

FUNDING OPTIONS FOR ENERGY EFFICIENT, LOWER-GWP REFRIGERATION AND AIR-CONDITIONING



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Funding options for Energy Efficient, lower-GWP Refrigeration and Air-Conditioning

- Context and Objectives
- Methodology for Determining Energy Efficiency (EE) Opportunities in Refrigeration and Air-conditioning (RAC)
- Findings





Context and Objectives

- Applications that currently use the most MP controlled substances, refrigeration and air-conditioning, are also the greatest growing source of energy consumption in many developing countries.
- About 80% of the GHG emissions in refrigeration and air-conditioning (RAC) equipment stem from energy use, with the remainder from direct leakage of ozone depleting and/or high-GWP refrigerant
- Experience shows that additional co-benefits arising from EE improvement could have been more systematically targeted and achieved (lost opportunity).
- Growing demand for high efficient cooling based on R-410A refrigerant (with a GWP of more than 2000 that of CO₂) in some developing countries is overtaking the speed of development and uptake of EE cooling based on low-GWP refrigerant.
- Risk of refrigerant technology (RT) lock-in if action is not taken now for several key RAC subsectors.



Context and Objectives

- Makes sense from a policy perspective to use refrigerant as the entry point for more transformative action.
- The principle reason to begin with refrigerant transition first in a coordinated or joint manner with EE action, is MP's value proposition – **compliance**. This is how Governments can make a case for leveraging action for multiple co-benefits.
- MLF also provides **financial incentives to developing country RAC manufacturers** (which rarely occurs under other multilateral funds), along with stable support to Governments for key pillars of compliance: **licensing and import quota systems** which enable control of imports according to MP reduction schedules.



Context and Objectives

- Before determining investments needed in EE and refrigerant transition first we need to define the space where **additional EE support could make the most impact for lowest cost**. i.e. exactly what and where are the opportunities that can bring quicker and larger returns in climate mitigation, ozone benefits and energy savings and at what cost?
- EE interventions will happen without MP – areas that **fall thru the crack** could be picked up and need focus.
- A key question is: what is the amount of EE investment and what impact in return...**right metrics** are key for various policymakers and financiers:
 - Cost-effectiveness (MP)
 - US\$/tCO₂ (Climate)
 - GW/h saved (Energy)



Context and Objectives

- The objectives of the report were therefore to assess the **funding needs and options** for climate and energy co-benefits alongside HCFC phase-out and HFC phase-down and
- Define where combining EE with MP goals leads to the **most effective and efficient solutions by....**



Methodology

- **Review** of past EE project examples with an MLF element and identification of lessons learned and barriers
- Analysis of **complementarities** between MP and EE action
- **Bottom-up costing of EE improvement** in RAC products alongside refrigerant replacement
- **Modeling potential benefits versus cost** to help identify priority subsectors for action.
- Facilitating consideration of **financial support** by mechanisms best suited to address specific measures and areas.
- Use TEAP HFC consumption estimates for Article 5 countries to determine consumption in RAC sectors and subsectors at a macro-level
- Identify and select subsectors and applications with co-benefit potential
 - Lay out current trends in refrigerants and RAC technologies



Methodology

- Used TEAP HFC consumption estimates for Article 5 countries to determine consumption in RAC sectors and subsectors at a macro-level.
- Identify and select subsectors and applications with co-benefit potential according to current availability and commercial viability of refrigerants and RAC technologies across major RAC subsectors.
- Bottom-up costing is done using 1) actual costs at manufacturing level to be able to manufacture more EE equipment in the subsectors of potential interest, 2) actual incremental cost of a more EE unit taking account component costs (compressor, etc.), 3) used MLF cost-effectiveness values for RT cost; and 4) came up with a C.E. value for EE improvement, using
- Actual costs limited to a few Art. 5 country manufacturers from 2 countries and extrapolated out.
- Subsector data from “climate co-benefit calculator,” used for developing the model.
- Second model growth of subsectors of potential interest for determining direct, indirect GHG emission reduction and energy savings potential. Results are at the global level (for Art. 5 countries).



Findings: Complementarities between MP and EE Action

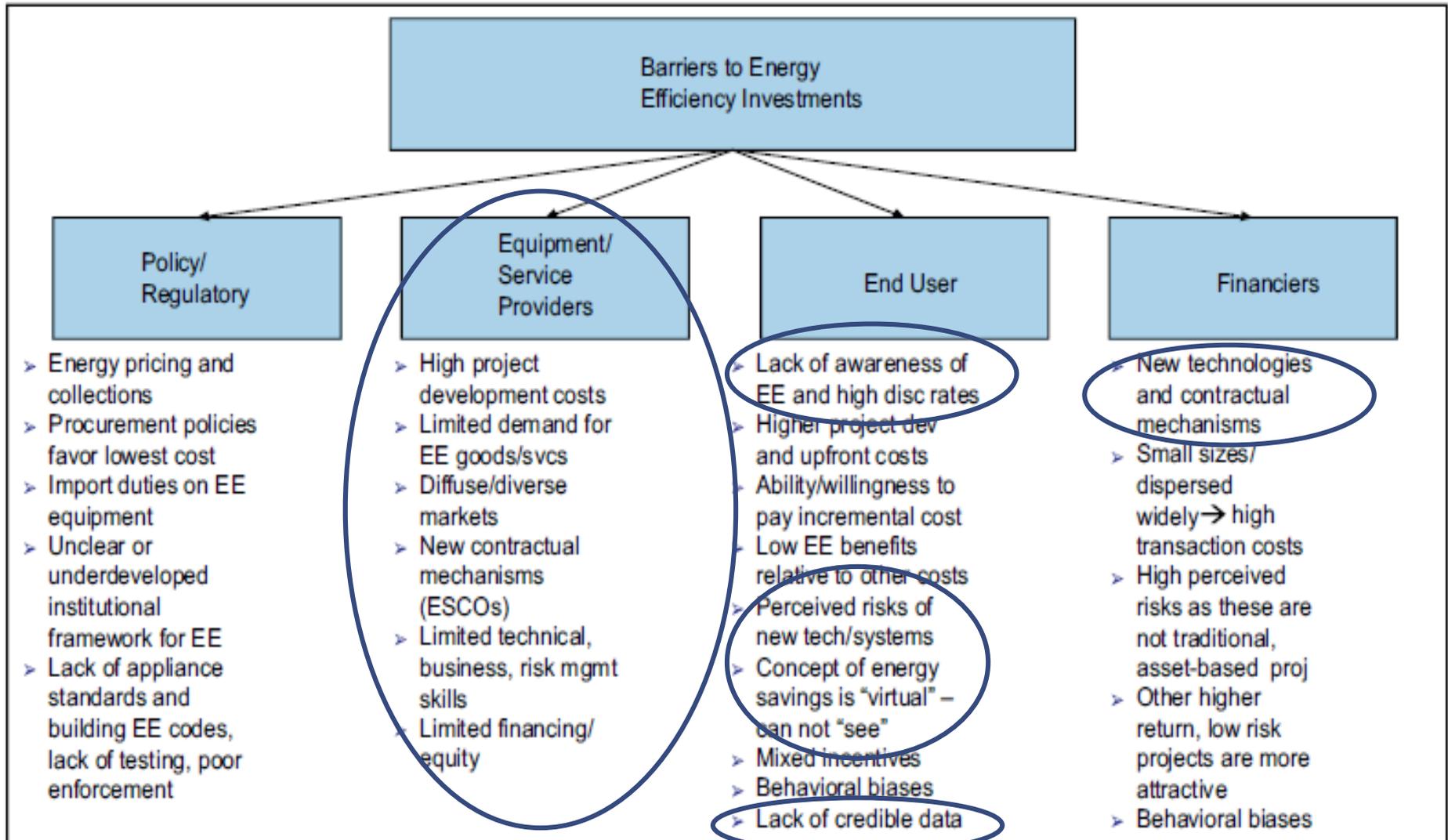
- **Similarities** between the scope of and approach used in MLF financing and EE financing (that center more on the demand-side):
 - Policy and regulatory framework to compel action combined with financial incentives and technical knowledge and information all are elements present in successful delivery of results that benefit all stakeholders.
- There is opportunity to better align activities under these elements



Comparison of Elements and Activities that Figure in MP and EE Investments

Approach	Policy/ Regulation	Institutions	Financing	Capacity	Information
HCFC Phase-out Management Plan and Institutional Strengthening	<ul style="list-style-type: none"> › Import quotas of controlled refrigerants › Manufacturing and import bans › Safety standards for AC with flammable refrigerant 	<ul style="list-style-type: none"> › Strengthening national ozone units › Customs training › Training to ministries of industry › Inter-ministerial steering committee est. 	<ul style="list-style-type: none"> › ICC and IOC grant financing for industry conversion › US\$4.80/kg in subsidies of HCFCs removed in the servicing/ end-user sector › Grants for TA 	<ul style="list-style-type: none"> › Targeted TA to facilitate adoption of new refrigerants › Workshops on alternative technologies › Servicing sector technicians trained & certified to handle new/old refrigerants 	<ul style="list-style-type: none"> › Public awareness campaigns on ODS-free appliances › Sector reviews › Reporting on HCFC phase-out & industry conversions.
EE Integrated model	<ul style="list-style-type: none"> › Standards and labelling › Tax incentives for EE appliances and equipment › Performance standards and testing obligations. 	<ul style="list-style-type: none"> › EE bureaus in ministries of industry › Customs training › Inter-ministerial steering committee est. 	<ul style="list-style-type: none"> › Concessional loans for buying EE RAC › EE funding for TA such as from the GEF › Guarantees to banks for EE lending › Public funded credits for AC purchase 	<ul style="list-style-type: none"> › Energy audits - food processing plants › Targeted TA to prove energy savings are achievable › Service sector enterprises certified in proper maintenance 	<ul style="list-style-type: none"> › Public awareness campaigns on EE appliances › Market assessments › Product databases

Common Barriers in EE Investments and where the MLF Could Help



Findings: Complementarities between MP and EE Action

- Gaps MLF could fill:
 - leveraging more risky finance due to its track record of stable and predictable funding
 - Filling gaps in the value chain that energy programs tend not to focus on, such as training and formalizing the servicing sector: training on safe and environmentally sound management of refrigerants & maintaining energy performance of equipment.
 - These could be mutually beneficial as well if a business model can be developed that reinforces the centrality of maintenance and servicing for real savings in direct and indirect CO₂ eq. emissions.
 - Support to the industry in R&D, accessing new EE technologies and the requisite know-how to apply these technologies.
 - Support to manufacturers to develop low-cost efficient components based on new, alternative refrigerants.
 - Innovation, further development of low-cost EE technological measures directly complementary to MP conversion activities.



Findings: Costing of EE Improvement (ICC)

Item	R-22 to R-32 Single-speed	R-22 single-speed to R-32 Inverter
Product Development		
Modification of R&D and testing facilities for handling flammable refrigerant (A2L or A3)	\$10,000	\$10,000
Improving calorimeter room for testing low load		\$150,000
Product design and performance optimization	\$3,000 (per model)	\$3,000+ (per model)
Development of prototypes	\$1,500 (per model)	\$1,500+ (per model)
Field test: AC unit	\$3,000 (per model)	\$3,000 (per model)
Product certification	\$1,000 (per model)	\$1,500 (per model)
New refrigerant charging machine (ex-proof)	\$75,000 (per unit)	\$75,000 (per unit)
Manufacturing Line Modification		
Replacement of vacuum pumps	\$2,500 (per unit)	\$2,500 (per unit)
Storage and transfer of flammable refrigerant	\$30,000	\$30,000
Safety: leak detectors, ventilation, fire suppression system...	\$50,000	\$50,000
Modifications to heat exchanger production line to handle higher pressure (R-32)	\$90,000	\$90,000
Inverter control box assembly station	0	\$15,000
Improvement of functional test on inverter in condensing unit assembly line	0	\$3,000
Total Minimum Cost	\$266,000	\$434,000

Source: Thailand AC Manufacturers



Incremental Cost of EE: Room AC (IOC)

Component	EE Measure Introduced	Unit Cost Baseline (US\$)	Unit cost of EE Component (US\$)	Incremental Cost (EE Component Cost – Baseline Unit Cost)
Room Air-conditioning - Increase from (2.9-3.1) to (3.8-4.1) with 33% Energy Savings				
Compressor	Variable speed (inverter technology)	80	150	70
Heat exchanger	Multi-channel	70	70	-
Motor	Brushless DC (BLDS) motor	50	70	20
Fan		20	20	-
Controls Printed Circuit Board (PCB)		70	90	20
Other (swing motor, sheet metal, sheet metal, plastics)		110	110	-
Total		400	510	110

Estimated Cost to the MLF and to Selected Sectors of HFC Conversion Costs (and Servicing Support)

Sector	2015 Estimated Consumption in Manufacturing (Kton)	C.E. Threshold (\$/kg of Controlled Substance)	Estimated MLF Financing Needs (US\$ million)	Estimated Total Conversion Threshold (US\$/kg of controlled substance*)	Estimated Total Cost – Refrigerant Conversion (US\$ million)
Air-Conditioning	74.34	8.46	628.916	10.58	786.146
Small Commercial Refrigeration	26.1	15.21	396.981	30.42	793.962
Large Commercial/Industrial Ref.	10.1	4.80	48.480	14	141.400
Mobile Air-Conditioning	32.6	8.46	275.796	10.58	344.908
Total	143.14	--	1,350.17	--	2,066
With Servicing	87	4.80	417.6	9.60	4,009

*Assumptions are: AC & MAC receive 80% coverage from the MLF; commercial refrigeration receives about half; and large commercial and industrial receives about a third of what is actually required for conversion. It is estimated that only a half to a third of the funds needed in the servicing sector are paid by the MLF.

Estimated Cost to the MLF and to Selected Sectors of Improving EE RAC Production Capacity (and Servicing Support)

Sector	Baseline Consumption (MT)	Cost-Effectiveness (\$/kg)	Expected Incremental Financing Need for EE-enabling conversion (US\$ million)
Air-Conditioning	74.34	1.85	137.529
Commercial Refrigeration	26.1	1.85	48.285
Large Commercial/Industrial Ref.	10.1	1.85	18.685
Mobile Air-Conditioning	32.6	1.85	60.310
Total	143.14	--	264.809
Servicing	87	0.90	78.3

Findings: Modeling Potential Benefits

- Modeling of the MP RAC priority subsectors demonstrates what could be by 2030 in terms of energy savings and direct and indirect climate benefits.
- Assumes:
 1. all manufacturers have the capacity, resources and motive to change over,
 2. that the demand side goes along, i.e. that it absorbs in the shorter term the inevitable higher costs.
- Just from limited experience under the MP and vast experience in EE in the WBG and world over, these two aspects are, independent of each other difficult to push through.
- Given now the impending reduction of high-GWP HFC supply and use through the Kigali Amendment and possible EE support, the MP and MLF are ideally poised to contribute to a more integrated and comprehensive approach that can draw these two ends of the spectrum together for enabling transformative change.

