Smart shopping centers, controlled emission: rooftop PV power generation for a clean metropolitan city Dhaka, Bangladesh

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Facts and figures: Dhaka City

- One of the fastest growing city
- Population: 5.6million
- 259kWh per capita consumption
- 500 shopping centers
- Unstable supply from the national grid

Renewable energy generation: Bangladesh

- Total 105 MW
- Solar Home Systems (SHS): 96 MW total
- new buildings to generate at least 3% of their load demand from the rooftop solar PV
- 10% of total energy to come from renewables by 2020

Dream and reality

Jamuna Future Park
Shopping complex

A shopping centre during power outage

Rooftop Solar PV implementation idea

Sustainable solution approach

Distributed energy generation using renewable resources:

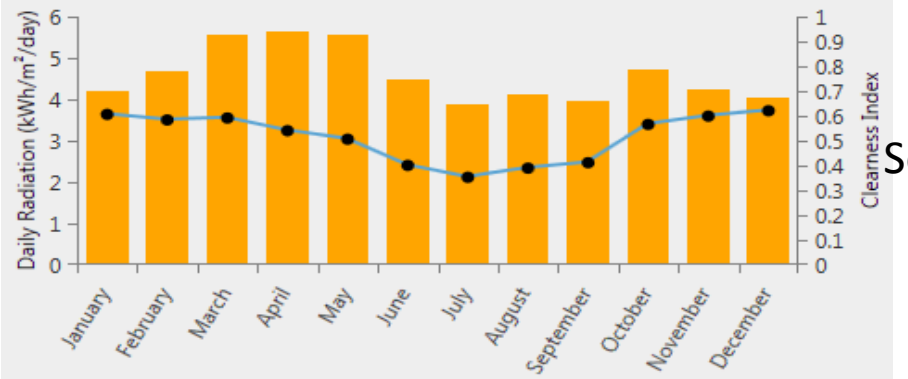
Q1. What resources?

Q2. Grid connected or not?

Q3. Financing Options and tools?

Q4. Policy framework?

Rooftop solar PV for shopping centres



Solar radiation over Dhaka

Solar PV power generating system

Rooftop PV system design approach

20 representative shopping centers were studied to find the detail-

1. Power consumption pattern
2. Load profile
3. Willingness to switch

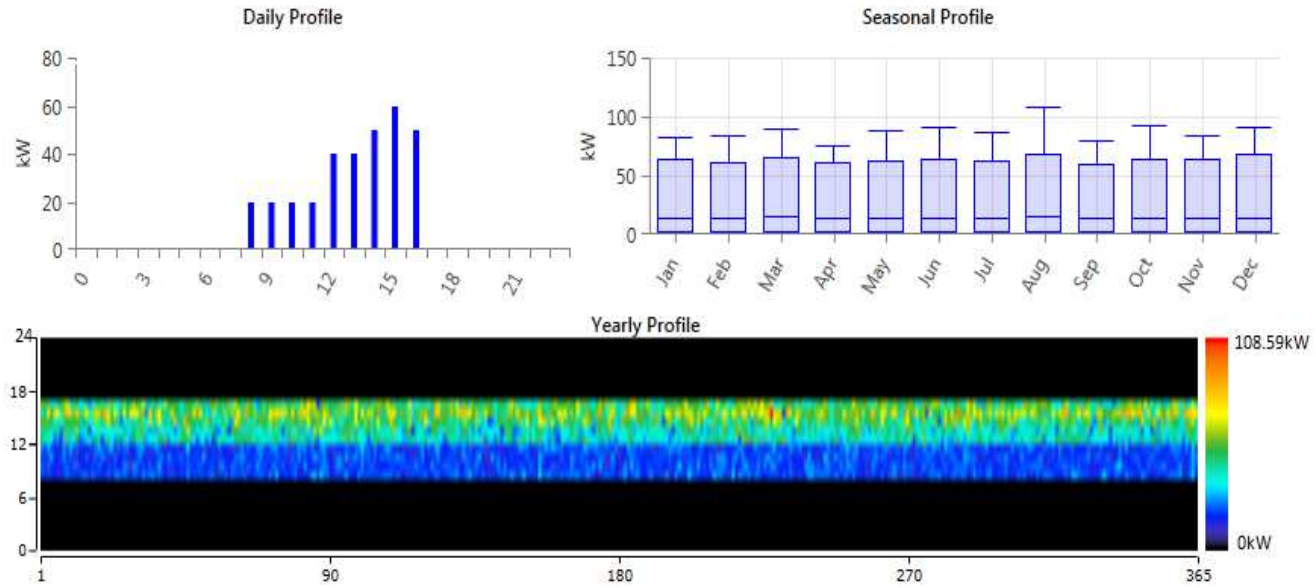
A model shopping center was designed having 50 different shops with detailed load profile for this study

Load assessment for the proposed PV system

Type of shop	Number	Load requirements	Running hours	Total load
Food shop (café, restaurant)	5	8 Florescent bulbs @ 20wt each 1 TV @ 100wt 1 Computer @40wt 1 Air conditioning* unit @ 800wt 2 Refrigerator @ 120wt each 1 Microwave* @ 1000wt each 2 Kettle* @800wt each 1 Toaster* @ 250wt 1 coffee machine @ 250wt	8 6 6 6 8 2 3 2 4	85.70kWh
General store (Stationaries, Clothing, Jewellers)	25	10 Florescent bulbs @ 20wt each 4 Electric fans @ 80wt each 1 TV @ 100wt 1 Computer @ 40wt	8 8 6 8	127.00kWh
Service shops (Communicat-ion, Tailors)	20	1 TV @ 100wt 6 Florescent bulbs @ 20wt each 2 Electric fans @ 80wt each	8 8 8	60.80kWh
All shops	1 Music player @ 60wt x 6 hours x 50 shops 1 Mobile Charger @ 0.5wt x 5 hours x 50 shops Shop sign boards @ 80wt x 5 hours x 50 shops Shopping center's own outer sign, internal lighting and cooling –@ 2000wt x 5 hours			48.13kWh
Total				321.63kWh
* Can be replaced by the usages of other electrical appliances, i.e. cooker				

Load assessment for the model shopping centre in Dhaka

Load profile



* To apply with HOMER software

Proposed System details

Item	Value	Item	Value
Size of PV array (kW)	140, 180, 220, 240	PV life (years)	20, 25
Converter size (kW)	40, 50, 60, 70	Interest rate	5%, 6%, 8%
Capacity shortage (%)	0, 5, 8, 10	Capital subsidy	0%, 30%
Grid power purchase price (USD/kWh)	0.10	Grid power sale price (USD/kWh)	0.10
Converter life (year)	5, 10, 15	Fixed cost (USD)	21,000; 30,000

Sensitivity variables

Generic flat plate PV initial investment cost (USD/kW)	750
Generic flat plate PV replacement cost (USD/kW)	500
Generic system converter initial investment cost (USD/kW)	300
Generic system converter replacement cost (USD/kW)	200
Solar PV and converter maintenance cost (USD/kW/yr.)	15
Rooftop system operation and maintenance cost (USD/yr.)	2000

Components costs

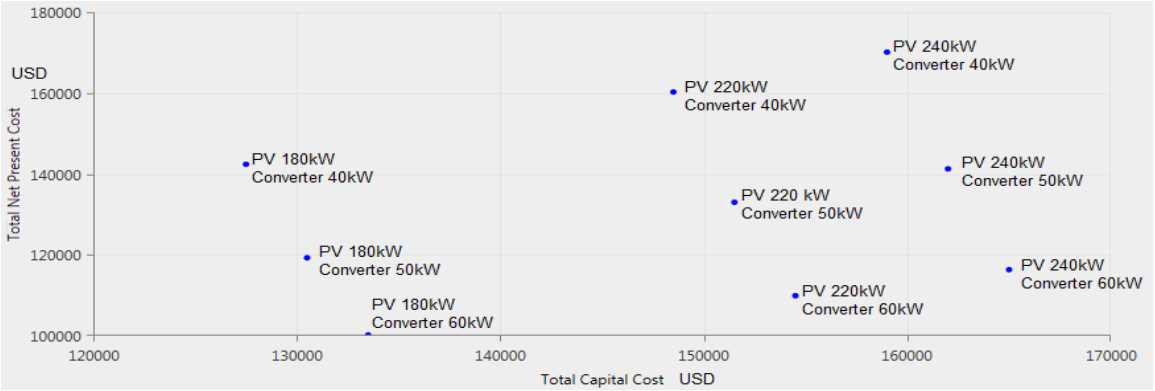
Proposed System details

Architecture					Cost				PV	Grid	
			PV (kW)	Converter (kW)	COE ($)	NPC ($)	Operating cost ($)	Initial capital ($)	Production	Energy Purchased	Energy Sold
			180	60.0	$0.0382	$95,174	-$2,965	$133,500	262,622	22,023	75,866
			180	60.0	$0.0545	$135,674	-$2,965	$174,000	262,622	22,023	75,866
			180	60.0	$0.0418	$104,174	-$2,965	$142,500	262,622	22,023	75,866
			180	60.0	$0.0581	$144,674	-$2,965	$183,000	262,622	22,023	75,866
			180	60.0	$0.0380	$94,751	-$1,373	$112,500	262,622	22,023	75,866
			180	60.0	$0.0543	$135,251	-$1,373	$153,000	262,622	22,023	75,866

The optimal system architecture was the combination of 180kW PV and 60kW converter, which produces 262,622kWh electricity every year serving almost 92% of this load requirement

PV system performance

Optimal system



	Component	Capital (USD)	Replacement (USD)	O&M (USD)	Salvage (USD)	Total (USD)
System with 30% Capital Subsidy	PV	94,500	0	23,270.00	0	117,770
	Grid	0	0	-69,606.00	0	-69,606
	Converter	18,000	5091.30	3,878.30	-958.23	26,011
	Other	21,000	0	0	0	21,000
	System	133,500	5,091.30	42,459.00	-958.23	95,174
System with no Capital Subsidy	PV	135,000	0	23,270.00	0	158,269
	Grid	0	0	-69,606.00	0	-69,606
	Converter	18,000	5,091.30	3,878.30	-958.23	26,011
	Other	21,000	0	0	0	21,000
	System	174,000	5091.30	-42,459.00	-958.23	135,674

Proposed system's detail

Initial investment	USD 133,500
Fixed cost	USD 21,000
Capital subsidy	30%
Soft loan	50% @6% interest
Equity	20%
NPC	USD 95,174
Architecture	180kW PV; 60kW Converter
Power production	262,622kWh/yr
Annual energy:	
Purchase from grid	22,023 kWh
Sold to the grid	75,866 kWh
COE	USD 0.0382/kWh

Electricity price of BPDB for Shops USD 0.07 – 0.09/kWh

Project of inspiration

Low COE achieved as there are no costs of: Land acquisition, expensive storage and backups! ($ 0.03 vs 0.09)

Clean city

Yearly 34,000kg of carbon dioxide, 147kg sulphur dioxide and 72kg nitrogen oxide can be reduced using the proposed PV system.

Having installed such PV system in all shopping centres Dhaka city can reduce at least 60,000 metric tons of carbon dioxide it to its atmosphere while reducing tremendous pressure on the national grid and thus this can be the most sustainable approach towards a smarter city.

Another example

4,000 solar panels atop Bangkok's Megabangna shopping mall

- 999 kilowatts at peak capacity
- can power up at least 200 average homes
- reducing about 716,000 kg of carbon dioxide emissions each year

To be aware of …. …

Failed renewable energy projects !!!

Lack of integrated approach

Biomass based RE mini-power plant in Gazipur, Bangladesh

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Can we achieve a Zero Carbon society?

Thanks a lot

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