

ENERGY EFFICIENCY IN SUB-SAHARAN AFRICAN CITIES

OCTOBER 27, 2015

RUTU DAVE

THE WORLD BANK

ESMAP Energy Efficient Cities Program and Tool for Rapid Assessment of City Energy (TRACE)



Cities are important....



Constrained services



Limited resources



Doing more with less



Prioritization



??
or



TRACE Why TRACE?

Strong Demand from Cities

- Strong desire to reduce energy costs through EE improvements
- A lack of decision-support tool to identify major EE interventions across urban sectors
- Desire to learn from peer cities' and international best practices

Key Advantages of TRACE

- Cross-sectoral
- Focuses on areas under the control of the city authority
- Relatively low data requirements, low cost, intuitive and quick to implement
- Strong ownership of cities



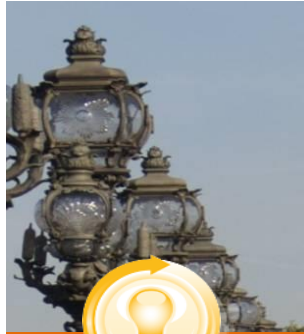
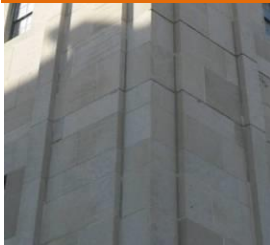
Evaluating Energy Efficiency Opportunities in 6 Municipal Sectors



TRANSPORT



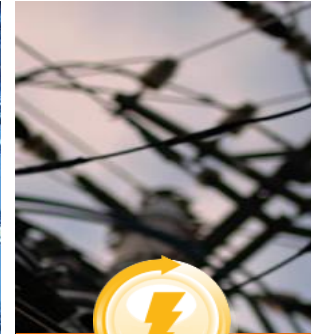
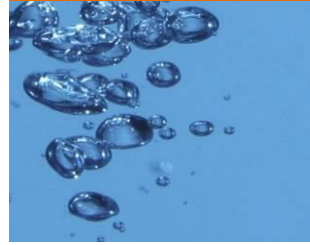
BUILDINGS



**PUBLIC
LIGHTING**



**WATER &
WASTEWATER**



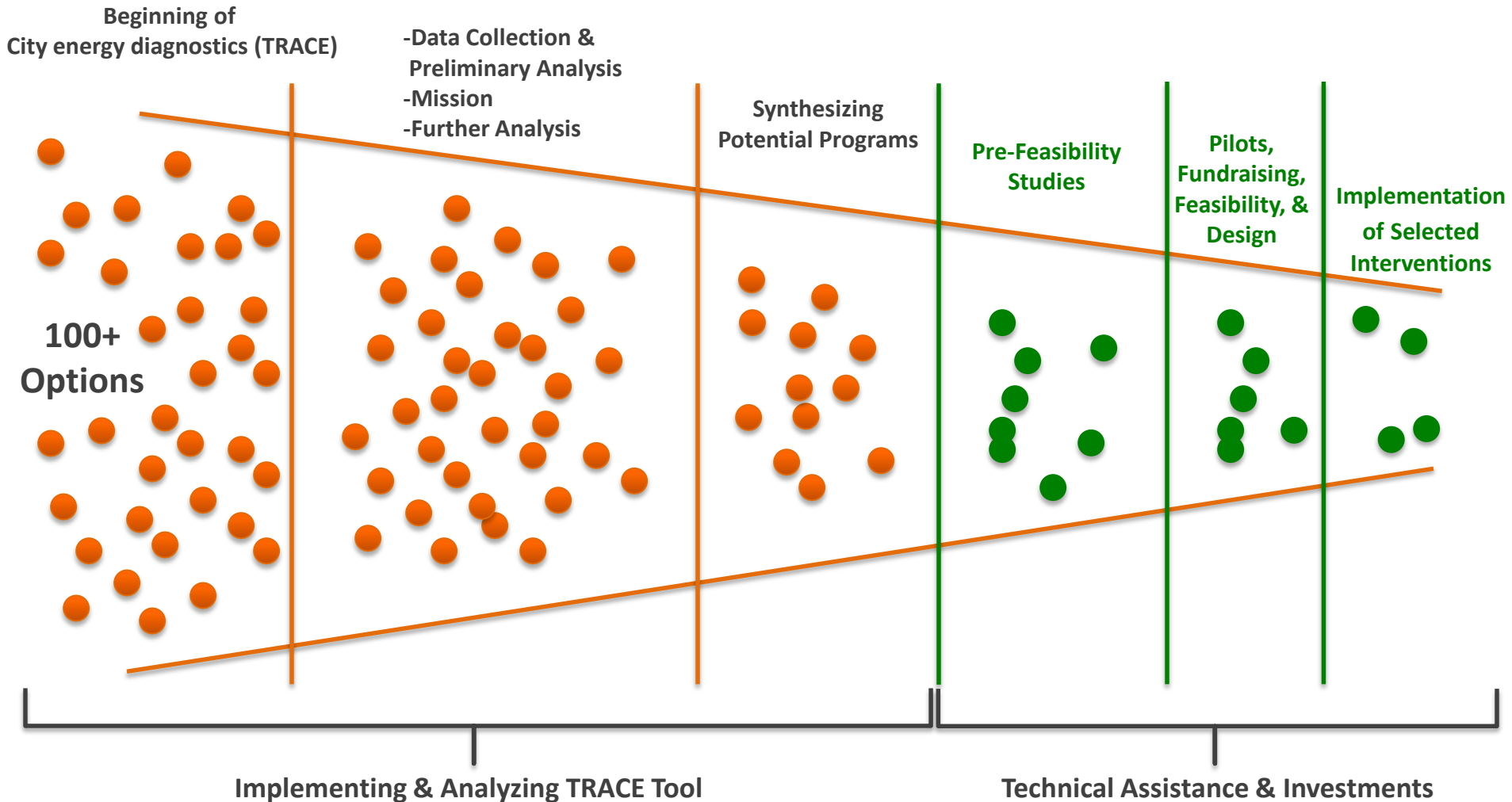
**POWER &
HEATING**



**SOLID
WASTE**



Overview of the World Bank's urban energy efficiency Technical Assistance Program



City Energy Efficiency Transformation Initiative

ENHANCING KNOWLEDGE & BUILDING CAPACITY – RESOURCES TO SUPPORT EE IN BUILDINGS



Knowledge
Products

- What can local governments do to improve energy efficiency in their cities? (Mayoral Guidance Notes - <http://www.esmap.org/node/3155>)



- How to measure the performance of energy efficiency projects? (*underway - focus on street lighting & buildings*)



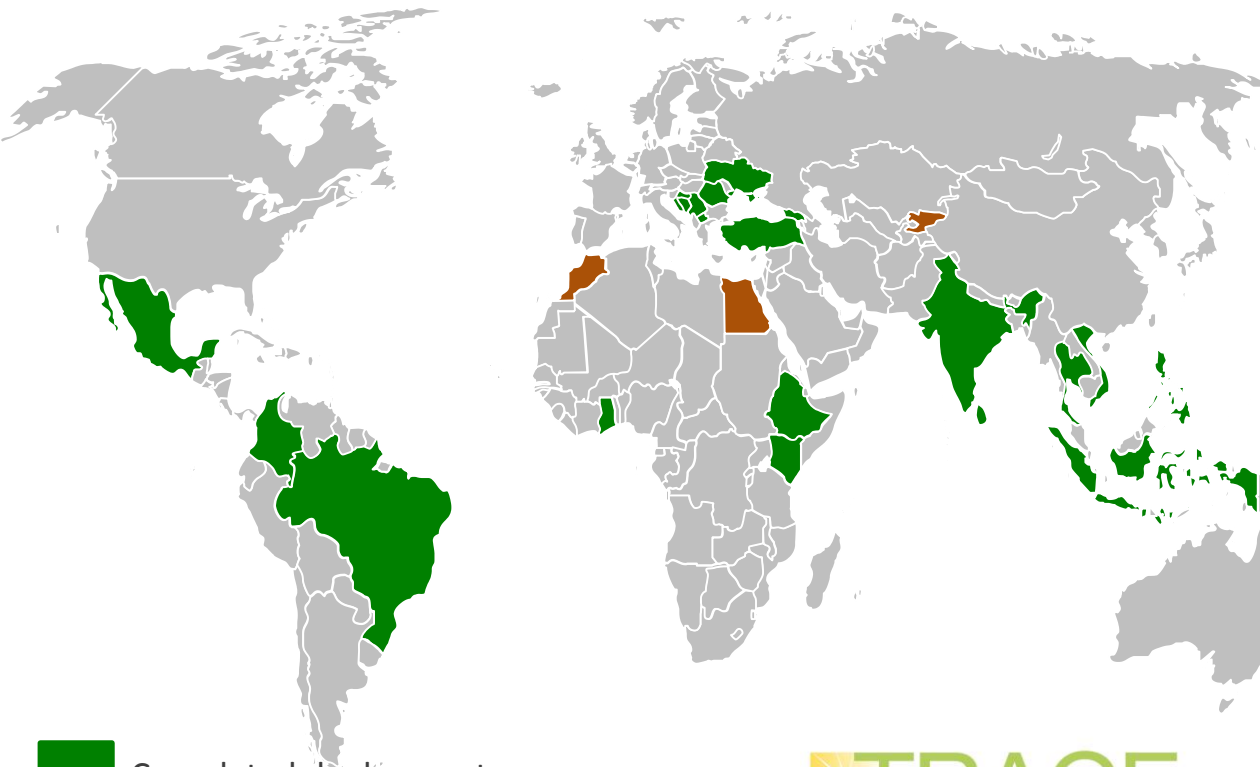
Capacity
Building



- Bring urban and energy practitioners together
- Extend reach of CEETI program
 - **Energy Efficiency Project Resource Center Resource Center EEPRC**) –in cooperation with the open wiki-platform Energypedia
https://energypedia.info/wiki/Energy_Efficiency_Project_Resource_Center
 - Development of **e-learning program** on energy efficiency in cities (incl. course on EE public buildings
<http://e institute.worldbank.org/ei/course/energy-efficiency-public-buildings>)

TRACE – Contributing to Genesis of EE Programs in 67 Cities

TOOL GOING THROUGH TARGETED DISSEMINATION AND MAJOR TECHNICAL IMPROVEMENT

35 Countries Reached & Targeted Dissemination Planned



 Completed deployment
 Upcoming deployment


Tool for Rapid Assessment of City Energy

Major Enhancement to TRACE 2.0

- Adding industry, commercial buildings and residential buildings sectors
- Updating the recommendations to include the latest technologies
- Adding new benchmarking data
- Improving usability of the tool
- Converting the tool to Excel for improved transparency and flexibility



Tools

City Energy Diagnostics – Tool for Rapid Assessment of City Energy (TRACE)

A DECISION SUPPORT TOOL FOR EVALUATING ENERGY EFFICIENCY OPPORTUNITIES IN CITIES

TRACE:

“ ...a practical tool for conducting rapid assessment of energy use in cities, that identifies and prioritizes sectors, and suggests specific energy efficiency interventions... ”
(public lighting; transport; buildings; water and waste water; solid waste; power and heat)

The screenshot displays the TRACE tool interface with the following components:

- Header:** "Energy Efficient Cities Initiative" and "Tool for Rapid Assessment of City Energy". A "Save" button is in the top right.
- Energy Benchmarking:** "Compare the performance of your city to others". Includes "Benchmark Data" (calendar icon) and "Benchmark Results" (bar chart icon).
- Sector Prioritization:** "Identify the sectors with highest priority". Includes "Relative Energy Intensity" (key and up arrow icon), "Sector Energy Spending" (dollar sign icon), "City Authority Control" (list icon), and "Sector Priority Results" (curved arrow icon).
- Energy Efficiency Recommendations:** "Find ways to improve your city's energy efficiency". Includes "Recommendations" (grid icon), "Initial Appraisal" (checkmark icon), "Energy Savings Assessment" (lightbulb icon), and "Review" (grid icon).
- Footer:** "TRACE Tool for Rapid Assessment of City Energy" logo and a "User Guide & Documents" button.

Energy Benchmarking

Data Collection Phase		TRACE Implementation				City Report
Gather data	Benchmark city energy use	Introduce TRACE / hold sector meetings	Assess most promising sectors	Review recommendations in priority sectors	Prepare final recommendations	Prepare final city report

Benchmark Data

Data collated during the pre-mission phase, using the templates provided should be entered here. Go through each of the tabs on the left to access each sector. Don't forget to add the year and source of the data. If a proxy has been used (e.g. national data), check the box on the right and enter the year and source

Data Point	Year	Source	Proxy
Population Within Municipal Boundary	2010	Gaz	<input type="checkbox"/>
Climate Type	2010	Gaz	<input type="checkbox"/>
HDI (by Country)	2009	Huma	<input type="checkbox"/>
Primary Electricity Consumption per Capita [kWh/capita]	2010	Gaz	<input type="checkbox"/>
Primary Electricity Consumption per GDP [kWh/\$GDP]	2010	Gaz	<input type="checkbox"/>
Primary Energy Consumption per Capita [MJ/capita]			<input type="checkbox"/>

Benchmark Results

Choose a Sector and a Key Performance Indicator from the menu to compare your city to others on the chart below. Uncheck a city in the table to remove it from the chart. Striped bars are proxy data. To generate a PDF file of a chart, click on Export.

Select a KPI: **Transport** - Metres of High Capacity Transit per 1000 People [m/1000 peop...]



Selected	City	Value
<input checked="" type="checkbox"/>	Sydney	225.01
<input checked="" type="checkbox"/>	Budapest	197
<input checked="" type="checkbox"/>	Warsaw	178
<input checked="" type="checkbox"/>	Paris	152

Energy Benchmarking
Compare the performance of your city to others

Benchmark Data

Benchmark Results

Evaluating Energy Efficiency

Data Collection Phase		TRACE Implementation				City Report
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Sector Prioritization

Identify the sectors with highest priority

- Relative Energy Intensity
- Sector Energy Spending
- City Authority Control
- Sector Priority Results

Relative Energy Intensity

The sliders below have been pre-set using the data provided in the Energy Benchmarking module. The TRACE City energy reduction value is calculated as the mean of the values of all chosen peer cities with better performance. The override value should only be used where the TRACE user has direct knowledge of the sector or sub-sector using the 'Technical Energy Savings Estimation' Form.

Sector	Energy Savings Potential
District Heating	0% 10% 20%
Power	0% 10% 20%
Potable Water	0% 10% 20%
Wastewater	0% 10% 20%
Solid Waste	0% 10% 20% 30% 40%

Override Saved

Override

Municipal Buildings

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

0% 10% 20% 30% 40%

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

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Home

Sector Energy Spending

Save

Enter the amount of money spent per calendar year (\$USD) in each sector using the input boxes below. If no money is spent at the city level in a sector, leave the box blank.

Sector	Energy Spending (\$USD) i	City Authority i	City Wide i
Public Transportation	<input type="text" value="51518994"/>	<input type="radio"/>	<input checked="" type="radio"/>
Private Vehicles	<input type="text" value="182328446"/>	<input type="radio"/>	<input checked="" type="radio"/>
Municipal Buildings	<input type="text" value="13836029"/>	<input checked="" type="radio"/>	<input type="radio"/>
Street Lighting	<input type="text" value="13547485"/>	<input type="radio"/>	<input checked="" type="radio"/>
District Heating	<input type="text" value="0"/>	<input type="radio"/>	<input type="radio"/>

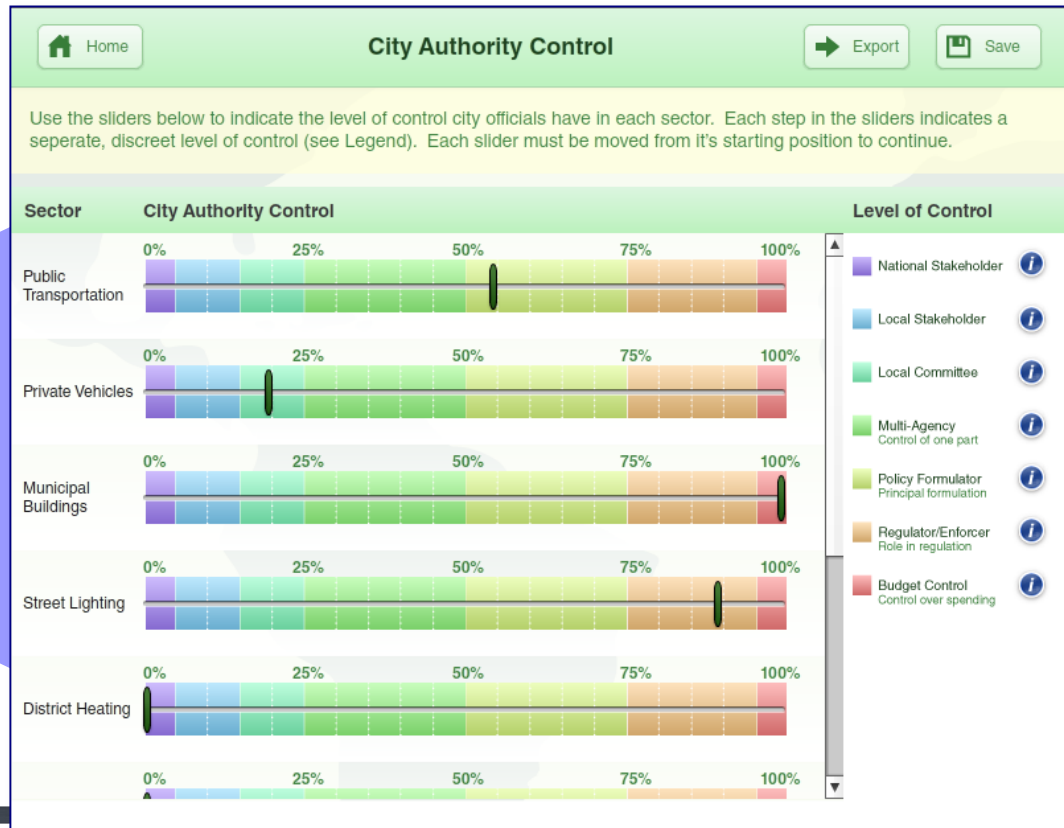
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-  Relative Energy Intensity
-  Sector Energy Spending
-  City Authority Control
-  Sector Priority Results

 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. 4 of 8 selected

City Authority Sector Ranking

Rank	Sector	REI%	Spending CA (US \$) Control	Score	Check to Select
1	Potable Water	86.0	20,046,760 0.80	13,799,229	<input type="checkbox"/>
2	Municipal Buildings	54.8	13,836,029 1.00	7,586,851	<input checked="" type="checkbox"/>
3	Solid Waste	48.2	500,000 0.75	180,803	<input type="checkbox"/>
4	Wastewater	5.0	1,194,840 0.95	56,754	<input type="checkbox"/>

City Wide Sector Ranking

Rank	Sector	REI%	Spending CA (US \$) Control	Score	Check to Select
1	Public Transportation	42.4	51,518,994 0.55	12,021,098	<input checked="" type="checkbox"/>
2	Private Vehicles	29.4	182,328,446 0.20	10,752,703	<input checked="" type="checkbox"/>
3	Street Lighting	51.2	13,547,485 0.90	6,251,823	<input checked="" type="checkbox"/>
4	Power	31.5	538,517,487 0.01	1,701,657	<input type="checkbox"/>

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

Energy Efficiency Recommendations
Find ways to improve your city's energy efficiency

- Recommendations
- Initial Appraisal**
- Energy Savings Assessment
- Review
- User Guide & Documents

Initial Appraisal

Using the information gathered during the initial round of interviews and site visits, an Initial Appraisal report accurately describes the situation in the TRACE city.

Finance

Level of Competency

- Low: Funding is available financial or political
- Medium: CA has experience with grants, soft loans
- High: CA has relevant expertise and other innovations

Human resources

Level of Competency

- Low: City Authority trained/workforce
- Medium: City Authority medium sized recommendations
- High: CA has access to energy audits

Initial Appraisal

The matrix below presents the results of the initial appraisal of recommendations in each prioritized sector, comparing each recommendation's minimum requirements against the observed levels of competency and opportunity in the TRACE city.

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

Recommendation	C	F	H	D	P	A	Check to select
Gaziantep, Turkey score		l	l	m	l	l	
Buildings Benchmarking Program	█	l	m	l	l	l	<input checked="" type="checkbox"/>
Computer PowerSave Project	█	l	l	l	m	l	<input checked="" type="checkbox"/>
Green Building Guidelines for New	█	l	h	l	m	m	<input checked="" type="checkbox"/>
Mandatory Building Energy Efficiency	█	l	h	l	m	m	<input checked="" type="checkbox"/>
Municipal Buildings Energy Efficiency	█	l	m	l	m	l	<input checked="" type="checkbox"/>
Municipal Hospitals Audit & Retrofit	█	m	m	m	m	m	<input checked="" type="checkbox"/>
Municipal Offices Audit & Retrofit	█	m	m	m	m	m	<input checked="" type="checkbox"/>
Municipal Residential (Public	█	m	l	m	m	m	<input checked="" type="checkbox"/>
Municipal Schools Audit & Retrofit	█	m	l	m	m	m	<input checked="" type="checkbox"/>
Solar Hot Water Program	█	l	l	l	m	l	<input checked="" type="checkbox"/>

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Energy Savings Assessment

Home Save

For each recommendation that has an energy savings calculator, undertake the calculation and enter the estimated energy savings in the box below.
Download the Energy Savings Calculator here: [Download Icon]

Recommendation	Value (kWh/annum)
Public Transportation	
Private Vehicles	
Municipal Schools Audit & Retrofit Program	
Municipal Office	
Municipal Resi. Program	
Municipal Hosp	
Computer Pow	
CA Management	

Municipal Buildings Upgrade Calculator

Background Information

Total floor area of Municipal Buildings: 100,000 m²
Average cost of electricity for municipal buildings: 0.15 \$/kWh
Sector Annual Energy Spend (\$): 52,000,000 \$

Municipal Offices Audit and Retrofit Program

Attribute	Current Office Space			Post-Retrofit Office Space		
	m ² owned	m ² leased	m ² private	m ² owned	m ² leased	m ² private
Ownership	20,000	0	0	20,000	0	0
Cooled area	15,000	0	0	15,000	0	0
Heated area	0	0	0	0	0	0

Attribute	Current Office Space				Run-Hours	Total kWh	Post-Retrofit Office Space				Run-Hours	Total kWh
	% Worst	% Bad	% Good	% Best			% Worst	% Bad	% Good	% Best		
Lighting	30%	30%	20%	20%	2000	724,000	0%	5%	60%	35%	1800	486,000
Cooling	30%	30%	30%	10%	1000	310,500	0%	10%	20%	70%	800	194,400
Heating	0%	0%	0%	0%	0	0	0%	0%	0%	0%	0	0
Computers / IT	30%	30%	30%	10%	2000	453,000	0%	10%	40%	50%	2000	339,000
Appliances	30%	30%	30%	10%	2500	213,750	0%	10%	40%	50%	2500	153,750
Other 2						0						0
Other 3						0						0
Other 4						0						0
Total						1,701,250						1,173,150

AUDITOR CHECK on total spend

Total Energy Savings: \$400,000
Percentage Improvement: 52%
Total Potential Cost Savings: \$79,215

AUDITOR CHECK on %

Lighting: 20%
Cooling: 20%
Computers / IT: 20%
Appliances: 20%

Lighting Rating Guidelines

- 25 W/m² WORST (incandescent, old fluorescent w/ mag ballast, pre 1990 lighting)
- 18 W/m² BAD (T12, direct illumin, pre 2000)
- 14 W/m² GOOD (T8, electronic ballast, indirect, post 2000)
- 12 W/m² BEST (super T8, indirect, lower illumination level)

Heating Rating Guidelines

- 25 W/m² WORST (SEER < 2.0, COP < 2.5, pre 1990)
- 21 W/m² BAD (SEER < 1.5, COP < 3.0, pre 1990)
- 18 W/m² GOOD (SEER > 1.5, COP < 3.0, post 1990)
- 15 W/m² BEST (SEER > 2.5, COP < 2.5, post 1990)

Computers / IT Rating Guidelines

- 20 W/m² WORST (I)
- 15 W/m² BAD (pre 1990)
- 12 W/m² GOOD (pre 2000)
- 10 W/m² BEST (post 2000, energy star or equivalent rating)

Appliance Rating Guidelines

- 7 W/m² WORST (pre 1990)
- 6 W/m² BAD (pre 1990)
- 5 W/m² GOOD (pre 2000)
- 3 W/m² BEST (post 2000, energy star or equivalent rating)

Guidance: Input current building floor areas and conditioned floor areas in the yellow shaded cells section based on a rough estimate of total floor areas. With consultation with CA facilities managers, local engineers and CA buildings department, estimate the percentage of each type of quality of lighting, cooling, heating, appliances and other significant energy consuming end-uses. The 'Post-Retrofit Offices' section is meant to be completed with estimates of the best-case technical scenario for a CA-wide upgrade over the life of a 5 year retrofit program.

Assumptions: ASHRAE 90.1 served as the basis for the assumptions in this calculator.

Evaluating Energy Efficiency

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Recommendation Review

All recommendations that were selected in the Initial Appraisal are displayed below along with their attributes. Where user input has been entered for Energy value has been updated to show a standard range in which the

Recommendation	Sector	Speed
Municipal Buildings Energy Effic...	Municipal Blds	<1yr
Buildings Benchmarking Program	Municipal Blds	1-2yrs
Municipal Schools Audit & Retrofit ...	Municipal Blds	1-2yrs
Municipal Offices Audit & Retrofit P...	Municipal Blds	1-2yrs
Municipal Residential (Public Hou...	Municipal Blds	1-2yrs
Municipal Hospitals Audit & Retrofi...	Municipal Blds	1-2yrs
Computer PowerSave Project	Municipal Blds	<1yr
Solar Hot Water Program	Municipal Blds	<1yr
Mandatory Building Energy Efficen...	Municipal Blds	>2yrs
Green Building Guidelines for Ne...	Municipal Blds	>2yrs
Enforcement of Vehicle Emission...	Public Transp	>2yrs
Taxi Vehicle Replacement Program	Public Transp	>2yrs
Traffic Flow Optimization	Public Transp	>2yrs

Recommendations Matrix

The matrix below shows all recommendations from prioritized sectors sorted by First Cost and Energy Efficiency. The check boxes allow the user to alter the display based on Speed of Implementation.

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

Energy Savings Potential	First Cost		
	> \$1,000,000	\$100,000 - \$1,000,000	< \$100,000
>200,000 kWh/annum	Municipal Offices Audit & Retrofit Program	Solar Hot Water Program	Mandatory Building Energy Efficiency Co...
100,000 - 200,000 kWh/annum	Municipal Residential (Public Housing) ...	Enforcement of Vehicle Emissions Stan...	Green Building Guidelines for New Build...
10,000 - 100,000 kWh/annum	Municipal Hospitals Audit & Retrofit Prog...	Taxi Vehicle Replacement Program	Procurement Guide for New Street Light...
<100,000 kWh/annum	Public Transportation Development	Traffic Flow Optimization	Lighting Timing Program
		Enforcement of Vehicle Emissions Stan...	Municipal Vehicle Fleet Efficiency Program...
	Non-Motorized Transport Modes	Traffic Restraining Measures	Municipal Buildings Energy Efficiency Ta...
	Congestion Pricing	Energy Efficiency Municipal Task Force	Buildings Benchmarking Program
	Non-Motorized Transport Modes	Energy Efficiency Strategy and Action Pla...	Parking Restraining Measures
		Capital Investment Planning	City-Wide Integrated Public Lighting Ass...
		Purchasing and Service Contracts	
			Computer PowerSave Project
		Municipal Schools Audit & Retrofit Progr...	Street Signage Lighting Audit and Retrof...
		Traffic Signals Audit and Retrofit Program	

TRACE results for Bangkok



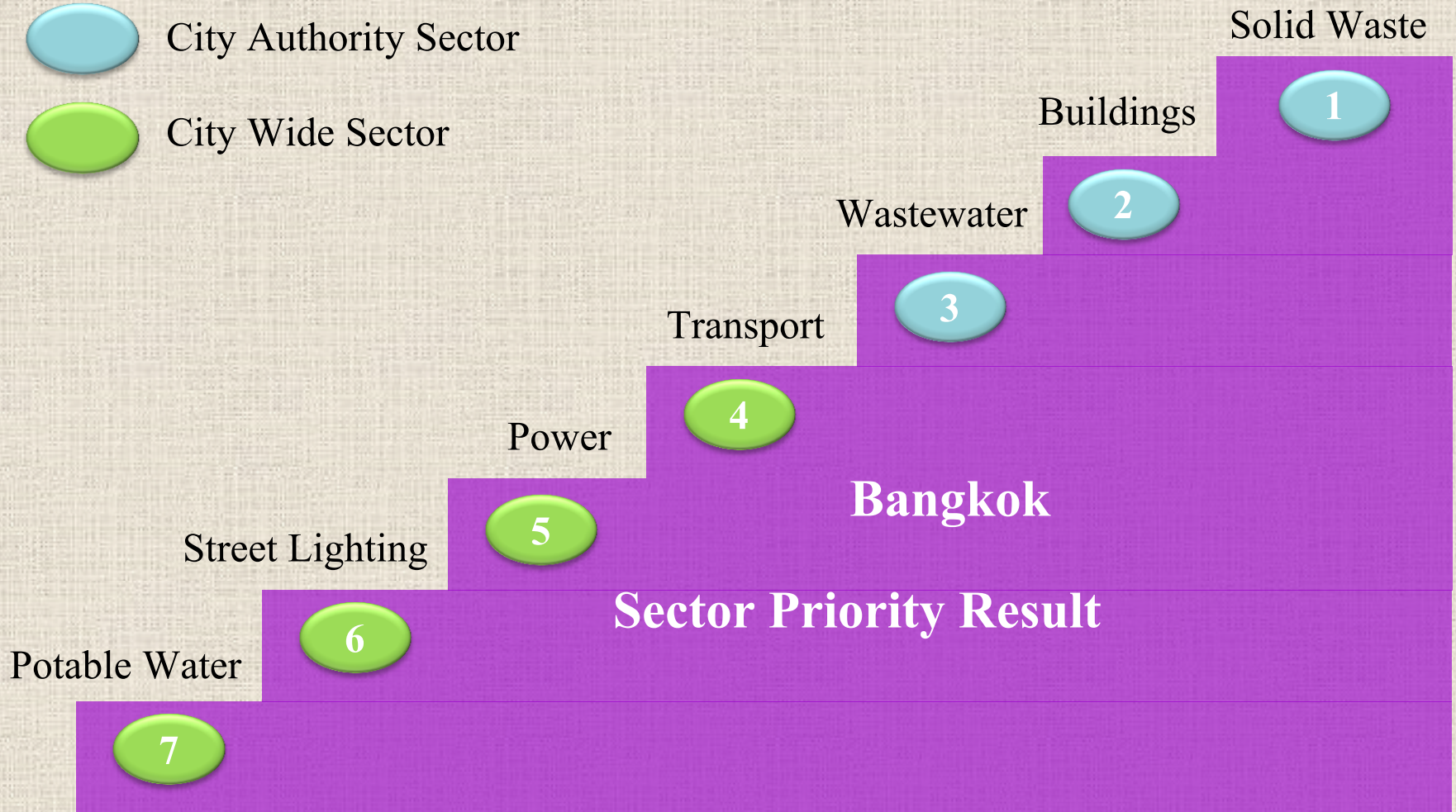
1. Sector Priority Result



City Authority Sector



City Wide Sector

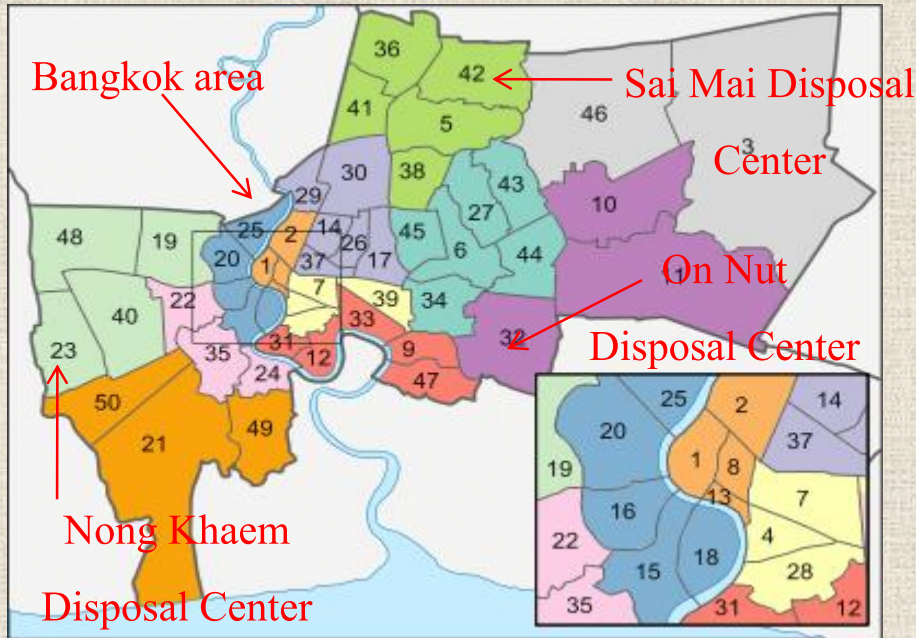




Realizing the Energy Efficiency Opportunities in the

Solid Waste Sector

Waste findings in Bangkok



Bangkok Waste Intermediate Stations

Findings:

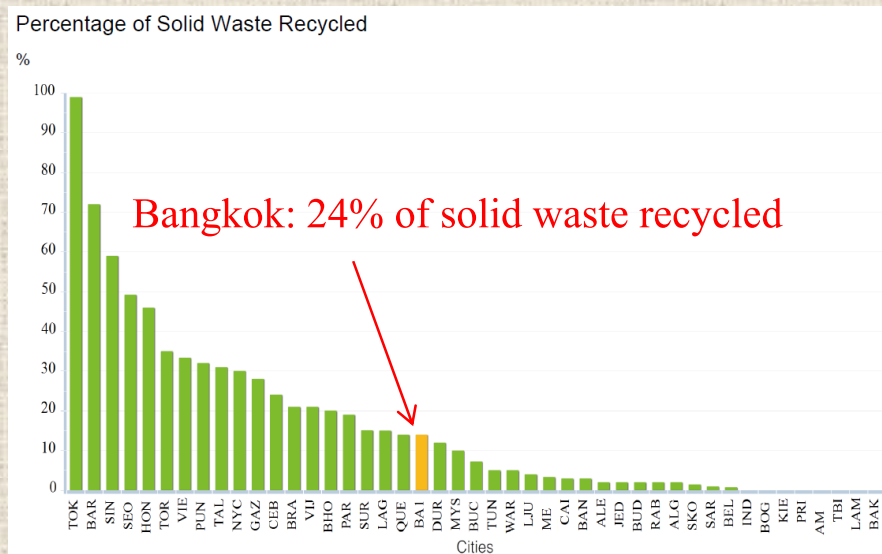
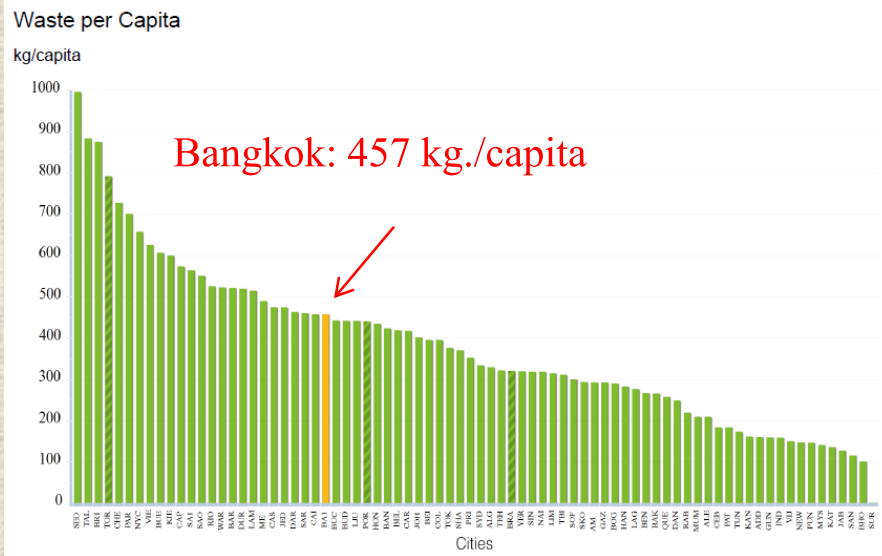
- The generated waste in year 2013 was 9,963 ton/day.
- There are 3 intermediate stations before transferring the waste to the sanitary landfill sites;
 - 1) Nong Khaem Disposal Center (4,000 tons/day)
 - 2) On Nut Disposal Center (4,000 tons/day)
 - 3) Sai Mai Disposal Center (2,000 tons/day)



Waste per capita, percentage of solid waste recycled and goes to landfills

Findings:

- Waste per capita in Bangkok is 457 kg./capita which is in between the cities of Bucharest, Romania (422 kg./capita) and Cairo, Egypt (457 kg./capita)
- Percentage of waste recycled in Bangkok (24%) is quite low when compared to the other big cities (Tokyo: 99%, Barcelona: 72, singapore:59, Seoul 49% and Hong Kong 46%).
- Apart from recycle process, all the waste (76% of total waste) are sent to the sanitary landfills Percentage of waste that goes to landfills.



Opportunities and recommendations



Finding:

- According to the BMA's 12-year development plan (2009-2020) the waste per capita is expected to be reduced to 0.7 kg/capita/day.

Opportunities:

- There is opportunity to increase more percentage of waste recycled by adding more recycling process and also waste separated at sources by color coding bin.
- There is opportunity to use all 76% that goes to the landfills by converting to energy as per the waste to energy program.

Recommendations:

- Waste to Energy Program
- Waste Infrastructure Planning
- Waste Vehicle Fleet Maintenance Audit and Retrofit Program.
- Fuel-Efficient Waste Vehicle Operations.



Realizing the Energy Efficiency Opportunities in the

Buildings Sector

Municipal buildings electricity consumption

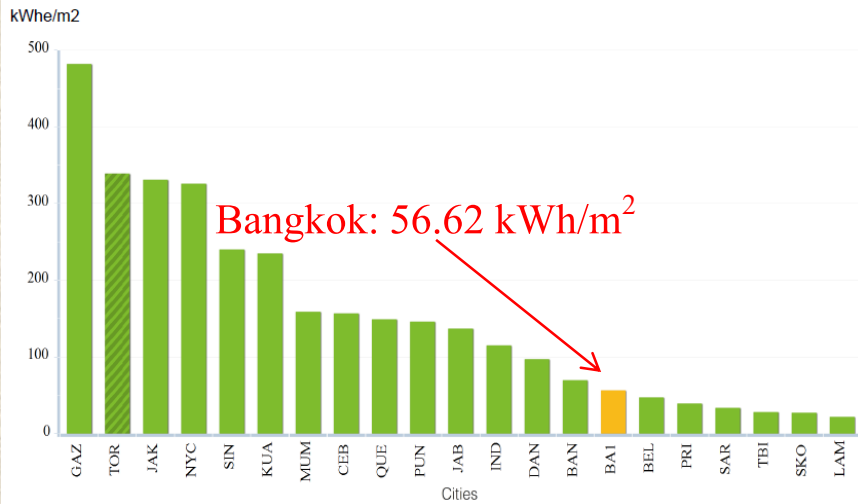


Municipal school building

Findings:

- BMA owns 622 municipal buildings, as of now only 86% of the building data available.
- 70% of total buildings are the school municipal buildings which most area are open air class room.
- The municipal hospital building is the highest energy consumption as its service hour is 24 hours for every day.
- Municipal building electricity consumption is 56.62 kWh/m² which is in between the cities of Belgrade, Serbia (47.26 kWh/m²) and Banja Luka, Bosnia and Herzegovina (69.74 kWh/m²)
- The municipal energy consumption is around 50% higher than those who consumed least energy such as Lampang municipality: 21.97 kWh/m² and Skopje :27.31 kWh/m²

Municipal Buildings Electricity Consumption



Opportunities and Action plan

Opportunities:

- There are a lot of energy efficiency opportunities by replacing the many old air conditioners or chillers in the municipal offices and hospitals.



Municipal hospital building

The recommendations for action plan of this sector listed below:

1. BMA should implement first with those low hanging fruit projects which are the municipal hospital energy efficiency improvement projects.
2. The action plan for municipal hospital energy efficiency project development should first pick up the first 10 projects that consumed most energy as demonstration project.
3. To select the first 10 projects, BMA should identify the readiness and barriers such as regulations, budget, etc. and select the most appropriate existing tools such as ESCO services. There are many types of ESCO schemes exist in the country such as ESCO with or without investment. Therefore, to start implementing those energy efficiency projects will depend on BMA's requirements and barriers.
4. After the first 10 demonstration projects then BMA should already learn how to scale up covering the rest hospital buildings.

Recommendations

Recommendations:

The TRACE recommendations can be grouped into three major steps:

- 1) Creating an EE municipal task force,
 - EE municipal task force
 - EE strategy and action plan
- 2) Implementing the audit and retrofit programs, and
- 3) Expanding EE programs to city wide buildings.
 - Green Guidelines for Energy Efficient Buildings
 - Mandatory Building Energy Efficiency Codes for New Buildings



Municipal office building



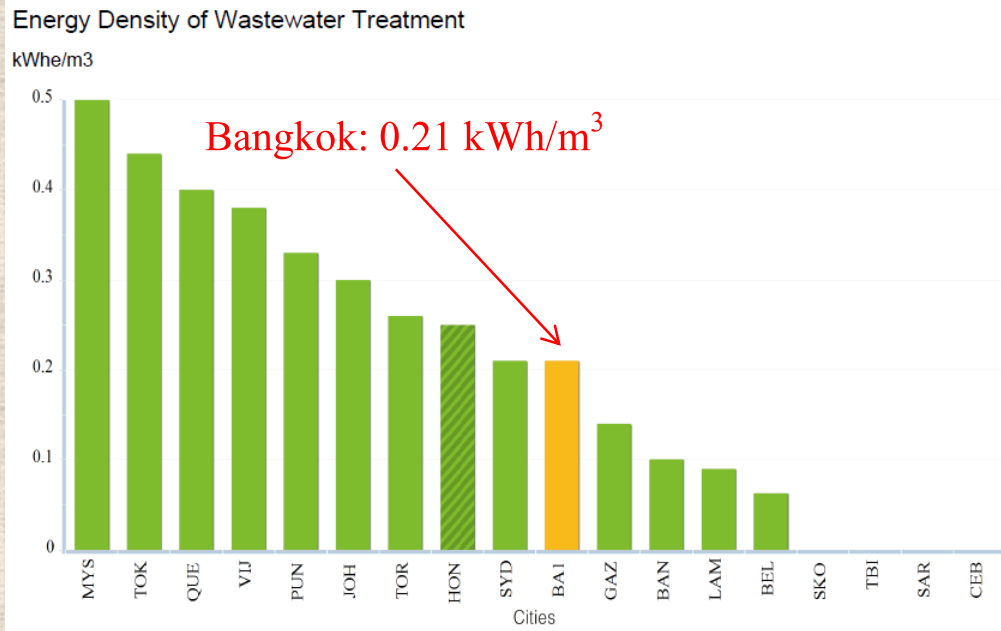
Private buildings



Realizing the Energy Efficiency Opportunities in the

Wastewater Sector

Energy density of wastewater treatment



Findings:

- There are 7 large wastewater treatment plants
- At present, the public sewage system is covered around 20% (992,000 m³/day) of total wastewater and then by year 2020, 5 more wastewater treatment plants will be installed to increase the capacity to 1,765,000 m³/day or 50% of total generated wastewater.
- Energy density of wastewater treatment in Bangkok is 0.21 kWh/m³ which is the same as its of Sydney, Australia.



1. Si Phraya plant



2. Rattanakosin plant



3. Chong Nonthri plant

Opportunities and recommendations



4. Nong Khaem plant



5. Thung Khru plant



6. Din Daeng plant



7. Chatuchak plant

Finding:

- There is a plan to increase the capacity of wastewater treatment plant to cover 50% of total generated wastewater,

Opportunity:

- There is opportunity to produce biogas or reuse sludge in the coming wastewater treatment plants.

Recommendations:

- Improve Efficiency of Pumps and Motors.
- Active Leak Detection and Pressure Management Program.
- Auditing and Retrofit of Treatment Facilities.
- Sludge Beneficial Reuse Program.
- Improve Performance of System Networks



Realizing the Energy Efficiency Opportunities in the

Transport Sector

Public transports in Bangkok



1. Sky train-BTS

2. Underground train-MRT



3. Train

Findings:

- There are 7 types of public transport in Bangkok;

- 1.Sky train-BTS,
- 2.Underground train-MRT,
- 3.Train,
- 4.Airport Rail Link,
- 5.Public bus by Bangkok Mass Transit Authority (BMTA) / private companies,
- 6.Minibus,
- 7.Boat.



4. Airport Rail Link

Total transportation energy use per capita



5. Public Bus

Findings:

- There are 6,776,644 private vehicles.
- 12 lines (classified by color coding) of sky / underground train have been implemented which are expected to be in service by year 2019.
- Total transportation energy use per capita in Bangkok is 42,230 MJ/capita (the 2nd highest) which is lower than the New York city at 44,287 MJ/capita (the first highest).



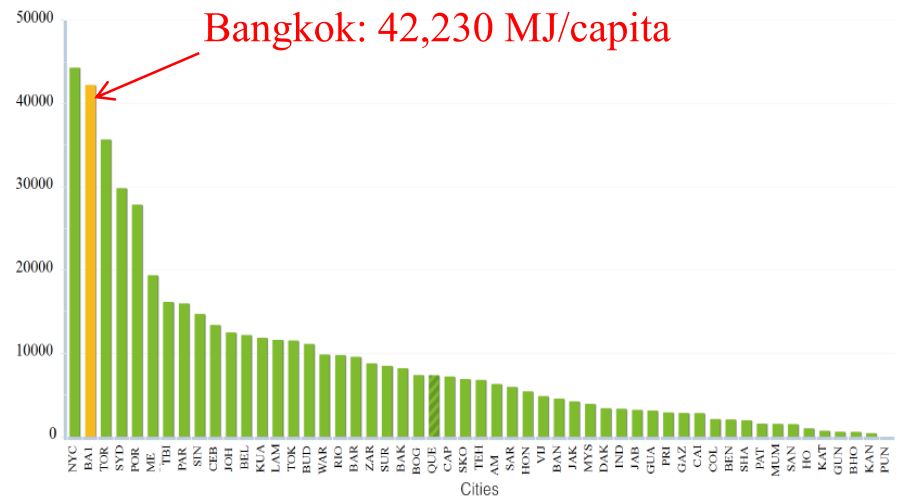
6. Minibus



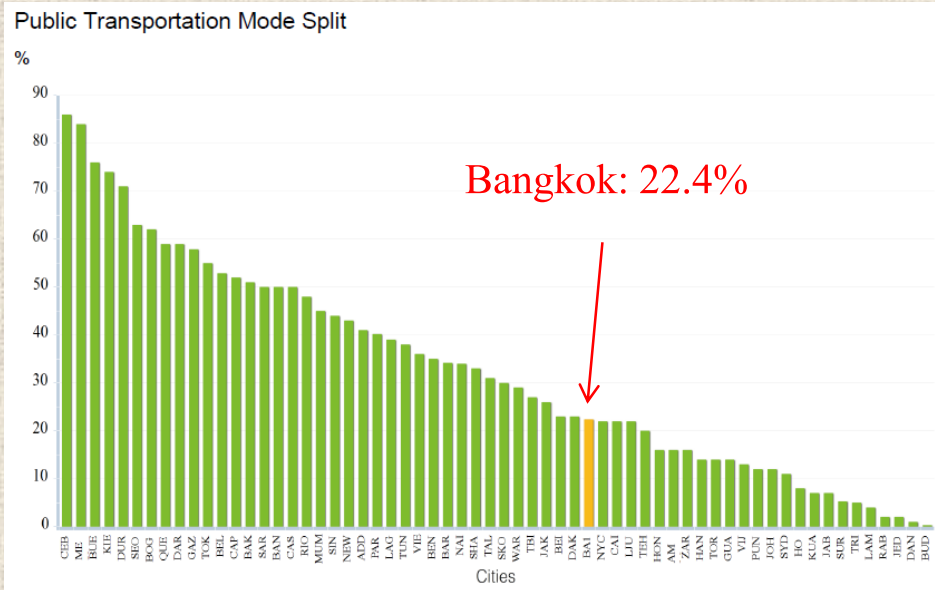
7. Boat

Total Transportation Energy Use Per Capita

MJ/capita



Public transportation mode split, Opportunity and Recommendations



Findings:

- The transportation mode split in Bangkok is 22.4% which is very closed to New York city at 22%.
- the development plan of 12 sky train lines would help reduce the total energy per capita which then increase the percentage of public mode split.

Opportunities:

- The traffic congestion has been a long time problem which every previous government had tried to tackle the problem, but non of them has successfully done. In this regards, there are opportunities to relieve or solve this problem.

Recommendations:

The TRACE recommendations are listed;

- Traffic Flow Optimization
- Traffic Restraint Measures.
- Congestion Pricing



Construction progress of Red line sky train



Realizing the Energy Efficiency Opportunities in the

Power Sector

Percentage of Total T&D Loss



Findings:

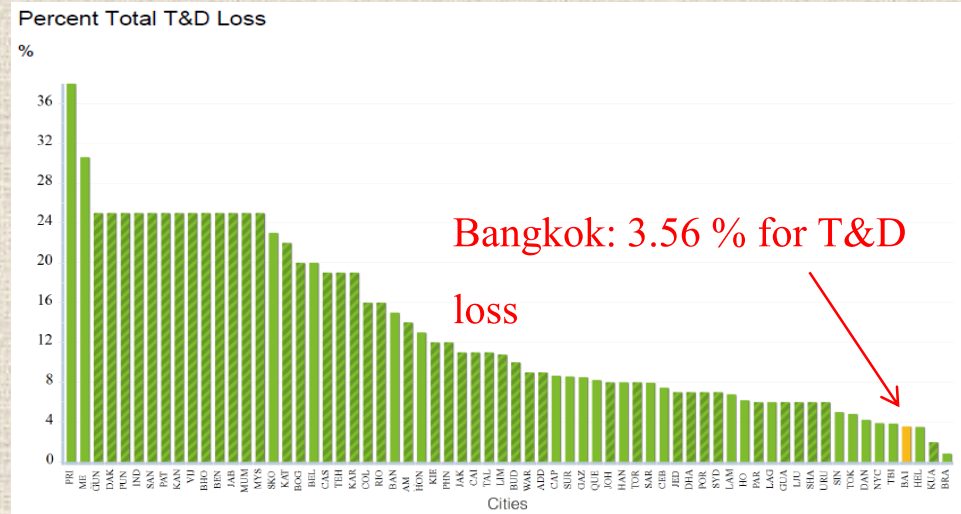
- Electricity in Bangkok is provided by Metropolitan Electricity Authority (MEA), an independent organization under Ministry of Interior.
- The percentage of total T&D loss in Bangkok is 3.56% which is higher than the cities of Helsinki, Sweden (3.5%) and Kuala Lumpur, Malaysia (2%).

Recommendations:

- In order to reduce the T&D loss, the commendations “Transformer upgrade program” and “Power factor correction program” would be implemented.

Opportunity:

- There is an opportunity to reduce the technical T&D loss to be the same those levels as Helsinki, Sweden (3.5%) and Kuala Lumpur, Malaysia (2%).



Percentage of Total T&D Loss due to Non-technical

Connecting point for Non-technical loss

Findings:

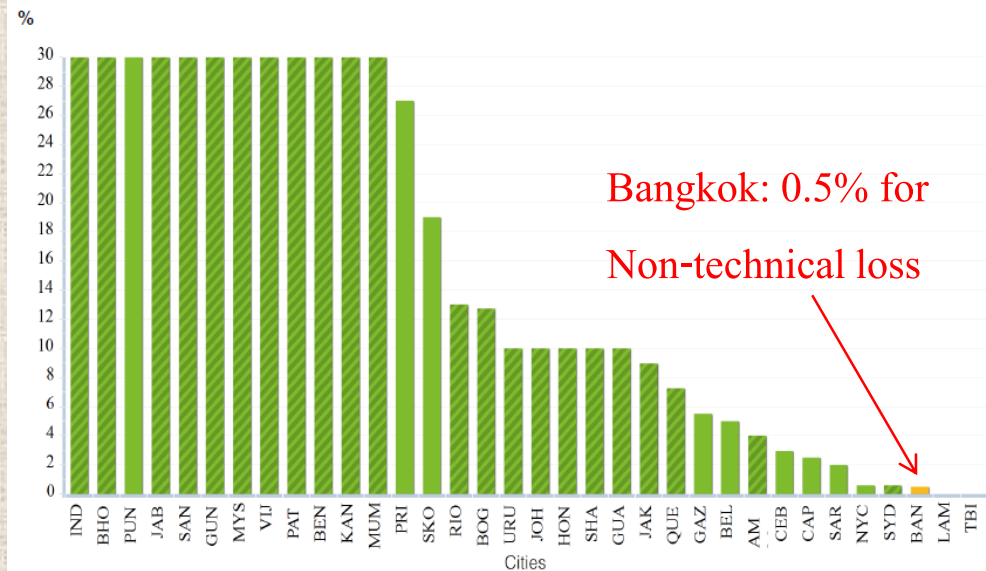
-The percentage of T&D loss due to non-technical is estimated 0.5%.

Opportunity:

- Due to the actual loss is not available, thus this loss is estimated. In this regards there is an opportunities to measure the actual loss and reduce it to be zero or least.

Loss due to non-technical

Percent of T&D Loss due to Non-Technical



Bangkok: 0.5% for Non-technical loss

Recommendation:

- In order to reduce or protect this loss, the auditing program is needed to find out the actual loss and then the recommendation “non-technical loss reduction program” could be applied



Realizing the Energy Efficiency Opportunities in the

Street Lighting Sector

Street Lighting in Bangkok

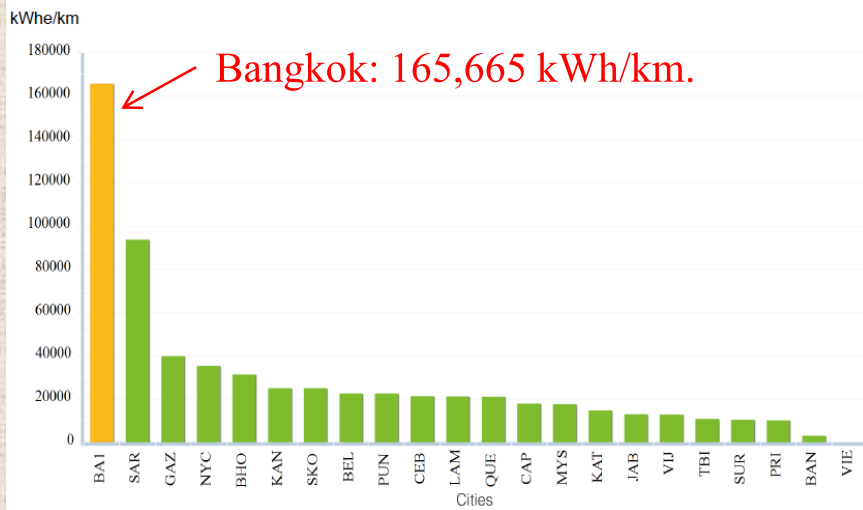


Findings:

- In year 2013, there are 320,872 light bulbs;
 - Mercury Vapor 73%
 - High Pressure Sodium 19%
 - Metal halide 0.2%
 - Other 8%
- All the light bulb facilities are owned by the BMA, but electricity is supplied by Metropolitan Electricity Authority (MEA) for free of charge. Therefore MEA will be the investor with the consent of BMA.
- There were no LED lights installed in street lighting prior to year 2013. The LED replacement program (LED 140 watt to replace HPS 250 watt) has just been starting up in year 2014 by MEA. There are 4 streets implemented this program:
 - 1) Phahurat Road
 - 2) Tri-Petch Road,
 - 3) Chak-Petch Road
 - 4) Tessaban soi 1.
- MEA plans to expand the LED replacement program in Yaowarat Road within year 2014.

Electricity consumption per km and light pole

Electricity Consumed per km of Lit Roads



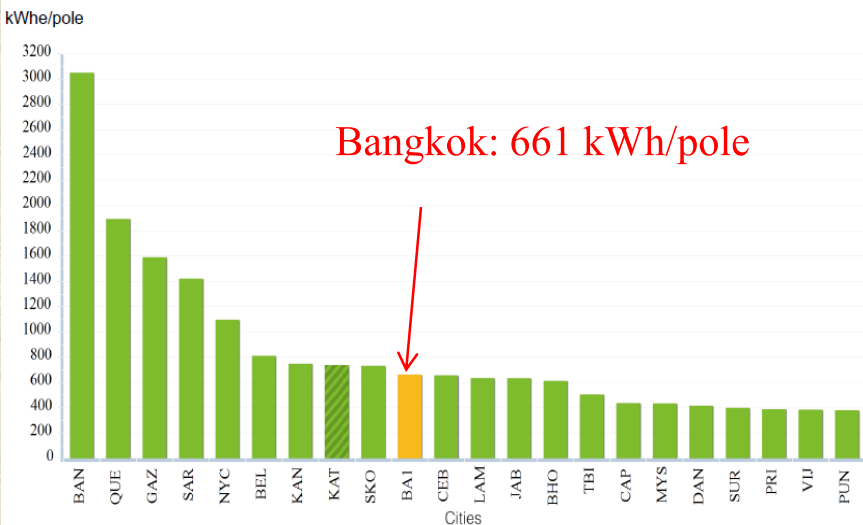
Findings:

- Electricity consumed per km of lit roads is 165,665 kWh/km which is the highest ranking.
- Electricity consumed per light pole is 661 kWh/pole which is in the between the cities of Cebu, Philippines (656 kWh/pole) and Skopje, Macedonia (733 kWh/pole).

Opportunities:

- LED replacement program could be expanded to all street lightings in Bangkok area.

Electricity Consumed per Light Pole



Recommendations:

- Street Lighting Audit and Retrofit Programs
- Procurement Guide for New Street Light Installation.
- Traffic Signals Audit and Retrofit Program
- Public Space Lighting and Retrofit Program.
- Lighting Timing Program



Realizing the Energy Efficiency Opportunities in the

Potable Water Sector

Potable water in Bangkok

Findings:

- Water in Bangkok is supplied by Metropolitan Waterworks Authority (MWA), an independent organization under Ministry of Interior.
- There are 4 water production plants with total capacity of 5,270,000 m³/day
 1. Mahasawad water treatment plant (capacity: 800,000 m³/day)
 2. Bang Khen water treatment plant (capacity: 3,600,000 m³/day)
 3. Samsen water treatment plant (capacity: 700,000 m³/day)
 4. Thonburi water treatment plant (capacity: 170,000 m³/day)



Metropolitan Waterworks Authority (MWA)



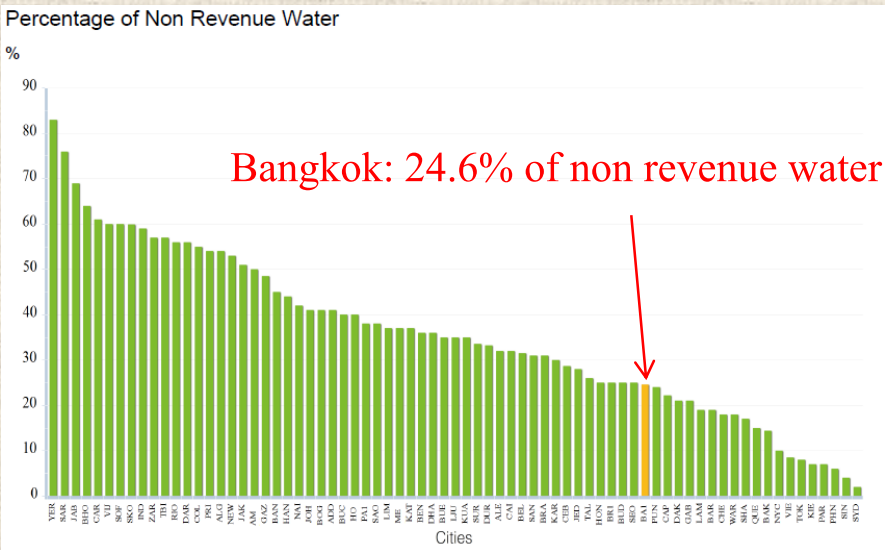
2. Bang Khen water treatment plant



1. Mahasawad water treatment plant



Percentage of non revenue water



Finding:

- Percentage of non revenue water is 24.6% which is in the between the cities of Pune, India (24%) and Seoul, South Korea (25%).

Opportunity:

- The percentage of non revenue water could be decreased to the level of other big cities; New York 10%, Vienna 8.5%, Tokyo 8%, Paris 7% or Sydney 2%

Recommendations for this sector are listed below:

- Improve Efficiency of Pumps and Motors.
- Active Leak Detection and Pressure Management Program.
- Improve Performance of System Networks.



Bangkok flood by pipe broken on 16 Oct 2013

2. Recommendations Summary

Summary of Energy Efficiency Opportunities for Bangkok

1 Solid Waste

- Waste Vehicle Fleet Maintenance Audit and Retrofit Program.
- Fuel-Efficient Waste Vehicle Operations
- Waste to Energy Program.
- Waste Infrastructure Planning.

2 Buildings; There are 3 major steps:

- 1) creating an EE municipal task force
 - EE municipal task force
 - EE strategy and action plan
- 2) Implementing the audit and retrofit programs
 - Municipal audit and retrofit programs
 - Municipal buildings benchmarking program
- 3) Expanding EE programs to city wide buildings
 - Green Guidelines for EE Buildings
 - Mandatory Building EE Codes for New Buildings

3 Wastewater

- Improve Efficiency of Pumps and Motors.
- Active Leak Detection and Pressure Management Program.
- Auditing and Retrofit of Treatment Facilities.
- Sludge Beneficial Reuse Program.
- Improve Performance of System Networks

4 Transport

- Traffic Flow Optimization.
- Traffic Restraint Measures
- Congestion Pricing

5 Power

- Non-technical Loss Reduction Program
- Transformer Upgrade Program
- Power Factor Correction Program

6 Street Lighting

- Street Lighting Audit and Retrofit Program
- Procurement Guide for New Street Light Installation
- Traffic Signals Audit and Retrofit Program
- Public Space Lighting and Retrofit Program
- Lighting Timing Program

7 Potable Water

- Improve Efficiency of Pumps and Motors.
- Active Leak Detection and Pressure Management Program.
- Improve Performance of System Networks



Brazil : Rio de Janeiro & Belo Horizonte

TRACE was implemented in Rio de Janeiro (hosting 2016 Olympics & 2014 FIFA World Cup) and Belo Horizonte (hosting FIFA World Cup). In Rio, WB is helping the city to prepare a US\$300million RFP for implementing LED lighting across the entire city, and helping Belo Horizonte prepare similar investments (US\$100million).



Kenya: Nairobi

TRACE was used to identify EE interventions, feeding into a program funded by the WB to fund the energy efficiency investments under the NAMSIP project.



Romania : 7 Cities

TRACE was used to identify EE interventions and priority sectors for the Romania Regional Development. Program funded by the EU, and TRACE has been implemented in 7 cities as part of a regional investment program



Turkey: Gaziantep

TRACE identified the need for investments in the water sector. The city is one of the a few cities in Turkey which are participating in a US\$300million dollar project though the urban department, and they intend to finance the water sector investments.

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Thank You.

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