ESMAP
Energy Sector Management Assistance Program

The Rapid Assessment Framework (RAF)

An Innovative Diagnostic Tool for City Energy Use

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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

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

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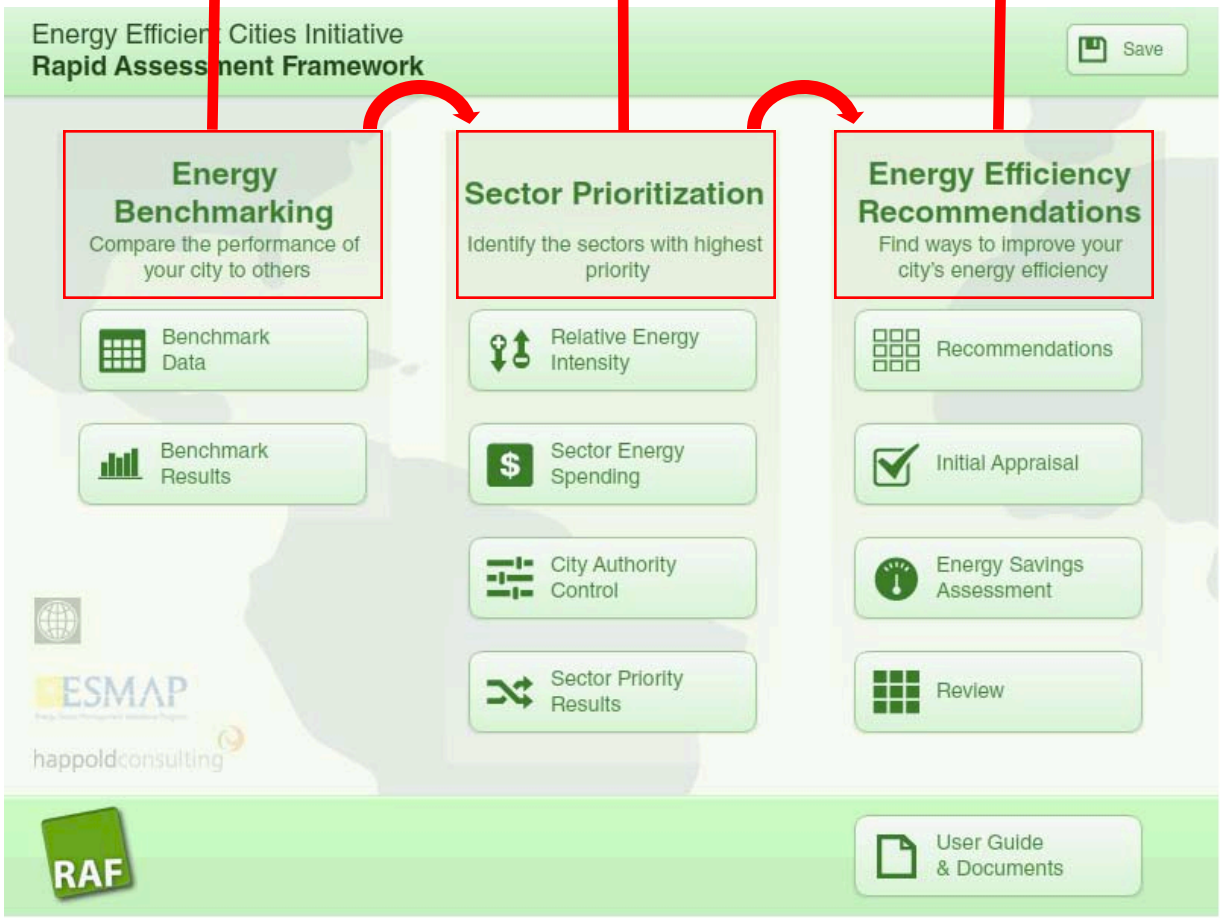
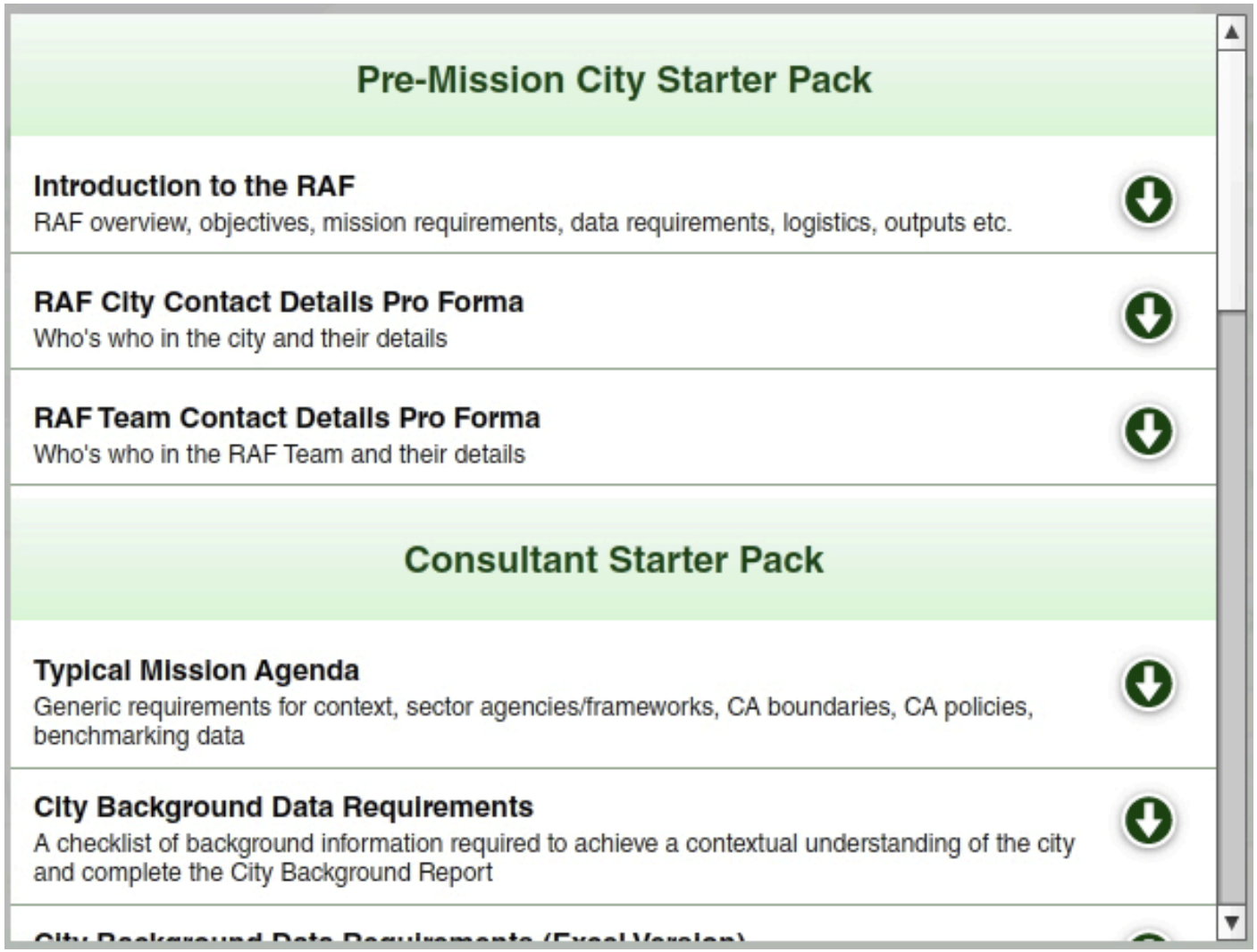
PROJECT TWO DEGREES

	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



Pre-mission | Mission | Post-mission

RAF Support Documentation



Pre-mission

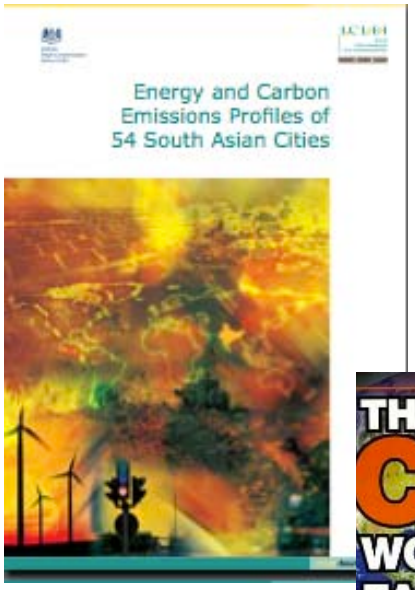
Sample KPIs for Benchmarking

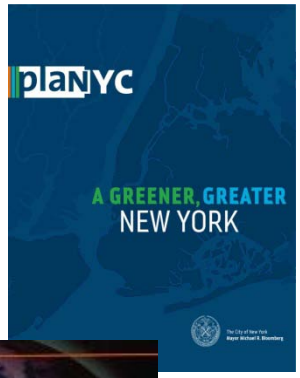
Key Performance Indicator	# cities w/ data
City Wide KPIs	
Electricity consumption (kWhe/capita)	52
Electricity consumption (kWhe/GDP)	11
Primary energy consumption (MJ/capita)	44
Primary energy consumption (MJ/GDP)	14
Transportation KPIs	
Total transport (MJ/capita)	40
Public transport (MJ/passenger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

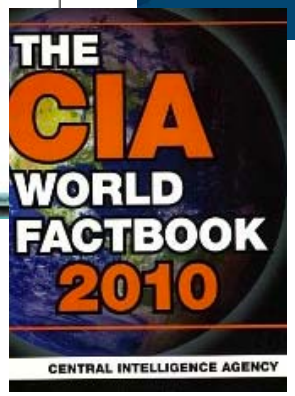
Pre-mission

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







UITP

Global City Indicators Facility

IBNET The International Benchmarking Network for Water and Sanitation Utilities

Pre-mission

Benchmarking Cities

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

28 KPIs are used in RAF

CITY WIDE KPIS

CW-1	Electricity consumption (kWhe/capita)
CW-2	Electricity consumption (kWhe/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 modes split (%)
T-6	Kilometres of high capacity transit per 1000 people

BUILDINGS KPIS

B-1	Municipal buildings (kWhe/m2)
B-2	Municipal buildings heat consumption (kWhth/m2)
B-3	Municipal buildings energy spend as percentage of municipal budget

STREET LIGHTING KPIS

SL-1	Electricity consumed per km of lit roads (kWhe/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 (kWhe/m3)
WW-3	Energy density of wastewater treatment (kWhe/m3)
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

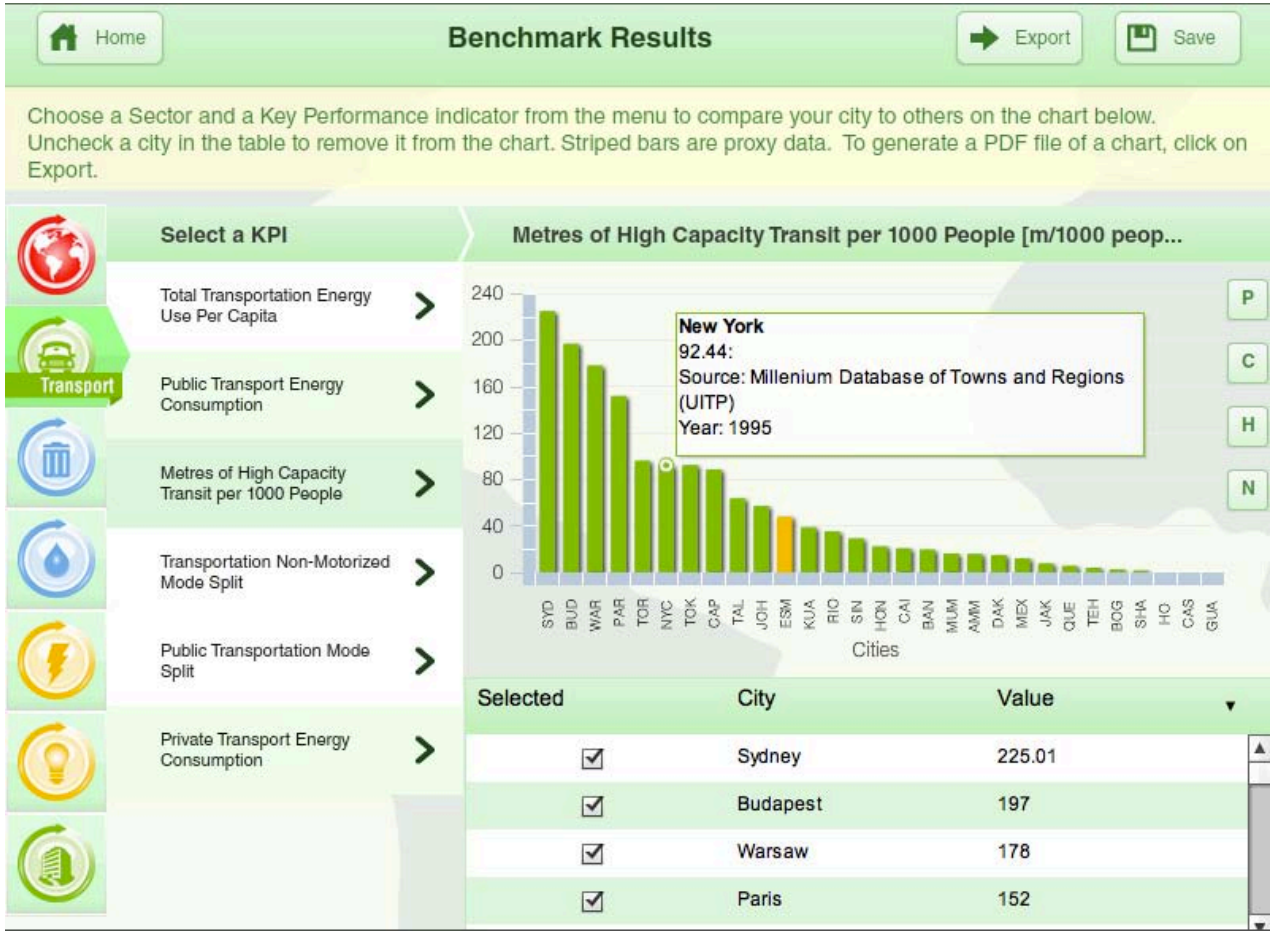
WASTE KPIS

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

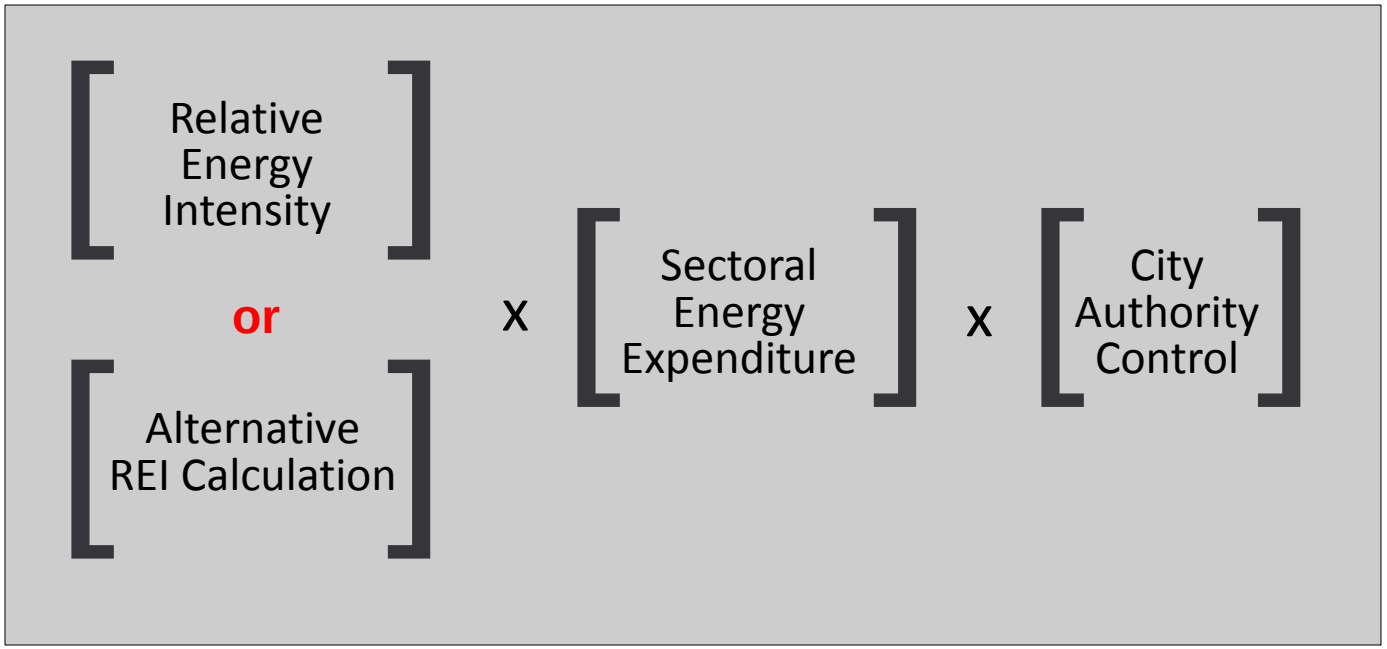
Pre-mission

Benchmarking Results

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



Sector Prioritization "Score"



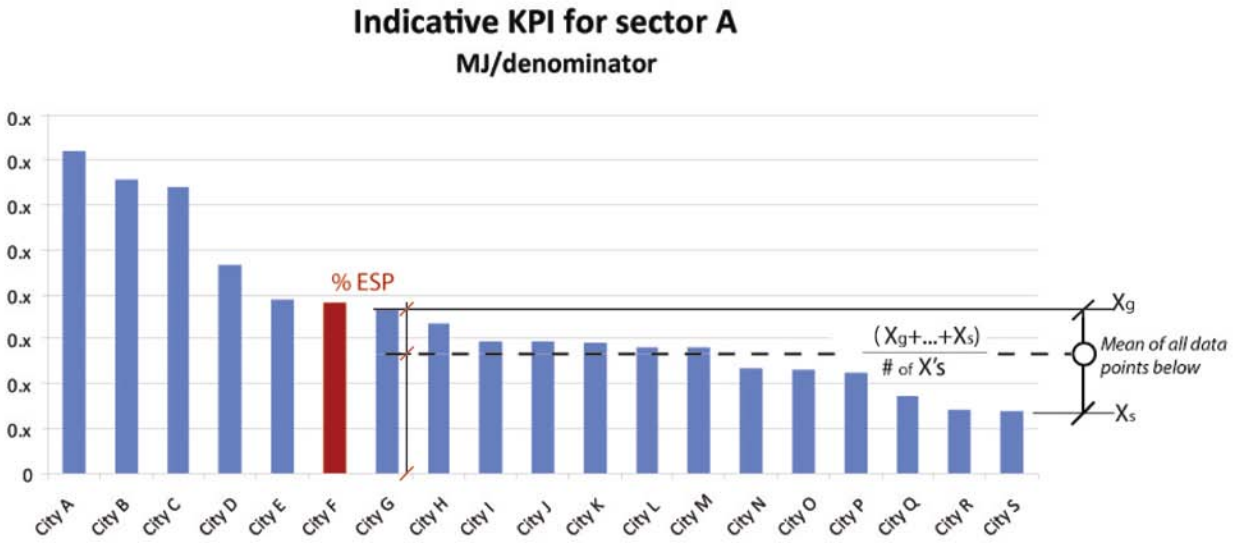
Relative Energy Intensity – Estimate of energy savings potential for the sector (based on benchmarking)

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

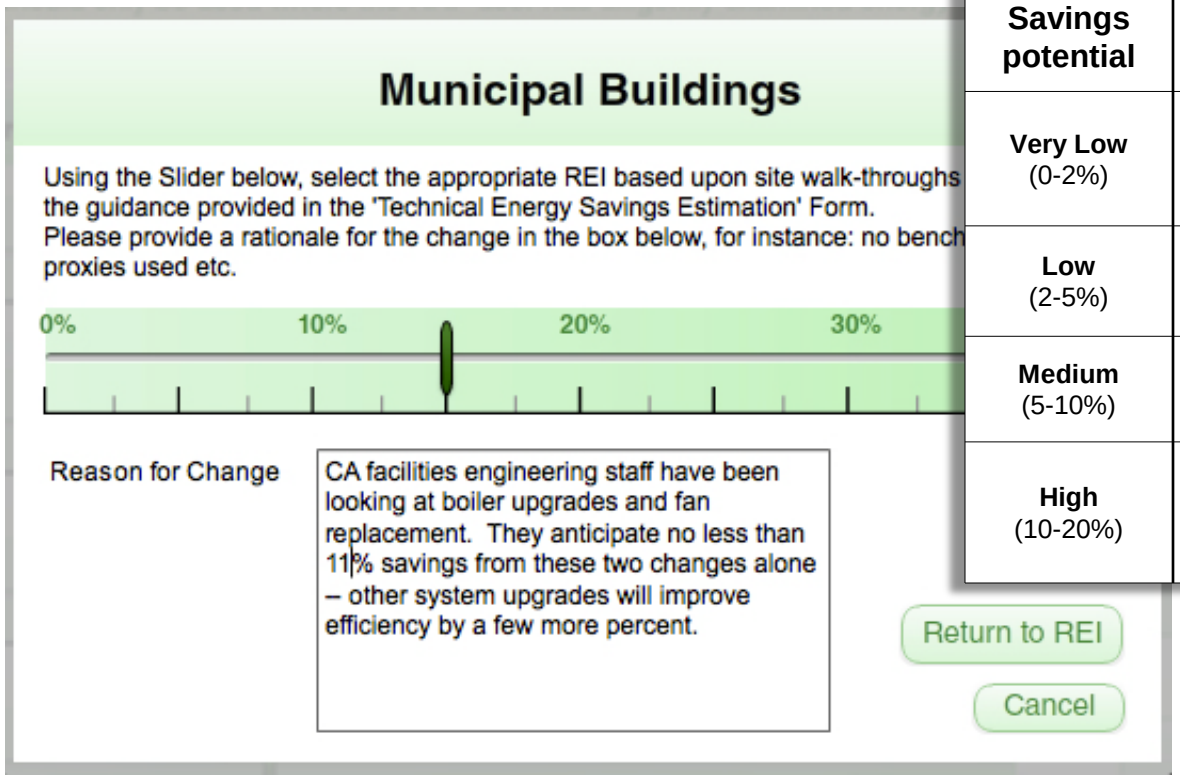
Sector Prioritization: Relative Energy Intensity



Sector	Sub-Sector	KPI
Buildings	Municipal Buildings	B1 - Municipal Building Energy Consumption (kWh_e/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 (kWh_e/m^3)
	Wastewater	WW3 - Energy Density of Wastewater Treatment (kWh_e/m^3)
Public Lighting	Street Lighting	SL3 - Electricity Consumed per Light Pole (kWh/pole/annum)
Power & Heat	Electricity	PH2 - Percentage Total Transmission & Distribution Losses
	Heating	PH1 - Percentage Heat Lost from Network
Waste	Waste	W1 - Average Waste per Capita (kg/capita/annum)

Sector Prioritization: Alternative REI Calculation

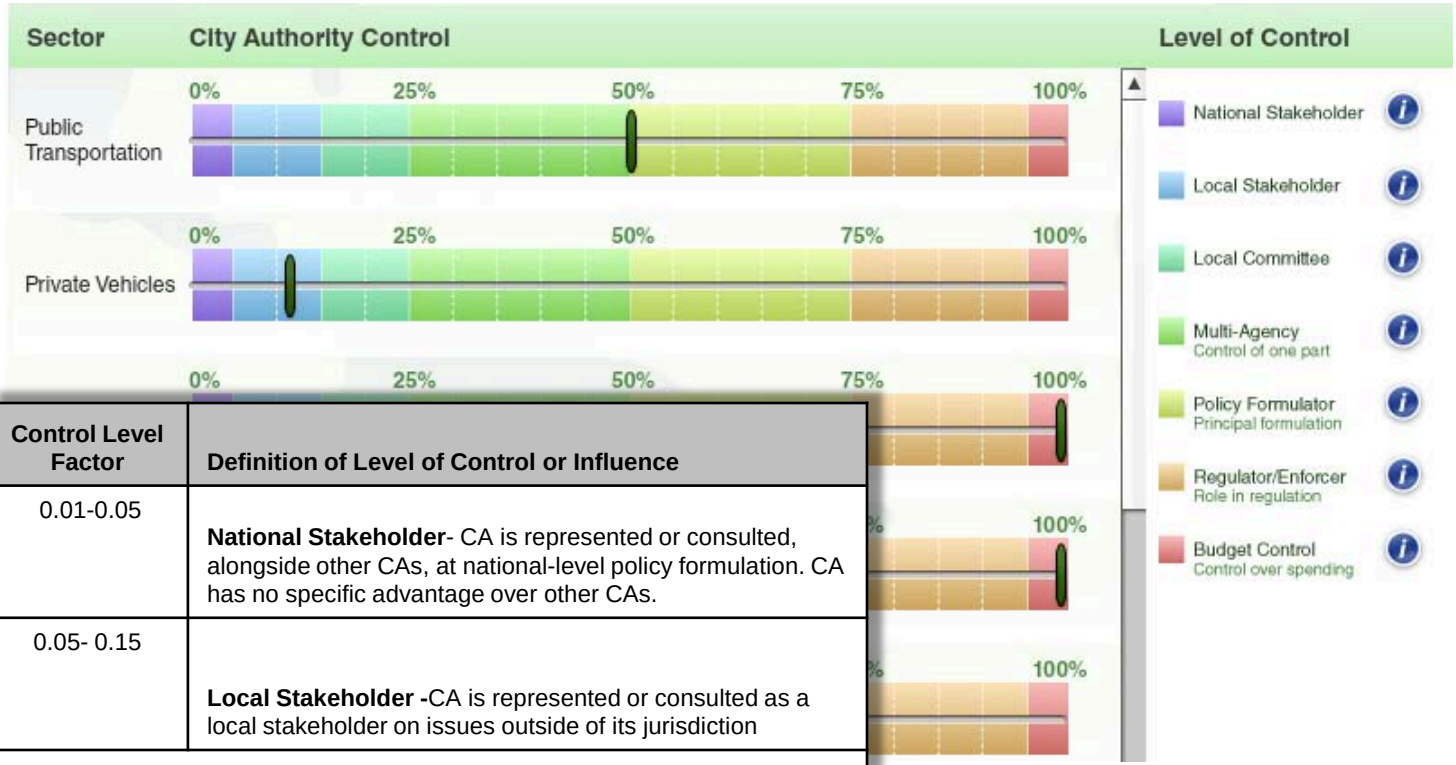
- For use when KPI-based REI calculation does not appear to match information acquired during stakeholder consultations
- Definition-based approach allows for uniform application across cities



Category+ Savings potential	Characteristics
Very Low (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
Low (2-5%)	Mix of old and new buildings where lighting upgrades seem consistent, and some A/C or heating systems could be upgraded
Medium (5-10%)	Some large buildings with major upgrade opportunities, but mostly old, smaller buildings
High (10-20%)	Majority of old buildings with: old lighting at >20W/m2, 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	**National Stakeholder**- 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	**Local Stakeholder -**CA is represented or consulted as a local stakeholder on issues outside of its jurisdiction
	...
0.95-1.0	**Budget Control**- CA has full financial control over the provision of services, purchase of assets and development of infrastructure

Home

Sector Prioritization

Export Save

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

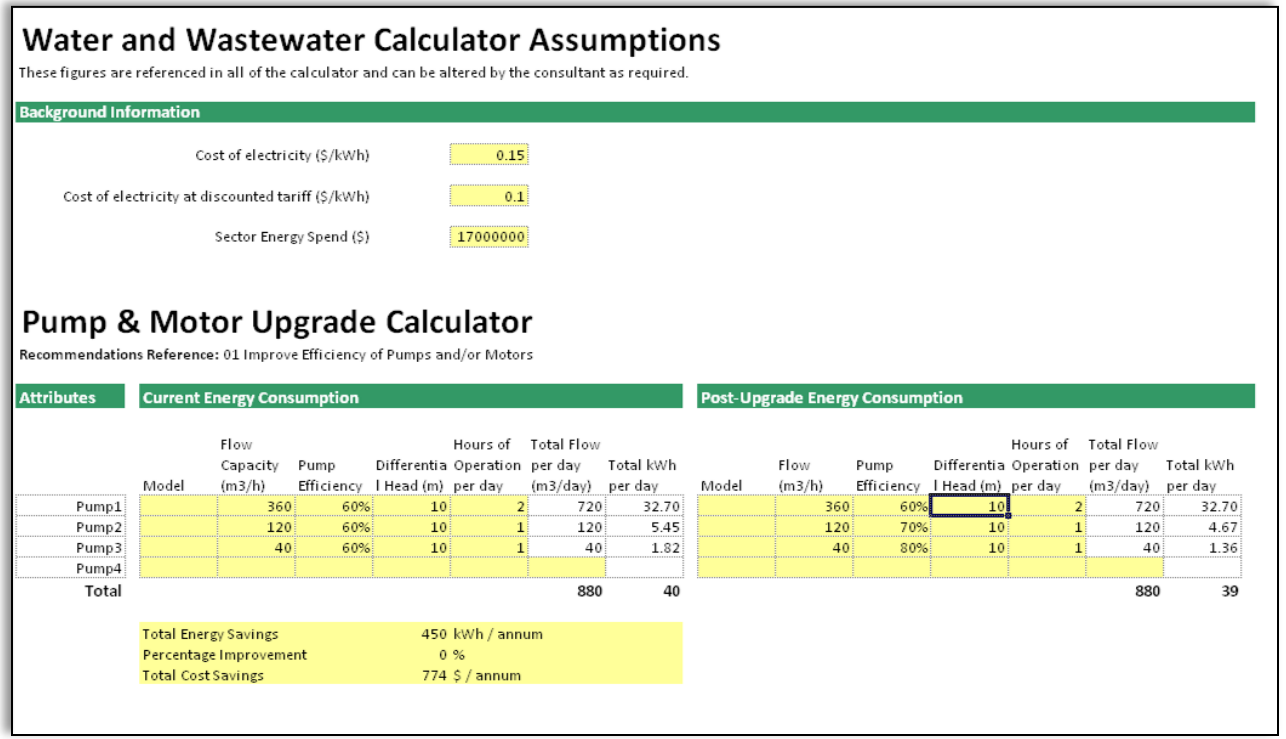
Rank	Sector	REI%	Spending (US $)	CA Control	Score	Check to Select
1	Public Transportation	53.3	1,800,000,000	0.51	489,600,000	☑
2	Solid Waste	67.3	600,000,000	0.50	201,981,818	☑
3	Potable Water	25.2	300,000,000	1.00	75,789,473	☑
4	Municipal Buildings	26.8	213,000,000	1.00	57,167,875	☑
5	Street Lighting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

City Wide Sector Ranking

Rank	Sector	REI%	Spending (US $)	CA Control	Score	Check to Select
1	Wastewater	22.8	350,000,000	0.50	39,999,999	☑
2	Power	52.5	569,888,000	0.05	14,964,956	☐
3	District Heating	0.0	140,000,000	0.26	0	☐

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

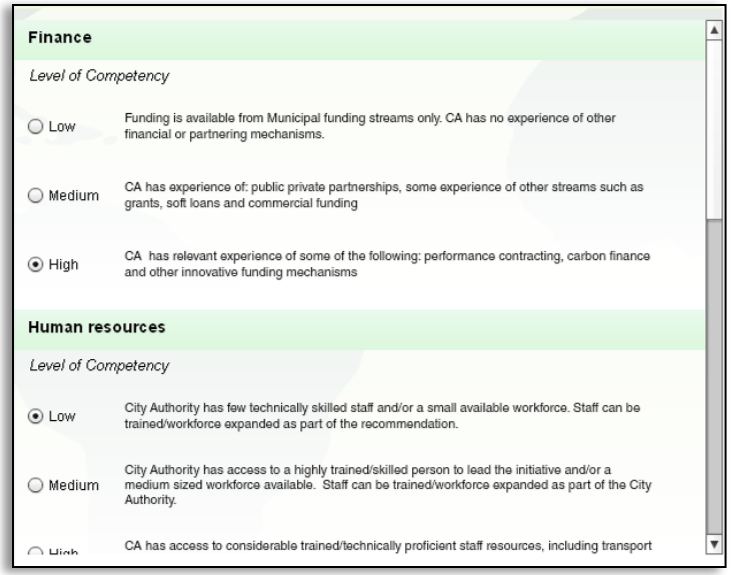
Attributes | **Current Energy Consumption** | **Post-Upgrade Energy Consumption**

	Model	Flow Capacity (m3/h)	Pump Efficiency	Differential Head (m)	Hours of Operation per day	Total Flow per day (m3/day)	Total kWh per day	Model	Flow (m3/h)	Pump Efficiency	Differential Head (m)	Hours of Operation per day	Total Flow per day (m3/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														
Total						880	40						880	39

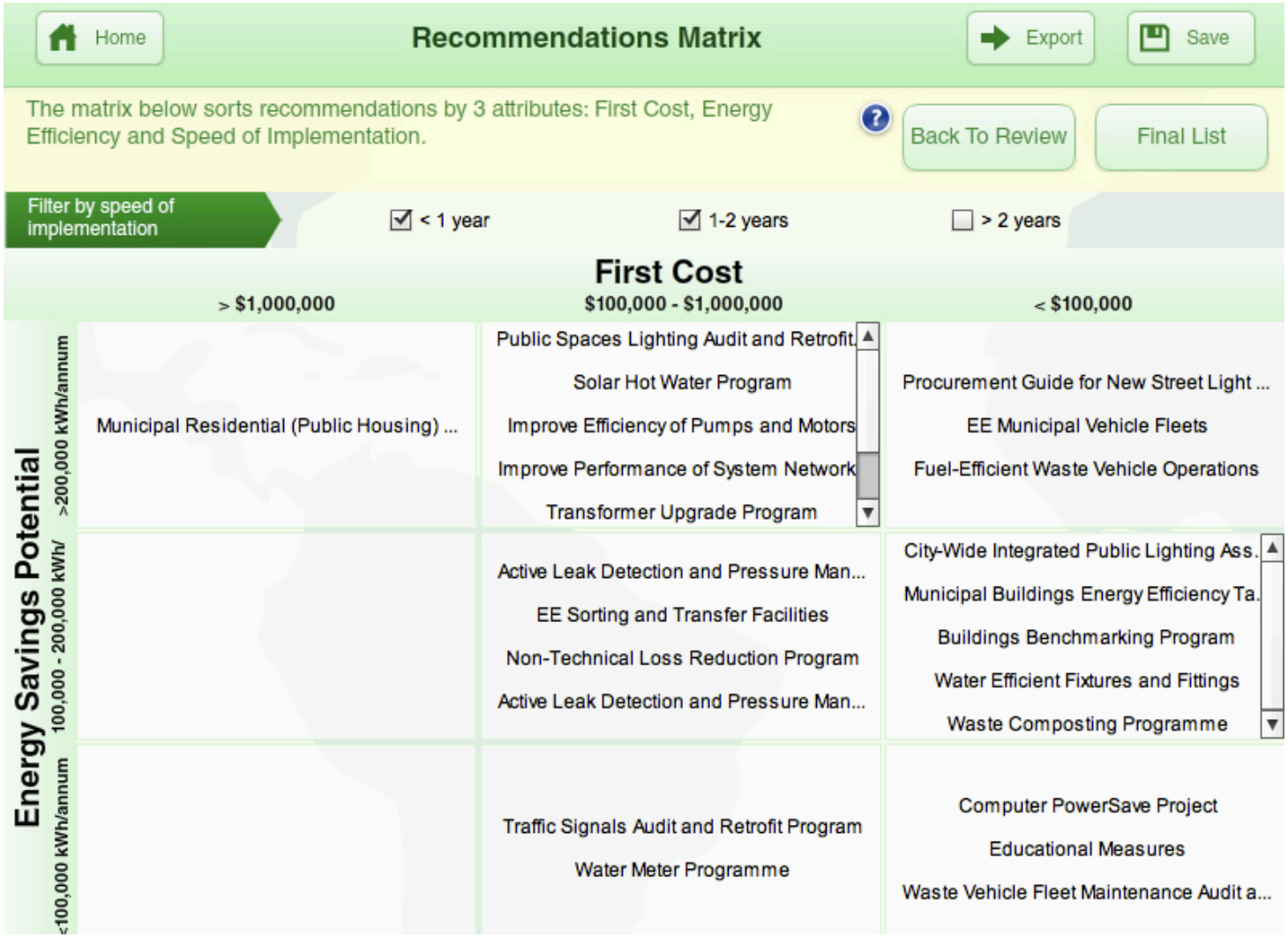
Total Energy Savings	450	kWh / annum
Percentage Improvement	0	%
Total Cost Savings	774	$ / annum

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



Recommendations: Recommendation Matrix



RAF Process Summary

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

	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

- 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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