

Transforming Energy Efficient Cooling Markets in Developing Countries: Implementation Challenges and Solutions

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The World Bank

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Energy Efficiency (EE) Ecosystems are Complex...

Scaling up Implementation has been a Development Challenge

Demand Side EE Measures

Supply Side Options (Conventional Supply & Large Scale RE)



- Large Investments
- Fewer Stakeholders
- Standardized Solutions
- Less Transaction Costs
- Homogenous Market



- Small and Dispersed
- Multiple Stakeholders
- No "One Size Fits All" Solutions
- High Transaction Costs
- Heterogenous Market

But solutions have been developed and are being applied...



Sustainable Cooling Landscape is even more complex... ... the Drivers, Challenges and Solutions and Different



End Uses/ Users are very heterogenous:

- Space Cooling (Residential, Commercial, Public Buildings, Grid/Off-Grid)
- Industrial Process Cooling, Transportation
- Refrigeration (Stationary/Buildings, Mobile/Food Cold Chain)

The Menu of Technology Interventions is Diverse:

- Ceiling Fans
- Evaporative Coolers (Desert Coolers)
- Air Conditioners (Room AC- Windows and Split, Chillers, Vapor Compression, Vapor Absorption, Heat Pumps, Solar Cooling, Liquid Air, etc.)
- District Cooling
- Building Insulation, Windows, Cool Roofs
- Smart Controls (Thermostats, Building EMS, etc)
- DC Appliances (Off-Grid)

Climate Change Incentives, Actions and Implications:

- Direct (refrigerants) → MP → Manufacturers
- Indirect (energy use) → CC Mitigation → Demand Side (End Users)



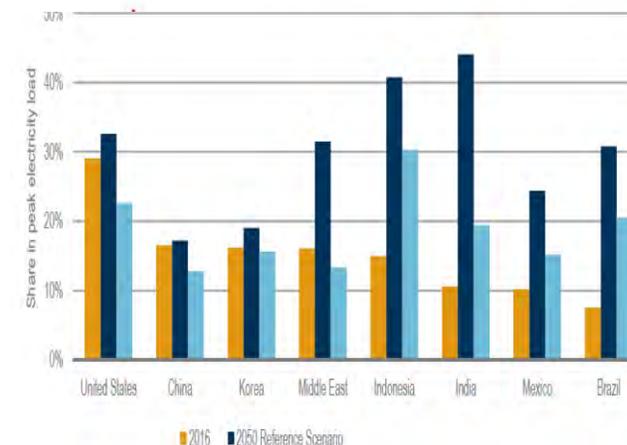
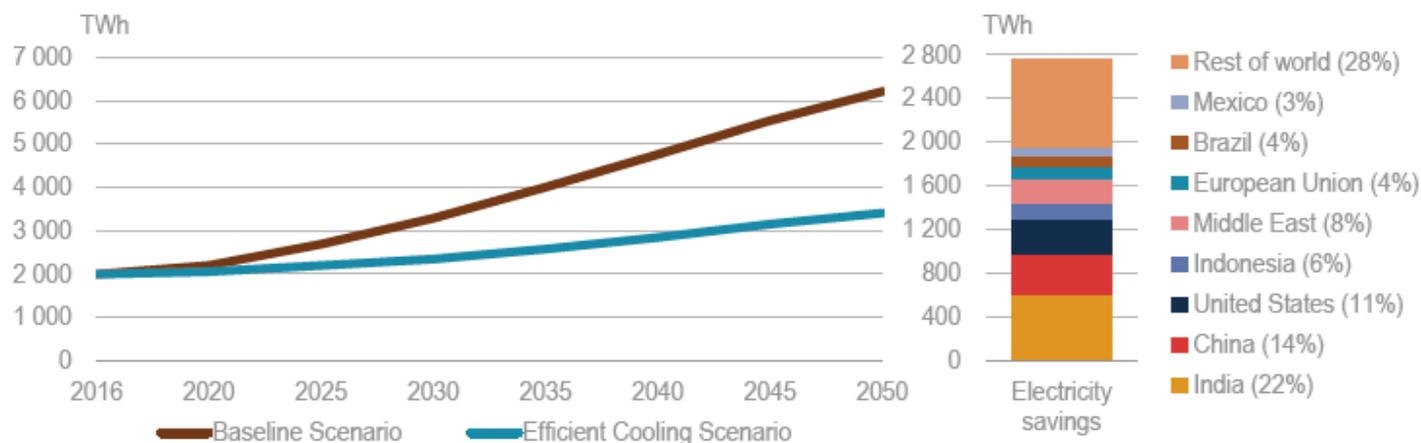
Global Buildings Space Cooling Energy Use Decomposition, Trends and Potential (through 2050)



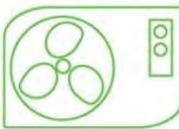
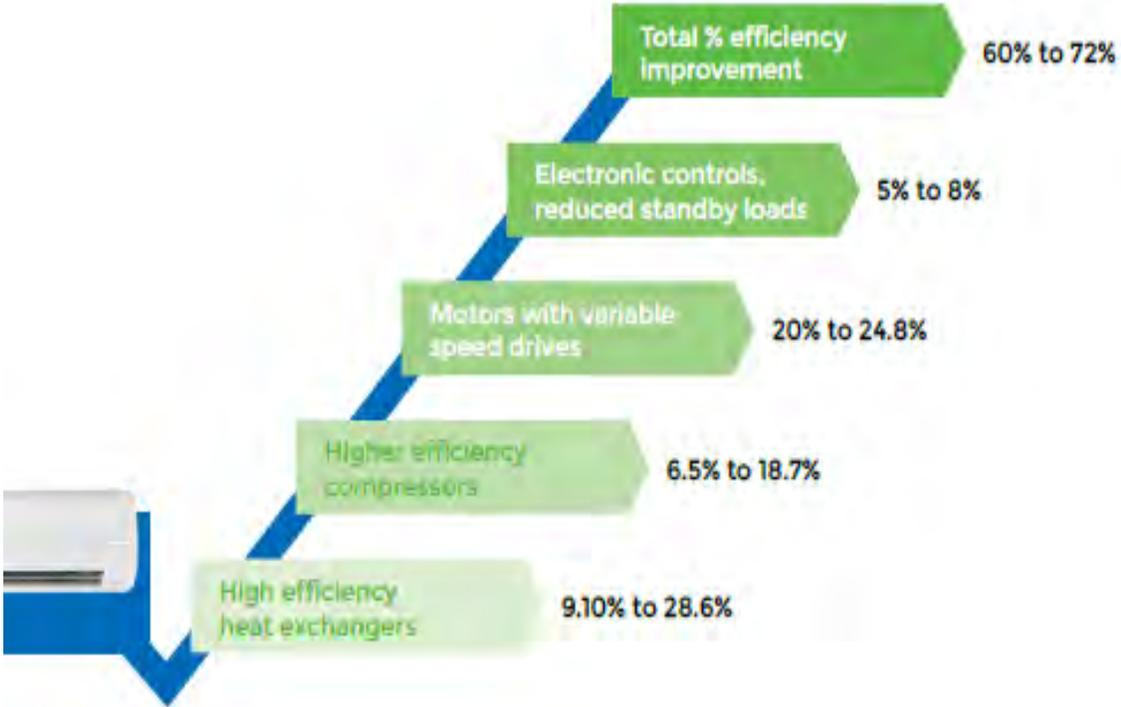
Efficient Cooling is not just about energy (KWh) and GHG emissions reduction.....
...It's about peak load (kW) avoidance

ELECTRICITY FOR AIR CONDITIONING ACCOUNTS FOR APPROXIMATELY:

30% OF SUMMER LOAD IN WARM CLIMATES (E.C. CALIFORNIA, US) & UP TO **60%** OF SUMMER LOAD IN HOT CLIMATES IN METROPOLITAN AREAS (E.G. DELHI, INDIA)

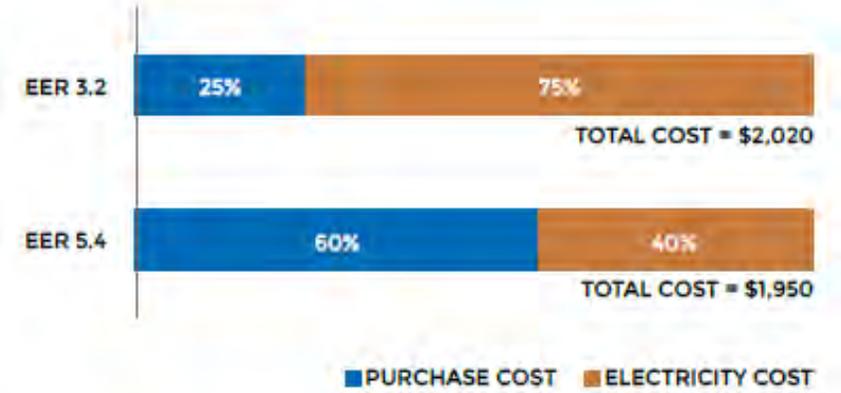


Air Conditioners- Improvement Potential (Cost Effective Over Life.... But Higher Upfront Cost)

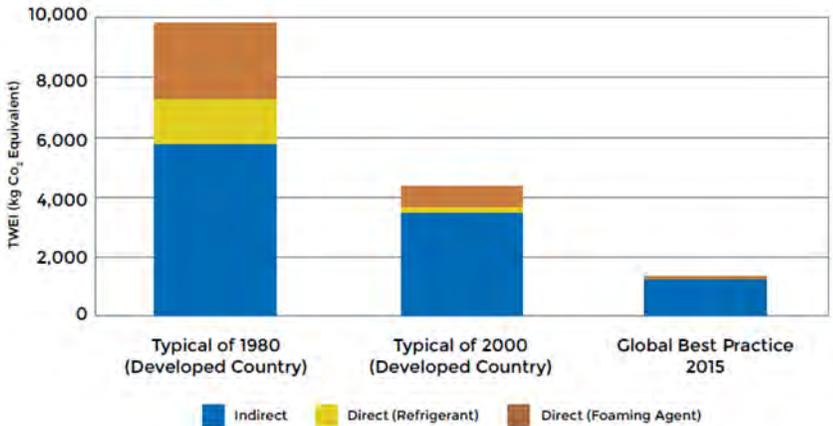
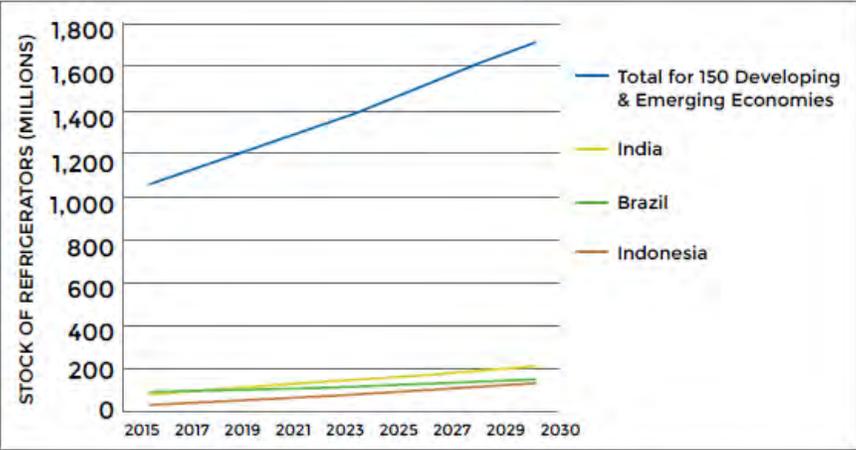


THE MOST EFFICIENT AIR CONDITIONERS ARE
> 30% MORE EFFICIENT
THAN AVERAGE PRODUCTS ON THE MARKET.

Air conditioning improves comfort levels and enhances air quality. The demand for air conditioners is increasing rapidly across the world, especially in regions with hot climates.

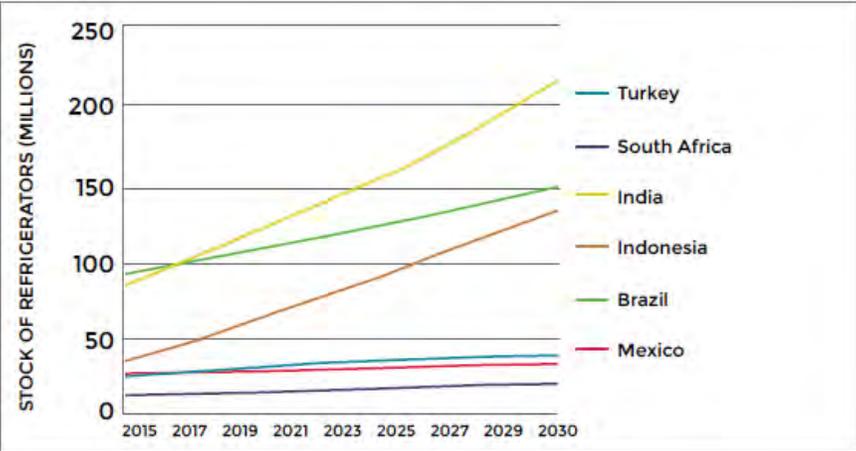


Refrigerators- Improvement Potential



THE BEST AVAILABLE
FRIDGE-FREEZERS IN THE MARKET
CONSUME OVER
60% LESS ELECTRICITY.

Refrigerators are the most convenient and
safest mean to preserve food.

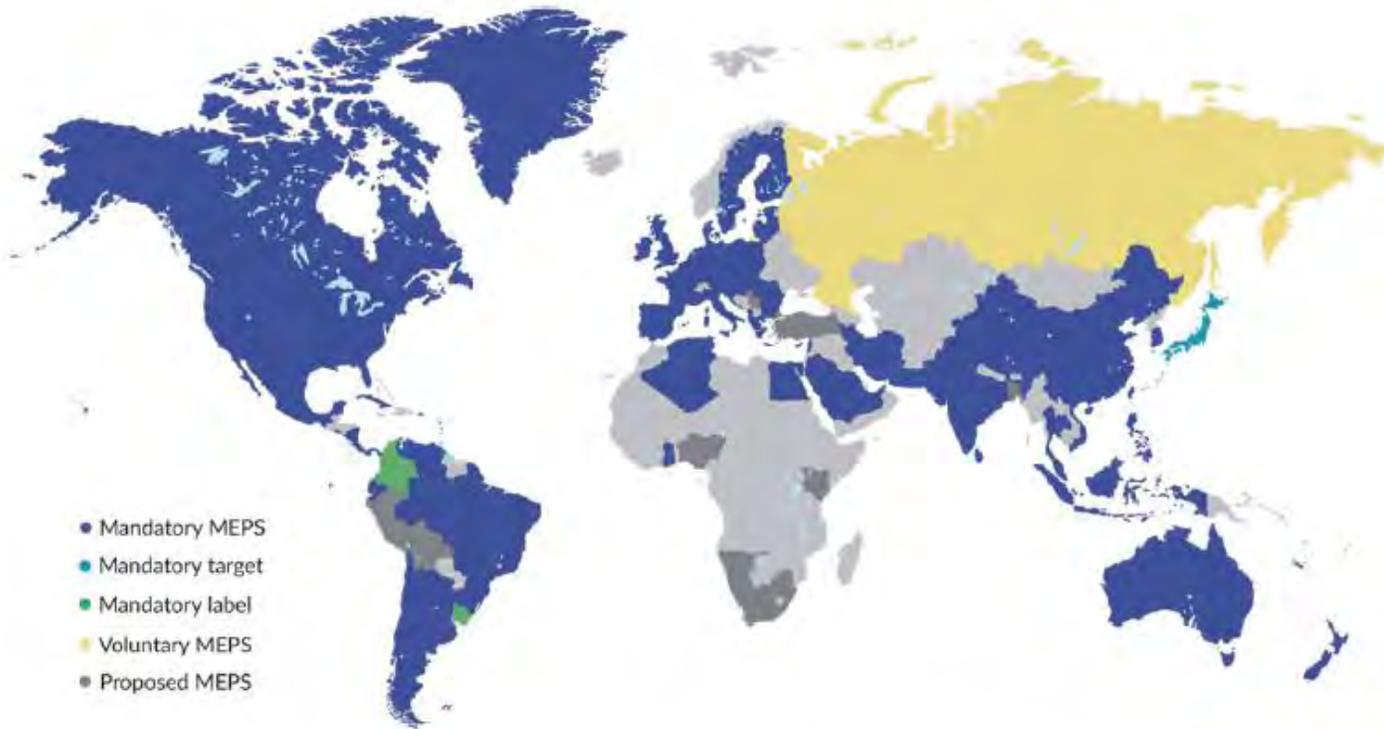


TECHNOLOGY LEVEL	DEVELOPING COUNTRY UNREGULATED MARKET	MEPS	TYPICAL US BEST PRACTICE OF 2015	TYPICAL EU BEST PRACTICE OF 2015
Annual energy consumption (kWh/year)	750	370	160	160
Refrigerant and (GWP*)	CFC 12 10200	HFC 134a 1300	HFC 134a 1300	HC 600a 3
Mass of refrigerant (g)	150	120	120	55
Foam blowing agent and (GWP*)	CFC 11 4660	HFC 245fa 858	HFC 245fa 858	Cyclopentane 11
Assumed mass of foam blowing agent (g)	530	815	815	563
Total indirect impact from energy use (kgCO ₂ e**)	5,830	2,880	1,240	1,240
Total direct impact from refrigerant and foam blowing agent (total release) (kgCO ₂ e**)	4,000	860	860	10
TEWI rating (direct and indirect), (kgCO ₂ e)	9,830	3,730	2,100	1,250

Global Cooling Equipment Policy Coverage 2017

Policy coverage is expanding but

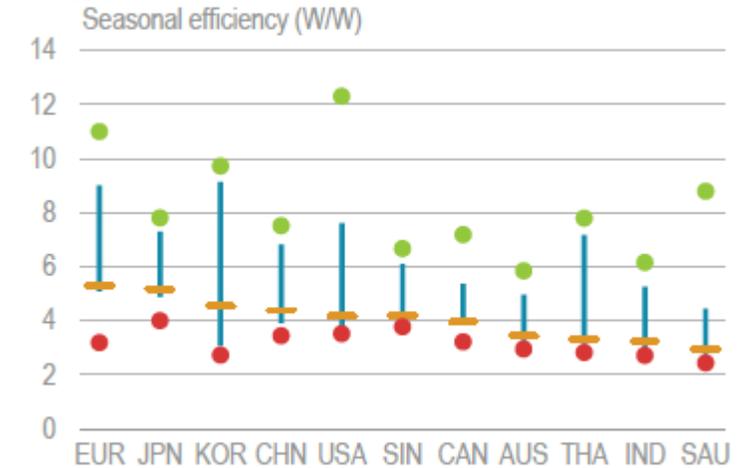
MEPS have large room for continuous improvements, robust enforcement and stronger implementation



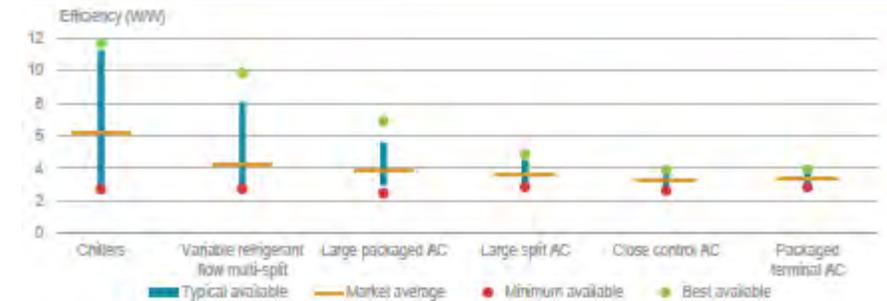
This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Note: Map shows one policy per country based on the strongest policy, e.g. the European Union has mandatory MEPS and labelling, but only mandatory MEPS are shown.

Energy Efficiency Performance of Small ACs 2018



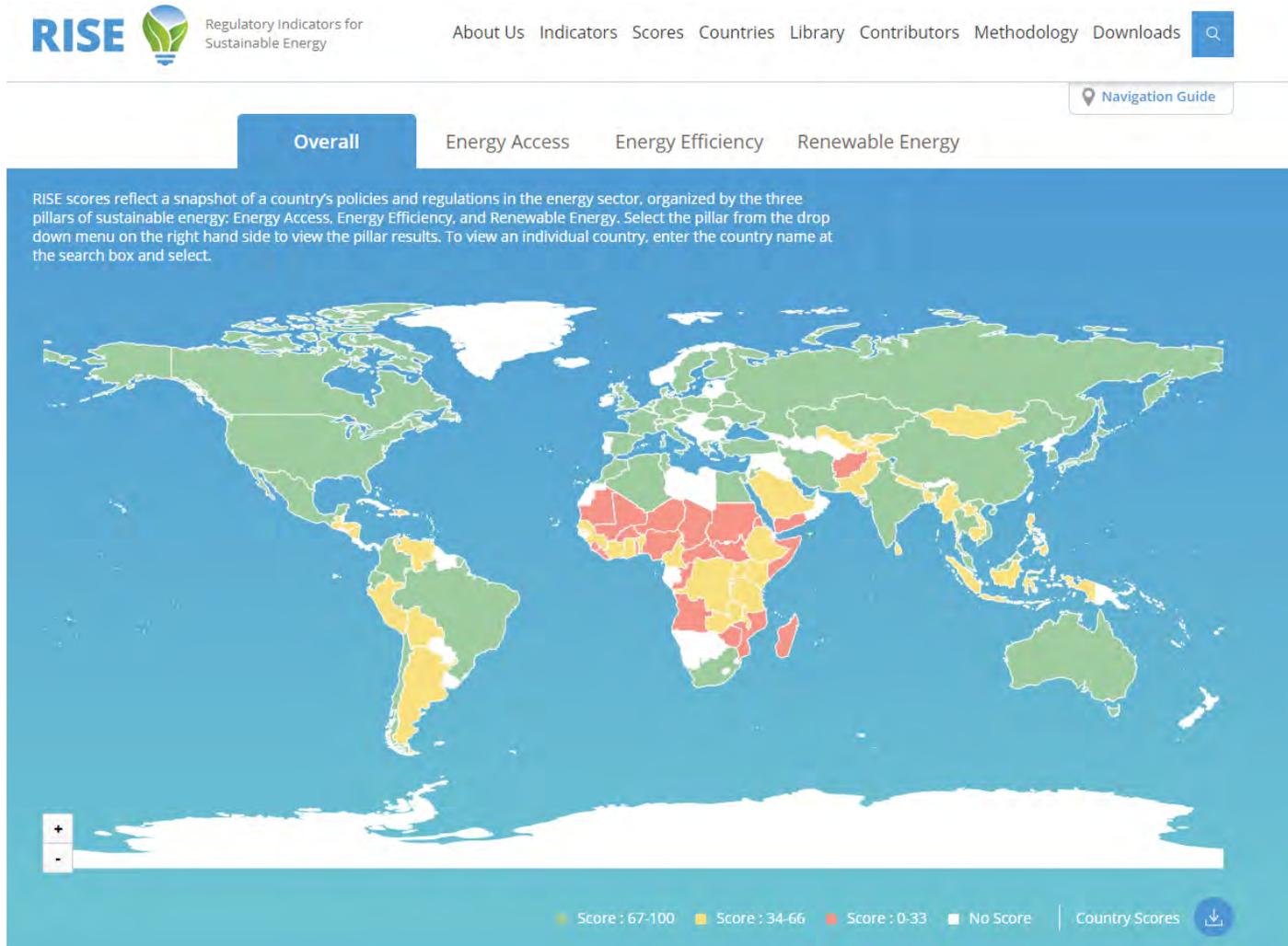
Energy Efficiency Performance of Commercial ACs 2018



Note: Efficiency represents the ratio of output cooling capacity to energy input at a set peak temperature point.

How Air Conditioning Standards are Evolving Worldwide?

<http://rise.worldbank.org>



How Effective Are EE Labeling of Air Conditioners?



European Union Label

Energy efficiency class: **B**

Energy consumption kWh/year: **340**

Iranian Label

Energy consumption kWh/year: **340**



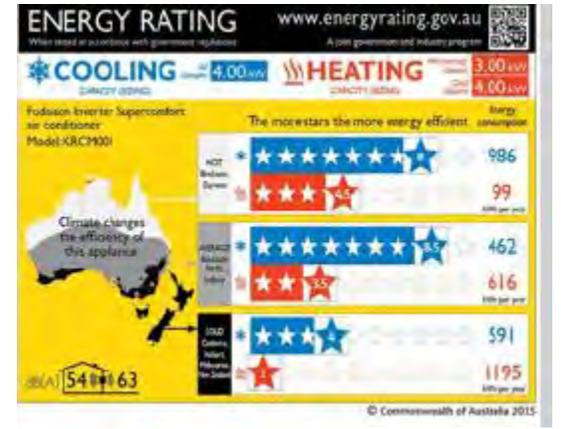
ENERGY EFFICIENCY LABEL

Energy consumption kWh/year: **720**



ENERGY RATING

Energy consumption kWh/year: **9,900**

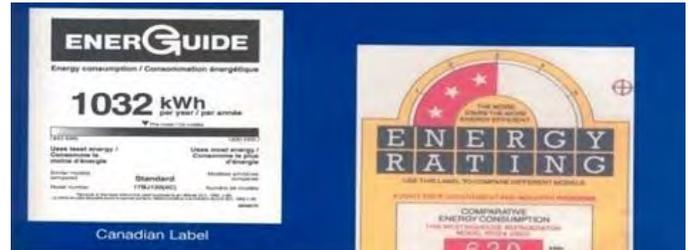


ENERGY RATING

COOLING: **4.00** stars

HEATING: **3.00** stars

Energy consumption kWh/year: **986**

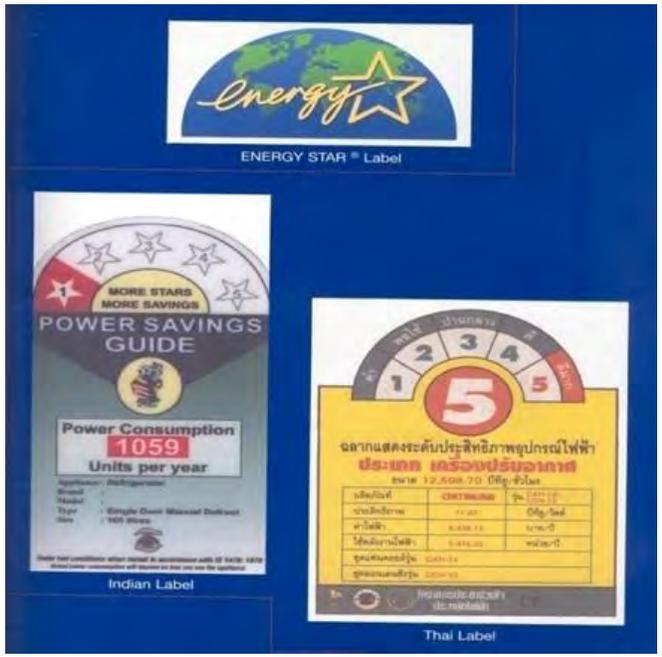


ENERGUIDE

Energy consumption kWh/year: **1032**

ENERGY RATING

Energy consumption kWh/year: **620**



ENERGY STAR Label

POWER SAVINGS GUIDE

Power Consumption: **1059** Units per year

Indian Label

THAI LABEL

Energy consumption kWh/year: **12,508.70**

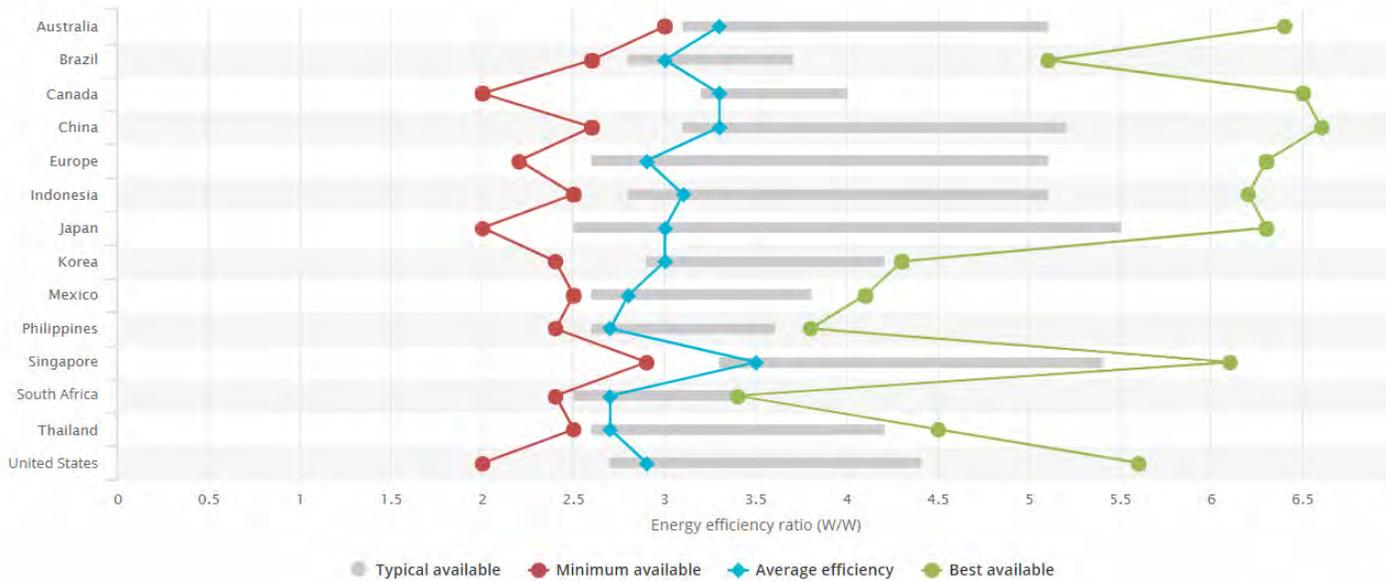


DER BLAUE ENERGI KLIMA

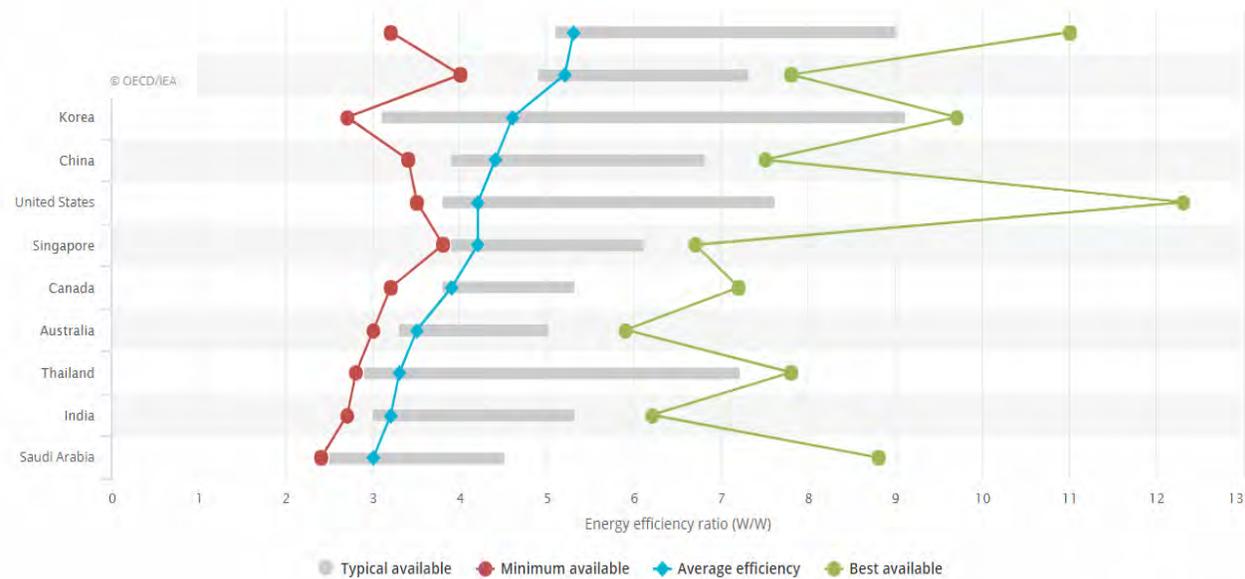
WORLD BANK GROUP
Energy & Extractives

Are Policies and Regulations Alone (MEPS, Labels) Effective in Residential AC Market Transformation?

Residential AC - EER



Residential AC - SEER



Source: IEA Global Exchange on Efficiency- Cooling

Barriers to Adoption of High Efficiency Air Conditionersexist beyond having policies and regulations

Barrier	Description	Examples
Financial	Magnitude of the first cost relative to incumbent less efficient appliances	<ul style="list-style-type: none"> • Higher relative upfront cost of high efficiency air conditioners, affecting affordability, especially to low-income consumers • Lack of sustainable financing schemes • Lack of incentives to local manufacturers to promote sales of efficient air conditioning products • Lack of enhanced producer responsibility (EPR) schemes requiring manufacturers to include the costs of recycling and disposal of the appliances in the sales price.
Market	Market structures and constraints that prevent efficient product investments and energy saving benefits	<ul style="list-style-type: none"> • Competition through low-cost, low-efficiency products • Limited availability of affordable high-quality products • High import costs or tariffs • Split incentive—landlord/tenant discrepancy (building owner/manager buys product, tenant pays utility bill) • Negative impact on local manufacturers and related industries.
Information, Awareness and Capacity	Lack of information provided on efficient technologies and their energy savings benefits	<ul style="list-style-type: none"> • Lack of air conditioner-related knowledge and skills among policymakers, air conditioning system designers, importers, suppliers, operation and maintenance (O&M) facility managers • Poor promotion of efficient air conditioner products • Low level of public awareness of the technologies and their benefits • Non-uniformity and technical detail in metrics (e.g. energy efficiency ratio (EER), seasonal energy efficiency ratio (SEER), and coefficient of performance (COP)) new to, or difficult to understand by, policymakers or consumers.

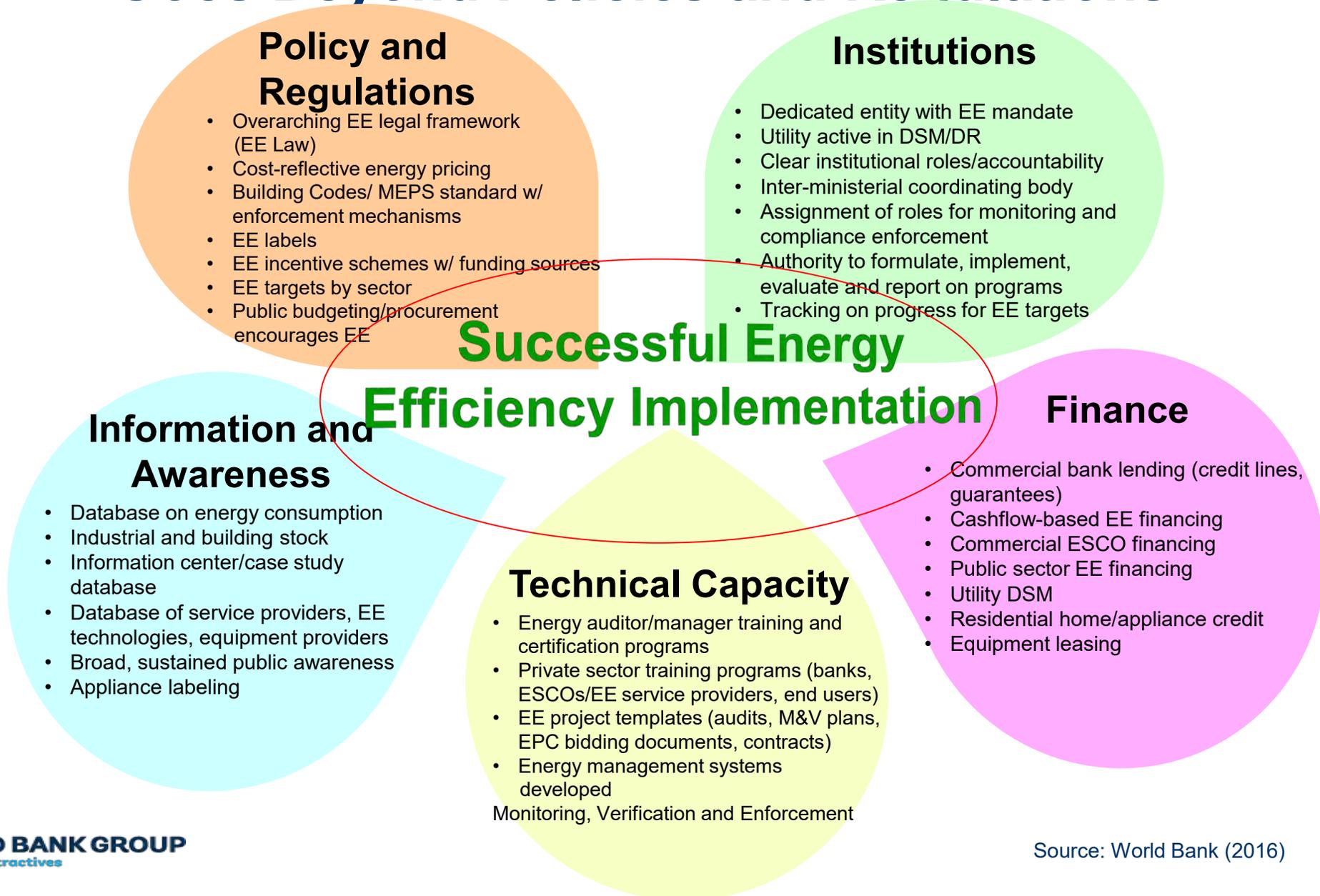
Barriers to Adoption of High Efficiency Air Conditioners...

...exist beyond having policies and regulations

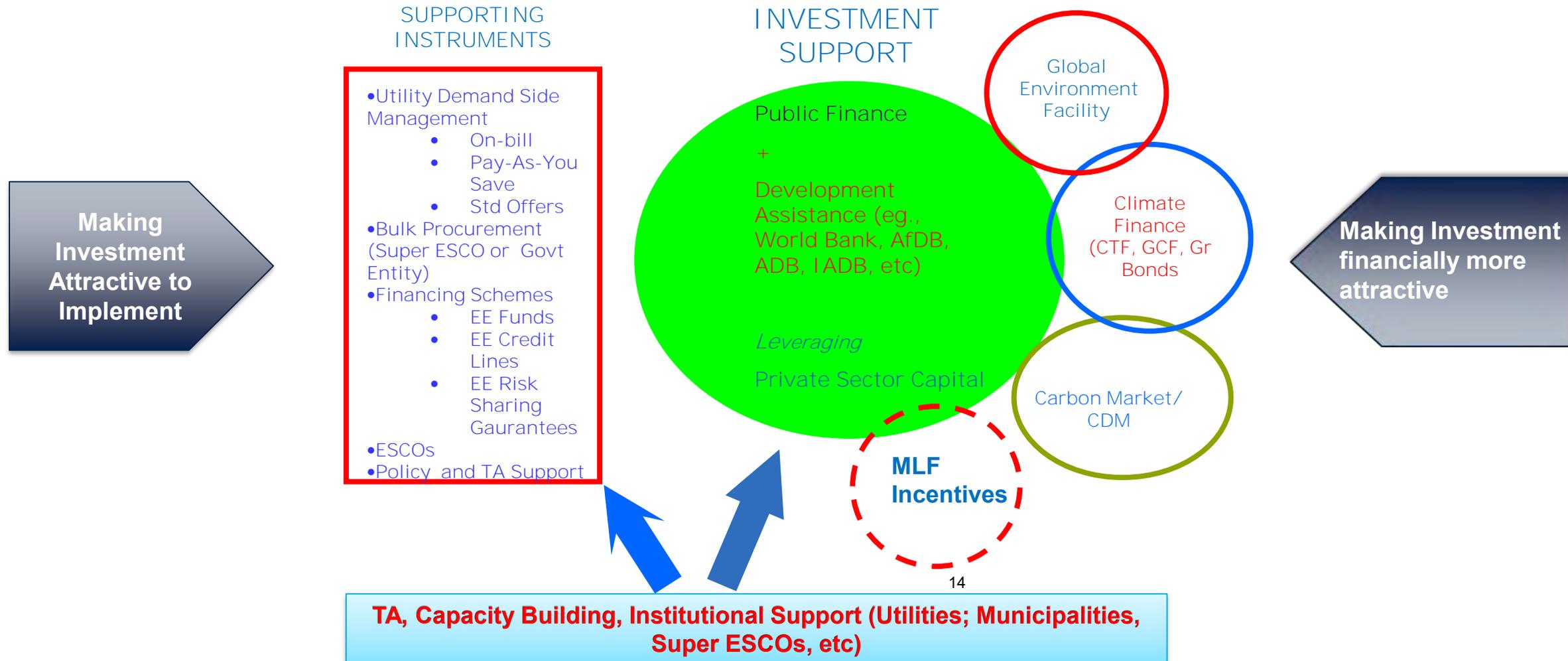
Barrier	Barrier	Examples
Regulatory and Institutional	Financial	<ul style="list-style-type: none"> • Lack of policies and practical experience to train local air conditioner manufacturers • Lack of policies encouraging energy-efficient air conditioners – regulatory, monitoring/verification, enforcement • Lack of warranties to ensure product quality; • Lack of regulations requiring installation and maintenance by certified and trained personnel • Restrictions on the use of flammable low GWP refrigerants-based air conditioners (even where these appliances are optimized with regard to charge minimization and additional safety features) • Lack of standards/code of best practice to guide installation, servicing and disposal of air conditioners with flammable refrigerants.
Technical	Market	<ul style="list-style-type: none"> • Lack of adequate or accredited testing facilities • Limited resources to monitor, verify and enforce national regulations • Lack of technical capacity for local suppliers to provide quality components, materials and product parts and for manufacturers to produce energy-efficient air conditioners • Lack of trained and certified technicians to properly install and service air conditioners with flammable refrigerants.
Environmental and Safety Risk Perception	Information, Awareness and Capacity	<ul style="list-style-type: none"> • Lack of collection and recycling schemes for reuse, recovery and treatment at end-of-life • Lack of public information about the safety of efficient air conditioner technologies in comparison to other widely deployed technologies and risks.

Source: United for Efficiency (UN Environment)

Transforming and Sustaining EE Markets Goes Beyond Policies and Regulations



How to Leverage Financing for Energy Efficiency Programs: Role of Multilateral Finance Institutions and Climate Finance



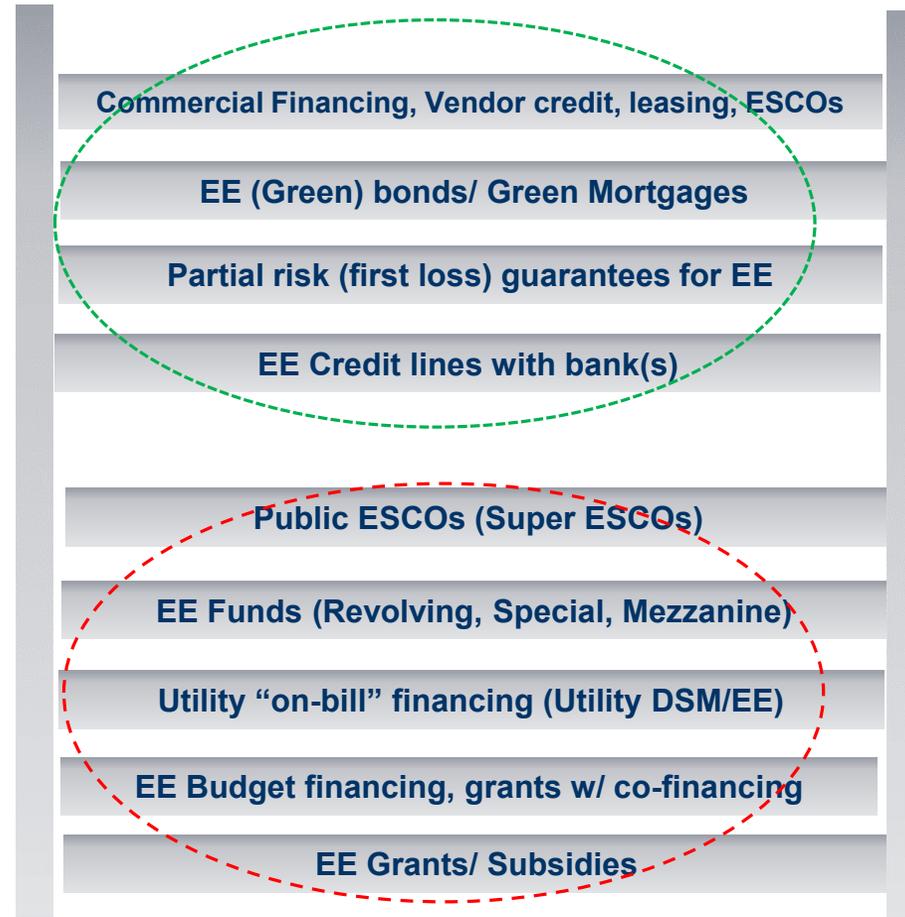
EE is key part of World Bank Group's Global Commitments

- ✓ **Sustainable Development Goal 7/Sustainable Energy for ALL**
 - Help individual client countries towards goal of doubling rate of EE improvement
- ✓ **Paris Accord**
 - Support NDCs (most countries have prioritized EE in their NDCs)
- ✓ **Climate Change Action Plan**
 - At least 50% WBG's infrastructure operations in urban space will integrate EE
 - At least \$1 billion in investments and 10 operations supporting efficient and resilient building by 2020.
 - Mobilizing \$25 billion commercial financing for clean energy
 - Helping large Asian countries (which in the business as usual case expect to contribute to 80% new coal power plant build up) to transition to low carbon path with the help of "Asia Energy Transition initiative"

Sustainable EE Financing and Delivery Solutions

The Energy Efficiency Financing “Ladder”

**Market
Maturity
& Innovation**



**Commercial
Financing**



**Public
Financing**

World Bank Demand Side EE Support Interventions: Program Delivery Solutions and Models for Different Sectors

Sectors	Industrial and commercial	Public and municipal	Residential
Program models	Credit lines, loan guarantees, mezzanine funds	Public financing, energy efficiency/urban development funds, super ESCOs, credit lines, loan guarantees	Utility DSM/rebates, bulk purchase, credit lines, loan guarantees, manufacturer incentives
Description	Lending to one or more local banks to support portfolio of smaller energy efficiency investments in public/private enterprises	Lending to government or financial intermediary to support portfolio of energy efficiency investments in public entities	Lending through utility/intermediary to support efficient appliances and home renovations
Implementing agencies	Commercial banks, guarantee companies	Ministry PIUs, energy efficiency funds, public ESCOs, commercial/development banks	Utilities, commercial/development banks, equipment manufacturers
Success factors	<p>Market analysis to identify target market(s)</p> <p>Strong, stable demand built through multiple channels and technical intermediation</p> <p>Appropriate financial products, standardized to lower transaction costs</p> <p>Committed banking partners with internal capacity raised as needed through technical assistance</p>	<p>Strong, committed implementing partners</p> <p>Target sectors with a strong stake in energy efficiency and credible borrowing profile</p> <p>Repayments and periodic recapitalization to ensure sustainability</p> <p>National program framework with regulatory obligations to drive demand</p> <p>Project bundling to lower transaction costs</p>	<p>Simple delivery mechanism to avoid disrupting typical supply chains</p> <p>Strong management commitment within utility and appropriate financing/ regulatory incentives for DSM</p> <p>Incentives targeting poorer consumers</p> <p>Effective outreach and social marketing</p>
World Bank examples	<p>Ongoing: China, India, Jamaica, Tunisia, Turkey, Ukraine, Uzbekistan</p> <p>In pipeline: Egypt, Russia, Vietnam</p>	<p>Ongoing: Armenia, Bosnia & Herzegovina, India, Kosovo, Montenegro</p> <p>In pipeline: Belarus, Macedonia, Mexico, Turkey</p>	<p>Ongoing: Bangladesh, Benin, Mexico, Rwanda</p> <p>In pipeline: Bulgaria</p>

Source: World Bank reports and data.

DSM = demand-side management; ESCO = energy service company

World Bank Demand Side EE Support Interventions: Program Delivery Solutions and Models for Residential Sector

Delivery Mechanisms in the Residential Sector

Delivery mechanism	Description	Key success factors	Country examples
Utility DSM programs	Regulatory mechanisms to oblige utilities to implement EE measures in their customers' premises. To meet these obligations, utilities may (i) directly implement EE measures in residential buildings, (ii) engage contractors for implementation, (iii) purchase energy savings achieved by others ² , or (iv) establish a (revolving) fund for EE measure implementation. This can include utility financing with on-bill repayments.	Proper incentives for utilities (e.g., utility obligations) and measures to address conflicts with utilities' core energy sales business (e.g., decoupling energy sales and profits)	Belgium, Canada, Denmark, France, Ireland, Italy, Netherlands, UK, USA
Commercial financing	Government or donor credit lines to commercial banks, or specialized lending windows, for on-lending to residential consumers. Schemes include direct loans to homeowners and HOAs for building renovations, or credit schemes through vendors or retailers for qualifying energy-efficient appliances.	Technical assistance to help strengthen banks' capacity to assess projects, standardized project appraisal procedures.	Poland, Lithuania, Thailand, Mexico, Serbia
Green mortgages	Subsidized or preferential mortgages to promote energy efficient building construction and retrofits based on predefined "green" measures.	Constant and predictable funding for green mortgages to allow investors to make long-term plans.	Germany, USA, Australia, Netherlands, Mexico
Credit guarantees	A public or private agency (e.g., development or commercial bank, insurance or guarantee company) provides guarantees that cover a portion of loan losses from defaults to encourage banks to lend for EE and defray perceived higher risks.	Credit guarantees require large enough project pipelines to justify such schemes, proper assessment and pricing of risks.	Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Slovakia
EE funds	Created by national or state governments to provide concessional loans or incentives for EE projects. In the residential sector, EE funds generally include some portion of grant funds (usually 20-30%) from government budgets or special taxes.	Funds can provide other services (e.g., audit templates, guidebooks, online EE calculators)	Bulgaria, Slovenia, Armenia, Romania
Market transformation	Bulk procurement and distribution: Purchase of a large quantity of energy-efficient appliances by the utility or a government agency to achieve price reductions, and distribution to customers.	Measures to ensure that efficient appliances are available in the market after the end of program.	Vietnam, Uganda, Rwanda, Ethiopia, Bangladesh, Philippines
	Market channel-based approaches: Utilize existing market channels to distribute energy-efficient appliances using a combination of coupons, branding and promotion programs and rebates.	Effective marketing campaign and awareness-building program to ensure high consumer participation.	Sri Lanka, India, Mexico
	Standards and labeling: Establish efficiency standards and/or labels to provide information to assist customer decision making. For lighting, many countries use phase-out policies, which eliminate incandescent bulbs from the market through legislation or regulation.	Strong market monitoring, verification and enforcement schemes to protect consumers from non-compliant products.	Cuba, Australia, Canada, UK, USA, EU

Air Conditioning - Drives Economic Growth and Well Being

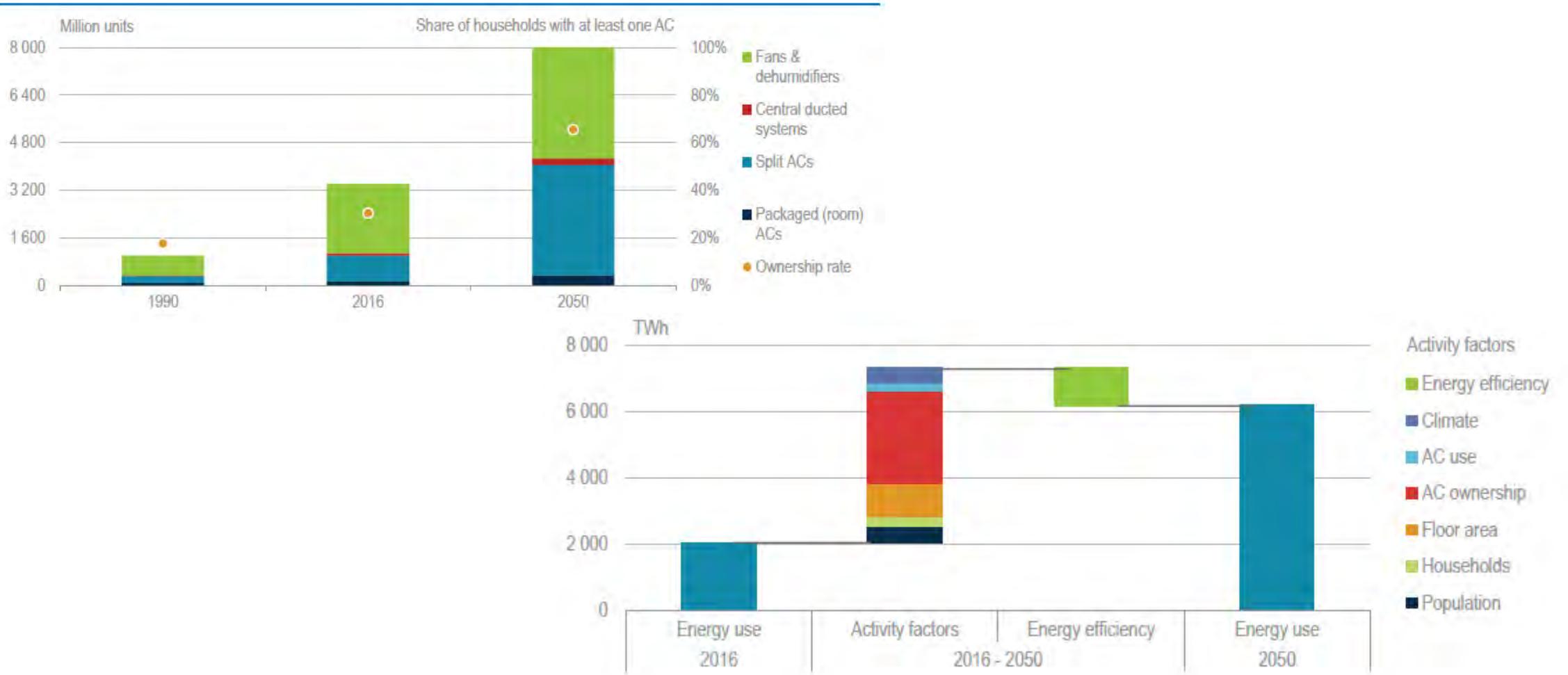


“Air conditioning was a most important invention for us, perhaps one of the signal inventions of history. It changed the nature of civilization by making development possible in the tropics.

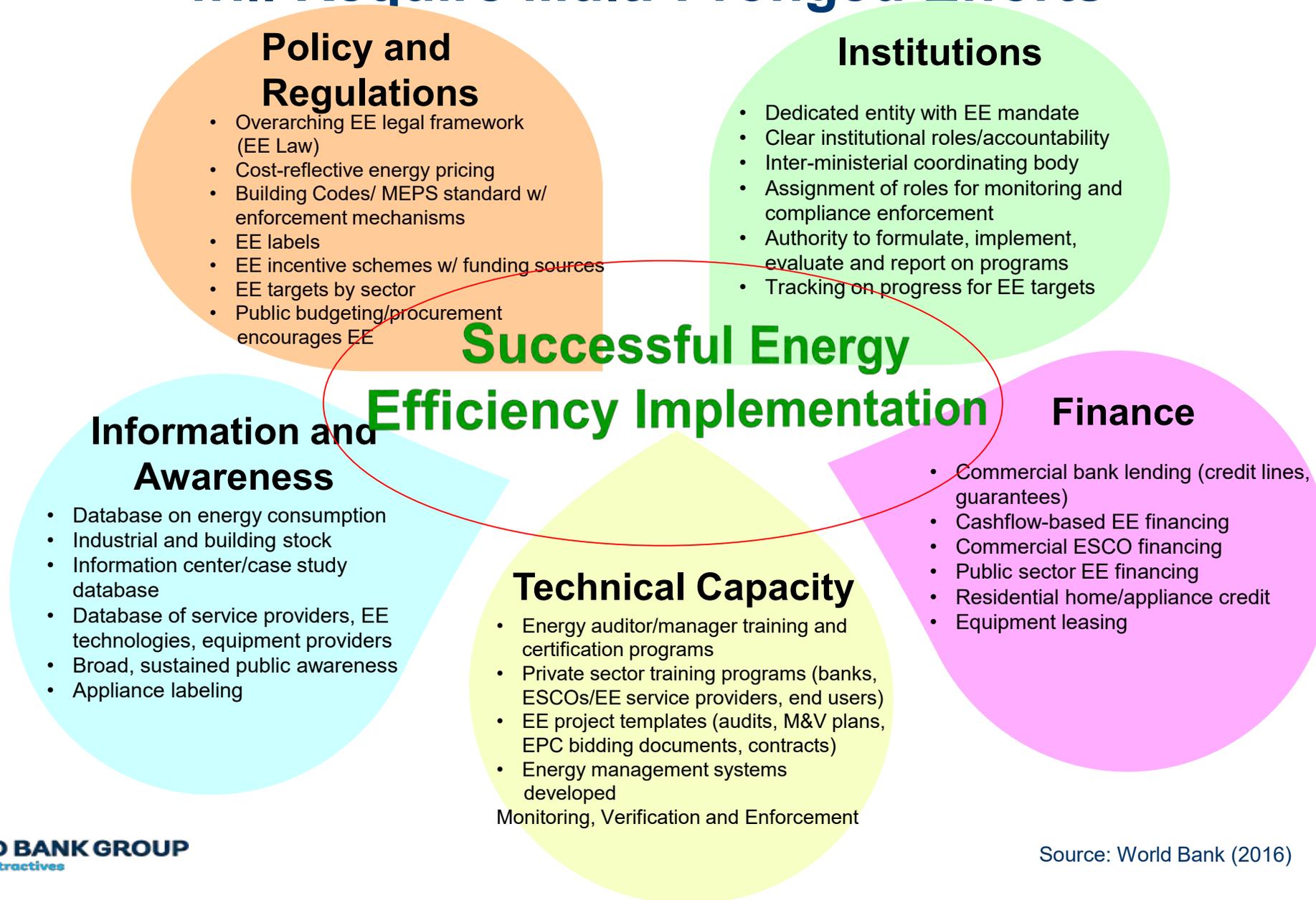
Without air conditioning you can work only in the cool early-morning hours or at dusk. The first thing I did upon becoming prime minister was to install air conditioners in buildings where the civil service worked. This was key to public efficiency.”

.....Late Lee Kuan Yew (Singapore's founding father and former Prime Minister), 2009

Rapidly Growing Cooling Market: A Challenge and An Opportunity



Transforming and Sustaining Energy Efficiency Cooling Market will Require Multi-Pronged Efforts



Thank You



For questions, please contact:

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