Impact of Proposed Increases to Motor Efficiency Performance Standards, Proposed Federal Motor Tax Incentives and Suggested New Directions Forward[1]

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[1] This report is an update of an ACEEE white paper of the same titled released in June 2007.

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EXECUTIVE SUMMARY

Motors use more than half the electricity in the United States and over two-thirds of the electricity in the industrial sector. Over the past 20 years, motor efficiency standards have succeeded in transforming the motor marketplace, resulting in significant energy savings and carbon reductions. As a result of the standards that were enacted as part of the *Energy Policy Act of 1992* (EPAct-92), the U.S. now has a motor standard foundation that leads the world.

As a result of these standards efforts, motor manufacturers and the motor efficiency community created the voluntary labeling program *NEMA Premium*® that defined the next step in efficiency. Seven years of promoting *Premium* motors has resulted in significant market acceptance of these products, representing a significant programmatic success with most large industrial consumers. The federal government has also embraced these products. However, the shift of the motor marketplace to *Premium* appears to have stalled in recent years as the programs have been unable to significantly impact the original equipment or many of the less sophisticated motor purchasers. As a result, motor manufacturers working through the National Electrical Manufacturers Association (NEMA) and ACEEE, with the support of the Northeast Energy Efficiency Partnership (NEEP) and Pacific Gas & Electric Company (PG&E), have negotiated an agreement to increase the minimum efficiency performance standards (MEPS) for motors covered by EPAct-92 and an expansion of the coverage to many other motors not covered by current law.

This agreement has been incorporated into the energy legislation that has been passed by both houses of Congress and is awaiting the conference to resolve the differences between the two bills. The ultimate fate of the overall energy legislation remains uncertain at the time of this writing; none of the uncertainty exists because of these motor provisions. While minor technical differences exist between the House and Senate legislation, both fully embody the standards agreement, and no significant changes to the agreement are anticipated to emerge from the legislative conference.

Scope of Increased and Expanded Motor Standard Proposals

The proposal would raise the minimum efficiency level for 1–200 horsepower (HP) motors covered by EPAct-92 to the *NEMA Premium*® level (NEMA 2006a, Table 12-12) except for fire pump motors that remain at the EPAct-92 level (NEMA 2006a, Table 12-12). In addition, the proposal expands the scope of covered 1–200 HP motors to include:

- U-frame motors
- Design C motors
- Close-coupled pump motors
- Footless motors
- Vertical solid shaft normal thrust (tested in a horizontal configuration)
- 8-pole motors
- All poly-phase motors with voltages up to 600 volts other than 230/460 volts (230/460 volt motors are covered by EPAct-92)

The required efficiency level for these motors is the "energy-efficient" level specified by NEMA MG-1, Table 12-11. This extends MEPS coverage to over 90% of motors 1–200 HP, with the balance as special purpose motors not readily adaptable to minimum standards. Manufacturers expressed serious technical reservations about raising these additional motors to the *NEMA Premium*® level because of customer requirements for reduced voltage starting in many of these categories, as well as difficulties with meeting premium levels for Design C and 8-pole motors.

The provision also calls for extending MEPS coverage for NEMA Design B motors from 201–500 HP at the NEMA (2006a), Table 12-11 (energy-efficient) level. Manufacturers expressed concerns about meeting energy-efficient levels for other categories of motors (e.g., Design A and C) due to concerns about motor in-rush current restrictions that many customers request for these motors. Design B motors represent about three-quarters of the 201–500 HP motors.

All of these standards would go into effect 36 months from the date of enactment of the federal legislation.

Companion Motor Tax Incentives

Proposed motor efficiency performance standards will raise the efficiency of poly-phase, integral horsepower induction motors in coming years. Because these motors will last more than 20 years in service, accelerating the production and purchase of these more efficient motors in advance of the standards will yield significant long-term energy savings. A tax credit was proposed as part of the original agreement to encourage end-use customers to invest in the new premium efficiency models rather than pre-buying the older, less efficient motors in anticipation of changes in energy standards, which is expected to increase costs of motors. The credit would have also encouraged taxpayers to replace motors in need of repair with new motors, rather than repairing and extending the life of older motors.

The standards are estimated to save 9,781 GWh per year and reduce peak demand by 1,341 MW, the equivalent of three new coal power plants, with an associated annual reduction of 2 million metric tonnes of CO_{2e} emissions. We cannot, however, declare victory and go home when these new standards go into effect. Much work remains to change motor management practices to insure that inefficient motors are replaced with new, efficient products. Without this effort, repairs could extend the lives of older motors indefinitely, missing the opportunity to realize the energy and carbon savings that would result from moving the motor stock to a higher level of efficiency. In addition to changing the standard, motor efficiency programs must also ensure that the correctly-sized motors are installed for applications and that motor systems are sized and operated such that they are optimized to meet the load required, thus saving even more energy.

The proposed tax incentives would play an important role in transitioning the motor market to *Premium* motors, while at the same time creating an opportunity to transition motor efficiency programs to focus on the remaining efficiency challenges that remain in the motor marketplace. It is important to act now, however, so that the tax incentives and the new program direction are in place once the standards are enacted.

Unfortunately, while the provision was introduced in legislation by Sen. Lincoln (D-AR) and Sen. Smith (R-OR), the provision was not included by the House Ways and Means Committee in the House-passed Energy Bill (HR-2661-EH). The Senate Energy bill, HR-6 ES, did not include tax provisions, and the likelihood of motor tax provisions emerging from the conference is not good. Motor efficiency advocates continue to seek other legislative vehicles for this proposal.

INTRODUCTION

Motors account for almost half of the United States' electricity consumption and over two-thirds of industrial electricity consumption. In the industrial sector, much of this electricity is consumed by integral horsepower poly-phase motors — the workhorses of industry. This class of motors also accounts for a significant portion of the motor electricity consumption in the commercial sector (Nadel et al. 2002). Because of the large share of electricity consumption accounted for by this class of product, in the 1980s it became an early target for minimum efficiency performance standards (MEPS), in some U.S. states and Canadian provinces. The *Energy Policy Act of 1992* (EPAct-92) enacted national MEPS in the U.S., setting the country on the path toward improving the efficiency of this important class of motors.

While the rule implementing the EPAct-92 motor standards has been a success and is estimated to eventually save an estimated 16 GWh per year, the time appears right to raise the efficiency levels to *NEMA Premium*®. Voluntary programs that promote *NEMA Premium*® such as *MotorUp* in the Northeast have achieved about 20% market share for new and replacement motors in markets where the programs operate, however these efforts have had little impact in other parts of the country and on original equipment manufacturer (OEM) sales. Raising efficiency levels to the *NEMA Premium*® will save an estimated 9,480 GWh and ensure that future motor installations will maximize energy savings in all markets and avoid the lost opportunity that would persist for well more than the 20 plus typical years of life of an EPAct-92 motor when considering subsequent repairs.

Likewise, operating on a national scale is *Motor Decisions Matter* (MDM), a public awareness program jointly funded by motor manufacturers, the motor repair industry and energy efficiency programs, and managed by CEE. MDM's objective was to influence the way industrial facilities managers made repair/replace decisions by highlighting the financial benefits of *NEMA Premium*® motors, best practice repairs and other proactive motor management strategies. The MDM initiative has formed the basis for many of the motor programs for the past five years, achieving a high degree of success. The Federal Energy Management Program (FEMP) at The U.S. Department of Energy (DOE) also adopted the *NEMA Premium*® as their recommendation for energy-efficient motor purchases and in 2006 implemented federal purchasing requirement for these motors as part of the implementation of the *Energy Policy Act of 2005*.

Rising electric rates, growing concerns about global warming, changes in the motor marketplace and a new political environment in Washington create an opportunity to adopt these higher standards as part of national energy legislation. After the protracted rule making process with the DOE EPAct-92 motor rule, motor manufacturers and energy efficiency advocates are not in favor of pursuing a regulatory process again.

In this report, we review the current motor market situation and discuss why a new national standard is needed to continue to grow the market for the highest efficiency motors. Details are provided on the proposed changes to the motor minimum efficiency performance standard that are under consideration by Congress, a proposed federal investment tax credit

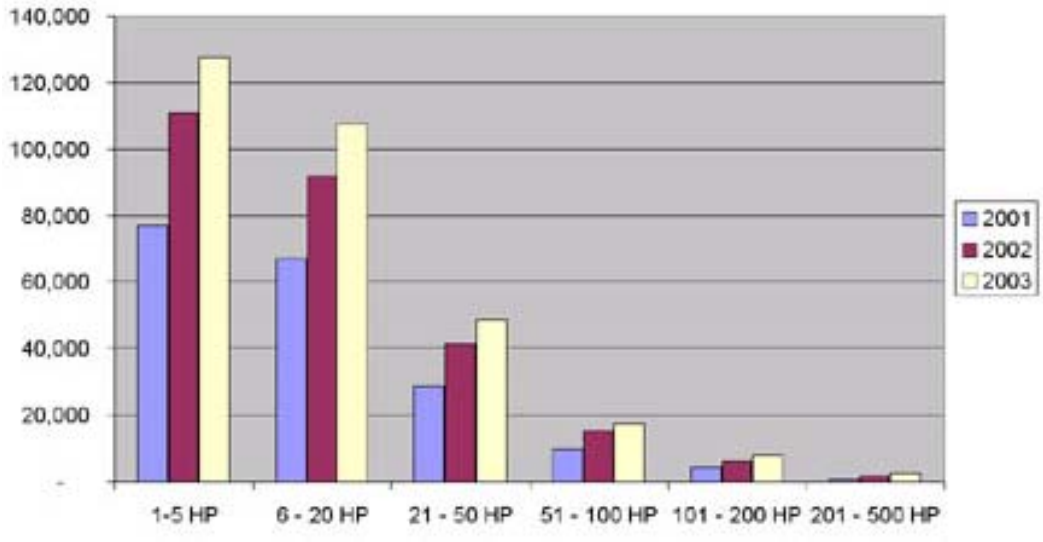
(ITC), and we consider how the credit complements the proposed efficiency standard. Estimates for savings resulting from the standard are also presented. Lastly, we discuss the substantial opportunities that still remain for voluntary programs, even with a new efficiency standard and investment tax credit.

Current Status of the Motor Marketplace

Motor standards and the development of the *NEMA Premium*® label have been a success, fundamentally changing the motor market place. *NEMA Premium*® commands an increasing share of the motor sales in spite of falling sales volumes for motors overall. Unfortunately, additional gains from existing policies may diminish in the future. At the same time, motor manufacturers are under increasing market pressure and we foresee the industry changing in coming years.

In November of 2004, NEMA released state-level shipment data on its *NEMA Premium*® program which suggest a growing demand for premium-efficiency motors (NEMA 2004b). The data show that in 2001–2002 the total net units shipped went up approximately 30 percent in spite of the declining sales of motors overall. In 2002–2003 there was a 14 percent increase over the previous years. Data for recent years are not yet available. These data are summarized in Figure 1.

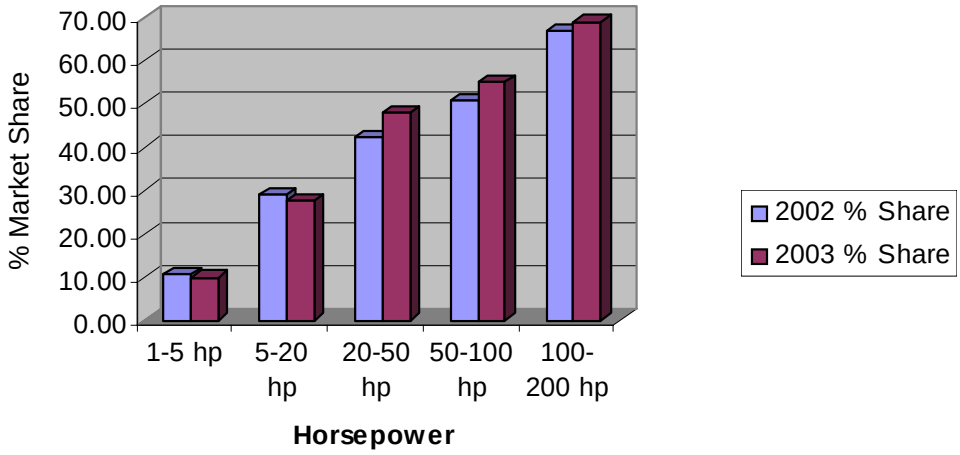
Figure 1. NEMA Premium Motors Shipped in U.S.



Source: NEMA 2004a

A second data source, Census (2004), also shows that the share of sales of energy-efficient motors as a share of total sales of motors has increased in the past few years as well for larger motors but perhaps declined slightly for smaller motors. These data are shown in Figure 2.

Figure 2. Energy-Efficient Share of Motor Shipments in the U.S.



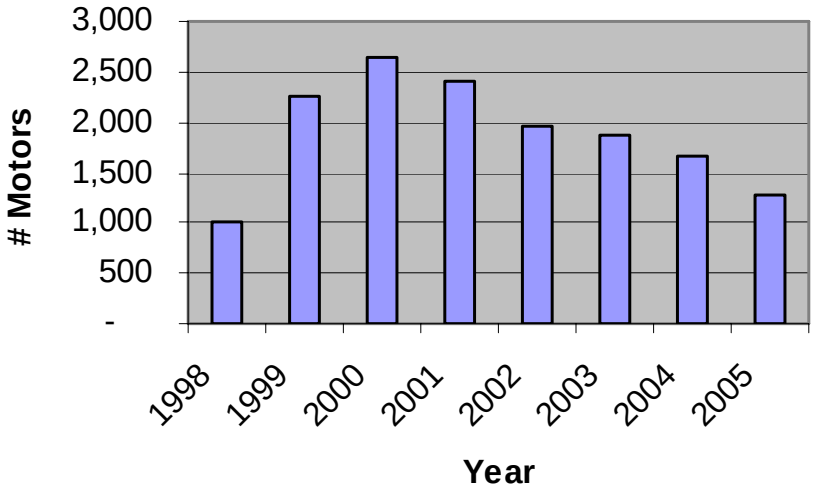
Source: Census Bureau (2004)

Taken together, these data show that as motor size increases, significantly fewer motors are sold, but that the premium motor share of the market increases.

Since 1998, sponsors of Northeast Energy Efficiency Partnerships' (NEEP) *Premium Efficient Motors Initiative* have operated regionally-coordinated, ratepayer-funded motor efficiency programs to promote *NEMA Premium*® (NEMA 2002), or CEE specified motors. Several of these program administrators joined in a regional promotion, *MotorUp*, consisting of vendor outreach, training and information, with regionally consistent rebates. Participants in *MotorUp* covered five New England states, as well as New Jersey and Long Island. Throughout New York, the New York State Energy Research and Development Authority (NYSERDA) has operated a mid-market focused program, *NY Energy Smart Motors*, promoting *NEMA Premium*® motors through vendor support and focusing on motor fleet management planning (Linn 2006).

Motors processed through *MotorUp* increased for the first three years of the program, however, starting in 2001 the yearly totals decreased. The decline in units reflects market effects as discussed below. Figure 3 displays *MotorUp* rebate totals for the first eight years of the program.

Figure 3. MotorUp Rebate Motor Count 1998 to 2005



Source: Linn 2006

Pacific Gas and Electric (PG&E) reports that the number of incentives paid for premium efficiency motors have leveled off (Hanna 2006). Since 1992, PG&E has utilized two main approaches to deliver rebates to promote the purchase of premium efficiency motors. The first approach is customer rebates. The second approach is an "upstream" rebate paid to the motor distributors. PG&E has alternated between a customer and upstream approaches over the last 12 years and found that the upstream rebate has resulted in a dramatic increase in premium efficiency motor sales. The average number of motors rebated downstream (in years 1995-98, 2002-3) was 381 per year, while the upstream rebates (in years 1999-2001, 2003-6) have resulted in an average increase of about 400% to 1881 per year. In 2006, the upstream program paid 2,266 rebates, but that increase may have more to do with increased distributor participation as a result of the convenience of the new, entirely paperless, online application processing system, rather than an increase in sales of *Premium* motors. Even though the increase in premium efficiency motor sales has been significant using an upstream strategy compared to customer incentives, it does not come anywhere close to capturing the market potential of the estimated 35,000 motors sold annually in PG&E's service territory (Barbour 2007).[2]

A major California distributor (Brithinee Electric) informs us that premium sales have flat-lined in the last couple of years. We have heard similar and off-the-record reports from several other key motor industry players, noting that the decrease in sales may be driven by steep increases in copper and steel prices that have been passed through to finished motors.

Alternatively, a recent tour by Brithinee Electric staff found *NEMA Premium*® motors were stocked by motor suppliers in those parts of the country where motor programs existed, but there was limited stocking in those parts of the country where there were no programs (Butek

[2] The market penetration of *Premium* motors in PG&E service territory is estimated at 8.7%, which suggests that the program is capturing less than half of premium sales.

2006). It seems clear that these local motor programs have had an important role in developing the market for *NEMA Premium*® motors.

Though there is clearly demand for *NEMA Premium*®, and sales have increased over the past few years, much of this growth appears to be among segments of the market most amenable to energy efficiency. Continued growth appears to be difficult and in fact recent indications are that barriers in the market and distribution channels have caused stagnation in terms of market penetration where programs are operated. At the national level, the same appears to be the case. For example, as shown in Figure 2, the *NEMA Premium*® share of the 1-20 HP market may have weakened. Likewise, incomplete data from 2004 show lower sales of *NEMA Premium*® motors in 2004 than in 2003 (NEMA 2006b).

This same trend of market-share leveling off after several years of effort happened in the 1980's with regards to high-efficiency motors. For example, Nadel et al. (1992) found that in 1988, high-efficiency motors accounted for about 20% of sales after about 15 years of promotion efforts. Ultimately, the EPAct-92 standards were established to address hard-to-move segments of the market. Furthermore, while copper and steel prices are expected to decline somewhat, incremental prices for *Premium* motors are likely to be significantly higher in the long-term than they were prior to 2004.

Motivation for Increasing Regulatory Standard

Given these trends, ACEEE thinks the most reasonable estimate is to assume a relatively level share of premium motors sales going forward. The motor marketplace can loosely be grouped into three categories:

1. **Industrial Motors:** The large, energy-intensive manufacturers have demanded higher-performing motors for many years, because they understand that first cost is a fraction of the life-cycle cost (LCC) of ownership for the motor. In fact in the 1970s and 80s they pushed the performance beyond what NEMA was delivering through the IEEE 841 specification. Motor manufacturers responded by making the NEMA design standards more rigorous and by building a "premium" product.
2. **Other Motor End-Users:** A second market is the rest of the end-user motor purchasing market, who generally buy on first-cost. They are not overly technically sophisticated, and because of the NEMA standards, they have confidence that the motors that they buy will "perform" — this means they will start and run the load reliably. They are not really aware of efficiency or the cost of owning a motor for many reasons, and it is difficult to sustainably change their buying practices.
3. **Original Equipment Manufacturers:** Finally, we have the original equipment manufacturer (OEM) market that again is first-cost driven. Because all motors will "perform" identically, they are motivated to buy as low a cost motor as can be had, because that creates potential margin that allows them to more easily balance price and market share to increase their profitability. This again is another market that is difficult to shift to a more efficient product.

The first market that is likely to adopt *NEMA Premium*® has largely already done so. The remaining markets are unlikely to change their purchasing behavior without continued active

and costly market intervention, and these changes are unlikely to be sustained without ongoing programs.

In addition, we have seen a number of states actively look at enacting state-level standards for motors not covered by EPAct-92. [3] Motor manufacturers, some of whom were already inclined to support raising the national standards levels for covered motors, found the threat of individual states enacting various motors standards as an additional motivation to support expanded national motor standards which would preempt individual state action. For the most part, manufacturers saw much to recommend more efficient and expanded standards. Motors manufacturers were also concerned about the Department of Energy's announced intent to begin a review of motor standards in 2008 (as they are required to do under the Energy Policy and Conservation Act of 1975 (EPCA)), the uncertainty that a protracted rulemaking process would create, and the time required to participate in the process. The combined prospects of pending events increased the urgency to act because of the fear that these bills would be the last for several years in which these provisions could be included, and if this opportunity was not seized the market disruption could be significant.

Thus, ACEEE and NEMA engaged in formal discussions beginning in November 2006 on formulating a joint standard proposal. These discussions continued until March 2007, when the parties agreed to a proposal with two components: a regulatory proposal to increase the existing efficiency standard levels and an expansion of the scope of product covered by national MEPS; and companion proposals for a tax incentive to end-users for the purchase of the *NEMA Premium*® product. These proposals were communicated to the U.S. House and Senate committees with jurisdiction over energy regulations and taxes, with the indication that ACEEE and NEMA were prepared to support the inclusion of these proposals in federal legislation. The organizations are now working with congressional offices to seek the inclusion of both the standard and tax incentive proposals in pending energy legislation.

Proposed Motor Efficiency Performance Standard

The standards proposal negotiated between NEMA and ACEEE raises the minimum efficiency level for 1–200 HP motors covered by EPAct-92 to the *NEMA Premium*® level (NEMA 2006a, Table 12-12) except for fire pump motors which remain at the EPAct-92 level (NEMA 2006a, Table 12-12). In addition, the proposal expands the scope of covered 1–200 HP motors to include:

- U-frame motors
- Design C motors
- Close-coupled pump motors
- Footless motors
- Vertical solid shaft normal thrust (tested in a horizontal configuration)
- 8-pole motors

[3] For example, PG&E had already worked with ACEEE to develop a proposal for California targeting motors not covered by EPAct-92. Because of the provisions in the *Energy Policy and Conservation Act of 1975* (EPCA), states are preempted from enacting their own standards on products for which federal standards exist. However, motors which were not covered by EPAct-92 are eligible for state-level standards.

- All poly-phase motors with voltages up to 600 volts other than 230/460 volts (230/460 volt motors are covered by EPAct-92)

The required efficiency level for these motors is the "energy-efficient" level specified by NEMA (2006a), Table 12-11. This extends MEPS coverage to over 90% of 1–200 HP motors, with the balance in special purpose motors not readily adaptable to minimum standards. Manufacturers expressed serious technical reservations about raising these additional motors to the *NEMA Premium*® level because of customer requirements for reduced voltage starting in many of these categories, as well as difficulties with meeting premium levels for Design C and 8-pole motors.

The provision also calls for extending MEPS coverage for NEMA Design B motors from 201–500 HP at the NEMA (2006a), Table 12-11 (energy-efficient) level. Manufacturers expressed concerns about meeting energy-efficient levels for other categories of motors (e.g., Design A and C) due to concerns about motor in-rush current restrictions that many customers insist on for these motors. Design B motors represent about three-quarters of the 201–500 HP motors. All of these standards would go into effect 36 months from the date of enactment of the federal legislation.

Proposed Motor Purchase Tax Credits

Proposed motor efficiency performance standards will raise the efficiency of poly-phase, integral horsepower induction motors in coming years. Because these motors will last more than 20 years in service, accelerating the production and purchase of these efficient motors in advance of the standards will yield significant long-term energy savings. A tax credit will encourage end-use customers to invest in the new premium efficiency models rather than pre-buying the older, less efficient motors in anticipation of changes in energy standards, which are expected to increase motor prices. A credit will also encourage taxpayers to replace motors in need of repair with new motors, rather than repairing and extending the life of older, less efficient motors.

As discussed above, the proposed standard will not raise all motors to the highest *NEMA Premium*® level, because of challenges in meeting the necessary efficiency levels while meeting other motors performance requirements (e.g., inrush current, frame size). Therefore, tax incentives that encourage the purchase of these *Premium* products that exceed the proposed standards will yield important efficiency benefits to the United States beyond the proposed federal motor standard. Similarly, tax incentives that encourage the purchase of premium motors prior to the start date of the proposed updated federal motor standard will yield significant energy benefits (avoiding lost opportunities). Such incentives will also help to steadily build the market for the capacity to manufacture and sell premium motors as the minimum requirement for the affected motors when the new standard takes affect. The pre-standards ramp-up of production volume resulting from the tax credits will enable manufacturers take advantage of the economies of scale to produce *NEMA Premium*® motors at a lower cost than might otherwise occur in the first years of the new standard.

The proposed ITC would provide a credit of $15 per horsepower installed for the purchase of premium efficient motors. The credit would be in effect for the 36 months prior to the

effective date of the new motor standards. It is important to reemphasize that the credits are for *NEMA Premium*® motors, even though not all motors are raised to that level by the MEPS.

Status of National Motor Standards Legislation

The proposed Motor standards agreement has been incorporated into the energy legislation that has been passed by both houses of Congress. The legislation is included as Sec. 229 of the Senate passed Energy Bill, HR-6 ES (Senate 2007). A somewhat more refined embodiment of the proposal is included in the House-passed energy bill, HR-2661 EH (House 2007) as Sec. 9002. Both pieces of legislation fully embody the standards agreement, and now await a conference to resolve the differences between the two bills. The House legislative language refined the Senate language (which was developed first) to reduce ambiguity. Subsequent to the passage of the House bill it was noted that the languages might be construed to create a laps in existing motor standards between the date of enactment and the effective date of the new provision. House and Senate staffs have been apprised of this problem and propose to make a technical correction during the House-Senate conference. While the ultimate fate of the overall energy legislation remains uncertain, none of the uncertainty exists because of these motor provisions.

Unfortunately, prospects for a tax provision are not as promising. A tax provision was included in proposed language by Sen. Lincoln (D-AR) and Sen. Smith (R-OR) yet never introduced. The likelihood of a motor tax provision being included in a House-Senate conference report is not good. As a result, motor efficiency advocates are now seeking other legislative vehicles for this proposed language, though the prospects are not looking promising at the time of this writing.

PROJECTED IMPACTS OF PROPOSED STANDARDS AND TAX POLICIES ON U.S. ELECTRICITY CONSUMPTION AND CARBON EMISSIONS

To project the savings that would be realized from the standard and the ITC, we started with an estimate of the motor market based on the annual motor sales figures provided in Table 1. This information was combined with the savings per motor estimates shown in Table 2 to approximate the energy savings that can be realized in each motor size. This value is combined with an estimate of the share of the market currently covered by EPAct and by the proposed standards, and an estimate of the energy and peak demand savings was calculated as presented in Table 3. Overall, we estimate that the U.S. could save 9,781 GWh per year and reduce peak demand by 1,341 MW through the standards proposal, the equivalent of three new coal power plants with an associated annual reduction of 2 million metric tonnes of CO_{2e} emissions.[4] These are the savings once the full motor stock turns over and thus would phase in over several decades.

[4] Based on an average coal power plant of 400 MW and a national average carbon emission rate of 0.212379 million metric tonnes of carbon per terawatt-hour of electric generation based on EIA (2005).

Table 1. Estimated 2006 Energy Use and Peak Demand of Electric Motors, 1-500 HP.

Size Range (HP)	2003 Shipments U.S.	Average Life (Yrs)	U.S. Stock	Average HP	Efficiency Base	Efficient	% Efficient	Avg. Op. Hrs.	Annual kWh/ Motor	Annual GWh of US Stock	% on at Peak	Pk. Dmd. (MW)
1-5	931,936	17	13,466,475	2.07	0.84	0.865	9.82%	2567	2,823	44,731	35%	6,128
6-20	410,414	19	6,628,186	11.9	0.895	0.917	27.59%	3113	18,404	143,511	43%	19,659
21-50	115,497	22	2,159,794	32.5	0.924	0.941	48.08%	3653	57,011	144,862	50%	19,844
51-100	40,669	28	967,922	70	0.941	0.95	55.07%	4663	154,452	175,879	64%	24,093
101-200	22,177	28	527,813	140	0.95	0.958	69.18%	4735	310,526	192,823	65%	26,414
201-500	11,152	29	274,897	350	0.954	0.962	75.00%	5444	888,404	287,317	75%	39,583
Total	1,531,845		24,025,087							989,123		135,720

Notes:

* 2003 shipments from U.S. Census Bureau.
* Average life from Nadel et al. 2002.
* Average operating hours are weighted averages (60/40 TEFC to ODP). TEFC taken from Nadel et al. (2002) and ODP taken from NEMA Reliance Motors
* Average HP in each class based on ADL data as reported in Nadel et al. 2002.
* Efficiencies in base and efficient cases come from Tables 2 and 3.
* % efficient from NEMA data for 2003.
* Annual kWh/motor assumes motors operate at an average of 60% of full load and includes conversion factor of .746 kW/HP. These figures also assume that some motors are efficient (given in % efficient column) and the remainder are at the base efficiency.
* Annual GWh of stock based on shipments in 2003, average motor life, and annual kWh/motor.
* % on at peak estimated by ACEEE as avg. op. hrs./8760 and then multiplying by 1.2 (to account for fact motors are more likely to operate during the day than at night). We capped % on at peak at 75% (which only applies to the largest motors).

Table 2. Electricity Savings and Peak Demand Savings for Standards Options (for Open Drip-Proof Motors)[a]

	Standard to High Efficiency (ODP)				High to Premium Efficiency (ODP)			
HP	Standard Effic[b]	High Effic	Savings (kWh/yr)[c]	Peak Demand Savings (kW)[d]	High Effic	Premium Effic	Savings (kWh/yr)[c]	Peak Demand Savings (kW)[d]
	(%)				(%)			
1	76.3	82.5	101	0.01	82.5	85.5	44	0.01
5	83.2	87.5	304	0.04	87.5	89.5	131	0.02
20	88.1	91	873	0.12	91	93	570	0.08
50	90.9	93	1686	0.23	93	94.5	1159	0.16
100	91.9	94.1	4173	0.57	94.1	95.4	2376	0.33
200	93.5	95	6104	0.84	95	96.2	4746	0.65
500	94.3	95.8	16391	2.79	95.8	96.2	4285	0.73
	Standard to High Efficiency (TEFC)				High to Premium Efficiency (TEFC)			
HP	Standard Effic[b]	High Effic	Savings (kWh/yr)[c]	Peak Demand Savings (kW)[d]	High Effic	Premium Effic	Savings (kWh/yr)[c]	Peak Demand Savings (kW)[d]
	(%)				(%)			
1	76.8	82.5	111	0.02	82.5	85.5	52	0.01
5	83.9	87.5	301	0.04	87.5	89.5	157	0.02
20	88.3	91	1020	0.14	91	93	717	0.10
50	91.5	93	1604	0.22	93	94.5	1553	0.21
100	91.9	94.5	7141	0.98	94.5	95.4	2381	0.33
200	94	95	5213	0.71	95	96.2	6112	0.84
500	94.1	95.8	25880	3.17	95.8	96.2	5956	0.73

[a] Refer to Table 1 for annual operating hours and % on at peak.

[b] Standard efficiencies for 1–200 HP are taken from Nadel et al. (1992) and those for 200–500 HP are taken from Motor Master 4.0 (EERE 2006).

[c] Savings is calculated using the formula: HP*0.746*60% average load*annual operating hours *(1/lower efficiency – 1/higher efficiency)*100.

[d] Peak demand savings is calculated using the formula: savings (kWh/yr)/annual operating hours*% on at peak.

Table 3. Savings Proposed Motor Efficiency Standards.

Size Range (HP)	Annual U.S. Sales	Annual Savings/ Motor (kWh)	% Covered by Standards	% Not Meeting Proposed Standard	Annual National Savings in 1st Yr. (GWh)	% on at Peak	Pk. Dmd. Savings in 1st Yr. (MW)	Average Motor Life (years)	Annual National Savings When Stock Turns Over (GWh)	(MW)
For motors NOT regulated by EPAct-92 to go to EPAct-92 levels										
1-5	931,936	149	25%	67%	23.3	35%	3.2	17	395	54
6-20	410,414	687	25%	67%	47.2	43%	6.5	19	897	123
21-50	115,497	1,599	25%	67%	30.9	50%	4.2	22	681	93
51-100	40,669	3,544	25%	67%	24.1	64%	3.3	28	676	93
101-200	22,177	3,996	25%	67%	14.8	65%	2.0	28	416	57
201-500	11,152	21,103	75%	33%	58.2	75%	8.0	29	1,689	233
Total					198.7		27.3		4754	653
For EPAct-92 and non-EPAct-92 motors to go to premium levels										
1-5	931,936	82	75%	90%	51.6	35%	7.1	17	877	120
6-20	410,414	444	75%	72%	99.1	43%	13.6	19	1,882	258
21-50	115,497	1,039	75%	52%	46.7	50%	6.4	22	1,028	141
51-100	40,669	1,471	75%	45%	20.2	64%	2.8	28	564	77
101-200	22,177	2,608	75%	31%	13.4	65%	1.8	28	374	51
201-500	11,152	7,434	0%	25%	0.0	75%	0.0	29	0	0
Total					230.9		31.6		4726	647

Notes:

* Annual Sales figures from Table 1.
* Savings per motor for premium efficiency is calculated using average motor size and operating hours from Table 1. For EPAct-92 efficiencies, savings per motor based on pre-EPAct-92 basecase efficiencies in Nadel et al. 2002, Table 9-1. For the largest class, we used an average basecase efficiency of 93.2%, which is Motor Master's default for standard efficiency motors of 350 hp.
* We estimate that 65% of motors are covered by federal standards and that another 25% of sales not now covered could be. The 65% figure comes from Nadel et al. 2002. The 25% figure is an ACEEE estimate based on discussions with industry experts.
* % not meeting proposed standard estimated by ACEEE for non-covered motors, and from Figure 3 for covered motors.
* % on at peak and motor lives comes from Table 5.
* Of the savings to go from EPAct-92 to Premium levels, approximately 72% of the savings come from motors now covered by EPAct-92 (based on 65% of motors now covered and exanded scope will cover 90%).

POSSIBLE IMPACTS OF PROPOSAL ON EXISTING MOTOR PROGRAMS

Clearly, the proposed changes to MEPS would have a profound impact on programs intended to promote efficient motors. When the new motor standard becomes effective, the provision of incentives for the stocking of *NEMA Premium*® motors would no longer be required to encourage purchase of the majority of these products, because the standards would complete the transformation. So the focus on changing purchase behavior of 1–200 HP motors would no longer be required. These standards would also reach the OEM market that most motor efficiency programs have been unable to successfully penetrate.

However, the proposed new MEPS will not go into effect until three years after enactment of the law, so there will be a significant number of new motors sold during the interim that will not be impacted by the regulation and will not be sold at the *NEMA Premium*® level. We have also seen important short-term negative impacts of anticipated regulations in the past with other products with customers — especially OEMs — stocking up on low-efficiency, low-cost products in advance of a standards deadline, increasing demand for lower-efficiency

products in the year before the deadline followed a precipitous reduction in volume once the standards go into effect. As a result we would likely see a reduced impact of the MEPS in the early years unless this market behavior can be successfully countered. So an important role for the motor efficiency program is to counter this market behavior. The combination of these effects could result in a significant lost opportunity because these motors will continue to persist in the marketplace for about 20 years.

It is also important to remember that the proposed MEPS would have no impact on the majority of motor decisions made in the U.S. — the decision to repair a motor rather than replace. This "repair versus replace" decision has been a critical element of most motor programs for well over a decade, and the new MEPS will not affect this market decision. In fact, the elimination of the "cheaper" EPAct-92 motors may in some cases shift purchasers toward repair for first-cost economic reasons. Thus, the importance of influencing motor decisions will not be diminished, and in some respects will be made more important because the energy consumption difference between repair and replace will become greater for many motors.

Suggested Changes to Energy-Efficient Motor Promotion Programs

So, for the longer-term what efficiency opportunities might efficient motor programs consider? At this point a new "premium plus" motor specification does not exist, and it is not clear that a further increase in the efficiency of general purpose integral horsepower induction motors is currently economically justified. So, just translating programs to a new, higher-efficiency level does not appear a viable strategy at this point in time.

However, the additional products covered by the MEPS are not proposed at the *NEMA Premium*® level (though there are significant products available at that level). These products include some very important end-use markets such as many irrigation and water-system motors, as well as 201–500 HP motors. As a result, motor efficiency programs can continue to play an important role in influencing motor purchase decisions in these markets. Because these are more narrow markets, this would suggest that programs should perhaps become more targeted on these key end-user markets, which in some ways may make for easier program design.

Possibility to Leverage National Tax Credits

As mentioned above, the end-user tax credits are intended to help shift the rest of the integral motor marketplace to *NEMA Premium*®. These tax credits represent an opportunity for motor efficiency programs to leverage the available federal funding. It has been demonstrated that the coordination of federal tax credits and state-level incentives can be more effective in transforming markets than either in isolation (Elliott 2001).

The tax credit proposal is significantly less well-formed than the MEPS, for which legislative language has already been drafted by congressional staff. In part this is because the energy tax legislation is on a much slower time schedule than the energy regulations, for which congressional leadership has targeted committee action by Memorial Day 2007, so there is some time yet to develop both the legislative proposal and support. In addition, the

challenges to seeing the tax credit included in federal energy legislation are much greater because the premium motor tax proposals must compete with other proposals for scarce federal funds, while the standards have no real cost to the government and are mostly non-controversial.

As the forum and support for the premium motor tax credits is as yet unformed, the final proposal is subject to influence. While some time remains, it is important for the motor efficiency community to immediately step up to support tax credits if they want this proposal to be enacted. ACEEE stands ready to assist the motor efficiency community in these efforts, and is already engaged with the manufacturers on this issue.

Conclusions

The North American experience over the past 20 years with motor efficiency performance standards has been an energy efficiency policy success story, and the newly-proposed consensus agreement to raise and expand the standards — if they are enacted — will add further benefits to those already realized from the previous standards.

We cannot, however, declare victory and go home when these new standards go into effect. Much work remains to change motor management practices to insure that inefficient motors are replaced with new, efficient products and not repaired, extending their life indefinitely. In addition, motor efficiency programs must ensure that motor systems are correctly sized and operated such that they are optimized to meet the application, thus realizing even greater energy and carbon savings.

The proposed tax incentives could play an important role in transitioning the motor market to *Premium* motors, while at the same time creating an opportunity to transition motor efficiency programs to focus on the remaining efficiency challenges that remain in the motor marketplace. It is important to act now, however, so that the tax incentives and the new program direction are in place once the standards clock commences.

References

Barbour, John (Energy Solutions). 2007. Personal communication with Neal Elliott. May.

Butek, Lynda (Brithenee Electric). 2006. Personal communication with Neal Elliott. October.

[Census] U.S. Census Bureau. 2004. *Motors and Generators: 2003.* U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau.

[EERE] Office of Energy Efficiency and Renewable Energy. 2006. *Motor Master+4.0* software. http://www1.eere.energy.gov/industry/bestpractices/software.html#mm. Washington, D.C.: U.S. Department of Energy.

[EIA] Energy Information Administration. 2005. *2005 Annual Energy Outlook.* Washington, D.C.: U.S. Department of Energy.

Elliott, R.N. 2001. *Federal Tax Strategies to Encourage the Adoption of Combined Heat and Power.* ACEEE Report IE015. Washington, D.C.: American Council for an Energy-Efficient Economy.

Hanna, Jim (Pacific Gas and Electric Company). 2006. Personal communication with Neal Elliott. August.

[House] United States House of Representatives. 2007. *New Direction for Energy Independence.* National Security, and Consumer Protection Act, HR-2661 EH. Washington, D.C.

Linn, Jon (Northeast Energy Efficiency Partnerships). 2006. Personal communication with Neal Elliott. August.

Nadel, Steven R., Neal Elliott, Michael Shepard, Steve Greenberg, Gail Katz, and Anibal T. Almeida. 1992. *Energy-Efficient Motor Systems: A Handbook on Technology, Program, and Policy Opportunities,* Revised First Edition. Washington D.C.: American Council for an Energy-Efficient Economy.

———. 2002. *Energy-Efficient Motor Systems: A Handbook on Technology, Program, and Policy Opportunities*, Second Edition. Washington D.C.: American Council for an Energy-Efficient Economy.

[NEMA] National Electrical Manufacturers Association. 2002. "NEMA Premium Energy Efficient Product Specification and Definition." http://www.nema.org/stds/complimentary-docs/upload/MG1premium.pdf. Rosslyn, Va.: National Electrical Manufacturers Association.

———. 2004a. "NEMA Premium Motors Show Increase in Sales." November 4 Press Release. http://www.nema.org/media/pr/20041104a.cfm. Rosslyn, Va.: National Electrical Manufacturers Association.

———. 2004b. *Annual Data for the NEMA Premium Efficiency Electrical Motor Program, Calendar Years, 2001-2004.* Rosslyn, Va.: National Electrical Manufacturers Association.

———. 2006a. *ANSI/NEMA MG 1-2006, Motors and Generators.* Rosslyn, Va.: National Electrical Manufacturers Association.

———. 2006b. *NEMA Premium™: Product Scope and Nominal Efficiency Levels.* http://www.nema.org/stds/complimentary-docs/upload/MG1premium.pdf. Rosslyn, Va.: National Electrical Manufacturers Association.

[Senate] United States Senate. 2007. *Renewable Fuels, Consumer Protection, and Energy Efficiency Act of 2007.* HR-6 ES. Washington, D.C.