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MED ENER

RCREEE
Regional Center for Renewable Energy and Energy Efficiency
المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

meetMED
Mitigation Enabling Energy Transition in the MEDiterranean region
Together We Switch to Clean Energy

Energy Efficiency (EE)/Renewable Energy (RE) Projects

Financing and Investment

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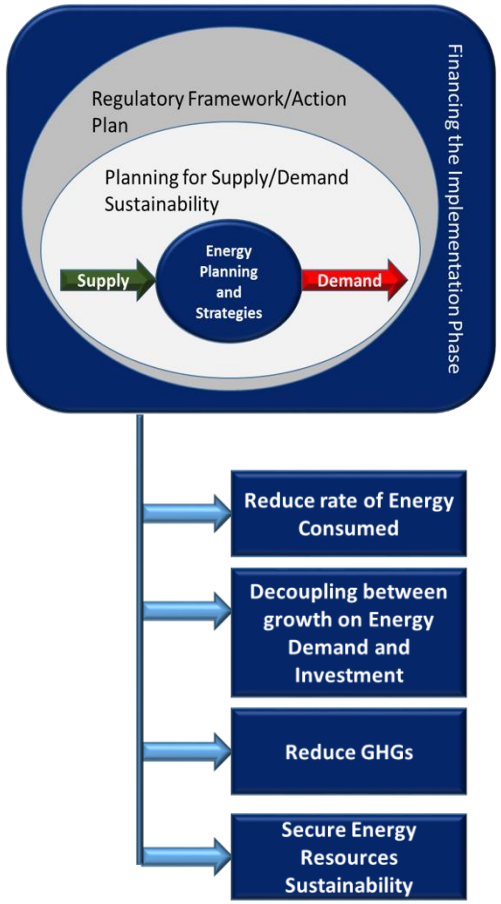
D5.2.2 Training Modules for bank on EE and appliances topics

Training Course Objectives

- To get good knowledge about the EE/RE technologies applied in many activity sectors.
- The Energy Labels for Appliances and Buildings.
- The Awareness regarding the Minimum Energy Performance Standards (MEPS) and the Green Buildings Approach.
- To enable new business venues for the financing industry/business.
- To illustrate the most proven EE/RE Technologies.
- To enable the link between energy sources and Global Climate Change plus impact on Circular Economy and Sustainability.
- To get proper awareness regarding the technical risks linked to the financing risks.
- To innovate the most suitable financing mechanisms for implementation of EE/RE Projects.
- To enable drafting the required regulatory framework/policies/action plans to encourage and secure the implementations of the EE/RE Projects.

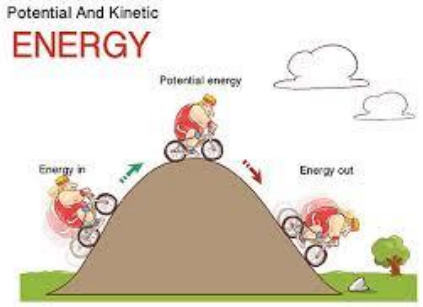
Training Course Content

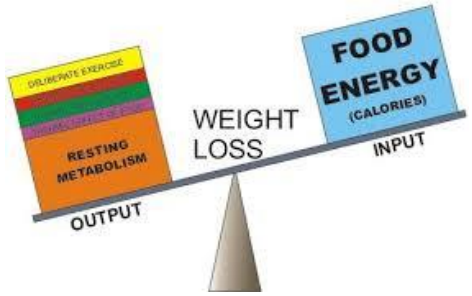


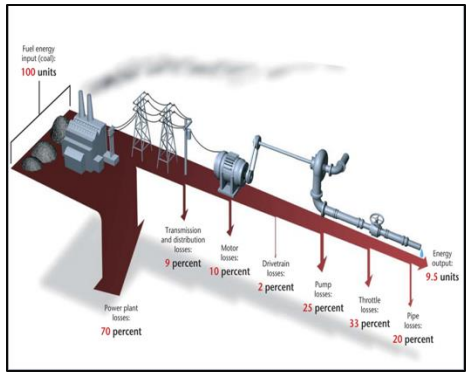
- **This course considers three main modules.**
- Module #1: Energy Concepts and Energy Resources Management regarding:
  - Energy Definitions.
  - Energy utilization and Efficiency.
  - Renewable Energy and Proven Resources.
  - Impact of EE/RE on Greenhouse Gases (GHGs) inventory/load.
  - Simple Calculation Techniques for Savings and Technical Risk Parameters to be mitigated in fund raising phase.
- Module #2: Minimum Energy Performance Standards (MEPS) regarding:
  - The MEPS structuring.
  - The Policies.
  - The benefits towards the planning and progress in upgrading the MEPS.
  - The Best Practices in MEPS.
- Module #3: Best Practices Financing EE/RE Technologies
- Module #4: Investment Grade Audit (IGA) and Risks Mitigation
- Module #5: EE/RE Transaction Technical Risk Assessment and Mitigation
- Module #6: MEPS Design Schemes And Financial Mechanisms
- Module #7: Innovative Financing and Mechanisms - Best Practices
  - EE/RE projects/technologies/programs.
  - The financing resources management in sectoral programs.
  - Risks and Mitigation action to motivate the EE/RE implementations.
- Module #8: EE/RE Technologies in Buildings - (Case Studies)

Session #1

Introduction to EE/RE Concepts and Climate Change Linkages







What is Energy?

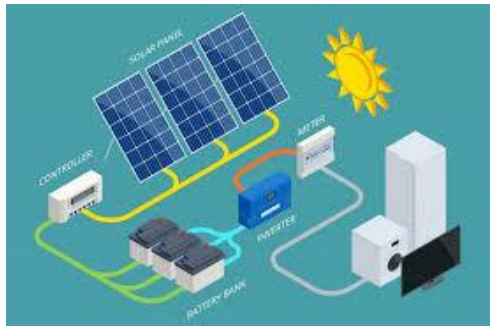
- Energy is the ability to do work.
  - Ability to do work. **Work makes a change**. The Change is like;
    - a Change in position
    - a Change in temperature and/or Pressure
    - a Change in form and state of a matter (Boiling – Melting …..)
- Energy is mainly categorized into;
  - Potential Energy.
  - Kinetic Energy.
- Energy is converted from type to another through the *Energy Conversion Devices*.
- These Energy Conversion Devices do possess certain Efficiency in converting energy from form to another.

$$\eta_{energy\ conversion} = \frac{Device\ Energy\ (output)}{Device\ Energy\ (Input)}$$

Input Energy and Useful Energy Relation

- The relation between the Useful Energy and the Input Energy, is described through several terminologies, all of them relates the Output of a system to its Input;
  - **Efficiency :** is the output divided by the input – and it's a unit less factor less than one expressed as a percentage – e.g. Motors Efficiency is the Out put Mechanical Power in kW divided by the Input electrical power in kW.
  - **Efficacy :** is the output divided by the input – and it is used to measure lamps performance, using the Lumen as the output light power unit and the Watt as the input electrical power – e.g. efficacy of a lamp is 50 lumen per Watt
  - Other terminologies are used to measure the performance of a system, in which the same form of energy is transferred e.g. for Air-conditioning **"COP"** Coefficient of Performance – for Heat exchangers **"Effectiveness"**

Energy Resources and Process of Conversion



Fossil Fuel

Solar

Wind

Geothermal

Primary Energy

Hydro

Wastes

Biofuel

Biomass

Conversion Technology

Thermal (Heating/Cooling)

Final Energy

Electrical

Mechanical

Energy Performance Cycles

- The Energy Performance Cycles are categorized into;
  - Conversion Cycle.
  - Transfer Cycle.
- **Conversion** is when **energy** changes from one form to another – like **in a** hydroelectric dam that converts the kinetic **energy** of water into electrical **energy**. Also, the engine where fired by fuel and motor of electricity driven to generate mechanical shaft power.
- **Transfer** is the movement of **energy** from one location to another, i.e. the energy carrier such as hot water, chilled water, refrigerant cycle, electrical cables, etc.

Energy Conversion Devices

Conversion Device	Description
Motion	
Diesel Engine	Compression ignition diesel engine: truck, car, ship, train, generator
Petrol Engine	Spark ignition otto engine: car, generator, garden machinery (incl. two-stroke)
Aircraft engine	Turbofan, turboprop engine
Other engine	Steam or natural gas powered engine
Electric Motor	AC/DC induction motor (excl. refrigeration)
Heat	
Oil burner	Oil combustion device: boiler, petrochemical cracker, chemical reactor
Biomass burner	Wood/biomass combustion device: open fire, stove, boiler
Gas burner	Gas combustion device: open fire, stove, boiler, chemical reactor
Coal burner	Coal combustion device: open-fire, stove, boiler, blast furnace, chemical reactor
Electric heater	Electric resistance heater, electric arc furnace
Heat exchanger	Direct heat application: district heat, heat from CHP

Energy Units Fundamentals

- Joule – Calorie – Btu – kWh
- The Joule (J);
  - the Basic Definition **"Energy is the Ability to Do Work"**, i.e. in Engineering Terms, The force Needed to move an Object for certain distance.

$$Work = Force \times Distance$$

$$Force = Mass \times Acceleration \ \ expressed\ in\ SI\ Units\ by\ \ (\frac{kg\ .m}{s^2})$$

This Force Unit $(\frac{kg\ .m}{s^2})$ **is entitled as Newton (N), Then the Work will be Newton . meter (N.m) and finally entitled as Joule (J).**

  - Hence, in SI Units, Work is expressed in Joule where 1 Joule = 1 N.m.

Energy Units Fundamentals

- Calorie (Cal):
  - **In SI System** : Is Defined as the amount of Heat Energy needed to Raise the temperature of one gram of water one degree centigrade Celsius.
- British Thermal Unit (Btu)
  - **In IP System** : Is Defined as the amount of Heat Energy needed to Raise the temperature of one pound of water one degree Fahrenheit.
- Watt . Hour (Wh)
  - The electrical power is measured in Watt = Voltage x Current
  - Voltage measured in Joules per Coulomb – **J / Cb**
  - Current measured in Coulomb per Second – **Cb / Sec**
  - Hence, **Watt is Joules per Second J/S**

Other Energy Units

- Ton Oil Equivalent (TOE);
  - Defined as the amount of energy released by burning one ton of crude oil – This unit was developed to be used for comparing the energy consumption and production of a country or region, regardless of the energy sources used.

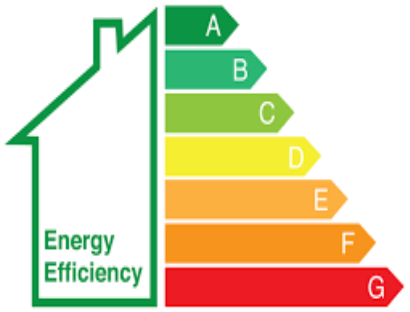
    1 ton of oil equivalent =10 million kCal, 41.868 (GJ) or 11,630 kWh
- Ton of Refrigeration (TOR);
  - The rate of heat removal to melt one ton of Ice in 24 hours – measured to be 288000 Btu per 24 Hours.
  - Hence One TOR = 12000 BTU/hr = 3.517 KW
  - The Cooling Energy is measured by TOR.hr = 12000 Btu = 3.517 kWh

Energy Resources and Conversion – Impact on Greenhouse Gases (GHGs)

- Conversion of Energy from a form to another yields to some losses related to the combustion products to the environment.
- These Products formulates the Carbon Dioxides, Nitrogen Oxides, Sulphur Oxides, and other emissions.
- This conversion increases the GHGs inventory as well as the load to the environment (Global Climate Change).
- This leads to focus first on upgrading the energy performance standards for the conversion devices and then for the resources management to switch for the renewable energy.

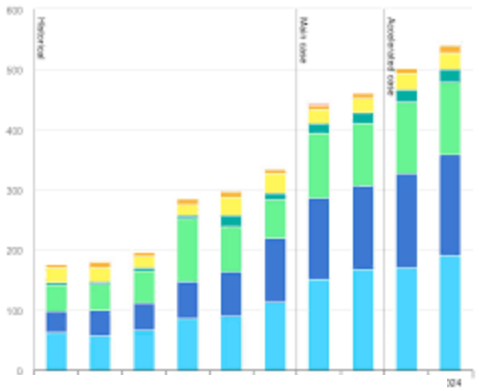
Climate Change Impact

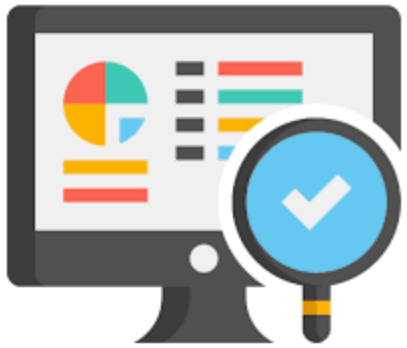
Why does this matter to Banks?



- Climate Resilience Investments
  - Buildings
    - Green Technologies.
    - Innovation in Best Efficient devices.
    - Green Labeling.
  - Agriculture
    - crop genotypes and livestock breeds with greater tolerance to climatic stress.
    - Implementing best management practices for climate resilience
  - Industry
    - Investments in EE/RE to mitigate energy availability and volatility
    - Investments in clean technologies
  - Tourism
    - climate change risk considerations into coastal development and land use planning
    - climate change considerations into existing loan products to the tourism sector

Global EE/RE Outlook & Concepts

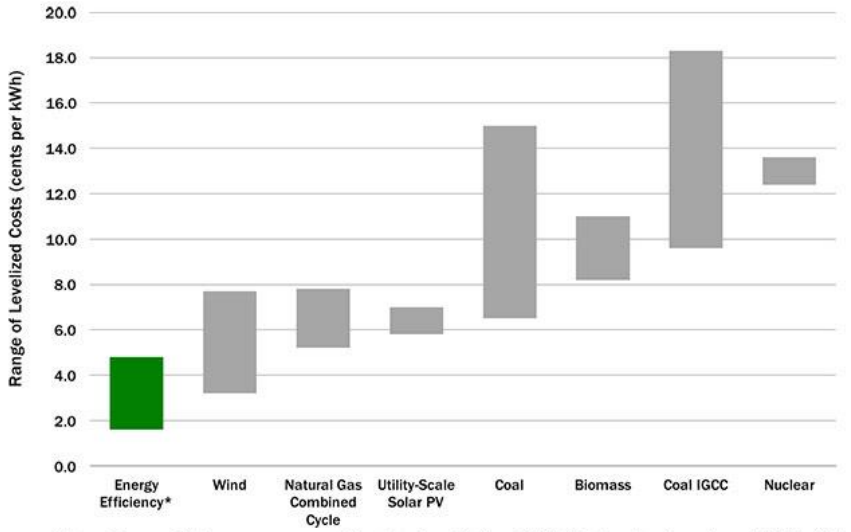




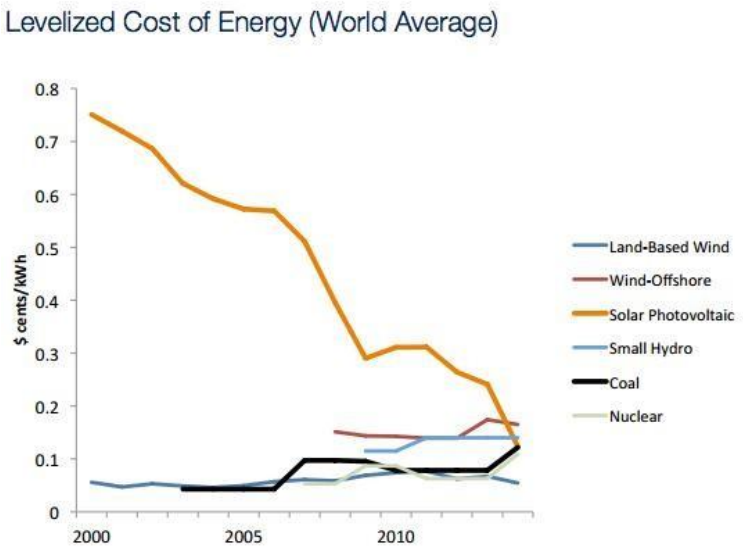
- Investing in clean energy "has been a noble way to lose money" – *Joseph A. Dear, Calpers Clean Energy & Technology Fund (USD460 million)*
- Energy efficiency is typically the cheapest and most available "source" of energy supply to power economies – *IEA*
- "Private investors will need to take a new approach to benefit from green investment opportunities" – *The Green Investment Report (2013): Green Growth Action Alliance*

EE/RE Investments

- The World Economic Forum (WEF) has determined that in many parts of the world, solar energy is now the same price or even cheaper than fossil fuels for the first time.
- EE is cheaper and less-risk than making energy.



*Notes: Energy efficiency program portfolio data from Molina 2014; All other data from Lazard 2015. High-end range of coal includes 90% carbon capture and compression.

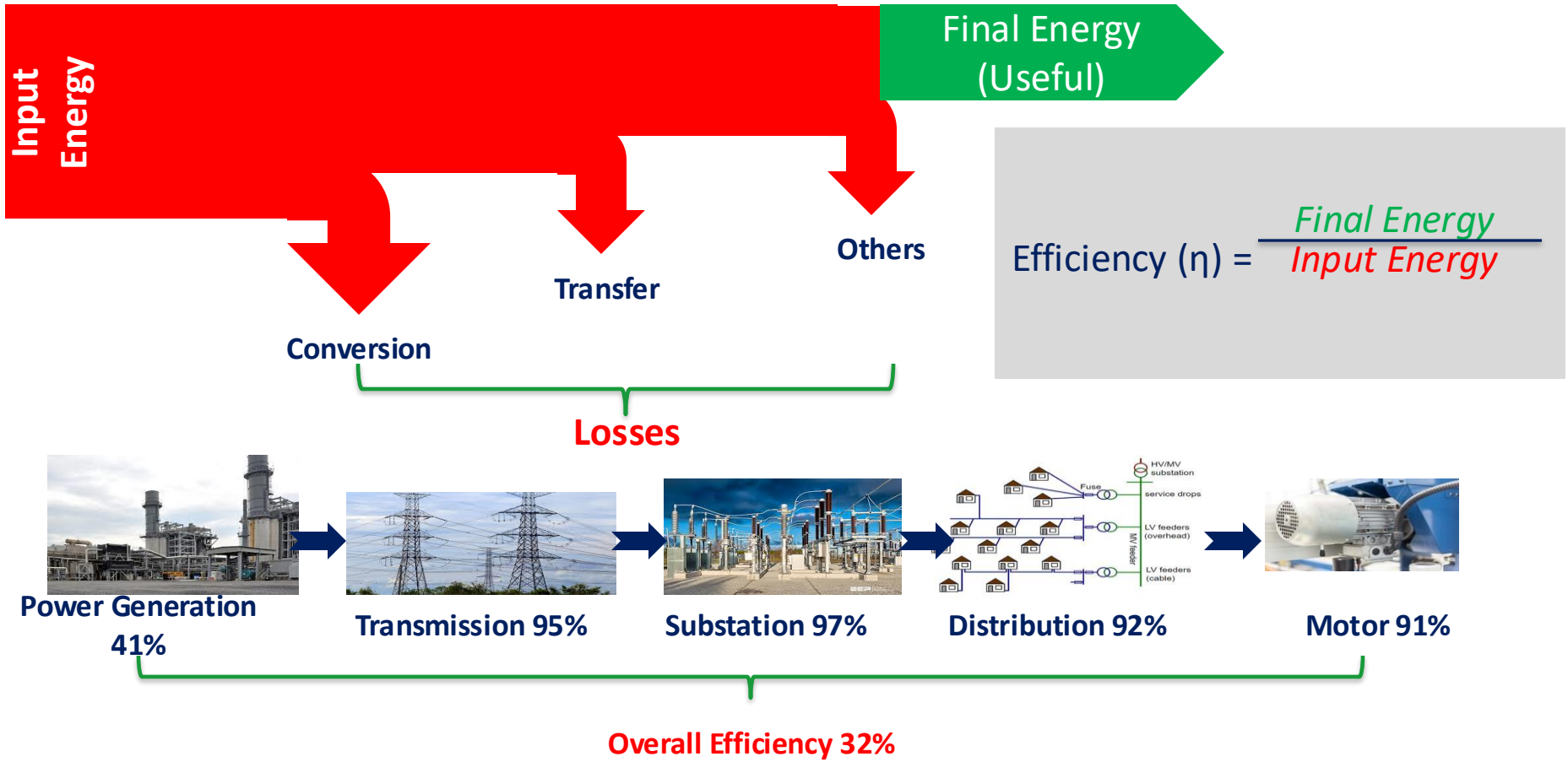


Source: OpenEI, Transparent Cost Database

Session #2

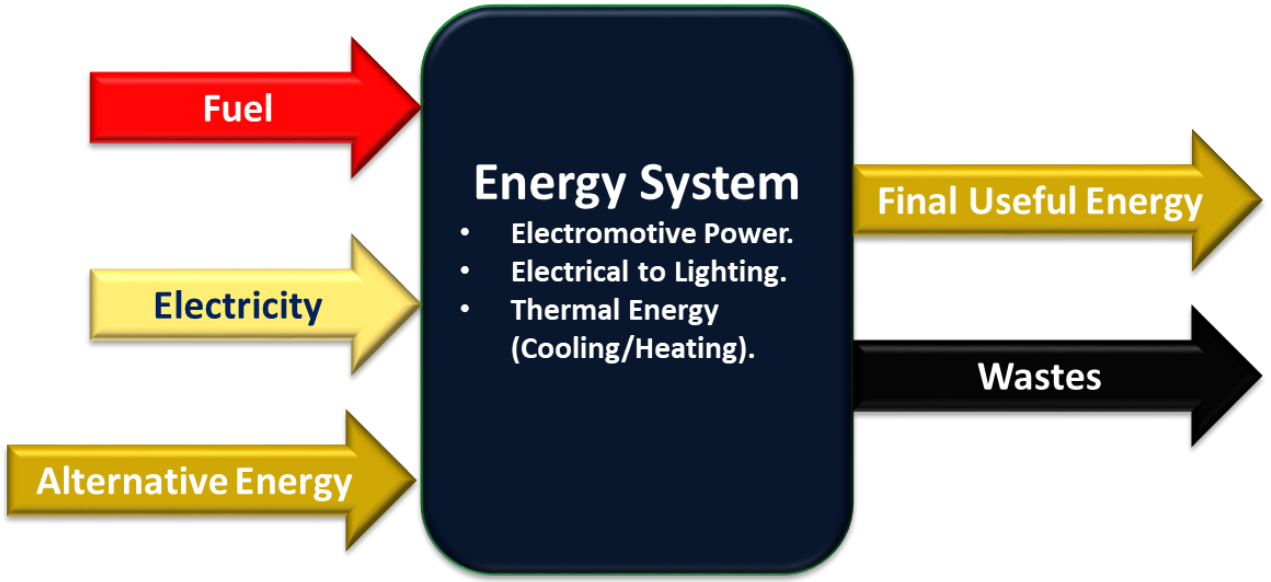
Energy Efficiency Technologies & Applications in Buildings

Energy Balance, Efficiency, and Technologies for Energy Consumption Reduction



Energy Efficiency Measures (Technologies)

- Energy Performance Control and Monitoring.



- Energy Systems Automation and Efficient Technologies;
  1. Efficient Motors, Drives, and Variable Speed Drives.
  2. Efficient Lighting Technologies (LED, Compact Fluorescent, Super Sodium, …etc.)
  3. Cleaner Production Technologies.
  4. Efficient Cooling Systems Generators.

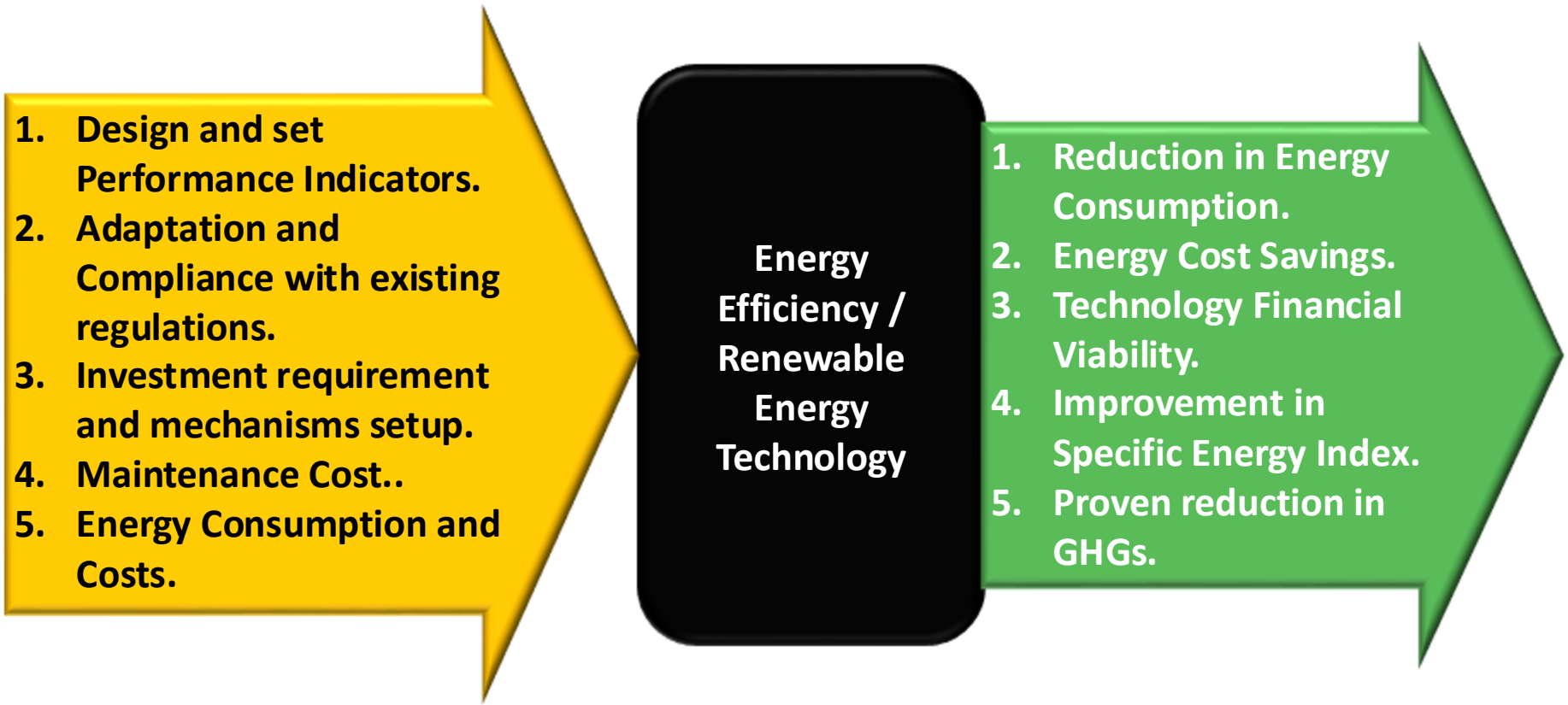
Energy Efficiency Measures (Technologies)

- Fuel Energy is to drive the combustion system to generate thermal energy needed for the relevant process activity such as furnaces, heater, and boilers. Therefore, the EE technologies are:
  1. Combustion Control Systems.
  2. Waste Heat Recovery Systems.
  3. Cogeneration and Tri-Generation.
  4. Efficient Boilers and Steam Systems Improvement.
  5. Self Regenerative Burners.

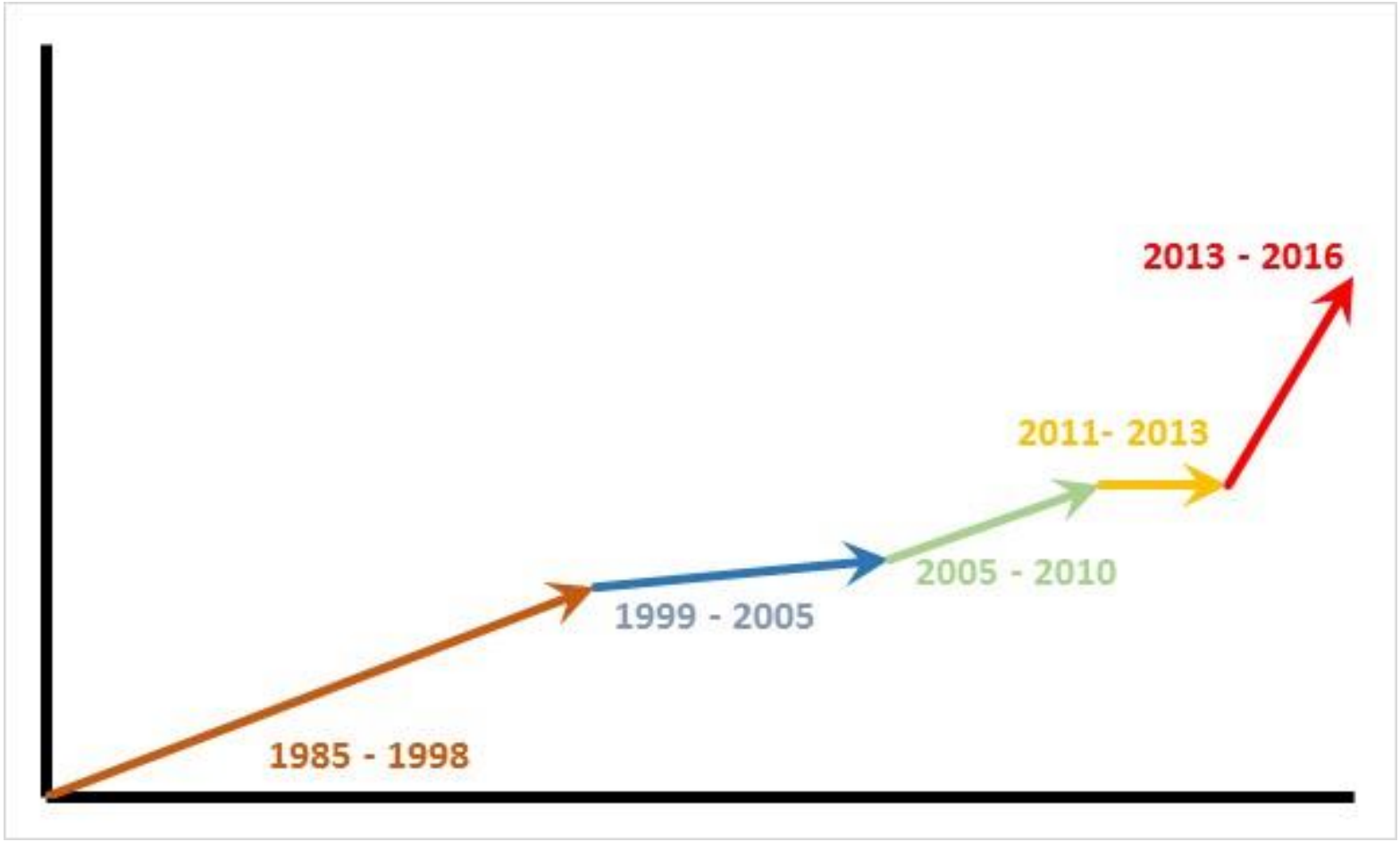
Alternative Energy Measures (Technologies)

- Alternative Energy/Fuel is an energy resources management that could be utilized such as:
  1. Solar Energy for heating purposes to generate thermal demand to the process (Solar Collectors and Concentrated Solar Thermal).
  2. Solar Light (Photovoltaic to generate electrical energy and Passive Lighting Systems).
  3. Wind Energy.
  4. Biomass and Biogas.
  5. Hydro Power.
  6. Reject Derived Fuels (RDF).

EE/RE Assessment and Analysis



EE/RE Technologies Growth in Developing Countries



Why Growth is slow in EE/RE sector?

- The slow growth in EE/RE sector is due to the barriers imposed;
  - Shortage in primary energy supply versus demand.
  - Energy Tariffs subsidy.
  - Low average weighted sold energy.
  - Increase in debt to equity.
  - Development for fund raising.
  - Energy Conservation and Efficiency Programs Awareness at Demand Side.

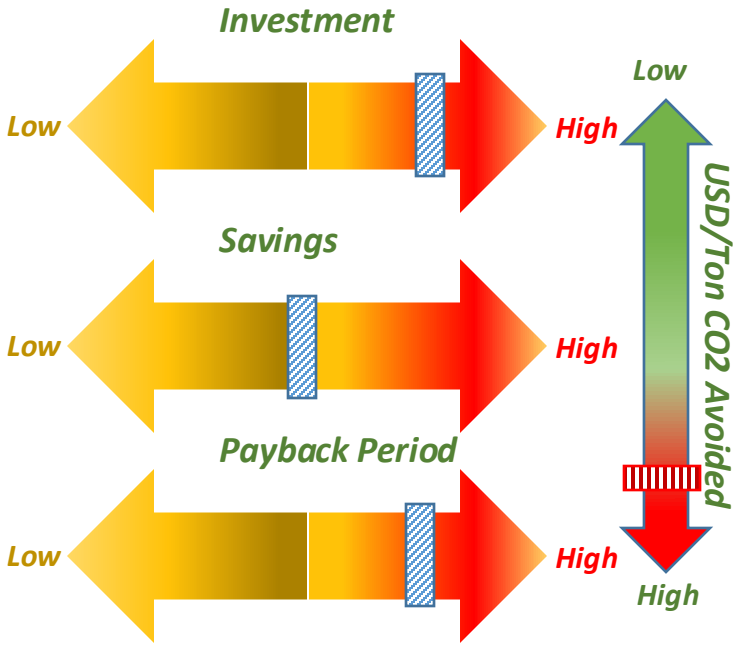
Recent Changes in the Sector

Actions Triggered	Increases Contribution of Energy to product cost.
	Demand side is triggered towards EE/RE to reduce operating expenses.
	The feasibility for EE/RE projects within the demand side became more attractive.
	Funding raising and financial mechanisms will be developed.
	EE/RE business will be booming.
	EE/RE technologies duties and taxes is being regulated.
	Increase market volume for ESCOs and ISP.

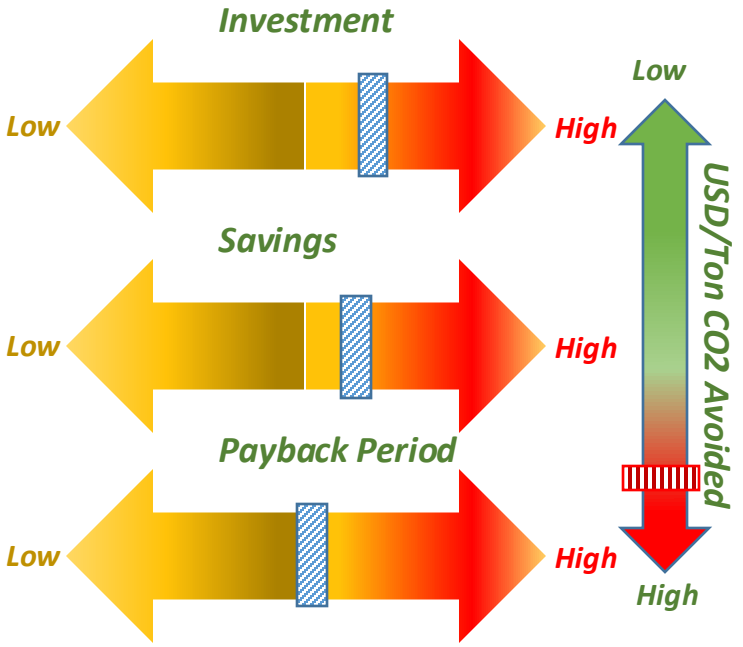
Tools to motivate energy business	Demand Side more regulations towards the consumption indices.
	Commitment to EE/RE at demand side implementation.
	Incentive packages to certify the GHG reduction of EE/RE based projects
	Regulate the RE penetration and contribution to energy consumption at demand side
	Regulate and enforce the MV protocol and contracts between demand side and ESCOs

EE/RE Technologies Investment Scale and Savings

1. Renewable Energy.
2. Cogeneration and Tri-Generation.
3. Supply Side Efficient Technologies.
4. Waste to Energy and Recovery Systems.



1. Efficient Lighting Technology.
2. Automation and Controls.
3. Drives and VSD.
4. Boilers and Steam Systems.
5. Efficient Cooling Systems.



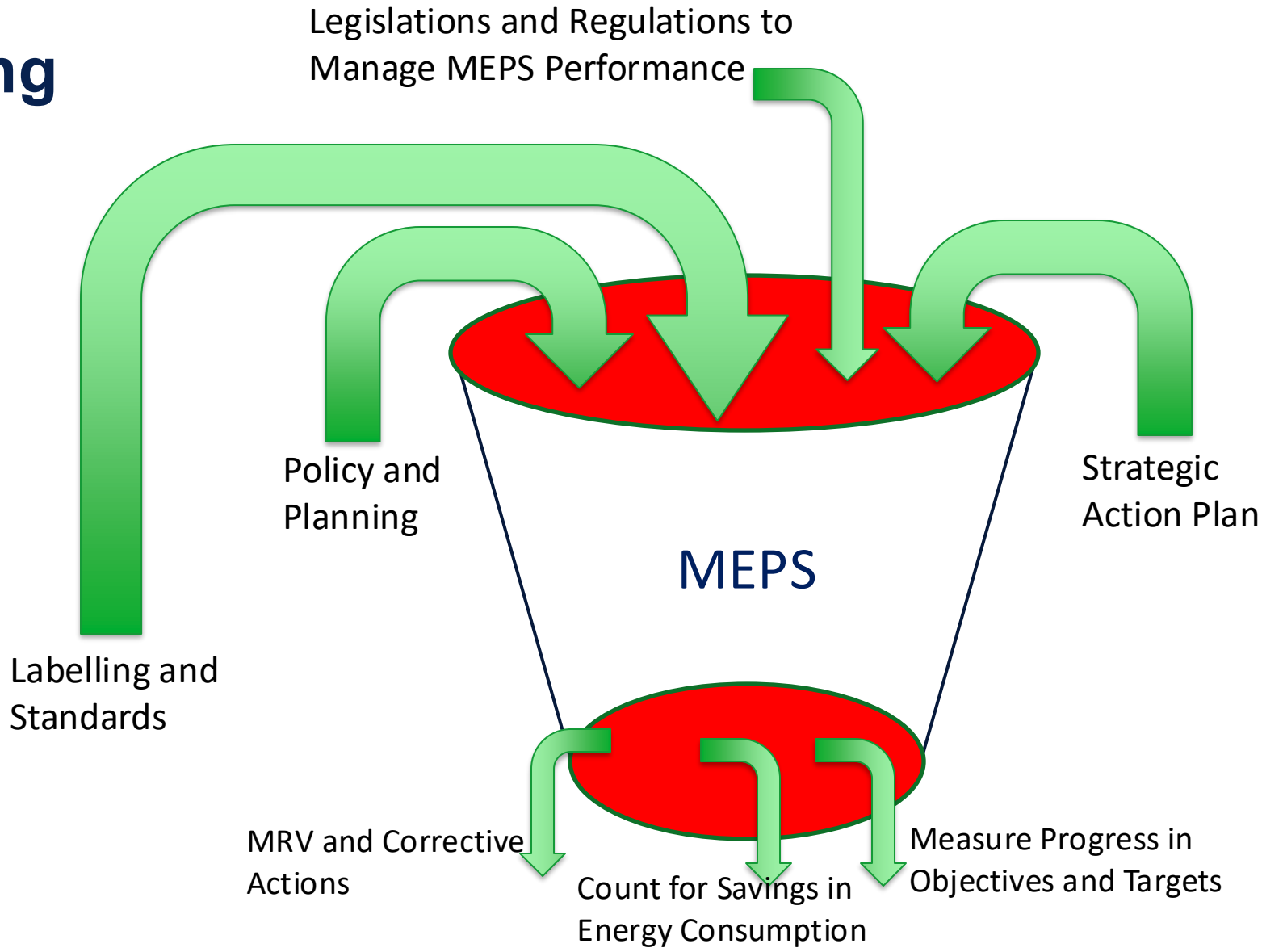
Session #3

Introduction to Minimum Energy Performance Standards (MEPS) and Energy Labelling Systems

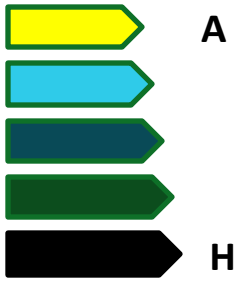
MEPS Definitions

- A minimum energy performance standard (MEPS) is a specification, containing a number of performance requirements for an energy-using device, that effectively limits the maximum amount of energy that may be consumed by a product/service in performing a specified task.
- Minimum Energy Performance Standards are an effective way to increase the energy efficiency of product/service. They ensure that products/services available for purchase use less energy and have lower running costs over their lifetime.

MEPS Structuring



MEPS Application



MEPS

- **Buildings**
  - Devices Labeling
  - Legislative Consumption Level (kWh/m2/year)
- **Industry**
  - Technology Labeling
  - Legislative Consumption Level (kWh/unit of Product)
- **Services**
  - Technology Labeling
  - Legislative Consumption Level (kWh/Unit of Service)
- **Tourism**
  - Technology Labeling
  - Legislative Consumption Level (kWh/Guest/year)

Concluded Class of Energy Labeling (A, B, ……, H)

Design Principle for MEPS in Buildings

1


G

B

To address the worst performing building.
So, immediate impact could be achieved.

2

Be aligned with the financial resources availability to invest.

3

MAKE REQUIREMENTS BINDING AND FORESEEABLE to accelerate innovation in the energy renovation supply chain.

4

Have an
EFFECTIVE COMPLIANCE SUPPORT
AND ENFORCEMENT SYSTEM.

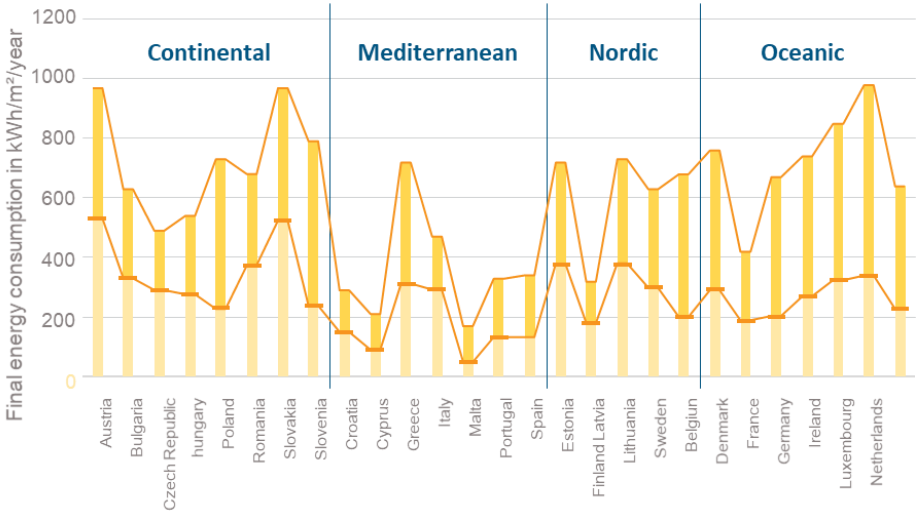
5

DEFINE
regular and frequent
MILESTONES.

Design Principle #1: Worst First

RENOVATING THE WORST-PERFORMING BUILDINGS FIRST REDUCES ENERGY CONSUMPTION QUICKLY WITH VULNERABLE GROUPS BENEFITINGASAPRIORITY.

- Worst-performing buildings are those that have the highest final energy consumption (in kWh/m²/year) of the national building stock.
- The example below gives an overview of the final energy consumption of the worst-performing 15% residential buildings in floor area in each member state, illustrating the high amount of energy used for space heating and hot water per square metre per year.



Design Principle #1: Worst First

- This figure shows that renovating the worst-performing 15% of the building stock by floor area would significantly reduce wasteful energy consumption.
- The worst performing 15% of the floor area is highlighted by the orange area. The orange bar marks the final energy consumption that corresponds in each Member State with the 15% Worst Performing Buildings threshold.
- Tapping this potential is crucial to bring the building sector on track to meet EU climate targets.
- However, reducing the energy consumption of the worst performing buildings is an obvious choice, the final energy consumption remains high – in many cases well above 200 kWh/m²/year.
- To meet climate targets, at least half of the worst performing floor area needs to be included in a MEPS scheme to ensure the entire building stock reaches target levels by 2050.
- There is another reason to address the worst-performing buildings first. These buildings are often occupied by the most vulnerable groups in society, who should benefit as a priority from structural measures to alleviate growing energy poverty as quickly as possible.

DESIGN PRINCIPLE 2: ABILITY TO INVEST

- Ownership patterns in real estate markets vary significantly for different building types and between Member States, which leads to differentiated investment abilities. In larger residential buildings, heterogenous ownership often inhibits investment decisions for deep renovation. In non-residential buildings, different usage types may result in varying investment cycles.
- To be effective, MEPS schemes need to be embedded in an ecosystem of financial support, especially for vulnerable groups. MEPS design should therefore consider ownership structures, the building type, and the related ability to invest in energy renovation. This will allow renovation demand to be met by the supply of well-tailored energy renovation services.

DESIGN PRINCIPLE 3: BINDING REQUIREMENTS

BINDING REQUIREMENTS WILL DRIVE INNOVATION IN THE CONSTRUCTION SECTOR AND PROVIDE CERTAINTY TO ALL ACTORS ACROSS THE VALUE CHAIN.

- The construction sector is one of the least innovative economic sectors in the EU.
- With the sector lacking the qualified workforce and coordination needed to accelerate comprehensive, high-quality renovation approaches, game-changers are needed to innovate and optimise energy renovation processes.
- Standards and binding requirements are key to drive industries to innovate. There are many examples where setting standards has triggered innovation and provided competitive advantages to pioneers, especially in relation to energy and resource efficiency.

DESIGN PRINCIPLE 4: CLEAR COMPLIANCE SUPPORT AND ENFORCEMENT SYSTEM

SPECIFIC TARGET GROUPS SHOULD RECEIVE SUPPORT TO ENABLE THEM TO COMPLY WITH MEPS. THIS SHOULD BE COMPLEMENTED

- Compliance with existing regulation in the buildings and construction sector is essential for many reasons.
- Continual review in comprehensive mode for Minimum Energy Efficiency Standard scheme shows that the mandatory character and expected sanctions for non-compliance led to high levels of compliance.
- Compliance also depends on awareness.
- Owners with small portfolios are less likely to be part of professional housing market networks, so their awareness of MEPS should not be seen as a given. Local authorities have an important role to play in providing information.
- Investment is essential to be considered by government and financial public institutions.
- Innovation in the building sector is all the more important to meet the energy renovation demand that the introduction of MEPS will trigger. Well-tailored support schemes addressing both the supply and the demand side can help steer energy renovation activity over time. Public money should be used widely and prioritise vulnerable groups.

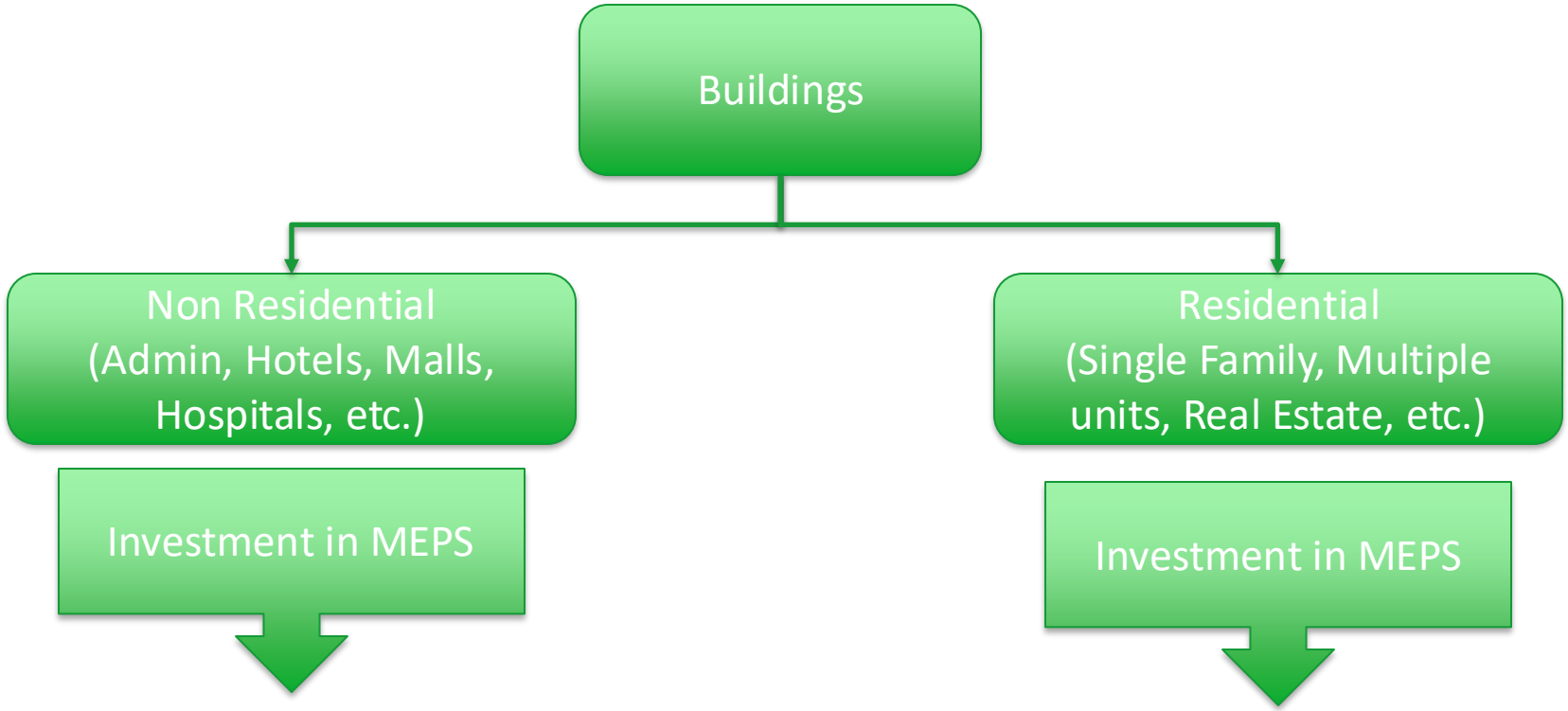
DESIGN PRINCIPLE 5: DEFINE MILESTONES CONSISTENT WITH LONG-TERM TARGETS

MEPS NEEDS TO BE CONSISTENT WITH LONG-TERM DECARBONIZATION TARGETS

- To meet the 2030 and 2050 climate targets in the building sector, deep renovation activity needs to ramp up this decade. Designing MEPS schemes that set compliance dates and thresholds will help reach mid- and longer-term climate targets.
- To have an impact, MEPS schemes need to cover a significant share of each segment of the building stock. MEPS based solely on trigger points (such as transfer of ownership, new lease, or major renovations) are therefore not consistent with a long-term full decarbonisation of the European building stock.
- The design of MEPS must also avoid locking in fossil fuel usage and infrastructure or inefficient building standards; all energy renovation activities should meet a minimum performance threshold as a step to higher performance.
- MEPS must be designed as a progressive scheme, with a high level of ambition from the start and a clear timetable of compliance dates.

- Survey
- Classify
- Identify the Opportunities
- Set Time plan for Implementation

Buildings Classification for MEPS



MEPS Design Schemes in Buildings

Residential Buildings

+

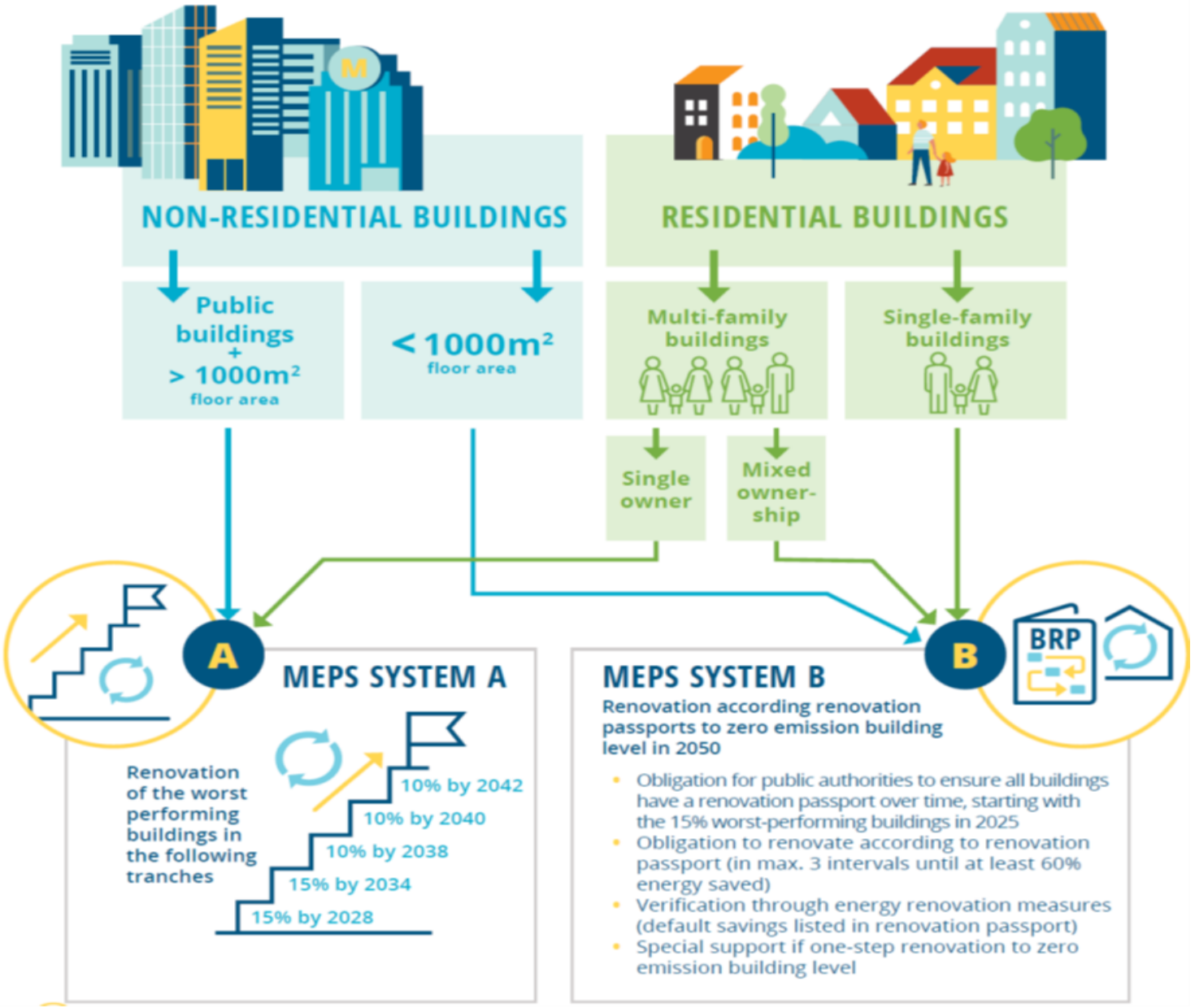
Non-Residential Buildings

- MEPS need to apply at building level to all building typologies. However, the different building segments require differentiated approaches.
- **MEPS schemes need to cover both residential and nonresidential buildings to capture the energy efficiency and carbon reduction opportunities. Since the ownership structure is very different in the two sectors, targeted support is needed to supplement a differentiated design for MEPS schemes.**
- The differentiation between non-residential and residential is important as non-residential buildings have a shorter renovation cycle and larger floor areas per building. Building owners are often in a stronger financial position, and the impact of the renovation process for building occupants and users is often easier to mitigate, for example due to a higher tenant turnover.

MEPS Design Schemes in Buildings

- ***In the residential building stock***, it is useful to differentiate between multi-family buildings and single-family homes. As well as being different types of buildings, they have different ownership structures, which will have an impact on decision-making processes and investments for renovation works. The policy mix providing support and incentive schemes must therefore be clearly targeted.
- ***Public buildings*** have a special role to play. Large buildings owned by public authorities should play an exemplary role in implementing the Renovation Wave Strategy. A MEPS scheme for public buildings will help achieve the requirement. MEPS requirements for public buildings will ensure that the worst-performing buildings of this segment are not forgotten.

Classification to Buildings



MEPS – System A

- MEPS system A should cover:
  - Larger non-residential buildings (>1000 m²)
  - Public buildings
  - Residential multi-family buildings with a single owner.
- This MEPS schemes follows a straightforward design. Progressive minimum performance thresholds, expressed in final energy consumption, are enforced over time, consistent with the path to fully decarbonise the building stock.

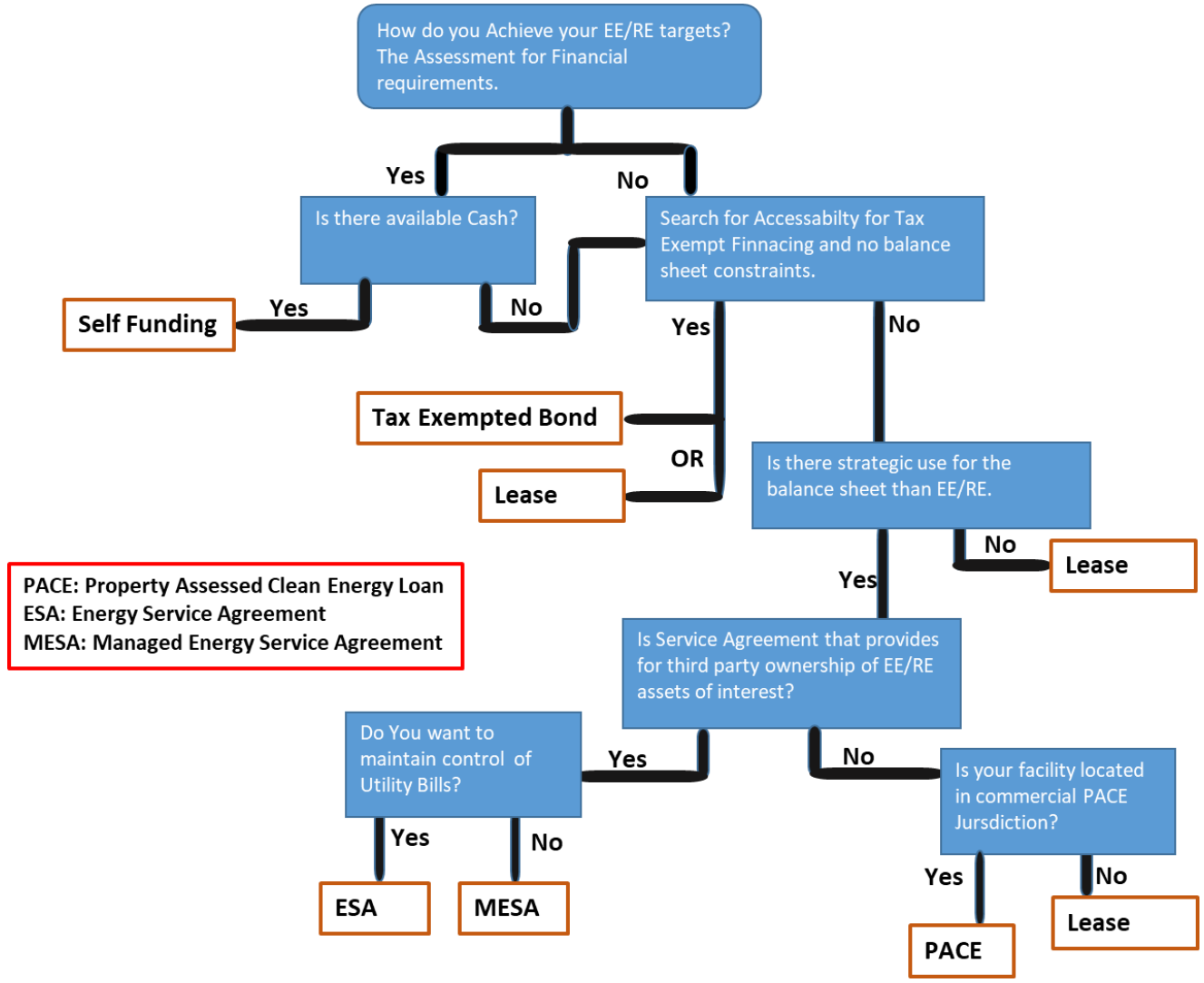
MEPS – System B

- **MEPS system B applies to smaller nonresidential buildings, multi-family buildings with many different owners of individual units, and single-family buildings.** In these building segments, decision-making processes can be more difficult, and building owners often require more advice and guidance on how to renovate and more support to finance the measures. In these cases, the MEPS scheme is linked to the implementation of renovation measures according to a long-term renovation passport for the building.
- MEPS system B, supported by mandatory building renovation passports, should cover:
  - Smaller non-residential buildings <1000m²
  - Residential multi-family buildings with multiple owners of the individual units
  - Single-family buildings.
- The core of this type of MEPS scheme is a mandatory building renovation passport. For all individual buildings under MEPS system B, building renovation passports must be issued progressively, starting with the 15% worst performing buildings. Worst-performing buildings can e.g. be identified through the EPCs. Public authorities should be required to issue the renovation passports. They should also ensure financing to cover their costs, including public or private funding (e.g. banks and other financial institutions). Public funding may e.g. be derived from energy efficiency obligation schemes or any available forms of funds.

MEPS – Systems A and B Conclusions

- **Address the worst-performing buildings first** so that people see an immediate and meaningful impact.
- Be aligned with the **owner's ability to invest.**
- **Make requirements binding and foreseeable** to accelerate innovation in the energy renovation supply chain.
- **Have an effective compliance support and enforcement system.**
- **Define regular and frequent milestones.**

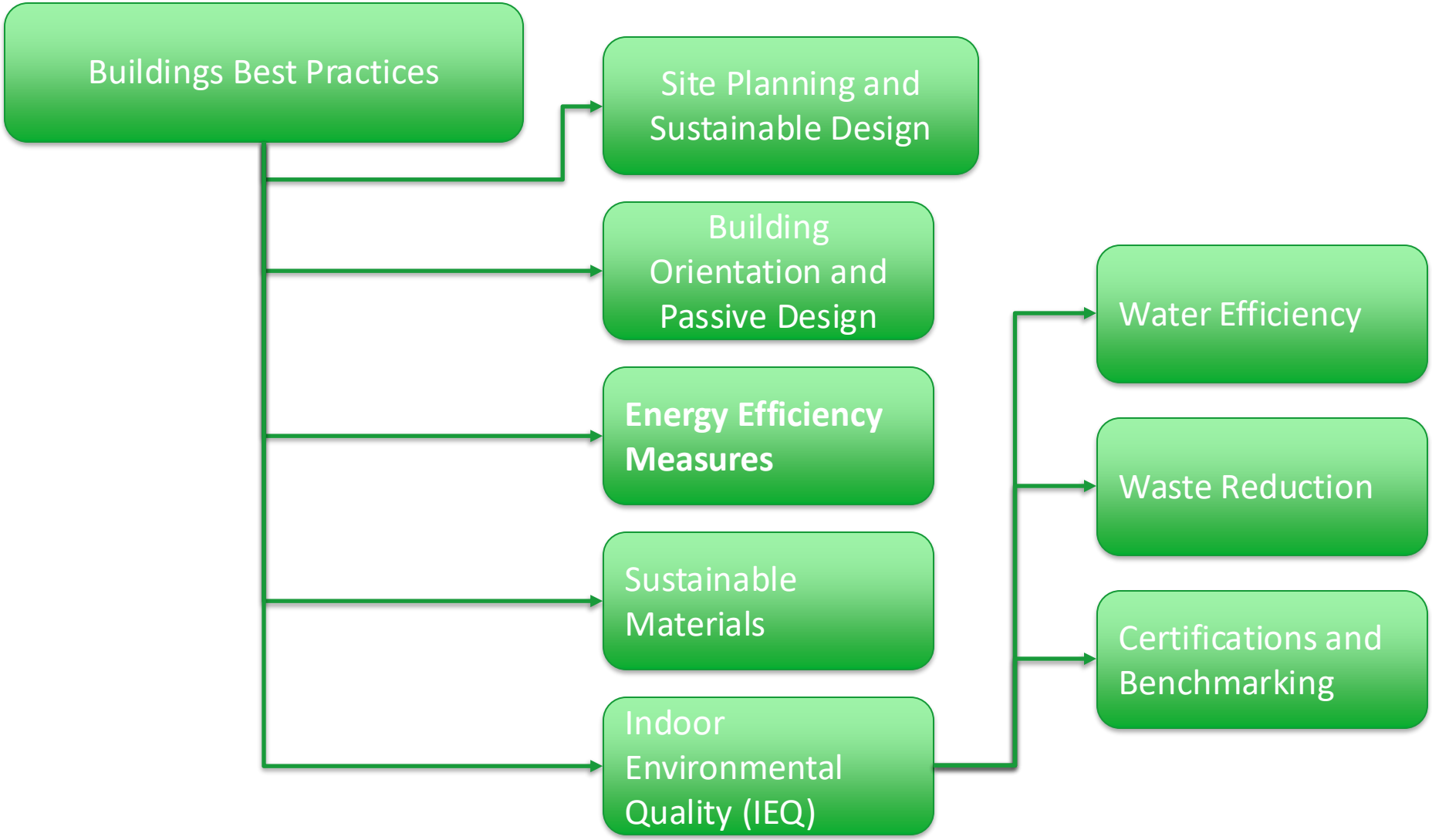
The MEPS Financing Choice



Session #4

Best Practices in Green Building Design and EE Measures

Categories of Best Practices



Categories of Best Practices

Site Planning and Sustainable Design

- **Site Selection:** Choose locations that minimize environmental impact, e.g., near public transportation, existing infrastructure.
- **Minimize Land Disturbance:** Preserve natural topography and vegetation.
- **Stormwater Management:** Use permeable paving, green roofs, and bioswales to reduce runoff.
- **Heat Island Reduction:** Incorporate cool roofs, green roofs, and shaded surfaces.

Building Orientation and Passive Design

- **Daylighting**: Orient buildings to maximize natural light and reduce need for artificial lighting.
- **Passive Heating/Cooling**: Utilize thermal mass, natural ventilation, and shading devices.
- **Window Placement**: Optimize for cross ventilation and natural airflow.
- **Building Envelope**: Use high-performance insulation, double/triple glazing, and airtight construction.

Energy Efficiency Measures

- **High-Efficiency HVAC Systems**: Use variable speed drives, heat recovery ventilators (HRVs), and zoned systems.
- **LED Lighting**: Replace traditional lighting with energy-efficient LEDs and use occupancy sensors.
- **Building Automation Systems (BAS)**: Install smart systems for energy monitoring and control.
- **Renewable Energy**: Incorporate solar panels, solar water heaters, or geothermal systems.
- **Energy Modeling**: Perform simulations to optimize energy performance before construction.

Categories of Best Practices

Sustainable Materials

- **Local and Recycled Materials**: Reduce embodied energy by sourcing locally and using recycled content.
- **Low-VOC Products**: Choose paints, adhesives, and finishes that emit fewer pollutants.
- **Modular Construction**: Design for adaptability, reuse, and easier disassembly.
- **Durable Materials**: Select materials with long life spans to reduce replacement needs.

Indoor Environmental Quality (IEQ)

- **Ventilation**: Ensure proper air changes per hour and use filtration systems.
- **Natural Light and Views**: Enhance occupant well-being with daylight and outside views.
- **Thermal Comfort**: Maintain consistent indoor temperatures and humidity.
- **Acoustic Comfort**: Use sound-absorbing materials and strategic layout to reduce noise.

Water Efficiency

- **Low-Flow Fixtures**: Install low-flow faucets, toilets, and showerheads.
- **Greywater Recycling**: Reuse water from sinks/showers for irrigation or flushing.
- **Rainwater Harvesting**: Collect and store rainwater for non-potable uses.
- **Efficient Landscaping**: Use native/drought-tolerant plants and drip irrigation systems.

Categories of Best Practices

Waste Reduction

- **Construction Waste Management**: Plan for recycling/reusing construction materials.
- **Material Optimization**: Use advanced framing techniques and modular dimensions.
- **Deconstruction Planning**: Design for end-of-life disassembly and reuse.

Certifications and Benchmarking

- **LEED, BREEAM, WELL, EDGE, or Passive House Standards**: Use third-party certifications to guide and validate green practices.
- **Energy Star Benchmarking**: Regularly monitor and compare energy performance.

Session #5

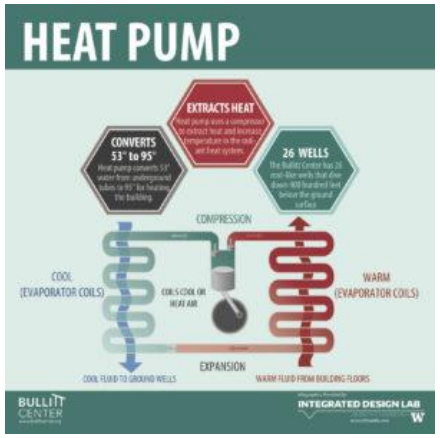
Case Studies – Successful EE/RE Projects in Buildings

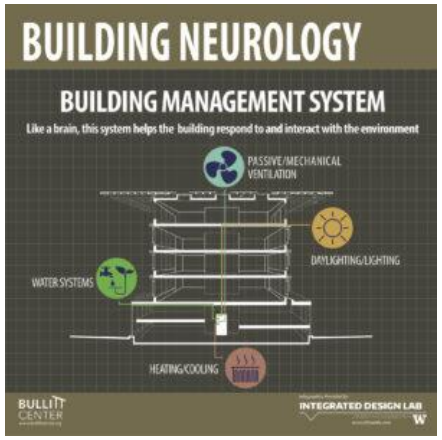
Bullitt Center – Seattle, USA

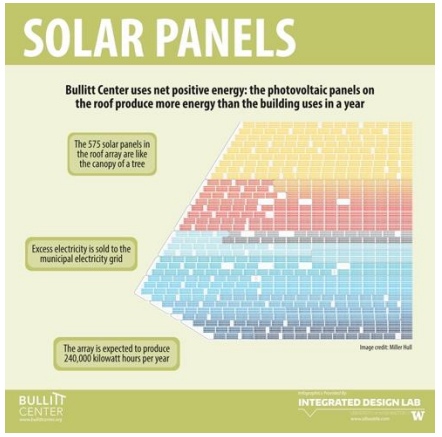
Type: Commercial Office Building

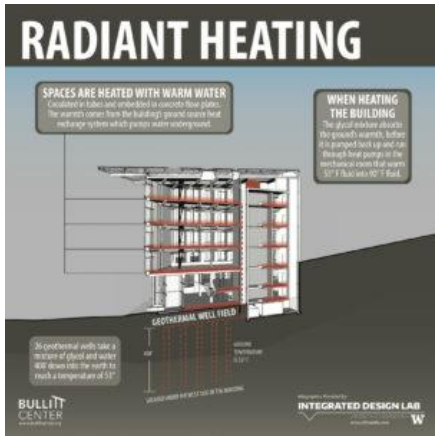
Highlights:

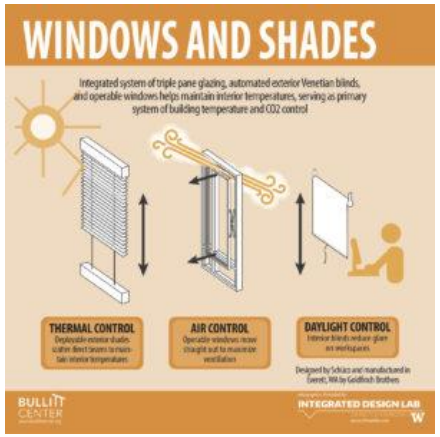
- Net Zero Energy Building
- 100% on-site solar PV generation (244 kW system)
- Rainwater harvesting and composting toilets
- Designed for a 250-year lifespan
- Natural ventilation, geothermal heating/cooling

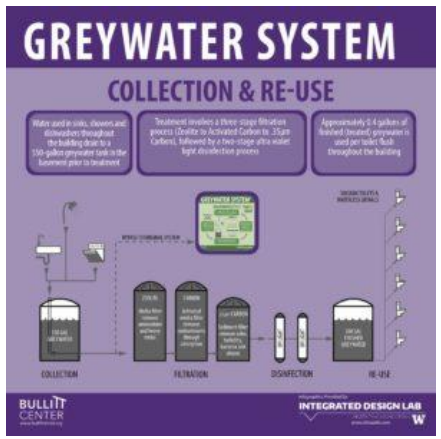


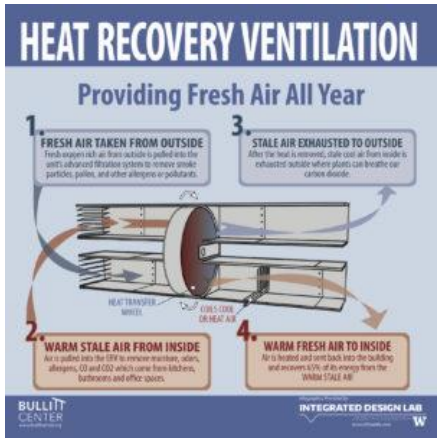












Edge Building – Amsterdam, Netherlands

Type: Commercial Office
Highlights:

- BREEAM Outstanding certification (score of 98.36%)
- Smart lighting system powered by 28,000 sensors
- Powered by rooftop solar and renewable energy from off-site sources
- Advanced energy analytics via IoT and cloud

1. Solar-powered

The Edge's innovative design harnesses solar power to its fullest potential.

Its distinctive southern facade features a series of solar panels and windows, equipped with a panel-covered roof as well. The building's orientation and glass facade maximise natural light without compromising internal temperature control. Thick load-bearing concrete and deeply recessed windows further regulate heat, reducing the need for shades. These features, combined with super-efficient solar panels on the south side, contribute to The Edge consuming 70% less electricity than typical office buildings.

2. Hot & Cold

How does The Edge maintain its perfect climate while staying eco-friendly?

The answer lies 130 meters underground, where two groundwater sources serve as thermal energy storage for warm and cold water. These aquifer thermal energy storage pumps regulate the building's temperature by circulating water based on internal and external conditions. Powered by self-generated solar energy, this system uses LED light panels with sensors to provide detailed temperature and humidity readings across each floor. This precision control eliminates natural hot and cold spots, particularly near windows, contributing to high employee satisfaction with the building's climate management.

Success Stories of Buildings

Indira Paryavaran Bhawan – New Delhi, India

Type: Government Office
Highlights:

- India's first **Net Zero Energy Building**
- Solar PV system (930 kW)
- High-efficiency HVAC, chilled beams, and radiant cooling
- 75% of construction materials from recycled content

Impact:

- Achieved 70% energy savings compared to conventional buildings.
- Received **Griha 5 Star** and **LEED Platinum** ratings.

Bosco Verticale – Milan, Italy

Type: **Residential High-Rise**
Highlights:

- "Vertical forest" with 900 trees and 20,000 plants
- Natural insulation and air purification
- High-performance façade and solar panels
- Efficient use of greywater for irrigation

Impact:

- Reduces CO_2 emissions by approximately 30 tons/year.
- Reduces energy consumption by 32% for heating and 45% for cooling.

El Mandara Eco-School – Alexandria, Egypt

Type: Educational Facility
Highlights:

- Retrofitted to improve insulation and ventilation
- Solar water heaters and solar lighting systems installed
- Students engaged in sustainability education

Impact:

- Reduced energy costs by up to 50%
- Promoted environmental awareness in the community

Session #6

Innovative EE/RE Financing Mechanisms (ESCOs, On-Bill...)

EE/RE Technologies to be financed

- Energy efficiency measures are related to buildings and are focused on complex thermal retrofitting of buildings including implementation of energy efficient equipment and lighting.
- Most of the best practices provided by project partners focus on energy efficiency measures in buildings, including:
  - included thermal insulation of external walls and roofs,
  - replacement of windows and doors,
  - roof modernization,
  - modernization of heating systems (including fuel switch),
  - installation of small RES sources supplying the building with energy,
  - implementation of energy management & monitoring systems,
  - modernization of internal and external lighting systems.

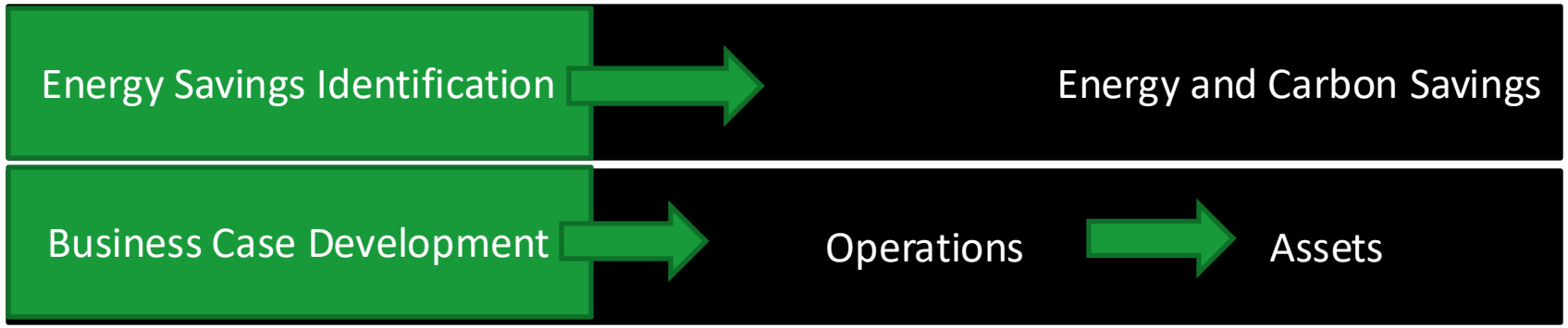
Funding Sources

- Apart from State budget, there are other sources of external capital for carrying out investments in energy efficiency and renewable energy sources.
- Currently, the most important funding are EU funds, which provide different types of funding opportunities, such as grants, loans, guarantees, subsidies and prizes.

1. Grants - funding for projects contributing to EU policies. Grants are awarded to private and public organisations, and exceptionally to individuals. Grants are a form of complementary financing. The EU usually does not finance projects up to 100 %. In other words, the project will be co-financed by the beneficiary organisation. Grants are mainly awarded through calls for proposals.
2. Loans, guarantees and equity - as forms of assistance, in relation to EU policy and programmes). The financing goes through local financial institutions — banks, guarantee societies or equity investors — which determine the exact financing conditions: the amount, duration, interest rates and fees.
3. Subsidies and other types of funding - are managed directly by EU national governments, not by the European Commission.
4. Prizes - are rewards to winners

Best Practices In Lending To EE And RE Projects

- EE Supports Value Chain.
- EE projects are effectively cost-cutting solutions.
- The project's benefits depend as much on the installed assets, (and their O&M), as it depends on the behavior of involved staff.

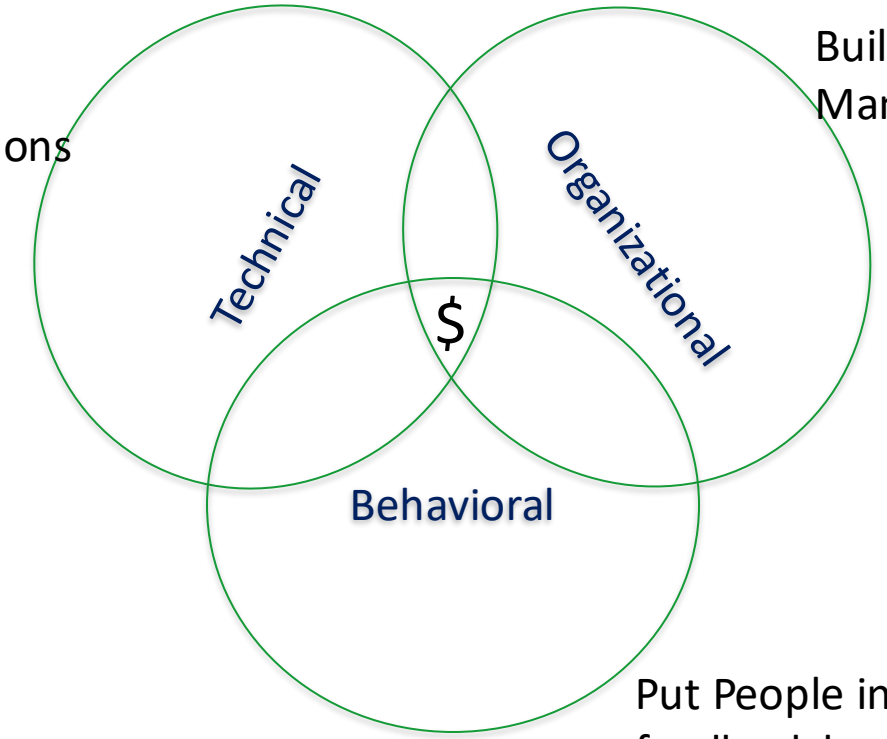


Motivation for Clean Energy

- Cost savings
  - Payments for energy (kWh, GJ or MMBtu of gas, etc.)
  - Payments for peak power demand (kW)
  - Operation and maintenance costs
  - Power factor charges
- Potential Ancillary Benefits
  - Comfort, productivity and safety improvements
  - More reliable operation and longer equipment life
- Environmental Concerns
  - Greenhouse gas emissions related to global climate change
  - Local pollution of air, water and land
- Addressing Risk
  - Future liability for pollution and emissions
  - Fuel cost volatility
- Marketing
  - Green image

Energy Efficiency: People and Technology

Operational & technological actions



Building Energy Management Culture

Put People in the feedback loop

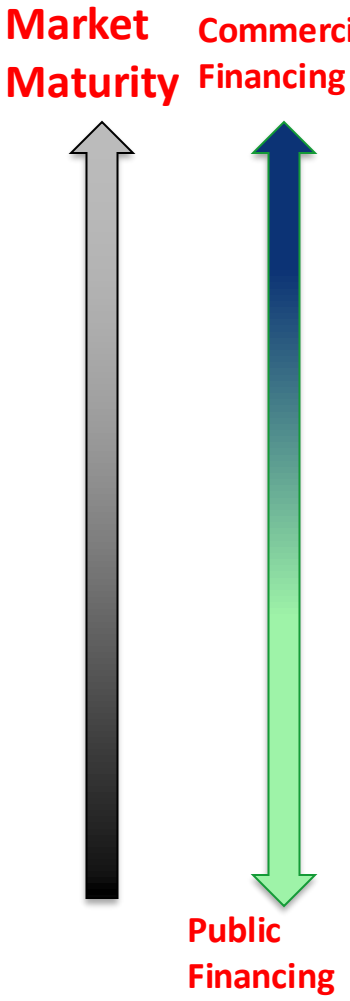
Barriers to EE Finance Uptake

- Misaligned financial incentives
  - Maintenance vs procurement department
  - Energy managers vs financial directors
- No standardization, benchmarking
  - Business case development
  - Measurement & verification
- Access to corporate financing
  - Lack of necessary confidence to invest
  - Complexity of financing, available financing products do not reflect the EE fundamentals

What is Best Practice Financing

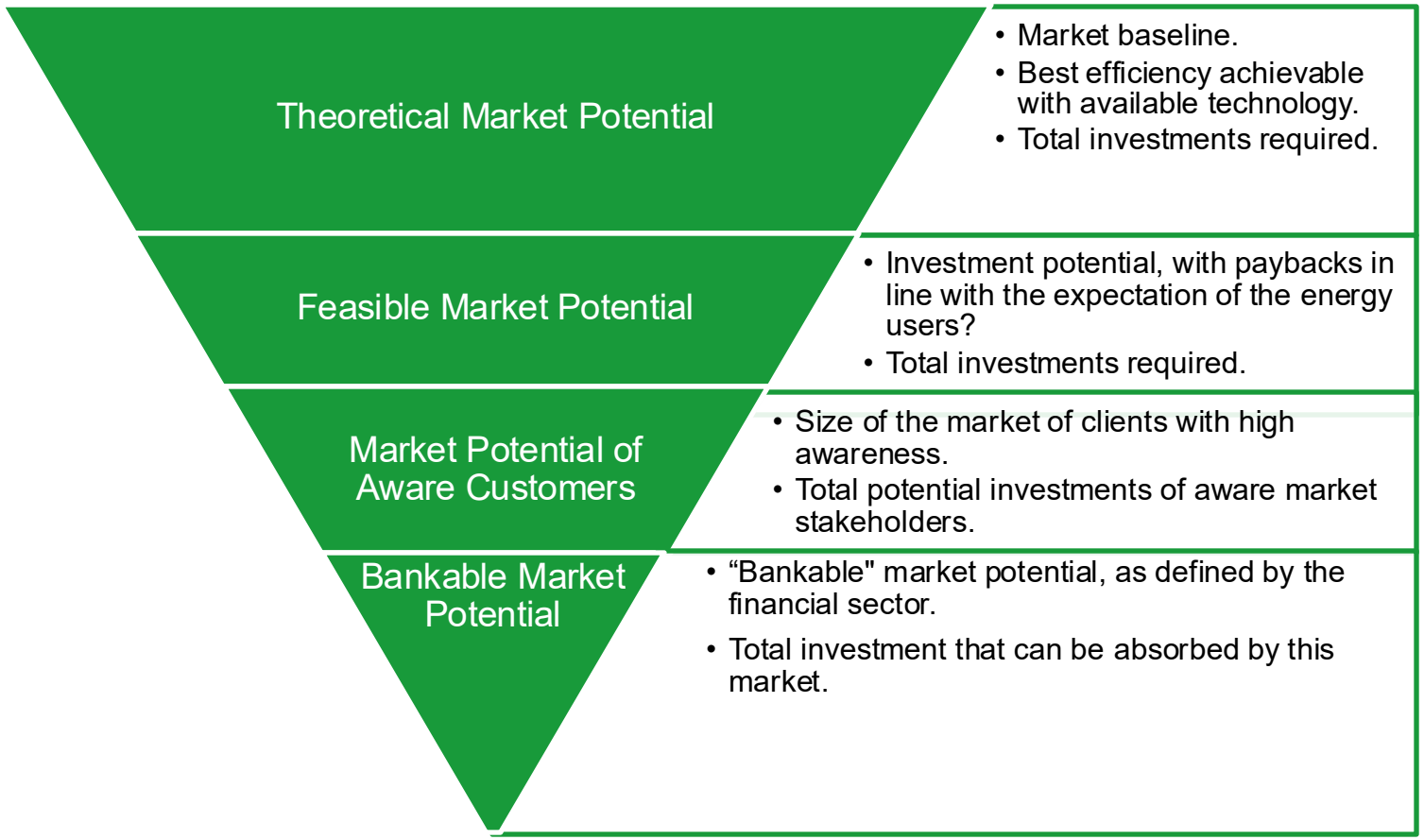
- Adequate to market demand
- Captures market investment drivers
- Makes use of existing legal framework
- Bridges gaps between supply and demand of financing.
- Favors simplicity
- Recognizes and manages all stakeholders.
- Perfect is the enemy of the good

Financing versus Market Maturity



Leveraging Commercial Financing through ESCOs	Can address financing and implementation issues and build ESCO Capacity. Needs market with operating ESCOs.
Commercial Financing (Loans/Bonds)	Can address financing issues. Needs clients with strong borrowing capacity
Partial Credit or Risk Guarantees	May scale up commercial financing. Needs relatively mature banking sector and eligible borrowers.
Dedicated EE Credit Lines	Leveraging of private funds. Needs Clients with Borrowing capacity.
Energy Efficiency Funds	Can be structured to address financing needs Challenging cost coverage from revenues.
Budget Financing with Budget Capture	Easy to implement; can directly finance projects. Sustainability is questionable
Budget Financing (Grants)	Easy to implement; can directly support projects. Not Sustainable; distorts the market

EE/RE Financing Approach in Buildings

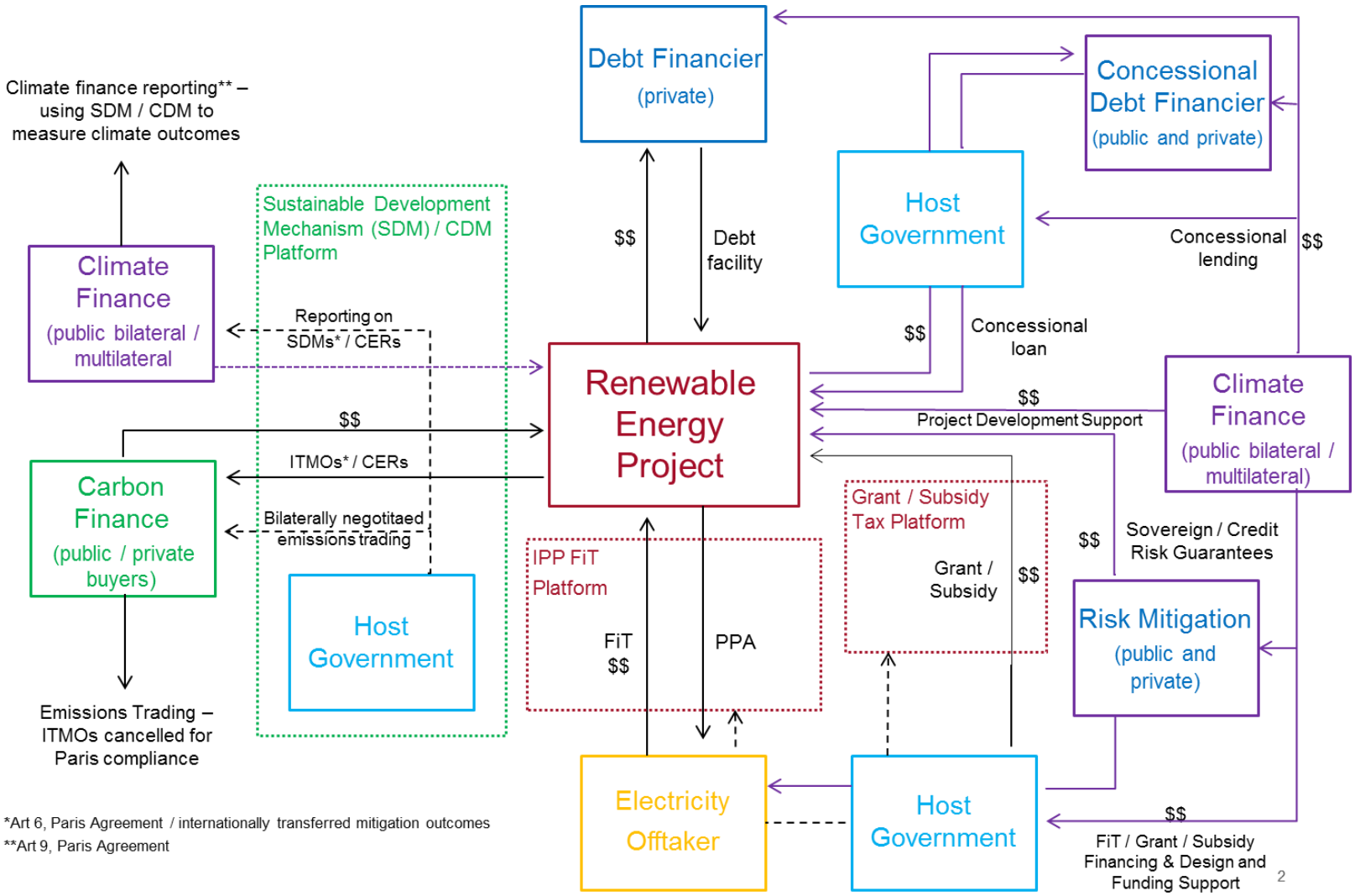


EE/RE Financing Approach in Industry

- The market assessment has narrowed down priority market sectors with high potential.
- Additional assessment cuts across technologies, to identify "financing sweet spots" suiting the bank's business model.

Energy Conservation Measure	Manufacturing of Machinery and Equipment	Food & Beverage	Textile Manufacturing	Hotels	Trade and Services	Pulp & Paper
Cogeneration		X		X		X
Boilers, Chillers, Compressors	X	X	X	X	X	X
Cooling Tower	X	X	X	X	X	
Lighting	X	X	X	X	X	X
Pumps	X	X	X	X		X
Efficient Furnaces	X	X	X			X
Energy Management System	X	X	X	X		X
Heat Pumps			X	X	X	
Insulation	X	X	X	X		X
Waste Heat Recovery System	X	X	X	X		X

Approach to RE Financing



Innovative Financing

Innovative financing is a term used to depict a financing mechanism to provide finance to projects which are insufficiently addressed by traditional finance, and try to provide financing more efficiently.
Innovative financing includes several models and/or approaches

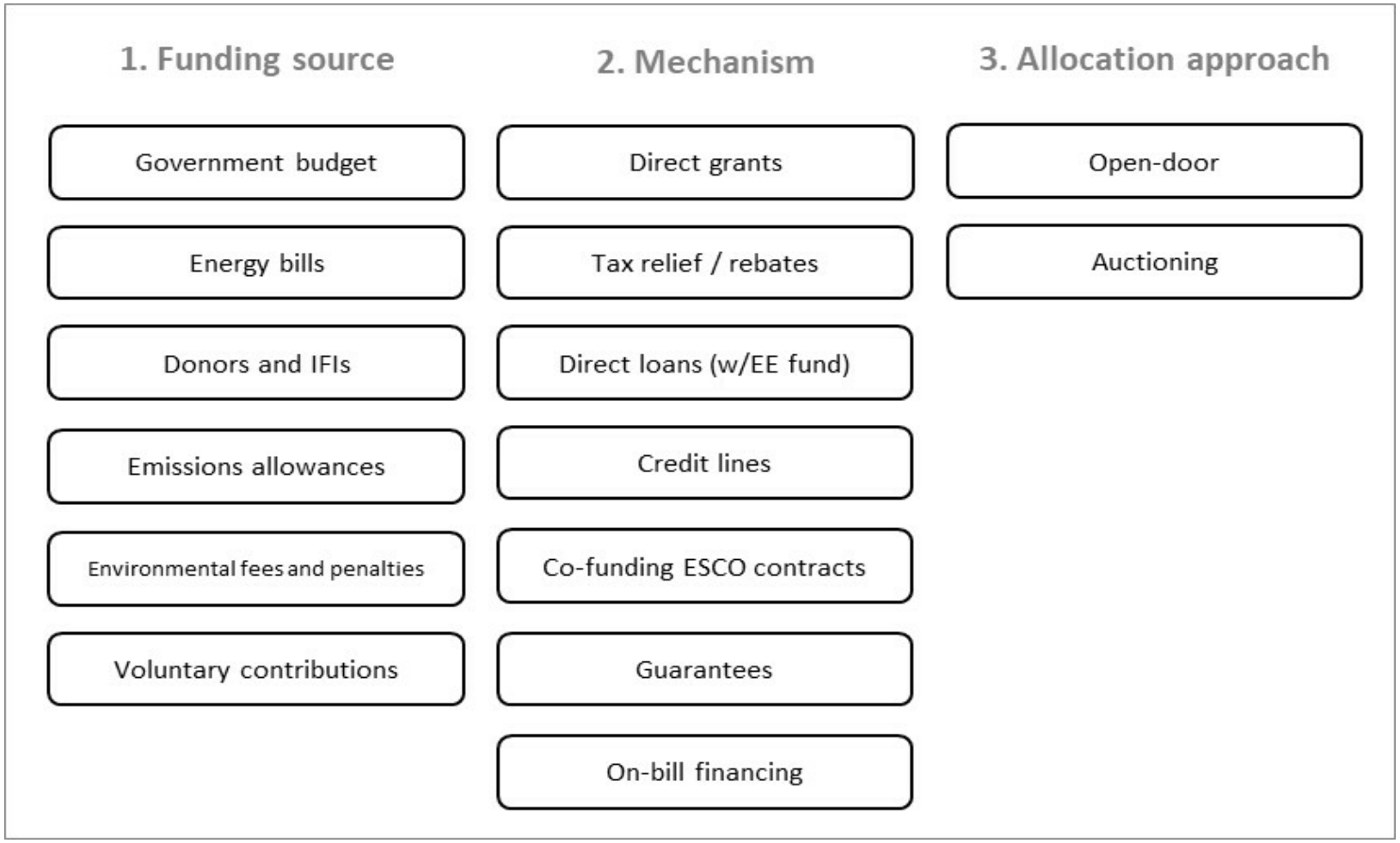
As defined by the Organization for Economic Co-operation and Development "OECD"

"Innovative financing comprises mechanisms of raising funds or stimulating actions in support of international development that go beyond traditional spending approaches by either the official or private sectors.

Energy Efficiency Financing Mechanisms

- Energy Efficiency “EE” financing mechanisms can provide support through several approaches; such as:
  - Upfront Grants
  - Tax Relief
  - Direct loans with softened conditions
  - Financial support via third party, typically Energy Services Company “ ESCO”
  - Provision of guarantees for loans
  - On-Bill financing with softened conditions

Financing Mechanisms Components



Source: EBRD – Centralized Energy Efficiency Financing Mechanisms : Policy Guidelines

Funding Sources

Source	Advantages	Disadvantages
Government budget	• Legislatively straightforward • Can be provided as loans	• Impact on government balance sheet • Lack of stability: subject to budget cycles
Energy Bills	• Can have more stability than general taxation • Easier to achieve scale	• Can be politically controversial • Collection difficulties for unregulated fuels
Donors and International Financial Institutions	• Government budget neutral • Can draw on expertise of donor	• Length of time to mobilize • Usually time-limited

Types of Mechanisms

- Direct Grant:
  - Subsidy and Rebates provided directly to reduce investment cost
  - May be supported by a list of products for subsidy
  - Good for early stage products where proof of concept is critical to gain
  - Main disadvantage is budget limits and distort by drawing focus away from life cycle cost.
- Tax Relief / Rebates
  - Can be provided as credits, or reductions
  - For enterprises by accelerated depreciation
  - Hel embed energy efficiency is decision making
  - Can be difficult to evaluate due to lack of data recording.

Types of Mechanisms

- Direct Loans:
  - Personal or business loans offered by public firms on preferential terms.
  - In revolving funds, repayments are used to initiate further projects.
  - Suited to large and costly projects
  - Main disadvantages: can be complex to set up – Consumers still bears risk.
- ESCO – Performance Contracting
  - Performance Contract with Energy Service Companies
  - Suited for public sector
  - ESCO takes technical risks
  - ESCO's may add value to the end-use.

Types of Mechanisms

- On-Bill Financing
  - ➢ Finance provided by Utility with repayment included in bills
  - ➢ Repayment may be tied with the savings achieved
  - ➢ Disadvantages: costly measures may not be covered by this mechanism

- The various mechanisms should not be considered mutually exclusive. Combinations of more than one mechanism have been successfully implemented; such as:
  - ✓ Combinations of on-bill financing and rebates, when the on-bill alone would have a long repayment period.
  - ✓ Combinations of loan with tax rebate.

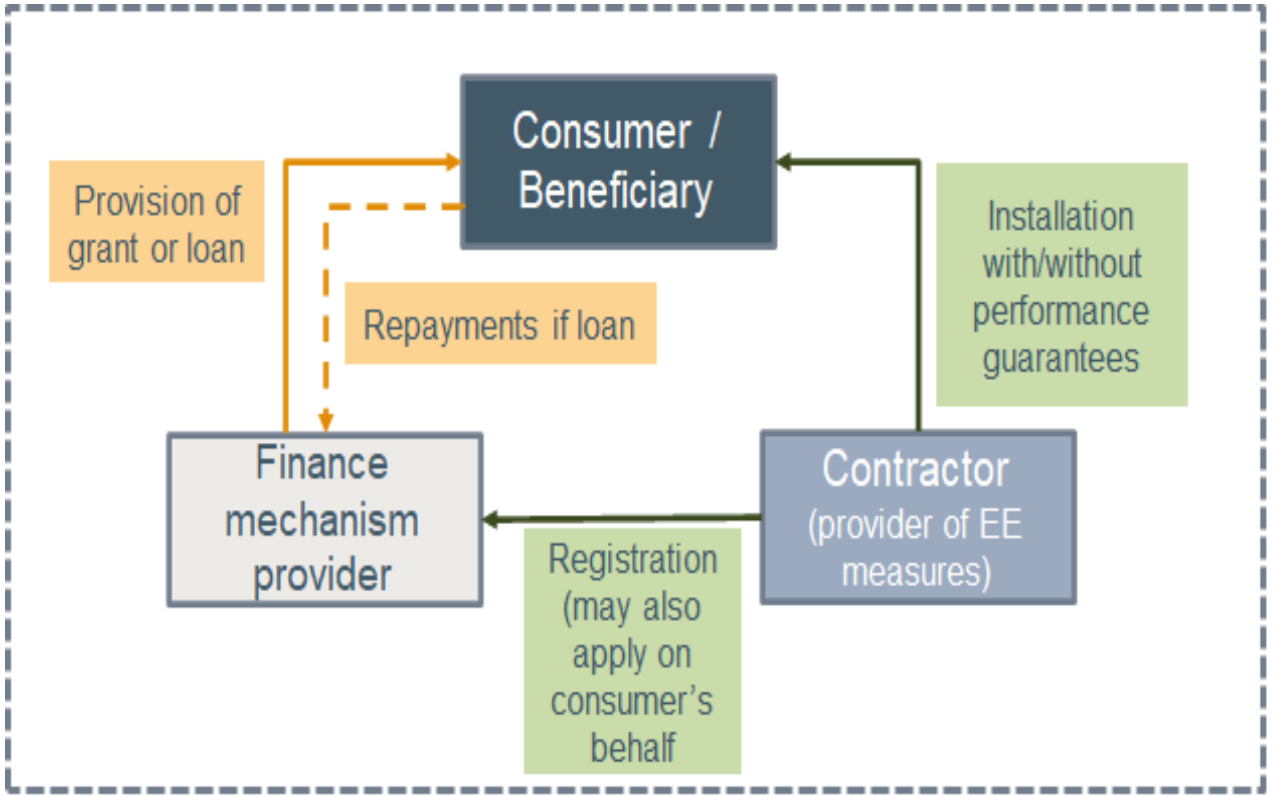
- The most appropriate mechanism to be deployed will depend on:
  - The end-use sectors
  - The Energy Efficiency Measure “EEM” – complexity – cost.
  - Profile of end users being targeted
  - The market failures being addressed

End-Use Sectors: EEM and Profiles

End-Use Sector	EEM	End-use profile
Residential	• Large volume of common measure • Combination of simple measures • Combination of expensive measures	• Owners –occupiers - renters • Single or multi-family homes • Differential income levels
Commercial	• Similar to residential with greater scale • Ability to aggregate	• Size of facility • Nature of the facility
Industrial	• Large volume common measures • Complex and costly	• Level of energy Intensity
Transportation	• Short term behaviour (Eco-driving) • Costly long term fuel switching	• Fleets or Private vehicles • Passenger cars, light or heavy trucks

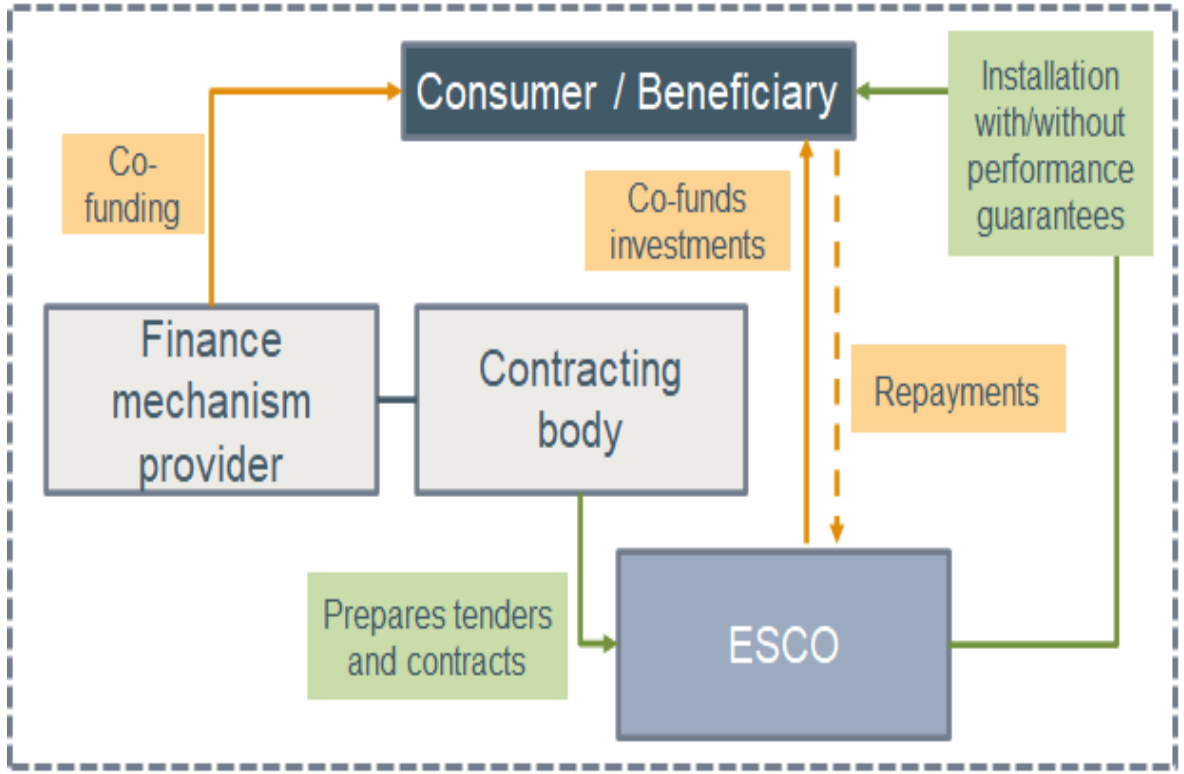
Contractual Models

Co-Funding through direct grants or loans provided to end user



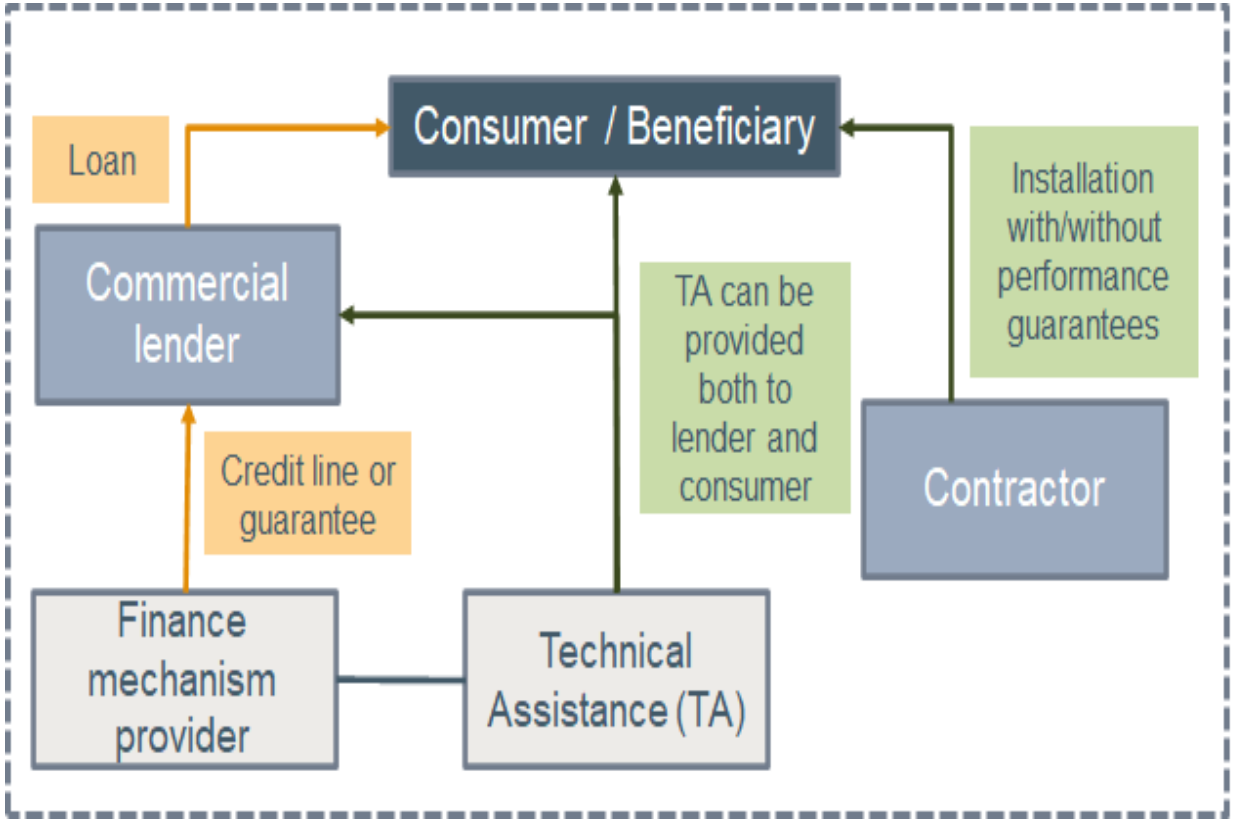
- Simple and clear structure
- Aligns with open door allocation for common measures
- High administration resources and cost
- May be supported by technical advice provided by agency at arms-length to financier

Co-Funding combined with performance contracting with ESCO



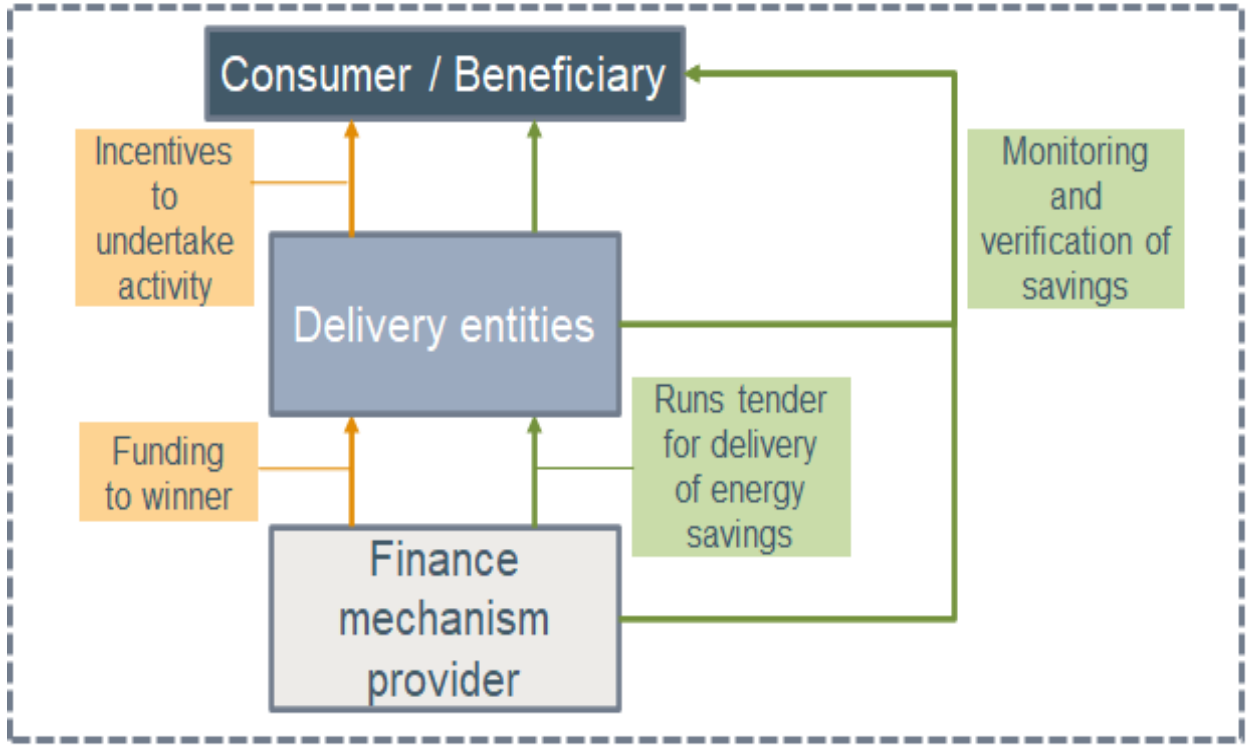
- Contracting body may be separate entity from finance mechanism provider via agreement
- Model fits with small number of large projects (typically public sector)
- Fits with ESCO model
- Risks may be passed through

Credit lines or guarantees provided via intermediary commercial lender.



- Finance mechanism provider and TA may be integrated entity or via agreement
- Registration or qualification requirements may be set for contractors and/or list of "approved appliances" issued

Tendering for financial support to intermediary project delivery entities



- Selection of projects outsourced to delivery entities
- Delivery entities may be ESCOs or intermediaries (e.g. utilities) who will themselves contract installers
- Selection based on least-cost alone or multi-criteria

Energy Services Company - ESCO

Energy Services Company “ESCO’s” are companies that offers a range of energy eservices to end-users – starting by performing energy audits, identification of potential Energy Efficiency Measures ”EMM” ending design, equipment procurement, installations and Operations and Maintenance Under an Energy Savings Performance Contract “ESPC”.

The services provided by an ESCO may include providing or arranging the finance needed for implementation. Such services are provided under a performance based contract under which payments to ESCP are dependent on achieving a pre-specified performance levels

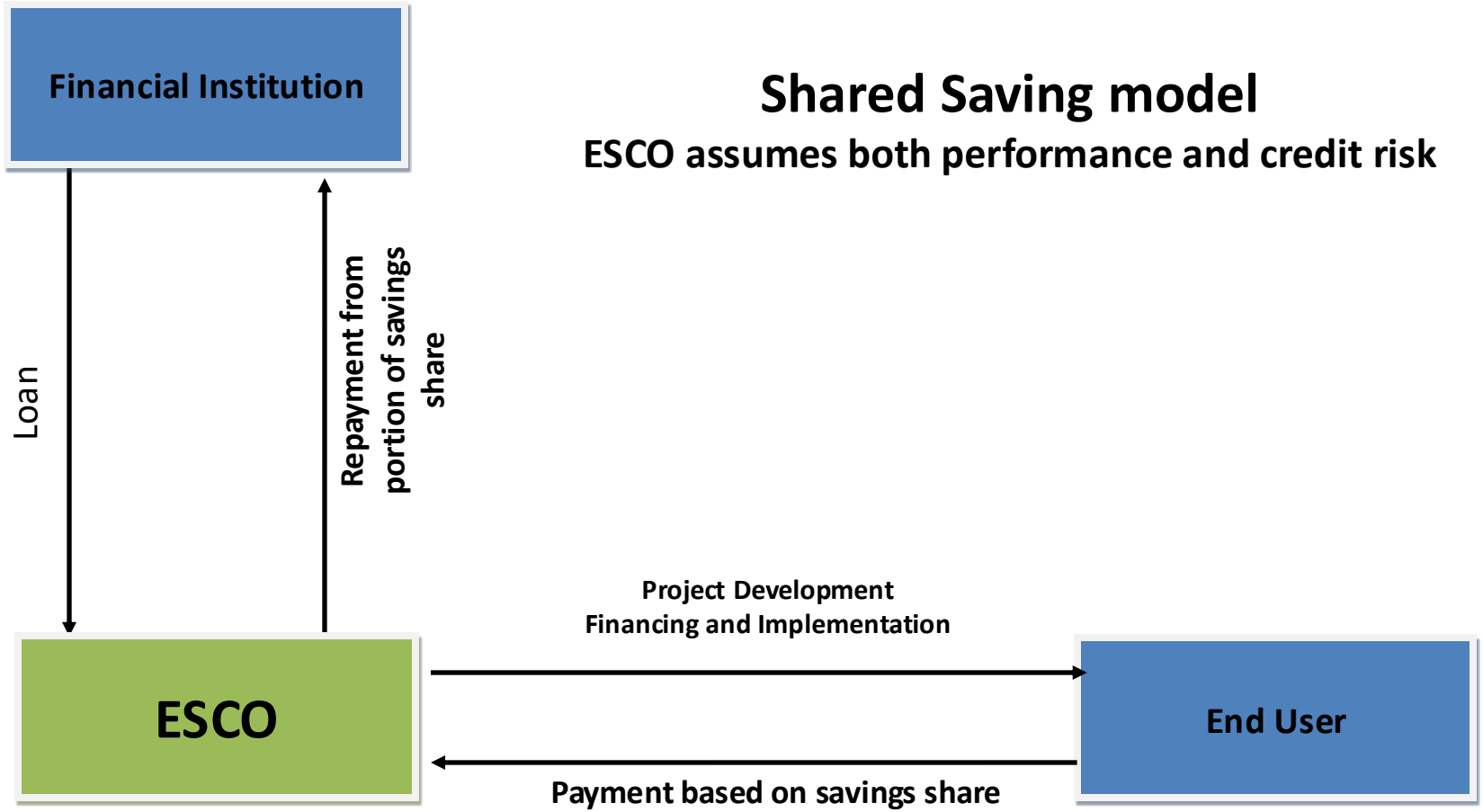
ESPC Models

The ESPC has two arrangements:

1. **Shared Savings :** in which the ESCO self-funds the project. The energy cost savings realized by the ESMs are shared between the ESCO and the asset owner over a set period of time at a pre-agreed percentage to allow the ESCO to recover its implementation costs and obtain the desired return on its investment.
2. **Guaranteed Savings**: in which the customer funds the project and the ESCO guarantees certain performance parameters (such as efficiency, energy saving and/or cost saving) in return for a fixed payment. The customer typically retains all of the savings achieved as a result of the ESMs. If the performance guarantees are not achieved and the savings are not enough to cover debt service, then the ESCO covers the shortfall (typically via payment of liquidated damages).

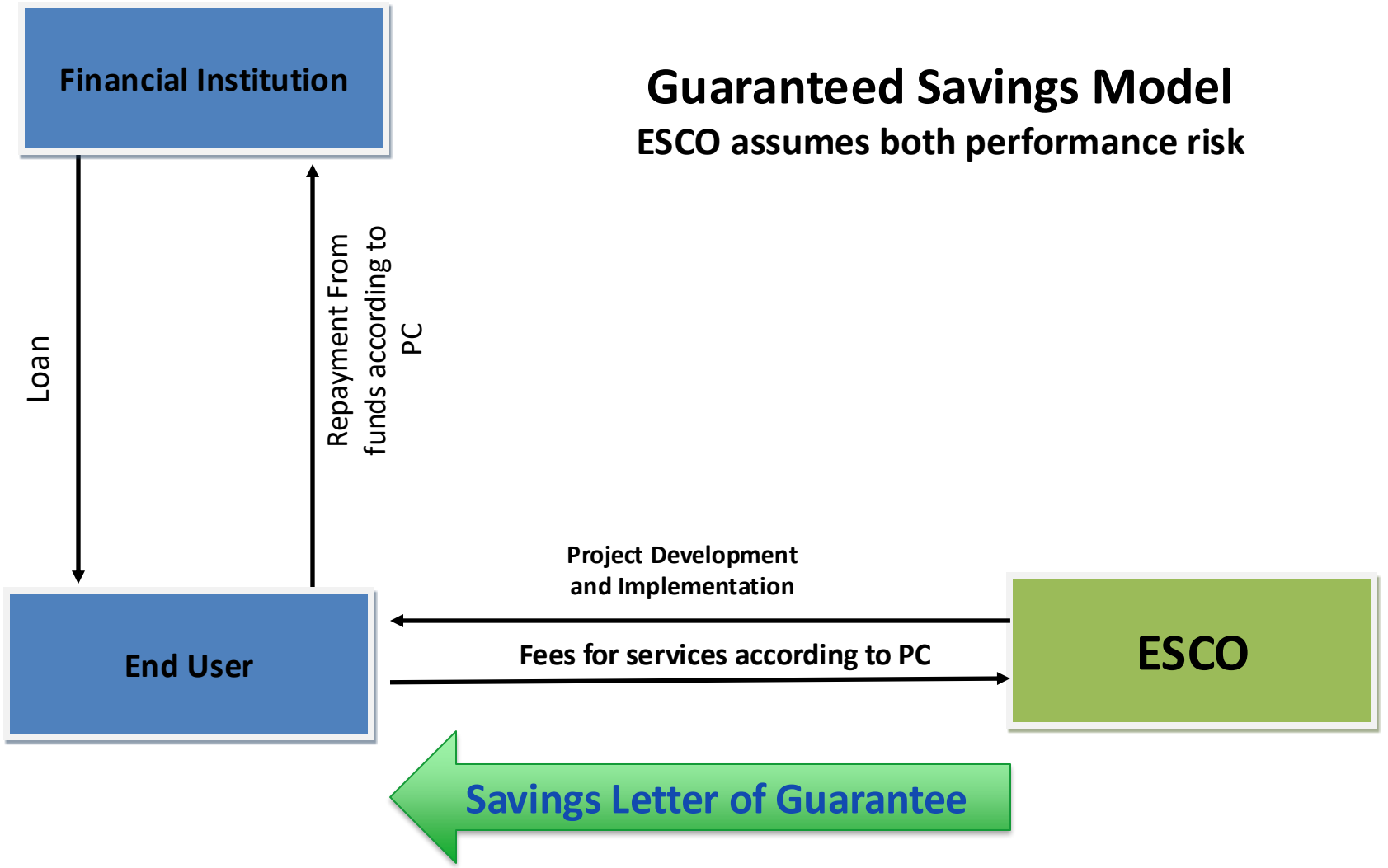
Shared Saving model

ESCO assumes both performance and credit risk



Guaranteed Savings Model

ESCO assumes both performance risk



Super ESCO

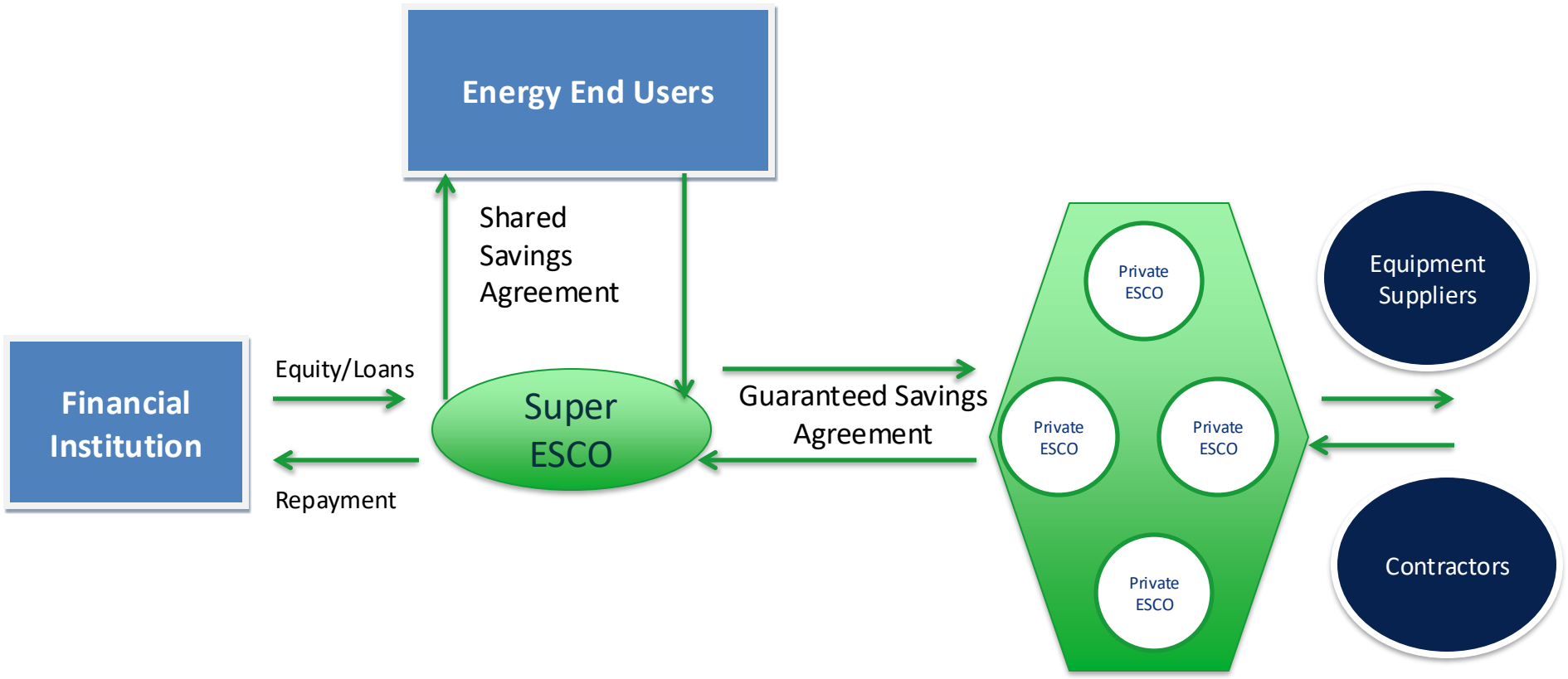
Large-scale implementation of energy efficiency projects by independent ESCOs is constrained by a number of factors:

- Customers lack of understanding
- Long Term commitments with several end-users
- Lack of legislations
- Lack of Measurement and Verification experience

The Super ESCO concept was developed as a potential solution to address the difficulties facing the Energy Services Companies.

A Super ESCO is an entity established by a government or via a public-private partnership to function as an intermediary between the government, facility owners and ESCOs to coordinate the large-scale implementation of energy efficiency projects

Conceptual Model For Super ESCO



Energy Efficiency Measures "EEM" in Residential and Commercial Buildings

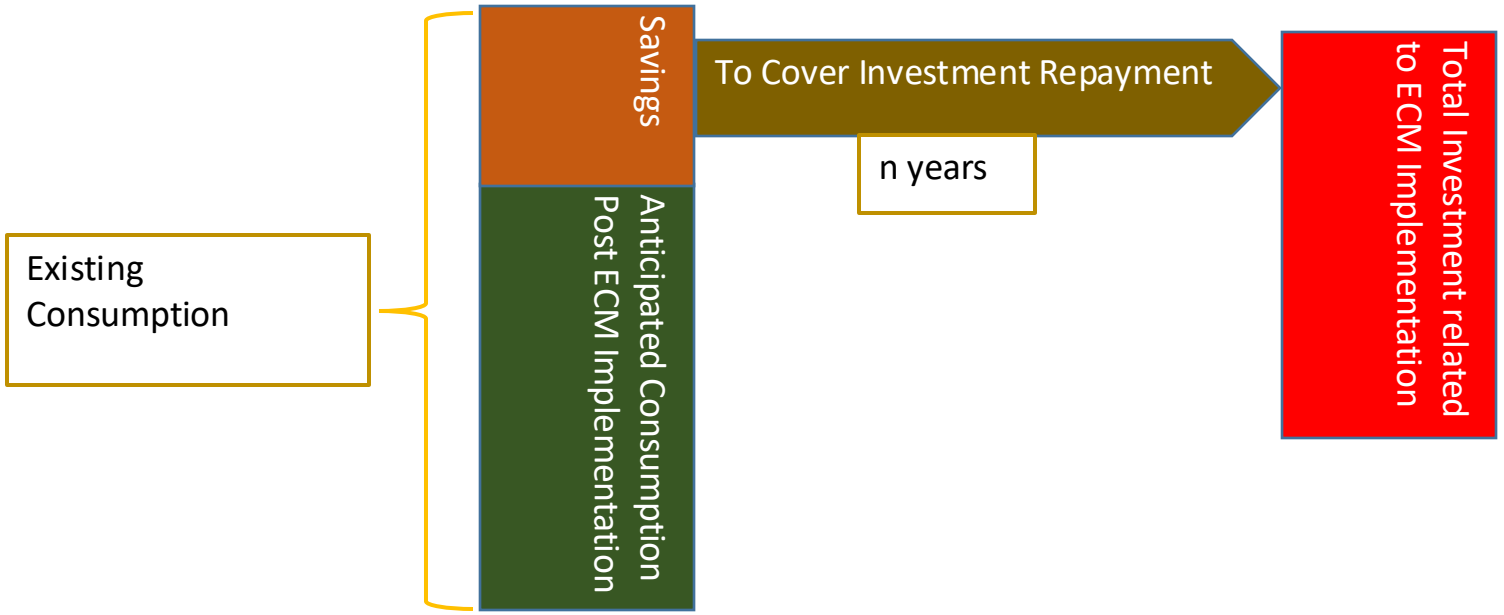
(1) efficiency improvements on existing and new building shells,
(2) efficiency improvements on new equipment,
(3) efficiency improvements on existing equipment,

Summary of Innovative Finance

- The innovative financing mechanisms are;
- Guarantees.
- Performance Based Contracts.
- Bonds.
- Microfinance.
- Development Impact Funds.
- Investment Funds.
- Auctions.

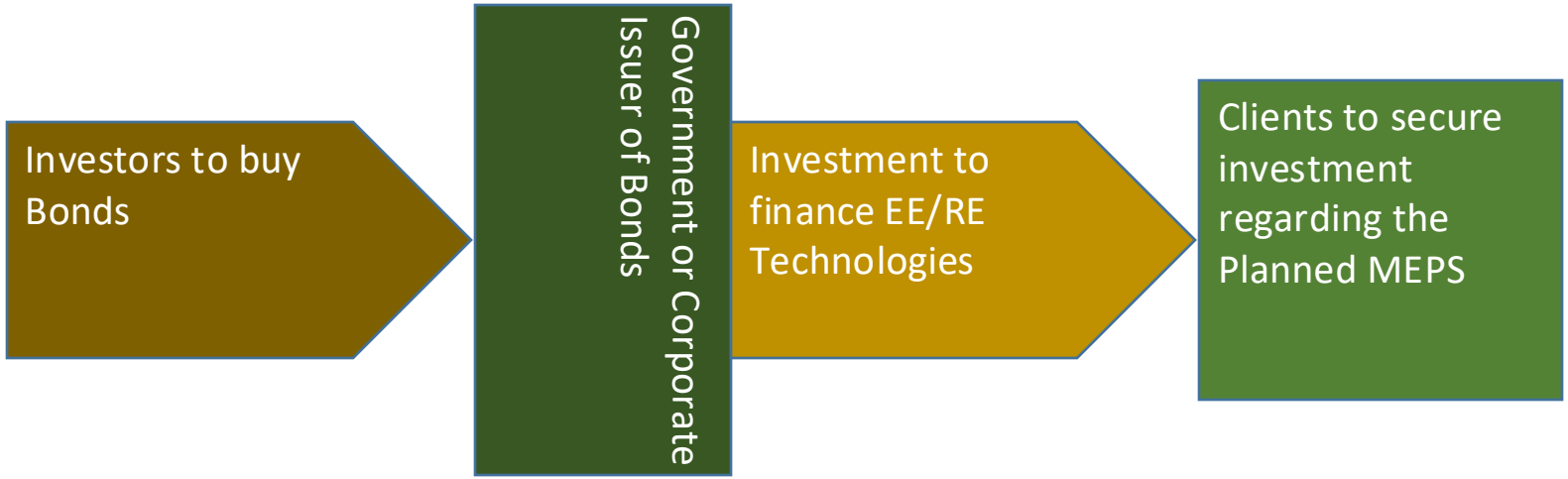
Microfinancing

- Microfinance refers to the financial services provided to low-income individuals or groups who are typically excluded from traditional banking. Most microfinance institutions focus on offering credit in the form of small working capital loans, sometimes called microloans or microcredit.
- It can be applied for cross cutting technology of energy efficiency based, i.e. Lighting systems, household energy labeled devices, etc.



Bonds

- Bonds are issued by governments and corporations when they want to raise money. By buying a bond, you're giving the issuer a loan, and they agree to pay you back the face value of the loan on a specific date, and to pay you periodic interest payments along the way, usually twice a year.



Performance Based Contracts

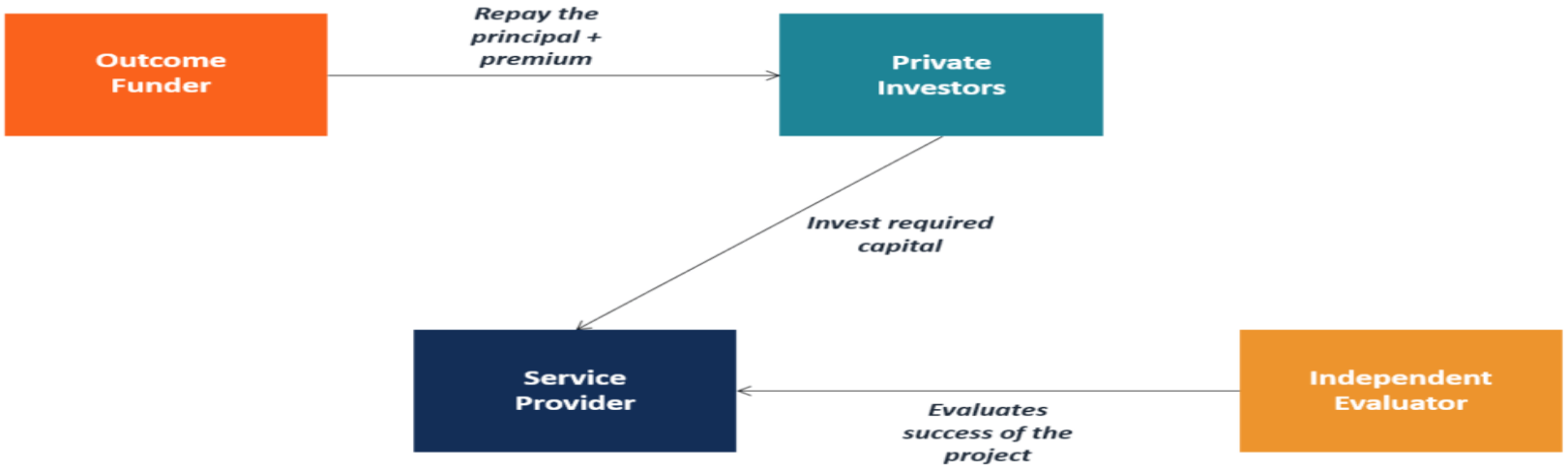
- An energy savings performance contract (or simply, performance contract) is an agreement between a building or facility owner or occupant and a performance contractor. The contractor identifies, designs, and installs energy conservation measures (ECMs) and guarantees their performance.
- The two most common types of EPCs are referred to as a (1) shared savings or (2) guaranteed savings model. The EPC provides the customer with a guaranteed level of energy savings and the ESCO with a reliable source of revenue.

Guaranteed Savings

- the customer assumes the obligation to repay the debt to a third party financier, which is often a commercial bank or a leasing company. In case if the project savings fall short of the amount needed for debt service, the ESCO is going to pay the difference.
- A Guaranteed Energy Savings Contract (GESC) is an agreement between a qualified provider and a building owner to reduce the energy and operating costs of a building or a group of buildings by a specified amount.

Development Impact Fund

- A development impact bond is a type of financial security that is used to finance development programs in low-resource countries by attracting private investors.
- Development impact bonds are considered a sub-type of social impact bonds. Similar to other social impact bonds, development impact bonds are new financial instruments that were introduced only in 2012.



Investment Funds

- The investment fund definition is that it is a pool of capital that a number of individual investors pay into, which is used to collectively invest in different securities.
- They are managed by a professional portfolio manager who makes investment decisions on behalf of the investors.
- There are various types of investment funds, including mutual funds, exchange-traded funds (ETFs), and hedge funds, each with its own investment strategy and risk profile.
- Investment funds are subject to fees, including management fees and expenses, which can impact the overall returns for investors.
- Investment funds provide investors with a diversified investment portfolio that might help reduce risk and increase returns. However, like every other financial product, they also come with risks, including the potential for losses and exposure to market fluctuations.

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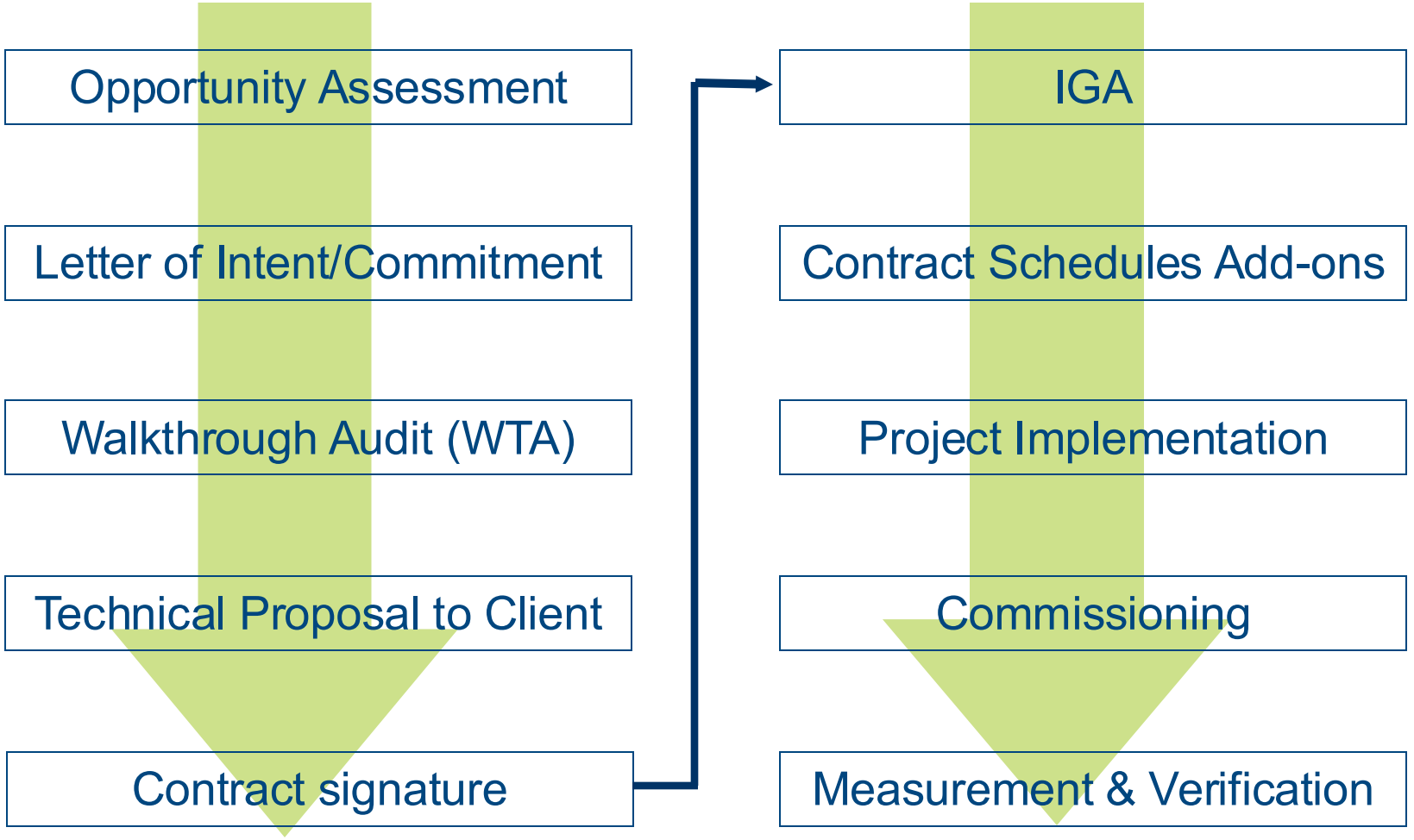
Auctions

- An auction is a system of buying and selling goods or services by offering them for bidding—allowing people to bid and selling to the highest bidder.
- The bidders compete against each other, with each subsequent bid being higher than the previous bid. Once an item is placed for sale, the auctioneer will start at a relatively low price to attract a large number of bidders.
- The price increases each time someone makes a new, higher bid until finally, no other bidders are willing to offer more than the most recent bid, and the highest bidder takes the item. An auction is considered complete when the vendor accepts the highest bid offered and the buyer pays for the goods or services and takes possession of them.

Session #7

Investment Grade Audit (IGA) and Risks Mitigation

Introduction and Process of IGA



Investment Grade Audit Vs Energy Auditing

- Cost calculation:
  - traditional: estimates
  - IGA: based on firm bids from entrepreneurs, manufacturers, etc.
- Savings calculation:
  - traditional: estimates, simulation
  - IGA: based on measured parameters
- An IGA costs at least 2 times more than a traditional energy audit.
- Allows making a savings guarantee accurately.
- The IGA has a higher value than a traditional energy audit.

Investment Grade Audit Vs Energy Auditing

- An investment grade audit is; A traditional energy audit
  +
  Risk assessment
  =
  Reduction of the level of uncertainty

IGA Objectives:

- **Establish the best scenarios for the energy efficiency project**
- **Put together tools for selecting energy-saving measures to be implemented**
- **Define the principal parameters for project design**

IGA Phases

Steps	Outputs
• Survey	• Data collection
• Analysis	• Energy analysis • Energy balance • Measures identification • Evaluation cost/savings
• Report	• Recommendations • Economic study

IGA Survey

- Basic information collection about facility/plant;
  - Function
  - Architectural, mechanical and electrical drawings and specifications
  - Occupancy and hours of operation
  - Year of construction
  - Energy bills for the last three years
  - Final use of each energy type
  - Monthly production level (for plant) for the last three years

- Information to gather (as much as possible)
  - Basic information collection about the facility
  - Collection and analysis of energy bills
  - Check for power factor penalties
  - Check if subscribed demand is adequate
  - Check for error and irregular patterns
  - Check if the rate applied is the best considering the energy usage pattern
  - Comparison with similar facilities.

Survey Outcome – before visiting the facility

- Comparison between energy bills and level of production for plants
  - Establish intensity index (energy by unit production)
  - Do a regression curve of production against energy to see what is the base consumption of the plant
  - Do a curve to plot demand against production
- Comparison with similar facilities
  - Using ESCO database of the yearly consumption for different types of faciities (to be built gradually)
  - Is the energy usage less or more than the average facility/plant of same type
  - Provide an indication of the potential for energy efficiency improvement

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Survey – Site Visit

- Meeting with Facility Manager and O&M Staff;
  - The Operation and Maintenance (O&M) staff will be part of the survey team as it knows system operations and the O&M personnel will operate new systems or equipment beyond project implementation.
- Site Visit Objectives;
  - Equipment survey
  - Schedules and operating set-points
  - Measurement of important parameters
  - Logging of some power loads
  - Discussion with upper management
  - Discussion with operators

Survey – Site Visit

- Meeting with Equipment/facility Operators;
  - Ask questions about seasonal variations
    - The audit time span is limited, we need to know what happens the rest of the time
  - Collaboration of the O&M team is essential
  - Meet the O&M team at the beginning of the project
  - Evaluate the O&M budget: the O&M of equipment that might be added will be performed on the basis of this budget
- Survey the Equipment Installed;
  - Quantity, nameplate information
  - Look at operating schedules
    - In control systems
    - In time clocks
  - Look at operating set-points
    - In control systems or control panels

IGA Measurement Campaign

- Confirm key value to be measured;
  - Temperature and Relative Humidity.
  - Flow rates.
  - Pressure.
  - Lux Level.
  - Combustion Efficiency Measurement.
- Install short and medium term data logger.
- Measure the energy flows with data logging to get the energy profile.

Lighting System Survey

- Review lighting drawings
- Review as-built specifications of equipment
- Develop on spot measurement plan
- For each type of space:
  - Take inventory of fixture types (lamp type, nameplate wattage, number of lamps of each type, ballast type, nameplate wattage of ballasts, number of ballasts/fixtures)
  - Identify type of control switching
  - Identify installed retrofits or system changes
  - Perform spot measurements (illumination, W, amps, V, power factor).

Mechanical System Survey

- Review mechanical drawings
- Record design parameters of major pieces of equipment
- Review as-built submittal specifications of equipment
- Develop spot measurement plan
- Identify location of equipment
- Take nameplate readings of equipment
- Verify location, numbers and capacities
- Identify installed retrofits or system changes
- Perform spot measurements (W, amps, V, power factor, RPM)

Example of Survey Form

Room Description	Equipment Description	quantity of equipment (Unit)	Total Power per unit (W)	Total Total Power (kW)	Sched. Number	Sched. Description
101	Small freezers and coke machines	8	1200	9.6	13	Freezers and cold rooms equipment
102	Cash registers	3	750	2.25	1	Hourly lighting schedule for store
103	air conditionner 18 000 BTU	8	2000	16	5	Air conditionning split systems #1 – store
103	miscellanious equipment	3	750	2.25	1	Hourly lighting schedule for store
103	air conditionner 18 000 BTU	6	2000	12	5	Air conditionning split systems #1 – store
103	miscellanious equipment	3	750	2.25	1	Hourly lighting schedule for store
104	Cash registers	2	750	1.5	1	Hourly lighting schedule for store
105	Evac fan	1	60	0.06	9	Other exhaust fans
105	air conditionner 12 000 BTU	1	1300	1.3	12	Air conditionning split systems #2 – office
106	computers and office equipment	2	600	1.2	4	Hourly lighting schedule for office
107	Evac fan	1	60	0.06	9	Other exhaust fans
108	air conditionner 12 000 BTU	1	1300	1.3	12	Air conditionning split systems #2 – office
109	Freezers (incl cond and evap fans)	2	8200	16.4	13	Freezers and cold rooms equipment
109	Coolers (incl cond and evap fans)	3	5500	16.5	13	Freezers and cold rooms equipment
110	UPS and stabilizer	2	1200	2.4	1	Hourly lighting schedule for store
110	Evac fan	1	60	0.06	9	Other exhaust fans
110	Evac fan	1	60	0.06	9	Other exhaust fans
111	Evac fan	1	60	0.06	9	Other exhaust fans
111	Evac fan	1	60	0.06	9	Other exhaust fans

Control System Survey

- Review control drawings
- Record design set-points and control strategies
- Review as-built submittal specifications of equipment
- Review trend logs if available
- Develop spot measurement plan
- Identify location of sensors, transducers, actuators and control panels
- Identify installed retrofits or system changes
- Perform/record spot measurements (temp, m^3/hour, Delta P)

Survey of Electrical Systems

- Review electrical drawings
- Confirm voltage of primary service, secondary service, tertiary service
- Inspect transformers
  - Note general condition of equipment
    - Floor around transformer should be dry
    - Transformer fins should be clean
    - Oil leaks?
  - Collect nameplate data

Energy Analysis Methods

- Simple Load Information Method
  - This method should be used for lighting, electric equipment, office equipment or any other load for which the kW load is known or measured.
- Motor Load Method
  - Method of estimating kW load based upon motor nominal horse power, loading and efficiency
  - Load factor is estimated

Energy Analysis by Usage

- ***Lighting Systems***
- Lux: Measure of adequate lighting
  (e.g.: office = 660 lux)
- Occupancy and hours of operation indicate a potential saving
- Important
  - Always measure real kW
  - Do not forget to include the ballast wattage
  - Low power factors are common

Energy Analysis by Usage

- ***Ventilation Systems***
- Ventilation Measurement
  - Flow
  - Pressure
  - RPM for motors
  - Motor load
    - AMP measurement only
    - AMP, volt and PF
    - Direct kW measurement

Energy Analysis by Usage

- ***Pumping Systems***
- Pumping Measurement
  - Flow (Doppler, ultrasonic)
  - Pressure
  - RPM for motors
  - Motor load
    - AMP measurement only
    - AMP, volt and PF
    - Direct kW measurement

Energy Analysis by Usage

- ***Heating Load Systems***

Degree-Day Method

A measure to correlate the outside temperature with the energy required for heating based on the assumption that heating is required when average daily temperature is less than 18°C (T balance)

Annual heating consumption SI (for T_{bal} = 18)

$$\frac{\text{Energy loss kW}}{\Delta T(^{o}K)} \times DD\ (^{o}K\text{-day}) \times \frac{24\ \text{hrs.}}{\text{day}} \times CF^{*} = kWh$$

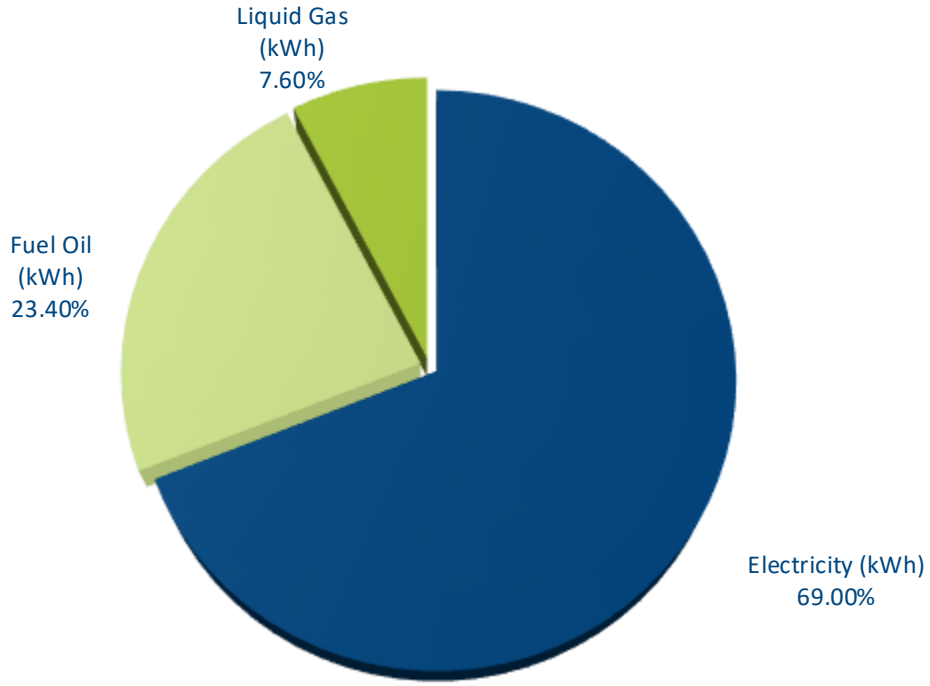
* A correction factor will be multiplied in the case of a different T balance

Energy Balance Objectives

- Establish historical performance and energy consumption of equipment
- Establish the balance between the energy bought to the distributor and the energy used by the facility
- Compare load and consumption evaluated from survey data with the billing
- Compare the actual situation with standards (benchmarking)
- Reduce the risk of overestimating or underestimating savings
- Determine actual temperature, humidity, air quality and illumination levels
- Evaluate demand and consumption per end-use

Concluded Energy Balance Presentation

- Overall Energy Consumed per each type of energy consumed is illustrated as below;

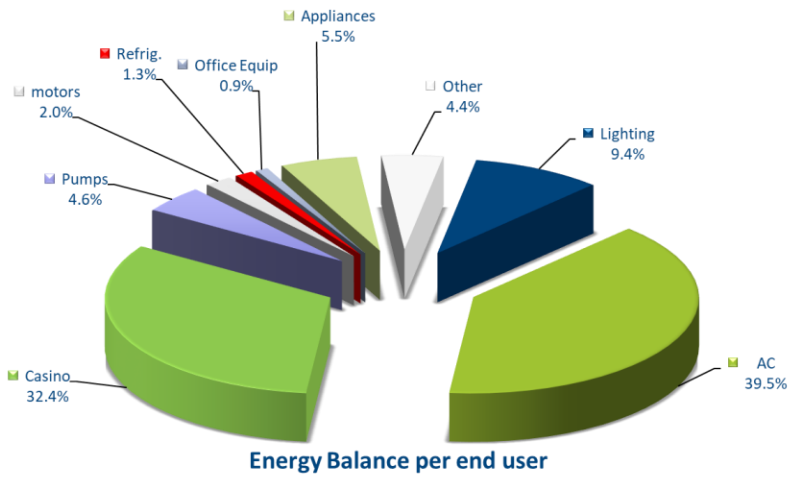


Total Annual Energy Consumption Distribution

- Also, per each energy source the individual energy devices could be presented.

Electrical Energy Consumption Distribution

- Example for 2,000 m2 Office Building in Country X:



Energy Balance per end user

Equipment	kW	kWh	kWh/m2/year	%
Lighting	44	71,563	35.78	9%
AC	311	301,430	150.72	40%
Casino	67	246,768	123.38	32%
Pumps	4	35,136	17.57	5%
motors	14	15,075	7.54	2%
Refrig.	4	9,728	4.86	1%
HVAC	0	0	0.00	0%
Office Equip	3	6,677	3.34	1%
Appliances	277	42,269	21.13	6%
Elevator	0	0	0.00	0%
Hot Water	0	0	0.00	0%
Other	40	33,770	16.89	4%
Total	**765**	**762,416**	**381.21**	**100%**

Average energy utilization index (kWh/m^2/year) for office building in country X: **381**

Energy Conservation Measures (ECMs)

- Identify energy conservation measures (ECM)
- Evaluate savings and risk for each measure.
- Preliminary design of measures.
- Assessment of implementation cost.
- Establish the best scenario for an energy efficiency project

✓ All activities, data, analysis and proposal are documented and presented in the IGA report.

MEPS Technologies/ECMs

- Lighting
- Motors
- VSD
- HVAC: Cooling, Heating
- Building Management Systems
- Compressed Air
- Building Envelope

Lighting Technology

- Average simple payback period: 2-3 years
  - High-efficiency lamps and ballast
  - Daylight controls and natural daylight design
  - Retrofits for existing fluorescent fixtures include electronic ballasts, T8 lamps, and reflectors.
  - Timers and occupancy sensors.
  - LED security lighting and exit signs
- The payback period is relying on the investment cost and the energy tariffs applied scale.

High Efficient Motors and Speed Drives

- Average simple payback period: 3-5 years
  - High-efficiency motors
  - Proper motor sizing for actual load profile
  - Power factor correction system
- Speed Drives of average simple payback period; 3-5 years
  - Applied to motors, pumps and fans
  - Matches motor use to variable operating load
  - Can save 40 percent in power consumption
  - Can be packaged with controls
  - Extends motor life
  - Many machines driven by electric motors, such as pumps and fans, usually do not require full speed/power output.
  - ASD is a device used to provide continuous range process speed control.
  - ASD can adjust both speed and torque.
  - AC or DC drives.

Heating, Ventilation, and Air Conditioning Systems (HVAC)

- Average simple payback period: 2-8 years
  - New packaged units can increase efficiency and indoor comfort
  - Proper sizing of HVAC equipment (full load operation, multiple units network, etc.)
  - VSDs for pumps and fans
  - Balance air and water supply systems
  - Install economizers and direct digital controls
  - Variable air volume conversions versus constant air flow
  - Switching the Cooling/Heating from technology to another upgrading the Coefficient of Performance (COP).

Cooling

- Average simple payback period: 5 – 10 years
  - Efficient equipment
    - Window/wall units, rooftop/split units
    - Heat pump
    - Efficient chillers: New chiller models are typically 30-40 percent more efficient than existing equipment
  - Simple measures on chillers
    - Chilled water temperature reset
    - Chiller operation optimization
    - Condenser temperature
    - Free cooling on chillers
    - Optimize HVAC operation to:
      - Improve temperature/humidity control
      - Eliminate unnecessary cooling loads
    - Optimize pumping energy for distribution of chilled water

Heating (Boilers) and Heat Recovery

- Average simple payback period: 1 - 5 years
  - Replace steam with hot water boilers to meet hot water heating loads
  - Improve maintenance
  - Optimize operation/staging in multiple boiler plants
  - Optimize boiler controls
  - Tune or replace burners
- Average simple payback period: 2 - 4 years (Heat Recovery)
  - Recovery of waste heat from water, process heat and exhaust air to preheat:
    - Intake air
    - boiler combustion air
    - boiler feed water
    - Inlet water for domestic hot water

Building Management System and Building Envelope

- Average simple payback period: 3 - 5 years
- Centralization of controls
  - Remote diagnosis, metering and monitoring: very efficient for a group of facilities
  - Energy management
- Average simple payback period: 3 - 10 years (Building Envelope)
  - Roof insulation, combined with reflective roof coatings in warm climates
  - Balance exhaust and intake air quantities
  - Install weather-stripping on doors and windows
  - Seal cracks and unnecessary openings
  - Window films to reduce solar heat gain and/or heat loss
  - Replace windows with more energy-efficient glazing

Evaluation of Cost Benefit Analysis

- Indicators to Determine Project Economic Interest
  - Simple payback period
  - Life-cycle cost analysis (LCCA)
  - Net Present Value (NPV)
  - Internal rate of return (IRR)

IGA Report Structure

- Executive summary
- Introduction
- Objectives of the report
- Current characteristics and operations of the facility
- Description of electrical and mechanical systems
- Energy bills of the facility
- Proposals and recommendations in energy efficiency
- Summary and balance
- Conclusion

Session #8

Role of Banks in EE/RE Financing – Barriers & Solutions

Risk Assessment and Mitigation

Role of Banks in Financing EE/RE

- Banks play a **crucial role in financing energy efficiency (EE) and renewable energy (RE) projects**, but their involvement is often limited by several barriers and Risks.
- **Role of Banks in EE/RE Financing**

1. **Capital Providers**: Offer loans, credit lines, or project financing for EE/RE investments (e.g., solar farms, green buildings).
2. **Risk Mitigators**: Develop risk-sharing mechanisms or partner with international funds.
3. **Market Enablers**: Drive demand for green technologies by offering attractive financing products.
4. **Financial Innovators**: Create tailored instruments such as green bonds, energy performance contracts (EPCs), and on-bill financing.
5. **Advisors and Aggregators**: Help clients assess project feasibility and bundle small EE/RE projects for bankability.

Barriers to EE/RE Financing by Banks

1. **Perceived High Risk and Uncertainty**
   - EE/RE projects often have unproven or long payback periods.
   - Performance risks and technology unfamiliarity increase caution.
2. **Lack of Technical Expertise**
   - Many banks lack in-house specialists to evaluate EE/RE projects.
   - Difficulty in assessing energy savings and ROI.
3. **Small Ticket Sizes**
   - EE investments (e.g., retrofits) often involve small capital, making due diligence costs disproportionately high.
4. **Collateral and Creditworthiness Issues**
   - Energy savings cannot easily be collateralized.
   - SMEs or households may lack sufficient credit history.

Barriers to EE/RE Financing by Banks

5 **Regulatory and Policy Uncertainty**

- Inconsistent subsidies, tariffs, or energy regulations deter long-term investment.

6 **Lack of Standardization**

- No uniform project templates or contracts for EE/RE financing.
- Makes project aggregation and securitization difficult.

Solutions for Barriers

1. **Capacity Building & Technical Support**
   - Train bank staff on EE/RE technologies and project evaluation.
   - Use external consultants or energy service companies (ESCOs) for due diligence.
2. **Lack of Technical Expertise**
   - Many banks lack in-house specialists to evaluate EE/RE projects.
   - Difficulty in assessing energy savings and ROI.
3. **Risk Mitigation Instruments**
   - Leverage guarantees from international donors (e.g., World Bank, GCF).
   - Use partial risk guarantees, political risk insurance, and first-loss reserves.

Solutions for Barriers

4 **Blended Finance**

- Combine public funds or concessional capital with private financing to reduce risk and enhance bankability.
- Example: Green Climate Fund co-financing programs.

5 **Green Financial Products**

- **Green bonds**: Fixed income instruments for large-scale EE/RE.
- **Green mortgages**: For energy-efficient homes with lower interest rates.
- **On-bill financing**: Repay EE loans through utility bills.

6 **Aggregation and Securitization**

- Bundle small-scale EE/RE projects into a portfolio to reduce transaction costs and diversify risk.
- Develop standardized contracts and performance metrics.

7 **Policy and Regulatory Support**

- Stable feed-in tariffs, carbon pricing, or EE standards increase confidence.
- Government incentives or mandatory green lending quotas for banks.

Types of Risk

- **Energy savings are affected by:**
  - **Construction / installation process**
  - **O&M of the equipment**
  - **Performance of installed equipment**
  - **Usage (runtime)**

- **Cost of construction overrun is another major risk**

While monetary energy savings are affected by:

- **Interest rate structure**
- **Inflation**

CONSTRUCTION/INSTALLATION Risk

- Implement “On Time” and “On Budget”
- Manage Contractors & Vendors
- Achieve “Turnkey” Installed Price
- Adhere to Design Specifications
- Meet Completion Deadlines
- Meet Commissioning Requirements
- Comply with Regulatory and Legal Issues

FREQUENTLY ENCOUNTERED CONSTRUCTION/INSTALLATION ISSUES

- Shortages of Equipment, Labor and Materials
- Difficulties with Final Permits & Licenses
- Commissioning is Not Achieved
- Contractor Does Not Complete Construction
- Cost Overruns Caused By:
  - Poor Original Estimate
  - Poor Construction Management
  - Force Majeure Events (Labor Strikes, Natural disasters)
  - Unanticipated Delays

Operation Risk

- Obviously EE Measures must be operational to generate savings
  - *What happens if equipment broke (even with warranty)*
  - *Effect of off-time on overall savings*
- **Example:**
  - *A new condensing boiler breakdown on warranty but requires 3 months for replacement. Most of the peak heating season savings are lost. So the project will support additional financing up to the next heating season and loose one year of contract.*

- Performance may be compromised by poor design or implementation.
- Manufacturers claim may not materialize in the field
  - *System effect ; Equipment are not installed in ideal condition*
- Equipment performance may change over time
  - *degradation and/or poor O&M practices.*
- These are factors that the borrower normally (but not always) controls.

Performance: Equipment Performance

- Equipment performance is affected by design and by long-term maintenance.
- Who is going to conduct the long-term maintenance?
- How will long-term performance be verified?
- Equipment performance is often linked to operations & maintenance procedures.
- If Owner conducts O&M, will the suppliers/installers be responsible for poor O&M practices?
- If a third party conducts O&M, what is the scope of services and at what the cost?
- What about repair & replacement?
- What if equipment life < loan term?

Usage Risk

- Usage can vary as a function of change in occupancy, utilization of the facility or external factors
- Usage comprises:
  - operating hours (lighting, equipment, ventilation)
  - heating & cooling loads (& setpoints)
  - weather
  - production
- *These are factors that the Owner/Borrower (or no one) controls.*

Operating Hours

- Energy use and savings fluctuate with equipment and facility operating hours.
- If the Owner reduces operating hours of equipment targeted by energy conservation measures and savings are not realized it may disrupt the debt service.
- If the Owner increases operating hours of equipment not targeted by the project, utility bills will increase, which again disrupts debt service.

Loads Changes

- The Facility Owner/Borrower may make changes that affect equipment loads (e.g., additional air conditioning).
- If loads increase and savings increase, the client will benefit from that, hence the credit risk will decrease.
- If loads and savings decrease, it may spoil debt service capability of the client.
- How will savings estimates be affected if:
  - The Owner adds or removes loads?
  - Adds building space?
  - Removes building space?
  - Changes thermostat settings?

PROJECT COST OVERRUN

- Cost overrun can create large problem:
  - Similar to any investment project
  - The borrower must adopt same estimating methods like general contractors
  - Contingencies are essential
- Some contractors do not provide turnkey pricing and just charge a project management fees on top of real pricing obtained by open book bidding
- Provisions in the loan contract should address the risk of cost overrun.

RISK LEVEL OF TYPICAL PROJECTS

Energy Efficiency Technologies	Risk Level
• High-efficiency lighting	Low
• Heating ventilation air-conditioning (HVAC) upgrades	(Med to High)
• New automated building and HVAC controls	(High – difficult to measure)
• Variable speed drives (VSDs)	(Med to High)
• High-efficiency chillers	Low
• High-efficiency boilers	Low
• Combustion and burner upgrades	Low
• Fuel switching	(Low if prices are stipulated)
• Water conservation; i.e., toilets, showers, faucets	Low
• Heat recovery and steam traps	Low
• Power factor correction	Low

RISK LEVEL OF Industrial Facilities

Energy Efficiency Technologies	Risk Level
• New automated process controls	Low
• Heat recovery from process air and water	Low
• Cogeneration used for peak savings	High (many variables)
• Water recycling	Low
• Process equipment upgrades	(Low to High)
• Process changes	(Med to high - depending on technology)

Risk Sources and Mitigation

- Contractor Selection
- Audits
- Design
- Construction Cost Evaluation
- Construction Management
- Health and Security
- Energy Savings Achieved
- Client Credit Strength
- Financial Parameters
- Change in Facility Use
- Savings Evaluation
- Maintaining Energy Savings Over Time
- User Behavior

RISK CONTROL – CONTRACTOR SELECTION

Sources

- Choose the wrong contractor
- Contractor has no motivation

Solutions

- Make sure company with proven track record is selected to implement the project
- Quality assurance guarantees to be provided upon payment

RISK CONTROL – PROJECT DESIGN

Sources

- Existing drawings and specifications not updated
- Use of new lines of equipment

Solutions

- Verify data from drawings and specifications
- Avoid utilization of unproved technology
- Carefully work with unfamiliar processes
- Always check references for a product
- Include a contractual clause for return of defect equipment

RISK CONTROL – CONSTRUCTION COST EVALUATION

Sources

- Some contractors are not very familiar with turnkey cost evaluation
- They do not have experience in cost evaluation

Solutions

- Obtain firm bid from contractors before presenting an offer to the client
- Maintain contingencies
- Evaluate site expenses
- Include a clause allowing cost adjustment within 10-15% of estimation

RISK CONTROL – CONSTRUCTION PERIOD

Source

- The more on-site work delays, the more temporary financing accumulates and the more the repayment period shortens, if the contract has a fixed duration.

Solutions

- For a fixed duration contract, the principal payment start-up date may be fixed when all the measures are implemented (flexible grace period).

Risks Mitigation

- Good financial analysis of the targeted facility
  - Owner and facility have to be in a good financial position.
- Off-setting projects
  - Integrate projects that react in a direction opposite to that of specific risks (e.g., natural gas consumption reduction in addition to a cogeneration project).
- Diversification
  - A secure project will include more than one measure so that the risk will be scattered among as many measures as possible.
- Front-loaded cash flow
  - The more the borrower commits himself upfront, the better.
  - Better to risk the potential profit than the bank funds.
- Price caps
  - If possible, the borrower should limit the risk on the variation of the construction costs related to changes in tax laws, import duties and variation of the exchange rates.

Risk mitigation strategies

- **Risk: Estimated Savings Are Not Realistic**
  - Ensure that an investment grade audit (IGA) is properly prepared and independently reviewed by technically competent energy engineers
  - Utilize a multi-level and independent savings estimate review process during the IGA; and
  - Reconcile estimated savings to performance requirements of all contractors/vendors.
- **Risk: Budgeted Implementation Cost Is Not Realistic**
  - Reconcile estimated design/build costs to performance requirements of all contractors/vendors
  - Fix major M&V, O&M and other costs with contractors

Risk mitigation strategies

- **Risk: Project Not Installed According to Design and Savings Specifications**
  - Ensure that experienced project managers, engineers, contractors are involved in project implementation
  - Bond major contractors
  - Utilize job cost control system & have project managers review progress on a frequent basis
  - Impose rigorous commissioning procedures on contractors, including performance specifications
  - Hold back a portion of payments to installation contractors until commissioning & other performance terms are met

Risk mitigation strategies

- **Risk: Technology or Equipment Does Not Work Properly**
  - Require demonstrated previous results from any technology contributing significant savings to ensure it is a proven technology
  - Contractually assign all major technology & technical risks to the applicable contractor or vendor by specifying performance requirements to be achieved as a condition for payment
  - Ensure each major contractor/vendor has adequate financial capacity to cover their respective level of technical risk

Session #9

Practical Exercise – Evaluating a Sample EE Project Proposal

Roof Top PV System in Buildings

- This case study tackles PV system roof top type without storage and On Grid Type.
- The installed capacity is 250 kWpeak on building roof of 3500 m2 area.
- The design of this PV system will yield about 416,000 kWh annually and having degradation of 2.5% over 25 years (PV cells lifetime).
- The investment cost on turn key basis project is about 850 US$ per kWpeak installed of PV System and the inverters lifetime is 8-10 years.
- The financial analysis is conducted with sensitivity analysis regarding;
  - Yield guaranteed.
  - Conventional energy tariff escalations.

Central Solar Water Heater for Domestic Hot Water Generation

- This building consumes about 2500 liters daily of hot water at 55°C. This hot water is generated via hot water boiler firing natural gas. The gas tariff is 4.75 US$/MMBtu.
- The energy content of hot water (Useful Energy) is about 117 kWh daily that acquires input energy of about 138 kWh of gas.
- The investment for Solar Water Heaters and Storage will be assessed in order to study the techno-economic feasibility of the project.
- Moreover, the sensitivity analysis will be conducted to ensure the domain of the project feasibility regarding the risks that might take place.

LED Lighting Technology and Air Conditioners

- Two cases will be discussed here referenced to the normalized systems for high efficient lighting system and Inverter technology of air conditioners.

Session #10

Financing Instruments Available in the Region

Funds and Financing Instruments for EE/RE

- The instruments for financing the EE/RE technologies are available in the Countries of MENA region.
- The presentation here will focus on the instruments related to this program and very specific for Egypt, Jordan, Morrocco, and Lebanon.
- The instruments are divided into two categories:
  - First is relevant to financing through the Domestic Financial Firms;
  - Second is relevant to financing through the International Financial Firms and/or the International applied programs.
- The international instruments are mainly relying on the EE/RE projects as basis for the Circularity, Green Technologies, Sustainability Development, and building Green Economy to ensure the Global Climate Change mitigations and adaptation.
- The Domestic Financing Instruments are initiated to develop/accelerate the achievement in country sectoral objectives referenced to the National Sustainable Development vision 2030, 2040, 2050.

The Domestic/International Financing Instruments

Egypt

- National Bank of Egypt (NBE)
- Commercial International Bank (CIB)
- Banque Misr
- QNB Alahli
- Banque Due Caire
- Arab African International Bank (AAIB)

Supported Activities:

- Offers dedicated green loans for PV – Small Scale up to Large Scale.
- Promotes financing for **sustainable agriculture** and **green buildings**.
- Funding for sustainable real estate and renewable energy projects.
- EE in buildings and industry
- Water-saving technologies
- Special loan packages for **solar water heaters** and **PV systems** for agriculture and tourism sectors.
- **Financing for Industrial Energy Efficiency**: Special packages for factories upgrading to energy-efficient technologies.

International Programs/Financial Institution

1. EBRD through GEFF.
2. **French Development Agency (AFD)** for green finance.
3. Green Climate Fund (GCF)
4. UNIDO.
5. Climate Investment Fund (CIF)
6. Solar Heaters Investment Program.

The Domestic/International Financing Instruments

Jordan

- Jordan Renewable Energy & Energy Efficiency Fund – JREEEF
- TAMWEELCOM

Supported Activities:

- Subsidies, revolving funds, and guarantees for EE/RE.

International Programs/Financial Institution

1. EBRD through GEFF.
2. Green Climate Fund (GCF)
3. Climate Investment Fund (CIF)

The Domestic/International Financing Instruments

Morrocco

- BP Green Invest - Banque Populaire
- Plan Green - Attijariwafa Bank
- Tamwilcom: Green Invest program
- TATWIR: Industry decarbonization support

Supported Activities:

- Subsidies, revolving funds, and guarantees for EE/RE.
- Subsidy / Grants
- Subsidy / Technical Assistance (TA)
- Debt / Green Loans

International Programs/Financial Institution

1. EBRD through GEFF.
2. Green Climate Fund (GCF)
3. Climate Investment Fund (CIF)

The Domestic/International Financing Instruments

Lebanon

- Bank Audi
- Central Bank of Lebanon

Supported Activities:

- Subsidies, and guarantees for EE/RE.
- Subsidy / Grants
- Green Economy Funding
- Climate Change Mitigation

International Programs/Financial Institution

1. LGIF - Lebanon Green Investment Facility
2. EBRD through GEFF.
3. Green Climate Fund (GCF)
4. Climate Investment Fund (CIF)
5. NEEREA "The National Energy Efficiency and Renewable Energy Action"
6. IEEHA "The Italian Energy Efficient Home Appliances Program"
7. The National Heat Pumps Project
8. KAFALAT Energy Programme
9. GGF Lebanon "The Green for Growth Fund Lebanon"

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For any inquires or comments, please don't hesitate to contact us

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