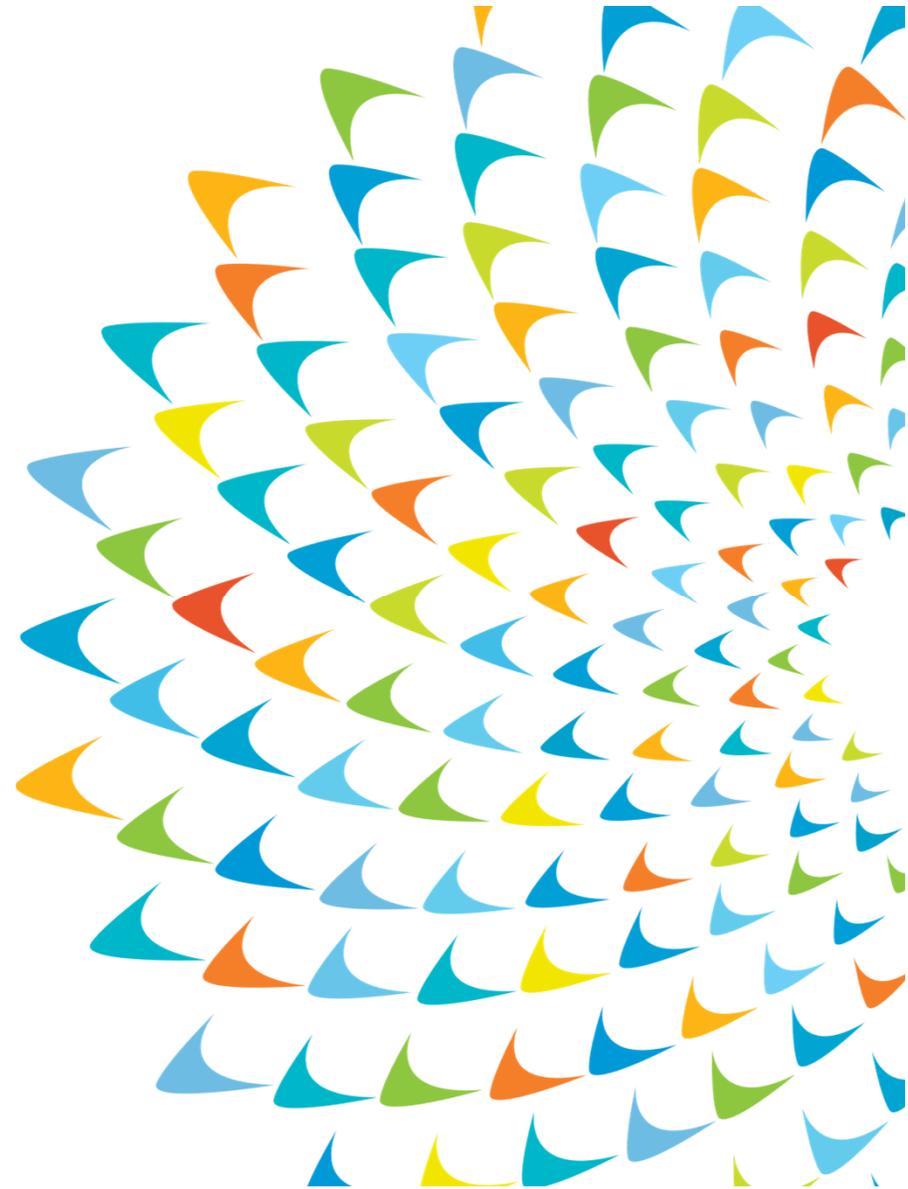




TA 9003: GMS Energy Efficiency Market Assessment in Cambodia, Lao PDR, and Myanmar

27 August 2021

Hyunjung Lee, SEEN





Targeted 3 GMS Countries



Greater Mekong Sub-region Energy Roadmap

- Reduction of energy consumption by 10% in the region by 2030-2035 compared to BAU case
- Increase the use of renewable energy & promote energy efficiency
- Energy Security in the region & energy access to all
- Ensure Cost effective energy supply

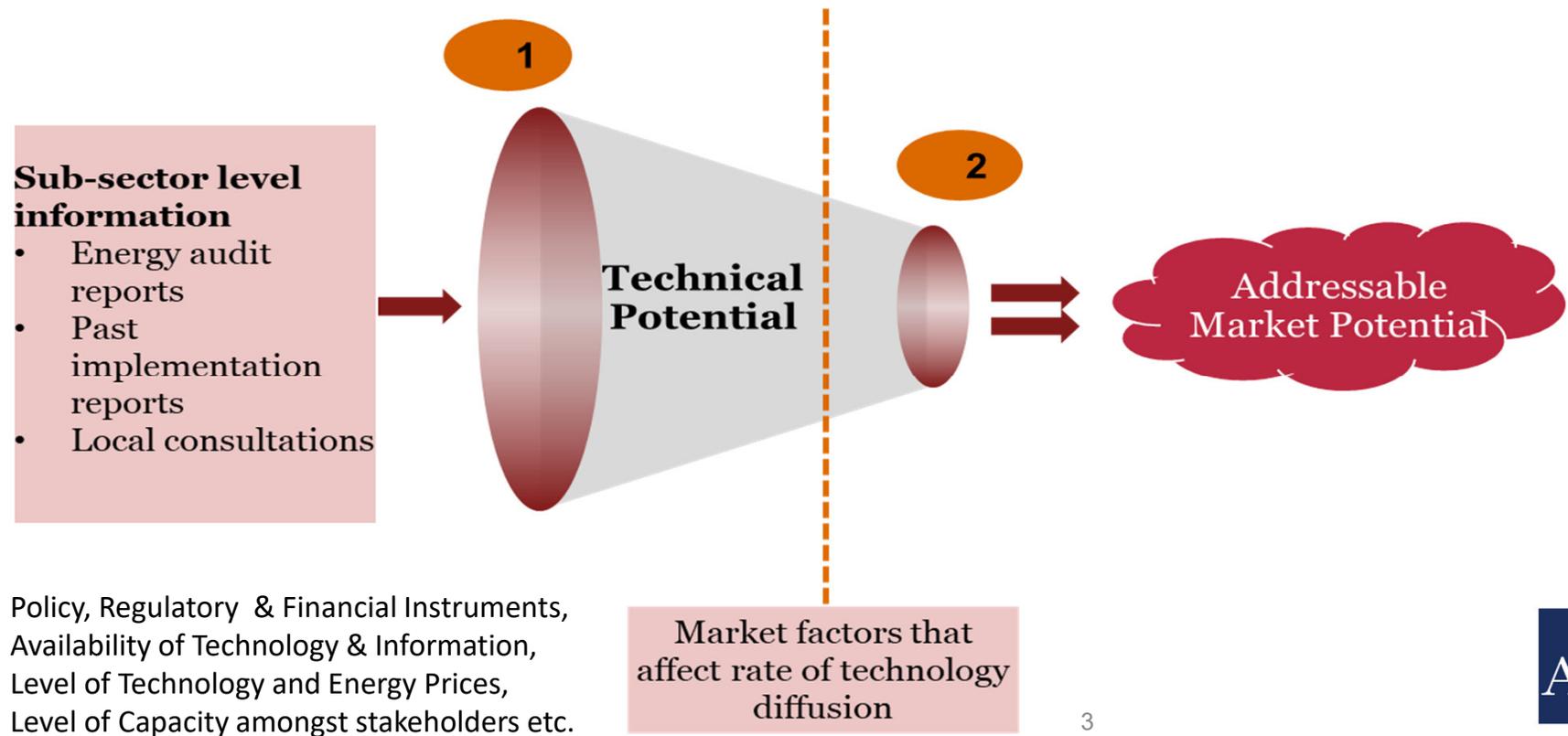
ADB Support with AfD Cofinancing

- Demand Side Energy Efficiency (DSEE) Assessment: market potential, business model, financial mechanism, and policy interventions**
- Energy Efficiency & Renewable Energy potential Investments



Approach for Market sizing for DSEE Potential

A combination of secondary research and consultations are carried out to estimate the technical potential, on which the effect of market factors will be evaluated to calculate the Addressable Market Potential



Targeted GMS Countries: Country Context

EE Potential (2021-2030)



Cambodia

- ❖ 12.2 TWh (1.5 Mtoe)
- ❖ 1.4 Bn USD of Investments
- ❖ 6.5 MtCO2 GHG Reduction
- ❖ 4.6 KgCO2 per USD

Population: 16.48 million (2019)
 GDP: USD 20.92 Bn (2019)
 GDP per Capita : USD 1,268 (2019)
 GDP Growth : 7.14% (2013-2018)

TFEC: 6.35 Mtoe (2016)
 Growth (CAGR) in TFEC: 5.71% (2000-2016)
 Installed Capacity: 2755 MW (2019)
 Domestic Elec. Cons: 8210 GWh (2018)
 Compounded Annual Growth Rate (CAGR) in Elec. Cons: **19.05%** (2010-2018)

- ❑ **93% access to electricity**
- ❑ **High dependence on hydro resource (48%) for electricity generation**
- ❑ **Increasing energy demand to be met from imports**
- ❑ **Higher electricity tariffs in S.E Asia**

EE Potential (2021-2030)



Myanmar

- ❖ 11.2 TWh (1 Mtoe)
- ❖ 1.3 Bn USD of Investments
- ❖ 3.4 MtCO2 GHG Reduction
- ❖ 2.6 KgCO2 per USD

Population: 54 million (2018)
 GDP: USD 76 Bn (2018)
 GDP per Capita : USD 1,573 (2018)
 GDP Growth : 6.8% (2013-2018)

TFEC: 15.3 Mtoe (2016)
 CAGR in TFEC: 3% (2000-2016)
 Installed Capacity: 5642 MW
 Domestic Elec. Cons: 19,535 GWh (2019)
 CAGR in Dom Elec. Cons: **8.51%** (2010-2019)

- ❑ **50% household electricity rate (2019)**
- ❑ **Dependence on hydro resource (57%) for electricity generation**
- ❑ **Peak shortages during peak dry season**
- ❑ **Use of DGs in industries due to unreliable power supply**
- ❑ **90% of oil demand is met from imports**
- ❑ **Low electricity tariff in S.E Asia**

EE Potential (2021-2030)



Lao PDR

- ❖ 7 TWh (0.6 Mtoe)
- ❖ 543 mn USD of Investments
- ❖ 2 MtCO2 GHG Reduction
- ❖ 3.7 KgCO2 per USD

Population: 7 million (2018)
 GDP: USD 18 Bn (2018)
 GDP per Capita : USD 2,585 (2018)
 GDP Growth : 7.2% (2013-2018)

TFEC: 2.5 Mtoe (2016)
 CAGR in TFEC: 3% (2000-2016)
 Installed Capacity: 7500 MW (78% is exported)
 Domestic Elec. Cons: 5,416 GWh (2018)
 CAGR in Dom Elec. Cons: **9.25%** (2010-2018)

- ❑ **95% household electricity rate (2020)**
- ❑ **High dependence on hydro resource (70%) for electricity generation**
- ❑ **Peak shortages during peak dry season which is met through import**
- ❑ **100% of oil demand is met from imports**
- ❑ **Lowest electricity tariff in S.E Asia**



Sectorial EE Potential in the Targeted GMS Countries



Sectorial Contribution to EE Potential & Investments breakup in GMS Countries

Sectors	EE Potential	Investments	EE Potential	Investments	EE Potential	Investments
 Industry*	7.7 TWh	235 mn USD	4.2 TWh	179 mn USD	2.69 TWh	138 mn USD
 Transport *	1.3 TWh	8.24 mn USD	3.3 TWh	8.8 mn USD	2.9 TWh	5 mn USD
 Commercial Buildings	1.94 TWh	135 mn USD	3.1 TWh	365 mn USD	374 GWh	44 mn USD
 Residential Buildings	1.05 TWh	993 mn USD	529 GWh	750 mn USD	538 GWh	333 mn USD
 Public Buildings	0.18 TWh	17 mn USD	-	-	146 GWh	17 mn USD
 Public Service	13.82 GWh*	3.34 mn USD	68 GWh	16 mn USD	30 GWh	6.4 mn USD

*Transport savings represents thermal savings. Industries includes thermal and electrical savings while the savings in rest of the sectors (buildings and public service) represents electrical savings.



Methodology for the EE Potential Analysis

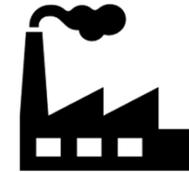
A 10 year timeline from 2021-2030 was considered for the analysis; Both Bottoms-up & Top-down models were created for the end use sectors and their outcomes were aggregated at the national level

To assess the potential of DSEE interventions, two scenarios were created

- Business as Usual (BAU) scenario – low/no Energy Efficiency (EE) interventions during the modelling period
- Energy Efficiency(EE) Reference scenario – EE interventions with moderate EE targets



DSEE Interventions in Industries



Sub-Sectors Considered*



Brick



Argo-processing



Cement



Textile, Footwear & Garments



Paper & Pulp



Iron & Steel

**The sub-sectors selection varies for different countries based on their value to respective GDP and energy consumption.*

EE Technologies*



Variable Speed Drives



EE Compressors



Pumps & Motors



LED Lamp & Luminaire



HVAC Systems

- Waste Heat Recovery Systems
- Boilers
- Use of alternative fuels such as diesel to LPG in dryers in Rubber factories

**Only few cross-sectoral technologies are provided here. The complete technologies and their applicability within industries are given in country specific slides in the annexures.*

**Images are shown only for representation purposes*



DSEE Interventions in Buildings



Commercial and Public Buildings

EE Technologies



LED Lamp & Luminaire



HVAC Systems



Residential Buildings

EE Technologies*



LED Lamp & Luminaire



Refrigerators



ACs

For Cambodia, more home appliances such as Washing Machines, Fans etc. are considered to estimate the EE potential.

**Images are shown only for representation purposes*



DSEE Interventions in Public Services and Transport

Public Service



EE Technologies

Replacement of Existing Streetlighting Stock



Water Pumping*



**Only for Cambodia municipal water pumping is considered in the EE potential from public services.*

Transport



EE Interventions

Installation of EV Public Chargers to promote transition from Internal Combustion Engine (ICE) vehicles to EVs



Introduction of Corporate Average Fuel Economy (CAFÉ) Norms for new ICE vehicles from 2028 onwards

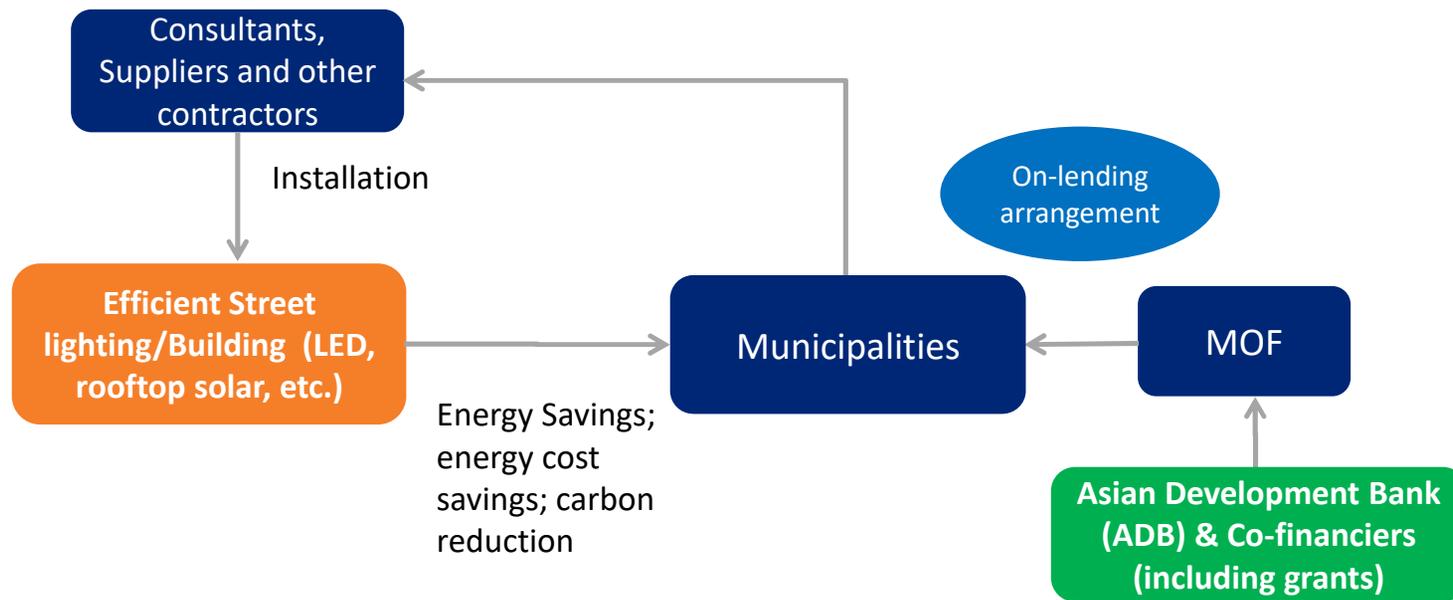


26% improvement in fuel efficiency of ICE vehicles





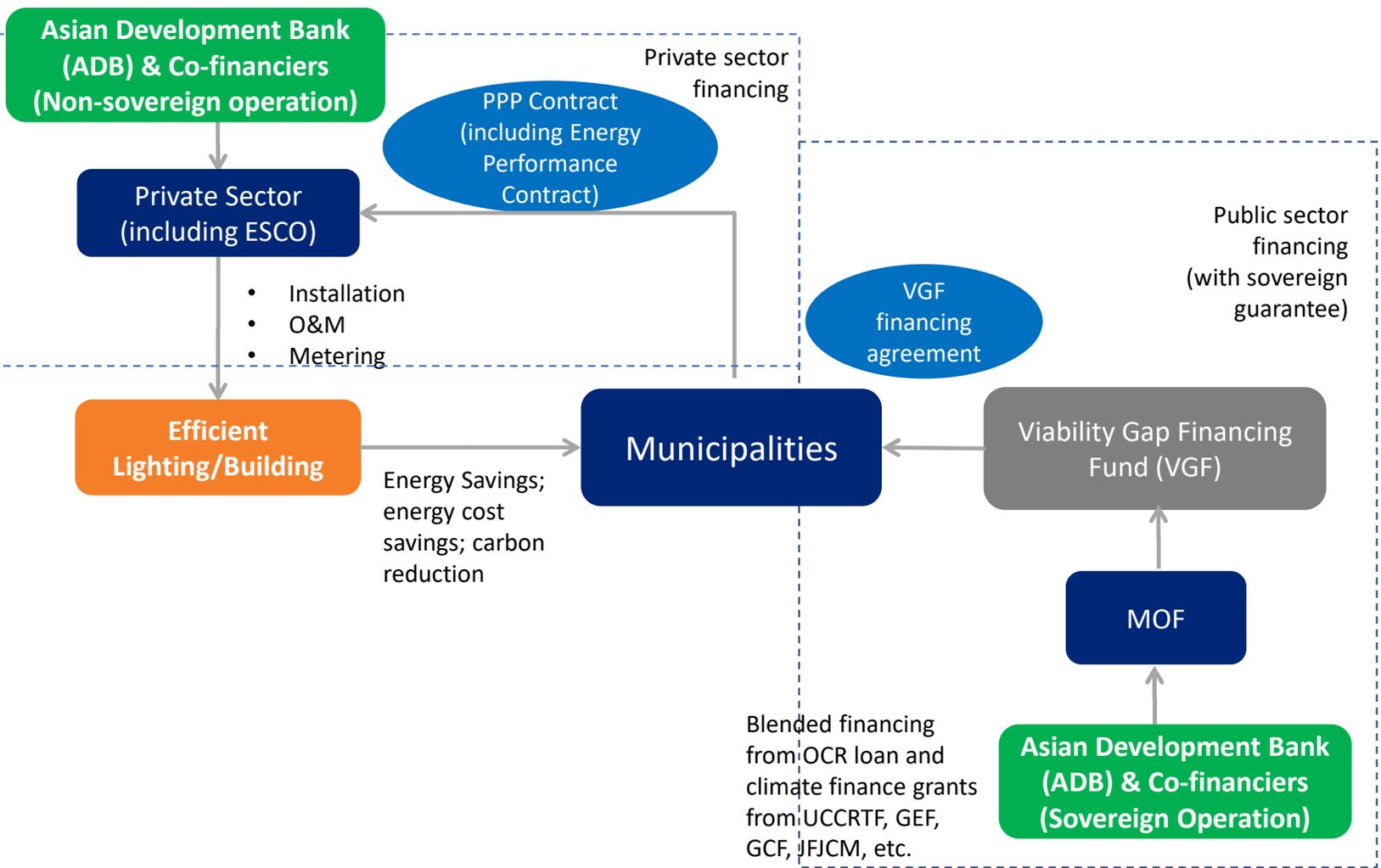
Possible business model/financing mechanism I – Public direct financing through municipalities



Blended financing from OCR loan and climate finance grants from UCCRTF, GEF, GCF, JFJCM, etc.

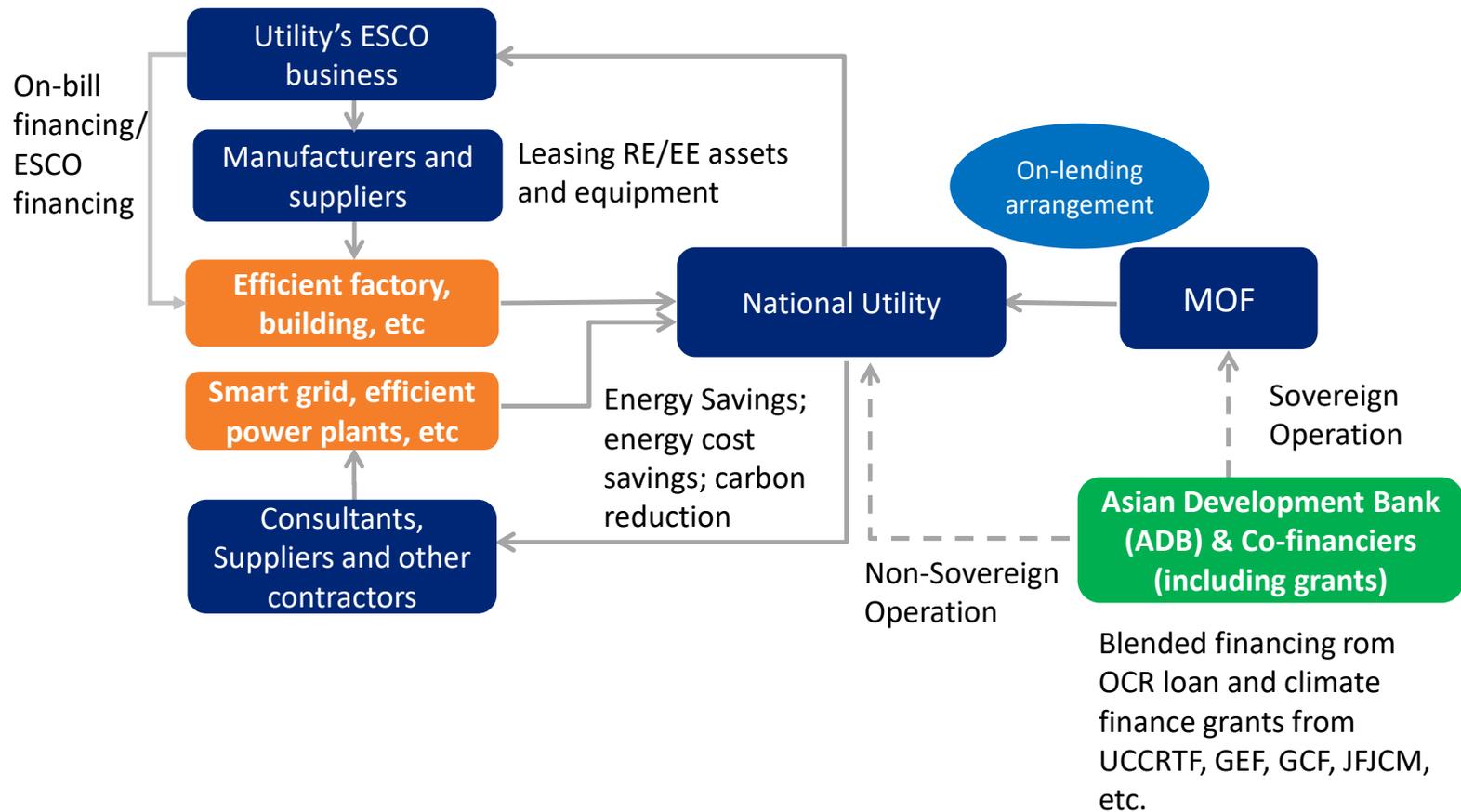


Possible business model/financing mechanism II – Public and Private Partnership (PPP)



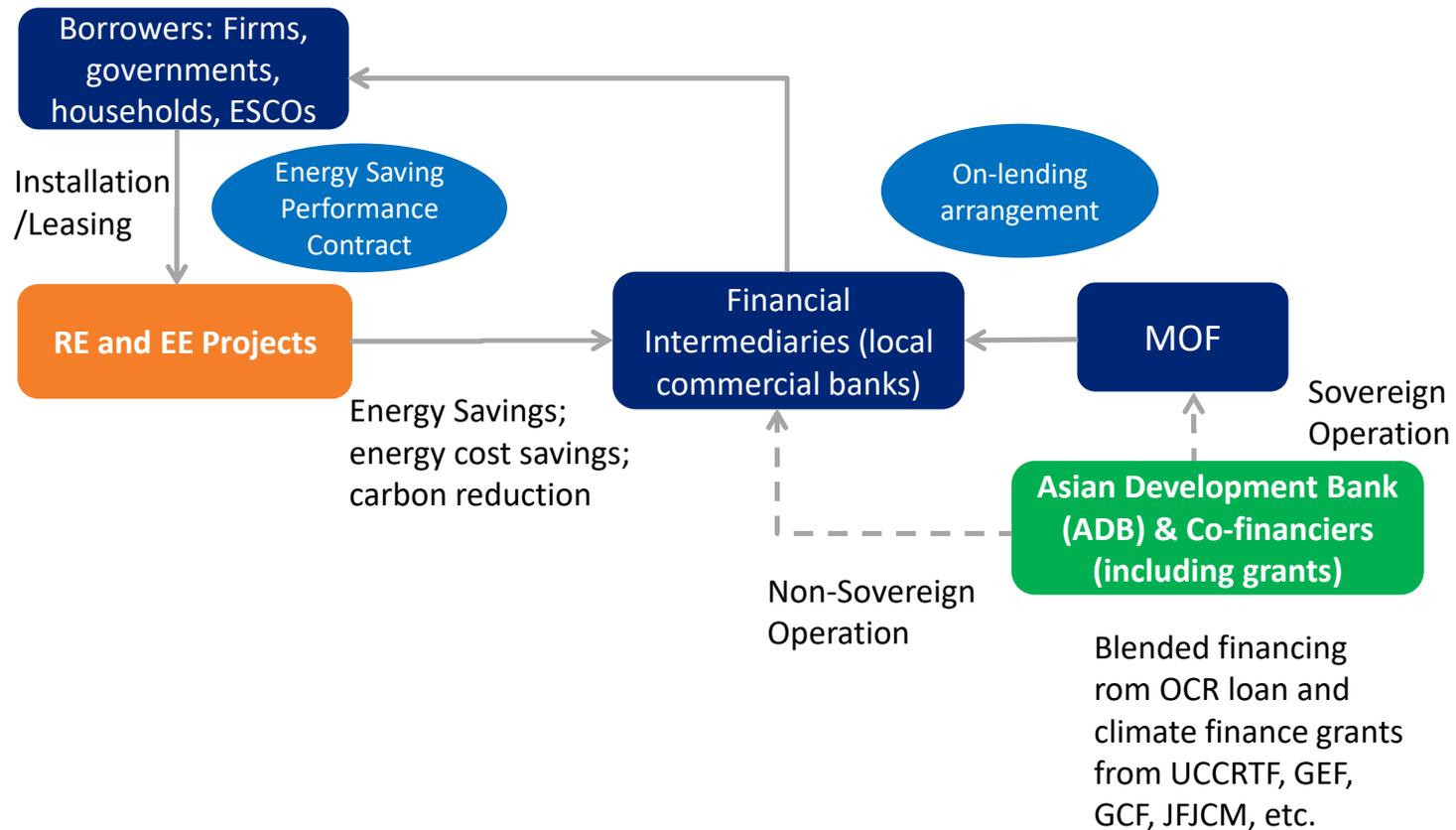


Possible business model/financing mechanism III – National utility EE and DR services (Energy as a Service)



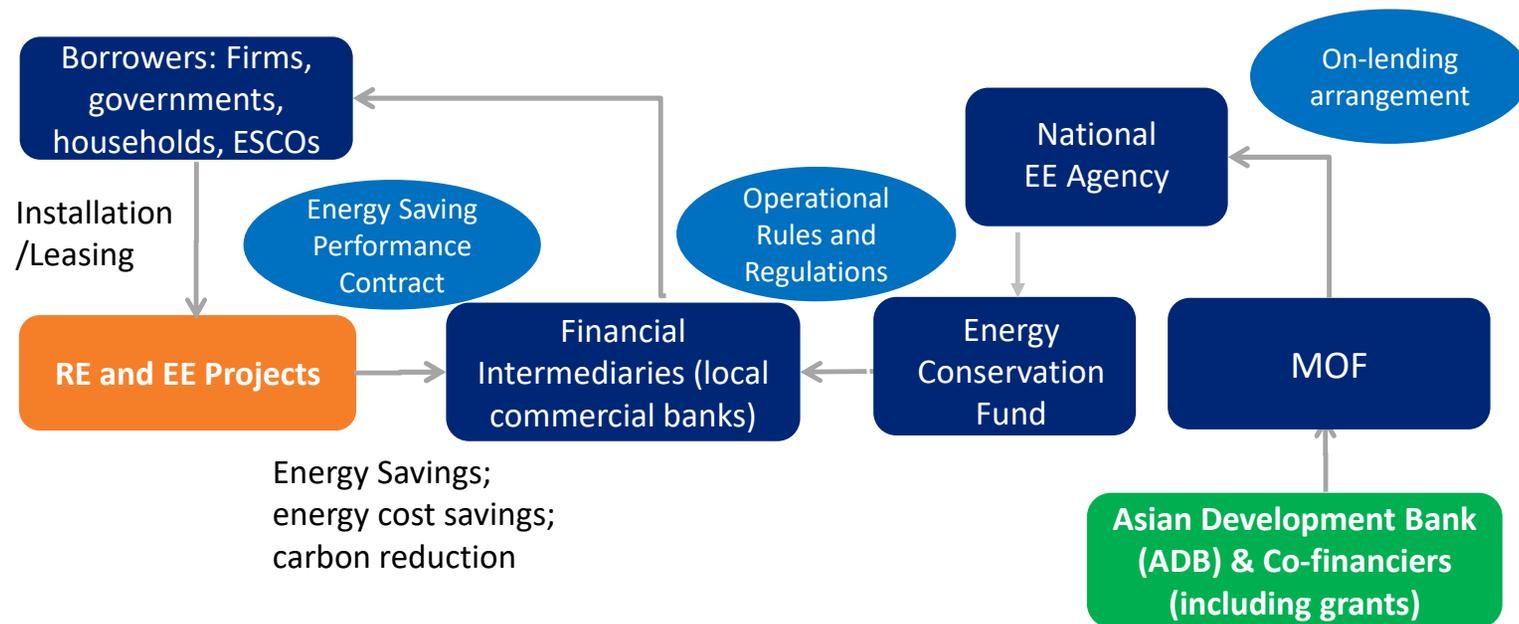


Possible business model/financing mechanism IV – Financing through financial Intermediary institutions





Possible business model/financing mechanism V - Energy Conservation Fund financing



Blended financing from OCR loan and climate finance grants from UCCRTF, GEF, GCF, JFJCM, etc.

EE Potential in Cambodia (2021-2030)

Industries

- 7.75 TWh of Energy Savings
- 235 million USD investments

Commercial Buildings

- 1.94 TWh of Energy Savings
- 135 million USD investments*

Transport (Road)

- 1.3 TWh (0.1 Mtoe) of Energy Savings
- 8.24 million USD investments

Residential Buildings

- 1.05 TWh of Energy Savings
- 993 million USD investments*

Public Buildings

- 0.18 TWh of Energy Savings
- 17 million USD investments*

Public Service (Streetlighting + MWP)

- 13.82 GWh of Energy Savings
- 3.34 million USD investments



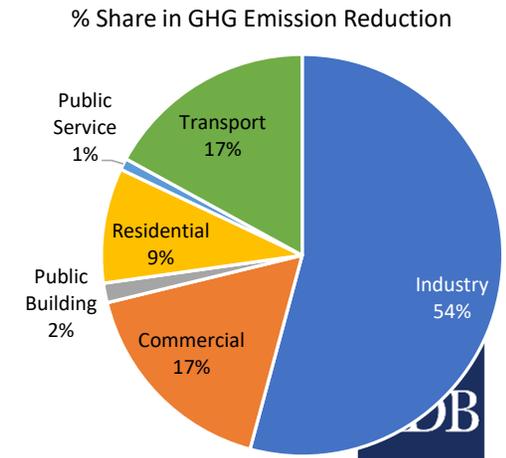
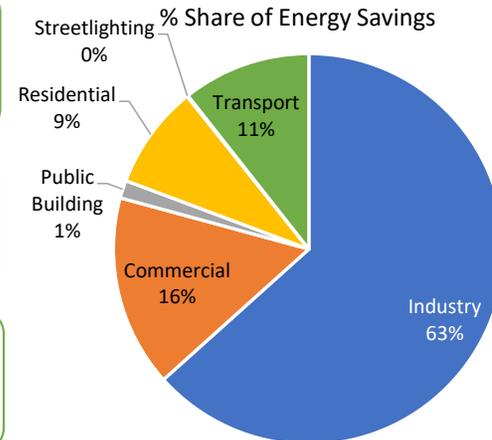
Total Energy Savings Potential of ~12.2 TWh (1.1 Mtoe)



Total Investment of ~1.4Bn USD is required



GHG Emission Reduction Potential of ~ 6.5 MtCO2



*Investments for commercial & residential buildings represents Incremental price of EE Appliances

*Transport savings represents thermal savings. Industries includes thermal and electrical savings while the savings in rest of the sectors (buildings and public service) represents electrical savings.



Assessment of EE&C Ecosystem in Cambodia

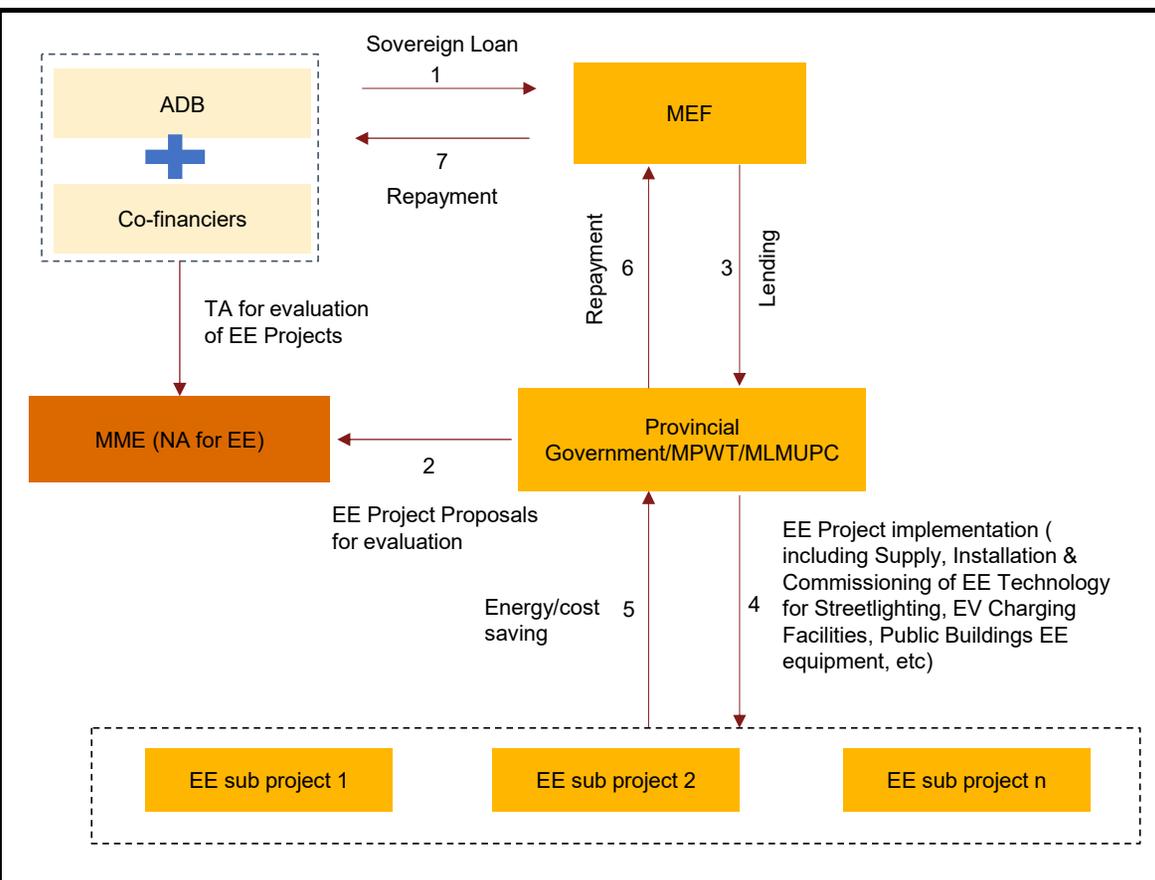
Parameters	Cambodia Context
EE&C Policy & Regulations	At present, there are no policy or regulatory frameworks for EE&C. The National Energy Efficiency Policy and S&L for air-conditioners and refrigerators are being developed with ADB support.
Past EE implementations	<ul style="list-style-type: none"> Both government agencies and private sector such as ESCOs have carried out EE projects in Cambodia. The government agencies were supported by development institutions. Commercial Banks have participated in financing EE projects in the past with support from gov. agencies and IDAs
ESCOs	At present there are few ESCOs implementing EE projects in Cambodia. However, there is no regulatory framework to empanel ESCOs and regulate 'Energy Performance Contracting'. Also, the existing ESCOs lack capacity to implement large-scale EE projects involving bulk procurement
Energy Price	The energy price (electricity tariff) in Cambodia is highest in the S.E Asia Thus, a major driver for private sector participation owing to commercial viability of demand side EE projects.
Institutional Capacity	<ul style="list-style-type: none"> MME is the nodal agency for EE&C in Cambodia Gov. agencies such as MME have previously carried out EE projects in Industries and commercial sectors with support from development partners. The National Bank of Cambodia has been directing local financial institution to develop polices for green financing and investments

In view of the above assessment, it can be concluded that sovereign based lending to appropriate gov. agencies along with involvement of local financial institutions is a feasible business model for large scale deployment of demand side EE interventions in the demand sectors in Cambodia.



Financial Mechanism I: Sovereign Lending for Public EE Projects

For EE Technology Uptake in Public Services and Public Buildings

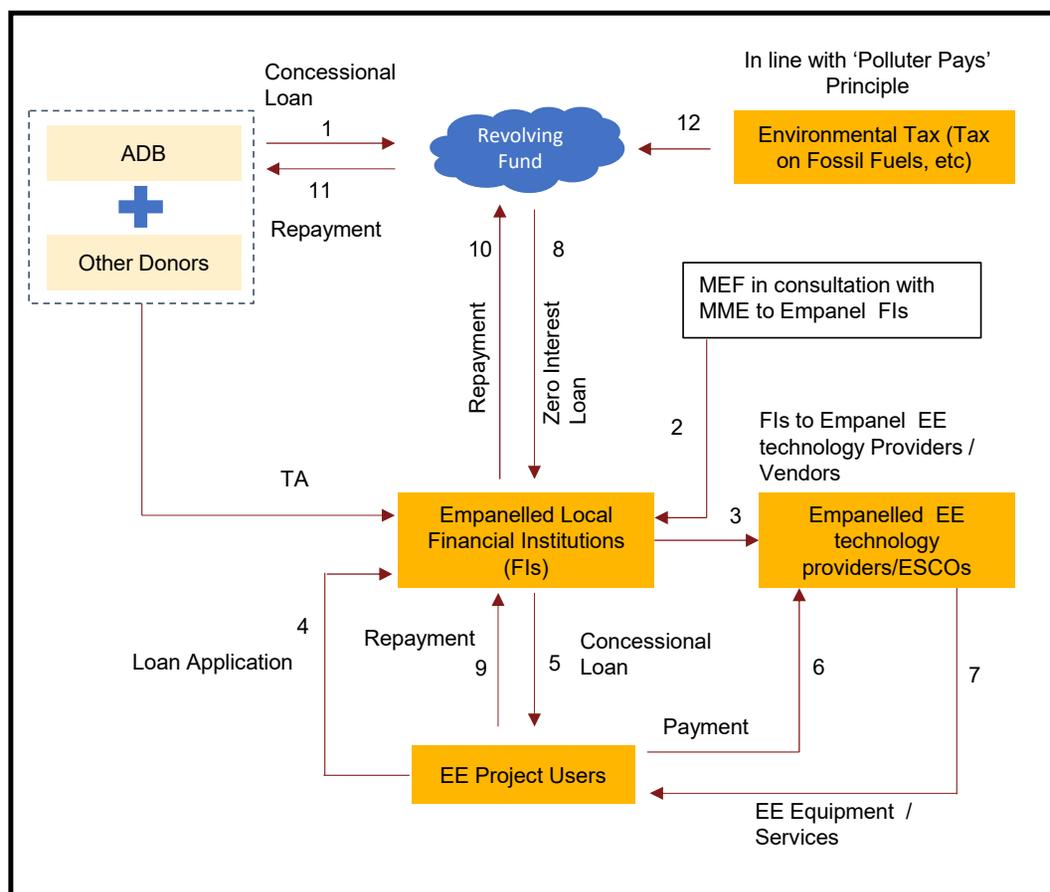


- Development Institutions and other co-financiers offer sovereign lending to government to finance public EE projects in the country - Public Streetlighting, Public Buildings, Municipal Wastewater pumping, EV Charging facilities, etc.
- The nodal agency for EE appraise EE projects of the provincial governments
- Upon EE project/sub-project approval funds are disbursed to provincial government for procurement of EE Services (tendering for EE procurement, selection of vendors and supervision of EE installation and commissioning).
- Provincial government shall select the EE Service providers through competitive bidding for the procurement of EE services.
- Provincial governments repay the loan based on energy cost savings which is further repaid to the development institutions and co-financiers.



Financial Mechanism II: EE Revolving Fund with Concessional Loan

For EE Technology Uptake in Industries, Commercial Buildings and Households

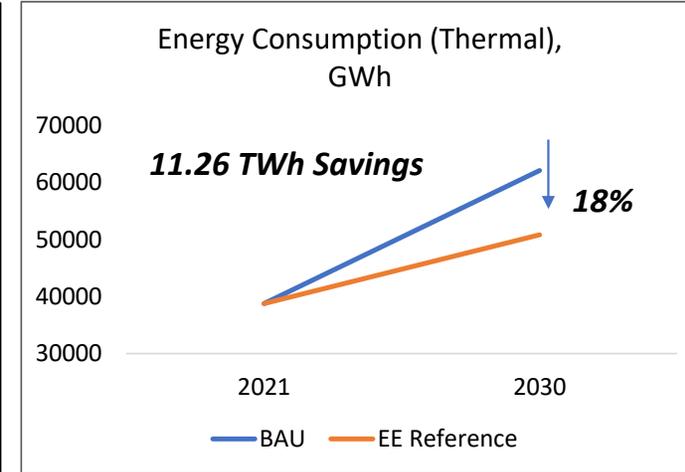
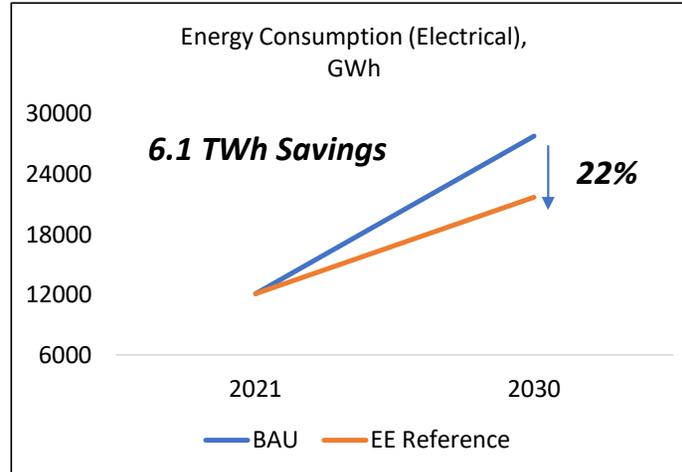
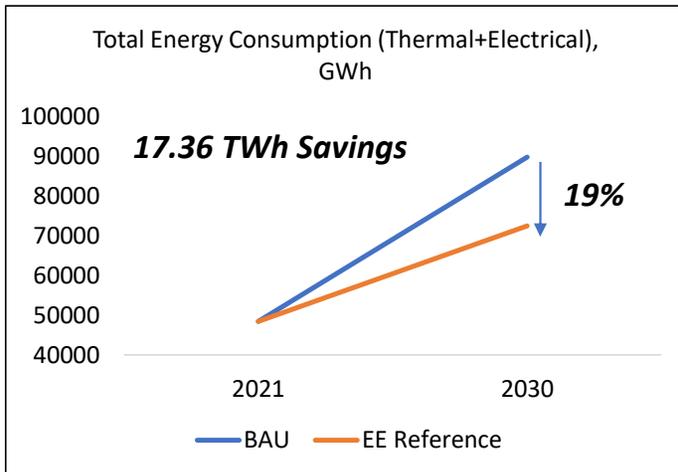


- Fund is established by the MME/MEF to finance EE technology uptake in the country
- MEF and MME empanel banks/FIs for the EE revolving fund programme
- FIs empanel EE technology providers by conducting due diligence
- Empanelled banks/FIs lend to EE projects proponents at concessional interest rates. The loan can also be accessed by retail bank account holders to finance EE technology. List of EE equipment with its specifications for programme eligibility is to be maintained by Nodal Agency
- Revolving fund provides low interest loans to empanelled banks/FIs, who are expected to pass on the lower interest rates to the concerned borrowers
- Loan approval criteria and requirements are designed by FIs / banks for each of the client categories
- The repayments and environmental tax are used to replenish the EE revolving fund
- Risk sharing facility can be provided by IDAs to FIs to make EE Lending more attractive



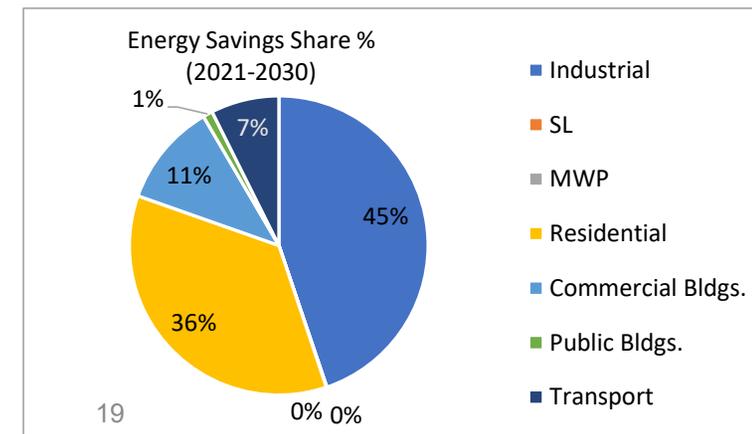
National level Summary: EE Reference Scenario

Sectors include – Industries, Residential, Commercial & Public Buildings, Public Services (Street Lighting, Municipal Wastewater Pumping) & Transport



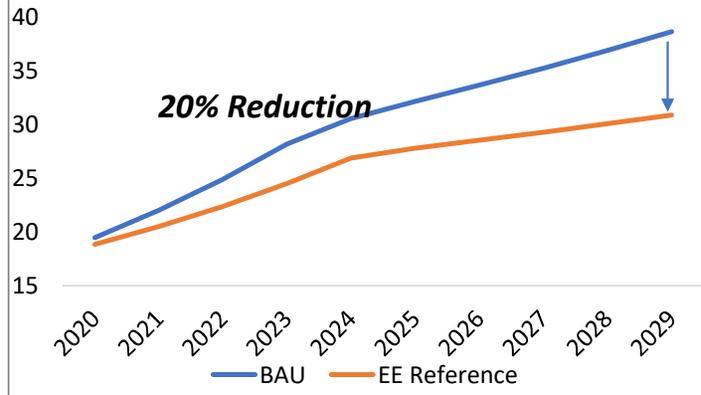
Investments to Realize EE Reference Scenario Potential (EE SC 01)

Investments (Million USD) (2021 – 2030)	Industries	Comm Bldgs.	Households	Public Bldgs.	Street Lights (Retrofit)	Waste water pumping	Transport
Electrical	164	135	993	17	3.2	0.11	8.24
Thermal	71	NA	90	NA	NA	NA	

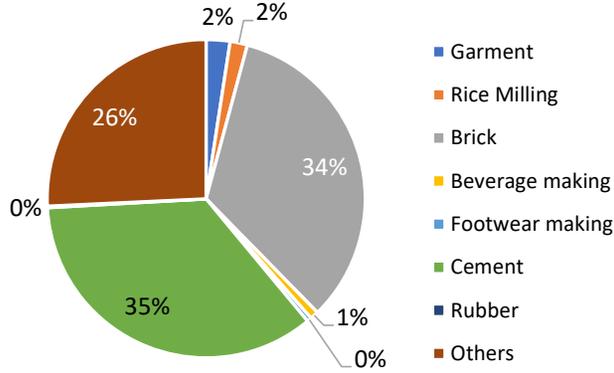


DSEE in Industrial Sector: Findings

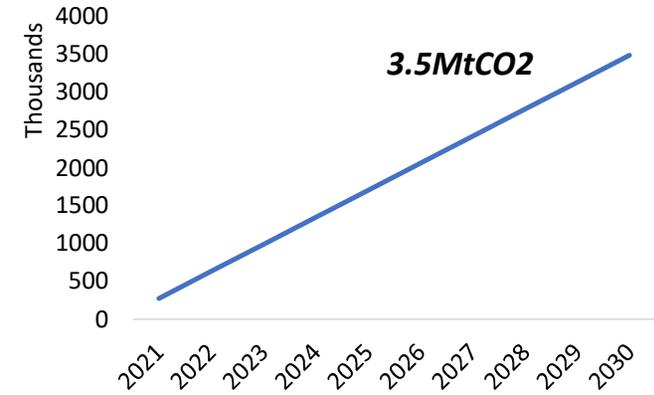
Energy Consumption, GWh, (2021-2030)



% Share in cumulative savings (2021 - 2030)



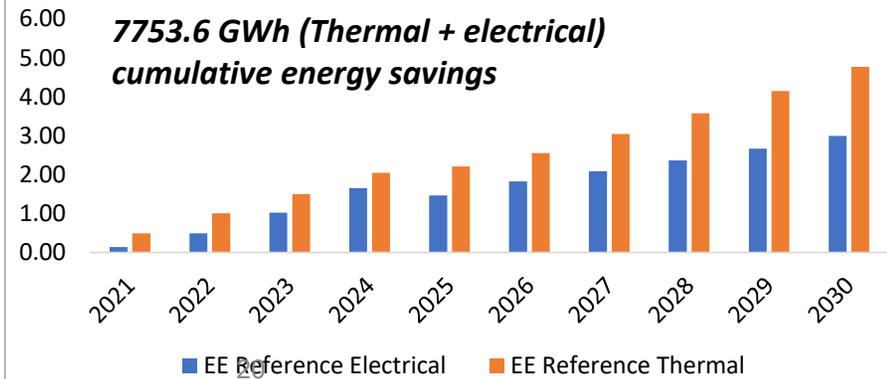
Cumulative GHG savings, tCO2 (2021-30)



Cumulative Figures (2021-30)

Industrial Sub-sectors	Cumulative Energy Savings (GWh)	Total Investment (Million USD)
Garment	112.7	6.48
Rice Milling	93.8	14.49
Brick	1,771.8	5.06
Beverage making	43.7	3.23
Footwear making	23.5	5.94
Cement	1,564.9	96.49
Rubber	6.9	0.55
Others	4,136.3	102.31
Total	7,753.6	234.54

Cumulative Energy Savings (TWh) - Thermal & Electrical (2021-2030)





Industrial Sub-sectors & DSEE Technologies in Cambodia

Interventions considered included both cross cutting interventions and sector specific interventions

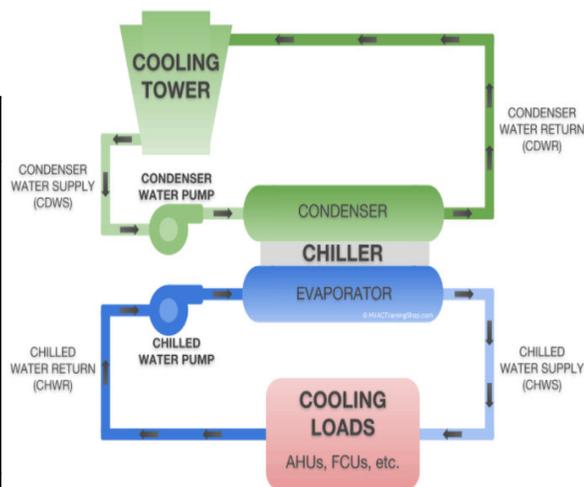
Textile (CMP)/Wearing apparel	Footwear	Rice Milling	Beverage
<ul style="list-style-type: none">• Replacement of air compressor with VSD• Replace the old fans with new fans in the ventilation system• Upgrading the lighting systems from old lights to LED based lights• Clutch motor replacement with Servo Motor• Replacement of old boiler with EE boiler	<ul style="list-style-type: none">• Upgrading the lighting systems from old lights to LED based lights• Install VFD on driving motors• Replacement of non VSD based air compressors with VSD based air compressors• Replacement of old ventilation fans with EE ventilation fans• Replacement of non inverter based AC with inverter based AC• Energy Efficient Oven	<ul style="list-style-type: none">• Replacement of conventional dehusking machine with EE dehusking machine• Replacement of conventional whitening machine with energy efficient whitening machine• Replacement of old air compressors with VSD based air compressors• Upgrading the lighting systems from old lights to LED based lights• Installation of VSD on motors• EE Dryer	<ul style="list-style-type: none">• Upgrading the lighting systems from old lights to LED based lights• Installation of VSD for large sized motors• Replacement of old compressors with EE compressors• Replacement of old chiller with EE chiller/AC• Replacement of present boiler with energy efficient boiler of same fuel type• Replacement of old fan with EE Ventilation fan
Rubber	Cement	Brick	
<ul style="list-style-type: none">• Installation of VSD in motors• Upgrading the lighting systems from old lights to LED based lights• Improvement in insulation of dryers• Replacement of old pumps with EE submersible pumps• Substitute diesel fuel/HFO with LPG in the dryer	<ul style="list-style-type: none">• Installation of VFD for preheater Fan• Adjustable speed drive for kiln fan• Use of alternative fuels• Replacing ball mill with vertical roller mill• Installation of Waste Heat Recovery Systems (WHRS)	<ul style="list-style-type: none">• Installation of VSD on the chimney fan• Replacement of diesel operated brick molding equipment with automatic molding equipment (electricity based)• Upgrading the lighting systems from old lights to LED based lights• Replacement of present mold with thinner molds for brick making• Replacement of Boat/elephant kiln with rotary/hoffman kiln	



DSEE in Commercial & Public Buildings: Interventions Considered

These include increased penetration of energy efficient Split Air Conditioners, Centralized AC Systems & LED Lighting

Scenarios Consideration	
BAU	The scenario represents with no transition towards energy efficiency.
	The average national energy performance levels of AC or Lighting Equipment remain constant between 2021 to 2030.
EE Reference	The scenario represents moderate EE targets. The average national energy performance levels of ACs and Lighting Equipment improves to a considerable level between 2021 to 2030.



Schematic of Centralised HVAC plant



Chiller (for centralised AC plant)



Split AC

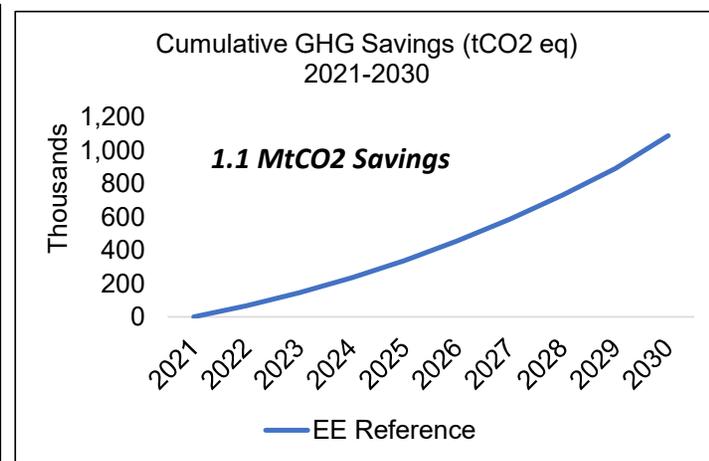
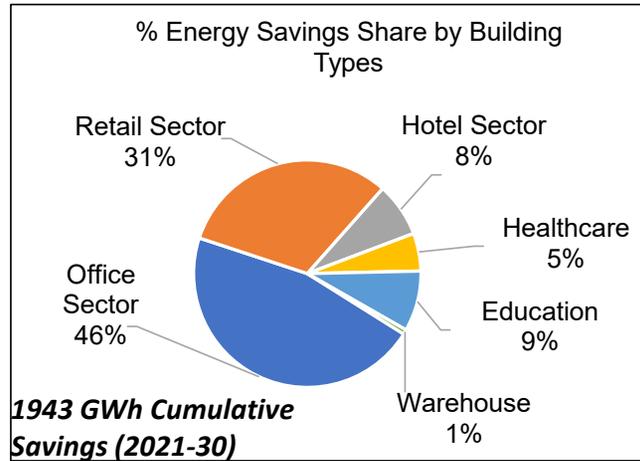
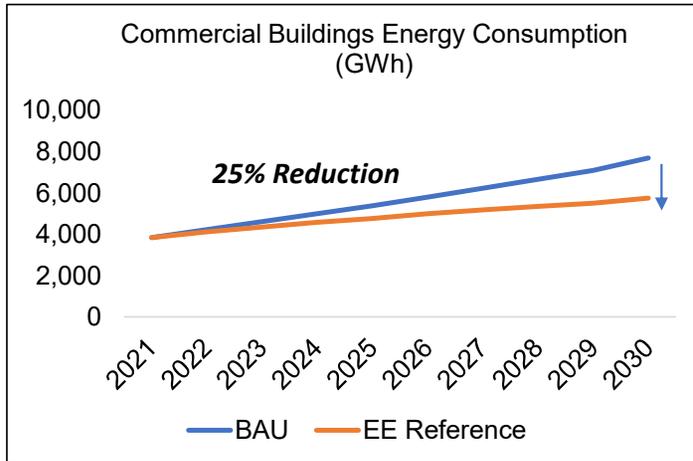


LED Lamp & Luminaire





DSEE in Commercial Buildings: EE Interventions in Centralized HVAC, Split AC & Lighting Systems (Findings)



EE Appliances / Equipment	Investment Type	Investments in Million USD	Energy Savings (GWh)	Electricity Cost Savings (Million USD)	Pay Back
	Type A or B	2021 - 30	2021 - 30	2021-30	Years
Centralized AC	Type A Investments at Incremental price of EE Equipment	10.69	116.58	18.65	< 1 year
Split AC		100.12	1379.53	220.72	< 1 year
Lighting		23.94	446.89	71.50	< 1 year
Centralized AC	Type B Investments at Total Price of EE Equipment	117.56	116.58	18.65	6 to 7 years
Split AC		1101.38	1379.53	220.72	4 to 5 years
Lighting		107.13	446.89	71.50	1 to 2 years

Cumulative Energy Savings Share (2021 – 2030) by Appliance Interventions:

- EE Split ACs with savings share of 71%
- EE Lighting with savings share of 23%
- EE Centralized ACs with savings share of 6%



DSEE in Residential Sector: DSEE Interventions Considered

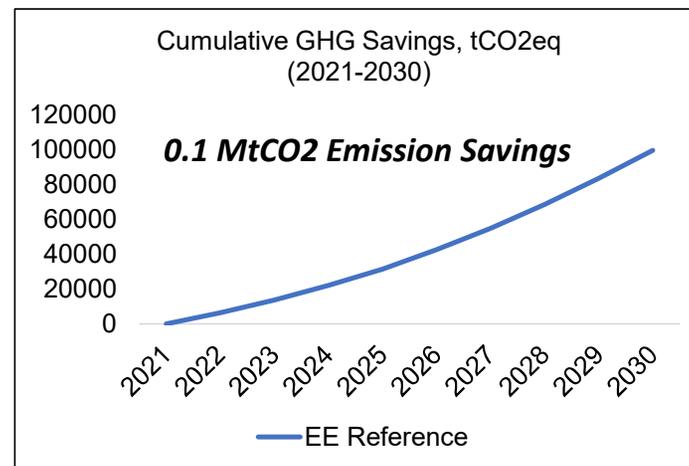
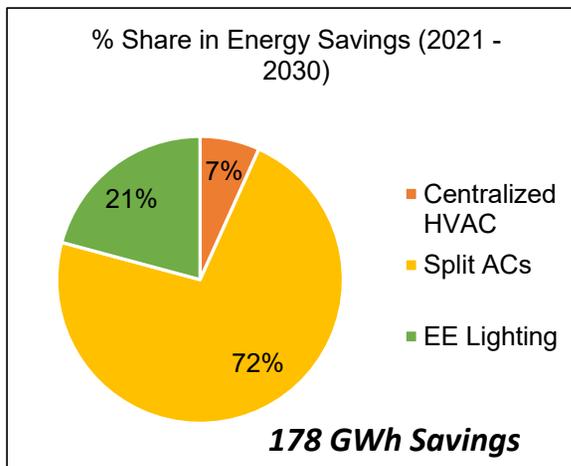
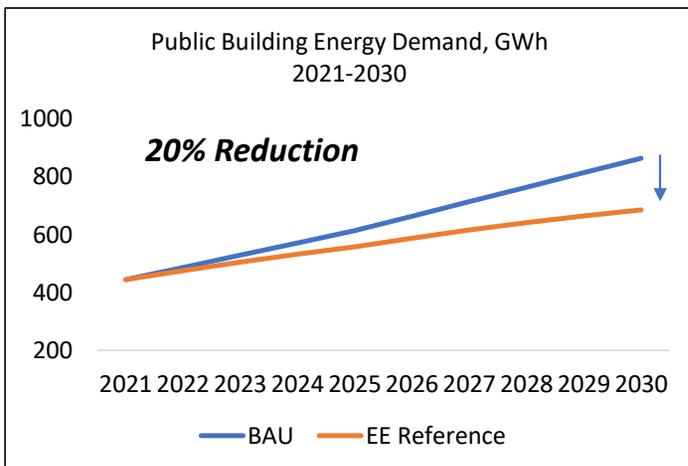
These include increased penetration of energy efficient household electrical appliances and cookstoves

- The energy efficiency in the residential sector was considered on account of DSEE policy interventions and market mechanisms that shall result in increased uptake of energy efficient appliances in future.
- The following are the appliance categories showing good potential for energy efficiency:
 - Air Conditioners
 - Refrigerators
 - Lighting
 - Comfort Fans
 - Rice Cookers
 - Water Pumps
 - Cookstoves





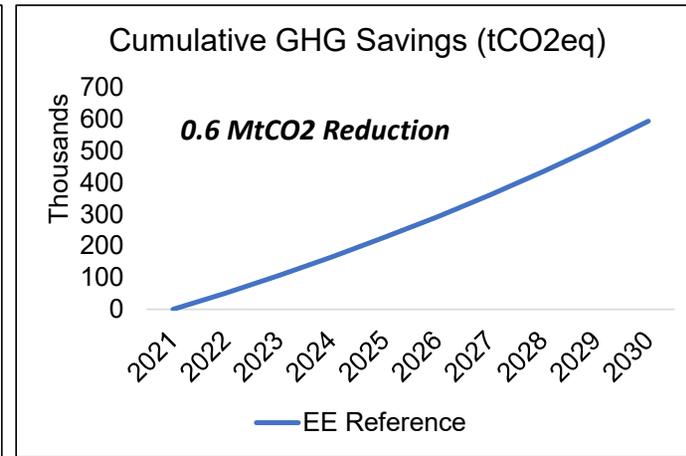
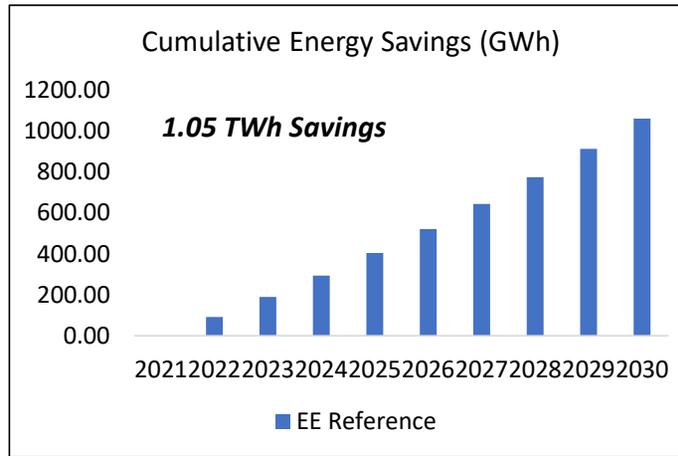
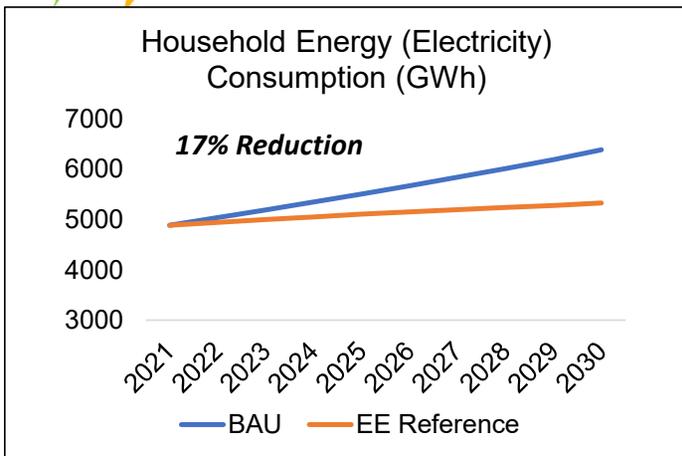
DSEE in Public Buildings: EE Interventions for Centralized HVAC, Split AC & Lighting Systems (Findings)



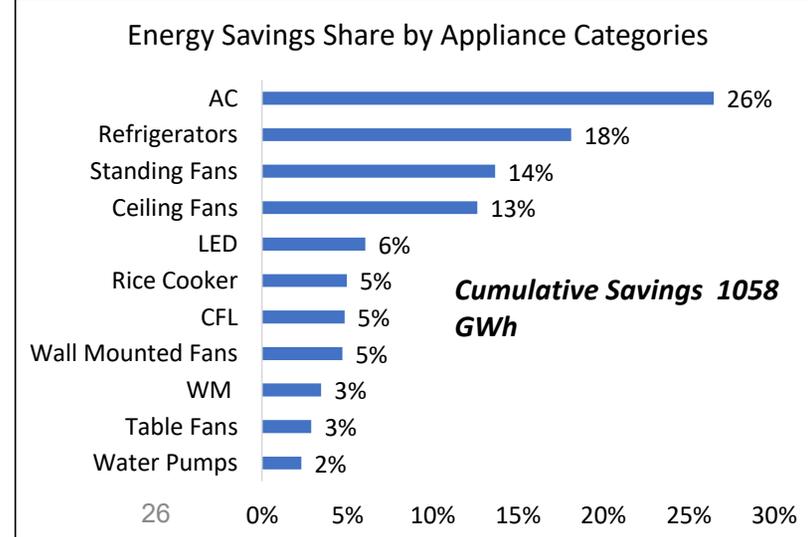
EE Appliances / Equipment	Investment Type	Investments (Million USD)	Energy Savings (GWh)	Electricity Cost Savings (Million USD)	Pay Back
	Type A or Type B	2021 - 2030	2021 - 2030	2021 - 2030	Years
Centralized AC	Type A at incremental price of EE Equipment	1.11	11.99	1.92	< 1 year
Split AC		9.14	129	20.64	< 1 year
Lighting		6.63	30.96	4.95	1 to 2 years
Centralized AC	Type B considering total price of EE Equipment	12.27	11.99	1.92	6 to 7 years
Split AC		100.62	129	20.64	4 to 5 years
Lighting		11.42	30.96	4.95	2 to 3 years



DSEE in Household Electrical Appliances: Findings



Appliance	For the period 2021-2030		
	Energy Cost Savings (Million \$)	Type A Investments (Million \$) at Incremental Price	Pay Back (Type A)
CFL	7	16	2 to 3 yrs.
LED	9	79	8 to 9 yrs.
Refrigerators	27	368	13 to 14 yrs.
AC	39	121	2 to 3 yrs.
WM	5	32	5 to 6 yrs.
Ceiling Fans	19	144	7 to 8 yrs.
Wall Mounted Fans	7	17	1 to 2 yrs.
Standing Fans	20	157	7 to 8 yrs.
Table Fans	4	8	1 to 2 yrs.
Rice Cookers	7	24	2 to 3 yrs.
Water Pumps	3	26	7 to 8 yrs.

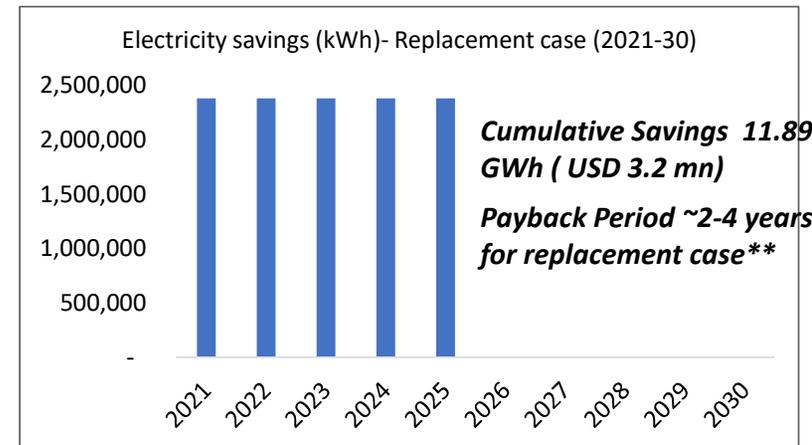




DSEE in Street Lighting – Interventions and Findings

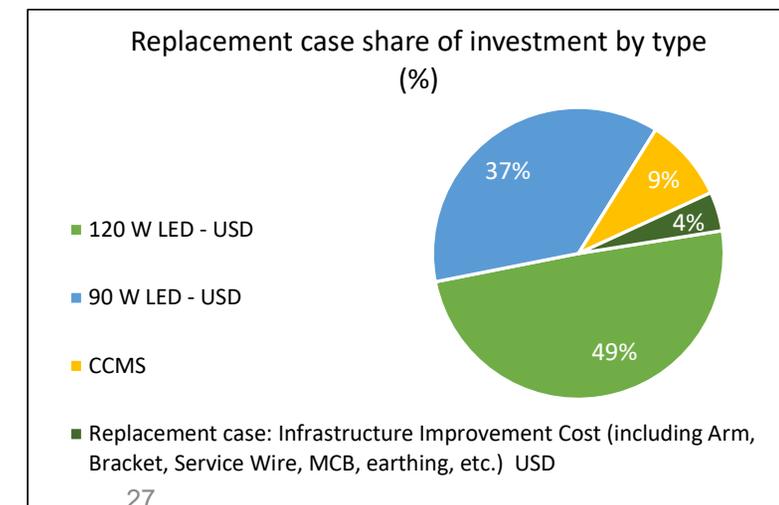
Interventions in the EE reference scenario

- **Replacement case:** Considers replacement of 100% of conventional lamps (HPSV 250W) with 120 W LEDs and 90 W LEDs in a 50:50 ratio, installation of CCMS based electrical cabinets and infrastructure improvement
- **Greenfield installations:** Considers installation of new streetlights (50% of technical potential) including luminaires in wattages ranging from 30 W LEDs to 140 W LEDs, poles, CCMS based electrical cabinets, cables, associated infrastructure and civil works.



Cumulative Investments (Million USD) (2021-30)			
	Replacement Case (BAU and EE Reference scenarios)	Greenfield installations (BAU scenario)	Greenfield installations (EE Reference scenario)
Total	3.2	123.6	206

** Price of electricity considered – USD 0.185/kWh



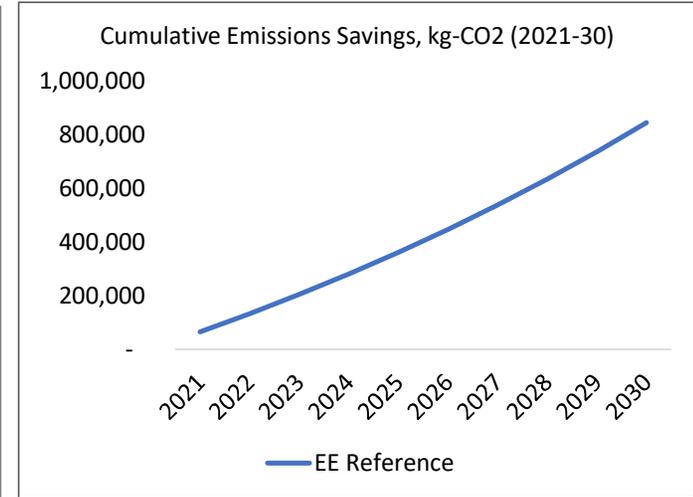
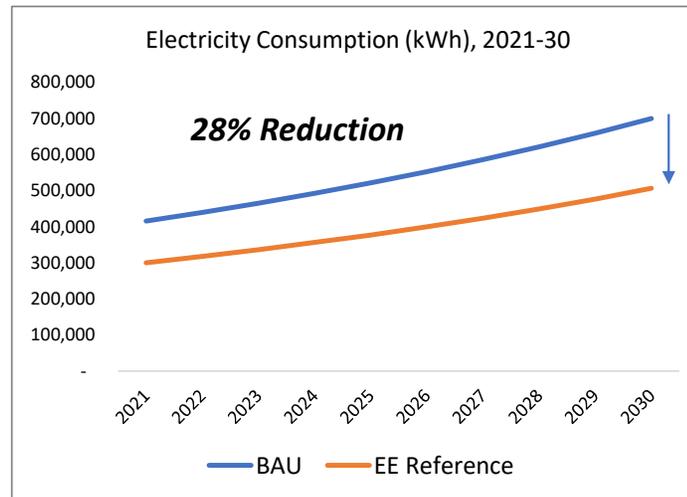


DSEE in Municipal Wastewater Pumping – Interventions and Findings

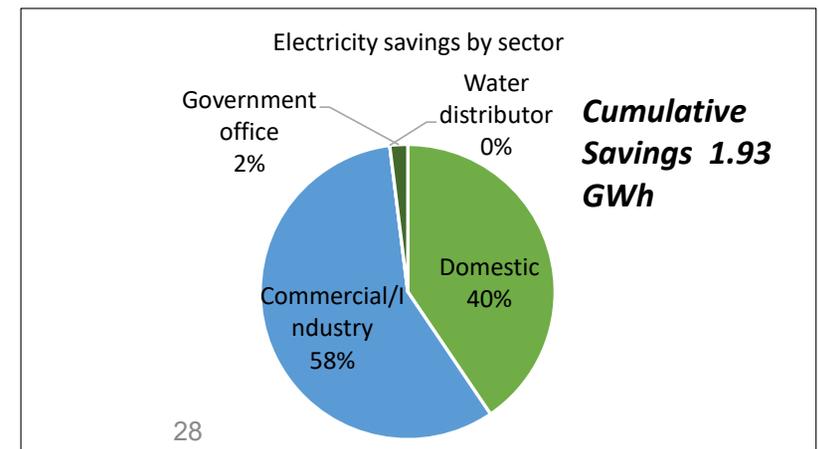
Interventions in the EE reference scenario

The following types of pumps in the wastewater pumping stations are to be replaced with **Energy efficient pumps**

- Horizontal (gate) pumps
- Submersible pumps
- Vertical shaft pumps



Cumulative Values (2021-30)				
Sector	Investment required for pump replacement (USD)	Cumulative Energy Savings (kWh)	Energy Cost savings (USD) considering USD .185/kWh	Payback period (yrs)
TOTAL	110,090	193,823	35,857	3.1



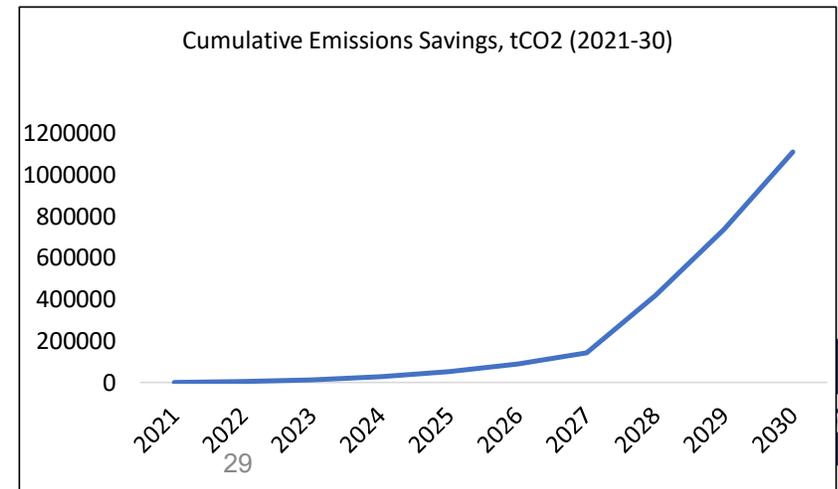
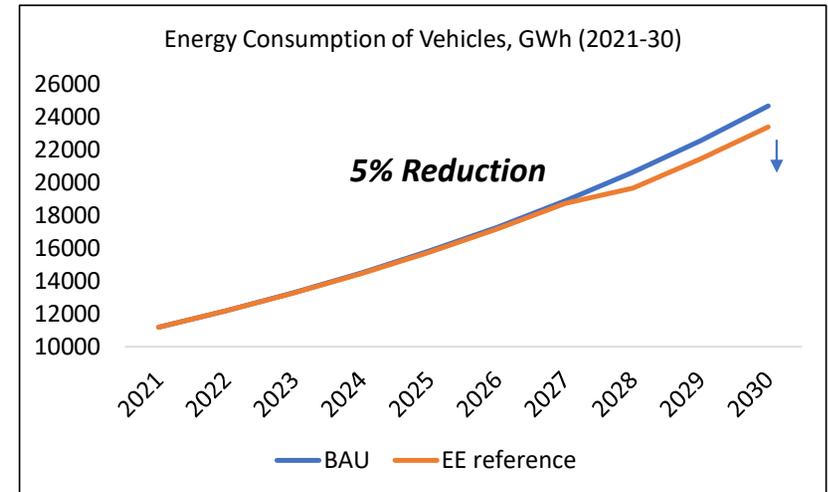


DSEE in Transport: Interventions and Findings

Interventions in the EE reference scenario

- Promoting transition from internal combustion engine (ICE) vehicles towards EVs by the installation of public chargers
- Application of CAFÉ standards on new ICE vehicles sales

Scenario	Investments in Public Chargers (Million USD), 2021-30	Cumulative Energy Sold through charging (kWh)	Revenue (Million USD) assuming charging fee of USD .18/kWh	Payback period (yrs)
EE Reference Scenario	8.24	44,000,000	7.9	1.04





Next Steps

- For Cambodia, based on the findings of this study, ADB is now implementing the feasibility study to prepare the Cambodia EE Sector Development Program Loan to materialize vast opportunities identified in EE, which includes policy and regulatory supports and capital investment from ADB.
- For other two countries, project team will finalize the recommendations on business models and financial mechanisms and submit the report to the GMS countries in next 1-2 months.
- TA 9003 will be closed in December 2021 and all TA reports will be made available on ADB website.
- GMS EE activities will continue to be supported under ADB's new Knowledge Service TA 6744, focused on
 - Drafting and enactment of policies, regulations, and standards on energy efficiency;
 - Design and organization of public procurement programs for more efficient appliances; and
 - Development of new EE project pipeline and business opportunities centered on “energy as a service” for the digital economy.