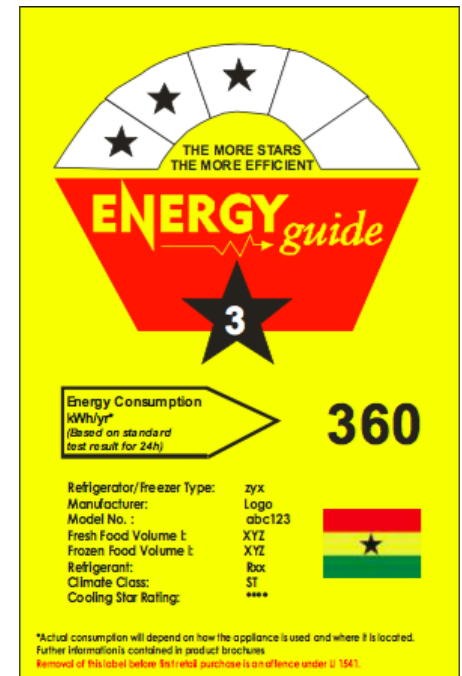


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# EVALUATION: PROMOTING APPLIANCE ENERGY EFFICIENCY AND TRANSFORMATION OF THE REFRIGERATING APPLIANCES MARKET IN GHANA

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# Project (Policy) Objective

- Improve the energy efficiency of refrigerators marketed and used
  - Combination of regulatory tools such as Minimum Energy Performance Standards and Energy Labels (S&L)
  - As well as rebates
- Reduce household energy demand
- Reduce GHG emissions

# Project targets (reconstructed)

- Market share of imported new refrigerators of at least 80% (and maximum 20% used refrigerators)
- Reduction in average annual energy demand of 60 GWh/a, due to market transformation (including a rebate program) and a corresponding reduction in GHG of 34 kton/a
- 50,000 old refrigerators traded in and environmentally sound recycled through a rebate program.
- Direct project emission reduction of 177 kton CO<sub>2</sub> equivalent, of which 55 kton through energy demand reductions and 122 kton through CFC removal
- Direct post-project emission reduction of 1,230 kton CO<sub>2</sub> equivalent, all through energy demand reduction.

# Project terminal evaluation goals

- Establish impact of project
  - GHG and energy demand reduction
  - Changes in the market
  - Results achieved
  - Process evaluation (not discussed here)
- Using:
  - Project reports
  - Monitoring data
  - Stakeholder interviews

# Indicators to assess Results and Changes in Market

- Policy evaluations typically use indicators to assess results (outcomes) of interventions / activities and changes in the market (impacts)
- Indicators are factors that are measurable and quantifiable and are a good proxy for the result and impact that should be achieved
- E.g., Market share of efficient technology; Sales number; Average energy performance

# GEF/STAP model for assessing impacts of energy efficiency policy

- Standard approach using assumptions for many baseline factors
  - E.g., 1% p.a. improvement in energy efficiency of baseline (displaced) technology; 5% p.a. increase in market share of promoted technology
  - Analysis period, Technology lifespan, Fuel type and emission factors
- Uses (simplified) stock model to calculate energy and GHG impacts

# Stock models to calculate impacts

- Describes
  - Stock of products in use in a country (within a sector)
  - Additions (new sales) and removals (scrapping) of products
  - Growth in no. households and product ownership
  - Product usage
  - Average efficiency of products in use and new products
- For the Base case and the Policy case

# Developing ex-ante base case

- Describe starting point: What happens anyway (with or without policy)
  - Base year, year of policy, end of impact period
  - Mix of technologies on the market; Mix of technologies in use
  - Number of households / users
  - Typical usage
  - New sales / retirements of technology
  - Stock turnover & new additions
  - Projections for all these factors for future years
- With this, build base case scenario: what is projected to happen without policy intervention?



# Base case example (Ghana stock model)

## Base case Ex-ante, No project

Year of project	0 (base)	1	2	3 (end)	4
Total Stock	2,000,000	2,100,000	2,200,000	2,300,000	2,400,000
Annual Sales	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Remaining pre-project Old stock	2,000,000	1,900,000	1,800,000	1,700,000	1,600,000
Old stock					
Annual energy demand (kWh)	1160	1160	1160	1160	1160
Imports new high-end					
Market share	10%	13%	17%	20%	20%
Annual energy demand (kWh)	320	315	310	306	301
Imports new low-end					
Market share	15%	17%	18%	20%	20%
Annual energy demand (kWh)	635	625	616	607	598
Imports used					
Market share	75%	70%	65%	60%	60%
Annual energy demand (kWh)	870	857	844	831	819
Annual energy demand pre-project stock (kWh)	2,320,000,000	2,204,000,000	2,088,000,000	1,972,000,000	1,856,000,000
Annual energy demand new Sales (kWh)	0	55,950,000	805,177,500	2,47,849,086	584,127,860

# Developing ex-ante policy case

- Describe what would change with policy:
  - Mix of technologies in use different? **Yes, through sales of better technologies**
  - Mix of technologies on the market different? **Yes, through ban on some products (standards) and promotion of others (labels, rebate)**
  - Number of households / users different? **No, same**
  - Typical usage different? **No, same**
  - New sales / retirements of technology different? **No, same**
  - Stock turnover & new additions different? **No, same**
  - Projections for all these factors for future years
- With this, build policy case scenario: what is expected to happen with policy intervention?

# Policy case example (Ghana stock model)

## Target Ex-ante project impact

Year of project	0 (base)	1	2	3 (end)	4
Total stock	2,000,000	2,100,000	2,200,000	2,300,000	2,400,000
Annual sales	200,000	200,000	200,000	200,000	200,000
Remaining pre-project old stock	2,000,000	1,890,000	1,770,000	1,650,000	1,550,000
Old stock					
Annual energy demand (kWh)	1160	1160	1160	1160	1160
Imports new high-end					
Market share	15%	40%	50%	40%	40%
Annual energy demand (kWh)	320	315	310	306	301
Imports new low-end					
Market share	15%	23%	32%	40%	40%
Annual energy demand (kWh)	635	625	616	607	598
Imports used					
Market share	75%	57%	38%	20%	20%
Annual energy demand (kWh)	870	857	844	831	819
Annual energy demand pre-project stock (kWh)	2,320,000,000	2,192,400,000	2,053,200,000	1,914,000,000	1,798,000,000
Annual energy demand new sales (kWh)	0	59,150,000	10,675,833	44,456,256	51,726,941

# Ex-ante Stock model data needs

Data needs	Data sources
Technology lifespan	Proxy data (EU)
Emission factors	National grid analysis
Target technology	Ghana MEPS levels
Displaced technology	Approximation based on initial inventory conducted before project; sales data; proxy data
Stock level	Initial inventory
Stock growth rate	Assumed, based on expert input
Annual sales in base year	Assumed, based on expert input
Sales growth rate	Assumed, based on expert input
Annual reduction in energy consumption target technology	Estimated, based on global market trends
Annual reduction in energy consumption displaced technology	Estimated, based on global market trends
Compliance with regulations	Assumed, based on customs reports and experience in other countries

# Ex-ante Calculations

- Stock model projections:
  - Old stock still in use (stock replacement rate)
  - New sales added to stock
  - Average energy demand new sales
  - Average energy demand all stock
  - Overall annual energy demand
  - Overall related GHG emissions
- All for base and project case, and for start of project and target years

# Reconstruction of project targets

- Project had set objective and approach, however, had not projected expected energy and GHG impact from policy intervention
- Based on approach, baseline data and ex-ante stock model, targets could be reconstructed
- Targets calculated for energy and GHG

# Developing ex-post analysis

- Describe changes in base case
  - New information about technologies in use? On the market?
  - Updated number of households / users? Usage?
  - Updated sales volume? Updated life span of equipment?
- With this, update base case scenario: what would have happened without policy intervention?
- Describe results from policy case:
  - What is the mix of technologies on the market, after policy intervention?
  - How does that affect energy demand?
- With this, update policy case scenario: What has happened with the policy intervention

# Ex-post project impact example (Ghana stock model)

## Results Ex-post project impact

Year of project	0 (base)	1	2	3 (end)	4
Total stock	2,000,000	2,100,000	2,200,000	2,300,000	2,400,000
Annual sales	200,000	200,000	200,000	200,000	200,000
Remaining pre-project stock	2,000,000	1,900,000	1,800,000	1,692,743	1,592,743
Old stock					
Annual energy demand (kWh)	1160	1160	1160	928	928
Imports new high-end					
Market share	10%	32%	54%	76%	77%
Annual energy demand (kWh)	320	315	310	306	301
Imports new low-end					
Market share	15%	14%	13%	12%	13%
Annual energy demand (kWh)	635	625	616	607	598
Imports used					
Market share	75%	55%	35%	15%	10%
Annual energy demand (kWh)	870	857	844	831	819
Annual energy demand pre-project stock (kWh)	2,320,000,000	2,204,000,000	2,088,000,000	1,570,865,504	1,478,065,504
Annual energy demand new sales (kWh)	0	55,950,000	88,131,129	97,221,365	83,883,693



# Ex-post Stock model data needs

Data needs	Data sources
Technology lifespan	Proxy data (EU)
Emission factors	National grid analysis
Target technology	Ghana MEPS levels + <b>observed energy performance levels</b>
Displaced technology	Approximation based on initial inventory conducted before project; sales data; proxy data + <b>measurements conducted during project</b>
Stock level	Initial inventory
Stock growth rate	Assumed, based on expert input
Annual sales in base year	Assumed, based on expert input
Sales growth rate	Assumed, based on expert input
Annual reduction in energy consumption target technology	Estimated, based on global market trends
Annual reduction in energy consumption displaced technology	Estimated, based on global market trends
Compliance with regulations	<b>Based on observed compliance levels</b>



# Ex-post Calculations

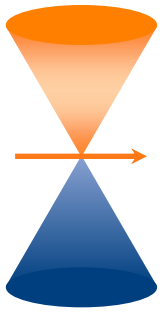
- Stock model projections:
  - Old stock still in use (stock replacement rate)
  - New sales added to stock
  - Average energy demand new sales (new values)
  - Average energy demand all stock (new values)
  - Overall annual energy demand (new values)
  - Overall related GHG emissions (new values)
- All for base and project case, and for start of project and target years

# Determination of project impacts

- Comparison of project and base case demonstrated:
  - Technology uptake
  - Change in market shares per technology
  - Change in energy demand per technology
  - Change in annual energy demand over impact period
- Results were accumulated over impact period, in energy and GHG emissions

# Project results

- Ghana initiative to introduce S&L for refrigerators and ban on import of used appliances
- Four year project, \$2.1 M international funding + \$1 M national funding
- Energy demand reduction of approx. 400GWh/a ( $\approx 3\%$  of all electricity generation)
- GHG emission reduction approx. 1.1 Mton (cumulative) ( $\approx 2\%$  of all CO<sub>2</sub> emissions)



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QUESTIONS?  
COMMENTS?

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