

# The Rapid Assessment Framework (RAF)

## An Innovative Diagnostic Tool for City Energy Use



## What is RAF?

A practical tool for conducting rapid assessment of energy use in cities to identify and prioritize sectors, and suggest specific energy efficiency interventions with 3 principal components:

1. A city energy benchmarking tool
2. A process for prioritizing sectors that offer the greatest EE potential
3. A 'playbook' of tried and tested EE recommendations

***The RAF is an Innovative Decision Support Tool for Evaluating Energy Efficiency Opportunities in Developing Country Cities***

# Positioning of RAF

## What it does:

- ✓ Focuses on areas where CAs have strong intervention power
- ✓ Sensitive to user-city context
- ✓ Simple and practical diagnostic tool and can be quickly applied
- ✓ Big-picture analysis based on available data and extensive interviews
- ✓ Produces basic strategy for choosing and pursuing solutions
- ✓ Energy efficiency expert-led, structured process

## What it doesn't do:

- ✗ Comprehensive energy audit or emissions inventory
- ✗ 'Black Box' approach to energy planning recommendations (data in, energy plan out)
- ✗ Detailed analysis of sector specific interventions, cross-sectoral linkages, and detailed costs and benefits

# RAF Vital Statistics

<b><i>Clients</i></b>	City mayors and municipal bodies
<b><i>Sectors Covered</i></b>	Buildings, transportation, water, public lighting, power & heat, waste
<b><i>Principal Components</i></b>	3 modules: energy benchmarking; prioritization of sectors; energy efficiency recommendations and quick appraisal
<b><i>Benchmarking KPIs</i></b>	28 KPIs spread across 6 sectors
<b><i>Performance Data</i></b>	54 cities; 691 data points with a minimum 8 data points per KPI
<b><i>Prioritization</i></b>	Energy expenditure, relative energy intensity, city authority control or influence
<b><i>EE Recommendations</i></b>	59 recommendations spread across 6 sectors and CA management
<b><i>Case Studies</i></b>	191 cases spread across 6 sectors
<b><i>Decision-Making Attributes</i></b>	Energy savings potential, upfront capital cost, speed of implementation
<b><i>Basic Training</i></b>	Essential as it requires experts' participation
<b><i>Duration</i></b>	~3 months
<b><i>Field Testing Done</i></b>	Quezon City, Philippines

# Informed by Other Leading City EE Tools

## Characteristics of other systems:

- Able to facilitate projections of future performance
- Helpful at linking potential recommendations to priority sectors
- Balance between automated approach and user judgment

## Where we differ:

- EE focused, not emissions focused
- External expert-led, thereby requiring less on-going training and CA support
- Fewer information requirements
- 3 month process from start-to-finish
- RAF enables city benchmarking
- RAF links benchmarking to recommendation tool









	Pre-mission		Mission/RAF Implementation				Post-mission
Principal Activity	Preparations for Mission-Data Gathering	City Energy Use Benchmarking	RAF Introduction/ Sector Meetings	Assess Most Promising Sectors	Review Recommendations in Priority Sectors	Prepare Final Recommendations	Prepare Final City Report
Duration	6 weeks		4 days	1 day	4 days	1 day	4 weeks





# RAF Support Documentation

Pre-Mission City Starter Pack	
<b>Introduction to the RAF</b> RAF overview, objectives, mission requirements, data requirements, logistics, outputs etc.	
<b>RAF City Contact Details Pro Forma</b> Who's who in the city and their details	
<b>RAF Team Contact Details Pro Forma</b> Who's who in the RAF Team and their details	
Consultant Starter Pack	
<b>Typical Mission Agenda</b> Generic requirements for context, sector agencies/frameworks, CA boundaries, CA policies, benchmarking data	
<b>City Background Data Requirements</b> A checklist of background information required to achieve a contextual understanding of the city and complete the City Background Report	
<b>City Background Data Requirements (Excel Version)</b>	

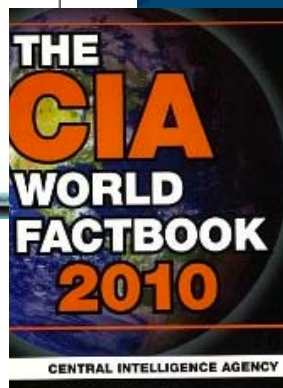
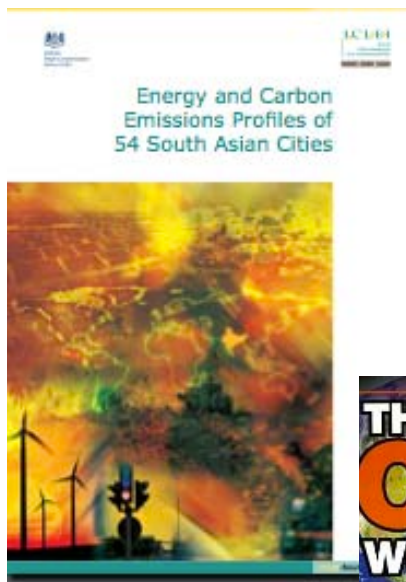
# Sample KPIs for Benchmarking

Key Performance Indicator	# cities w/ data
<b>City Wide KPIs</b>	
<i>Electricity consumption (kWh/capita)</i>	52
<i>Electricity consumption (kWh/GDP)</i>	11
<i>Primary energy consumption (MJ/capita)</i>	44
<i>Primary energy consumption (MJ/GDP)</i>	14
<b>Transportation KPIs</b>	
<i>Total transport (MJ/capita)</i>	40
<i>Public transport (MJ/passenger km)</i>	27
<i>Private transport (MJ/passenger km)</i>	26
...	



# Benchmarking Data Sources

- Hundreds of data sources reviewed
- NGO publications, academic and trade journal articles, city climate plans, World Bank databases & publications, etc.
- National Data used as proxy data for power/heat sector due to lack of city data.
- No fewer than 8 data points/KPI



# Benchmarking Cities

- 54 cities representing a cross section of Population, Climate and Level of Development



# 28 KPIs are used in RAF

## CITYWIDE KPIs

CW-1	Electricity consumption (kWh/capita)
CW-2	Electricity consumption (kWh/GDP)
CW-3	Primary energy consumption (MJ/capita)
CW-4	Primary energy consumption (MJ/GDP)

## TRANSPORTATION KPIs

T-1	Total transport (MJ/capita)
T-2	Public transport (MJ/passenger km)
T-3	Private transport (MJ/passenger km)
T-4	Transportation Non-Motorized mode split (%)
T-5	Public Transportation mode split (%)
T-6	Kilometres of high capacity transit per 1000 people

## BUILDINGS KPIs

B-1	Municipal buildings (kWh/m <sup>2</sup> )
B-2	Municipal buildings heat consumption (kWhth/m <sup>2</sup> )
B-3	Municipal buildings energy spend as percentage of municipal budget

## STREET LIGHTING KPIs

SL-1	Electricity consumed per km of lit roads (kWh/km)
SL-2	Percentage of city roads lit
SL-3	Electricity consumed per light pole (kWh/pole)

## POWER & HEAT KPIs

PH-1	Percentage heat loss from network
PH-2	Percentage total T & D losses
PH-3	Percentage of T & D loss due to non-technical

## WATER & WASTEWATER KPIs

WW-1	Water consumption (L/capita/day)
WW-2	Energy density of potable water production (kWh/m <sup>3</sup> )
WW-3	Energy density of wastewater treatment (kWh/m <sup>3</sup> )
WW-4	Percentage of non-revenue water
WW-5	Electricity cost for water treatment (potable- and wastewater) as a percentage of the total water utility expenditures

## WASTE KPIs

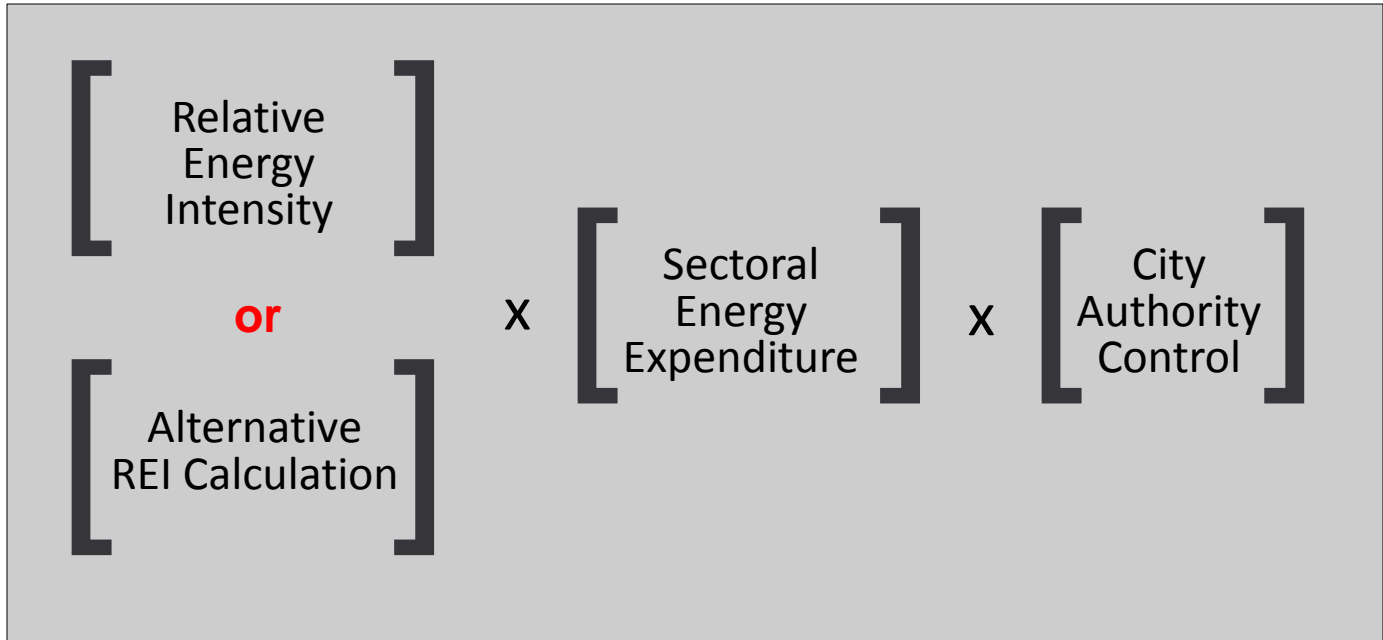
W-1	Waste per capita (kg/capita)
W-2	Percentage capture rate of solid waste
W-3	Percentage of solid waste recycled
W-4	Percentage of solid waste that goes to landfill

# Benchmarking Results

- Used to engage City Authority
- Used to estimate energy savings potential for city



# Sector Prioritization “Score”



*Relative Energy Intensity* – Estimate of energy savings potential for the sector (based on benchmarking)

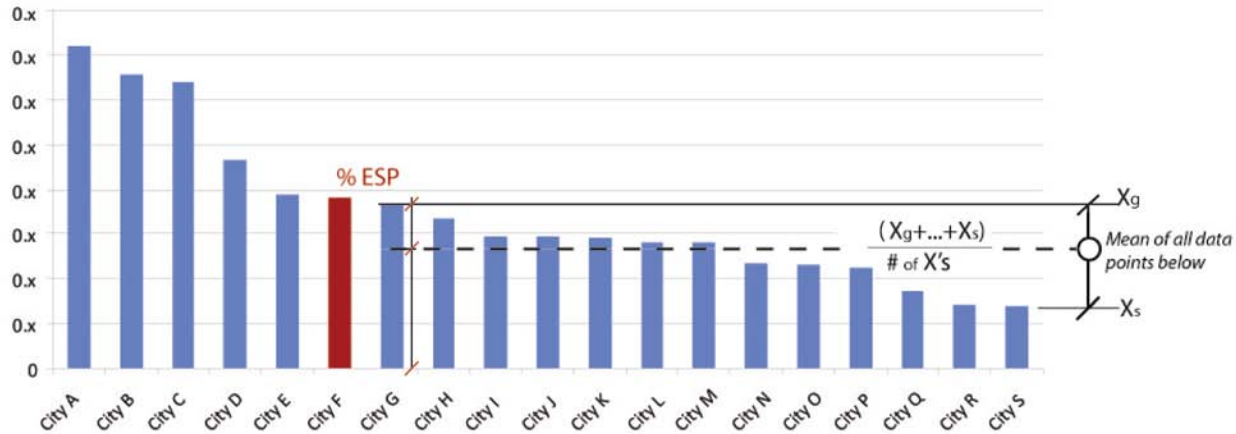
*Alternative REI Calculation* – Estimate of energy savings potential (based on CA/external expert assessment)

*Sectoral Energy Expenditure* – Estimate of money spent on energy in this sector

*City Authority Control (%)* – weighting factor to gauge the ability of the City Authority to influence change in the sector

# Sector Prioritization: Relative Energy Intensity

Indicative KPI for sector A  
MJ/denominator



Sector	Sub-Sector	KPI
Buildings	Municipal Buildings	B1 - Municipal Building Energy Consumption ( $\text{kWh}_e/\text{m}^2$ )
Transportation	Public Vehicles	T2 - Public Transportation MJ / Passenger km
	Private Vehicles	T3 - Private Transportation MJ / Passenger km
Water	Supply Water	WW2 - Energy Density of Potable Water ( $\text{kWh}_e/\text{m}^3$ )
	Wastewater	WW3 - Energy Density of Wastewater Treatment ( $\text{kWh}_e/\text{m}^3$ )
Public Lighting	Street Lighting	SL3 - Electricity Consumed per Light Pole ( $\text{kWh}/\text{pole}/\text{annum}$ )
Power & Heat	Electricity	PH2 - Percentage Total Transmission & Distribution Losses
	Heating	PH1 - Percentage Heat Lost from Network
Waste	Waste	W1 - Average Waste per Capita ( $\text{kg}/\text{capita}/\text{annum}$ )



# Sector Prioritization: Alternative REI Calculation

- For use when KPI-based REI calculation does not appear to match information acquired during stakeholder consultations
- Definition-based approach allows for uniform application across cities

## Municipal Buildings

Using the Slider below, select the appropriate REI based upon site walk-throughs the guidance provided in the 'Technical Energy Savings Estimation' Form. Please provide a rationale for the change in the box below, for instance: no benchmarks used etc.

0%

10%

20%

30%

Reason for Change

CA facilities engineering staff have been looking at boiler upgrades and fan replacement. They anticipate no less than 11% savings from these two changes alone – other system upgrades will improve efficiency by a few more percent.

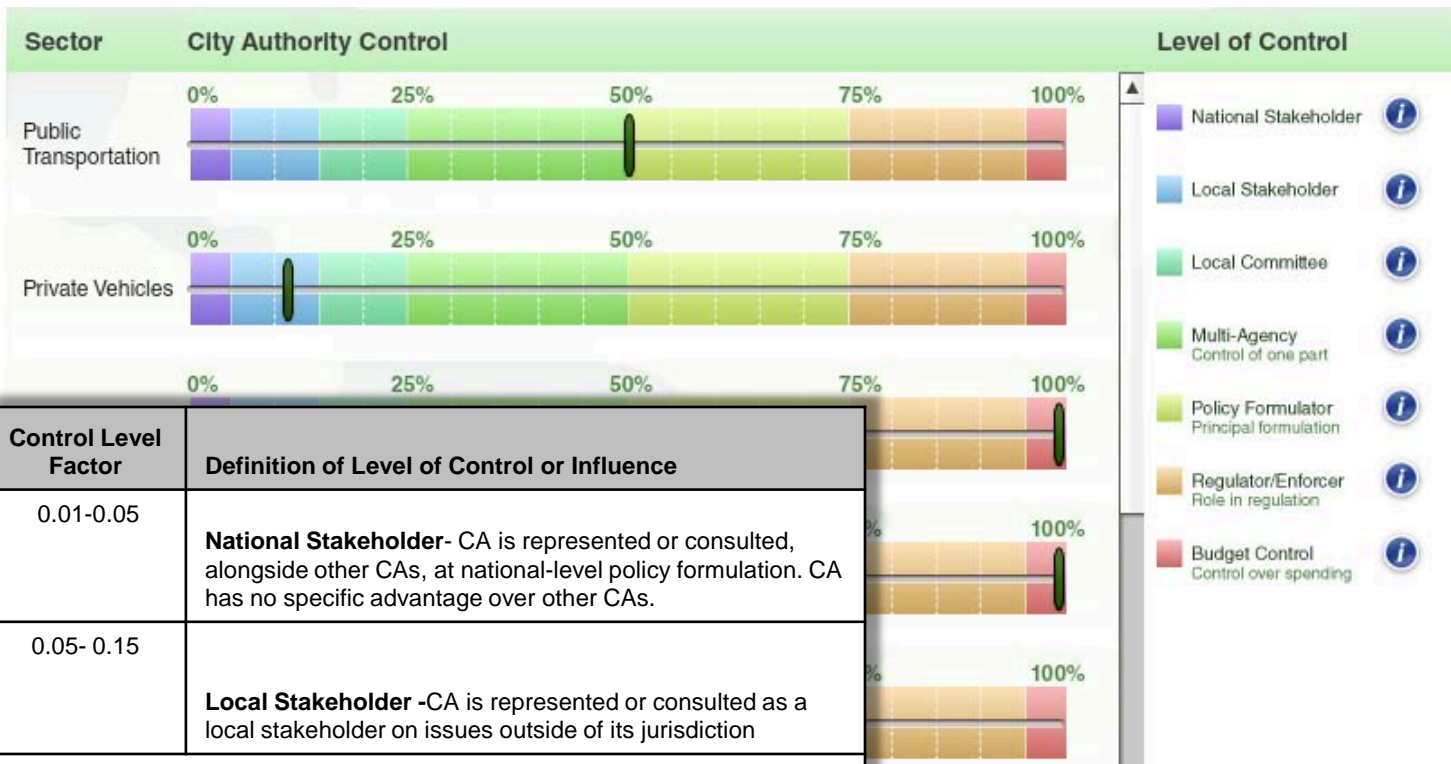
Return to REI

Cancel

Category+ Savings potential	Characteristics
<b>Very Low</b> (0-2%)	Some buildings have opportunity for basic lighting upgrades, but most systems are new or most buildings are under-serviced and designed very sparsely
<b>Low</b> (2-5%)	Mix of old and new buildings where lighting upgrades seem consistent, and some A/C or heating systems could be upgraded
<b>Medium</b> (5-10%)	Some large buildings with major upgrade opportunities, but mostly old, smaller buildings
<b>High</b> (10-20%)	Majority of old buildings with: old lighting at >20W/m <sup>2</sup> , old A/C with COP < 3.0, old heating with efficiency < 0.7, old elevator/pump motors.

# Sector Prioritization: Level of CA Control

- Weighting factor for sector priority score
- Each city has a unique political, economic and policy-making context



Control Level Factor	Definition of Level of Control or Influence
0.01-0.05	<b>National Stakeholder</b> - CA is represented or consulted, alongside other CAs, at national-level policy formulation. CA has no specific advantage over other CAs.
0.05- 0.15	<b>Local Stakeholder</b> -CA is represented or consulted as a local stakeholder on issues outside of its jurisdiction
...	
0.95-1.0	<b>Budget Control</b> - CA has full financial control over the provision of services, purchase of assets and development of infrastructure

Based upon the answers to the sector prioritization questions, two separate lists of sectors have been created: CA Control and City-wide.



**5 of 8**  
selected

## City Authority Sector Ranking

Rank	Sector	REI%	Spending CA (US \$)	Control	Score	Check to Select
1	Public Transportation	53.3	1,800,000,000	0.51	489,600,000	<input checked="" type="checkbox"/>
2	Solid Waste	67.3	600,000,000	0.50	201,981,818	<input checked="" type="checkbox"/>
3	Potable Water	25.2	300,000,000	1.00	75,789,473	<input checked="" type="checkbox"/>
4	Municipal Buildings	26.8	213,000,000	1.00	57,167,875	<input checked="" type="checkbox"/>
5	Street Lighting	12.3	18,000,000	1.00	2,222,608	<input type="checkbox"/>

## City Wide Sector Ranking

Rank	Sector	REI%	Spending CA (US \$)	Control	Score	Check to Select
1	Wastewater	22.8	350,000,000	0.50	39,999,999	<input checked="" type="checkbox"/>
2	Power	52.5	569,888,000	0.05	14,964,956	<input type="checkbox"/>
3	District Heating	0.0	140,000,000	0.26	0	<input type="checkbox"/>

# Recommendations

- 59 Recommendations in total
- Mix of strategic programs and specific sector activities
- 191 case studies with hyper-links to other resources and tools
- Each recommendation 'rated' on three attributes: *Energy Savings Potential, First Cost, Speed of implementation*
- 23 "technical" recommendations include energy savings calculators

## Water and Wastewater Calculator Assumptions

These figures are referenced in all of the calculator and can be altered by the consultant as required.

### Background Information

Cost of electricity (\$/kWh)	0.15
Cost of electricity at discounted tariff (\$/kWh)	0.1
Sector Energy Spend (\$)	17000000

## Pump & Motor Upgrade Calculator

Recommendations Reference: 01 Improve Efficiency of Pumps and/or Motors

### Attributes

### Current Energy Consumption

### Post-Upgrade Energy Consumption

	Current Energy Consumption				Post-Upgrade Energy Consumption									
	Model	Flow Capacity (m <sup>3</sup> /h)	Pump Efficiency	Differentia I Head (m)	Hours of Operation per day	Total Flow per day (m <sup>3</sup> /day)	Total kWh per day	Model	Flow Capacity (m <sup>3</sup> /h)	Pump Efficiency	Differentia I Head (m)	Hours of Operation per day	Total Flow per day (m <sup>3</sup> /day)	Total kWh per day
Pump1		360	60%	10	2	720	32.70		360	60%	10	2	720	32.70
Pump2		120	60%	10	1	120	5.45		120	70%	10	1	120	4.67
Pump3		40	60%	10	1	40	1.82		40	80%	10	1	40	1.36
Pump4														
<b>Total</b>						<b>880</b>	<b>40</b>						<b>880</b>	<b>39</b>

Total Energy Savings	450 kWh / annum
Percentage Improvement	0 %
Total Cost Savings	774 \$ / annum

# Recommendations Appraisal

- As part of recommendation appraisal process, the CA's 'capacity to act' is rated on five factors:
  - Finance
  - Human Resources
  - Assets/Infrastructure
  - Policy/Regulation/ Enforcement
  - Data/Information

**Finance**

*Level of Competency*

Low Funding is available from Municipal funding streams only. CA has no experience of other financial or partnering mechanisms.

Medium CA has experience of: public private partnerships, some experience of other streams such as grants, soft loans and commercial funding

High CA has relevant experience of some of the following: performance contracting, carbon finance and other innovative funding mechanisms

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**Human resources**

*Level of Competency*

Low City Authority has few technically skilled staff and/or a small available workforce. Staff can be trained/workforce expanded as part of the recommendation.

Medium City Authority has access to a highly trained/skilled person to lead the initiative and/or a medium sized workforce available. Staff can be trained/workforce expanded as part of the City Authority.

High CA has access to considerable trained/technically proficient staff resources, including transport

Home
**Initial Appraisal**
Export
Save

The matrix below presents the results of the initial appraisal of recommendations in each prioritized sector, against the observed levels of competency and opportunity in the RAF city. Back to Initial Appraisal

- Public Transportation
- Private Vehicles
- Solid Waste
- Potable Water
- Wastewater
- Power
- District Heating
- Street Lighting
- Municipal Buildings

Recommendation	C	F	H	A	P	D	Check to select
ESMAP City score	C	m	m	h	h	m	
Car Parking Management	C	l	m	m	m	m	<input checked="" type="checkbox"/>
Congestion Pricing	C	h	m	h	h	h	<input type="checkbox"/>
EE Municipal Vehicle Fleets	C	l	m	l	m	m	<input checked="" type="checkbox"/>
Enforcement of Vehicle Emissions	C	l	m	l	m	m	<input checked="" type="checkbox"/>
Non-Motorized Modes	C	m	m	m	m	m	<input type="checkbox"/>
Public Transportation Development	C	m	m	m	m	h	<input checked="" type="checkbox"/>
Taxi Vehicle Replacement Program	C	m	m	l	m	m	<input checked="" type="checkbox"/>
Traffic Flow Optimization	C	l	m	m	m	h	<input type="checkbox"/>

**D** Data and Information  
**P** Policy, Regulation and Enforcement  
**A** Assets & Infrastructure  
**H** Human Resources  
**F** Finance

# Recommendations: Recommendation Matrix

Home **Recommendations Matrix** Export Save

The matrix below sorts recommendations by 3 attributes: First Cost, Energy Efficiency and Speed of Implementation. ? Back To Review Final List

Filter by speed of implementation  < 1 year  1-2 years  > 2 years

		First Cost		
		> \$1,000,000	\$100,000 - \$1,000,000	< \$100,000
Energy Savings Potential	>200,000 kWh/annum	Municipal Residential (Public Housing) ...	<ul style="list-style-type: none"> <li>Public Spaces Lighting Audit and Retrofit</li> <li>Solar Hot Water Program</li> <li>Improve Efficiency of Pumps and Motors</li> <li>Improve Performance of System Network</li> <li>Transformer Upgrade Program</li> </ul>	<ul style="list-style-type: none"> <li>Procurement Guide for New Street Light ...</li> <li>EE Municipal Vehicle Fleets</li> <li>Fuel-Efficient Waste Vehicle Operations</li> </ul>
	100,000 - 200,000 kWh/yr		<ul style="list-style-type: none"> <li>Active Leak Detection and Pressure Man...</li> <li>EE Sorting and Transfer Facilities</li> <li>Non-Technical Loss Reduction Program</li> <li>Active Leak Detection and Pressure Man...</li> </ul>	<ul style="list-style-type: none"> <li>City-Wide Integrated Public Lighting Ass.</li> <li>Municipal Buildings Energy Efficiency Ta.</li> <li>Buildings Benchmarking Program</li> <li>Water Efficient Fixtures and Fittings</li> <li>Waste Composting Programme</li> </ul>
	<100,000 kWh/annum		<ul style="list-style-type: none"> <li>Traffic Signals Audit and Retrofit Program</li> <li>Water Meter Programme</li> </ul>	<ul style="list-style-type: none"> <li>Computer PowerSave Project</li> <li>Educational Measures</li> <li>Waste Vehicle Fleet Maintenance Audit a...</li> </ul>



# RAF Process Summary

3-stage (12 week) process for a full city report

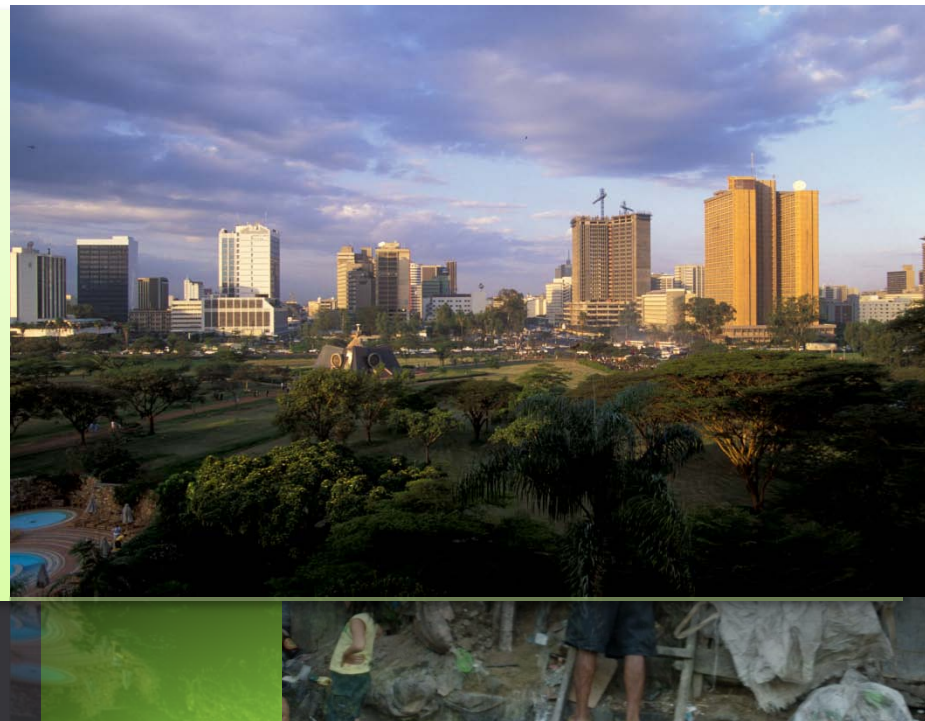
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Duration	6 weeks		4 days	1 day	4 days	1 day	4 weeks

- All information, insights, recommendations and calculations feed into Final City Report
- External energy efficiency expert’s formal role ends here, although they may be contracted directly by CA to provide implementation support

## Next Steps for RAF's Operational Leveraging

- Select a candidate city for pilot before it is deployed in different regions
- Criteria for city selection
  - Proactive Mayor – local champion
  - Cost sharing from the region
  - Linkage to potential Bank investment operation
  - Availability of credible data

Thank you!



For more information:

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