Natural Gas Based Trigeneration : An Energy Efficiency Option for Buildings

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15-16 January 2010

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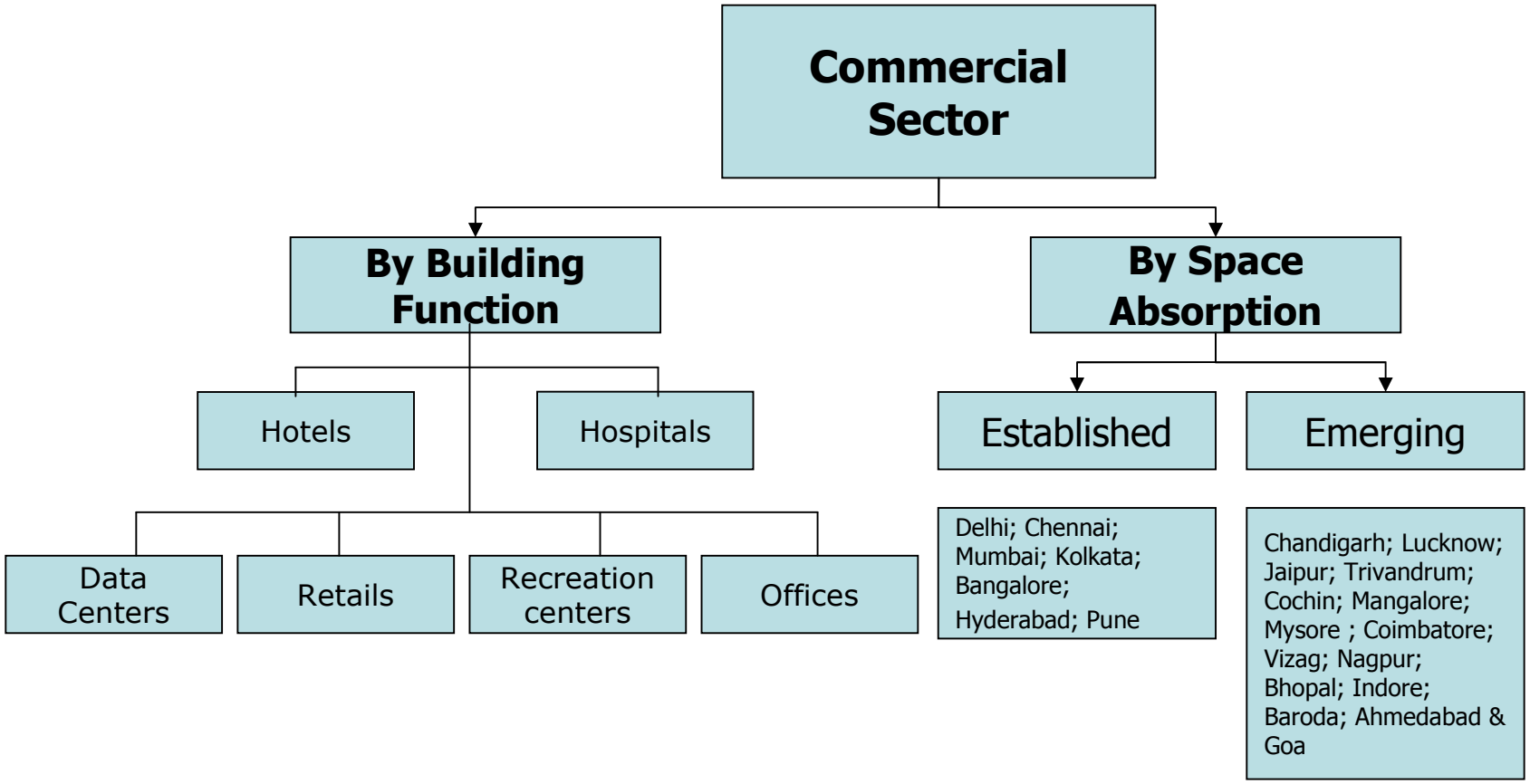
Eight National Mission on Climate Change

- Solar
- Enhanced Energy Efficiency
- Sustainable Habitat
- Water
- Sustaining Himalayan Eco-System
- “Green India”
- Sustainable Agriculture
- Strategic Knowledge on Climate Change

Enhanced Energy Efficiency

- Market based mechanism (PAT)
- Accelerated shift to energy efficient appliances in the designated sector
- Financing DSM programs through future saving
- Fiscal incentive to promote energy efficiency

Building Sector-Different Classifications



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Space Growth Analysis-Summary

Market Segment	Space Estimate			Remarks
	Unit	Existing Stock (Year)	Projected Stock (Year)	
Private Offices	X 10^6 Sq Ft	226.5 (2009)	400 (2011)	Data for 11 cities major cities considered based on availability of data
Government Offices	X 10^6 Sq Ft	13.3 (2008)	Not Available	Only central government. Data for state government and municipal offices are not available
Retail	X 10^6 Sq Ft	30 (2006)	132 (2010)	Represents organized retail segment only which is 4% of the total retail space.
Hotels	Rooms	65,614 (2009)	117,117 (2011)	Include only 3 star and above rating for 11 cities
Hospital	Beds	482522 – Govt 387,639- Private (2007)	Not Available	Include 154,031 beds in rural hospitals- not immediate target

Energy Efficiency Initiative in the Building Sector

- BEE Program
  - Standard & labeling
  - ECBC
  - Energy Audit
  - Project implementation in Government buildings under performance contract
  - Star rating for commercial buildings
- Others
  - CII Green building
  - MNRE/TERI Green building
- Projects
  - Major 5 star hotels
  - Large hospitals
- ITES Buildings
  - 3rd party service contracting
- Integrated complexes
  - Energy service delivery
- Trigeneration/Cogeneration

Building a case for application of Trigeneration technology in commercial buildings

Increasing Cooling Load in Buidlins

Segment	Basis	Reference
Private & Government Office Commercial	0.04 TR/m^2	Normative data for centrally AC multi-stories offices.
Organized Retail	0.045 TR/m^2	DSCLES Energy Audits & case study from vendors; 5 samples
Hotels	For 4 & 5 Star Hotels In Composite and Hot & Dry Zone - 2.5 TR/Room In Warm and Humid Zone - 2 TR/Room Others – 1.3 TR/ Room For 3 Star Hotels - 1.0 TR/ Room	DSCLES Energy Audits; 25 Samples covering 4 climatic zones

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Cooling Load-Contd

Segment	Basis	Reference
Private Hospitals	Private Hospitals • 1.10 TR/Bed (for 30 -100 beds hospital • 2.32 TR/Bed (for greater than 100 beds hospital)	DSCLES Energy Audit; 5 samples covering 3 climatic zones
Urban Government Hospitals	0.1924 TR/Bed	Energy Efficiency in Hospitals – Best Practice Guide, USAID

Power Load Assessment

Segment	Basis	Reference
Private Commercial Office & Government Office	As per the Specific Energy Consumption Norms for Office Buildings having more than 50% air conditioned space corresponding to 1 Star Rated Buildings Composite : 177 kWh/m^2 Warm and Humid : 187.5 kWh/m^2 Hot and Dry : 167.5 kWh/m^2 Considering 9 hours of operation a day, 5 days of operation a week & 52 weeks of operation an year, the specific power consumption (kW/m^2) has been computed as Composite : 0.076 kW/m^2 Warm and Humid : 0.08 kW/m^2 Hot and Dry : 0.072 kW/m^2	Scheme for Star Rating of Office Buildings, Bureau of Energy Efficiency; February 2009
Organized Retail	Based on actual information	DSCLES Database

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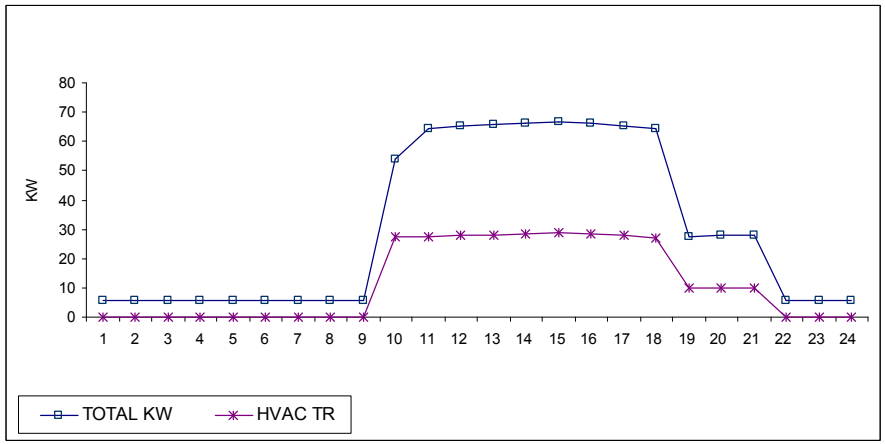
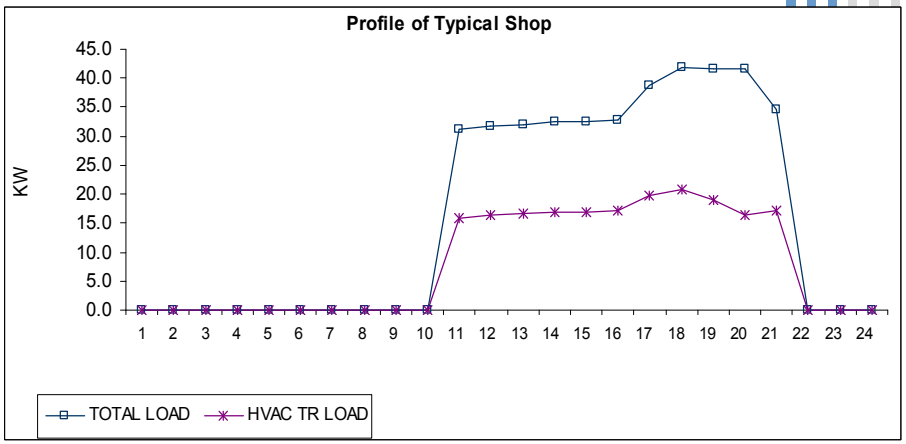
Power Load Assessment

Segment	Basis	Reference
Hotels	Based on actual information pertaining to corresponding samples referred to in Table 29. Specific Power Consumption (kW/ Room) is as follows 9.41 kW/Room (for 4 star and above and for composite, hot & dry climatic zones) 3.5 (for 4 star and above and for warm & humid climatic zones) 6.15 (for 4 star and above and for temperate climatic zone) 3.5 (for 3 star hotels in all climatic zones)	DSCLES Database
Private Hospitals	Based on actual information	DSCLES Database
Urban Government Hospitals	Derived from Specific energy consumption data (kWh/bed/year) assuming 24 hours operation for 365 days per year	Energy Efficiency in Hospitals – Best Practice Guide, USAID;

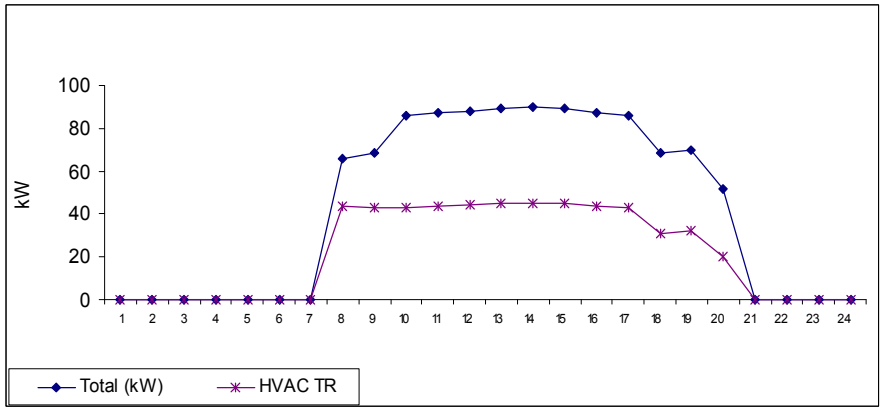
Total kW/TR profiles



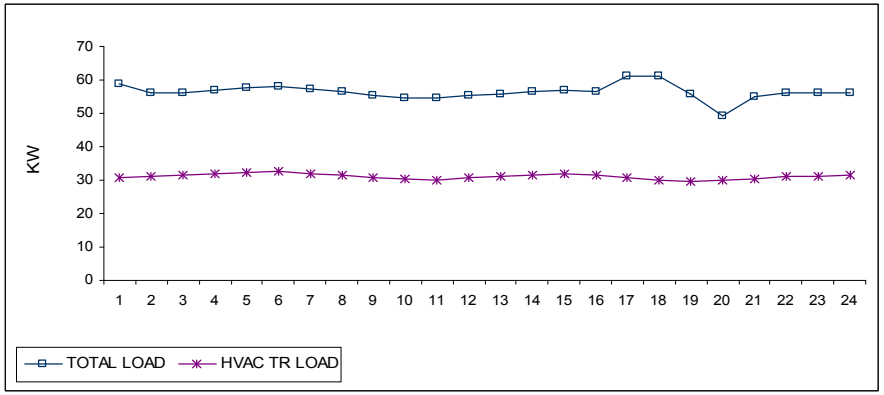
Office



Shop

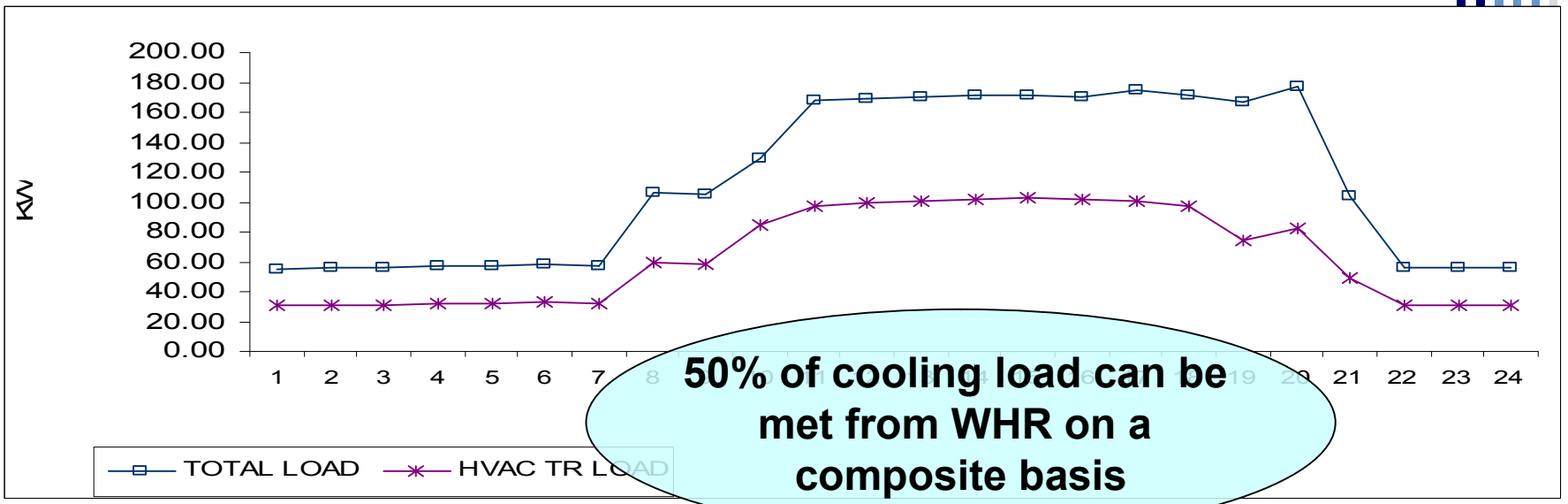


Bank



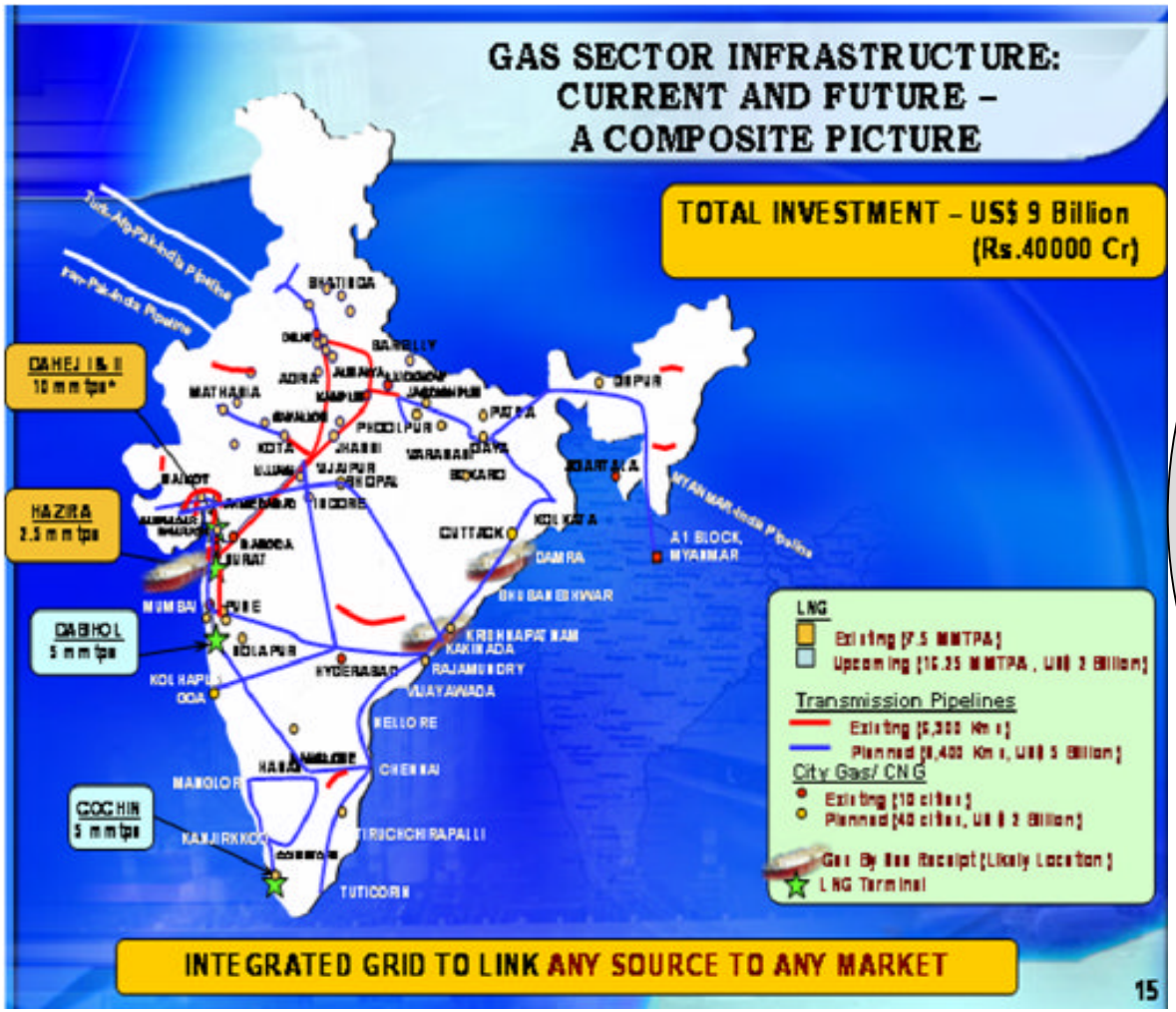
Hotel

Combined Load Profile



Facility	Peak load	HVAC Load			Operation
	KW	Peak TR	Peak KW	High end KW	Hrs/Year
Office	67	29	44	30	3744
Retail	43	18	27	19	3744
Bank	72	33	50	35	7920
Hotel	58	33	50	35	7920
Combined	177	102	153	107	6226
Ratio of high end KW to peak			61%		
Ratio of WHR VAM to generation			30%		

Gas Pipeline Grid



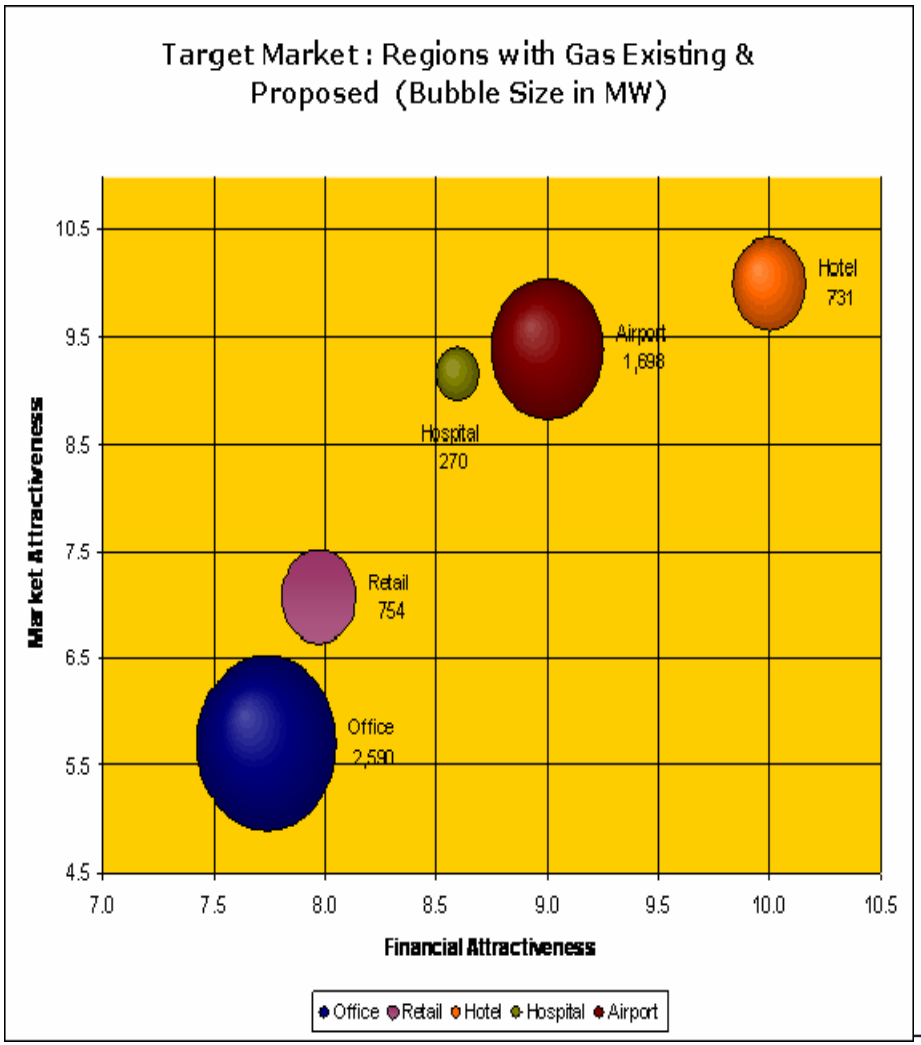
Except for Bangalore
All the major cities in the Power deficit regions & good Trigen potential areas are covered

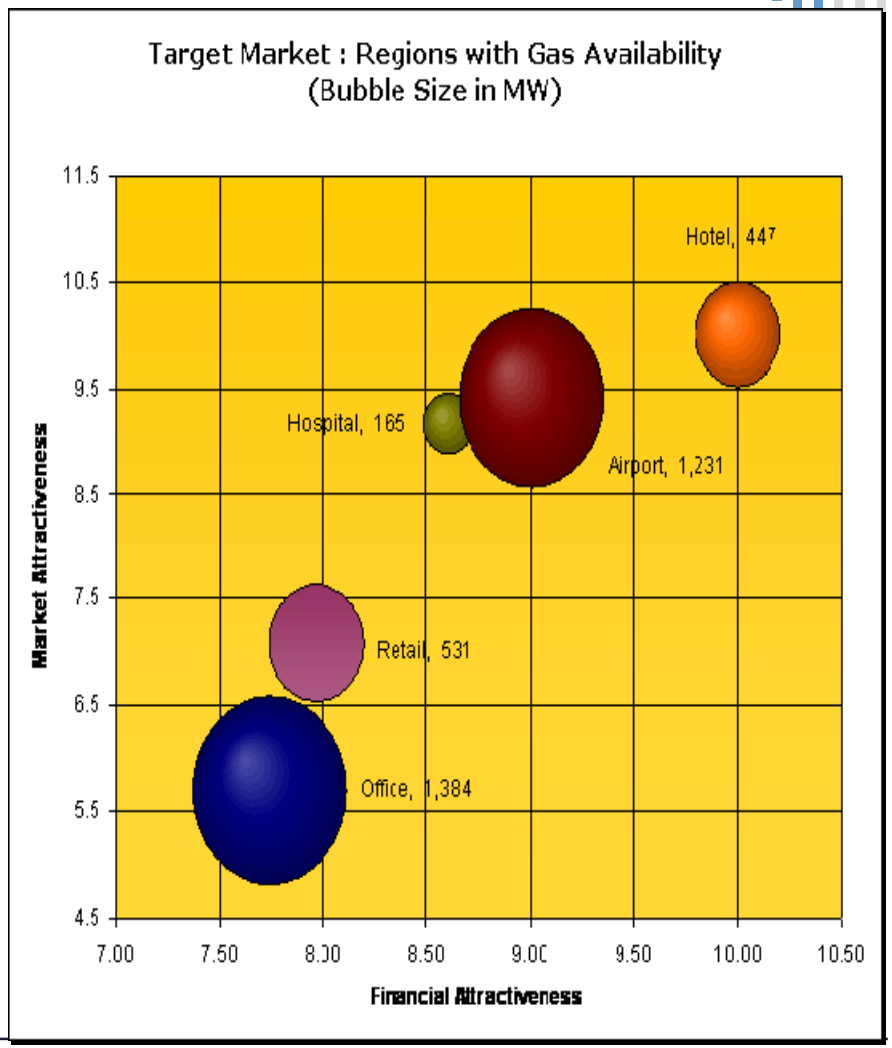
Overall Potential

Segment	Space Estimate		HVAC Index		HVAC Market Size (TR)	MW Approach	TR Approach
	Unit	Estimate	Unit	Average			
Private Office (a)	SqM	21037205	TR/m²	0.04	841488	3902	7877
Government Office (a)	SqM	1211592	TR/m²	0.04	48464	78	163
Retail(b)	SqM	8931000	TR/m²	0.045	404172	540	1347
Hotel 5 Star (b) (c)	Rooms	30172	TR/Rm	(c)	63690	189	212
Hotel 4 Star (b) (c)	Rooms	140802	TR/Rm	(c)	29876	90	100
Hotel 3 Star (b)	Rooms	20640	TR/Rm	(c)	20640	127	69
Private Hospital (b)	Beds	387639	TR/Bed				
< 30 beds	Beds	325617	TR/Bed	Excluded			
30-100 beds	Beds	38764	TR/Bed	1.10	42640	53	142
> 100 beds	Beds	23258	TR/Bed	2.32	53959	86	180
Urban Government Hospital (b)	Beds	328491	TR/Bed	0.1924	63202	149	211
Market Size					**1,568,132**	**5,214**	**10,301**

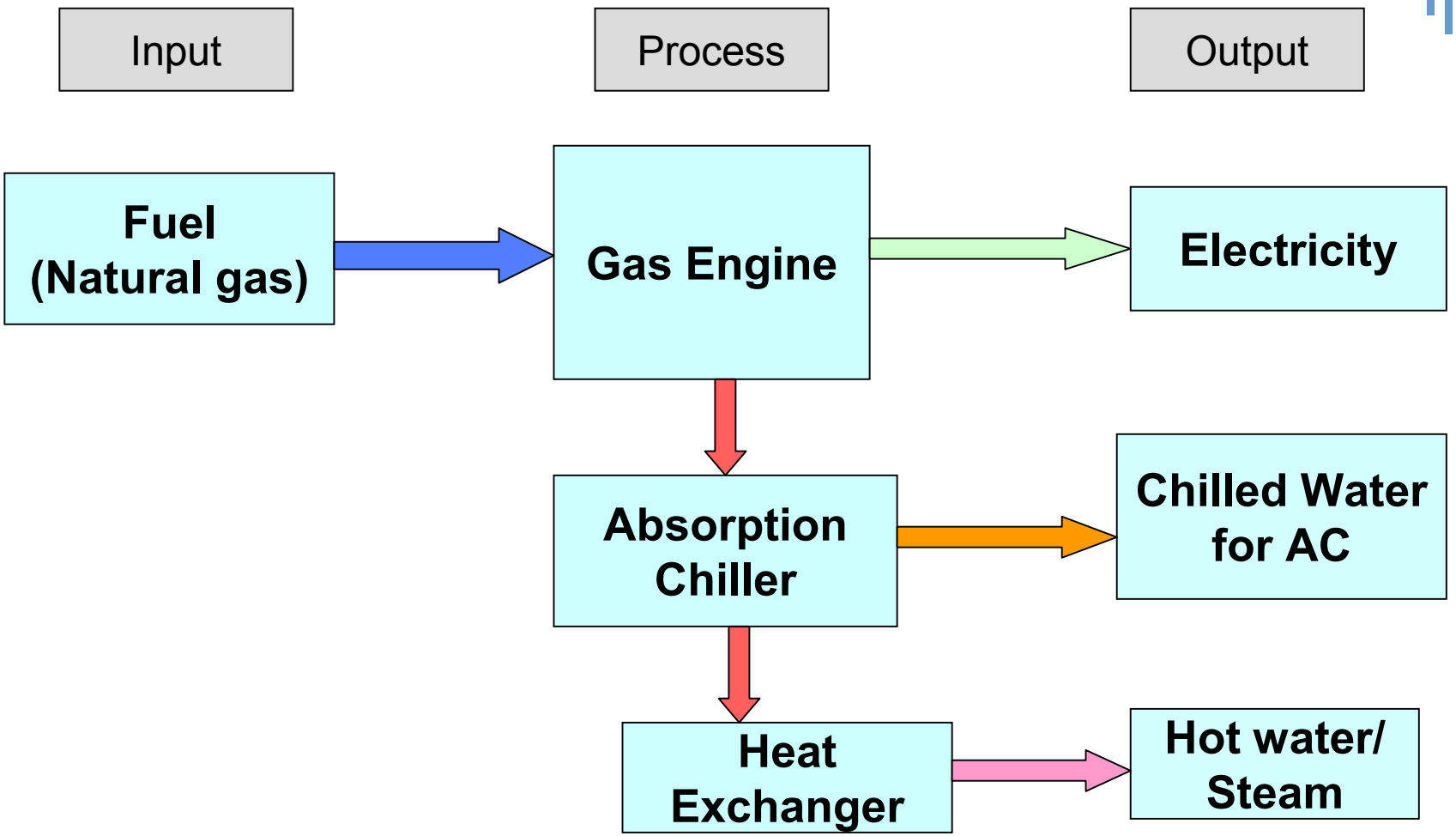
TR approach yields maximum system efficiency-extra power to be exported

Market Potential





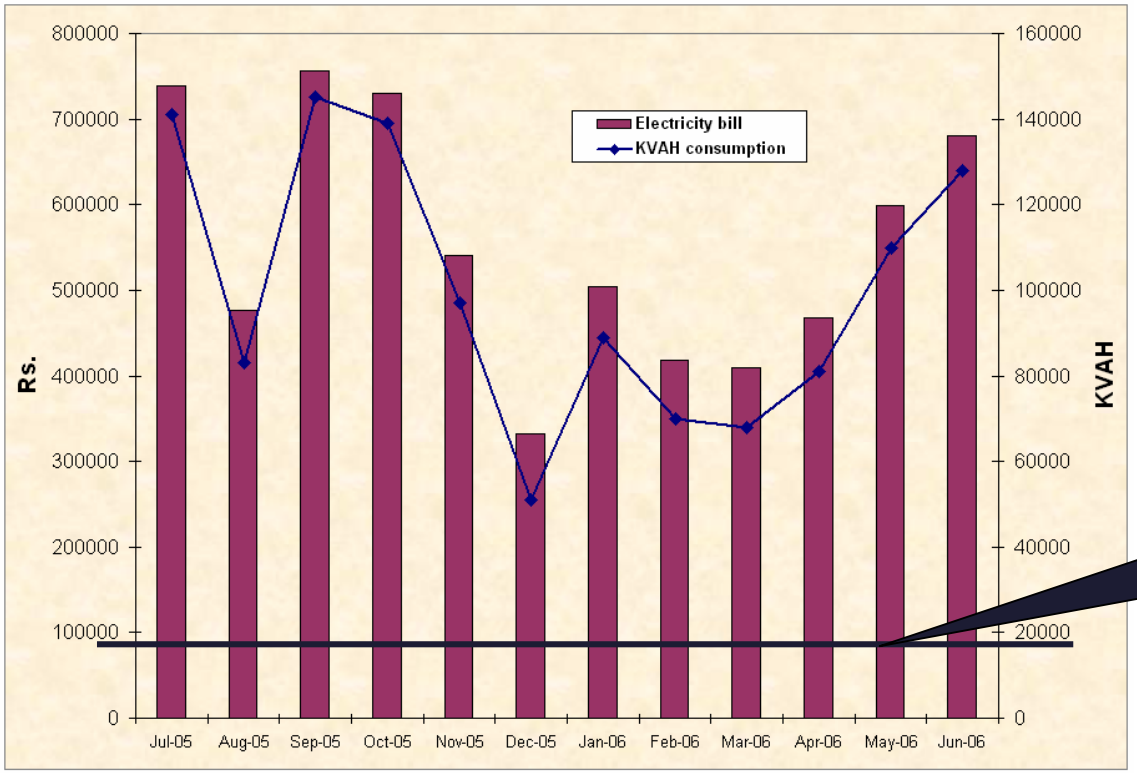
Trigeneration Process



Case Study-A Commercial Building in New Delhi

- Present system
  - Power is drawn from grid for meeting the general power demand, low side of the cooling system and heating and hot water application
  - Gas is drawn from grid for VAM application to meet the high side of the cooling demand
- Proposed system
  - Grid is kept as standby
  - Entire power demand is met from gas fired engine
  - Part of the cooling demand is met from VAM based on VAM
  - Hot water demand is met from further recovery from waste heat

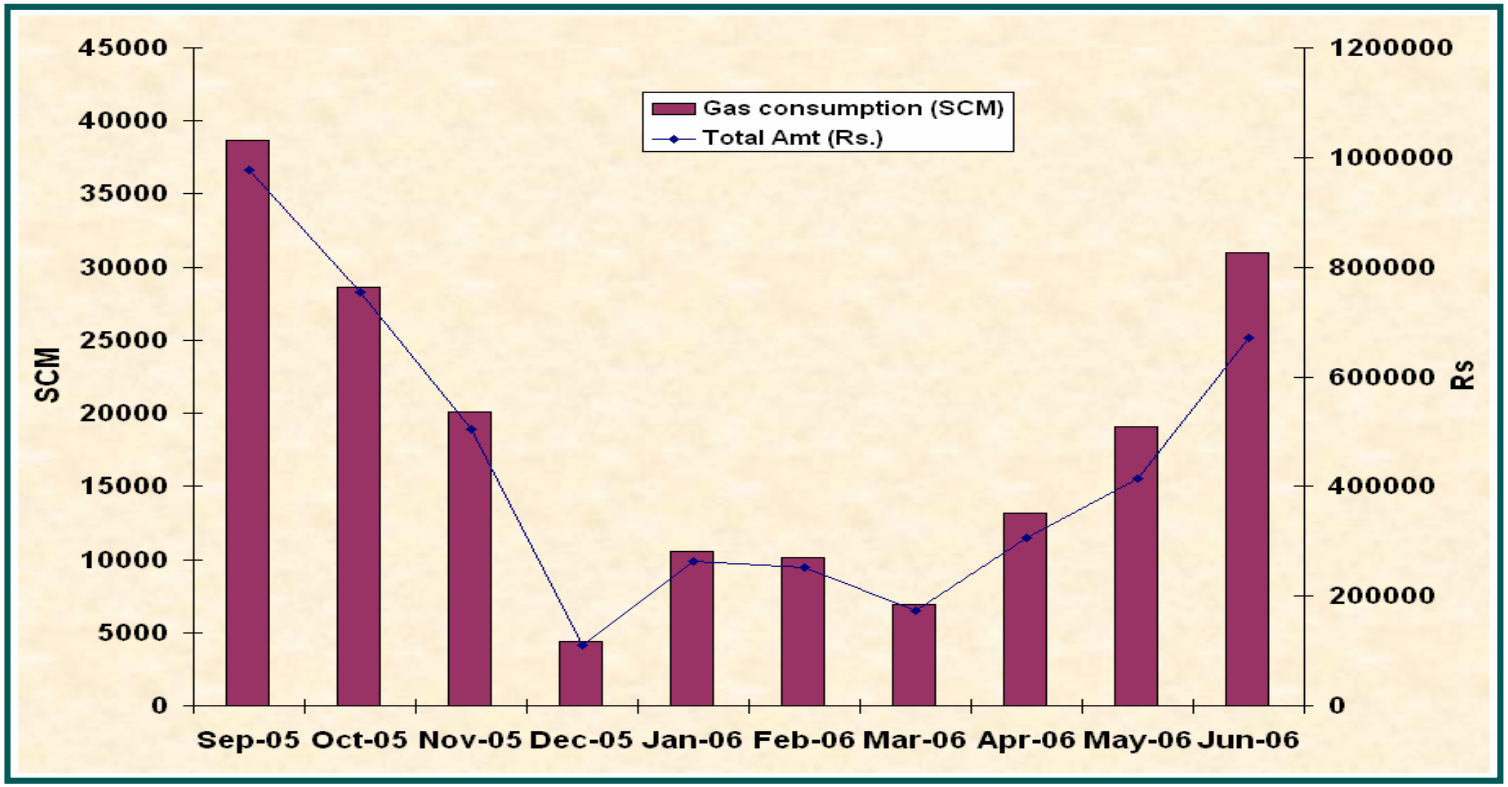
Power & electricity bill trend



Demand charges are constant at Rs. 93300

Demand is 622 KVA. TNH pays demand charges at the rate of Rs. 150/KVA. Power factor is at 0.95

PNG consumption



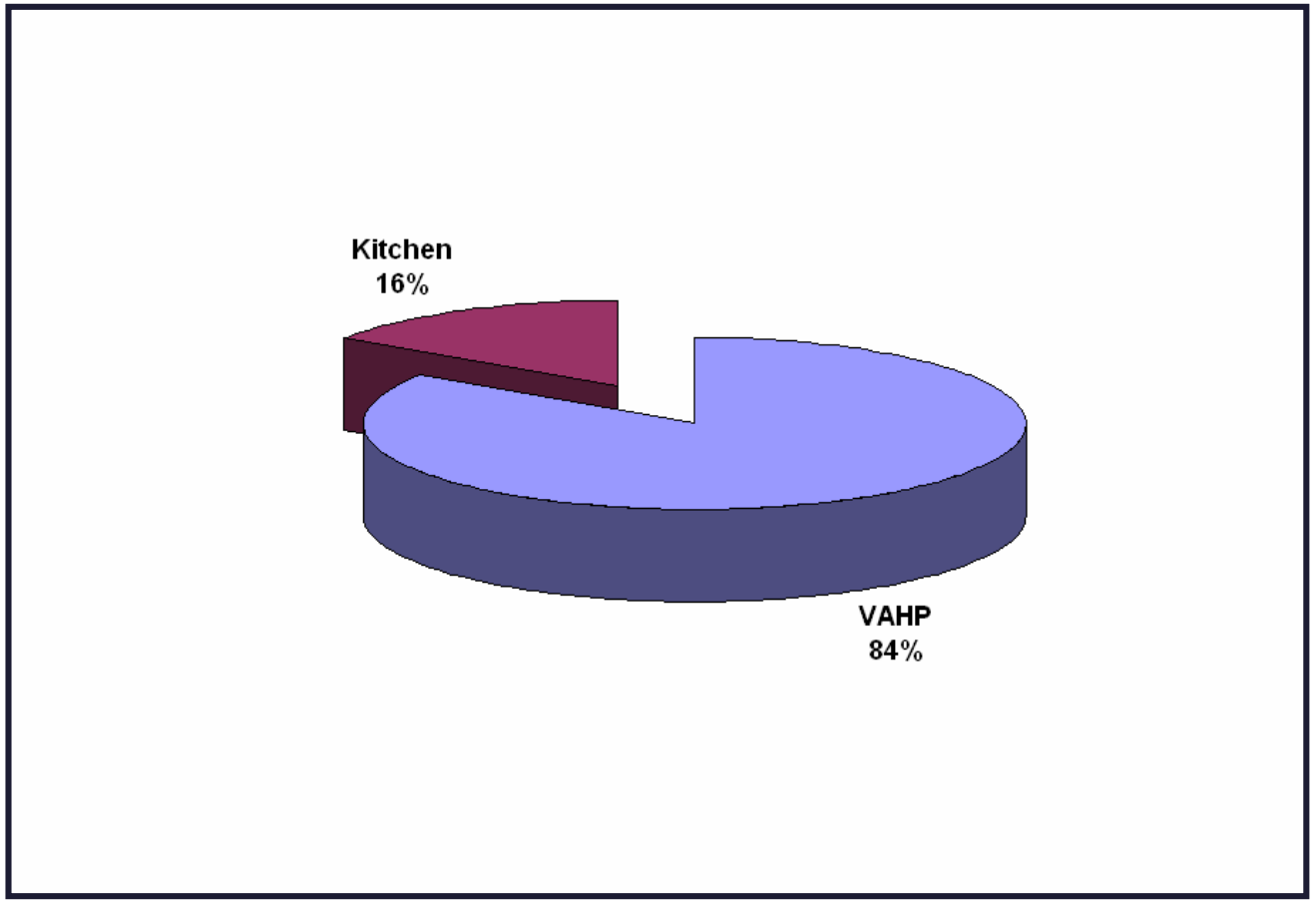
Total PNG consumption (VAM + kitchen) varies between 145 SCM to 1290 SCMD.

Latest cost of PNG

Upto 2100 SCMD : Rs. 20.83

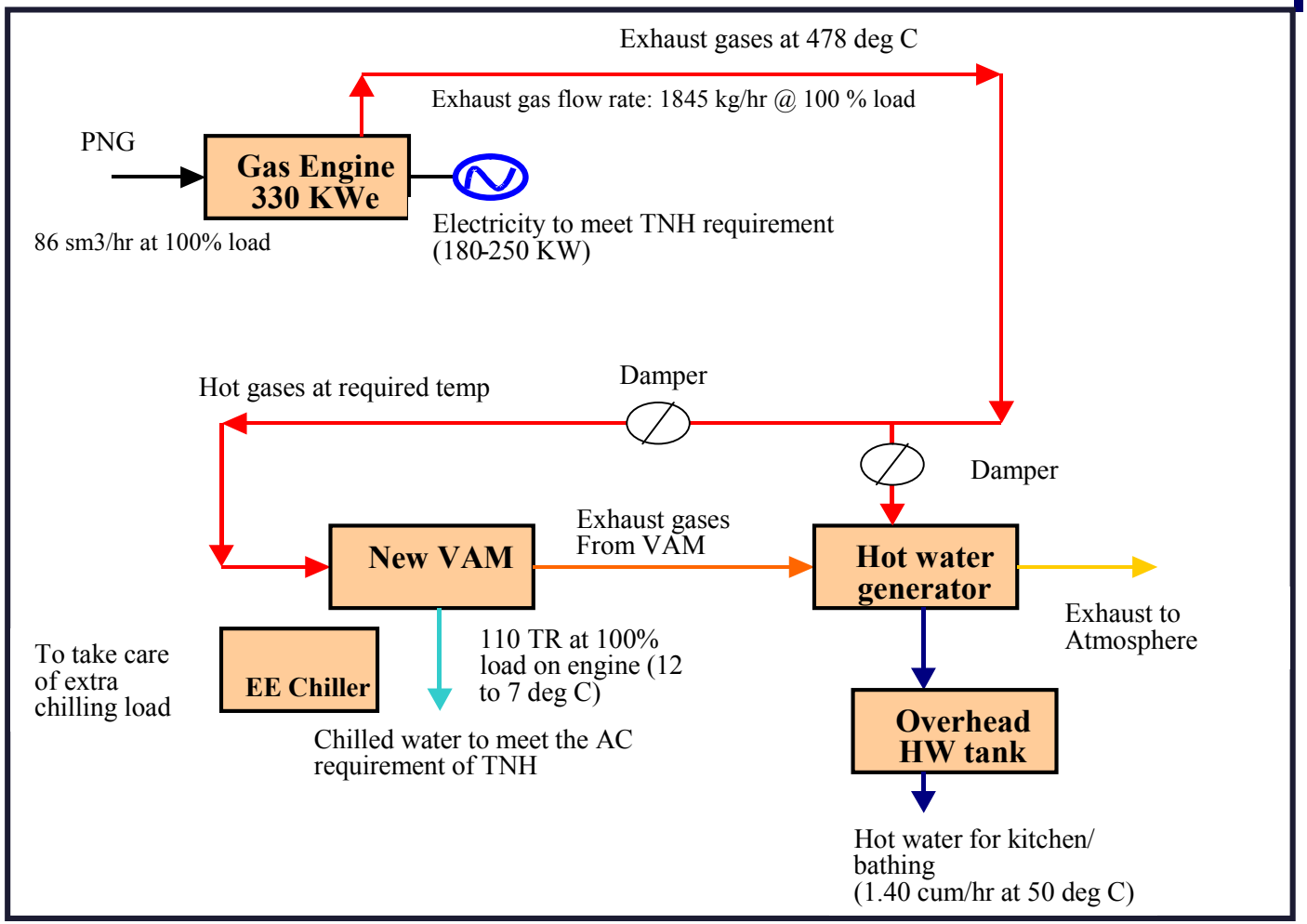
Above 2100 SCMD: Rs. 12.23

PNG consumption



84% of the PNG consumption is at the chiller

System configuration



Estimated system efficiency of 77% against current best level of about 35%

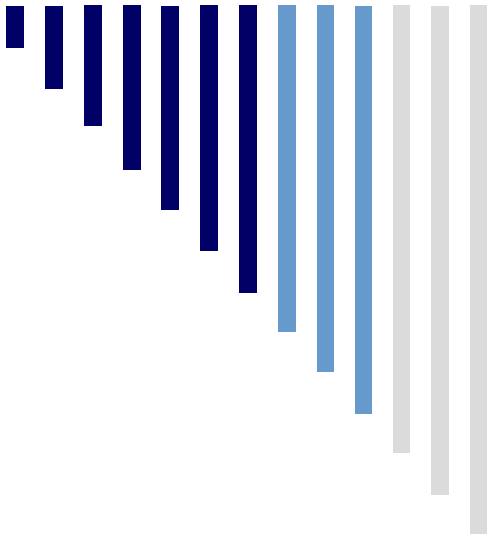
Reduction in GHG Emission

Particulars	Unit	Present	Post
Power from grid	MWH/Year	1348	0
Gas from grid	000SCM/year	262	378
Emission factor-power	T/MWH	0.9	0.9
Emission factor-gas	T/000SCM	1.98	1.98
Total emission	T/Year	1732	748
Emission reduction	%		57%

Large benefit due to twin factors
Efficiency gain
&
Clean fuel use

Conclusions

- Application of Trigeneration system has the potential of doubling the end-use productivity of gas compared to use in combined cycle power station
- Huge benefits in terms of reduction of GHG emission-estimated at over 50% from the current levels in buildings having mix of cooling and heating load
- As against identified potential of 5000 to 1000 MW, current installed capacity is insignificant
- Policy push is required for accelerated application of this environment friendly technology in the commercial building segment:
  - Highest priority for gas allocation
  - Right pricing of gas
  - Fiscal incentive for technology import
  - Regulatory support for priority open access for export of surplus power even below the current threshold limit of 1 MW
  - Development of financial mechanism for ESCOs to take up such projects under BOOM model



Thank You