

WHITEPAPER:

HIGH EFFICIENCY MOTORS ACCELERATED REPLACEMENT PROGRAM



(As on 7th March 2017)

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1

Electric motors use around 70% of the electricity consumed by industry, globally. Since industry accounts for around 40% of the electricity demand in India, it follows that motors use around 28 % of total electricity making it a larger user than lighting at 24%. Historically, the motors sold in India have had much lower energy-efficiencies than the improved designs available today. Since motors have long life-times that can extend up to 20 years or beyond, in a Business-As-Usual scenario, it will take many years of sales of new, more efficient motors to have a discernible impact on the overall efficiency of the installed stock, even if these were to be mandated, which is not the case in India as yet. Therefore, there is a need for a program to accelerate the replacement of inefficient motors and save on industrial electricity consumption.

1.1 ENERGY EFFICIENCY STANDARDS & REGULATIONS FOR LV MOTORS

1.1.1 International

The International Electrotechnical Commission standard IEC 60034-30-1:2014 “Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code)” has globally harmonised the energy-efficiency classes of all electric motors that are rated for line operation. This includes all single- and three- phase motors between 0.12-1000 kW. It defines four ascending energy-efficiency classes IE1 to IE4 (a fifth aspirational efficiency class IE5 shall be defined by IEC in future editions). For a typical 2.2 kW motor used in industry, this represents a gain of 4-9 % in energy-efficiency from IE1 to IE4. A further standard IEC 60034-2-1:2014 “Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)” specifies test methods.

Internationally, forty-one countries representing 76% of energy consumed by motor systems have worked to transform their regional and national markets towards high efficiency motors and motor systems through a combination of regulatory measures and supporting policies. These include China, USA, EU28 (plus Norway, Switzerland and Turkey), Japan, South Korea, Brazil, Canada, Mexico, Saudi Arabia, Australia and New Zealand. Other countries, including Egypt and Indonesia, are working to develop such policies. The majority of these countries have adopted IE3 as MEPS.

1.1.2 India

BIS has adopted the earlier versions of both IEC standards through IS 12615: 2011 “Energy Efficient Induction Motors – Three Phase Squirrel Cage”, and IS 15999 (Part 2/Sec 1): 2011 “Standard Methods of Determining Losses and Efficiency from Tests (excluding Machines for Traction Vehicle)” respectively. BIS has subsequently issued an Amendment No. 1 to IS 12615:2011 in November 2014 which requires the minimum efficiency performance class of the motors under its scope (defined as 3 phase squirrel cage induction motors in 2, 4, 6 poles for frame sizes from 71 up to and including 315L) to be IE2. However, the adoption of this standard is voluntary until 30.09.2017.

Induction motors are also covered by BEE’s voluntary star-labelling scheme; however, Indian manufacturers have not taken this up for various reasons. While the awareness levels of energy users has been improving due to other voluntary actions of market participants and civil society, the market has been slow to transform in the absence of mandatory MEPS regulations so far. According to IEEMA statistics, more than 92% of the motors sold in 2015-16 were still below the IE2 efficiency level.

In order to address this regulatory gap, the DIPP has issued a Quality Control order requiring all imported and domestically manufactured motors to conform to the revised IS:12615 which specifies IE2 as the minimum efficiency class, with effect from 1.10.2017. It is also expected that BEE shall notify motor MEPS at IE2. While these measures can be expected to transform the market for new motors to a minimum of IE2 in the near future, the installed base of motors would remain unaddressed.

1.1.3 Efficiency profile of installed motors

According to available records, the market share of “eff3” efficiency class (sub - IE1) motors was 60% and “eff2” (equivalent to IE1) motors was 40% prior to 2002. Eventually, domestic producers stopped the manufacture of “eff3” motors, but it is suspected that these may have continued to come in via imports. Since motors have long lifetimes, sometimes extending to 20 years and beyond, during which period these are repaired multiple times (which usually reduces the efficiency further), it is safe to assume that 90% to 95% of the current installed stock of motors is at IE1 and sub-IE1 levels.

1.1.4 How will an EESL led replacement program complement regulations?

It will take many years of sales of new, more efficient motors to have a discernible impact on the overall efficiency of the installed stock. Therefore, an EESL led voluntary replacement program for motors will supplement the DIPP/BEE/BIS regulations and standards in two ways. For one, it will address the replacement of the installed stock of IE1 and sub-IE1 motors, which is by definition outside the scope of regulations, with IE3. Secondly, it will bring down the costs of IE3 motors, and stimulate the voluntary adoption of these for new requirements, thus taking the market higher than the MEPS of IE2 mandated from 1.10.2017.

1.2 BARRIERS TO THE REPLACEMENT OF INEFFICIENT MOTORS BEFORE END OF LIFE

1.2.1 Information and capacity

- Many end-users lack the awareness of, or lack the tools and knowhow to be able to establish the energy savings potential of energy efficient motors within their plants reliably, and create a business case for investment. Even in units that are knowledgeable, decision-makers remain sceptical about the business cases put up by their operations and maintenance teams.
- Many professional energy auditors are better equipped to assess the savings potential from improvements in other plant areas such as process energy, thermal leakages, air and water leakages, etc. rather than from motors.
- Motor dealers and sales representatives have inadequate information, or lack the technical capacity to educate and convince users about the savings potential of energy efficient motors.

1.2.2 User practices

- Energy-users are often unwilling to pay for energy audits, and even if one is conducted, these are not always followed through on recommendations involving substantial up-front investments.
- Operating plants are seldom disturbed for up-gradation to higher efficiency motors. The opportunity only arises when a motor fails. In such an event, the priority is often to get the plant up and running again as fast as possible by quickly repairing the failed motor. This is partly due to the non-availability of spare motors during a breakdown and partly a financial decision. Thus, motors are repaired repeatedly over their lifetimes rather than replaced.

- Even if a motor reaches the end of its life and has to be replaced, plants with large inventories of spare motors would prefer to exhaust these first, because it is considered wasteful to scrap an unused motor even if it is inefficient.
- Even if a motor reaches the end of its life and has to be replaced, the focus during procurement of a replacement motor is on lowest upfront costs rather than on lifetime costs including the recurring costs of lost energy. Therefore, a failed inefficient motor is replaced with another inefficient motor.
- Even after replacement, users keep the old motor as a spare, or for the cannibalisation of its parts, or simply because the resale value is not high enough in their perception.
- Nameplate data of old motors is not always available and this becomes a hurdle in specifying a replacement motor.

1.2.3 Financial

- Even if a user is convinced of the business case for the accelerated replacement of inefficient motors, own funds may not be available readily, as this may be a lower priority to investments in the core business of the user.
- Conventional corporate lending practices require collateral, and motors represent inadequate market resale value post-installation for financiers. Usually, financiers are ill equipped to assess and securitise the returns from future energy savings, and are not confident about these. Thus, the availability of finance for energy efficiency investments becomes dependent upon the overall credit-worthiness of the energy-user, which is particularly challenging for SME's.
- Individual investments in energy-efficient motors involve small and complex transactions, further discouraging financiers.

1.2.4 Market

- Purchasers in the replacement market, particularly SME's lack the volumes and therefore the bargaining power of larger users or new projects. According to anecdote, the price levels offered by suppliers for small non-recurring purchases can be as much as 30 to 35 % higher than those offered to a large project.
- Dealers stock what sells in the local market leading to limited availability and longer delivery times of high efficiency motors until usage picks up, which in turn constrains the growth in usage. In turn, motor suppliers produce what sells, leading to a chicken-and-egg situation.
- Due to the existence of a market for second-hand motors, replaced failed motors find their way back into use after repairs, rather than being scrapped.

1.3 HOW THE REPLACEMENT PROGRAM WILL ADDRESS THESE BARRIERS

The barriers identified above shall be addressed through the five components of the replacement program, which are described in detail in Section 3.

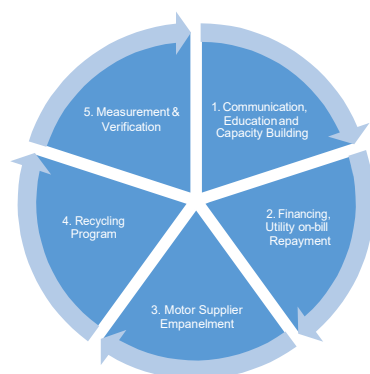


Figure 1 : The five components of the motors replacement program

1. Gaps in information and capacity shall be overcome through a **Communication, Education and Capacity Building** campaign.
2. **A Financing** option may be offered with re-payment through EMI's.
3. The anticipated increase in demand, aggregated nationally, will enable motor suppliers to offer special prices and better terms for motors procured under the scheme. **Motor suppliers** shall be **empowered** as project partners through a tendering process.
4. There shall be a strict requirement that in order to avail of the special prices and better terms under the scheme, motors will have to be **Recycled**.
5. A **Measurement & Verification** component (deemed savings approach) shall ensure that the benefits anticipated under the program are fully realized.

1.4 EXPECTED BENEFITS

1.4.1 Energy & Environment

The estimated national savings in electricity and CO₂ emissions resulting from the program are as shown in Table 1.

Estimated annual electricity savings - consumer (TWh)	8.5	TWh
Avoided CO2 emissions	7.0	MtCO2
Avoided power plant capacity	1.6	GW
Avoided power plant investments	11.3	Rs. Thousand Crores

Table 1 : Motors replacement program impact on energy & environment

1.4.2 Utility demand shaping

Industries operate during peak hours, and therefore any reduction in industrial electricity consumption directly reduces peak demand.

1.4.3 Industrial cost-competitiveness

Industries will save around Rs. 5,300 crores in recurring annual costs over the lifetimes of the motors against an estimated initial investment of Rs. 14,000 crores at current market prices of IE3 motors. Not only does this represent an attractive simple payback period of 2.6 years for the investment on an average, it would improve the cost-competitiveness of Indian industry structurally, in keeping with the “Make in India” objective. The payback period would reduce still further with the expected market price reduction of IE 3 motors due to aggregation of demand and the higher capacity utilisation of motor manufacturers.

1.4.4 Technological advancement of Indian motor industry

Due to the higher domestic demand, the Indian motor industry’s design and manufacturing capabilities will advance towards the global best practice level of IE3 at an accelerated pace, and provide economies of scale for higher exports in keeping with the “Make in India” objective.

1.4.5 Employment generation

The replacement program will create additional employment in technical services, financial services, manufacturing, sales, installation, after sales services, recycling etc.

1.4.6 Additional energy savings in motor systems

The motors replacement project may stimulate industrial users to undertake additional energy-efficiency improvement measures in the motor system, such as changes in the mechanical transmission, mechanical process components, design of the driven equipment, and by introducing a variable speed drive.

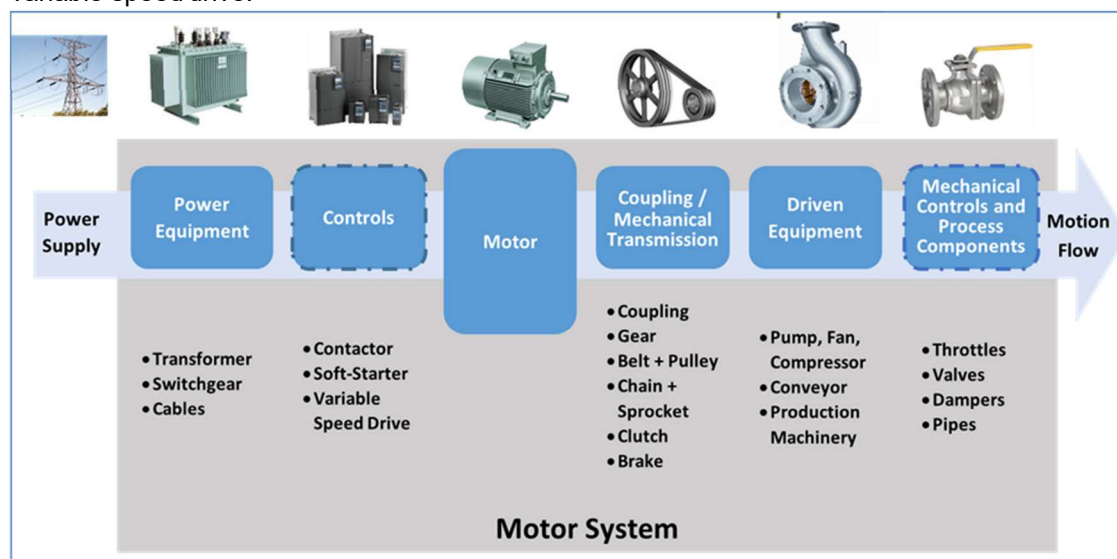


Figure 2 : Components of a Motor System

1.4.7 Linkage to EESL/UNIDO/GEF MSME project

EESL is executing a GEF-5 funded project to promote the implementation of energy efficiency in the MSME sector together with UNIDO; to create and sustain a revolving fund mechanism to ensure replication of energy efficiency measures in the sector; and to address the identified barriers for scaling-up energy efficiency measures and consequently promote a cleaner and more competitive MSME industry in India. The replacement program fits in very well with the objectives of this program.

1.4.8 Expansion of EESL’s footprint in the industrial space

The replacement program would be an opportunity to expand EESL’s footprint in the industrial sector, gain further experience and acquire requisite skill sets to address the needs and challenges of this sector.

2

2.1 DEMAND SIDE ASSESSMENT

2.1.1 Size

It is estimated that there are over 25 million standard low voltage motors (frame sizes 63 to 355) aggregating to 183 MW in the pan - India installed base. Of these, 11.5 million motors, mostly in the sizes 2.2 kW, 3.7 kW, 5.5 kW and 7.5 kW can potentially be targeted for replacement through the program based on their higher hours of operation and loading (These estimates and assumptions are to be validated through bottom-up surveys).

<u>LV Squirrel cage Induction Motors :</u> <u>Frame size</u>	<u>Below 63 to</u> <u>132</u>	<u>160 to 200</u>	<u>225 to 355</u>	<u>All Frame</u> <u>Sizes</u>
Popular Ratings (kW) for 4-Pole	0.18, 0.25, 0.37, 0.5, 0.75, 1.1, 1.5, 2.2, 3.7, 5.5, 7.5	11, 15, 22, 30, 40	37, 45, 55, 75, 90, 110, 132, 180	
Estimated size of installed base (GW)	52.2	55.0	76.1	183.3
Estimated nos. in Installed base (millions)	20.7	3.4	1.0	25.1
Estimated percentage that could be replaced (%)	50%	30%	10%	46%
Estimated nos. that could be replaced (millions)	10.4	1.0	0.1	11.5

Table 2 : Estimated incremental demand for motors

2.1.2 Financial analysis

We analyse below the economics of replacement for three representative motor sizes 2.2 kW, 15 kW and 75 kW, all 4-pole, assumed to be operating for 4000 hrs/p.a. at 60% loading. The average electricity cost is estimated at Rs 6.25 / kWh for industrial users. Since the percentage of efficiency improvement between IE3 and IE1 is higher in smaller motors, the payback is also quicker.

2.1.2.1 Target payback method

At prevailing market prices, the simple payback period ranges from 2.3 to 4.7 years as the motor size increases. If we uniformly set the target payback period as 2.0 years across all sizes, the cost of replacement needs to be reduced by 14% to 57%.

Frame Size	63 to 132	160 to 200	225 to 355
Representative size, 4 pole motors (kW)	2.2	15.0	75.0
Annual cost of Electricity Saved (Rs.)	3,343	9,364	29,382
Estimated cost of replacement at prevailing market prices(Rs)	7,758	30,895	137,659
Present Estimated Simple Payback Period (No. of Years)	2.3	3.3	4.7
Target Simple Payback Period (years)	2.0	2.0	2.0
Target Cost of replacement (Rs)	6,686	18,729	58,763
Reduction in Cost of replacement (% age)	14%	39%	57%

Table 3 : Financial Analysis – Target Payback method

2.1.2.2 Target price method

If the approach adopted is to aim for a uniform reduction in the cost of Replacement by say 25 %, the respective payback periods are reduced to 1.7 - 3.5 years.

Frame Size	63 to 132	160 to 200	225 to 355
Representative size, 4 pole motors (kW)	2.2	15.0	75.0
Annual cost of Electricity Saved (Rs.)	3,343	9,364	29,382
Present Estimated Cost of replacement (Rs)	7,758	30,895	137,659
Present Estimated Simple Payback Period (No. of Years)	2.3	3.3	4.7
Target Reduction in Cost of replacement (% age)	25%	25%	25%
Revised Cost of replacement (Rs)	5,819	23,171	103,245
Reduced payback period (years)	1.7	2.5	3.5

Table 4 : Financial Analysis – Target Price method

2.1.3 Prioritisation of target user industries

Given the gigantic size, it is necessary to segment target groups and prioritise these in terms of the impact to effort ratio. The key considerations are – size of installed base; annual operating hours; energy management culture; degree of concentration in decision-making ; simplicity of procurement processes; credit-worthiness. Using these criteria, as well as subjective judgment, we arrive at the following priorities:

2.1.3.1 Cement sector (PAT industry)

The cement sector represents a sizable installed base of standard LV motors operating continuously in conveyors, fans and pumps. The industry has a strong focus on energy efficiency as a business

strategy. Almost all companies are in the private sector with a degree of concentration of decision-making authority and therefore speed. The sector is profitable and not over-leveraged, thus credit-worthy. Ultratech, ACC and Ambuja have a pan – India presence. Large regional companies include Shree, Ramco, Dalmia Bharat, India Cements etc. The industry follows technical specifications of major consultants such as Holtec Engineers, but also in-house guidelines.

2.1.3.2 Automobiles sector

The automobile sector is energy intensive and extremely competitive. Companies such as Maruti Suzuki, Hyundai Motors, Tata Motors, Mahindra & Mahindra, Hero Motocorp, Bajaj Auto, Toyota, Honda, General Motors etc. would be highly receptive to ideas for reducing costs. All companies are in the private sector and nimble in decision-making.

2.1.3.3 Textiles sector (PAT industry)

The Indian textiles industry contributes 4% to GDP and 14 % to industrial production. Major companies are Bombay Dyeing, Welspun, Alok Industries, Raymond, Arvind, Digjam etc, but the bulk of the industry is in SME clusters in locations such as Coimbatore, Surat, Bhilwara etc. All companies are in the private sector and nimble with decision-making. About 55-60 % of the energy consumed in a mechanised textile plant is in spinning (yarn production) and weaving (fabric production), mostly by electric motors. Given that this is a low margin, high volume business, saving energy costs is part of the business strategy for most firms.

2.1.3.4 Pulp & Paper (PAT industry)

The Pulp & paper sector comprises 715 industrial units with capacities from 2 to 800 tonnes per day, almost all in the private sector. A few large companies include Ballarpur Industries, ITC, J.K. Paper, TNPL, AP Paper, Emami Paper, etc. Energy comprises 10 % -17 % of the manufacturing cost. The electricity consumption is 1500-1700 kWh / tonne. For these reasons, the industry is likely to be receptive to the accelerated motor replacement program. Almost all companies are in the private sector and nimble in decision-making.

2.1.3.5 Conglomerates

Industrial conglomerates such as Reliance Industries, the Tatas, the Aditya Birla group, Vedanta, etc. represent the opportunity of a very large installed base of motors across sectors, with some degree of harmonisation of policies. Some of these have already standardised on IE3 motors for new requirements.

2.1.3.6 Consulting Engineering Firms

The procurement specifications created by Consulting Engineering Firms are revered documents for companies in several sectors. These include Engineers India Ltd (Hydrocarbons, Chemicals, Fertilisers, Power, Mining, non-ferrous Metals), MECON, M.N. Dastur & Co, SAIL/RDCIS (Metals), Holtec (Cement, Power), DCPL (Cement, Power, Chemicals, Paper, Mining, Material Handling) etc. If these firms could be convinced to specify IE3 for new projects, it would create the platform for persuading the users in the respective industries, many of which are in Public Sector PAT industries to go in for accelerated replacements.

2.1.3.7 Other sectors

Other sectors such as Thermal Power Generation, Coal, Mining and Material Handling, Iron & Steel, Aluminium, Fertilisers, which have a very large installed base could be targeted later, either due to stressed finances and/or bureaucratic decision-making processes, with some exceptions like NTPC etc. In any case, these sectors would be addressed through the Consulting Engineering Firms.

2.2 SUPPLY SIDE ASSESSMENT

2.2.1 Market profile

The Low Voltage Motors (0.37-375 kW) market in India is estimated as having been around 16,250 MW in 2014-15. It is estimated that roughly around 70% were sold to OEM's, 20% for new / expansion projects and 10% for replacements. On the supply side, around 55% was catered to by members of the IEEMA Rotating Machines Division, 17% by non-IEEMA member manufacturers in the SME sector, and 28% by imports.

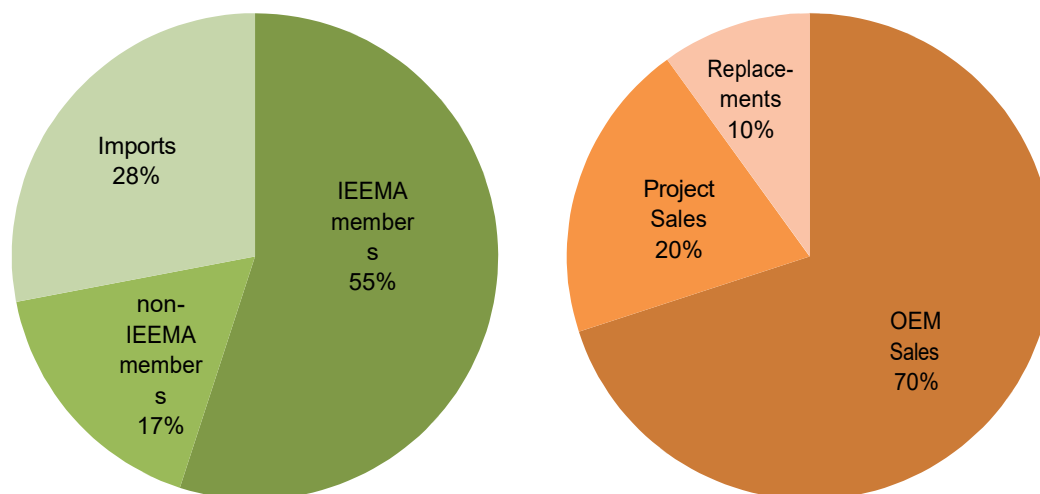


Figure 3: Market segmentation by supplier group and customer type [Size 16,250 MW in 2014-15]

2.2.2 Technology availability

The capabilities for the design and manufacture of IE2 motors, which will become mandatory from 1.10.2017 are widely available in the country. The technological improvements over IE2 required for producing IE3 are incremental, rather than substantial in nature. As a point of reference, motors with the efficiency class IE3 are commercially available in India, and comprised 5.7% of the reported production of the IEEMA Rotating Machines division members in terms of MW and 2.4% in numbers in 2015-16, up from just 0.2% and 0.1% levels respectively in the previous year. Nevertheless, consultations shall be carried out with both large and small motor suppliers to determine if any of these foresees constraints in upgrading their respective capabilities to produce IE3 motors.

2.2.3 Manufacturing capacities

The program can potentially generate an additional replacement demand for about 11.5 million motors aggregating 50,000 MW during the 3-year program period, over and above the normal demand from OEM's and for new / expansion projects. Consultations shall be carried out with the

domestic motor industry to determine its ability to meet such an increase in demand. Imports may be necessary to meet the incremental demand and keep up the competitive intensity.

3

The guiding principles for the development of the Program Framework are:

- Build in economic incentives to stimulate voluntary actions
- Maintain competition and market dynamics
- Minimise incremental transaction costs
 - Incorporate prevalent procurement practices and payment mechanisms as far as possible
 - Keep processes, contracting and transactions simple
 - Use mobile apps and digital technology for tracking, accounting, aggregation

3.1 COMMUNICATION, EDUCATION & CAPACITY BUILDING

3.1.1 Which is the target audience ?

The target audience for the Education and Capacity Building campaign is :

User companies	Supply chain	Other influencers
Decision-makers Energy managers Operations managers Maintenance managers Purchase managers	Motor dealers Sales representatives	Energy auditors Technical consultants System integrators

Table 5 : Target audience

For users, the aim is to overcome the barriers of inadequate knowledge, capacity, and poor practices and catalyse decisions to replace inefficient motors before end-of-life. At the working level, users and other influencers shall be provided with practical tools, guides and manuals as well as business case templates. Business case studies shall be shown to decision makers.

For the supply chain, the focus will be on comprehensive information about the program – scope of coverage, terms and conditions, finance, obligations, procedures, installation, recycling, verification protocols and soon.

3.1.2 What are the message delivery mechanisms ?

A combination of message delivery mechanisms shall be used :

- A dedicated web portal hosted by EESL for dissemination of policy details and updates, business case templates, case studies and so on.
- Video-recorded presentations delivered through the dedicated portal as well as through social media.
- Onsite workshops for large user companies and offsite workshops at neutral venues, preferably along with industry cluster associations for smaller users. Such programs have been conducted by ICAI for several years, co-sponsored by motor suppliers, and are partly responsible for the voluntary transformation of the market for new motors.
- Face-to-face meetings with key decision makers: Focussed messages can be delivered in such meetings where the undivided attention of the decision makers is assured. Client visits by motor

company business managers / sales representatives / dealers armed with a suitable communications toolkit are a good opportunity for such interactions.

Further,

- Participation in industry events by senior representatives from EESL, ICAI, IEEMA, and participating motor suppliers, by way of a keynote address, panel discussion or presentation, shall create awareness and raise the program profile among industry circles.
- Press releases, interviews and technical articles by senior representatives to industry journals, shall keep the program continuously in the news.

3.1.3 What is the toolkit for delivery?

- PowerPoint presentations
 - soft copy for projection
 - hard copy for across the table discussions
 - video recording for online viewing
- Compilation of case studies
- Motor Decisions Matter / S.A.F.E. tools
 - Video demonstration of how the tools are used
- Business case template
- Other workshop materials

The Communication, Education & Capacity Building campaign shall be carried out by a Technical Service Provider to be appointed by EESL.

3.1.4 What role will supplier sales campaigns play?

The Education and Capacity building campaign can only lay the groundwork. Sales campaigns will be needed, in addition. It will be up to the individual motor supplier's sales channels to conclude the sale of high efficiency motors for accelerated replacements under the program.

3.2 MOTOR SUPPLIER EMPANELMENT

3.2.1 What is the opportunity for empaneled motor suppliers?

It is estimated that the incremental demand generated by the program would potentially be up to 11.5 million motors over the project period. This would be in addition to the normal demand for new and expansion projects.

This is to be compared with the estimated pan-India market size of 2.5 million motors in 2015-16. Thus, the program represents a significant incremental opportunity for empanelled motor suppliers, who would be selected through a tendering process.

The value proposition for empanelled suppliers is

- Volume growth and improved capacity utilisation
- Availability of financing / recycling schemes
- Co-branding
- Premiumisation of their brands

3.2.2 What will be the obligations of empanelled motor suppliers?

Empanelled motor suppliers would have the following obligations

- To offer attractive price discounts and make the returns on the discretionary investment in accelerated motor replacement more attractive for users.
- To offer attractive credit terms.
- To offer an extended warranty, in excess of the repayment period at the minimum.
- Ensure ready stocks at dealerships for smaller IE3 motors, and quick guaranteed delivery times for larger ones.
- Actively participate in Education & Capacity Building.
- Undertake active sales efforts and provide the final “push” to swing the user decision.
 - This would also generate healthy competition. There will be no allocation of territories or user groups through the scheme.
- Implement a Quality Assurance program as per the scheme.
- Fulfil the scheme requirements on documentation and reporting.

3.2.3 Product Quality Assurance

Empanelled suppliers would be required to furnish their respective Quality Assurance plans and to produce test certificates for the energy performance of the IE3 motors to be registered under the program from an independent, accredited laboratory. The tests must be performed according to IEC 60034-2-1:2014 or the equivalent IS 15999 (Part 2/Sec 1) : 2011 “Standard Methods of Determining Losses and Efficiency from Tests (excluding Machines for Traction Vehicles)”. Concerns have been raised about the availability of adequate capacity for such testing within the country, and these will need to be addressed before the launch of the program.

3.2.4 Would the program benefit non-empanelled motor suppliers as well?

Being a free market, non-empanelled motor suppliers could offer prices and terms that are more competitive and thereby cater to the demand generated by the scheme as well. However, the scheme financing and co-branding would not be available for such transactions.

3.3 FINANCING AND PROCUREMENT MODELS

Even after a user is convinced of the business case for the accelerated replacement of inefficient motors, the barriers of non-availability of finance identified in section 1.2.3 may still need to be overcome, particularly for MSME’s. Three alternative financing and procurement models are being proposed.

3.3.1 Direct Payment model

Some users, particularly large cash rich industries, may not wish to avail of any financing but would still like to avail of the special prices and terms for IE3 motors available through the program. This shall be permissible, provided the old motor is recycled. Under this option, the transaction is directly conducted between the user and the motor supplier according to prevalent industry practices, without reference to EESL. There shall however be an obligation on motor suppliers to ensure recycling of the old motor and to provide a consolidated report of such transactions to EESL.

3.3.2 Classical ESCO model

This model is applicable to users with whom EESL enters into a business relationship comprising some or all classical ESCO elements, whether restricted to motor systems or otherwise - turnkey energy solutions, system design, energy audits, implementation of energy-efficiency projects, performance-based contracting, etc. EESL backed up by financial institutions and the Partial Risk

Guarantee Fund shall procure, supply, and finance the respective motors at an attractive interest rate and easy repayment terms. EESL may also take on other responsibilities such as the supervision of installation and commissioning, performance evaluation etc. depending on the terms of the individual ESCO contract with the user. Due to its resource intensive nature, it is expected that this model will be more suited to large industries.

3.3.3 Modified ESCO model

This model is applicable to users, particularly MSME's and large users with whom EESL does not enter into a classical ESCO relationship. In this model, EESL's principal role shall be the delivery of finance at an attractive rate of interest and repayment terms., backed up by financial institutions and the Partial Risk Guarantee Fund. The repayment shall be effected through electricity bills in instalments, and shall be secured through the existing contractual relationship between the user and the DISCOM supplying power to it, supplemented with a codicil (additional agreement). The repayment duration shall be kept sufficiently long so that the instalment amount is demonstrably lower than the expected electricity cost savings, thus ensuring no adverse impact on the user's cash flow.

3.3.3.1 How will the modified ESCO model work in practice ?

In practice, the sale and supply of motors under the scheme shall take place directly between the motor supplier / dealer and the user as per prevailing industry practices with two differences. Instead of a monetary payment, the motor supplier/dealer shall collect a legally binding undertaking by the user, in a format to be prescribed, committing to pay the price of the motor(s) in EMI's through electricity bills. In addition, the transaction details will be captured on a mobile app, which will generate a unique transaction ID for tracking and aggregation purposes. Thereafter, EESL shall pay the respective motor supplier for the supplied motors against consolidated invoices, supported by receipted delivery challans and user undertakings on a monthly basis. In turn, EESL shall receive consolidated EMI collections from the respective DISCOM on a monthly basis. The underlying contracting and transaction models are described in detail in Annexure 1.

3.3.3.2 How will the risk of default in EMI payments be minimised?

Since users are critically dependent upon DISCOM's for the uninterrupted supply of electricity, and DISCOM's are legally empowered to cut off the electricity to industrial users in the case of the non-payment of bills beyond a grace period, the risk of defaults on EMI repayments is minimal.

3.3.3.3 What is the benefit for DISCOMs ?

It is expected that DISCOMs would participate in the program because:

- The program reduces peak demand since industries operate during peak periods, thus reducing power purchase costs and possible load-shedding.
- DISCOMs are not required to bear any program costs as these are entirely borne by EESL and other stakeholders.
- It places no financing burden or risk on them. These are entirely borne by EESL and the financial institution.
- Since existing billing and payment mechanisms would be used, it does not entail any incremental collection costs.
- In fact, DISCOM's would enjoy a "float" period for the money collected from users and its reimbursement to EESL and would earn bank interest on it.

- Apart from acting as a collection agent on behalf of EESL, DISCOM would have no other obligation. Therefore, the Forum of Regulators and SERC's can be expected to approve of such agreements without any significant reservations.

3.4 INSTALLATION, OPERATION & MAINTENANCE

3.4.1 How will the motor replacement be carried out ?

The in-house maintenance departments of industrial units are generally capable of replacing an existing motor with a new motor of the same frame-size, which is a routine task these have to perform during breakdowns due to motor failures. The mounting-dimensions and shaft heights of induction motors are standardised according to IEC-frame sizes by IS 1231 : 1974 'Dimensions of three phase foot-mounted induction motors', irrespective of manufacturer. As a result, motors of the same frame size are mechanically interchangeable. The electrical connections are generally made with flexible cables and these can be re-connected without difficulties – care should only be taken while ordering the new motor that the terminal box is on the same side as on the old motor so that cable routes and lengths are adequate. The setting of the overload relay or release in the motor control centre may need to be adjusted downwards for the lower current rating of the IE3 motor. In case, the new motor has a smaller frame size due to improved motor efficiency or other system efficiency improvements, it may become necessary to fabricate a mechanical base frame insert or a coupling sleeve to reuse the existing installation. In such a case, smaller industrial units may need to take the assistance of external locally available installation agencies but larger companies can ordinarily manage with in-house resources. Further, in the event that the old motor was fed from a variable speed drive without an auto-tuning feature, the parameters may need to be changed for the new motor, and this may require the services of a drives technician.

The motor replacement will ordinarily be scheduled during planned maintenance shutdowns to ensure no disruption in the production. Thus, there will be a gap of a few days to a few weeks from the date the replacement motor is received by the unit, its installation, and the eventual delivery of the old motor to the recycler, respectively. The program design considers this.

3.4.2 Who will be responsible for Operation & Maintenance ?

The user shall be responsible for the operation & routine maintenance of the motors in the same way as for other motors in the plant.

3.4.3 Who will bear the warranty liabilities ?

Motor suppliers would be required to provide an extended warranty for motors supplied under the program for a period to be specified in the tender. This would be longer than current industry practices and shall extend beyond the contracted repayment period contracted with the user. The supplier shall address all warranty claims directly with the user without involving EESL. The supplier shall indemnify EESL from all technical and performance related obligations to the user under the scheme, fully and without cost. In case the root cause of an operating failure is attributable to faulty operational and maintenance practices, it shall be the responsibility of the empanelled supplier to contest the claim by the user, or alternatively to accept the same without any impact on EESL.

3.4.4 Where should repairs be carried out during the warranty period?

In case repairs are required to be carried out to the motor during the (normal & extended) warranty period, it shall be ensured by the supplier that these are carried out professionally in the supplier's

authorised service centre. In particular, it must be ensured that the efficiency of the repaired motor is no less than the efficiency of the original motor.

3.5 RECYCLING PROGRAM

3.5.1 Why is a Recycling Program needed ?

The average material content used in the manufacturing of cast-iron frame induction motors by weight, is as follows:

- Cast iron 35-45%
- Steel 46-55%
- Copper 7-11%
- Aluminium 1-3%
- Stainless steel <1%
- Brass <1%
- Plastic, rubber, insulation materials etc. <1%
- Bearing grease, other <1%

The cast iron, steel, aluminium, copper, stainless steel and brass parts, which constitute more than 98% of the material content, are fully recyclable, and are valuable metals. The recycling of metals not only conserves valuable natural resources, but also requires less energy than winning the respective metal from its ore.

Replaced motors may not ordinarily get recycled, as users could keep the old motor as a spare, or for the cannibalisation of its parts, or simply because the resale value is not high enough in their perception. These could also be sold in the second hand motors market for use elsewhere, thus defeating the energy savings objective of the program.

Therefore, a compulsory-recycling component is an integral part of the program in order to ensure against such leakages, and to reduce the upfront costs by obtaining a fair value from the scrapping of the replaced motor.

3.5.2 How much is the realisable value of a scrapped motor?

On a rough estimate, the value of the scrap materials is Rs. 55 - Rs. 70 / kg of the scrapped motor. This is to be balanced by the costs of collection, disassembly and processing as well as the recycler's margin. At a net level, the realisable value is estimated at between 15% - 25% of the cost of a new motor.

3.5.3 How would the Recycling Program work in practise?

EESL shall appoint recycling agencies across India through a tendering process based on the resale price offered per kg. of scrapped inefficient motors of different frame sizes, and other relevant criteria including warehouse location, collection, storage and processing facilities, human resource practises, environmental performance, quality systems etc. The resale prices shall be tabulated according to the size / type of motor respectively, and shall be published on EESL's website. These shall be indexed to spot metal and material prices of the previous day through a formula.

After receipt and installation of the new motor, the user shall be obliged to dispose the old motor off to any empanelled recycler, who shall pay the value of the scrap to the user directly, at the prevailing

day's rate under the scheme. The recycler shall also record the transaction on the mobile app against the unique ID generated at the time of the sale of the respective new motor.

Immediately thereafter, the recycler shall be obliged to punch the housing of each old motor with the respective transaction ID, and cut the electrical connections at the terminal box to render it unusable. The recycler shall retain the thus defaced / damaged motor in its stockyard for random inspection by EESL or its agents for a minimum verification period to be specified in the tender.

3.5.4 What will be the payment terms?

Users shall have to negotiate payment terms with the recycler directly, according to prevailing practices for the disposal of scrap. This may include Earnest Money Deposits, Bank Guarantees, Spot Payment etc.

3.5.5 What is the incentive for recycling instead of reuse / resale?

Being a voluntary action, there cannot be any compulsion on recycling. There are two incentives for the user to go in for recycling of the old motor instead of re-using it as a spare or selling it in the second hand motors market. Firstly, the user will receive a fair value for the old motor directly from the recycler. Secondly, the user will receive an additional recycling discount on the new motor.

3.5.6 How will the recycling discount be administered in practice?

Each type of motor shall have two published prices under the scheme, with and without recycling respectively, the former being lower. In the financing option, the number of EMI instalments for repayment shall be calculated using the higher scheme price (without recycling), by default. Once the old motor has been deposited with the recycler, the number of EMI instalments will be shortened based on the lower scheme price. In the direct payment option, a credit note shall be issued by the motor supplier.

3.5.7 What about users who must dispose scrap off only by tender?

Many users dispose of scrap through tenders. It is possible that parties than the empanelled recyclers become successful in such tenders. A supplementary mechanism shall be built in to recognise the disposal of old motors by such means, so long as the purchaser is a scrap dealer, and the motors being disposed of are individually listed in the documentation.

3.6 MEASUREMENT & VERIFICATION

The Measurement & Verification component is designed with a view to minimise interruptions in the user's production processes, as well as to keep M&V costs low.

3.6.1 How will electricity savings be measured ?

3.6.1.1 Option 1 : Deemed savings estimation through modelling only

Assuming that the baseline motor had a kW rating and loading identical to the new IE3 motor and was of an IE1 efficiency class, the annual electricity savings (AES) for the motor shall be calculated as

$$AES = kW \times (1/Eff_{old} - 1/Eff_{new}) \times h_a \times I / 100$$

Where

kW	=	rated power of the motor
Eff _{old}	=	Efficiency of IE1 motor at full load
Eff _{new}	=	Efficiency of IE3 motor at full load
h _a	=	Assumed annual average number of operating hours
l	=	Assumed average loading percentage

The obvious advantage of this estimation method is the near-zero costs, but its accuracy will depend on the statistical application of the assumed operating hours / loading percentage from the available case studies to the overall population of replaced motors.

3.6.1.2 Option 2 : Deemed savings through measurement and modelling

In this option, electricity savings shall be measured through a combination of in-situ measurement and modelling. A statistically significant and representative sample out of the newly supplied, installed and commissioned motors by application, size and type respectively shall be selected for in-situ testing. A Designated Energy Auditor (DNA) shall take measurements of input power at frequent uniform intervals over one production shift for determining the average input power (P_{inav}) and shall record the hours (h) of operation per shift. The operations and maintenance personnel shall be interviewed to determine the number of operating shifts per annum, net of holidays and maintenance shutdowns (n).

The part-load efficiency of the new motor closest to the percentage loading observed shall be noted from the nameplate (Eff_{new}). This may differ from the theoretical full load efficiency. Assuming that the baseline motor had a kW rating and loading identical to the new motor and was of an IE1 efficiency class, the efficiency of the old motor that had been replaced shall be read off a table (Eff_{old}).

The annual electricity savings (AES) for the sample motor shall be calculated as

$$AES = P_{inav} \times (Eff_{new}/Eff_{old}-1) \times h \times n$$

The results for the sample motors shall then be extrapolated to other motors of the same size in the population of replaced motors, thus arriving at the overall estimated electricity savings under the program.

The benefits of this approach are

- Statistical sample selection ensures a greater correlation with the population.
- Actual loading and hours of operation are considered, not the theoretical maxima.
- The calculation automatically excludes the savings due to other improvements in the motor system including any new variable frequency drives, or changes in the process, or differences in operating conditions with respect to the baseline.
-

There is however a cost to be paid in order to get these benefits. An even more accurate approach would additionally involve in-situ measurements on the old motor as well, doubling the costs.

3.6.2 How will compliances with the scheme be verified?

Purchase orders, manufacturer's test certificates, delivery challans, recycler's records and other transaction documents shall be inspected by the M&V agency on a sample basis to verify that motors

supplied under the scheme are exclusively of the IE3 efficiency class and that financing is availed of only for replacements, not for new / expansion projects.

From time to time, suppliers may be asked to submit specific motors for conformance testing by an independent laboratory just prior to delivery. The motors shall be selected by the M&V agency, at its sole discretion, on a spot basis. The number of motors required to be so tested will be less than 0.01% of the supplies in total (around 1150 motors over the program cycle).

The premises and stockyards of empanelled recyclers shall be inspected at short notice to cross-verify the issued motor receipts; and to ensure that motors received for recycling under the program are indeed being defaced / damaged upon receipt, and not being resold.

4

4.1 PILOT PROJECTS

There shall be three pilot projects for testing the business models and perfecting the processes, one each in a PAT industry, a large non-PAT company and a MSME cluster respectively, all preferably within the domain of a single DISCOM. The pilot projects would test the effectiveness of the program model in terms of take-up, ease of transactions, cost of transactions, process times, compliances, repayment discipline, energy savings, replicability and scalability.

4.2 NATIONAL SCALE-UP

The experience gained from the pilot projects would be used to perfect the program model before national scale-up.

5

The contracting framework and transaction modalities between various program participants for the respective financing and procurement models are shown in the following pages

Figure 4 : Contracting Framework (Direct Payment model)

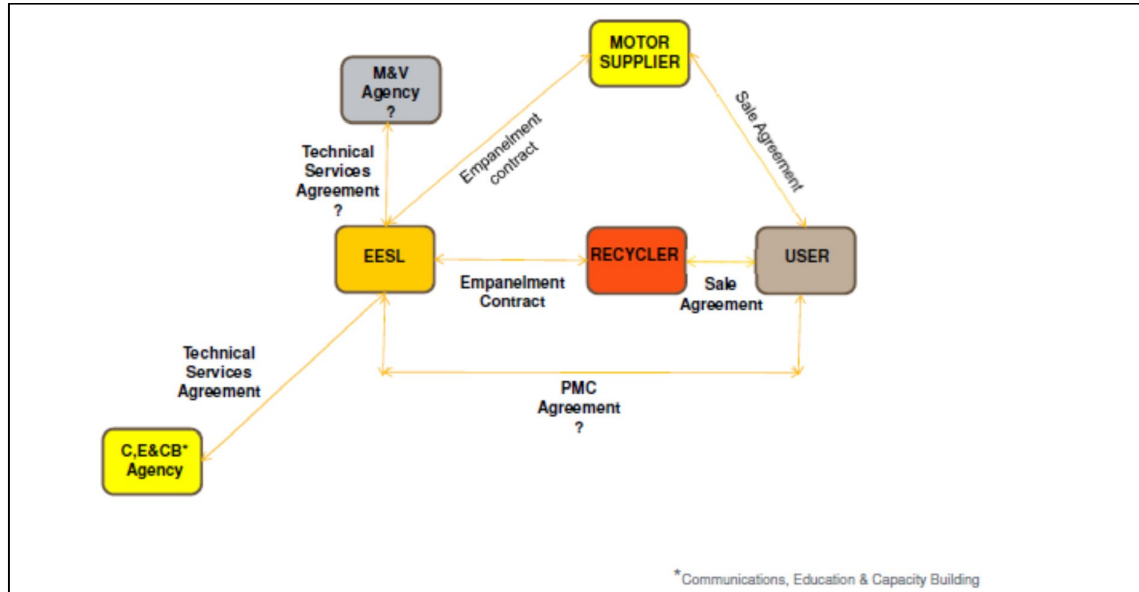


Figure 5 : Flow of Transactions (Direct Payment model)

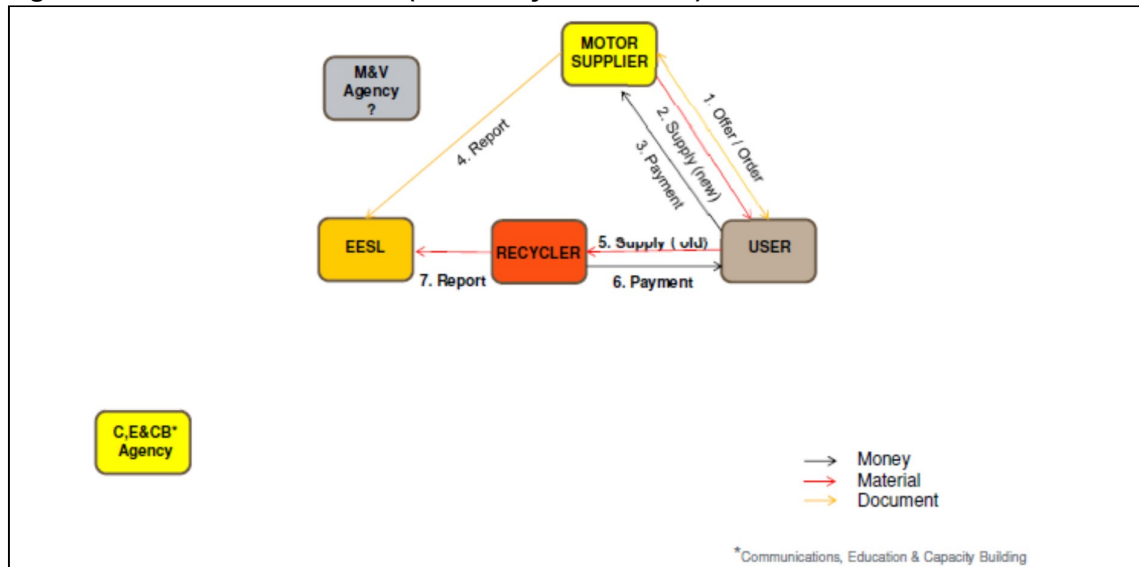


Figure 6 : Contracting Framework (Classical ESCO model)

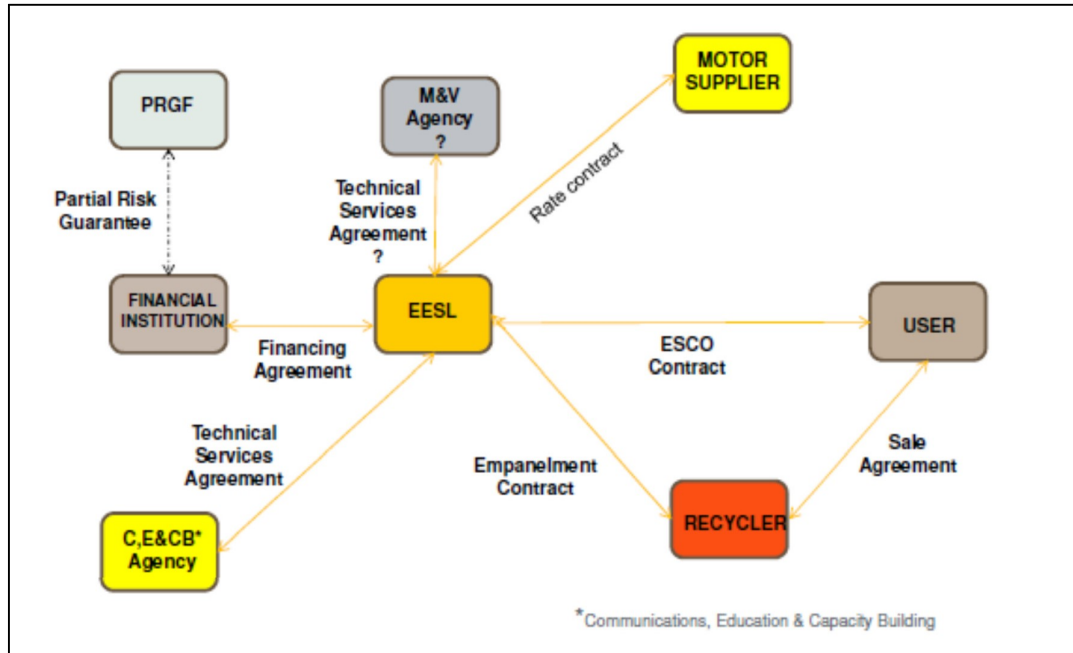


Figure 7 : Flow of Transactions (Classical ESCO model)

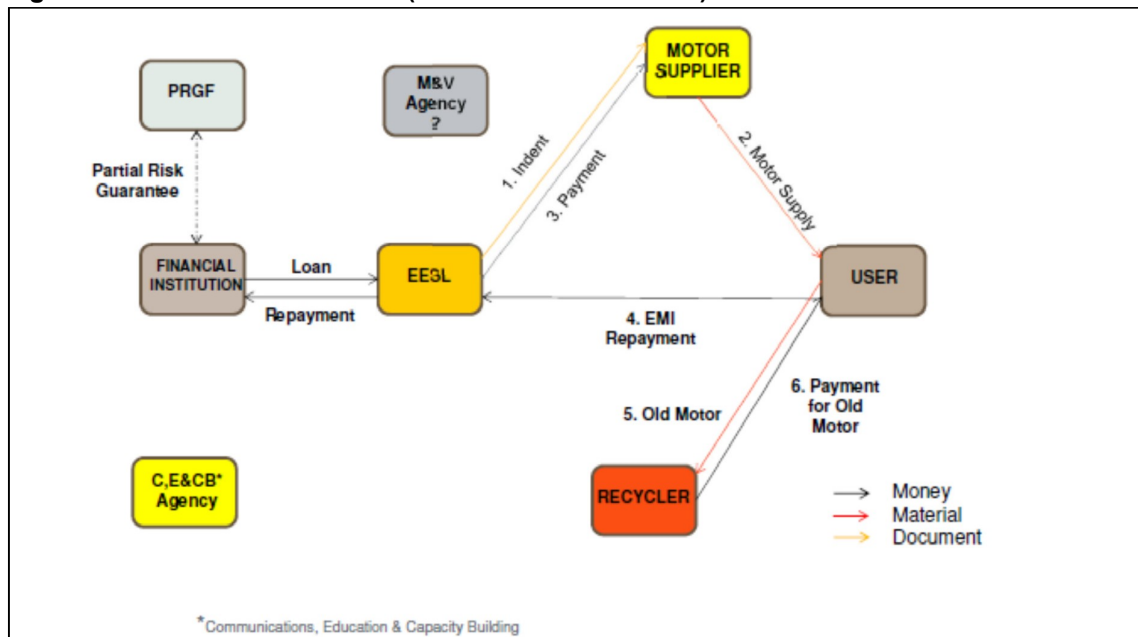


Figure 8 : Contracting Framework (Modified ESCO model)

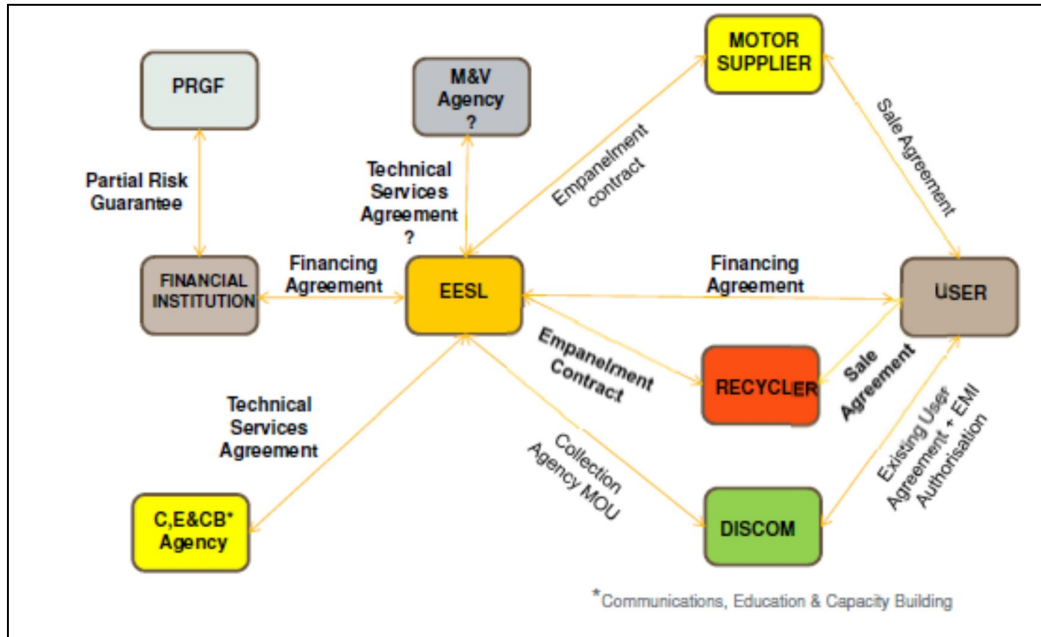


Figure 9 : Flow of Transactions (Modified ESCO model)

