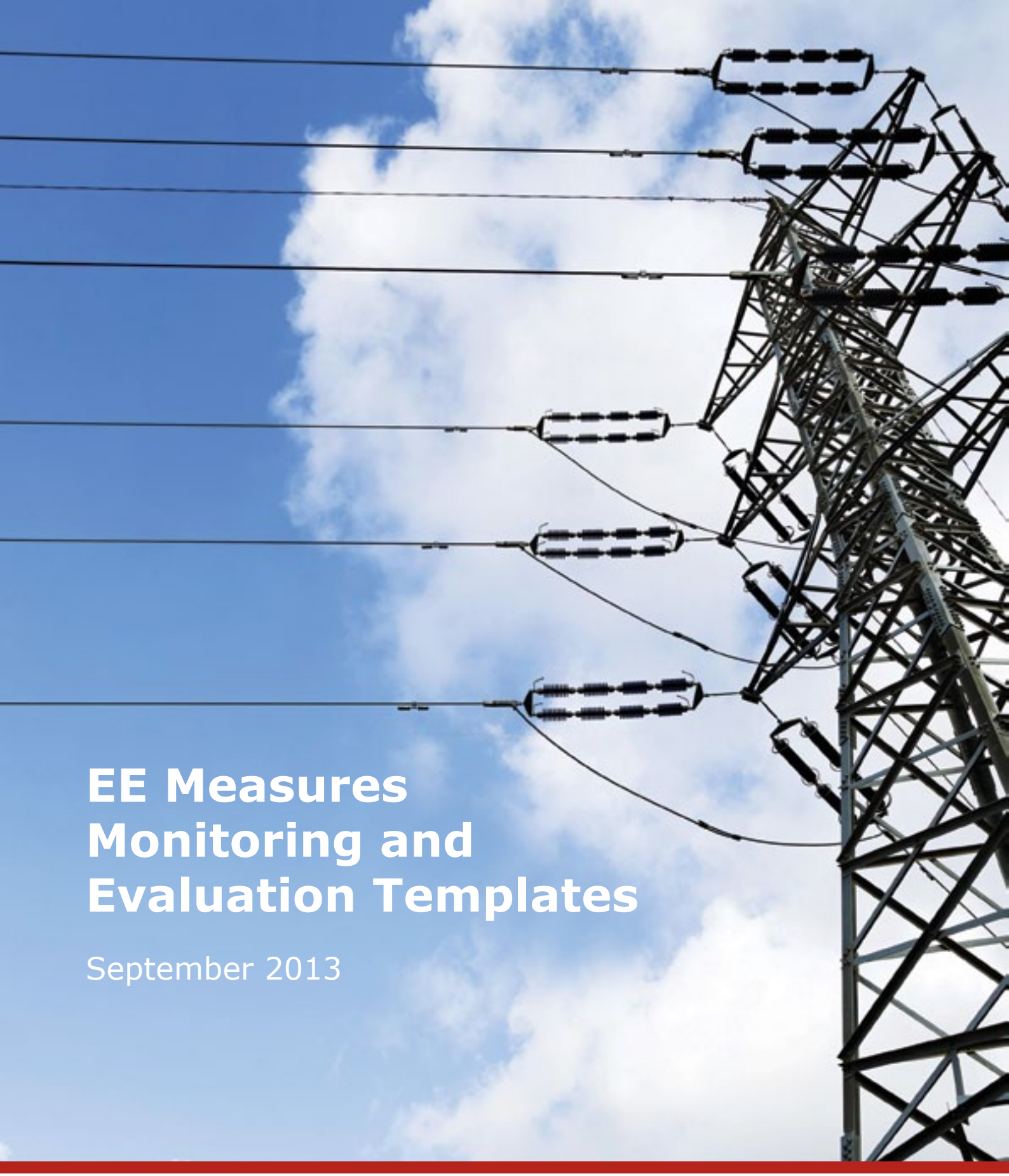

EE Measures Monitoring and Evaluation Templates

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

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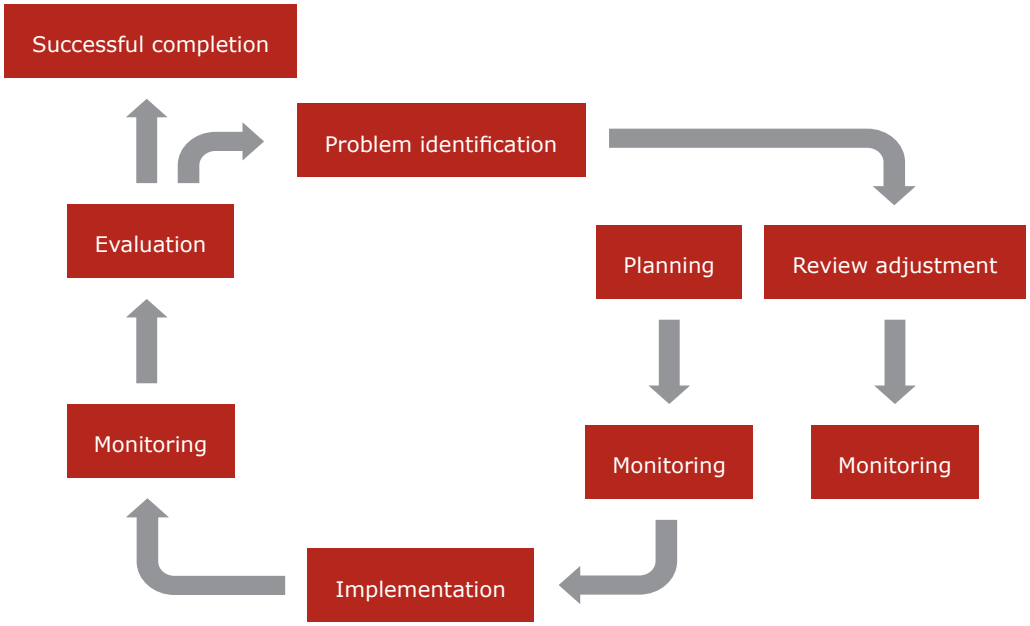
1. Introduction

1.1 Monitoring and evaluation definition

The intention behind monitoring and evaluation is to inform interested parties about the performance of the national energy efficiency action plans (NEEAP's) and to improve the planning as well as the design of the future one's.

Monitoring process concentration is based upon collecting data and information regarding the measures. Meanwhile, evaluation refers to the analyses of the data collected from the monitoring stage based on process, impact and market evaluations. Thus evaluation output concludes with either the measure's success or failure and in case of failure monitoring stage helps to identify the obstacles faced and their causes accordingly they could be prevented in the future.



{The diagram above illustrates the sequence of the entire process and shows where the role of Monitoring and Evaluation comes}

1.2 Bases of analyses

The analyses were based on three key levels, which are process, impact and market.

Process analyses evaluate the measure's progress from design to implementation, taking into consideration the implementation plan, the financial statutes, capacity building and regulations. On the other hand, impact focuses on energy and financial savings as well as the CO_2 emission reduction. In order to assure funding and have the public's support for energy efficiency programs reliable evidence of energy saving and emission reduction is essential. Meanwhile, the market section emphasizes the market transformation resulting from the growth of demand.

Process:

- **Implementation:**
  - This section includes the surveys made to base the plan upon, a description of the plan and the implementation section also mind the current status of the measure to be compared with the baseline where the measure first started.
- **Finance:**
  - The finance sector takes account of the financing source, allocated and consumed budget that indicates the operation of the measure.
- **Capacity building:**
  - Capacity building takes into consideration the knowledge and experience of those implementing or benefiting from the measures implementation.
- **Regulation:**
  - The regulation part covers the law-based rules/ codes and enforcement regarding the measures implementation.

Impact:

- **Energy savings:**
  - …concerns the data required to calculate energy savings that differs from a measure to another.
- **Financial savings:**
  - …is the amount of subsidy saved equivalent to the energy savings.
- **CO_2 emission reduction:**
  - …regards the amount of CO_2 reduced for the total amount of energy saved provided in a form of percentage.

Market:

- **Market transformation:**
  - The section about Market transformation studies the supply and demands role in shaping the market.

1.3 Calculation

Bottom up and/or the top down are the main two approaches to calculate energy savings out of implementing energy efficiency measures.

Top-down approach refers to the method of energy savings evaluation where "Amount of energy savings or energy efficiency progress are calculated using national or aggregated sectorial levels of energy saving as the starting point." (Bruno Lapillonne, 2009)

Bottom-up evaluation starts from data at the level of a single energy efficiency improvement (EEI) measure, mechanism, program, or energy service (e.g. monitoring energy savings per participant and number of participants), and then aggregates results from all EEI measures reported by a Member State to assess its total energy savings in a specific field. (Evaluate Energy Savings EU)

2. Energy Efficiency Measures Evaluation Template

2.1 Replacing regular inefficient lamp with Compact Fluorescent Light bulbs (CFL)

Introduction:

Compact fluorescent light bulbs (CFL) are often stated as one of the simplest approaches to shrink your power bill as well as your carbon footprint. "Saving money and helping the environment" is presenting the ultimate win-win situation.

The high retail price and the toxic mercury content are the most potent threats to CFL's superiority. CFL's would pay for itself in about six months and the mercury content is very small. It won't cause any health hazard unless it breaks. As CFL´s usually last up to ten times longer than normal bulbs the break of a CFL is less likely to happen but still a safe disposal of CFL's is advised.

Questionnaires

The questionnaire is divided into three key sections, which are process, impact and market evaluation questions. Each section contains a sub unit targeting a specific concern.

Process questionnaires:

This section aims to evaluate the measure's progress from design to implementation.

- **Implementation plan:**
  - What is the current situation with the contractors?
    - Whether it is still at the competitive betting stage, negotiating with the contractors or undergoing the implementation phase.
  - Please provide a brief description of the implementation plan for the selected approach?
  - Has there been any modification in the plan?
  - How many bulbs have been replaced\distributed\ installed?
- **Finance:**
  - Has the financing source been identified? If so please name the sources of funding.
  - What is the incentives mechanism for the measure?
  - Has the budget been optimally allocated?
  - What is the current consumed budget?
  - What is the current percentage of the awareness campaigns consumed budget?
- **Capacity building:**
  - Is there a plan for capacity building in order to develop a technical knowledge about CFL's?
    - Kindly provide a brief description of the capacity building plan.
  - What is the current status of capacity building?
- Regulations:
  - Please provide a brief description of the installment regulations?

Impact questionnaires:

The purpose of this section is to determine both demand and energy savings along with other co-benefits such as avoided emission.

- **Calculating energy savings:**
  - What is the power of the replaced bulbs?
  - What is the power of the replacement bulbs?
  - Electricity consumption of households for lighting before the procedure?
  - The current electricity consumption of households for lighting?
  - Number of permanently occupied dwellings before the procedure?
  - The current number of dwellings occupied?

- **Other savings:**
  - What is the amount of financial savings?
  - Did the procedure meet the expected financial savings?
    - I.e. the savings earned after restoring the capital spent in the project.
  - What is the percentage of the reduced CO_2 emissions?
  - What is the percentage of the peak hours load reduction out of implementing this measure?

Market questionnaires:

This final section of questionnaires aims to estimate the influence of the measure on the market transformation.

- **Market transformation calculations:**
  - What is the current percentage of the increased demand?
    - How many lamps have been sold before the procedure?
    - How many lamps have been sold after the procedure?
  - What was the number of factories/suppliers involved in the CFL's production before the procedure?
  - What is the current number of factories/suppliers involved in the CFL's production?
- **Survey:**
  - Has the market survey on the "use of CFL's instead of the incandescent lamps" been conducted to test the market transformation in the country?

Calculations

There are two main approaches when it comes to calculating energy savings: there is the top down TD and the bottom up BU models.

- **TD:**

Starting with the Top Down approach using S_CFL indicator for electricity of households for lighting in [KWh\year per dwelling], which is the ratio between the electricity consumption of households for lighting and the number of permanently occupied dwellings. It is usually estimated via a calculation that takes into account the number of lighting points, or the average lighting power and average number of hours of lighting per year. An increase in the number of lighting points and/or in the number of hours of lighting may offset energy savings and may lead to an underestimation of these savings or to the impossibility to measure any savings.

$$S_{CFL}=(EC_r/D_r - EC_t/D_t)\times D_t$$

Where:

EC_r ,EC_t ≡ Electricity consumption of households for lighting in referenced year and in year t respectively.

D_r ,D_t ≡ Number of permanently occupied dwellings in referenced year and in year t respectively

Unit ≡ [kWh/year per dwelling]

- **BU:**

The total annual energy savings achieved (kWh/year) "Calculated by multiplying the annual unitary final energy savings by the number of efficient light bulbs sold or installed for residential use". The annual unitary final energy savings UFES_CFL "are calculated by the difference between the lamp stock average power consumption in the reference year and the power of the efficient lamps sold or installed".

$$TES_{CFL}= UFES_{CFL}\times N_{CFL}$$
$$UFES_{CFL}=(P_{STOCK\_AVERAGE}- P_{CFL})\times \eta_h \times F_{rep})/1000$$

Where:

First equation:

TES_{CFL} ≡ Total energy savings [kWh/year].

$UFES_{CFL}$ ≡ Annual unitary final energy savings [kWh / unite / year].

N_{CFL} ≡ The number of efficient light bulbs sold or installed [unite].

Second equation:

$P_{STOCK\_AVERAGE}$ ≡ Power average of the existing lighting bulbs in households [W]

P_{CFL} ≡ Power of the market promoted efficient bulb in this case CFL [W].

η_h ≡ Average number of operating hours

F_{rep} ≡ Correction factor taking into consideration that a proportion of bulbs sold will not immediately replace existing bulbs $F_{rep}\leq 1$.

Recommendations

Since the required data for the S_CFL equation is not available for most countries in the region, thus they tend to settle with assumptions that are unquestionably inaccurate. Therefore it is highly recommended to calculate the energy savings with it instead of using the top-down model S_CFL...

2.2 Solar Water Heater (SWH) for domestic use

Introduction

The use of domestic Solar Water Heaters (SWH) have a great potential to contribute significantly in saving fossil energy sources. However, low ecological awareness and ignorance of the SWH added value exemplifies the barrier behind its wider dissemination.

In developing countries and countries in transition high start-up cost of purchase and installation exceed a great portion of the interested household's financial ability. Therefore, a suitable incentive mechanism is a necessity and it is essential for the incentive instrument to be in line with the legal framework, tax in addition to the market competition rules.

Questionnaires

The questioner is divided into three key sections, which are process, impact and market evaluation questions. Each section contains a sub unit targeting a specific concern.

Process questionnaires:

This section aims to evaluate the measure's progress from design to implementation.

- **Implementation plan:**
  - Have targeted areas and types of domestic water heaters been quantified and identified?
  - What is the current status of the measure?
    - Whether it is under the feasibility study or it moved to the implementation phase.
  - What is the approach followed in the NEEAP?
    - The most common approaches are distribution, replacement and installation, etc.
  - Kindly provide a brief description of the implementation plan for the selected approach?
  - Has there been any modification in the plan?
  - What is the current number of SWH's that have been replaced/ distributed/ installed?
- **Finance:**
  - Kindly name the source of funding? And specify the amount of money funded?
  - What is the current situation with the financing system?
    - Is it in the feasibility study phase, preparation before implementation or has it been implemented?
  - What is the incentive mechanism used in the NEEAP?
    - Financial incentives mechanisms normally received in a form of tax deduction, low interest loans (soft loans) or even in a form of direct grants.
      - In case of using soft loans as an incentive mechanism
        - What is the percentage of the interest rate?
        - What is the duration of the loan?
  - Has the source of funding been identified?
  - Is there an "incentive phase out" plan? If so kindly state a specified description.
  - Has the budget optimally been allocated?
  - What is the current percentage of the consumed budget?
  - Has the awareness campaigns budget been allocated?
    - What is the amount of the allocated budget?
    - What is the percentage of the consumed budget?
- **Capacity building:**
  - Is there a plan for capacity building in order to develop a technical knowledge about SWH?
  - Kindly provide a brief description of the capacity building plan.
  - What is the current status of capacity building?
- **Regulations:**
  - Kindly provide a description of the regulations regarding usage of domestic Solar Water Heaters.
    - For example, state the type whether there is any law incorporated into building code to enforce the use of SWH in new and/ or existing building etc.
  - Have any of the regulations been implemented? If so kindly point them out.

Impact questioner:

In order to assure funding and have the public's support for energy efficiency programs, reliable evidence of energy saving and emission reduction is essential. The impact questioner aims to provide that.

- **Calculating energy savings:**
  - What is the average energy efficiency of the electrical water heaters?
  - What is the average energy efficiency of the solar water heaters used in the measure?
  - What is the energy consumption of households for water heating in the referenced year?
  - What is the current energy consumption of households for water heating?
  - What is the specific hot water demand?
- **Other savings:**
  - What is the amount of financial savings out of using SWH?
  - Did the procedure meet the expected savings?
    - I.e. the savings earned after restoring the capital spent in the project.
  - What is the percentage of the reduced emissions?
  - What is the percentage of the peak hours load reduction?
- **Advertisement strategies:**
  - Did the authorities in charge evaluate the success? If so did they promote?

Market questionnaires:

This final section aims to estimate the influence of the measure on the market transformation.

- **Market transformation:**
  - What type of governmental support has been provided for the local manufacturers?
  - What is the current percentage of the increased demand?
    - How many SWH's have been sold before the procedure?
    - How many SWH's have been sold after the procedure?
  - What was the number of factories/ suppliers involved in the SWH's production before the procedure?
  - What is the current number of factories/ suppliers involved in the SWH's production?
- **Survey:**
  - Have there been any surveys conducted to evaluate the market transformation on the use of SWH instead of the electrical water heaters EWH?

Calculations

There are two main approaches when it comes to calculating energy savings: there is the top down TD and the bottom up BU models.

- **TD:**

Top down approach uses the solar water heater savings S_SWH Indicator to calculate the saving in [KWh\year per dwelling], which is the ratio between the energy consumption for water heating in the residential sector and the total population. Therefore, data such as the energy consumption of water heating and the total population is essential in calculating the saving.

$$S_{SWH}=(EC_r/P_r - EC_t/P_t)\times P_t$$

Definition:

EC_r, EC_t ≡ Energy consumption of households for water heating in the refinance year and in year t.

P_r ,P_t ≡ Total population in the reference year and in year t.

- **BU:**

The total energy savings for SWH UFES_SWH in [kWh/year], which is the efficiency difference between the electrical the newly installed solar water heater, multiplied by the specific hot water demand, the solar fraction and the number of SWH sold or installed.

$$TES_{SWH}=(1/\eta_{elec} - 1/\eta_{swh})\times Q_{HWD}\times N_{SWH}\times 0.8$$

$$Q_{HWD}= (365\times 0.001163\times C\_DHWC\times N\_pb\times \Delta T)/1000$$

Definition:

First equation:

Q_{HWD} ≡ Specific hot water demand.

η_{elec} ,η_{swh} ≡ Energy efficiency of the electric water heater used and the solar water heaters.

N_{SWH}≡ number of SWH sold or installed.

Second equation:

C_{DHWC} ≡ Average daily hot water consumption per person in residential or tertiary building supplied by the water heater.

N_{pd} ≡ Average number of persons living in the building supplied by the water heater.

$\Delta T=(t_{HW} - t_{CW})$ ≡ Difference between hot water temperature and the cold water temperature.

Recommendations

Based on the incentive mechanisms chosen in each country the following assessment ideologies should be taken into consideration.

- **Reliability in the announcement and operation of the project's promotion is vital.** If one can't rely on it as proposed the measure simply won't be realized in the market. In Some cases it has been observed that an unstable political situation usually pushes investment-willed households away. The reason for this behavior is the fact that people fear whether the incentive is going to end sooner than primary announced or whether the budget allocated will be used up.
- **The simpler the incentive processes the better.** Interested households are often put off because of too complex and extensive application processes. Therefore, to guarantee demand for the incentive thus the program's success the proposed incentives need to be easily accessed and understood.
- **Link the incentive to the SWH quality standards.** This is an equitable step towards preventing possible negative backlashing on the demand of SWH's.
- **Sustainable measures and a clear exit strategy.** Keep in mind the measures sustainability by planning it beforehand. Consider the period of a decreasing level of incentive - better known as phase out. When the incentive duration ends a non-considerate strategy usually faces a significant retracement.
- **Clear political framework conditions.** This seems to have a greater influence on the success of measures implementation.
- **Establish an infrastructure for proper database.** The data collection and analyses is highly recommended due to the lack of essential data required in calculating energy and financial saving.

2.3 Standards and Labeling

Introduction

The measure of standardizing and labeling of some household appliances aims to assist the buyer in having an educated purchasing decision by increasing the market transparency. Nevertheless, encourage industrial sector to develop and further improve their product energy efficiency beyond the minimum energy performance standards MEPS enforced as the demand for better energy performance increases.

Energy and power savings can increase tremendously in the long run simply by redirecting the consumers purchasing behavior towards the more efficient products specially ones with long life spans.

Questionnaires

The questionnaire is divided into three key sections, which are process, impact and market evaluation questions. Each section contains a sub unit targeting a specific concern.

Process questionnaires:

This section aims to evaluate the measure's progress from design to implementation.

- **Implementation plan:**
  - Has there been a survey evaluating the appliances based on market penetration and energy consumption?
  - Has the process of standardizing and labeling the appliances been identified?
  - What is the current status of the measure?
    - Whether it is under the feasibility study or it moved to the implementation phase.
  - Kindly provide a brief description of the implementation plan.
  - What is the minimum energy performance standard MEPS required for each appliance?
  - Is there a local testing facility and is it equipped for the measure implementation?
  - Is there a qualified local labeling facility?
  - Is there a time bound to the standards?
  - Does the labeling body notify their customers with the expected upcoming standard beforehand?
- **Finance:**
  - What is financing system?
  - Establishment of the project or the running costs of the project.
  - What is the current situation regarding project finance?
  - Are there financial incentives for the measure?
  - Kindly provide a brief description of the incentive mechanism.
    - Financial incentives mechanisms normally received in a form of tax deduction or payment installment.
  - Has the source of funding been identified?
  - Kindly name the source of funding. Specify the amount of money funded.
  - Has the budget optimally been allocated?
  - What is the current percentage of the consumed budget?
  - Has the awareness campaigns budget been allocated?
    - What is the amount of the allocated budget?
    - What is the percentage of the consumed budget?

- **Capacity building:**
  - Is there a plan for capacity building in order to upgrade the technical knowledge in testing facilities as well as labeling facilities?
  - Are there any capacity building measures provided to the manufacturers?
  - Kindly provide a brief description of the capacity building plan/plans.
- **Regulations:**
  - Is the project voluntary, mandatory or a mixed measure for manufacturers depending on the type of the appliance?
  - Do any legal documents regarding implementation of the measure and/or enforcement of the execution exist?
  - Has the MEPS been designed for the appliances undergoing the procedure?
  - Has there been an announcement of a regulation obstructing the importation of the un-labeled household appliances targeted in the measure

Impact questionnaire:

In order to assure funding and have the public's support for energy efficiency programs reliable evidence of energy and financial saving as well as CO_2 emission reduction is essential and the impact questionnaire aims to provide that.

- **Energy savings:**
  - What is the average annual energy consumption for the most commonly used type of each appliance targeted to undergo the labeling procedure in the country?
  - What is the average annual energy consumption for the most commonly purchased labeled appliance of each appliance undergoing the labeling procedure?
  - What the number of the soled labeled appliances based on their ranking?
- **Financial savings:**
  - What is the amount of financial savings?
  - Did the procedure meet the expected savings?
    - I.e. the savings earned after restoring the capital spent in the project.

Market questionnaires:

- **Market transformation:**
  - What is the mechanism of quantifying the number of labeled appliances sold?
  - What is the number of labeled appliances sold? And kindly classify by rank?
  - How many labeled appliances have been sold?
- **Survey:**
  - Have there been any surveys conducted to evaluate the market transformation towards the labeled and certified appliances?

Calculations

The main approaches when it comes to calculating energy savings out of using efficient appliances is the bottom-up BU formula which calculates the total energy savings. It differs from a product to another biased on its size, features and its penetration.

- **BU:**

The total annual energy savings per appliance type in [KWh/year], Which is the difference between the annual energy consumption of the reference year stock average and the annual energy consumption of the efficient appliances sold or installed multiplied by the number of energy efficient appliances units sold or installed.

$$TES_{S\&L} = AEC_{REFapp} \times N_{S\&L} - TAEC_{EEapp}$$
$$TAEC_{EEapp} = (AEC_A \times N_A + AEC_B \times N_B + \ldots)$$

First equation:

$TES_{S\&L}$ ≡ Total energy savings out of using efficient appliances

AEC_{REFapp} , $TAEC_{EEapp}$ ≡ Average annual energy consumption of the appliance stoke in the reference year and the energy efficient appliance in the market.

$N_{S\&L}$ ≡ The number of energy efficient appliances units sold or installed.

Second equation:

$TAEC_{EEapp}$ ≡ The total energy consumption for the labeled appliances.

AEC_A , AEC_B ≡ Annual energy consumption of the A or B labeled appliance.

N_A , N_B ≡ Number of A, B raked appliance respectively.

Recommendations

- **A visible Label.** The test/rating label should be placed visible on the front of the household appliances while showcasing for sale.
- **A Customer awareness Campaign.** The awareness campaigns should shed the light on the fact that label scheme isn't the reason behind the high prices. Energy efficient appliances tend to cost more but live longer and save energy. The customer has the choice.
- **A Manufacturer education Campaign.** The manufacturer should be taught and aware of the advantages of the label. It can be used as a marketing tool thus giving them an incentive to undergo the procedure and unconsciously help on raising awareness in a wider range.
- **A Communications/Marketing Campaign.** It is essential informing the customers, the manufacturer or/and the distributor about the new generation/the upcoming standards of labeled appliances. As a result these groups are prepared for it beforehand consequently the majority of the market will meet the new standards. Therefore, a good functioning communication tool between the implementing agency and the stakeholders is vital.
- **Reliable collected Data Analyses.** Reliable data is necessary for a reliable and when calculating energy and financial savings. Therefore, establishing an infrastructure for proper database is highly recommended.

2.4 Street lighting

Introduction

Unnecessary yearly costs imposed by old inefficient street lighting installations could be reduced to approximately 60% simply by utilizing today's technology. Meanwhile in the Arab region we can fairly say that the majority of street lighting facilities are outdated thus highly inefficient which indicates a room for improvement.

Energy savings out of upgrading street lighting depends entirely on the underlying technology. Therefore, technology chosen should be based on good analyses.

Questionnaires

The questionnaire is divided into three key sections, which are process, impact and market evaluation questions. Each section contains a sub unit targeting a specific concern.

Process questionnaires:

This section aims to evaluate the measure's progress from design to implementation.

- **Implementation plan:**
  - Has the process of quantifying the number of lamps and identifying the targeted areas been made?
  - Do the targeted areas have infrastructure?
    - Whether there is columns and electrical grid etc. or is it unequipped.
  - What is the current situation with the contractors?
    - Whether it is still at the competitive betting or at negotiation stage etc..
  - What is the plan approach followed in the NEEAP?
    - The most commonly used approaches are replacement and installation.
  - What is the type of technology chosen in the NEEAP?
    - The approach chosen to upgrade street lighting, the most common approaches in the region are installation of new photo-sensor devices, using solar energy technology and high pressure sodium lamps etc..
  - Please provide a brief description of the implementation plan for the selected approach.
  - Has there been any modification in the plan?
  - What is the targeted amount of bulbs to be upgraded/ replaced or installed?
  - How many bulbs have been replaced or installed?
- **Finance:**
  - Has the budget been optimally allocated?
  - What is the current consumed budget?
  - What is the current percentage of the awareness campaigns consumed budget?
- **Capacity building:**
  - Is there a plan for capacity building in order to develop a technical knowledge about installation and maintenance of the upgraded lighting system?
  - Kindly provide a brief description of the capacity building plan.
  - What is the current status of capacity building?
- **Regulations:**
  - Has there been any adaptation of a new street lighting code? If so kindly provide a brief description of the code.
  - Does any legal document exist regarding the enforcement of the implementation?

Impact questionnaire:

In order to assure funding and have the public's support for energy efficiency programs reliable evidence of energy saving and emission reduction is essential and the impact questionnaire aims to provide that

- **Calculating energy savings:**
  - What is the power of the replaced bulbs?
  - What is the power of the replacement bulbs?
  - What are the average hours of operations for street lighting?
  - What are the average hours of operation after using a photo sensor?
  - What is the current number of lamps underwent the procedure?
- **Other savings:**
  - What is the amount of financial savings?
  - Did the procedure meet the expected savings?
    - I.e. the savings earned after restoring the capital spent in the project.
  - What is the percentage of the reduced co2 emissions?
  - What is the percentage of the peak hours load reduction out of implementing this measure?
- **Market:**
  - the market section was not applicable in this stage of monitoring and evaluation due to the low and inconsistent demand, thou it could exist in the new or second NEEAP's.

Calculations

The calculation regarding this measure depends entirely on the underlying technology and the reduction of energy related to it.

In case of installation of new photo sensors PS:

$$TES_{SL\_PS}=[(P_{SL}\times\eta_h - P_{SL}\times\eta_{h\_PS})/1000]\times N_{SL}$$

Definitions:

TES_{PS}≡ Total energy savings out of installing PS in [kWh\year].

P_{SL}≡ Average power required for the existing street lighting bulbs in [W].

η_h ,η_{hPS} ≡ The average number of operation hours and the average number of hours of operation after installing the photo sensor respectively.

N_{SL}≡ The number of street lighting lamps that underwent the installations.

In case of using solar energy technology PV:

$$TES_{SL\_PV}=[(P_{SL}\times\eta_h)/1000]\times N_{SL}$$

Definitions:

TES_{PV} ≡ Total energy savings out of installing PV's in [kWh\year].

P_{SL}≡ Average power required for the existing street lighting bulbs in [W].

η_h ≡ The average number of operation hours.

N_{SL} ≡ The number of street lighting lamps that underwent the installations.

In case of replacing street lights into high pressure sodium lamps HPSL:

$$TES_{SL\_HPSL}=[(P_{SL} - P_{HPSL})/1000]\times\eta_h\times N_{SL}$$

Definitions:

TES_{HPSL} ≡ Total energy savings out of installing HPSL in [kWh\year].

P_{SL} ,P_{HPSL} ≡ Average power requirement for the old street lighting bulbs, the power required for the high pressure sodium lamps respectively in [W].

η_h ≡ The average number of operation hours.

N_{SL} ≡ The number of street lighting lamps that underwent the installations.

Recommendations

- **Law based regulations and codes.** It is recommended to ensure the success of the measure through long run law based regulations such as codes for street lighting designing and/or efficiency restrictions.
- **Analyses of infrastructure.** New and refurbished installations should be based on proper analyses taking into consideration the road infrastructure (electricity grid, masts) and other factors such as roads design, complexity and traffic volume.