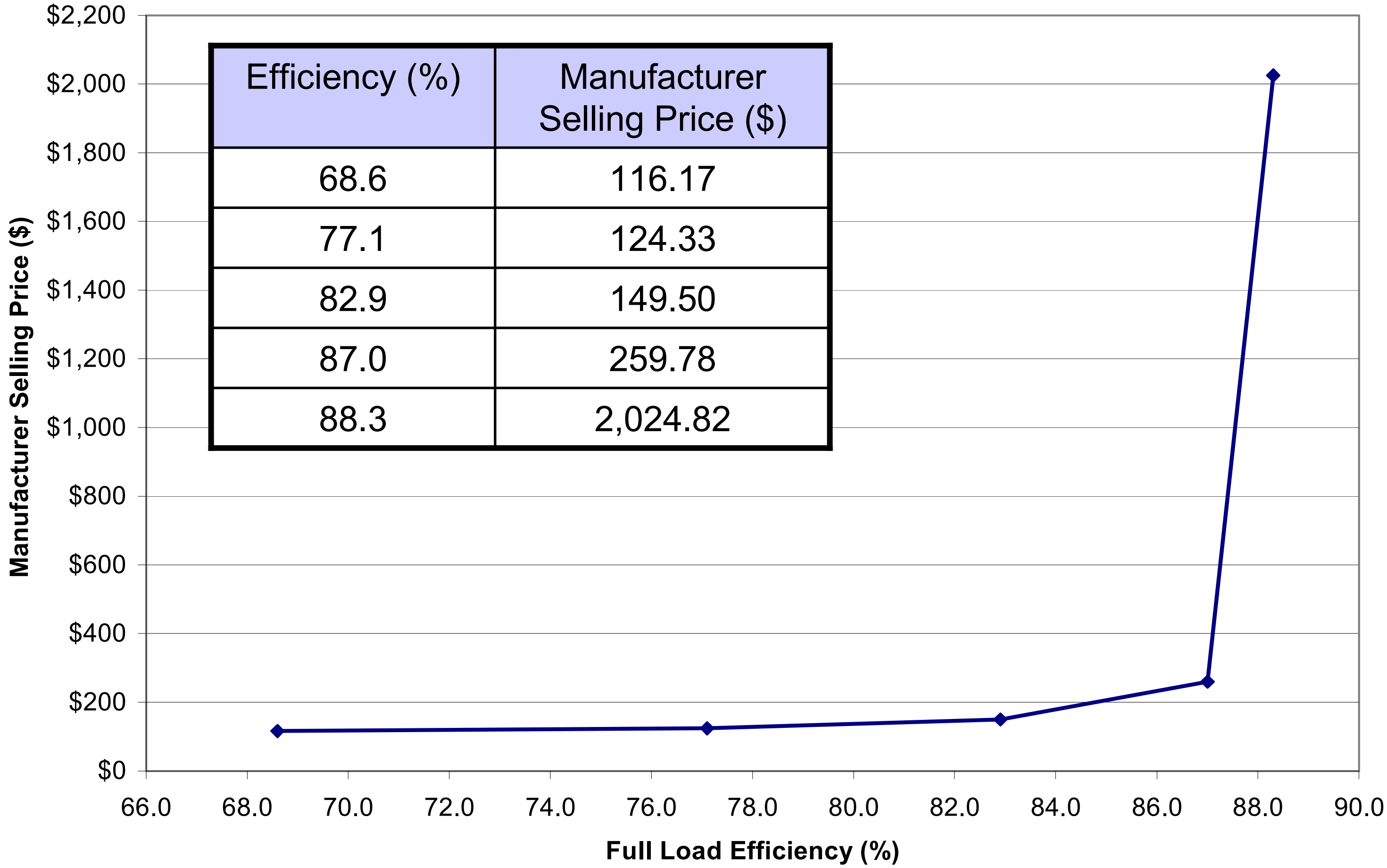
Results for CSIR, ½ hp, 4 Pole, 48 Frame Motor

Table 5.5.6. Capacitor-Start, Induction-Run, 1/2 Horsepower, 4-Pole, 48-Frame Motor Designs

Parameter	Units	Baseline	Energy Efficient	Premium	Premium Plus	Max Tech
Efficiency	%	62.3	69.5	74.1	81.7	82.0
Line Voltage	*V*	115	115	115	115	115
Speed	*RPM*	1737	1736	1738	1765	1743
Torque	*oz-ft*	24.2	24.4	24.2	24.2	24.2
Current	*A*	9.0	8.1	8.1	7.3	6.7
Steel		24M56	24M56	24M19	29M15	Hiperco 50 0.006
Rotor Conductor Material		Aluminum	Aluminum	Aluminum	Copper	Copper
Main Wire	*AWG*	19.5	20.5	20.5	20.0	20.5
Auxiliary Wire	*AWG*	20.0	20.0	20.0	21.5	21.5
Main Wire Weight	*lbs*	1.561	2.591	2.636	3.114	4.498
Auxiliary Wire Weight	*lbs*	0.916	0.957	0.974	1.155	1.262
Rotor Conductor Weight	*lbs*	0.645	0.675	0.688	2.392	3.990
Start Capacitor	*μF*	300	300	300	440	440
Peak Slot Fill	%	49.0	72.2	72.2	74.9	74.6
Locked Rotor Torque	*oz-ft*	85.3	89.2	90.1	84.1	114.3
Locked Rotor Current	*A*	35.1	34.3	34.4	45.2	42.2
Stack Length	*in*	2.65	2.90	3.00	3.40	4.00
Laminations per Stack	#	106	116	120	243	667
Housing Weight	*lbs*	4.70	4.90	5.00	5.50	6.65
Slot Liner	in^2	121.440	133.008	137.575	155.920	188.990
Slot Peg	in^2	15.710	17.211	17.802	20.177	24.410

Results for Capacitor-Start, Capacitor-Run, ¾ hp, 4 Pole, 56 Frame Motor

Efficiency (%)	Manufacturer Selling Price ($)
68.6	116.17
77.1	124.33
82.9	149.50
87.0	259.78
88.3	2,024.82



Results for CSCR, ¾ hp, 4 Pole, 56 Frame Motor

Table 5.5.8. Capacitor-Start, Capacitor-Run, 3/4 Horsepower, 4-Pole, 56-Frame Motor

Parameter	Units	Baseline	Energy Efficient	Premium	Premium Plus	Max Tech
Efficiency	%	68.6	77.1	82.9	87.0	88.3
Line Voltage	*V*	115	115	115	115	115
Speed	*RPM*	1725	1732	1735	1759	1745
Torque	*oz-ft*	36.4	37.6	36.6	36.4	35.9
Current	*A*	11.6	8.7	7.6	7.3	6.3
Steel		24M56	24M56	24M19	29M15	Hiperco 50 0.006
Rotor Conductor Material		Aluminum	Aluminum	Aluminum	Copper	Copper
Main Wire	*AWG*	20.5	19.5	19.0	20.0	19.0
Auxiliary Wire	*AWG*	20.0	20.0	21.5	20.0	20.0
Main Wire Weight	*lbs*	2.201	2.937	3.354	4.124	5.745
Auxiliary Wire Weight	*lbs*	0.741	0.699	1.104	1.495	1.614
Rotor Conductor Weight	*lbs*	0.778	1.123	1.136	2.242	3.516
Start Capacitor	*μF*	550	550	400	550	550
Run Capacitor	*μF*	20	45	50	50	50
Peak Slot Fill	%	44.7	55.7	61.6	74.2	71.7
Locked Rotor Torque	*oz-ft*	119.4	119.2	126.7	129.9	156.4
Locked Rotor Current	*A*	51.2	46.9	39.7	53.3	52.1
Stack Length	*in*	2.60	2.95	3.10	3.30	4.00
Laminations per Stack	#	104	118	124	236	667
Housing Weight	*lbs*	6.10	6.15	6.30	6.50	7.86
Slot Liner	in^2	119.168	135.261	142.164	151.220	183.030
Slot Peg	in^2	14.904	17.503	18.396	19.567	23.660

More Information on the Engineering Analysis

- **TSD Chapter 5**
  - Detail on baseline motors analyzed
  - Detail on methodology followed for the engineering analysis
  - Detail on the cost model, including material prices and assumed hourly fully-loaded labor rate
  - Results of the engineering analysis, including performance characteristics
- **TSD Appendix 5A**
  - Design information on one electric motor design from each of the four representative equipment classes analyzed in the engineering analysis.

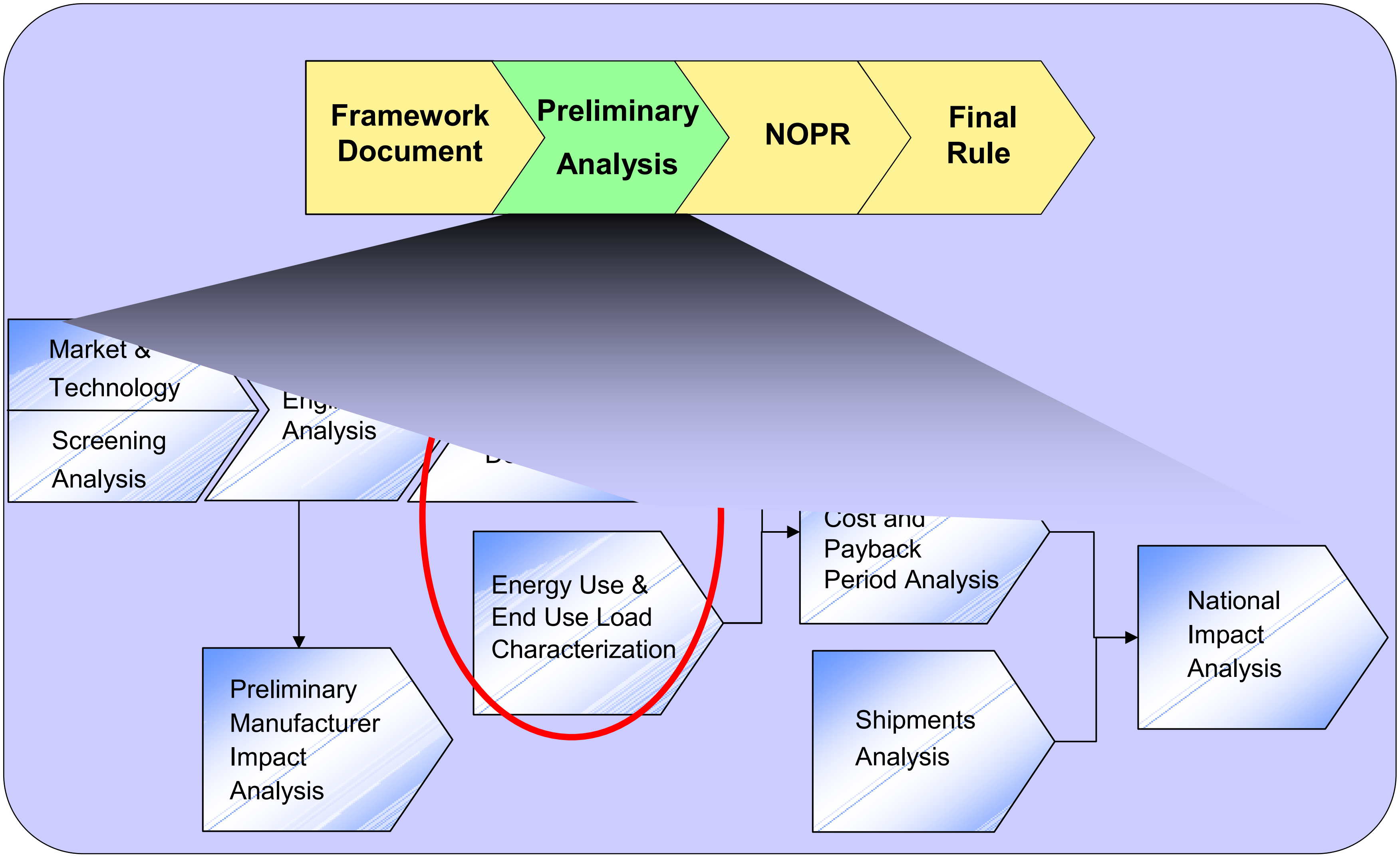
Issues for Discussion

Issue: DOE invites comments on the methodology followed for the preliminary TSD, namely use of engineering software to design more efficient versions of the four representative units analyzed. DOE is also interested in comment on the baseline models selected, and whether these are the appropriate baseline models on which to be base the engineering analysis. Finally, DOE is also interested in comments on the estimated manufacturer markups and labor rates that enable the conversion of input costs to selling prices. Please refer to section 2.4 of chapter 2 of the preliminary TSD.

Issue: DOE invites comments on the findings of the engineering analysis. DOE also invites comment on the decision to drop one of the four motors from the preliminary TSD analysis due to the similar findings between the 48- and 56-frame size CSIR motors.

Public Meeting Agenda

1. Statute and Context
2. Market & Tech; Screening; Engineering
3. **Energy Use; Markup Analysis**
4. Life-Cycle Cost and Payback Period Analysis
5. National Impact Analysis
6. Preliminary MIA; NOPR Analyses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NOPR
Final Rule
Market & Technology
Screening Analysis
Analysis
Energy Use & End Use Load Characterization
Payback Period Analysis
National Impact Analysis
Preliminary Manufacturer Impact Analysis
Shipments Analysis

Markups to Determine Equipment Price
Purpose, Inputs, and Output

- **Purpose**
  - Determine customer prices under a standards scenario based on manufacturer costs.
  - Characterize equipment distribution channels and market segments.
  - Describe SEM equipment distributor/wholesaler direct costs, expenses, and profits.
- **Inputs**
  - Firm balance sheets.
    - Wholesalers: U.S. Census Bureau Financial Data on Other Commercial Equipment Merchant Wholesalers from *Wholesale Trade, Miscellaneous Subjects (*2002).
- **Output**
  - Baseline and incremental markups.

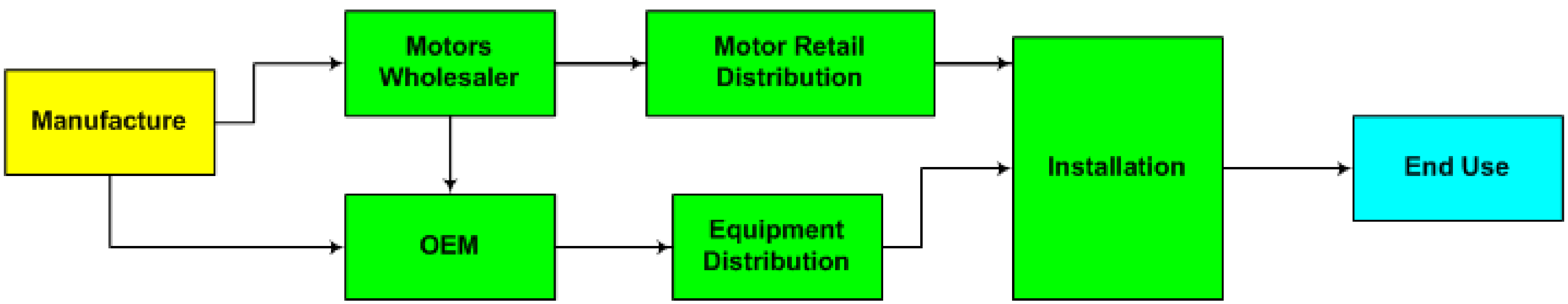
SEM Equipment Distribution Channels

- **Estimated Fraction (%) of Equipment Shipments by Distribution Channels***

40% Direct to OEMs

25% via Distributors to OEMs

35% via Distributors to End Users



*DOE assumed the same market shares by distribution channel for all new SEMs.

Baseline and Incremental Markups

- ***Markups*** **relate customer price to cost of goods sold (COGS)**
- ***Baseline markups*** **relate price to cost prior to a change in efficiency**
  - Baseline markups indicate a customer price that covers all of a wholesaler's or contractor's expenses plus profit.
  - Direct labor costs (salaries, payroll, rental and occupancy) are included.
- ***Incremental markups*** **relate the incremental change in customer price to the incremental change in COGS beyond baseline**
  - Some distribution costs remain constant with COGS increases.
  - Incremental markups cover only expenses that vary with COGS – in this case, expenses that increase due to an increase in equipment efficiency.
    - For example, direct labor costs (salaries, payroll, rental and occupancy) do not vary with efficiency-induced changes in COGS.
  - DOE assumes other operating costs and profit will scale proportionally with COGS.

Distribution and Installation Markups and Sales Tax

- **Wholesaler, OEM and retailer markups estimated from Census Financial Data**

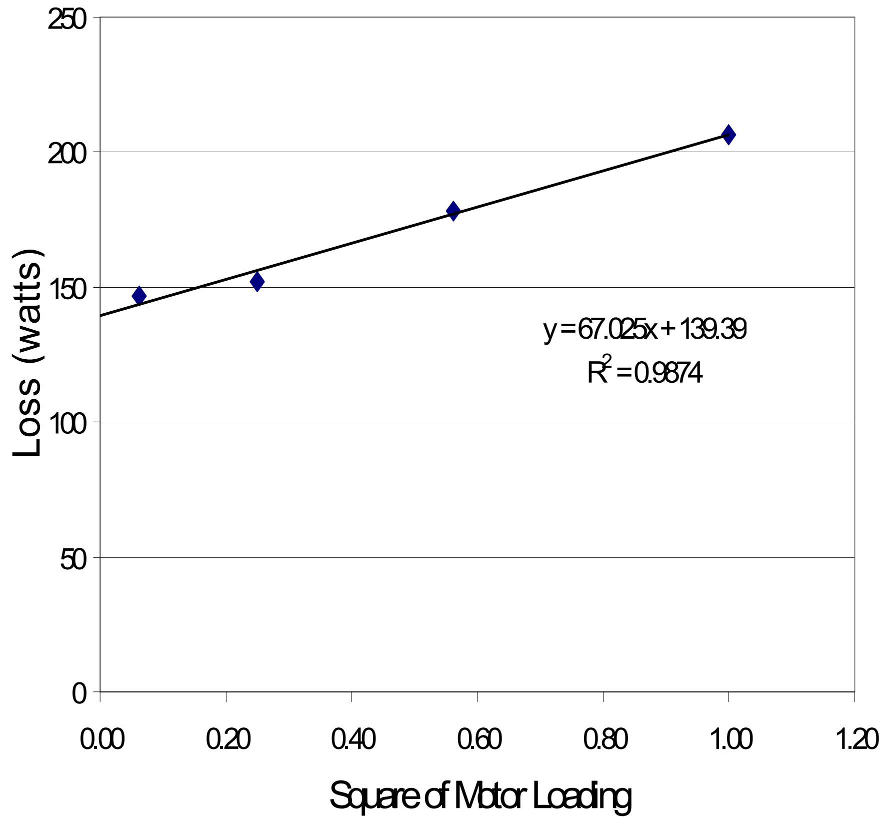
	Direct to OEMs (40%)		Via Distributors to OEMs (25%)		Via Distributors to End-Users (35%)	
	Baseline	Incremental	Baseline	Incremental	Baseline	Incremental
Motor Wholesale Distributor	-	-	1.28	1.10	1.28	1.10
Equipment Manufacturer (OEM)	1.37	1.27	1.37	1.33	-	-
Equipment or Motor Distributor or Retailer	1.43	1.18	1.43	1.18	1.44	1.18
Contractor or Installer	1.10	1.10	1.10	1.10	1.10	1.10
Sales Tax	1.0684		1.0684		1.0684	
Overall	2.30	1.76	2.95	2.03	2.17	1.53

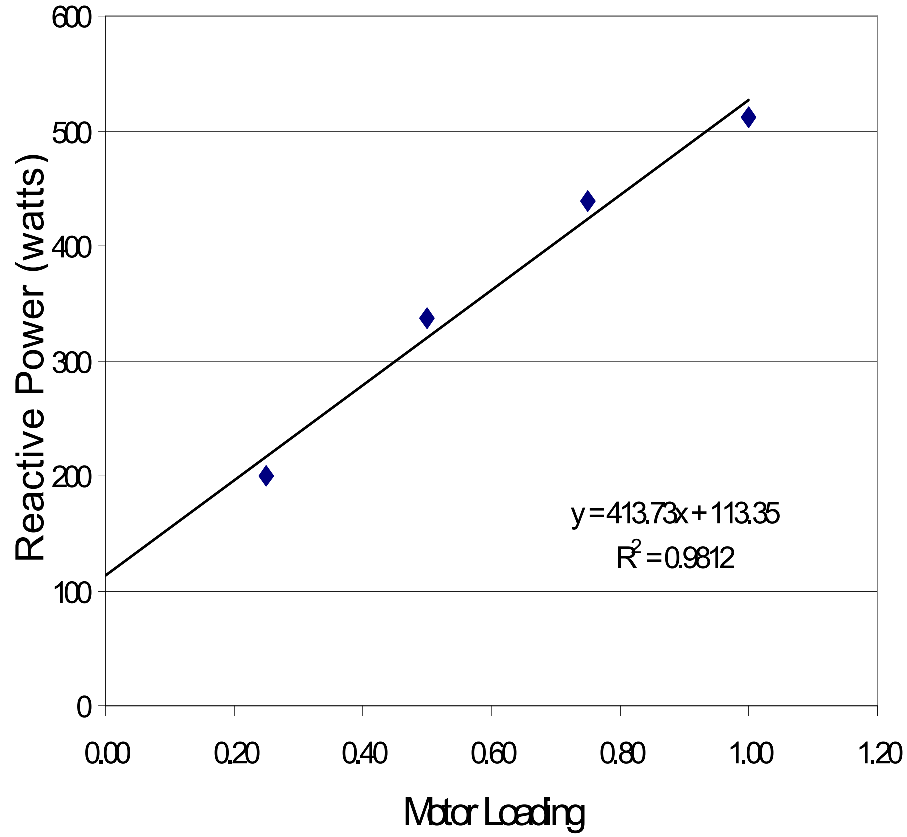
Energy Use Characterization

- **Motor losses consist of I^2R losses (both stator and rotor), core losses, stray losses and friction and windage losses**
- **DOE's mathematical description of energy use separates motor losses into a constant component and a component that depends on the square of the motor loading.**
  - Annual energy (E) consumed by was calculated as:

    $$E_{ann} = H_{op} \times (P_{NL} + P_{LL} \times L^2)$$
- **Reactive power may or may not contribute to increased energy use**

Energy Use Characterization (cont.)





Request for Comment:
Costs and Losses from Reactive Power

Issue: Reactive power creates costs for the electrical supply system by requiring either power factor correction or requiring more current capacity to deliver the same actual power. Reactive power may also induce consumptive losses both on the consumer electrical circuit and on the electrical system in general. DOE invites comment on how best to estimate the cost implications of reactive power. DOE also invites comment on the size and importance of reactive power effects and on analytical approaches and data that can be used to characterize the fraction of motor reactive power that may result in consumptive losses.

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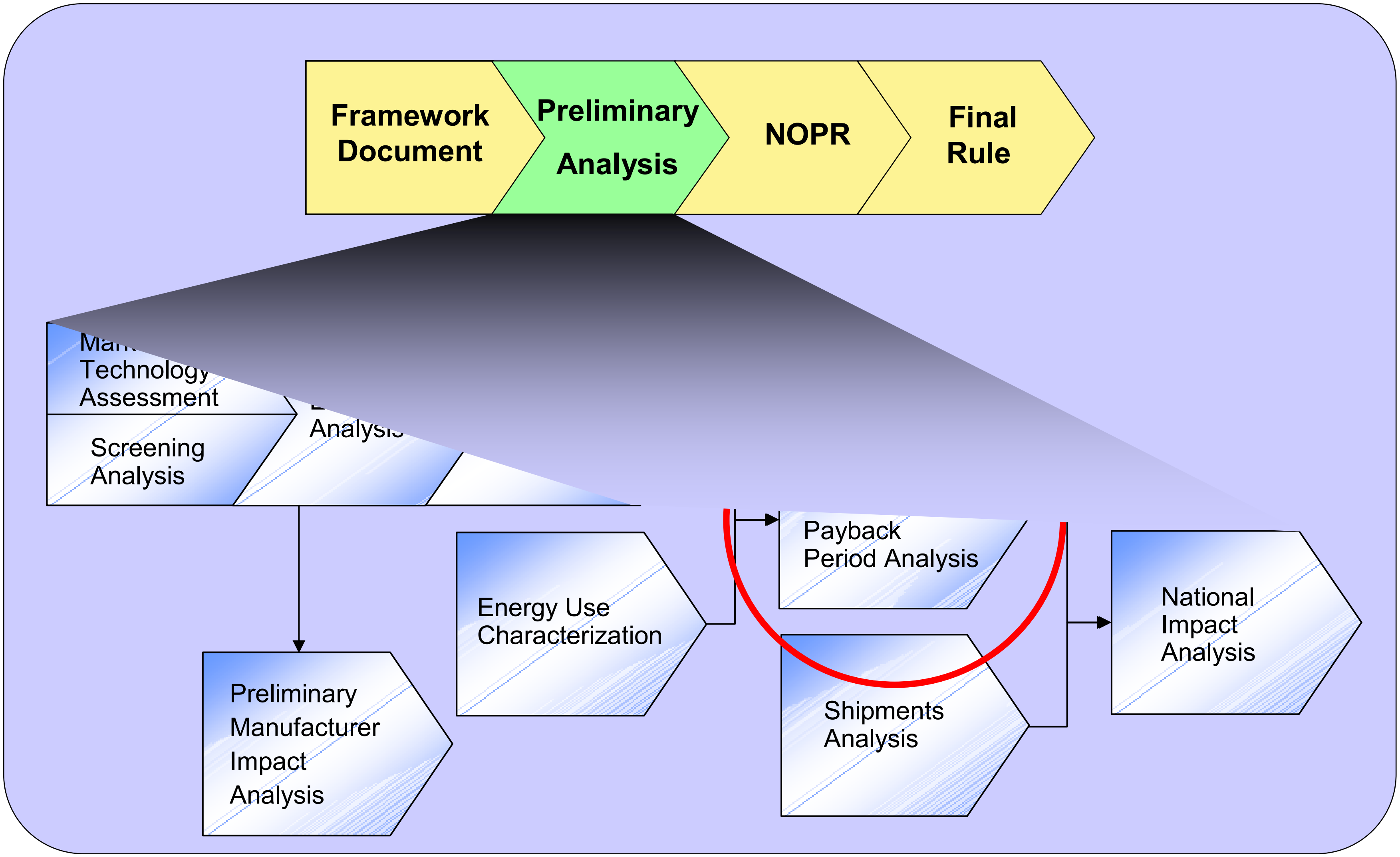
3. Energy Use; Markup Analysis
4. **Life-Cycle Cost And Payback Period Analysis**
5. National Impact Analysis
6. Preliminary MIA; NOPR Analyses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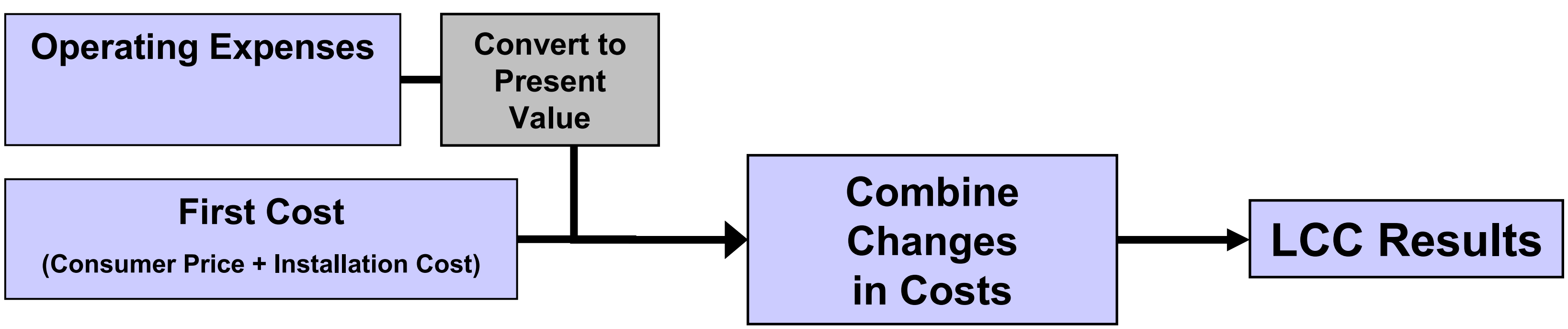
Life-Cycle Cost Analysis

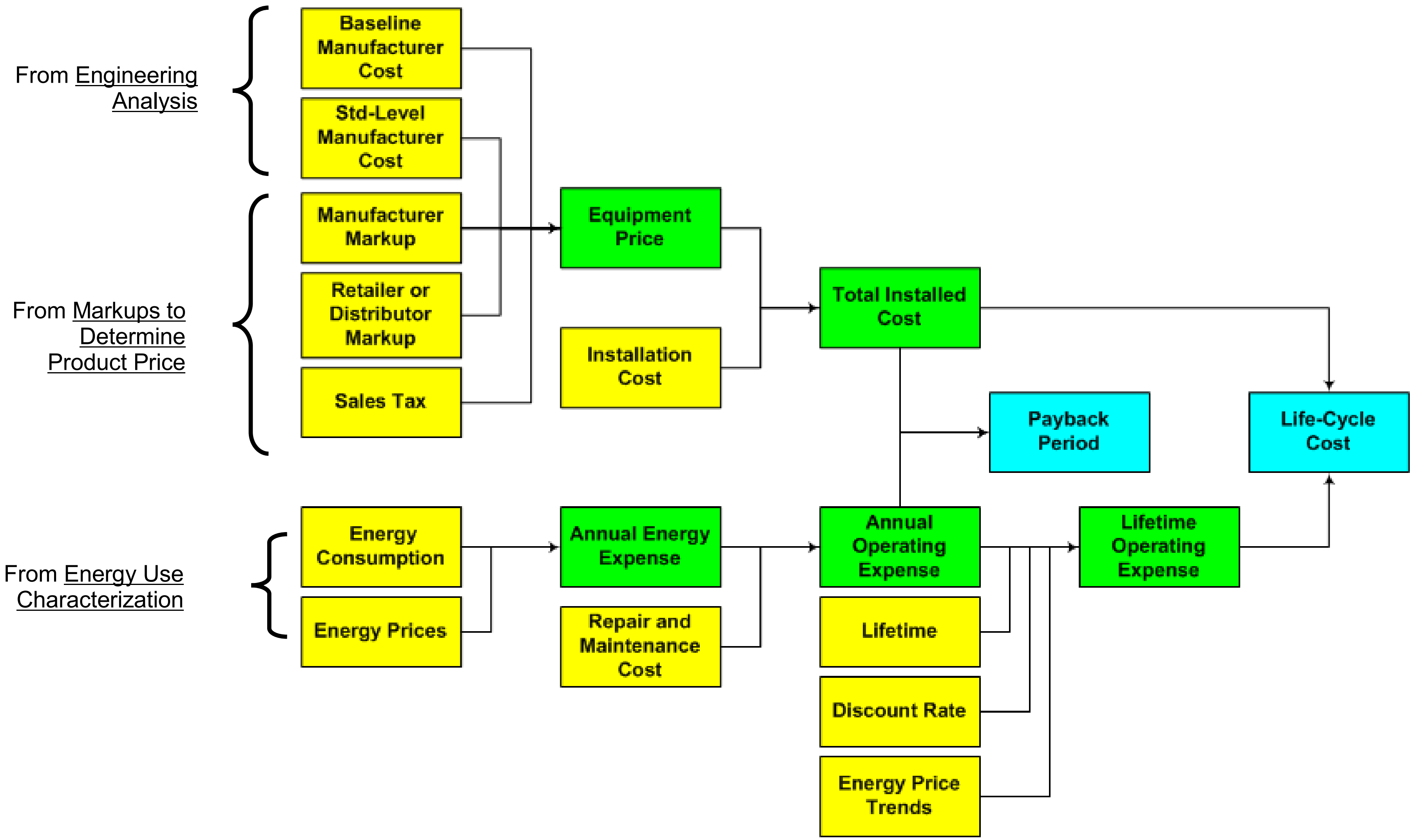
- Economic evaluation from the customer perspective.
- Life-cycle cost (LCC) equals customer price plus the sum of annual operating costs discounted to a particular base year.
- Results are expressed as LCC difference of the baseline (Level 1) minus the standard level.
- Simple payback period (PBP - in years) is also calculated and reported in this analysis.



Selection of Efficiency Levels for Analysis

- **Five efficiency levels were examined for equipment in the engineering analysis.**
- **Five adjusted efficiency levels were selected for the LCC analysis.**
    - Level 0 represents the current market level SEMs.
    - Level 1 is 1% below NEMA premium for a 1 HP polyphase motor
    - Level 2 is equivalent to the NEMA premium level for medium motors
    - Level 3 is 1% above NEMA premium for a 1 HP polyphase motor
    - Level 4 is 2.5% above NEMA premium for a 1 HP polyphase motor
    - Level 5 is Max Tech
- **Efficiency levels are matched between product classes and power ratings using engineering scaling laws and scaling factors.**

LCC Calculation Flowchart



Request for Comment: Baseline Efficiency

Issue: DOE estimated an average efficiency in the base case close to the engineering baseline efficiency, and assumed no efficiency trends in the base case. DOE invites comments on the baseline efficiency estimate and information on the distribution of efficiencies currently in the marketplace along with expected trends in the these market efficiencies.

Electricity Prices

- Electricity prices are distributions of average prices derived from 2006 EIA form 861 data and adjusted for inflation.
- Electricity price projections based on Energy Information Administration's Annual Energy Outlook (AEO) 2008 reference case for the commercial sector.
- AEO 2008 high growth and low growth cases will be run as sensitivities.

Other Inputs

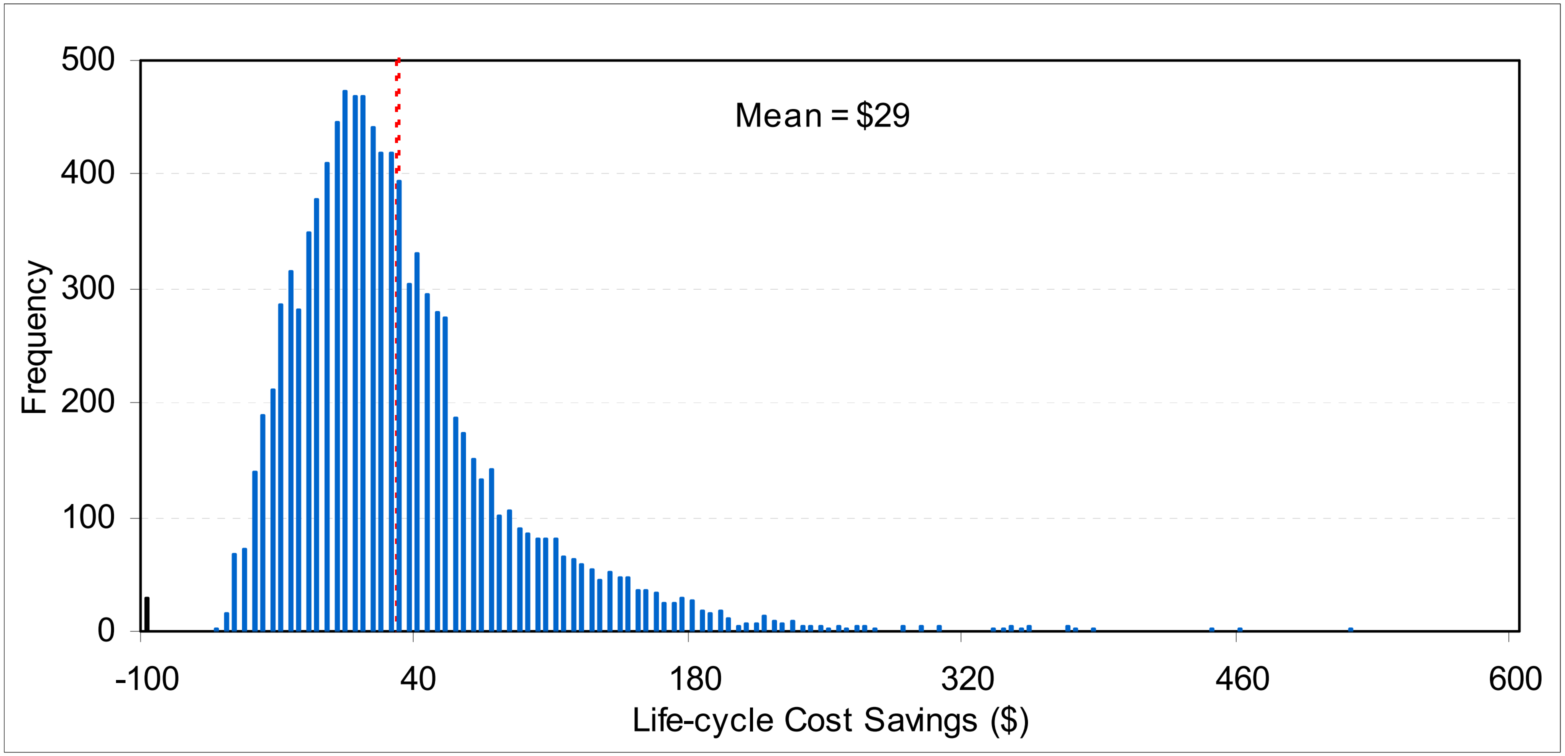
- **Installation Costs**
  - DOE assumed a $252.90 installation cost (2007$)
  - Costs were based on RS Means electrical cost data.
  - Installation costs assumed not to vary with equipment price or efficiency level.
- **Discount Rates**
  - Derived from estimates of the cost of capital of companies for commercial and industrial sectors.
  - Cost of capital is calculated from the weighted-average cost of capital (WACC) to the company to obtain equity and debt financing.
  - Estimate is made using 40-year averages of cost of capital equation parameters.
  - Weighted-average value (real) is: 5.92% for agricultural and industrial owners and; 5.89% for commercial owners.

Other Inputs (cont.)

- **Equipment Lifetime**
  - Used average age of 9 years for polyphase motors and 7 years for capacitor start motors based upon the literature survey and industry input during the analysis and discussion period for the "Determination Concerning the Potential for Energy Conservation Standards for Small Electric Motors" published on July 10, 2006.

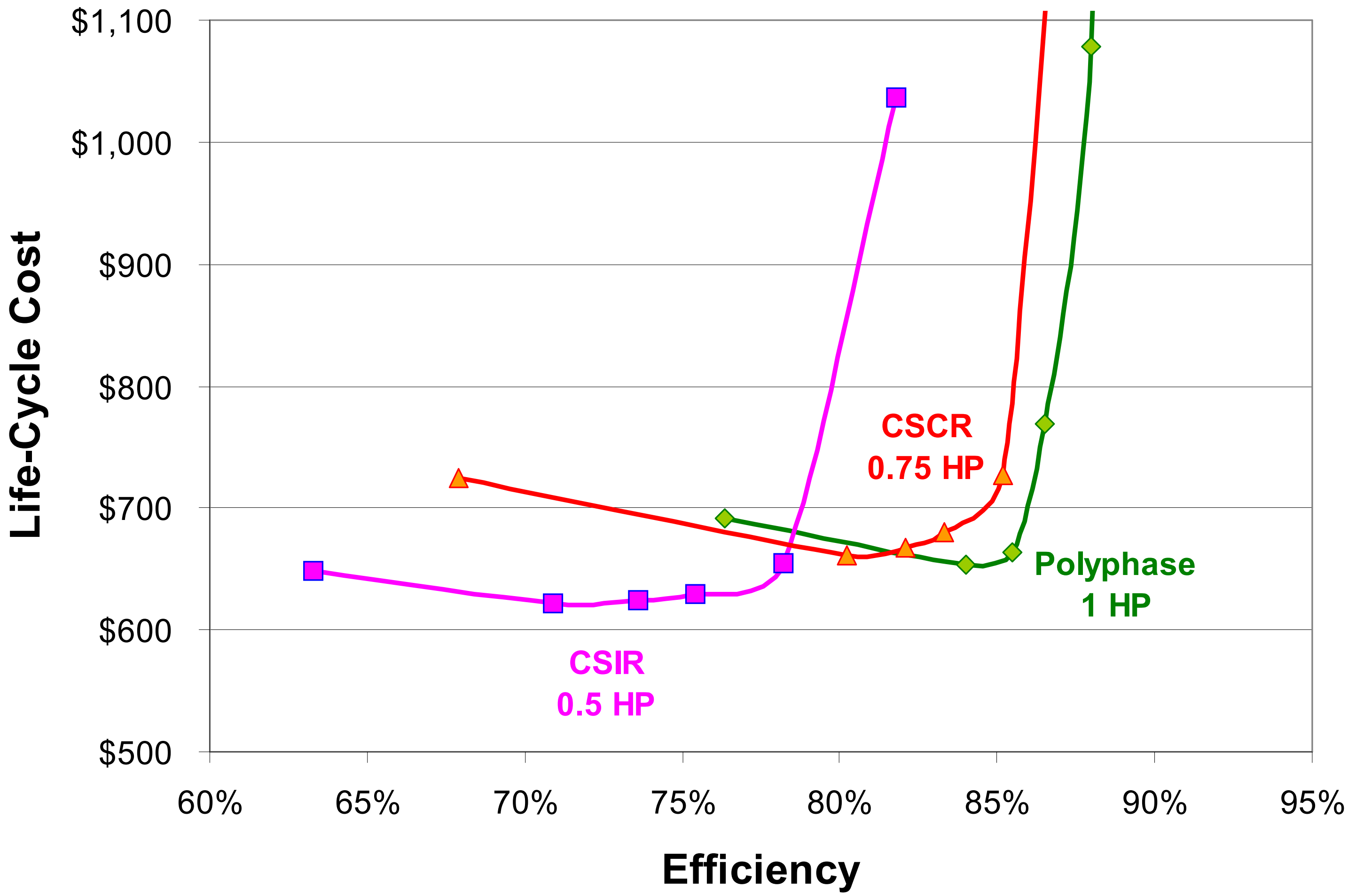
Example of Life-Cycle Cost Analysis Results

(LCC Savings)

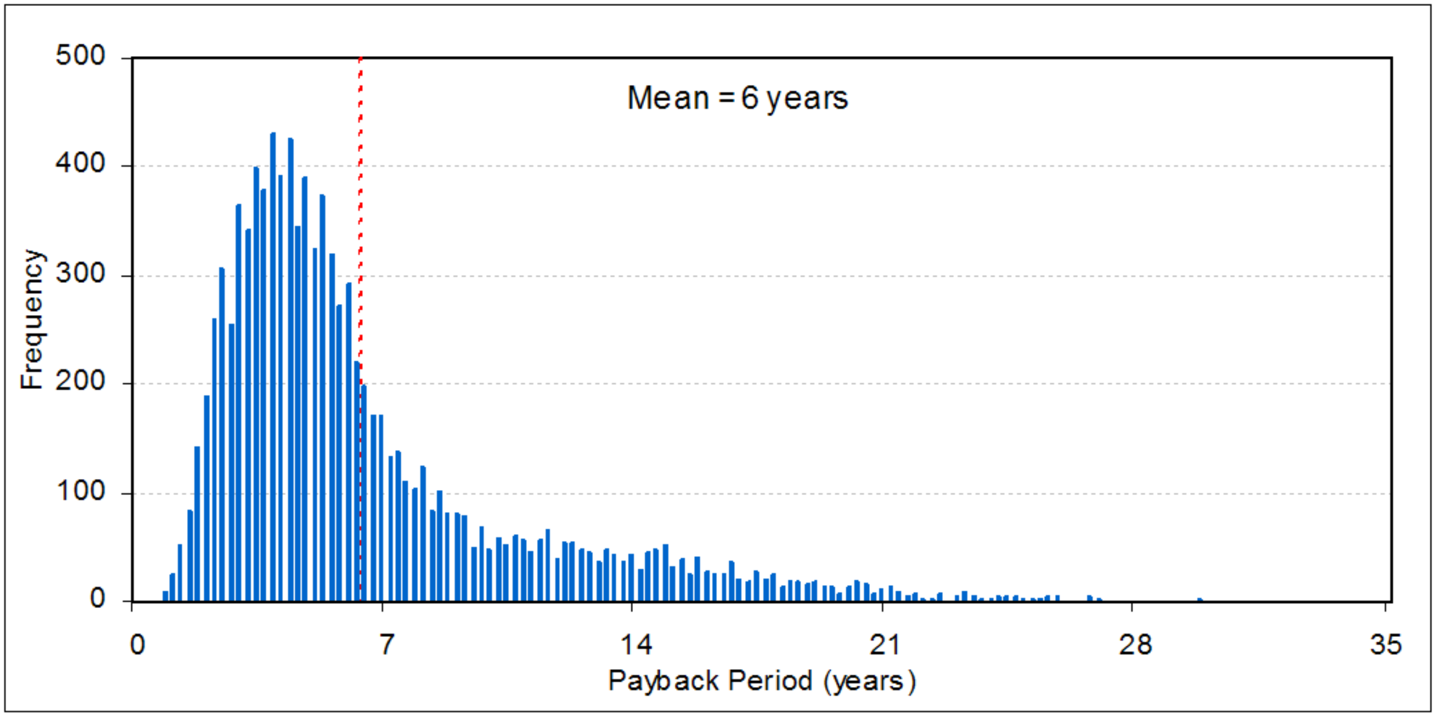


Polyphase, 1 HP motor, Candidate Standard Level 2, 85.5%

U.S. National Average Life-Cycle Cost Analysis Results

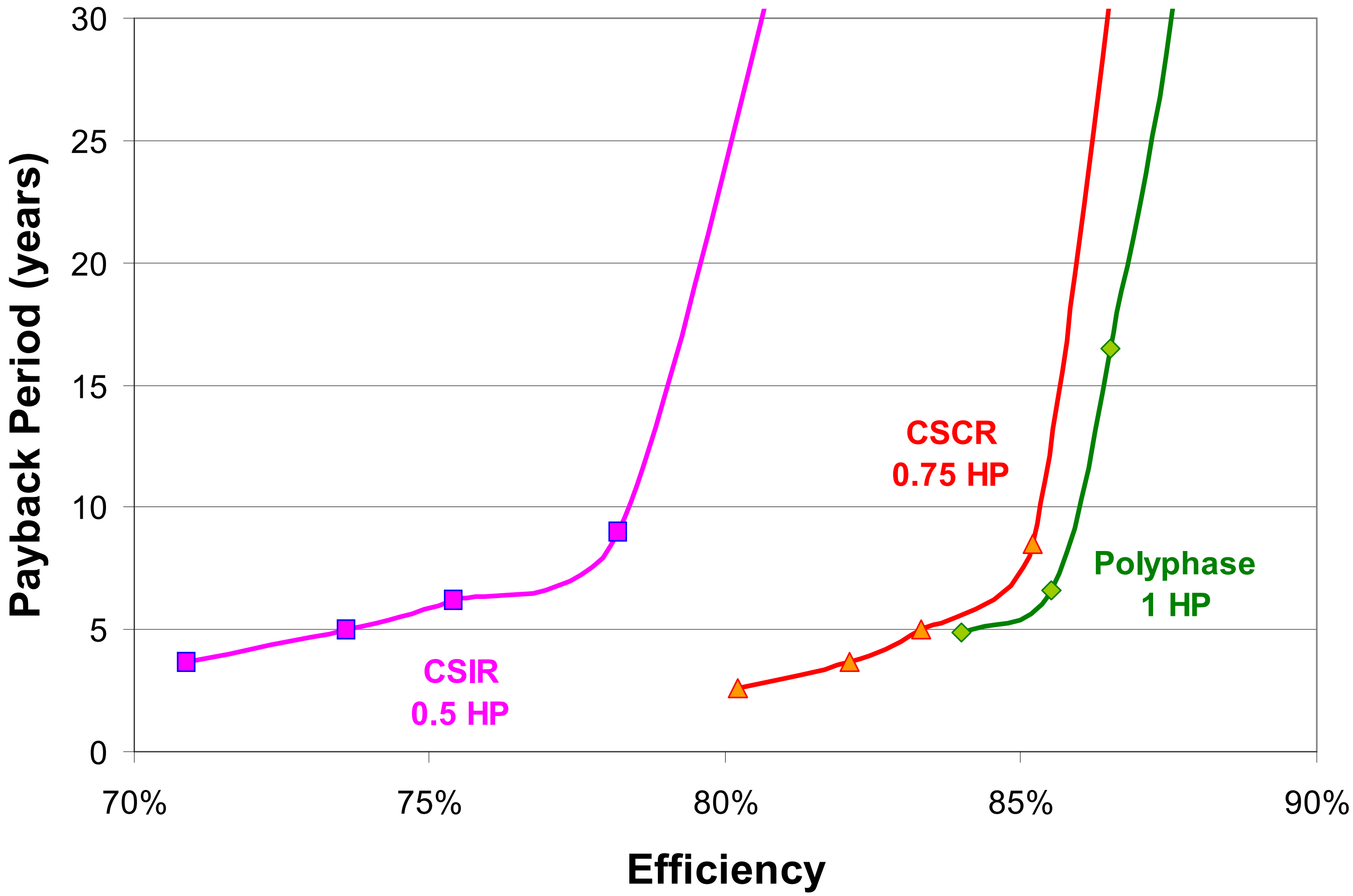


Example of Payback Period Analysis Results



CSIR, 0.5 HP motor, Candidate Standard Level 3, 75.4%

U.S. National Average Payback Period Analysis Results



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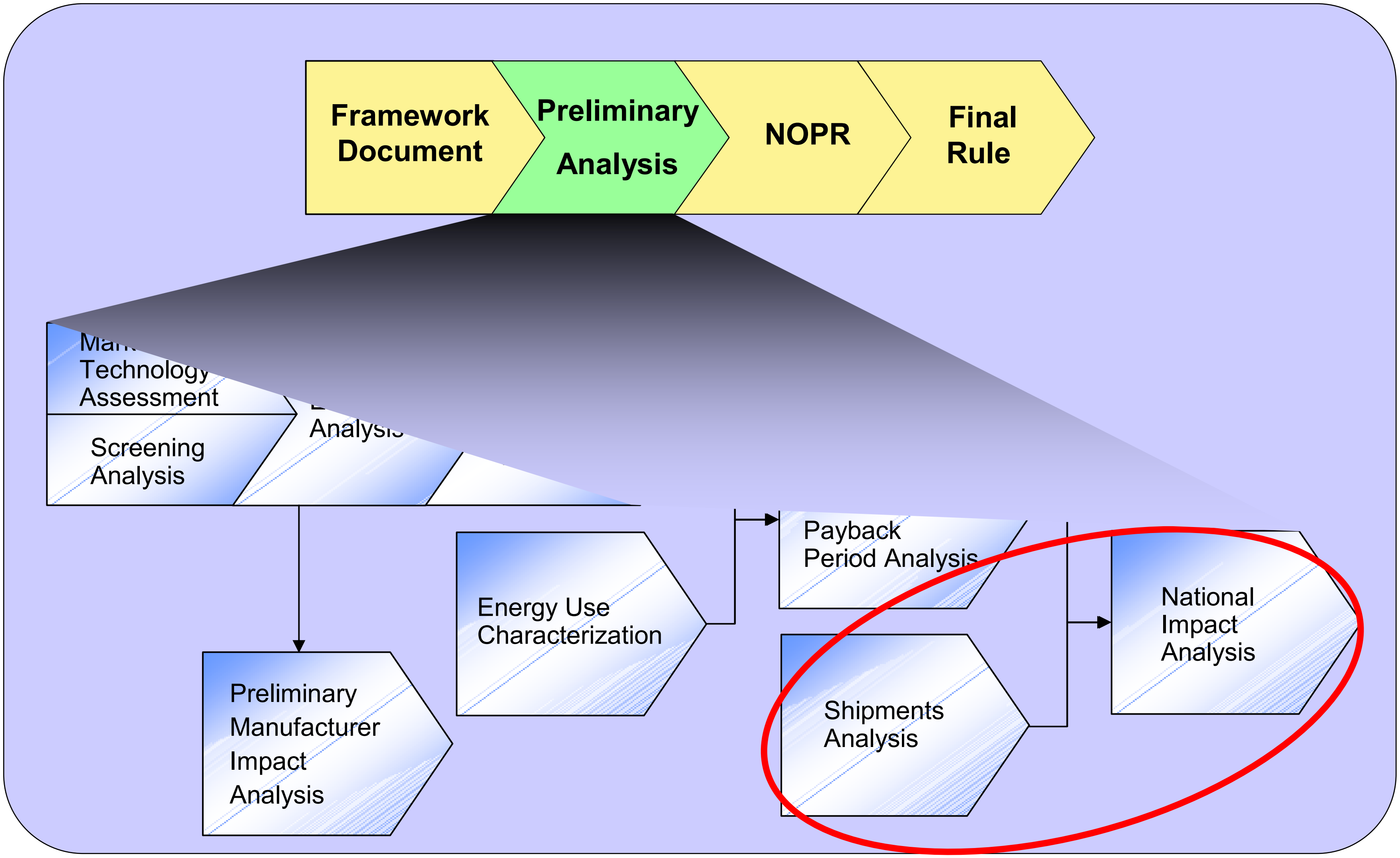
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Technology Assessment
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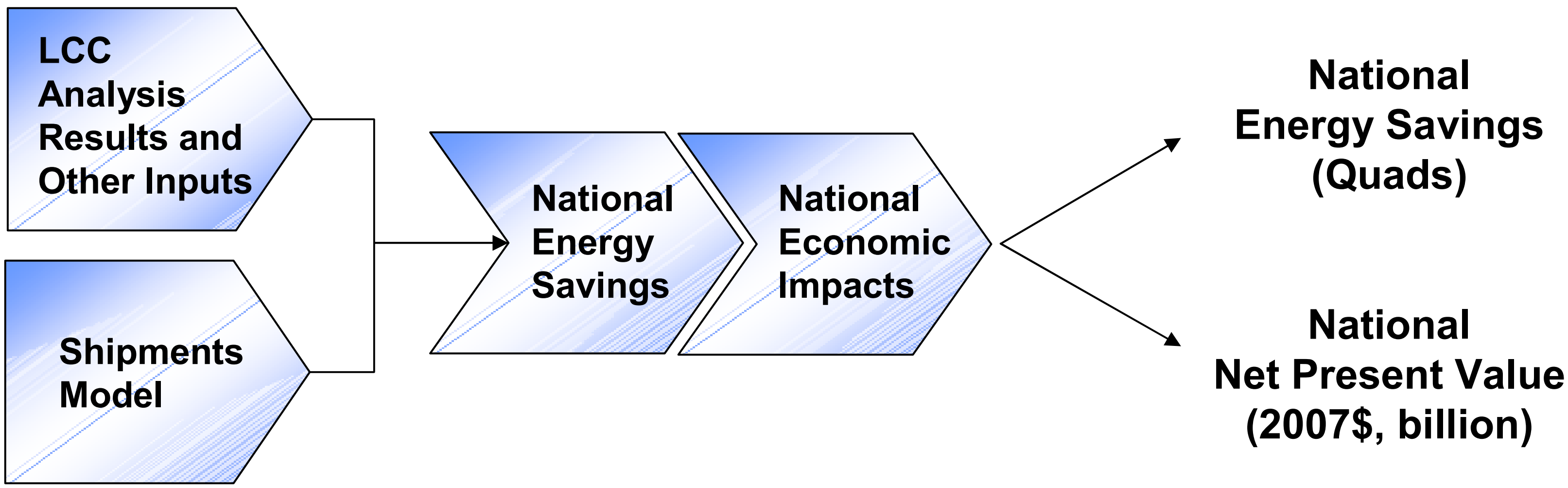
Analysis
Payback Period Analysis
Energy Use Characterization
National Impact Analysis
Shipments Analysis
Preliminary Manufacturer Impact Analysis

Purpose

- **Shipments Analysis**
  - Estimate small electric motor (SEM) equipment shipments over time.
- **National Impact Analysis**
  - Estimate the National Energy Savings (NES) from SEM equipment at different efficiency levels.
  - Estimate the national economic impact on the nation (or the Net Present Value (NPV)) of the SEM equipment at different efficiency levels.

National Impact Analysis Process



- **National energy savings calculated for period from 2015-2045 (30 years).**
- **NPV calculated for period from 2015-2055 (40 years).**

Request for Comment:
Purchase Price Elasticity

Issue: An increase in the installed cost of small electric motors could reduce their purchase due to migration by OEMs to totally enclosed motors, which are not covered by DOE standards, or other factors. However, DOE has not found any data that would allow it to estimate the elasticity of small electric motor shipments with respect to change in their purchase price or other factors. DOE requests information on the level of price change for covered small electric motors that would be likely to induce migration to totally enclosed motors, as well as data on what would be an appropriate value for purchase price elasticity.

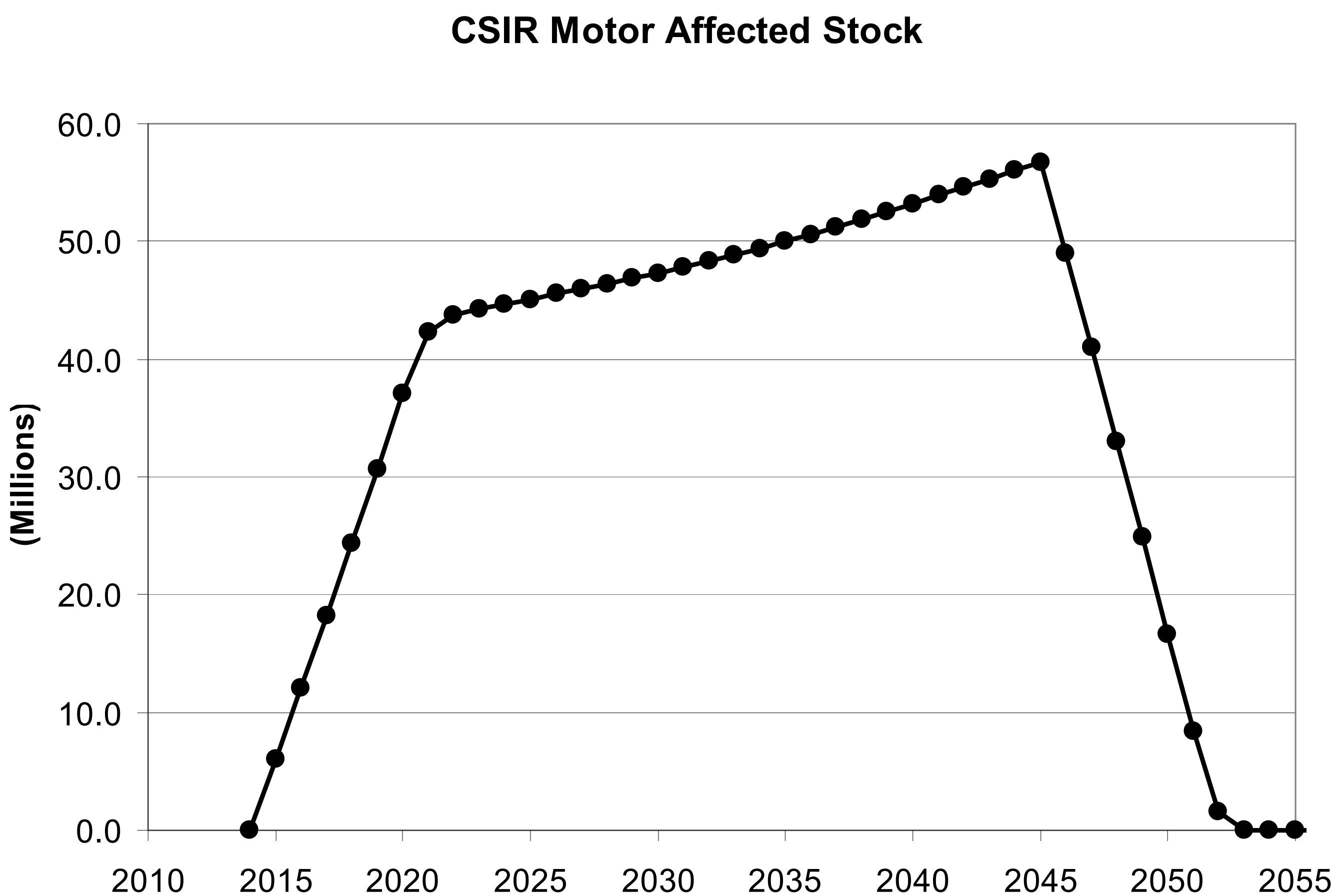
Shipments by Application

		Equipment Class		
No.	Application	Polyphase	CSIR	CSCR
1	Air and gas compressors	9.2%	8.1%	8.1%
2	Commercial and industrial heating, ventilating, air-conditioning, and refrigeration equipment	4.3%	8.4%	8.4%
3	Commercial laundry machinery	0.4%	1.2%	1.2%
4	Conveyors	18.8%	11.8%	11.8%
5	Farm machinery	3.0%	10.9%	10.9%
6	Food machinery	8.2%	2.1%	2.1%
7	General industrial machinery	3.4%	2.4%	2.4%
8	Industrial and commercial fans and blowers	5.6%	5.9%	5.9%
9	Machine tools	7.3%	1.9%	1.9%
10	Packaging machinery	1.0%	0.3%	0.3%
11	Pumps and pumping equipment	33.0%	41.1%	41.1%
12	Service industry machinery	1.5%	3.0%	3.0%
13	Textile machinery	1.2%	0.4%	0.4%
14	Woodworking machinery	3.1%	2.4%	2.4%
	TOTAL	100%	100%	100%

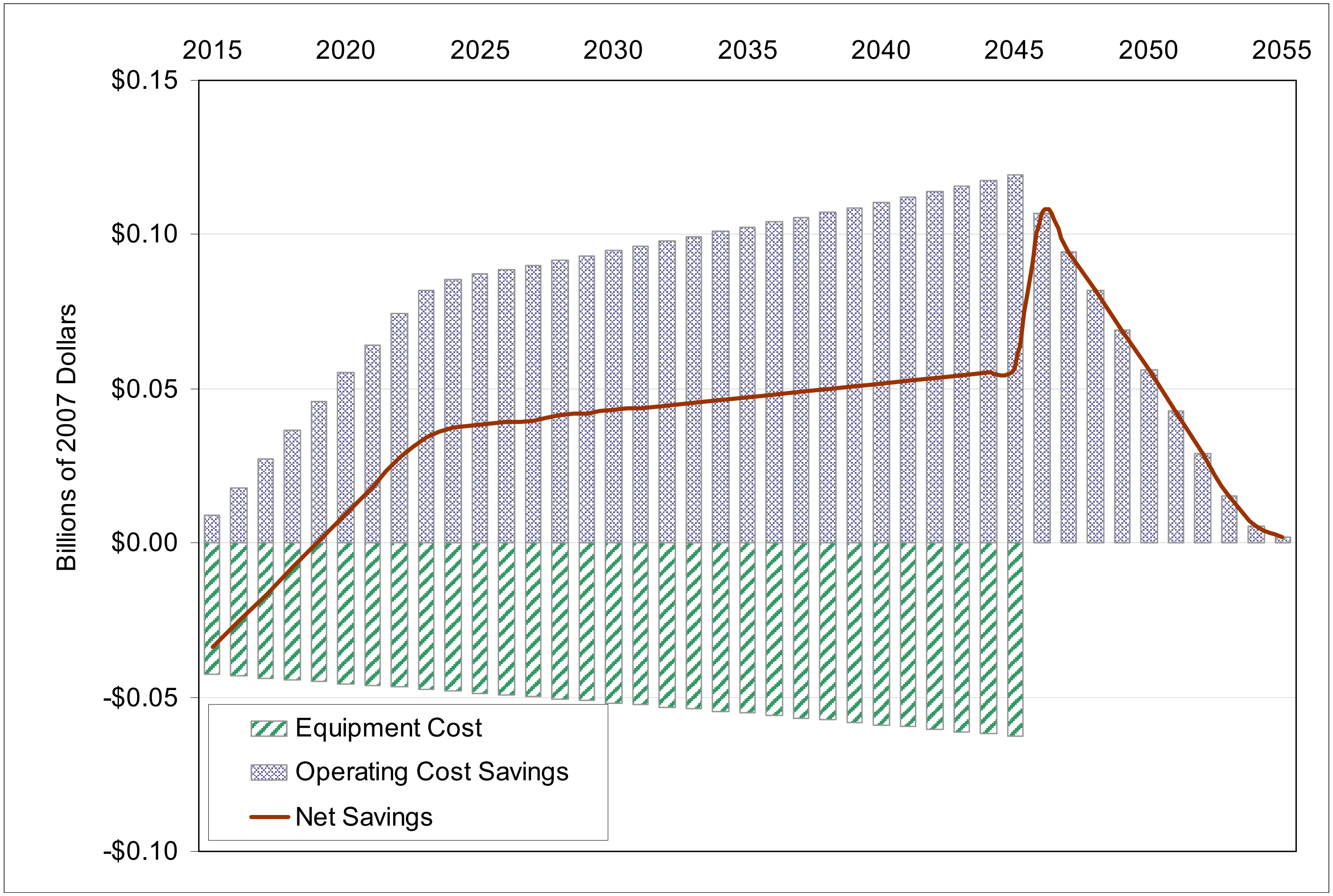
Polyphase Shipments by Size and Poles
Estimate for Year 2007

Motor Horsepower/Standard Kilowatt Equivalent	Six Poles	Four Poles	Two Poles	Total
1/4 hp/0.18 kW	1,967	7,637	1,967	11,571
1/3 hp/0.25 kW	4,784	16,289	3,264	24,338
1/2 hp/0.37 kW	8,181	49,884	3,607	61,671
3/4 hp/0.55 kW	12,286	59,460	82,596	154,342
1 hp/0.75 kW	17,608	71,708	17,608	106,925
1½ hp/1.1 kW	5,885	146,033	5,885	157,804
2-3 hp/1.5-2.2 kW	-	28,268	12,817	41,084
Total	50,711	379,279	127,744	557,735

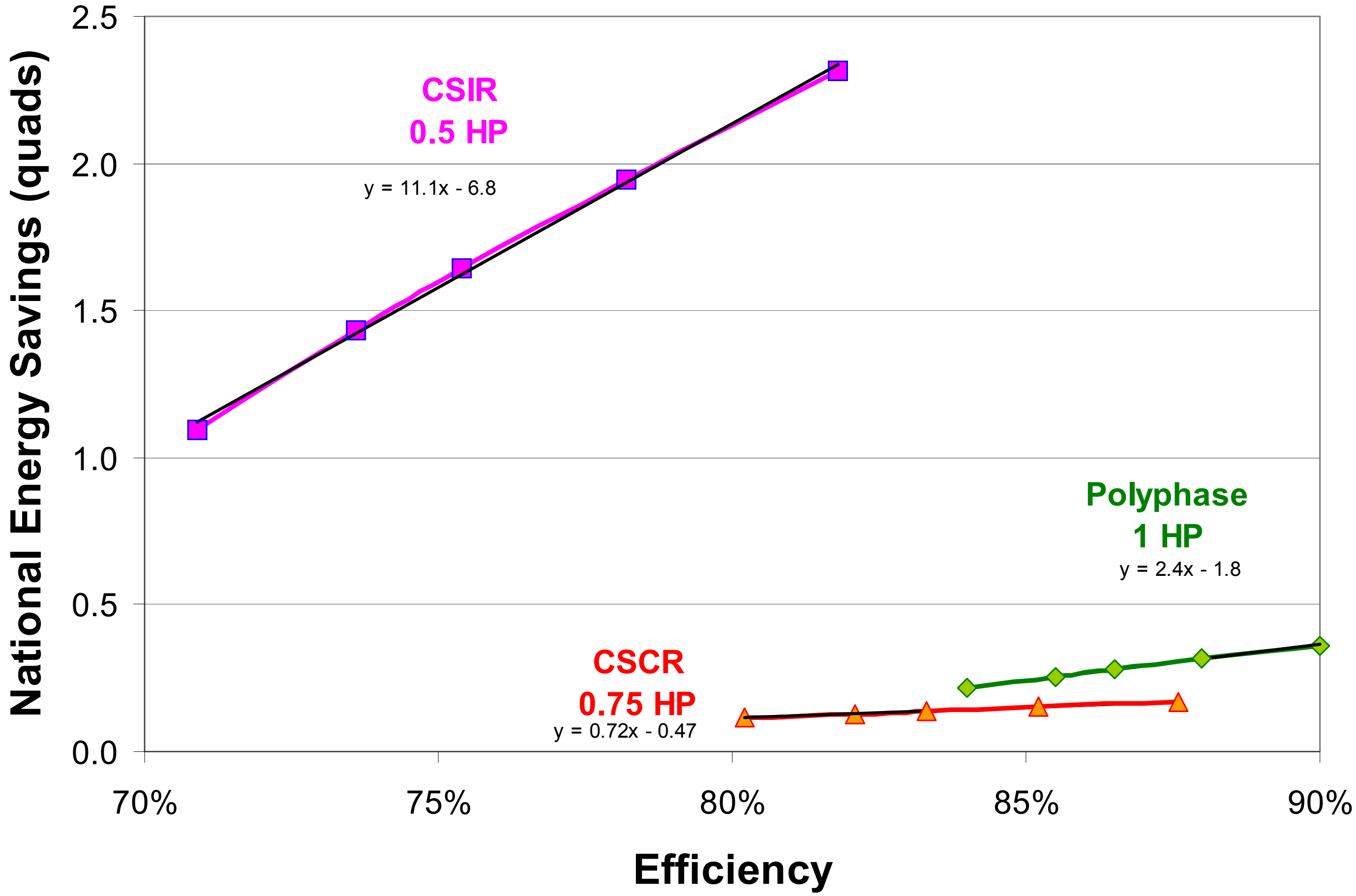
Profile of Affected Stock



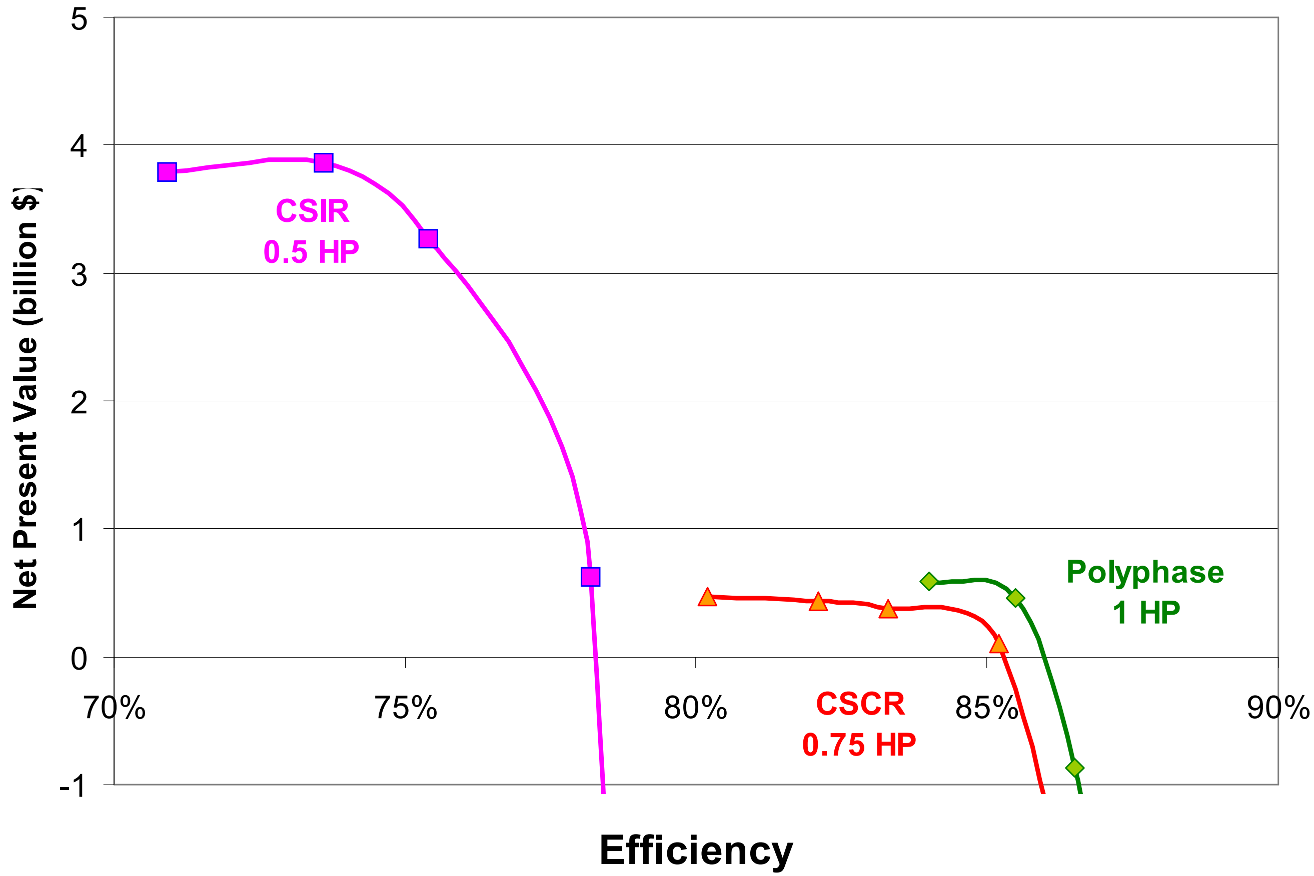
Annual Savings and Expenses



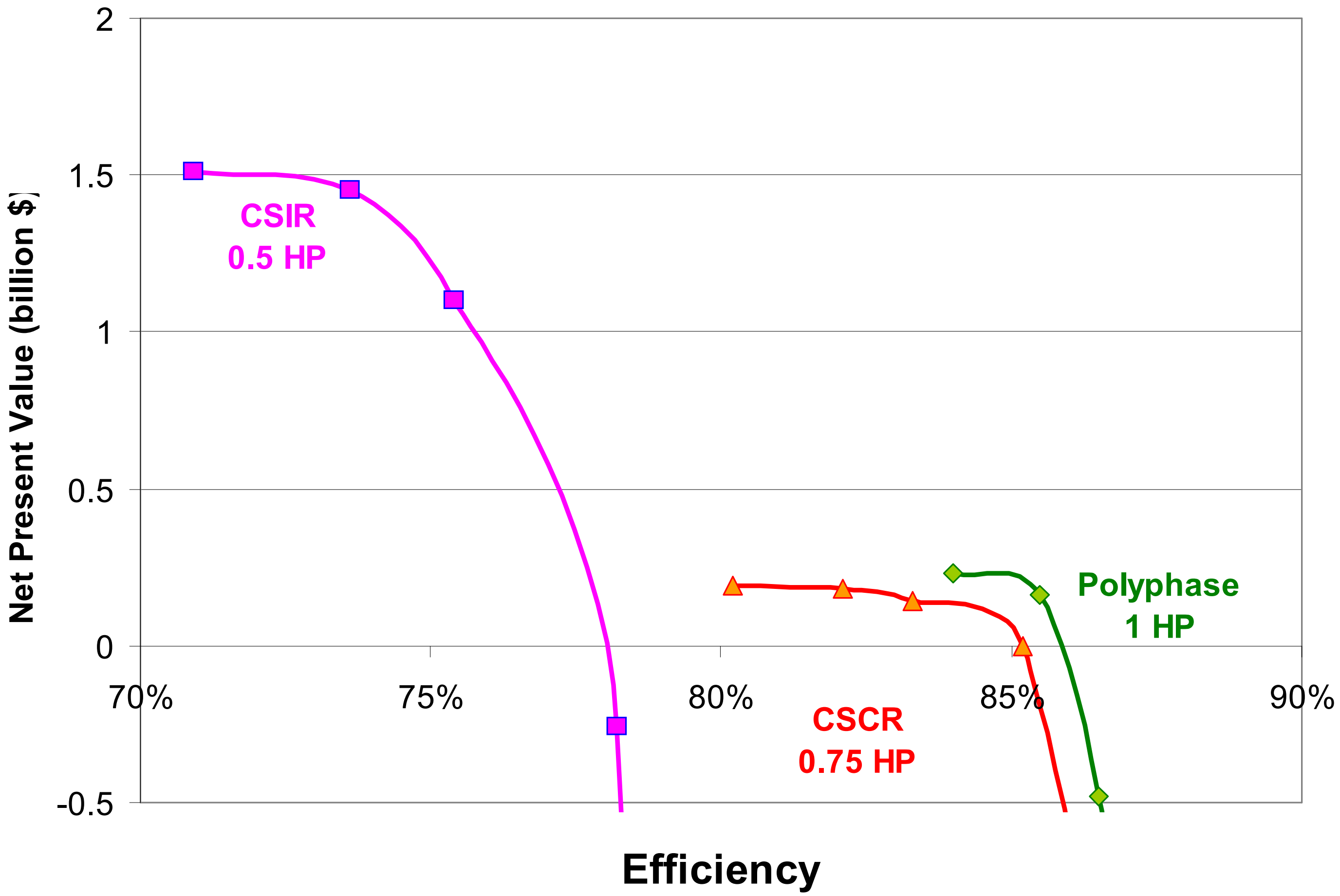
National Energy Savings



National Net Present Value at 3% Real Discount Rate



National Net Present Value at 7% Real Discount Rate



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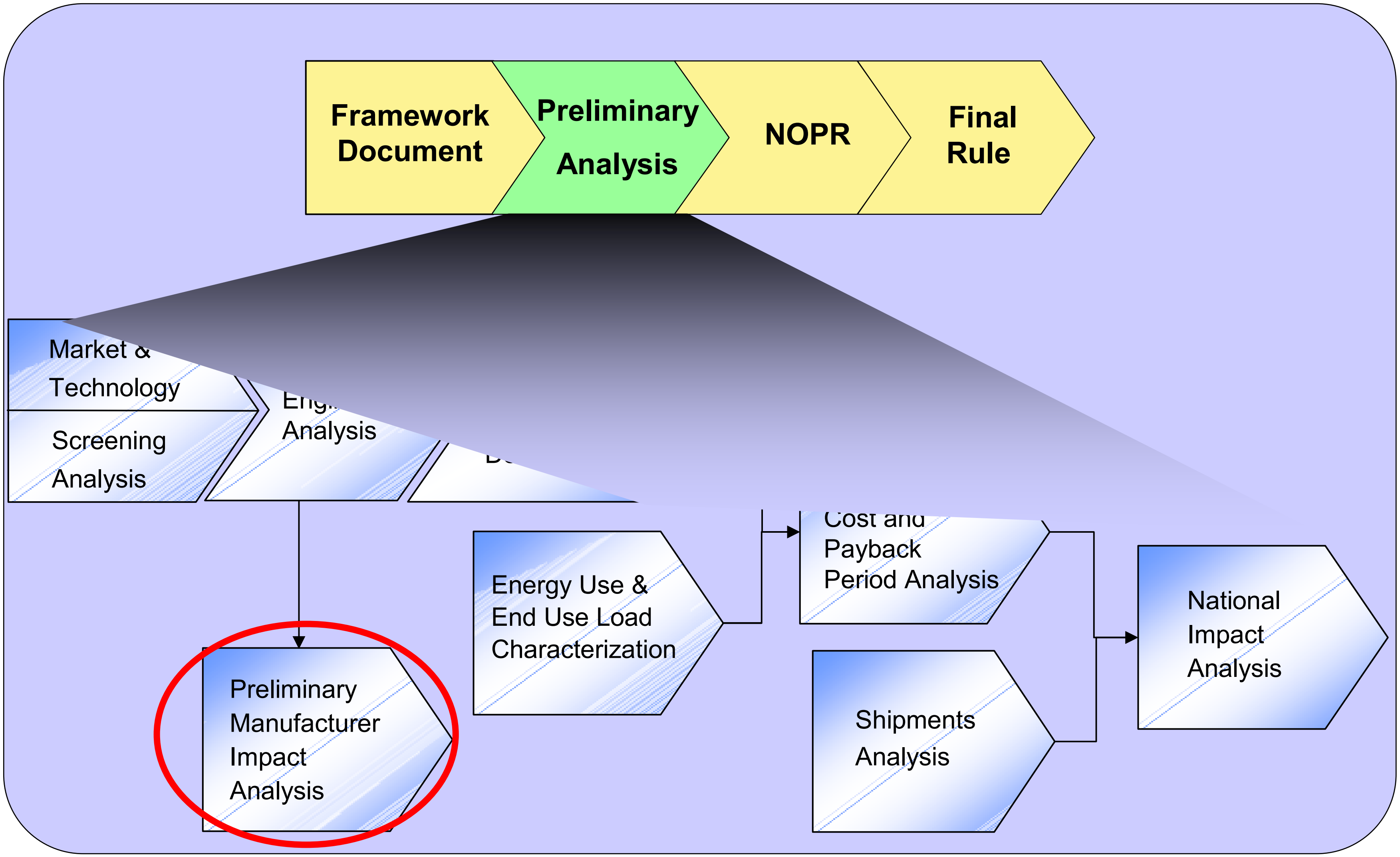
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Analysis
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Energy Use & End Use Load Characterization
National Impact Analysis
Preliminary Manufacturer Impact Analysis
Shipments Analysis

Preliminary Manufacturer Impact Analysis Overview

- **DOE obtained information from NEMA members**
  - Sent an interview guide to four big manufacturers
  - Received written responses
  - Discussed responses on individual telephone interviews
- **Topics discussed**
  - Engineering analysis
  - Market information (e.g. shipments)
  - Key issues (as defined by the manufacturers)
  - Company niches
  - Capital costs and investments
  - Facility impacts
  - Impacts on consumers

Small Electric Motors Key Issues

- **Production and product mix**
  - Higher standards means higher per-unit costs
  - Consumers may shift to less costly products
- **Compliance costs**
  - Conversion capital expenditures
  - Product-conversion expenses
- **Exports, Foreign Competition, and Outsourcing**
  - Export sales
  - Domestic market served by foreign competition
  - Domestic production levels

Small Electric Motors Key Issues

- **Market Shares and Industry Consolidation**
  - New companies entering
  - Companies exiting
  - Companies merging
- **Cumulative Burden**
  - Combined effect on manufacturers, groups of manufacturers, or entire industry
  - Level and timing of investments expected
  - What circumstances allow manufacturers to make expenditures to comply

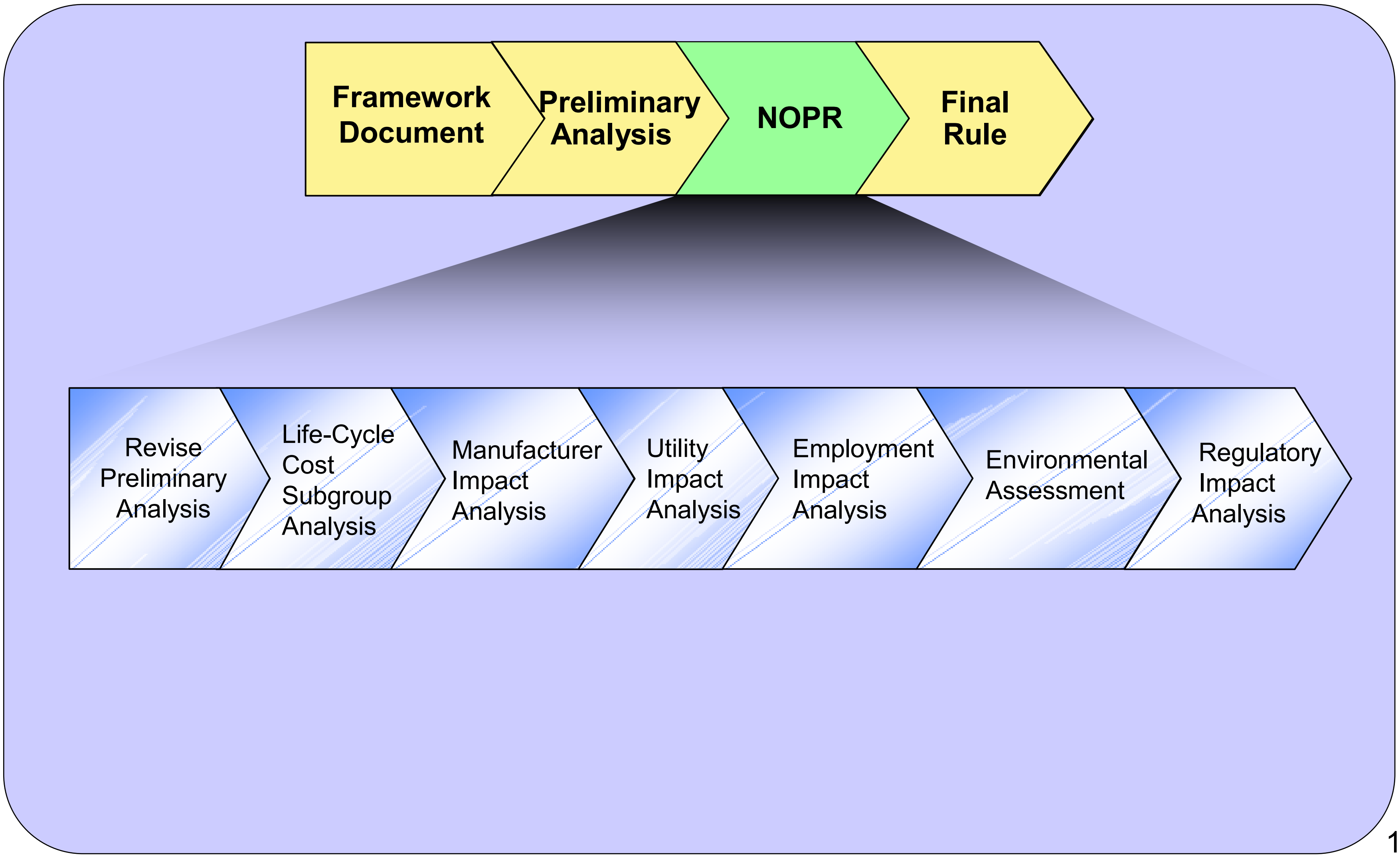
Summary of Major Issues

- **Capital expenses to produce standards compliant motors**
  - Small electric motors represent a small portion of the major manufacturers business
  - Small manufacturers have fewer sources from which to raise money
  - Manufacturers may leave the market
- **Maintaining product availability and features**
  - Motors may physically become larger which could inhibit use in certain applications
  - Horsepower ratings could consolidate, eliminating part of the market
- **Enforcement of standards**
  - Concern about the feasibility of enforcement

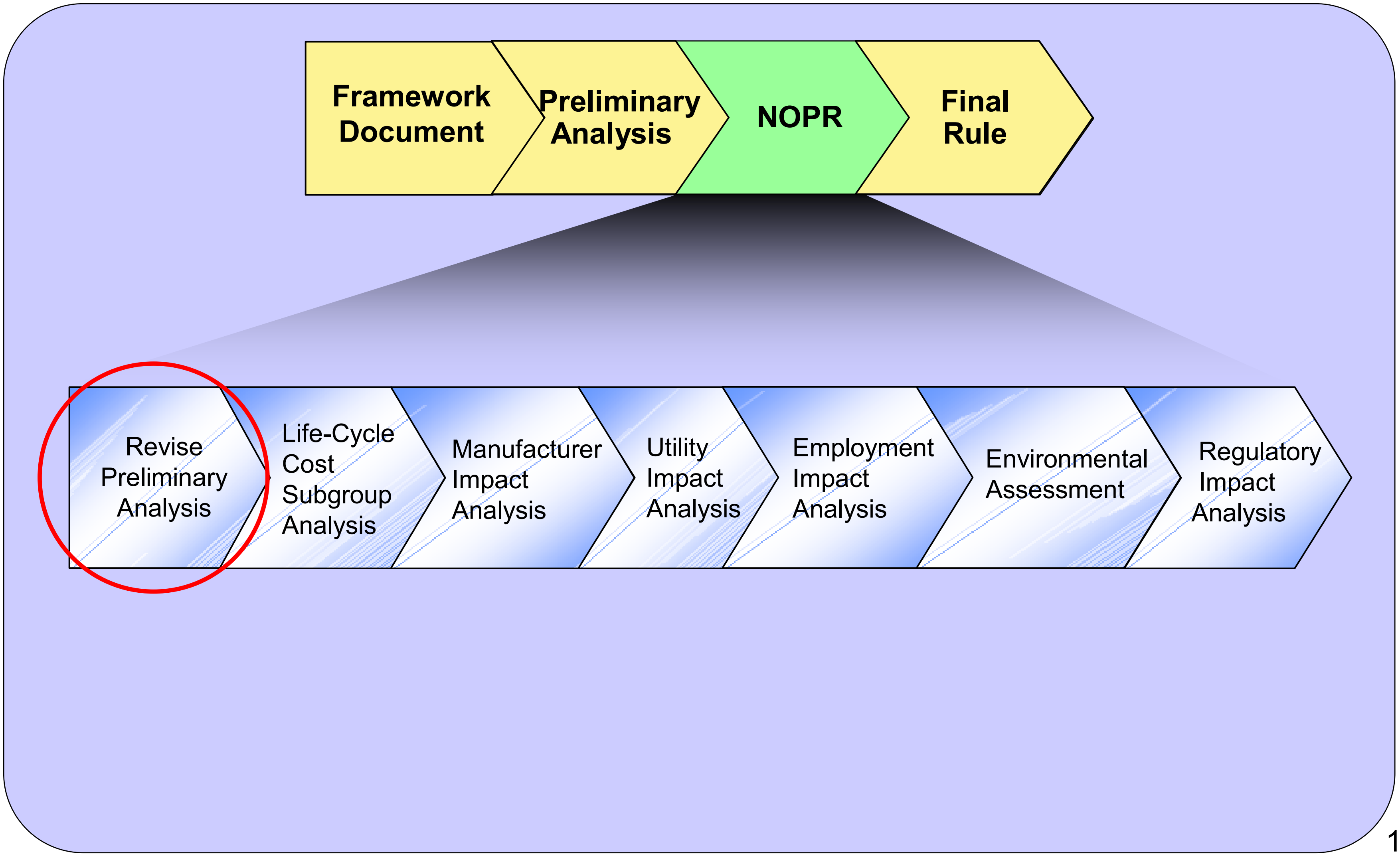
Request for Comment:
Enforcement of imported OEM equipment

Issue: DOE understands that enforcement of energy efficiency requirements for small electric motors is unlike other consumer products or commercial equipment, where small motors are components of domestic and imported OEM equipment. DOE requests data and information from interested parties that can assist in evaluating the potential impact on exports, foreign competition, and outsourcing.

Analyses for Notice of Proposed Rulemaking (NOPR)



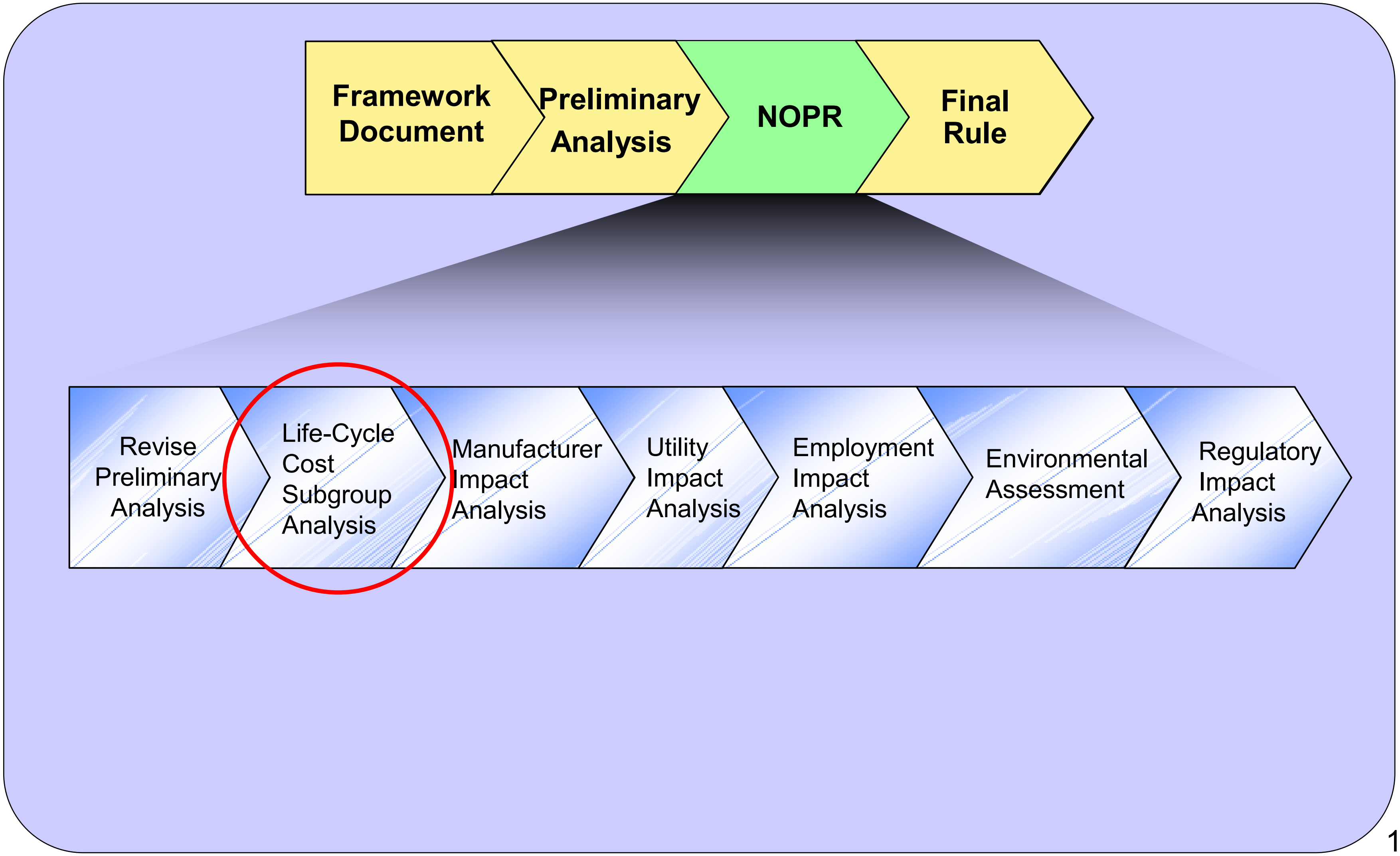
Analyses for Notice of Proposed Rulemaking (NOPR)



Revise Preliminary Analysis

Analysis	Action
Engineering Analysis	• Consider comments • Revise using latest data
Life-Cycle Cost and Payback Period Analyses	• Consider comments • Revise using latest data • Conduct LCC sub-group analysis
National Impacts Analysis	• Consider comments • Revise using latest data

Analyses for Notice of Proposed Rulemaking (NOPR)



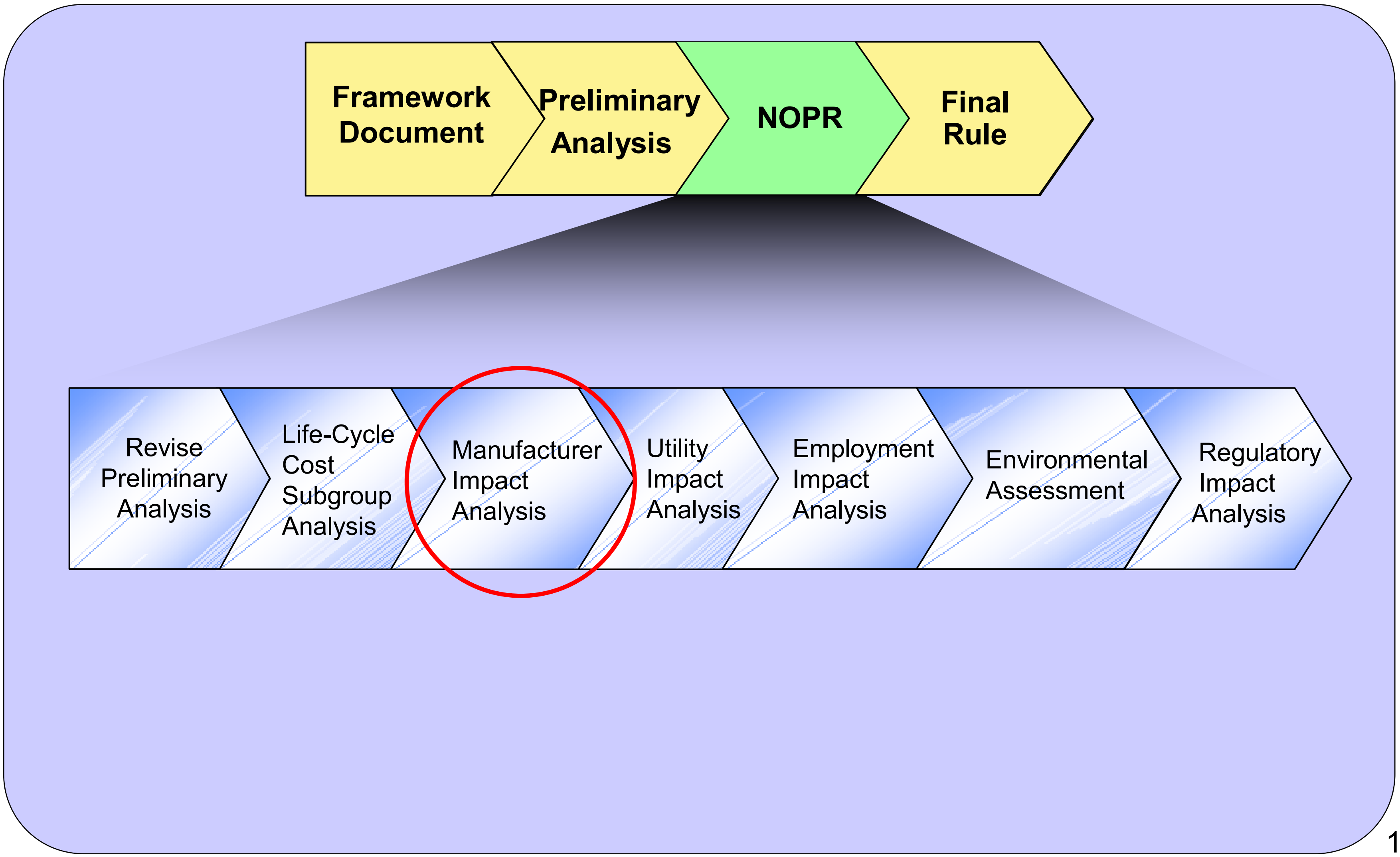
Life-Cycle Cost Subgroup Analysis

- **Purpose**
  - Evaluate impacts on any identifiable groups or customers who may be disproportionately affected by any national energy efficiency standard level.
- **Method**
  - Analyze the LCC and payback periods (PBPs) for those customers that fall into any identifiable groups. LCC spreadsheet model allows for different inputs to represent particular groups.
  - Possible subgroups include small businesses (*i.e.* those with small annual revenues) and farmers.
- **Output**
  - Customer subgroup life-cycle costs and payback periods.
  - Identification of subgroups particularly affected by a new standard.

Purchase Price Impacts

- DOE will be especially sensitive to increases in the purchase price of the equipment due to new standards, to avoid negative impacts on identifiable population groups that may not be able to afford significant increases in equipment price.

Analyses for Notice of Proposed Rulemaking (NOPR)

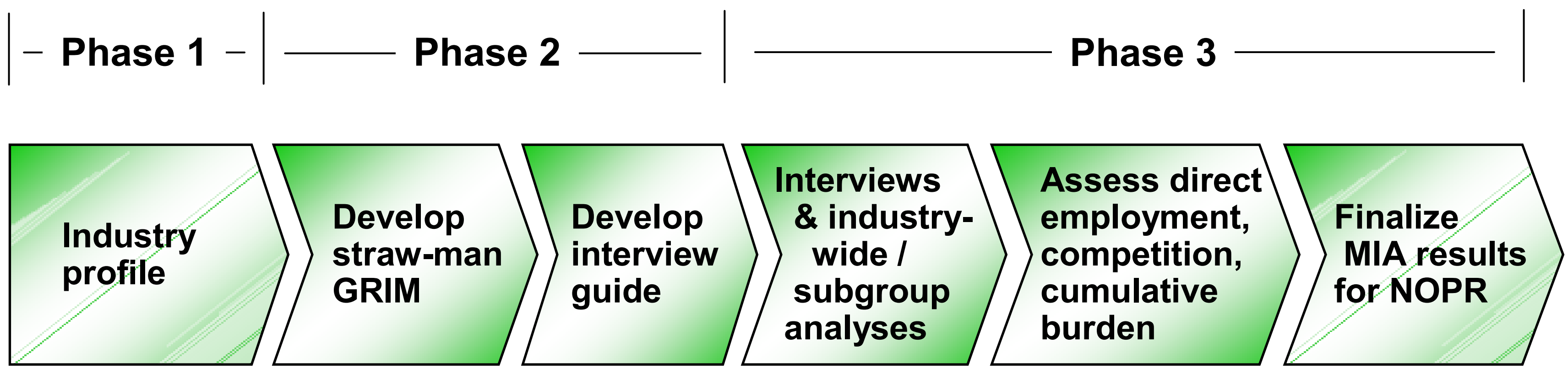


Manufacturer Impact Analysis

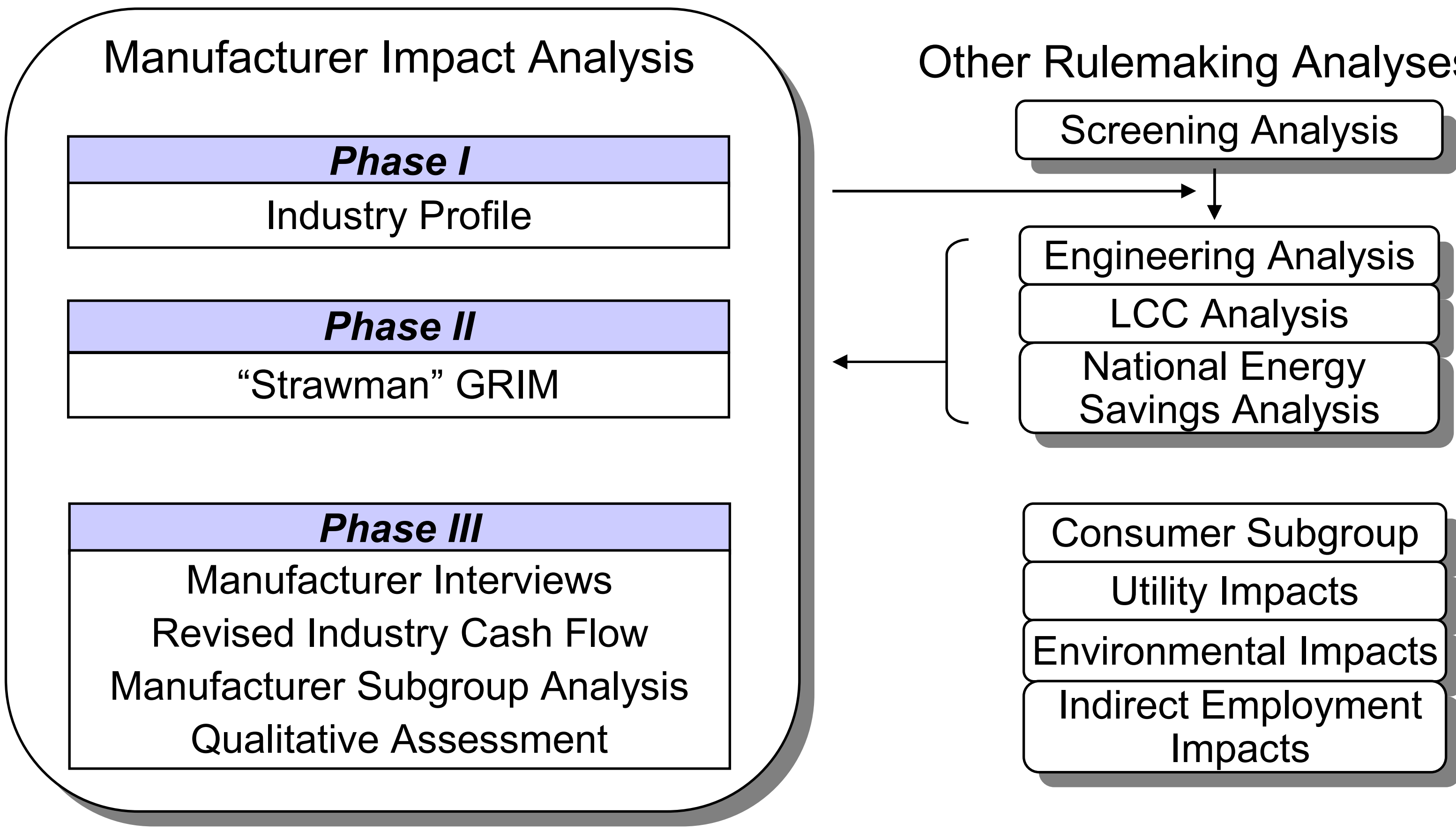
- **Purpose**
  - Assess the impacts of standards on small electric motor manufacturers.
  - Identify and estimate impacts on manufacturer sub-groups that may be more severely impacted than the industry as a whole.
  - Examine the impact of cumulative regulatory burdens on the industry.
- **Method**
  - Analyze industry cash flow and net present value through use of the Government Regulatory Impact Model (GRIM).
  - Interview manufacturers to refine inputs to the GRIM, develop sub-group analyses, and address qualitative issues.
- **Output**
  - Manufacturer sub-group net present value impacts.
  - Other sub-group net present value impacts.
  - Other impacts.

Manufacturer Impact Analysis (MIA) Process

- **The MIA process consists of three phases:**



The MIA is both concurrent and coordinated with activities throughout the rulemaking process.

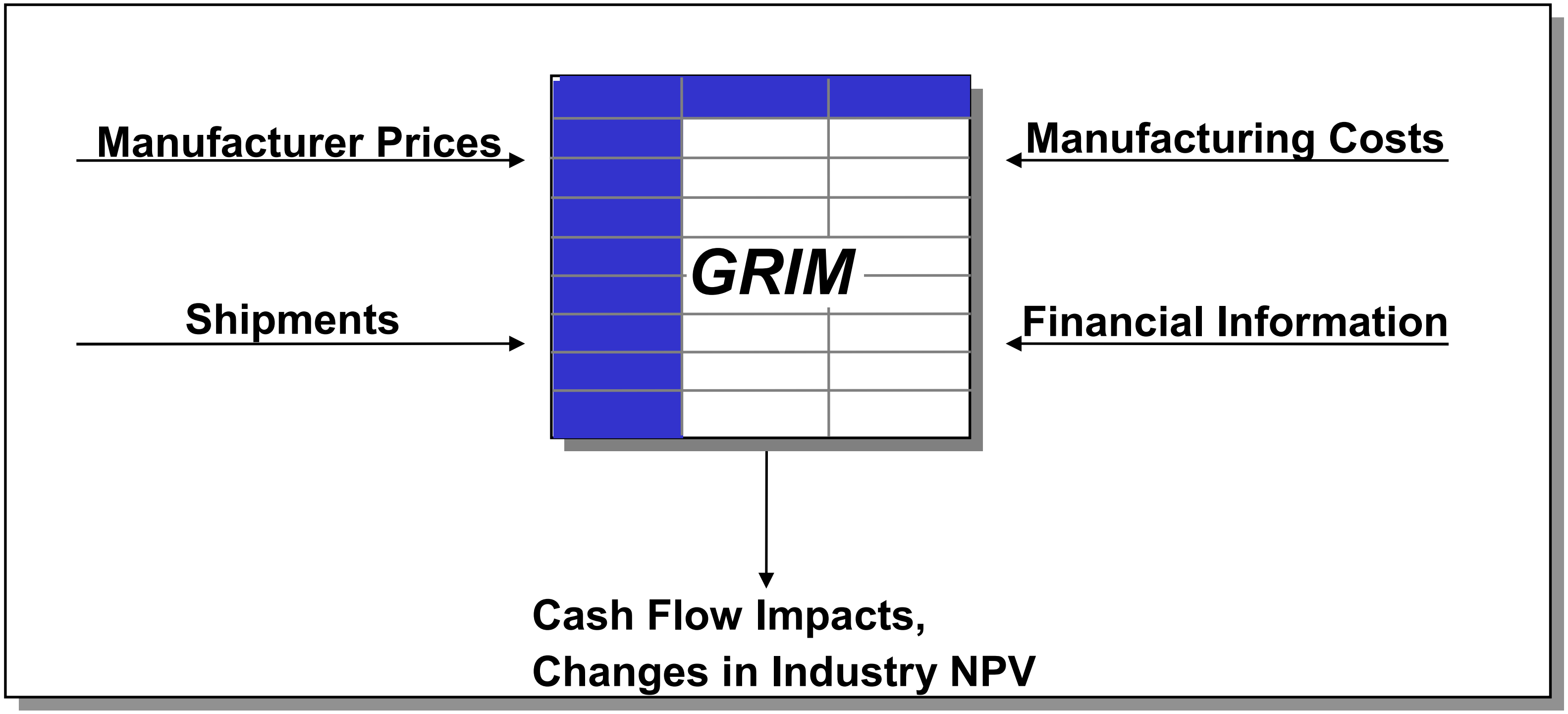


Phase I: Industry Profile

- **Collect financial and market information:**
  - Industry reports;
  - Company annual reports and websites;
  - Trade journals;
  - U.S. Census Bureau;
  - SEC 10-K form filings;
  - Information from the preliminary activities preceding the NOPR: manufacturer production costs, markups; and manufacturer selling prices, shipments.

Phase II: Develop Straw-man GRIM

- The Government Regulatory Impact Model (GRIM) is an industry cash flow analysis that estimates the change in industry value due to the introduction of new efficiency standards.



Phase II: Develop Interview Guide

- **A critical aspect of the MIA involves interviews with manufacturers. An interview guide is sent to manufacturers in preparation for Phase III.**
- **Interview topics will include:**
  - Engineering analysis;
  - Shipments model;
  - Cost structure and financial parameters;
  - Conversion costs (capital expenditures, tooling, R&D, testing);
  - Impact of other regulations / cumulative burden;
  - Direct employment impacts;
  - Import / Export issues;
  - Consolidation / competitive impacts;
  - Replacement parts or refurbishments;
  - Impact of the standard's effective date; and
  - Other topics important to manufacturers

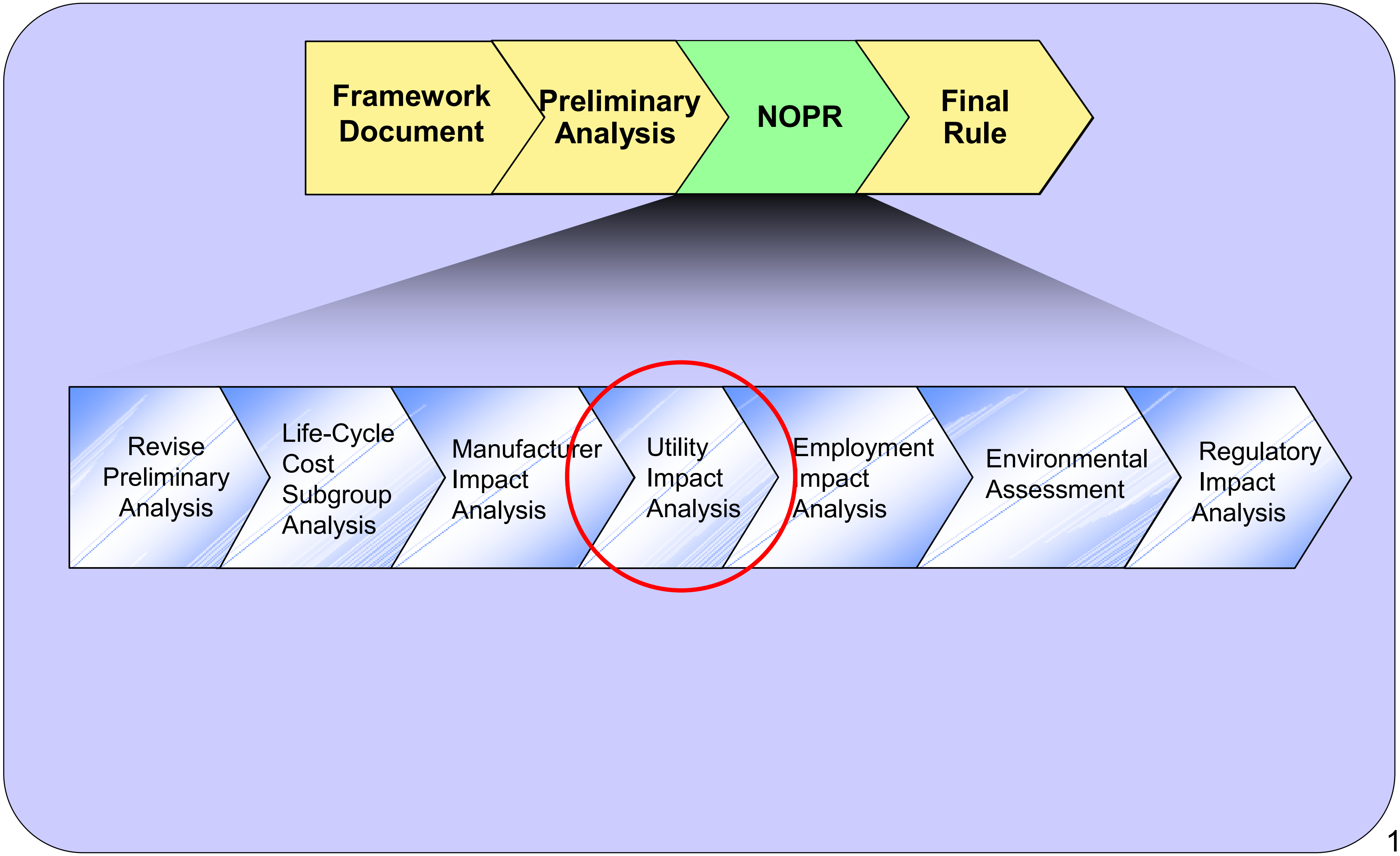
Phase III: Manufacturer Interviews

- **Expected timeframe.**
- **Time and personnel commitment for manufacturers (industry-wide GRIM, GRIM assumptions, subgroup analysis discussion).**
- **Confidentiality agreements.**

Phase III: Manufacturer Subgroup Analysis

- **The subgroup analysis is a more focused version of the industry-wide analysis.**
  - Work with subgroup representatives to tailor a GRIM incorporating unique financial characteristics.
  - Consider and focus on issues of importance to the subgroup, including employment, capacity utilization and cumulative burden.
  - Review draft findings with subgroup members during development.

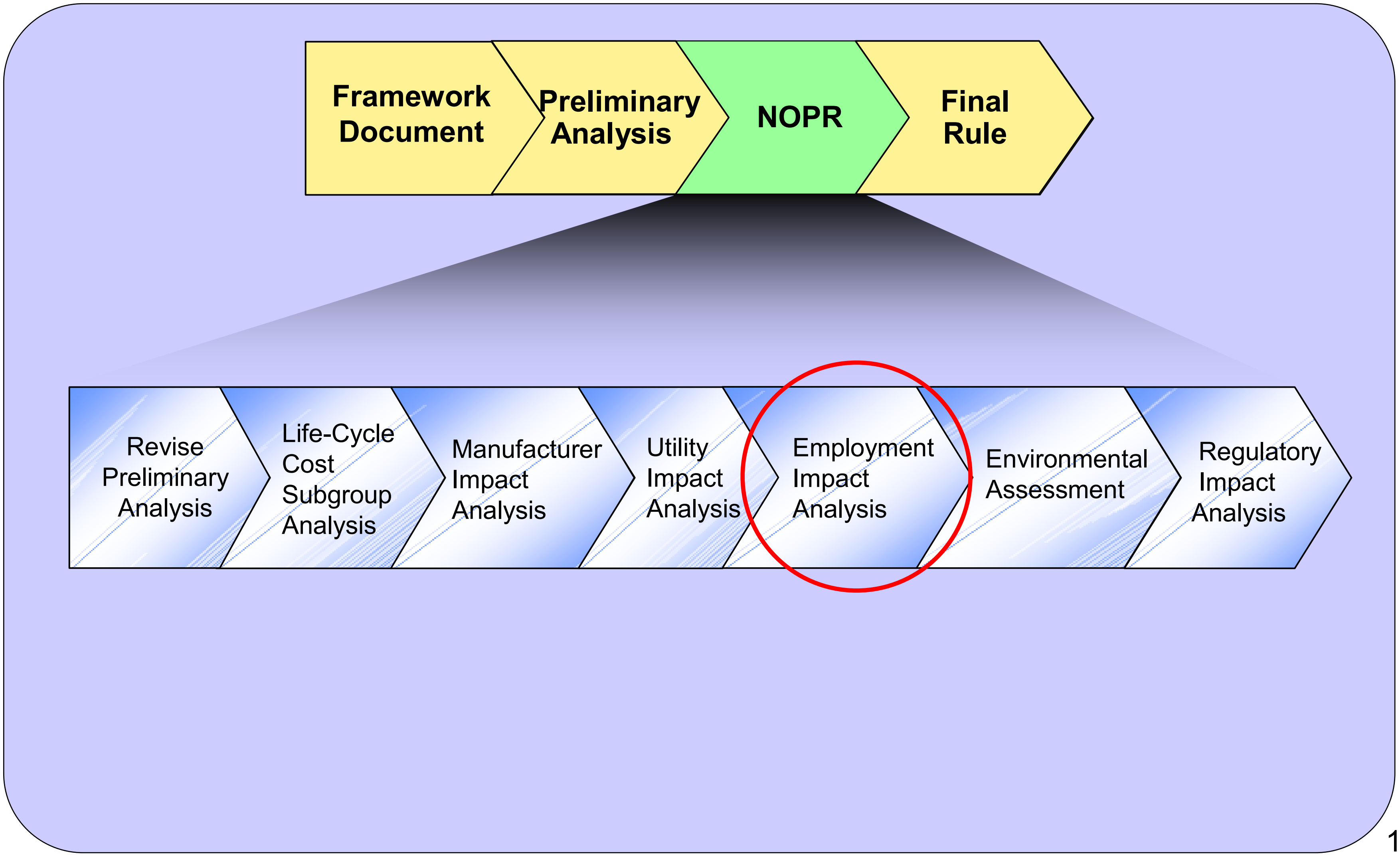
Analyses for Notice of Proposed Rulemaking (NOPR)



Utility Impact Analysis

- **Purpose**
  - Investigate the effects on electric utilities from reduced energy consumption and reduced peak load demand due to new energy conservation standards.
- **Method**
  - Uses national energy savings results.
  - Uses the Energy Information Administration's National Energy Modeling System (NEMS) tailored for DOE's Building Technologies Program (NEMS-BT).
- **Output**
  - Change in electricity sales and price by region.
  - Change in the mix of electricity generation.
  - Change in new capacity construction.

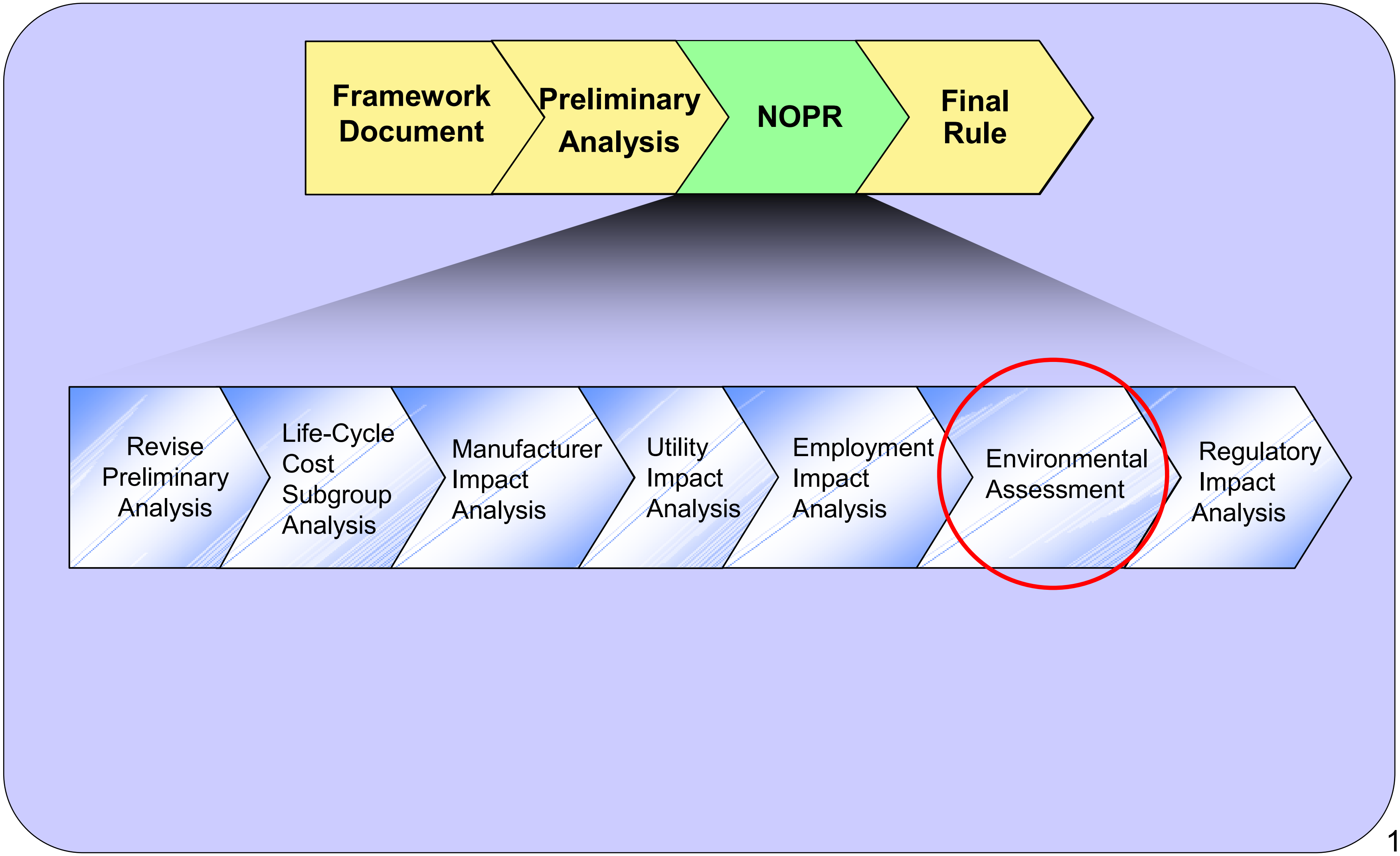
Analyses for Notice of Proposed Rulemaking (NOPR)



Employment Impact Analysis

- **Purpose**
  - Report net jobs created or eliminated nationally as a consequence of new energy conservation standards.
- **Method**
  - Uses the ImSET (Impact of Sector Energy Technologies) model for the evaluation of indirect employment impacts.
  - Changes in equipment and energy expenditures are developed in the National Energy Savings Analysis.
  - Direct employment impacts are developed in the Manufacturer Impact Analysis.
- **Output**
  - Change in the commercial and energy sector employment as a consequence of new energy conservation standards.

Analyses for Notice of Proposed Rulemaking (NOPR)



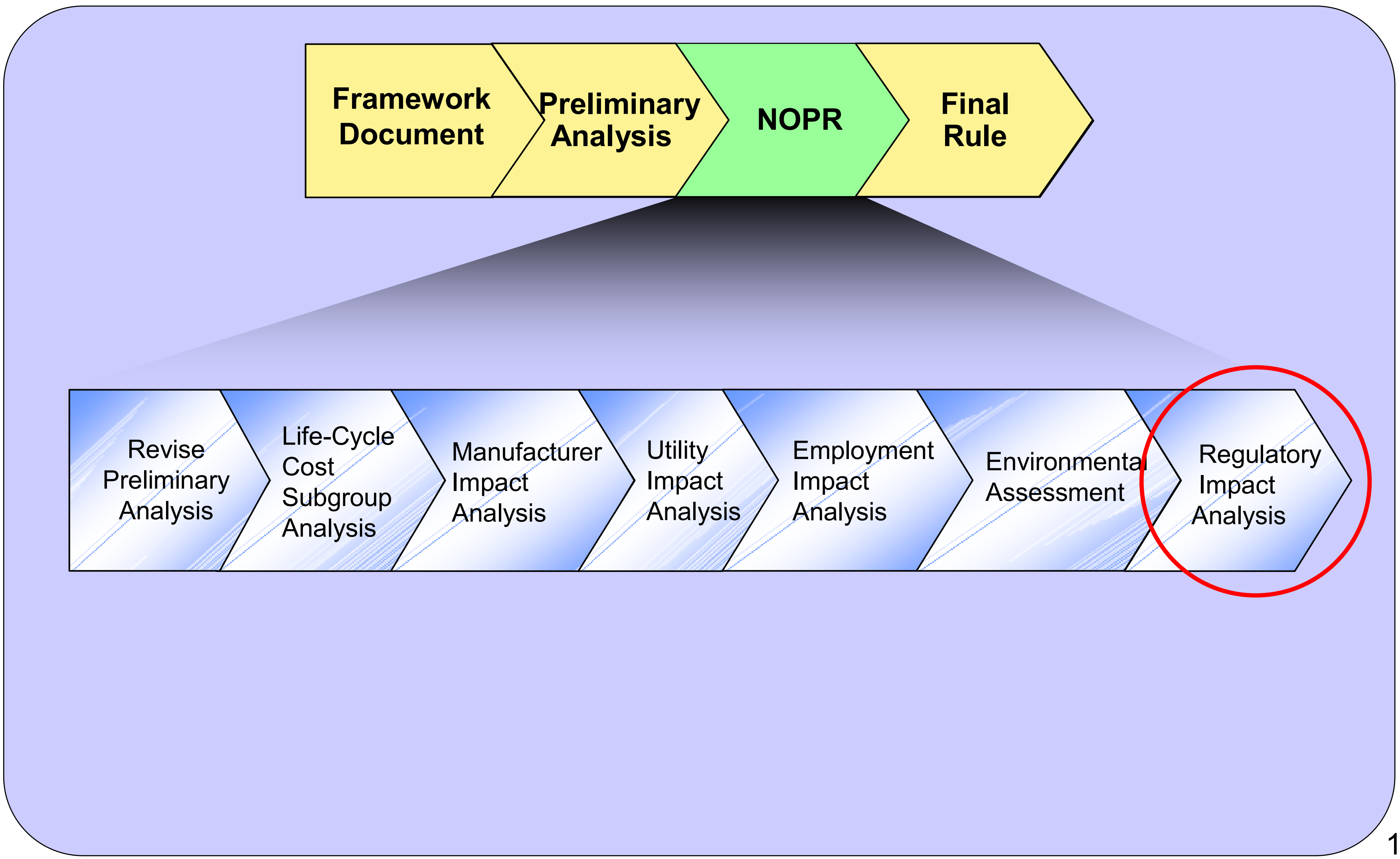
Environmental Assessment

- **Purpose**
  - Report environmental impacts as a consequence of new energy conservation standards, including changes in power plant emissions.
- **Method**
  - Energy savings results taken from the National Energy Savings Analysis.
  - Energy Information Administration's National Energy Modeling System (NEMS) provides power-plant emissions.
- **Output**
  - Estimate of national emission reductions of sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon dioxide (CO_2) and mercury (H_g).

Request for Comment:
Monetary Value of Emissions

Issue: DOE invites comment on the monetary value of Green House Gas emissions reduction. DOE will use monetary values to represent the potential value of such emissions reductions. DOE invites comment on methods for estimating the net monetary value of Green House Gas emissions reductions. DOE also invites comment on which data and reports provide information regarding widely accepted values that may be used in DOE's analyses.

Analyses for Notice of Proposed Rulemaking (NOPR)



Regulatory Impact Analysis

- **Purpose**
  - Investigate the national impacts due of non-regulatory alternatives compared with mandatory energy conservation standards.
  - The non-regulatory alternatives that may be considered include:
    - No new regulatory action; early replacement; prescriptive standards; customer tax credits; manufacturer tax credits; customer rebates; voluntary efficiency targets; bulk government procurement.
- **Method**
  - NES spreadsheet model is modified to consider scenarios. These include: energy prices and escalation factors; implicit market discount rates; customer purchase price, operating cost, and income elasticities; and equipment stock data.
- **Output**
  - National Energy Savings and Net Present Value of the non-regulatory alternatives.
  - Impact of non-regulatory alternatives on purchase price and use of energy-efficient equipment.

Consensus Recommendations

- **DOE seeks to encourage development of consensus proposals for new standards because standards with such broad-based support are likely to balance effectively the economic, energy, and environmental interests affected by standards.**

- **Any recommendation must satisfy the seven statutory criteria provided by EPCA for determining whether an energy conservation standard is technologically feasible and economically justified, and will result in significant energy savings.**

- **Any consensus recommendation should also include information that DOE can use to assess the seven statutory criteria that determine whether the benefits of the standard exceed its burdens to the greatest extent practicable.**

The Energy Policy and Conservation Act (EPCA) directs DOE to consider seven factors when setting energy conservation standards

Factor	Analysis
1. Economic impact on consumers and manufacturers	Life-cycle cost analysis Manufacturer impacts analysis
2. Lifetime operating cost savings	Life-cycle cost analysis
3. Total projected energy savings	National impact analysis
4. Impact on utility or performance	Screening analysis Engineering analysis
5. Impact of any lessening of competition	Manufacturer impacts analysis
6. Need for national energy conservation	National impact analysis
7. Other factors the Secretary considers relevant	Environmental assessment Utility impact analysis Employment impact analysis

DOE Seeks Comments on its Proposal

In all correspondence, include all of the following:

- Energy Conservation Standards for Small Electric Motors
- Docket Number EERE-2007–BT–STD–0007
- Regulatory Identification Number (RIN) 1904–AB70

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Comment period closes: March 2, 2009