添付資料 4

技術系関係機関ヒアリング結果

添付資料 4　　技術系関係機関ヒアリング結果

HVAC および照明について技術系関係機関のヒアリングにより得られた主な情報を以下に記載する。なお、この内容は本文の表 2.3.3-1 に反映している。

(1) トルコ空調衛生技術者協会（TTMD）

a) 新築ビルについては、規制があり、省エネ化が義務付けられているが、既存ビルには規制も省エネ化へのインセンティブ制度もない。これらの「規制」と「インセンティブ制度」も大切だが、調査団としては最大の課題は「適用すべき（可能な）ビルの省エネ技術に係るターゲットモデル、情報」が未整備な点と考える。
b) まず壁・屋根およびサッシュの断熱強化が最優先、次いで「低減された冷暖房設備容量」に対応した機器の高効率化を促進していくのが最も合理的な改修となる。
c) インバータとヒートポンプ技術はエアコンの省エネ促進に有効である。しかしながら一般にインバータ機種はノンインバータ機種に比べ高価なため、インバータ導入による経済効果をわかりやすく提示する必要がある。この意味でITUにて実施するエアコンの実証試験はこの良い事例となりうる可能性がある。
d) 換気については、トルコ国には規制がない。ビルの換気は成り行き自然換気（窓開け、隙間風による）が過半。高断熱・高気密化により機械換気が必要になるが、換気に伴う熱ロスを提言するために全熱交換器等の併用が望まれる。

(2) イスタンブール工科大学（ITU）Onaygil 教授 (照明専門家)

a) 政府ビルの照明の省エネ改修において最も大切なポイントは「トータルデザイン」である。照明器具の交換だけでなく、最初に目標とすべきデザインの目標を見極めるべき。
b) この観点でCFL/T5 ランプの導入は勧めない。
c) これらの代わりとしてLEDランプの導入は近い将来（至近ではない）のトルコの目標モデルとなる可能性が高い。
d) 数年以内にLEDの技術は確実に進歩し、またコストも確実に低下する。
e) 並行して昼光利用を含めたライティングコントロールシステムを導入すべき。
f) LEDの導入により、空調負荷も低減できる。

添付資料 5

EVD ヒアリング結果

添付資料 5　EVD ヒアリング結果

(1) トルコ国における EVD

トルコ国内には 2012 年 9 月末現在 34 の EVD が存在するが、実質的な活動を展開している EVD は限られているのが現状である。EVD と EVD 協会加盟企業のリストを表 5-1 に示す。

34 社の EVD のうち、産業部門および建築部門の両部門の免許をもつものは 13 社、産業部門のみの免許をもつものは 6 社、建物部門のみの免許をもつものは 15 社となっている。地域的には、イスタンブールに 19 社、アンカラに 4 社、アンタリヤに 3 社、イズミールとブルサに各 2 社、その他地域に 4 社となっている。

EVD の事業は、省エネ診断、改修提案の作成が中心であり、改修工事までを実施する案件はほとんどなく、コンサル業務に留まっている。EVD の課題は、机上での知識や情報はすでにあるものの、実際の診断を通しての経験が不足しているということである。

尚、2010 年 5 月に EVD 協会が設立、2012 年 9 月現在では 29 社の企業（内、EVD は 22 社）がこの協会に所属している。協会は民間団体であり任意の活動であるが、業界団体として省エネ制度設計の初期段階から関係官庁への情報提供・上申を行っている。

EVD 協会は、その会員に対し、①省エネに関する情報収集と会員内共有化、②会員（EVD）への能力強化プログラムの提供等の活動を行い、技術の向上に努めている。なお、今回の調査の中で、EVD 協会から EVD の能力向上のためには、計測診断・報告書の書式やマニュアル整備だけでなく、診断現場での OJT を含む能力強化プログラムが必要との意見があった。

EVD 協会加盟企業のうち、7 社は EVD 免許を持たない企業であり、この内 3 社は省エネ法規則の改定による資格者数を確保できず EVD 免許の更新を行わなかった企業である。これらの企業を含み EVD の中で、資格制限の厳しい官庁受注を嫌い、民間受注にその軸足を移そうとする動きが見られる。

(2) 診断用機材

省エネ診断・省エネ提案を実施するにあたってエネルギー計測は不可欠である。しかし、診断に必要な計測機器すべてを有する EVD（TS17025 に則った計測機器を持つ会社）は少なく、計測を他社に再委託して実施するケースが発生している。高価な省エネ計測器を EVD 各社が所有し、管理していくことは、EVD の診断・省エネ提案策定への障壁にもなっている。また改定された省エネ法規則（En-Ver 2011 年 10 月改定）では EVD に計測機器の所有と自身での計測を義務付けているが、実態と規制との矛盾が懸念される。この問題の解決に向けて、計測機材のリースシステムの拡充・容認または政府の EVD 向け計測機材貸出しシステム等の構築などの仕組みを検討する必要がある。

表 5-1　トルコ国内 EVD リストと EVD 協会加入状況（2012 年 9 月現在）

No.	Name	Certificated EVD	Category		Member of Associaton	Location
			Industry	Building		
1	EVD Enerji Yönetimi ve Danışmanlık	1	1	1		Istanbul
2	EDSM Enerji Denetim Danışmanlık	X	(1)	(1)	1	Istanbul
3	VET Enerji Verimliliği	1		1	1	Ankara
4	MTB Enerji Danışmanlık	X	(1)		1	Ankara
5	EKOTEST Çevre Danışmanlık	X	(1)	(1)	1	Ankara
6	ALARKO CARRIER	1		1	1	Kocaeli
7	EKO-EVD Enerji Yönetimi	1	1	1	1	Antalya
8	İSTANBUL ENERJİ	1		1	1	Istanbul
9	ESCON Enerji Sistemleri	1	1			Istanbul
10	EPSİLON Enerji Danışmanlık	1	1			Istanbul
11	EFEKTİF Endüstriyel Enerji	1	1	1	1	Kayseri
12	SIEMENS Sanayi ve Ticaret Anonim Şirketi	1	1			Istanbul
13	BUREAU VERITAS Gözetim Hizmetleri	1	1	1	1	Istanbul
14	BES ENERJİ Danışmanlık	1		1	1	Istanbul
15	ENVE ENERJİ Eğitim Danışmanlık	1	1	1	1	Istanbul
16	UGETAM	1		1		Istanbul
17	ERENCO - Erdemir Mühendislik	1	1	1	1	Istanbul
18	SETAŞ ENERJİ	1	1	1		Izmir
19	ETİK ENERJİ Verimliliği Danışmanlık	1		1	1	Istanbul
20	AVD Enerji Verimliliği Danışmanlık	1		1	1	Bursa
21	GÜRIŞIK Enerji Verimliliği	1		1	1	Istanbul
22	TARU Mühendislik	1	1			Ankara
23	TEKNOYAD Teknoloji Yatırımları	X	(1)			Istanbul
24	ISORAST Yapı Elemanları	1		1	1	Istanbul
25	S.A.İ. ENERJİ	1	1			Bursa
26	3E Enerji Verimliliği Danışmanlık	1		1	1	Istanbul
27	PROMET İnşaat Proje	1	1	1	1	Istanbul
28	ATLAS Uluslararası Belgelendirme	1		1	1	Ankara
29	ENSA Enerji Verimliliği	1	1	1	1	Istanbul
30	ERKA-EVD	1	1		1	Adana
31	SCHNEIDER Elektrik	1	1	1	1	Istanbul
32	ARGE İNOVASYON	1		1		Antalya
33	EKONORM Enerji Danışmanlığı	1		1		Denizli
34	VEMEKS Mühendislik	1		1		Antalya
35	TFM Enerji ve Teknik Hizmetleri	1	1	1	1	Istanbul
36	MYB Isı Sistemleri	1		1		Ankara
37	ESKON Enerji Verimliliği	1	1	1	1	Izumir
38	S&Q Mart Eğitim Ve Yönetim Hizmetleri	1	1	1	1	Istanbul
39	ESER ESCO	XX		(1)	1	Ankara
40	Standart BM Trada	XX		(1)	1	Istanbul
41	Alberk QA Teknik, Belge. ve Kont. Hizmetleri	XX	(1)	(1)	1	Istanbul
42	EE Istanbul Proje ve Danışmanlık Ltd. Şti.	XX		(1)	1	Istanbul
TOTAL		34	19	28	29	—

Remark: X - Former EVD Company
XX - Potential EVD Company

添付資料 6

省エネ診断結果

6-1 **我が国の建物省エネ性能評価手法適用例**

6-2-1 DSI Buildings

6-2-2 EM Hospital

添付資料 6-1　我が国の建物省エネ性能評価手法適用例

DSI ビルおよび EM 病院について、2012 年 11 月～12 月に実施された省エネ診断の中で、我が国の建物省エネ性能評価手法および省エネ目標設定支援手法による評価を実施した。その概要を以下に示す。

(1)　診断対象建物概要

1)　DSI ビル

DSIビルの概要を表6-1-1に、外観写真を図6-1-1に示す。

表 6-1-1　DSI ビル概要

建物名	延床面積 (m^2)	階数	建築年
A	29,449	13	1969
B	3,291	3	1969
C	7,444	7	1980
ホール	830	2	
計	41,014	－	－

図 6-1-1　DSI ビル外観

2)　EM 病院

EM病院の概要を表6-1-2に、外観写真を図6-1-2に示す。

表 6-1-2　EM 病院概要

建物名	延床面積 (m^2)	階数	建築年
外来棟	8,000	3	2003

図 6-1-2　EM 病院外観

(2)　我が国の建物省エネ性能評価手法の概要

我が国では BEP-TR に相当する省エネ性評価ツールである PAL (断熱性能) および CEC（機器の省エネ性能）を活用した建物の省エネ性評価手法が規定され、新築時の許認可に評価結果の提出が義務化されている。また、中小規模の建物の省エネ性評価のためには簡易型の評価手法（ポイント法：PAL/CEC 計算を必要としない）が採用されている。数多く存在する中小規模の建物における省エネ推進を加速する意味で、このような簡易評価手法を導入するアプローチはトルコ国の参考になる（図 6-1-3、表 6-1-3 および-4 参照）。

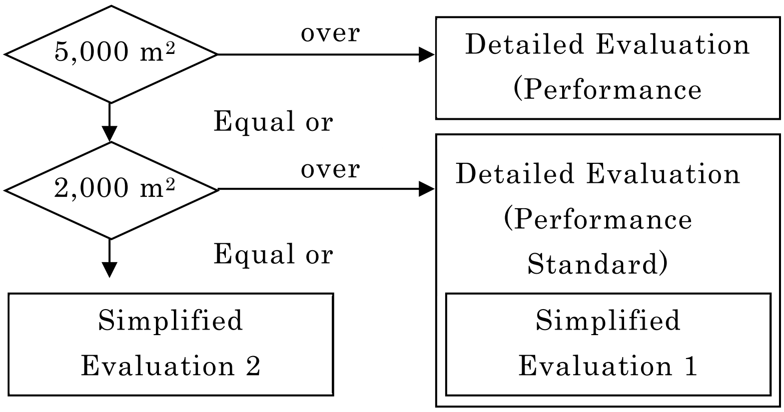


図 6-1-3　我が国の建物規模に応じた建物省エネ性能評価手法

表 6-1-3　我が国のポイント法評価における評価項目（その１）

	1. Building heat loss	2. Air conditioning	3. Ventilation
	1) Basic building design	1) Reducing of fresh air heating /cooling	1) Control system
	Direction, plan, core position and floor height	Working time and pre-heating time	CO2, human sensor, temperature control, linkage to lighting, time schedule etc.
	2) Wall/roof insulation	2) Location of outdoor unit and length of pipe	2) Efficiency of motors
	3) Window insulation	3) Efficiency of air conditioner	3) Introduction of natural ventilation
	4) Solar heat control	4) Adjustment point	4) Adjustment point
Total point	100 ≦ Clear		
	100 > Not good		

表 6-1-4　我が国のポイント法評価における評価項目（その２）

	4. Lighting	5. Hot water supply	6. Elevator
	1) Efficiency of lighting fixture	1) Piping root and insulation	1) Control system
	Type of lamps, efficiency of fixture	Insulation for pipes, bulbs and flange, root of pipe line and pipe diameter	Inverter control and regenerative control
	2) Control system	2) Control system	
	Human sensor, day light/dimmer control, brightness control, time schedule, zone or spot control etc.	Circulation pumps, water tap of lavatory and shower	
	3) Placement of fixtures luminous level and interior finish	3) Efficiency of heat source	
	Task and ambient lighting, room shape and interior color	Efficiency of heat source, solar heating and heat recovery	
	4) Adjustment point	4) Adjustment point	4) Adjustment point
Total point	100 ≦ Clear		
	100 > Not good		

(3)　我が国の建物省エネ性能評価手法および省エネ目標設定支援手法適用例

1)　我が国のポイント法による省エネ性能評価

a)　DSI ビル

DSI　A～C ビル 3 建物に対するポイント法による評価結果を表 6-1-5 ~ -7 に示す。断熱性能の欠如が顕著にわかる。また本省エネ診断と並行して実施された EVD 協会による BEP-TR を用いた建物省エネ性能評価結果は以下の通りであった。

A ビル評価：G、　B ビル評価：F、　C ビル評価：F

この評価結果は若干の差異はあるが、ポイント法による評価結果と概ね一致している。

表 6-1-5　DSI　A ビルに対するポイント法による省エネ性評価結果

	1.Building heat loss	Point	2. Air conditioning	Point	3. Ventilation	Point
	1) Basic building design	12	1) Reduction of fresh air heating/cooling load	0	1) Control system	0
	2) Wall/roof insulation	0	2) Location of outdoor unit and lenth of pipe	0	2) Efficiency of motors	0
	3) Window insulaton	0	3) Efficiency of air conditioner	0	3) Introduction of natural ventilation	10
	4) Solar heat control	25				
	5) Adjustment point	10	4) Adjustment point	95	4) Adjustment point	80
Total point	100 ≦　Clear	47	100 ≦　Clear	95	100 ≦　Clear	80
	Evaluation	X	Evaluation	X	Evaluation	X

	4.Lighting	Point	5. Hot water supply	Point	6. Elavator	Point
	1) Efficiency of lighting fixture	0	1) Piping root and insulation	1	1) Control system	20
	2) Control system	11	2) Control system	0		
	3) Placement of fixtures, luminous level and interior finish	12	3) Efficiency of heat source	0		
	4) Adjustment point	80	4) Adjustment point	70	2) Adjustment point	80
Total point	100 ≦　Clear	103	100 ≦　Clear	71	100 ≦　Clear	100
	Evaluation	OK	Evaluation	X	Evaluation	OK

表 6-1-6　DSI　B ビルに対するポイント法による省エネ性評価結果

	1.Building heat loss	Point	2. Air conditioning	Point	3. Ventilation	Point
	1) Basic building design	12	1) Reduction of fresh air heating/cooling load	0	1) Control system	0
	2) Wall/roof insulation	0	2) Location of outdoor unit and lenth of pipe	0	2) Efficiency of motors	0
	3) Window insulaton	0	3) Efficiency of air conditioner	0	3) Introduction of natural ventilation	10
	4) Solar heat control	0				
	5) Adjustment point	10	4) Adjustment point	95	4) Adjustment point	80
Total point	100 ≦　Clear	22	100 ≦　Clear	95	100 ≦　Clear	80
	Evaluation	X	Evaluation	X	Evaluation	X

	4.Lighting	Point	5. Hot water supply	Point	6. Elavator	Point
	1) Efficiency of lighting fixture	12	1) Piping root and insulation	1	1) Control system	
	2) Control system	0	2) Control system	0		
	3) Placement of fixtures, lminous level and interior finish	12	3) Efficiency of heat source	0		
	4) Adjustment point	80	4) Adjustment point	70	2) Adjustment point	80
Total point	100 ≦　Clear	104	100 ≦　Clear	71	100 ≦　Clear	
	Evaluation	OK	Evaluation	X	Evaluation	

表 6-1-7　DSI　C ビルに対するポイント法による省エネ性評価結果

	1.Building heat loss	Point	2. Air conditioning	Point	3. Ventilation	Point
	1) Basic building design	12	1) Reduction of fresh air heating/cooling load	0	1) Control system	0
	2) Wall/roof insulation	20	2) Location of outdoor unit and lenth of pipe	0	2) Efficiency of motors	0
	3) Window insulaton	0	3) Efficiency of air conditioner	0	3) Introduction of natural ventilation	10
	4) Solar heat control	25				
	5) Adjustment point	10	4) Adjustment point	95	4) Adjustment point	80
Total point	100 ≦　Clear	67	100 ≦　Clear	95	100 ≦　Clear	80
	Evaluation	X	Evaluation	X	Evaluation	X

	4.Lighting	Point	5. Hot water supply	Point	6. Elavator	Point
	1) Efficiency of lighting fixture	18	1) Piping root and insulation	1	1) Control system	20
	2) Control system	0	2) Control system	0		
	3) Placement of fixtures, luminous level and interior finish	12	3) Efficiency of heat source	0		
	4) Adjustment point	80	4) Adjustment point	70	2) Adjustment point	80
Total point	100 ≦　Clear	110	100 ≦　Clear	71	100 ≦　Clear	100
	Evaluation	OK	Evaluation	X	Evaluation	OK

b) EM 病院

EM 病院に対するポイント法による評価結果を表 6-1-8 に示す。空調・換気の非効率性がわかる。また本省エネ診断と並行して実施された EVD 協会による BEP-TR を用いた建物省エネ性能評価結果は C 評価（新築建物に対する規制をぎりぎりクリア）であった。

一方、ポイント法による評価結果では我が国の新築建物に対する規制をクリアしていない（空調、換気および給湯の評価値が 100 未満）。

表 6-1-8　EM 病院に対するポイント法による省エネ性評価結果

	1.Building heat loss	Point	2. Air conditioning	Point	3. Ventilation	Point
	1) Basic building design point	9	1) Reduction of fresh air heating/cooling load point	0	1) Control system point	0
	2) Wall/roof insulation point	25	2) Location of outdoor unit and lenth of pipe point	0	2) Efficiency of motors point	0
	3) Window insulaton point	75	3) Efficiency of air conditioner point	0	3) Introduction of natural ventilation point	0
	4) Solar heat control point	25				
	5) Adjustment point	▲25	4) Adjustment point	95	4) Adjustment point	80
Total point	100 ≦　Clear	134	100 ≦　Clear	95	100 ≦　Clear	80
	Evaluation	OK	Evaluation	X	Evaluation	X

	4.Lighting	Point	5. Hot water supply	Point	6. Elavator	Point
	1) Efficiency of lighting fixture point	6	1) Piping root and insulation point	15	1) Control system point	20
	2) Control system point	11	2) Control system point	0		
	3) Placement of fixtures, luminous level and interior finish point	12	3) Efficiency of heat source point	0		
	4) Adjustment point	80	4) Adjustment point	70	2) Adjustment point	80
Total point	100 ≦　Clear	109	100 ≦　Clear	85	100 ≦　Clear	100
	Evaluation	OK	Evaluation	X	Evaluation	OK

2)　我が国の省エネ目標設定支援手法による評価

我が国の省エネ目標設定支援手法の ECTT を用いた省エネポテンシャルのシミ

ュレーション結果を参考として以下に記載する。

ECTT（Energy Conservation Target Tool）は(財) 省エネセンターが開発したビルのエネルギー消費目標値算定手法であり、現状に対して3段階の省エネ対策即ち、対策(1) 投資不要、対策(2) 少規模投資、および対策(3) 大規模投資の効果を算定するものである。

以下にDSIビルおよびEM病院それぞれに対する試算結果を示す。

a) DSIビル

図 6-1-4 に、DSIビルの現状、対策(1)、対策(1)+(2)、対策(1)+(2)+(3) およびエネルギー診断による対策を実施した場合のエネルギー消費量を現状に対する比率（%）で示す。DSIビルでは対策(3)まで実施すれば、エネルギー消費量は現状の 42.6%に削減できる。

省エネ診断結果に示すように暖房設定温度の下方修正、建物壁の断熱改修による空調の省エネ効果が大きい。診断による対策に加えて、高効率ボイラ、高効率空調機の導入による省エネポテンシャルがある。

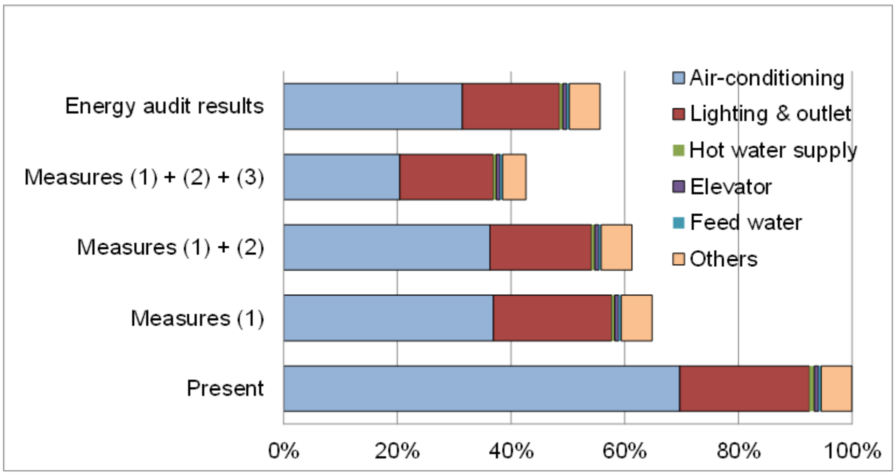


図 6-1-4　ECTTによる DSIビルの省エネポテンシャル試算

b) EM病院

図 6-1-5 に、EM病院の現状、対策(1)、対策(1)+(2)、対策(1)+(2)+(3) およびエネルギー診断による対策を実施した場合のエネルギー消費量を現状に対する比率（%）で示す。対策(3) まで実施すれば、エネルギー消費量は現状の 46%に削減できる。

省エネ診断結果に示すように外気導入量の削減、ボイラ運転管理強化による空調の省エネ効果が大きい。診断による対策に加えて、高効率ボイラ、高効率チラー（冷水機）の導入による省エネポテンシャルがある。

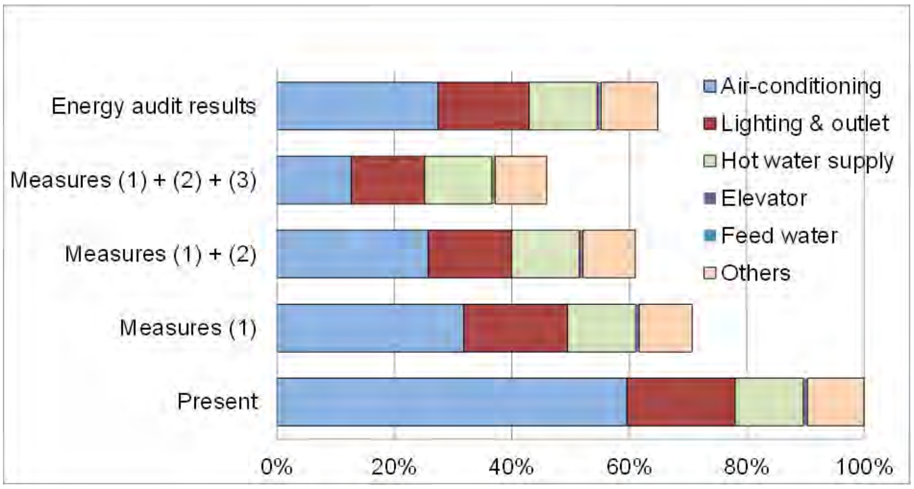


図 **6-1-5　ECTT** による **EM** 病院の省エネポテンシャル試算

Energy Audit Report
of
DSI Buildings

January 2013

Japan International Cooperation Agency (JICA)
J-POWER

添付資料 6-2-1

1. Outline of the building

1.1 Building name	DSI Building			
1.2 District	Ankara			
1.3 Address of building	Devlet Mah. Inonu Bukvan No. 16			
1.4 Use of building	Block-A	Block-B	Block-C	Conference hall
1.5 Completion year	1969	1969	1980	
1.6 Renovation year				
1.7 Total floor area (m^2)	29,449	3,291	7,444	830
1.8 Stories above ground	13	2	7	1
1.9 Stories below ground	2	1		
1.10 Average persons in building Person/day	1500			

2. Outline of energy audit

a. Person engaged in energy audit

JICA Study Team: Dr. Kimio Yoshida (Architect)
Mr. Niro Okamoto (Civil)
Mr. Yukio Nakagawa (Architect)
Mr. Norio Fukushima (Heat)
Mr. Hisatoshi Akiyama (Electrical)
Representative of EVD Association: Gurisik, ENVE, EMAR,TFM and Sqmart:

b. Persons in charge of energy audit: Mr. Serhat Sayiner

b. Energy auditing date: Preliminary energy audit: 28 November 2012 (1 day)
Detailed energy audit: 3 to 5 December 2012 (3 days)

c. Request items on energy audit (main items)

Scope of energy audit is 3 buildings of Block-A, B and C

3. Energy audit results

(1) Improvement proposal items and the expected effect after improvement measure implementation

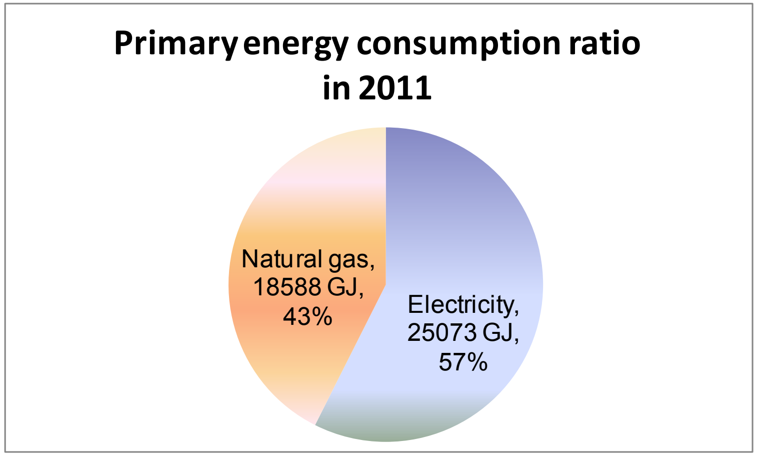
No.	Observation list Classification No.	Improvement items (Itemized corresponding to an appending observation list)	Expected effects: Kind of Energy	The amount of energy conservation (1,000m3/y, MWh/y etc.)		Amount of energy saving (TL/y)	Investment needed (TL)	Expected simple payback years
1	Enforcement of operation management							
1.1	1-1	Formulating PDCA cycle	Natural gas	27	km3	64,000	0	0
			Electricity	113	MWh			
1.2	1-6	Blind for heating period	Natural gas	23.1	km3	21,000	0	0
1.3	2-2-1)	Reduction of boiler: operation hour	Natural gas	107	km3	97,000	0	0
1.4	2-2-2)	Improvement of water boiler operation	Natural gas	25	km3	23000	0	0
2	Improvement of equipment with small investment							
2.1	3-1	Thermo control of inverter	Electricity	10	MWh	96000	43,000	0.4
			Natural gas	102	km3			
2.2	2-3-1)	Improvement of insulation of pipe in B block	Natural gas	4.5	km3	4,200	12,000	2.9
2.3	2-3-2)	Improvement of insulation of valves and pipe	Natural gas	18	km3	16,000	6,000	0.4
2.4	-2-1	Improvement of Boiler air ratio	Natural gas	17.5	km3	16,000	6,000	0.4
2.5	5-2-3)	Introduction of electronic ballast	Electricity	3	MWh	1100	5,000	4.4
2.6	5-2-4)	Introduction of motion sensor for WC	Electricity	4	MWh	1400	5,200	3.7
2.7	2-4	Introduction of high efficiency motor	Electricity	7.5	MWh	2600	18,000	6.8
2.8		Adjustment of energy saving in boiler	Natural gas	(16.0)	km3	(14,600)		
3	Improvement of system with large investment							
3.1	6-1	Improvement of insulation of wall and windows	Natural gas	261	km3	248,000	3,000,000	13.5
			Electricity	27	MWh			
3.2	6-1	Introduction of mechanical ventilation					360,000	
Total of expected results of Case 1: Room temperature control (1 + 2)			Fuel (total)	301,000 m3/y		327,500	95,200	0.3
			Electricity (total)	137.5 MWh/y				
A			Crude-oil equivalent of fuel and electric power (total)					286.4 TOE/y
(A/B)×100			Energy conservation rate of the whole factory					26.7 %
Total of expected results of Case 2: Room temperature control and Insulation (1 + 2 + 3)			Fuel (total)	562,000 m3/y		566,000	3,455,200	6.1
			Electricity (total)	154.5 MWh/y (Adjustment (10MWh))				
A			Crude-oil equivalent of fuel and electric power (total)					506.4 TOE/y
(A/B)×100			Energy conservation rate of the whole factory					47.3 %

(Note) Oil equivalent of electricity is 0.277 TOE/MWh, and that of natural gas is 0.825 TOE/km3, (B)=2,258,904*0.277/1,000+538,161*0.825/1,000=1,067.7 TOE/y

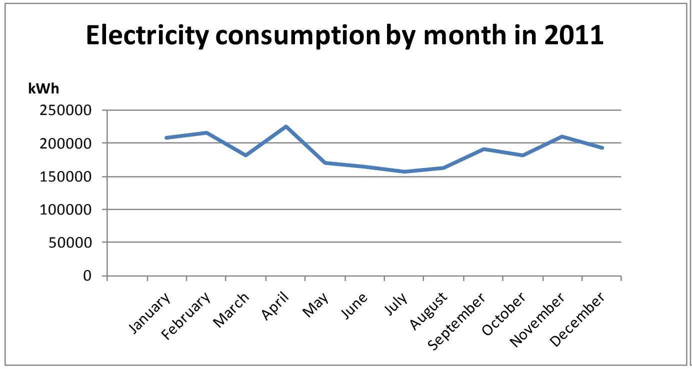
(2) The amount of the annual energy consumption, the energy cost ratio, and energy intensity of the building

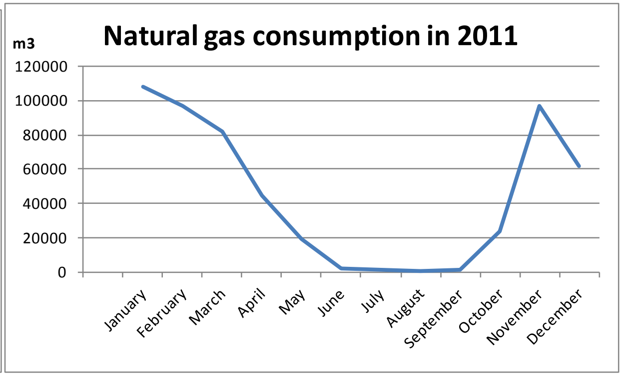
	Energy	Annual consumption		Conversion factor to MJ		Primary energy consumption		Energy intensity		Annual cost (*1)	
1	Electricity	2,258,904	kWh	11.1	MJ/kWh	25,073,834	MJ	611	MJ/m^2	797,393	TL/y
								55	kWh/m^2		
2	Natural gas	538,161	m^3	34.5	MJ/m3N	18,588,081	MJ	444		409,727	TL/y
3	Total					43,661,915	MJ	1,055	MJ/m^2	1,287,120	TL/y

(Note) (*1) For unit price, 2012 price is applied, electricity: 0.353TL/kWh, natural gas: 0.91TL/m3



Energy type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Electricity (kWh)	208,800	215,820	180,720	224,880	169,440	164,160	156,480	162,960	190,080	182,400	210,000	193,164	2,258,904
Natural gas (m^3)	107,919	97,153	81,628	44,363	19,348	1,962	1,171	903	1,340	23,906	96546	61,924	538,163





Use of energy sources assumed by equipment capacity and load factor

Natural gas ---------------------- Water boiler for space heating (93%) 500,000 m3N/y --------------- A Block Building (73%) 365,000 m3N/y

(538,000 m3N) ----------- Steam boiler for hot water supply (5%) 27,000 m3N/y -----------B Building (6%) 30,000 m3N/y

------------Gas range for cooking in restaurant (2%) 11,000 m3N/y ---------- C Building (16%) 80,000 n3N/y

---------- Conference hall (5%) 25,000 m3N/y

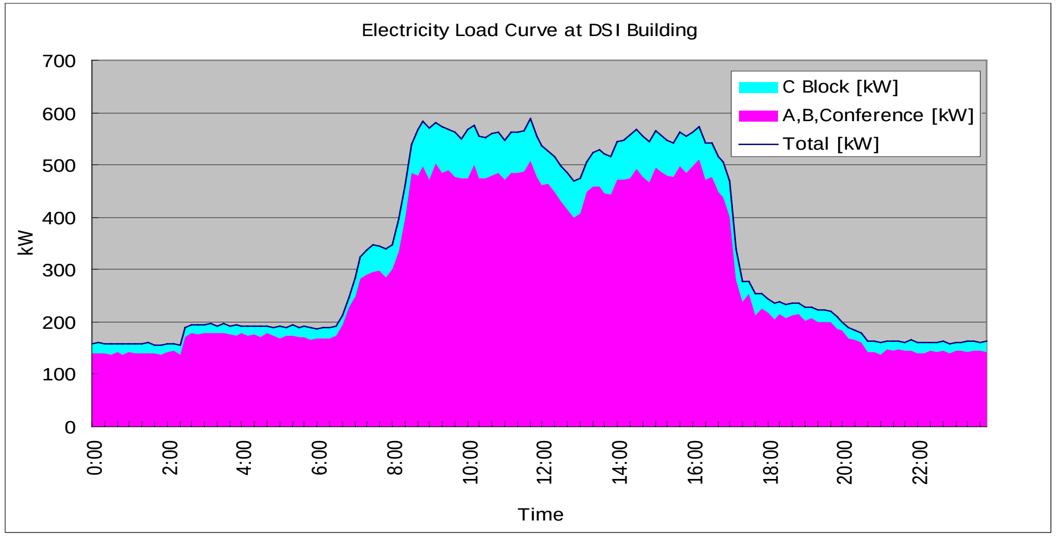
Electricity----------- Air conditioner of split type
- ------- Electrical space heater
- ------- Pump and fan for heat transfer
- ------ Lighting
- ------- Elevators
- ------- Office appliances: Computer, printer, etc.
- ------- Servers for LAN

(3) Daily electricity consumption by hour

(3)-1 Winter season (Date: 4 December 2012)

Hour	1	2	3	4	5	6	7	8	9	10	11	12	
Electricity(kWh)	158.2	157.4	181.0	193.6	191.4	190.1	219.3	339.8	519.7	567.1	558.5	561.8	
A+B Block(kWh)	139.9	139.6	164.3	177.8	173.9	170.5	197.1	292.2	444.0	484.7	481.0	484.1	
C Block(kWh)	18.3	17.8	16.7	15.8	17.5	19.6	22.2	47.6	75.7	82.4	77.5	77.7	
Hour	13	14	15	16	17	18	19	20	21	22	23	24	Total
Electricity(kWh)	495.2	523.3	555.9	554.6	524.9	274.6	234.6	217.3	173.4	163.0	161.0	161.5	7877.2
A+B Block(kWh)	427.0	454.6	479.6	487.5	458.2	238.0	209.8	196.1	153.3	144.9	143.4	143.6	6885.1
C Block(kWh)	68.2	68.7	76.3	67.1	66.7	36.6	24.8	21.2	20.1	18.1	17.6	17.9	992.1

Hour	12	13	14	15	16	17	18	19	20	21	22	23	
Electricity(kWh)	545.4	482.8	511.5	542.6	528.5	490.2	264.7	193.9	172.8	161.5	160.1	158.3	
A+B Block(kWh)	470.4	415.8	443.1	465.8	459.5	421.4	227.5	169.0	151.7	142.0	141.2	140.0	
C Block(kWh)	75.0	67.0	68.3	76.8	69.1	68.8	37.2	24.9	21.1	19.5	18.8	18.4	
Hour	24	1	2	3	4	5	6	7	8	9	10	11	Total
Electricity(kWh)	159.7	158.2	157.5	181.0	193.6	191.4	190.1	219.3	339.8	519.7	567.0	558.5	7648.1
A+B Block(kWh)	142.5	139.9	139.5	164.5	177.2	173.4	170.9	198.2	291.3	444.5	485.2	479.5	6654.0
C Block(kWh)	17.2	18.3	18.0	16.5	16.4	18.1	19.2	21.1	48.6	75.2	81.8	78.9	994.1



Remarks
Energy price

	2011	2012	Calorific value
Natural gas: (TL/m3)	0.761	0.91	8,250 kcal/m3N
Electric power: (TL/kWh)	0.294	0.353	

Building energy conservation audit
Observation list (Detailed explanation of improvement and expected effects are indicated in attached sheet)

1. General management items

Check items and contents	The present condition and problems	Measures for improvement
1.Energy management system - Development of organizational structure and human resource education - Goals for energy conservation and investment budget - Establishment of management standards - Implementation status of energy conservation - Annual plans, and medium- and long-term plans - PDCA management cycle	1) Top Management Concern for Energy Conservation. Responsible person is clear. 2) Control system, 3) Turn off of lighting is implemented. 4) Room interior color is good	PDCA cycle is to be established. Target of energy conservation is to be established. Effects of energy management activity: Reduction of energy is 5% Fuel saving volume: = 538,000 * 0.05 = 27,000 m3/y Fuel saving amount: = 27,000 * 0.91= 25,000 TL/y Electricity saving volume: = 2,259 * 0.05 = 113 MWh/y Electricity saving amount: = 113 * 353 = 39,900 TL/y
2. Implementation status of measurement and recording - Status of installation of measuring equipment and its operation - Status of implementation of measurement and recording - Status of introduction of measurement and control systems		
3. Management of energy consumption - Status of recording of daily reports - Daily consumption and daily load curve - Visualization - Monthly consumption - Comparison with previous fiscal year		
4. Maintenance management of equipment - Periodical inspection and daily check - Cleaning of filters and strainers		
5. Management of specific energy consumption - Management of specific consumption (MJ/(m2-year)) - Management of specific consumption (thousand TL/(m^2-year))		

Check items and contents	The present condition and problems	Measures for improvement
6.Building operation	Many blinds of windows are opened in winter time	At winter peak time, by closing blind, 0.5W/m2 energy can be saved = 3.3 m3/ym2, 3.0 TL/ym2

2. Heat source and heat-conveying equipment

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (m^3, kWh, 1000 TL)	
1. Performance management of combustion equipment - Management of air ratio and exhaust gas - Burners, fuels, and ventilation systems - Combustion control devices - Fuel conversion (boilers, generators ,etc.)	3 sets of water boiler of capacity of 3,500,000 kcal/h for space heating are operated from November to April. 1) Air ratio of water boiler is 2.2. Measurement device of oxygen conents of exhaust gas is not installed. 2) Combustion control of burner is made by air damper with link lever mechanism according to fuel oil volume change.	1) Air ratio of water boiler is to be 1.3 from 2.2. Heat loss of exhaust gas is reduced by 3.5%. Fuel saving volume : 500,000 * 0.035 = 17,500 m3/y 2) Air damper of burner is adjusted by monitoring of oxygen contents (%) of exhaust gas with an oxygen analyser. An oxygen analizer is purchased. 3) Air damper control unit with oxygen analyser of Zirconia sensor is installed. 4) High efficient water boilers with smaller capacity are to be installed after renovation of building insulation.	1) Fuel saving amount : 17,500 * 0.91 = 16,000 TL/y Investment cost: 6,000 TL (Purchase of 1 set of oxygen analyzer) Payback year: = 6,000 / 16,000 = 0.4 years
2. Operational management and efficiency management - Status of load factor and start-up/shutdown - Control of number of units - Heat efficiency, heat balance, and heat distribution - Steam pressure - Water quality management, and blow management	1) Reduction of operation hours of boilers Operation of boilers start at 2:30 AM, although business starts at 8:30 AM. Temperature of office rooms rises from 20^0C to 24C for 4 hours after boilers combustion start.	1) Reduction of warming-up hour by 3 hour in the morning, because temperature of room rises to 24C in Room 522 for 3 hours. Room temperature rises to 24C by 8:30. Start time is changed at 2:30 to at 5:30 Natural gas saving volume: = 500,000 * 3/14 = 107,000 m3/y	1) Fuel saving amount: = 107,000 * 0.91 = 97,000 TL/y Investment cost: Free Payback year = 0 year

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (m^3, kWh, 1000 TL)	
	2) Boiler operation pattern improvement Operation numbers of water boiler are 1 set usually and 2 sets in January of coldest season. Load factor of boilers are 70% at fuel gas combustion base, which shows lower efficiency Operation condition is not continuous but on-off operation. On-off operation is 5% lower than continuous operation in thermal efficiency	2) Continuous operation of 1 set of boiler, except for the coldest season such as January. Control of difference of water temperature between output and inlet of boiler is made. High load factor of boiler is to be kept within boiler capacity of 3,500,000 kcal/h Fuel saving volume: = 500,000 * 0.05 = 25,000 m3/y	2) Fuel saving amount: = 25,000 * 0.91 = 23,000 TL/y Investment cost: Free Payback year = 0 year
3. Operational management of auxiliary equipment - Operational control of cooling towers - Water quality management (electrical conductivity) - Operational control of pumps (water volume and pump head) - Improvement of routes	1) Insulation work of piping is not good especially in pipe duct. Piping in the office rooms in B1 floor of B building is not insulated of 80 mm diameter of 200m in total, which surface temperature is 60^0C.	1) Enforcement of insulation of pipes in the office room in B building Insulation work of pipes of 80 mm diameter of 200m length Glass wool insulation work Heat saving: 13,400 kcal/h Annual operation hour: 2,250h/y Boiler efficiency: 80% Natural gas saving volume: = 13,400 * 2,250 / 0.8 = 4,568 m3N/y Office work conditions will be improved.	1) Natural gas saving amount = 4,568 * 0.91 = 4,157 TL/y Investment cost: 12,000 TL for pipe of 80mm D X 200m L Payback year: = 12,000 / 4157 = 2.9 years

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (m^3, kWh, 1000 TL)	
		2) Enforcement of insulation of pipes and valves for feed and return of hot water in buildings Insulation work of pipes of 100 mm to 150 mm diameter of 117m length in total. Rock wool insulation work Heat saving: 52,500 kcal/h Annual operation hour: 2,250h/y Boiler efficiency: 80% Natural gas saving volume: = 52,500 * 2250 / 0.8 = 17,898 m3N/y	2) Natural gas saving amount: = 17,898 * 0.91 = 16,287 TL/y Investment cost: 6,070 TL for piping Payback year: = 6,070 / 16,287 =.0.4 years
4. Operational management of heat-conveying equipment - Multiple unit control of pumps and fans - Control of rotation speed of pumps and fans - Status of opening and closing of valves (automatic valves, header bypass valves. etc.) - Flow rate and pressure - Improvement of routes (open and closed)	1) Heating system (Heat transmission system) Flow rate control of hot water Valves of circulation pumps are 100% open. Long operation time (2:30~17:30), and motor efficiency is normal.	1) Circulation pump for heating Introduction of high efficiency motor Motor efficiency is improved by introduction of high efficiency motor. 2 sets * 7.5kW of motor efficiency: 80% → 88.5% 15kW of motor efficiency: 83% → 90.6% Electricity saving volume: 2,255h/y*2*7.5kW*(100/80-100/88.5)=4,061kWh/y 2,255h/y*15kW*(100/83-100/90.6)=3,419kWh/y Total: 7,480kWh/y	1) Electricity saving amount: = 7,480 * 0.353 = 2,640 TL/y Investment cost: 18,000 TL_ Payback year: = 18,000 / 2,640 = 6.8 years

3. Air-conditioning and ventilating facilities

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (m^3, kWh, 1000 TL)	
1. Operational management of air conditioners - Optimization of preset temperature and humidity - Appropriateness of humidified zones and methods - Appropriateness of reheating - Uneven distribution of temperature - Warm-up operation - Control of outdoor air intake volume- Review of operation hours - Switching-off of air conditioners in unused rooms - Outdoor air blocking - Indoor condition management (CO_2 etc.)	1) No thermal control of room temperature (Hot as 26^0C) 26 ^{0}C measured, some window are opened Present annual gas consumption 538,161m3/year (Around 95% is for heating) Flow rate control of hot water Valves of circulation pumps are 100% open.	1) Target room temp change from 26^0C to 22^0C = 20% reduction Temperature control system should be introduced such as thermostatic valve of convector. Visualize room temperature (setting thermometer) a) Adding temperature control system Fuel saving volume: = 538,161*0.95*0.2 =102,000m3/y 19% reduction b) Adding inverter controller into circulation pumps can reduce flow rate of 19%, which 15% Electricity can be saved for pumps: Electricity saving volume: 2,255h/y*30kW*0.15 =10,148kWh/y	1) a) Fuel saving amount by temperature control system = 102,000 * 0.91 = 92,820TL/y b) Electricity saving amount by inverter control: =10,148 * 0.353 = 3,582TL/y c) Total saving amount: = 96,000 TL/y Investment cost of temperature control system and inverter: 43,000 TL, Payback year: = 43,000 / 96,000 =0.4 years_
2. Management of air conditioning efficiency - Restriction of air conditioning areas - Use of outdoor air (outdoor air cooling) - Setting of dew-point control - Prevention of mixing loss - Night purge - Water sprinkling on rooftop and outdoor units - Accuracy of automatic control			

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (m^3, kWh, 1000 TL)	
3. Management of ventilating equipment - Optimization of ventilation frequency - Review of operating hours - Control of ventilation in the parking space (CO concentration) - Management of operating temperature (electrical room. machine room, CVCF room) - Local ventilation - Switching-off of ventilators in unused rooms - Control of air blower speed (VAV. VWV)			

4. Hot water supply, feed water and drainage, freezing, refrigerating, and kitchen equipment

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (m^3, kWh, TL)	
1. Management of hot water Supply equipment - Hot water supply temperature - Improvement of hot water supply efficiency (descaling, etc.) - Stopping of operation except during winter - Scheduled control during holidays and at night-time - Utilization of waste heat - Use of solar heat	2 sets of steam boiler of capacity of 426,000 kcal/h for hot water supply are operated in all days. Load factor of steam boiler is 50% to 70%	In winter season, hot water of water boilers can be used instead of steam boilers, and so stop of steam boilers is recommended.	

5. Power receiving/transforming facilities, lighting and electrical system

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (m^3, kWh, 1000 TL)	
1. Management of power receiving/transforming facilities - Adjustment of electrical voltage - Management of power factor - Control of improvement of power factor	1) Receiving transformers are supplied by electric distribution company. 2) Power factor control is implemented.		

<table>
<tr><th>Check items and contents</th><th>The present condition and problems</th><th colspan="2">The measure against improvement, and the expected effect per year (m^3, kWh, 1000 TL)</th></tr>
<tr><td rowspan="2">2. Management of lighting systems
- Management of optimum illumination
- Turning off the lights during unnecessary time (use of daylight, etc.)
- Cleaning and change of lighting apparatus
- Mounting position of lamp fitting, and circuit partitioning
- Darkening and extinction by automatic dimming control system
- Local lighting
- Use of energy-saving fluorescent tubes
- Improvement of utilization factor (reflectance ratio)
- Management of outdoor light
- Turning off night-time guide light
- Use of high efficiency lamps</td><td>1) Lightings are turned off at unnecessary area
Some lighting circuit are separated → Easy to select the lighting area
2) Luminance measurement
Entrance of C building is high (standard: 150, measurement result: 216 Lx)
3) 70% of Fluorescent lamp are used magnetic ballast</td><td>3) Reduction loss for ballast of fluorescent lamp
Replacement of magnetic ballast into electronic ballast
10% Energy can be saved by replacement of ballast.
Electricity of installed fluorescent lamps:
2*36W type (80W)*200units=16kW
Electricity saving volume:
16kW*1,980h/y*10% = 3,168kWh/y</td><td>3) Electricity saving amount:
= 3,168 * 0.353
= 1,100TL/y
Investment cost: 5,000TL for 200sets of ballast
Payback year:
= 5,000/1,100 = 4.5 years</td></tr>
<tr><td>4) Sensor control
No motion sensor is installed at WC
Lightings at WC are keeping turned on</td><td>4) Electricity reduction of unnecessary area
Introduction of motion sensor for WC
30% Energy can be saved by introduction of motion sensor.
Total lighting capacity:
6.72kW for 26 WC
Electricity saving volume:
= 6.72kW * 1,980h/y * 30%
= 3,993kWh/y</td><td>4) Electricity saving amount:
= 3,993 * 0.353
=1,400TL/y
Investment cost: 5,200TL for 26sets of motion sensors
Payback year:
= 5200 / 1,400 = 3.7years</td></tr>
<tr><td>3. Management of office automation equipment
- Reduction of standby electricity
- Power-oft unless then are needed
- Introduction of energy-saving types</td><td></td><td>.</td><td></td></tr>
</table>

6. Buildings

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (m^3, kWh, 1000 TL)	A check item and contents
1. Energy conservation in buildings - Heat insulation properties of the structure - Heat insulation properties and air tightness of windows - Blocking of outdoor air - Sunlight protection of windows - Sunlight protection on the roof - Air-flow windows - Rooftop greening - Green government building project	1) Glass ratio is high and single glass with non-insulated sash for Building A and B, and connecting corridors. Double glass with non-insulated sash for Building C 2) No insulation for walls for Building A and B 3) Additionally building surface is old and not functional 4) So total retrofitting is needed a) For Building A and B, Heat loss through window and sash is high, Not closing blinds b) For Building C, Wall and heat insulation is good, but heat is being lost through sash. Insulation for sash is needed c) For connecting corridor, Wall insulation (XPS) is good, but heat is being lost through window. Insulation for window and sash is needed 5) Comparison of room temperature trend for 24 hours with a hospital building which is well insulated building. Temperature drop of DSI is 26^0C to 19^0C, while that of EMH is 23^0C to 22^0C in the night time due to insulation level.	1) Heating load (gas) reduction by building insulation a) Fuel saving volume by insulation enforcement: =182,000m3N/y b) Adding room temp control system from 26^0C to 22^0C Fuel saving volume by temperature control: = 62,600m3N/y a)+b) = 245,000m3N Heat supply is reduced by 48%. c) By 48% flow rate reduction, 40% of electricity can be saved for pumps Electricity saving volume: = 2,255h/y*30kW*0.40 =27,000kWh/y	1)-a) Natural gas saving amount: = 245,000 * 0.91 =238,000TL/y 1)-c) electricity saving amount: = 27,000 * 0.353 =10,000TL/y Total energy saving amount: 248,000TL/y Investment cost: Window and wall insulation :3,000,000TL, Mechanical ventilation: 360,000TL Payback year=3,360,000/248,000=13.5years (Refer to P21)

7. Elevators

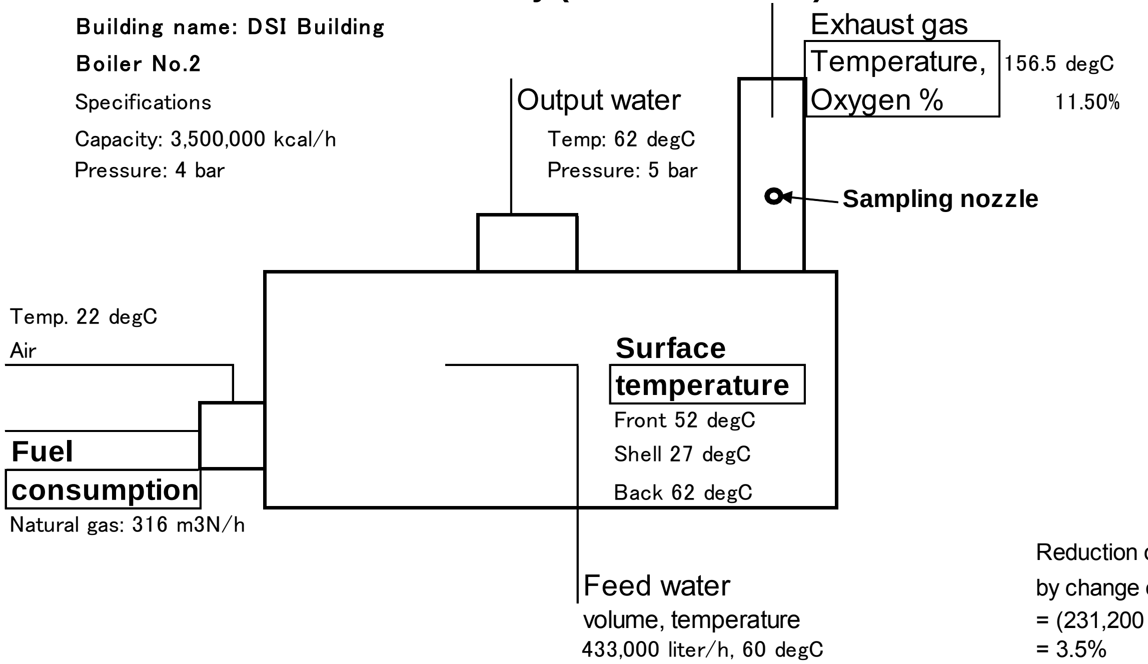
Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (m^3, kWh, 1000 TL)	
1. Operational management of elevators - Control of number of elevators in operation - Time-zone operation schedule management - Reduction of power transmission mechanical loss - Decrease in number of floors at which an elevator stops - Use of inverter control	Inverter control for elevators is installed. Every time all elevators works	Operating number control should be considered for night time and holidays	

Referential Information

1. Boiler

1.1 Improvement of air ratio of water boiler

Water boiler thermal efficiency (Indirect method)

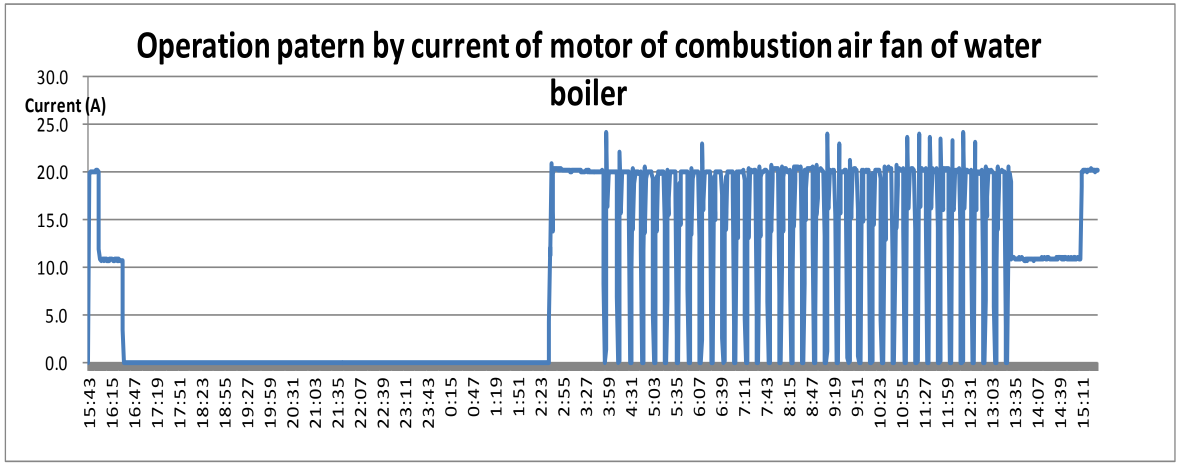


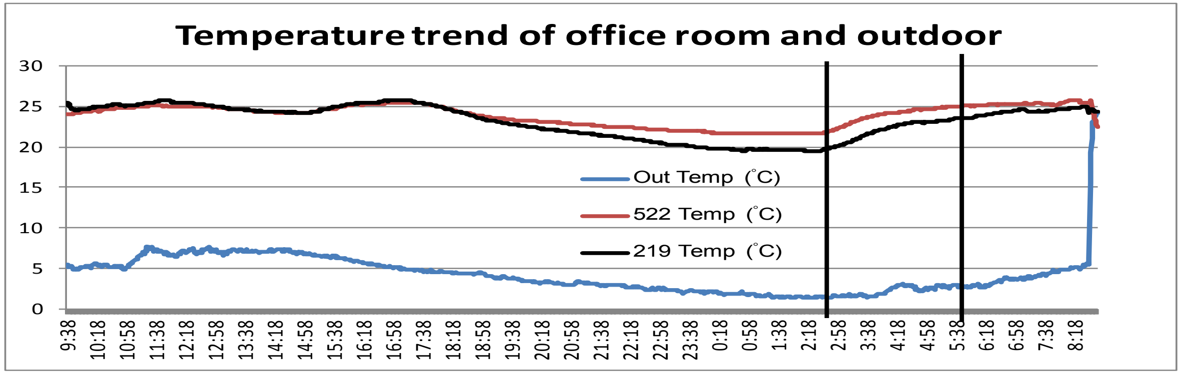
Reduction of exhaust gas heat loss
by change of air ratio 2.2 to 1.3
= (231,200 - 140,484) / 2,607,000 * 100
= 3.5%

1	Input heat				Equation
a	**Fuel combustion heat**	**2,607,000**	**kcal/h**		= b * c
b	Fuel heat value	8,250	kcal/m3N		
c	Fuel consumption	316.0	m3N/h		
d					

2	Heat loss	m=2.2		m=1.3	
e	**Exhaust gas heat loss**	**231,200**	**kcal/h**	**140484**	**kcal/h**
f	Theoretical gas volume	10.1	m3N/m3N	10.1	m3N/m3N
g	Theoretical air volume	9.2	m3N/m3N	9.2	m3N/m3N
h	Excess air ratio	2.20		1.3	
i	Specific heat of ex. gas	0.311	kcal/m3NC	0.311	kcal/m3NC
j	Actual exhaust gas vol.	21.19	m3N/m3N	12.87	m3N/m3N
k	Exhaust gas heat loss	732	kcal/m3N	444	kcal/m3N
l	**Radiation heat loss**	**6,468**	kcal/h	**6,468**	kcal/h
m	Convection heat loss	2,373	kcal/h	2,373	kcal/h
n	Emission heat loss	4,095	kcal/h	4,095	kcal/h

1.2 Improvement of operation pattern of water boiler
Reduction of operation hours of water boiler





1.3 Enforcement of insulation of pipes and valves

Deteriorated insulation

No insulation

No insulation for valves

Insulation for valves

Date of measurement 5 Dec. 2012

No.	Equipment name	Pipe size	Quantity	Surface temp	Pipe length	Un-insulated length	Heat loss by insulation		heat loss at present		Saving
				deg C	m	m	kcal/h/m	kcal/h	kcal/h/m	kcal/h	kcal/h
1	**B-block B-1 piping @ W, S and E wall in the office room**	80A	2	60	100	100	16	3,200	83	16,600	13,400
2	**Piping**										
2.1	A-block high vertical pipe	100A	4	60	40	40	29	4,640	208	33,280	28,640
2.2	A-block low vertical pipe	100A	4	60	12	12	29	1,392	208	9,990	8,598
2.3	C-block horizontal pipe	100A	2	60	90	45	29	2,610	82	7,353	4,743
2.4	Boiler to B-block connecting	125A	2	60	30	30	34.4	2,064	95	5,728	3,664
2.5	Boiler to C-block connecting	150A	2	60	50	50	39.8	3,980	108	10,836	6,856
	Total of piping					177		14,686		67,186	52,500

2. Renovation of insulation of buildings

(1) Present condition of building

a) Glass ratio is high and single glass with non-insulated sash for Building A and B, and connecting corridors.
Double glass with non-insulated sash for Building C: U value = 4-5W/m2^{0}C
(U value is an indicator for evaluating insulation level)

b) No insulation for walls for Building A and B: U value = 4W /m2^{0}C
>> Average U value or windows and walls is 4.5W/m2^{0}C

c) Additionally building surface is old and not functional, and so total retrofitting is needed

For Building A and B,
Heat loss through window and sash is high, No closing blinds
For Building C,
Wall and heat insulation is good, but heat is being lost through sash. Insulation for sash is needed
For connecting corridor,
Wall insulation (XPS) is good, but heat is being lost through window. Insulation for window and sash is needed
Comparison of room temperature trend for 24 hours with a hospital building which is well insulated building.
Temperature drop of SDI is 26^{0}C to 19^{0}C, while that of TMH is 23^{0}C to 22^{0}C in the night time due to insulation level.

(2) Heating load (gas) reduction by building insulation

a) 2.5W/m2^{0}C*(22-(-12)) ^{0}C*13,000m2*(8760h*0.15) *1.2(loss)/8,250kcal/m3*0.86lcal/W=182,000m3

b) Adding room temp control system from 26^{0}C to 22^{0}C
(538,161*0.95-182,000-16,500)*0.2 = 62,600m3
a)+b) = 261,000m3=238,000TL/y 48 % reduction
48% flow rate reduction → 40% Electricity can be saved for pumps
2,255h/y*30kW*0.40 =27,000kWh/y=10,000TL/y
Totally 248,000TL/y reduction

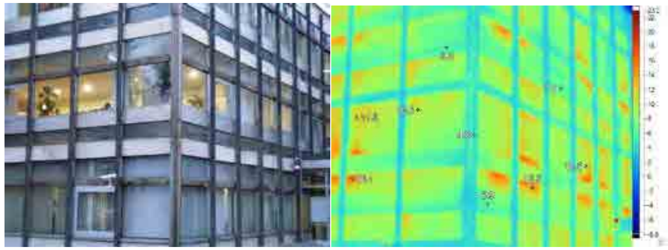
Reduction of cost

(1) Expected energy and cost reduction
Gas 261,00m3* 0.91TL/m3=238,000TL/y
Electricity 27,000kWh*0.353=10,000TL/y
Total 248,000TL/y saving
19.1TL/m2 (wall & window) / year can be saved

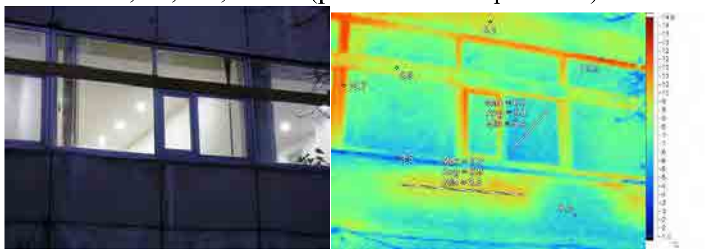
(2) Expected investment

1) Wall and glass insulation: 2,860,000TL (13,000m2*220TL/m2)
2) Additional design retrofitting + some equipment replacement
Total = 3,000,000TL?

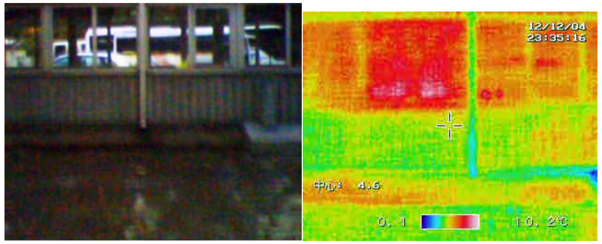
For Building A and B,
Heat loss through window and sash is high,
Not closing blinds



For Building B,
Waste of heat means waste of money:
456,000TL/y through wall and window (heat loss)
Since 1969, 18,000,000TL (present value equivalent)



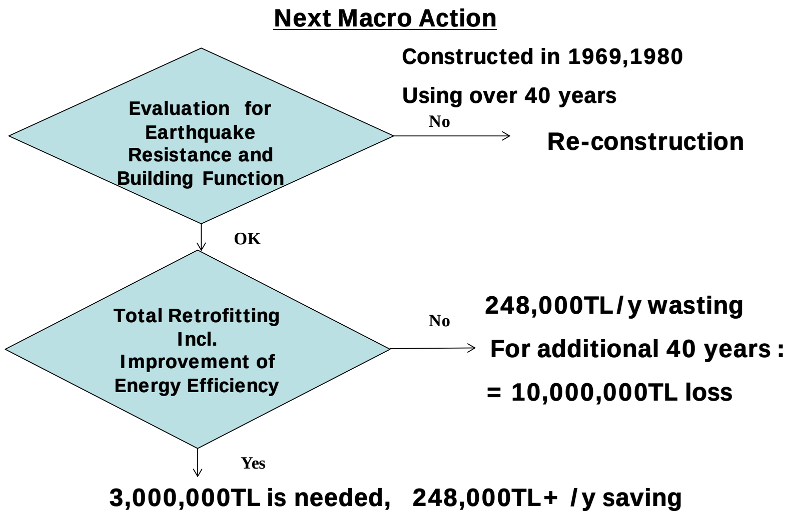
For Building C,
Wall and heat insulation is good, but heat is being lost through sash. Insulation for sash is needed.



For connecting corridor,
Wall insulation (XPS) is good, but heat is being lost through window. Insulation for window and sash is needed

Recommended procedure

DSI building was constructed in 1969,1980 and have been used over 40 years



3. Ventilation of building

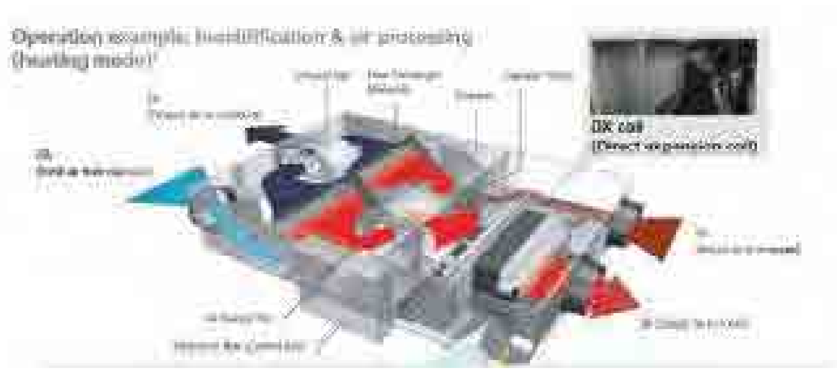
CO_2 density in meeting room is indicated as 1,800PPM > 1,000PPM (Criteria of Japanese office standard)

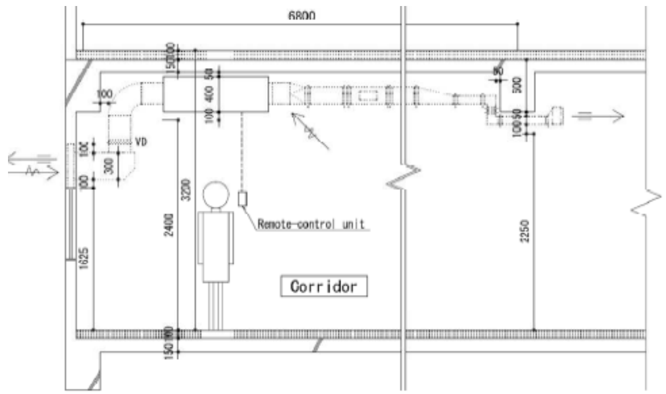
Now natural ventilation, but by introducing air tight sash (higher insulation), mechanical ventilation system should be also introduced

Ex) Introducing heat exchanger (HEX) (recover the wasted heat) is recommended

In DSI room size is small, so install HEX for corridor and meeting rooms only

Heat Exchanger (HEX) for Ventilation
Ex) 500m3/h HEX (Efficiency 70%) heat recovery
Price: 6,000TL/unit * 60 units = 360,000TL
1,500person * 20m3/h / (500m3/h) = 60 units





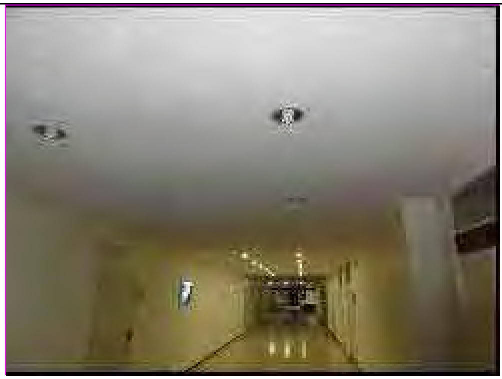
Heat Exchanger (HEX) for Ventilation

4. Lighting facilities

Survey for illuminance in the EM Hospital

Building (A, B, C)	Floor	Place (Office room, Corridor, etc.)	Illuminance [lx]	Measured height from floor [cm]	Notes (Main lamp equipment etc.)
A	Z	Corridor (in front of elevator)	35	15cm	CFL 18W
A	3	Meeting room	97	50cm	CFL 18W
A	3	Executive office room	141	50cm	FL 36W *2
A	3	WC	142	40cm	CFL 18W
A	3	Corridor (in front of elevator)	37	50cm	CFL 18W * 2
A	4	Corridor (in front of elevator)	52	60cm	CFL 18W * 2
A	12	Cafeteria	152	75cm	FL 36W *2
A	B1	Corridor (turned off lightings)	66	15cm	CFL 18W
A	B1	Corridor (turned on lightings)	133	15cm	CFL 18W
C	Z	Corridor	216	25cm	CFL 18W
C	6	Office room	168	55cm	CFL 18W

Typing room: 500lx
Documents room: 100lx
Administration room: 250lx
Waiting room: 150lx
Conference room: 200lx
Cafeteria: 150lx

		
Lightings are turned off at unnecessary areas	Only entrance of Building C is high (standard: 150lx, measurement result: 216lx)	70% of Fluorescent lamp are used magnetic ballast → Electronic ballast is more energy saving.
		
No thermal control of room temperature (Hot as 260C)	Lightings at WC are kept turned on →Energy can be saved easily by installing motion sensors	✓ Valves of circulation pumps are 100% open ✓ Long operation time (2:30~17:30), and motor efficiency is normal

5. Other energy conservation measures

Ref.1 Replacement of Fluorescent lamp into LED (In priority to long operation area)

Effects:

Existing Fluorescent lamp: 4 * 18W type (80W) * 100units, 2 * 36W type (80W) * 32units=10.56kW

→ 49% energy can be saved by installing LED

Electricity saving volume = 10.56kW * 1,980h/y * 49% = 10,581kWh/y

Electricity saving amount = 10,581 * 0.318 = 3,365TL/y

Investment cost: 41,867TL for 464units of LED lamps

Simple payback = 41,867 / 3,365 = 12.4 years

Ref.2 Replacement of split AC into inverter AC

Effects: Approx. 20% energy can be saved from the view point of SEER, not COP

Average 12,000BTU*200units*600h/y*20% saving

Electricity saving volume = 31,000kWh/y=11,000TL/y

Inverter AC: 3,800TL

Non-inverter AC: 2,000TL

Energy Audit Report
of
Etimesgut Military Hospital

January 2013

Japan International Cooperation Agency (JICA)
J-POWER

添付資料 6-2-2

1. Outline of the building

1.1 Building name	Etimesgut Military Hospital		
1.2 District	Ankara		
1.3 Address of building	Erler Etimesgut, Etimesgut		
1.4 Use of building	Hospital		
	Outpatient (target of energy audit)	Main	Engineering & maintenance
1.5 Completion year	2003	1964	1978
1.6 Renovation year		Scheduled in 2013	
1.7 Total floor area (m^2)	8,000	14,475	3,725
1.8 Stories above ground story	3	4	2
1.9 Stories below ground story	0	0	0
1.10 Average persons in building Person/day	1,200	300	100

2. Outline of energy audit

a. Person engaged in energy audit

JICA Study Team: Dr. Kimio Yoshida (Architect)
Mr. Niro Okamoto (Civil)
Mr. Norio Fukushima (Heat)
Mr. Akiyama (Electrical)

Representatives of EVD Association: Gurisik, ENVE and EMAR

b. Persons in charge of energy audit: Mr. Alb.A.Hamdi

c. Energy auditing date: Preliminary energy audit: 29 November 2012 (1 day)
Detailed energy audit: 5 to 7 December 2012 (2.5 days)

d. Request items on energy audit (main items)

Scope of energy audit is outpatient building.
Main building is demolished in 2012 to rebuilt new building.

3. Energy audit results

(1) Improvement proposal items and the expected effect after improvement measure implementation

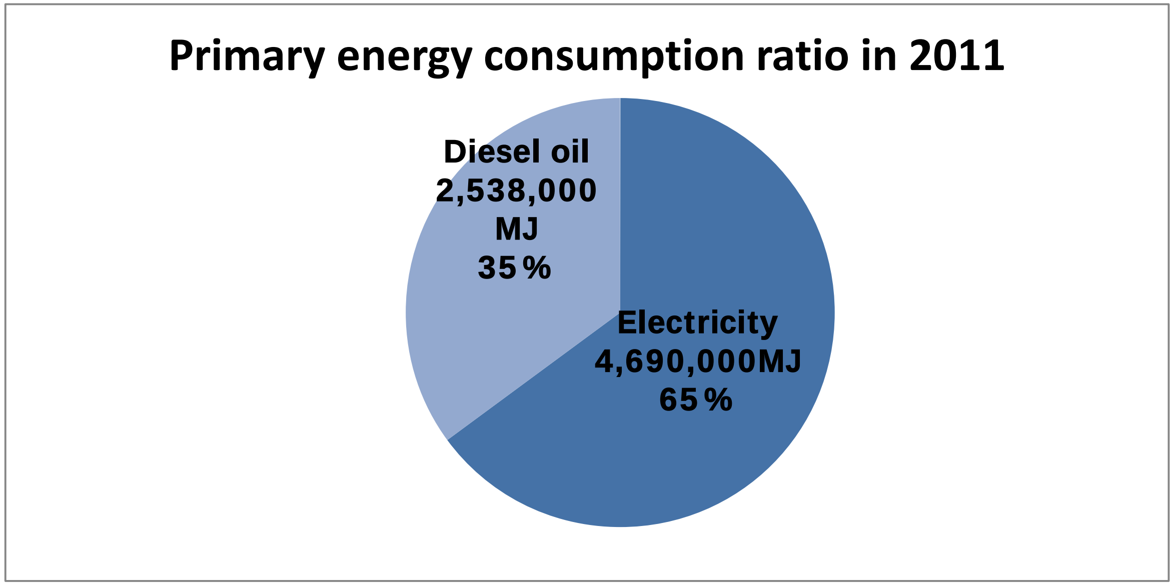
No.	Observation list Classification No.	Improvement items (Itemized corresponding to an appending observation list)	Expected effects					
			Kind of Energy	The amount of energy conservation (kL/y, MWh/y etc.)		Amount of energy saving (1000 TL/y)	Investment needed (1000TL)	Expected simple payback years
1	Enforcement of operation management							
1.1	1-1	Formulating PCDA cycle	Diesel oil	3.5	kL	6.8	0	0
			Electricity	21.1	MWh	6.7	0	0
1.2	1-6	Blind for heating period	Diesel oil	0.9	kL	1.7	0	0
1.3	2-3-1)	Reduction of boiler operation time	Diesel oil	7.7	kL	15.0	0	0
1.4	2-3-2)	Improvement of boiler operation	Diesel oil	3.5	kL	6.8	0	0
1.5	5-2-2)	Change setting of motion sensor for WC	Electricity	1.9	MWh	0.6	0	0
1.6	3-1-1)	Case1. Reduction of fresh air intake from 47,000m^3/h to 30,000m^3/h	Diesel oil	19.3	kL	37.4	0	0
			Electricity	36.6	MWh	11.6	0	0
2	Improvement of equipment with small investment							
2.1	3-1-2)	Case2. Reduction of fresh air intake to 20,000m^3, Introducing small HEX and control	Diesel oil	27.4	kL	52.0	150.0	2.0
			Electricity	73.1	MWh	23.2		
2.2	2-1	Boiler: Air ratio improvement	Diesel oil	2.9	kL	5.7	6.0	1.1
2.3	2-4-2)	Insulation for valves	Diesel oil	1.3	kL	2.4	2.4	1.0
2.4	5-2-1)	Introduction of electronic ballast	Electricity	2.1	MWh	0.67	3.3	4.9
3	Improvement of system with big investment							
3.1	3-1-3)	Case 3. Replacement of Air Handling Unit				66.0	422.0	6.4
4		Adjustment of energy saving in boiler	Diesel oil	(0.9)	KL/y	(1.7)	0	
Total of expected results: Case 1			Fuel (total)	38.2	KL/y	74.1	11.7	0.1
			Electricity (total)	61.7	MWh/y	19.6		
		A	Crude-oil equivalent of fuel and electric power (total)				33.1+16.8= 49.9 TOE/y	
		(A/B)×100	Energy conservation rate of the building					28.1%
Total of expected results: Case 2			Fuel (total)	46.3	KL/y	88.7	161.7	1.3
			Electricity (total)	98.2	MWh/y	31.2		
		A	Crude-oil equivalent of fuel and electric power (total)				40.1+27.0 = 67.1 TOE /y	
		(A/B)×100	Energy conservation rate of the building					37.8%
Total of expected results: Case 3			Fuel (total)	48.3	KL/y	110.7	433.7	3.9
			Electricity (total)	61.6	MWh/y			
		A	Crude-oil equivalent of fuel and electric power (total)				41.9 +16.8=58.7 TOE/y	
		(A/B)×100	Energy conservation rate of the building					33.1%

(Note) Oil equivalent of electricity is 0.277 TOE/MWh, and that of diesel oil is 1.02 TOE/ton, , and 0.867 TOE/kilter, (B)=422.5*0.277/1,000+69,920*0.867/1,000=177.6 TOE/y

(2) The amount of the annual energy consumption, energy cost ratio and energy intensity of the building of outpatient in 2011

	Energy	Annual consumption		Conversion factor to primary energy		Energy consumption		Energy intensity per floor area		Annual cost (*1)	
1	Electricity	422,500	kWh	11.1	MJ/kWh	4,690,000	MJ	586.3	MJ/m^2	134,360	TL/y
2	Diesel oil	69,920	Liter	36.3	MJ/Liter	2,538,000	MJ	317.2	MJ/m^2	135,600	TL/y
3	Total					7,228,000	MJ	903.5	MJ/m^2	269,960	TL/y

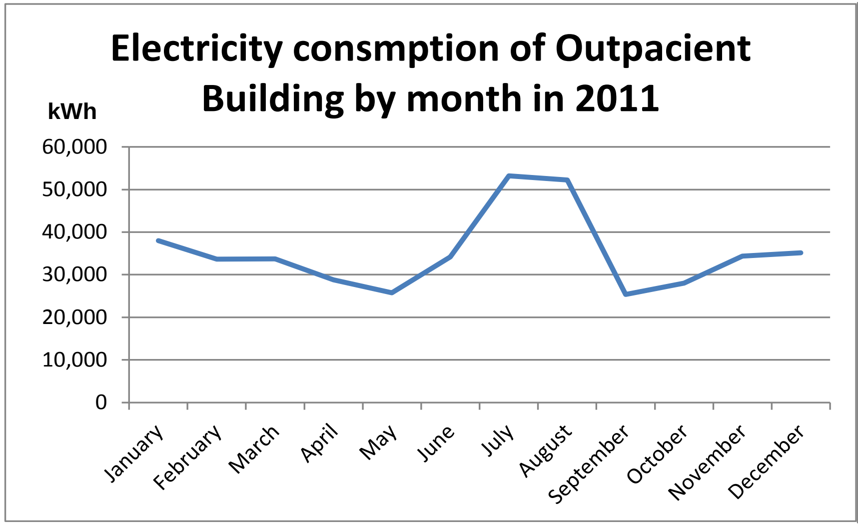
(Note) (*1) For unit price, 2012 price is applied, electricity:0.318TL/kWh, diesel oil: 1.94TL/liter

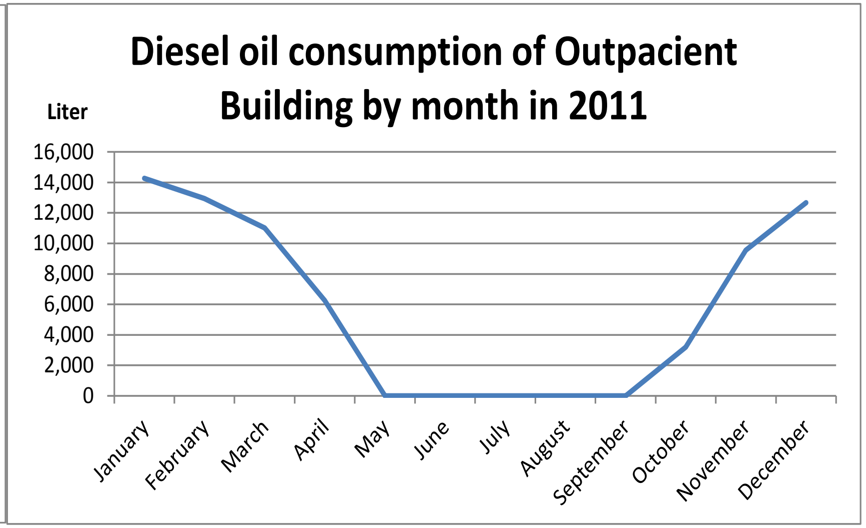


Energy consumption by month in 2011: Whole hospital

Energy type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Electricity (kWh) Total	151,875	134,646	134,946	115,044	99,561	110,192	148,574	144,638	101,358	112,144	137,566	140,491	1,531,035
Electricity (kWh) Outpatient (*1)	37,975	33,667	33,742	28,766	25,774	34,163	53,243	52,246	25,344	28,041	34,397	35,129	422,488
LPG(kg) Main	333	333	333	333	333	333	333	333	333	333	333	333	4,000
LPG(kg) Engineering	4,765	4,331	4,303	1,976	0	0	0	0	0	120	3,073	4,404	22,972
LPG(kg) Total	5,098	4,664	4,636	2,309	333	333	333	333	333	453	3,406	4,737	26,972
Diesel oil (Liter) Main	34,290	35,860	34,180	24,220	11,200	7,470	6,140	5,640	6,560	18,650	35,230	36,780	256,220
Diesel oil (Liter) Outpatient	14,280	12,940	11,010	6,260	0	0	0	0	0	3,200	9,550	12,680	69,920
Diesel oil in total(Liter)	48,570	48,800	45,190	30,480	11,200	7,470	6,140	5,640	6,560	21,850	44,780	49,460	326,140

Note: (*1) Electricity consumption in outpatient building is estimated as 25% of the total electricity consumption of EM Hospital. In addition, electricity consumption of chiller is added to electricity consumption of outpatient building in summer season.

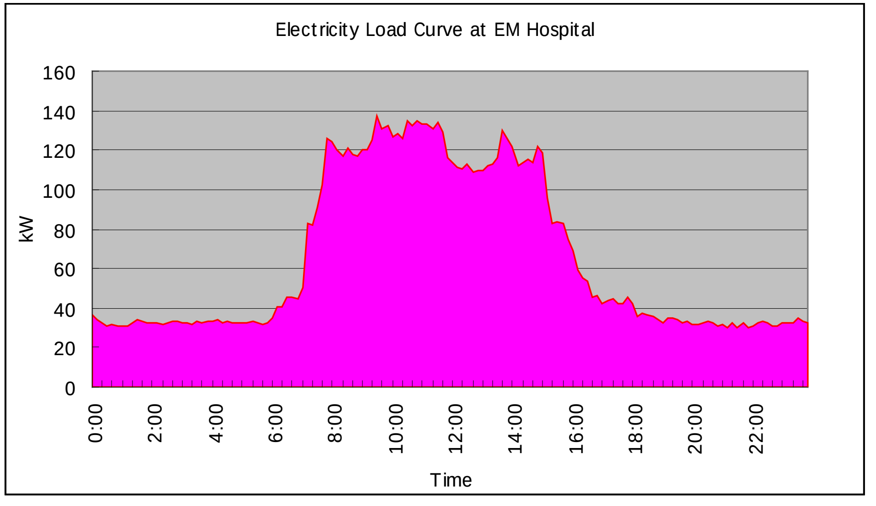




(3) Daily electricity consumption by hour

(3)-1 Winter season (Date: 6 December 2012)

Hour	1	2	3	4	5	6	7	8	9	10	11	12	
Electricity(kWh)	31.8	32.6	32.6	32.8	32.8	32.9	44.5	101.3	118.9	128.8	131.4	126.2	
Hour	13	14	15	16	17	18	19	20	21	22	23	24	Total
Electricity(kWh)	110.7	119.6	115.9	81.5	50.4	43.5	35.3	33.6	32.0	31.0	32.0	33.1	



Remarks

1. Energy price
1.1 Diesel oil: 2.22784TL/kg = 1.94 TL/liter (Specific weight = 0.85) in November 2012
1.2 Electric power: 0.318TL/kWh in 2012

Building energy conservation audit
Observation list (Detailed explanation of improvement and expected effects are indicated in attached sheet)

1. General management items

Check items and contents	The present condition and problems	Measures for improvement
1. Energy management system - Development of organizational structure and human resource education - Goals for energy conservation and investment budget - Establishment of management standards - Implementation status of energy conservation - Annual plans, and medium- and long-term plans - PDCA management cycle	Organization of energy management is established and General Manager, Mechanical Manager and Electrical manager are nominated for energy and environment management. Target of energy consumption is not decided. Environmental management meeting is held once 3 months. Sign boards of energy saving are installed on all the outlets and switches. Unnecessary lighting is switched off. All the lamps in the office room are switched off. All the personal computers are switched off at the completion of work. Elevators are stopped during night and off-day.	PDCA cycle is to be established. Target of energy conservation is to be established. Effects of energy management activity: Reduction of energy is 5% Fuel saving volume: = 69,920 * 0.05 = 3,500 L/y Fuel saving amount: = 3500 * 1.94= 6,800 TL/y Electricity saving volume: = 422.5 * 0.05 = 21.1 MWh/y Electricity saving amount: = 21.1 * 0.318 = 6,700 TL/y
2. Implementation status of measurement and recording - Status of installation of measuring equipment - Status of implementation of measurement and recording - Status of introduction of measurement and control systems	Fuel consumption is recorded every day. Flow meters of water of air-conditioning are not installed. Although electricity consumption is recorded everyday, not each building but the total of EM Hospital. Air ratio control unit is not installed. Lighting illumination and humidity are not regulated for buildings.	Measurement equipment are to be installed, and so energy management based on data analysis is to be implemented.
3. Management of energy consumption - Status of recording of daily reports - Daily consumption and daily load curve - Monthly consumption - Comparison with previous fiscal year	Energy consumption of heat and electricity is checked in the monthly meeting. Systematic energy data analysis is not implemented.	
4. Maintenance management of equipment - Periodical inspection and daily check - Cleaning of filters and strainers	Cleaning of strainer of water is implemented 2 times a year.	

Check items and contents	The present condition and problems	Measures for improvement
5. Management of specific energy consumption - Management of specific consumption (MJ/(m2-year)) - Management of specific consumption (1000 TL/(m^2-year))	Specific consumption is not checked	Specific consumption is to be compared with the other hospitals.
6. Building design and operation - Heat insulation properties of the structure - Heat insulation properties and air tightness of windows - Blocking of outdoor air	1) Insulation structure of building is good, which windows are double grazing type and wall is insulated with insulated material at exterior.	
	2) Many blinds of window are opened.	Energy saving of 0.5W/m2 by closing blind of windows Fuel saving volume = 1.8litter/ym2 * 500 = 900 liter/y Fuel saving amount: = 900 * 1.94 = 1,700 TL/y

2. Heat source and heat-conveying equipment

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kliter, kWh, TL)	
1. Performance management of combustion equipment - Management of air ratio and exhaust gas - Burners, fuels, and ventilation systems - Combustion control devices - Fuel conversion (boilers, generators ,etc.)	2 sets of water boiler of capacity of 500,000 kcal/h for space heating are in operation from November to April. 1) Air ratio of water boiler is 2.2. Measurement device of oxygen conents of exhaust gas is not installed. 3) Combustion control of burner is made by air damper with servo motor according to fuel oil volume change.	1) Air ratio of water boiler is to be 1.3 from 2.2. Heat loss of exhaust gas is reduced by 4.2%. Fuel saving volume : 69,920 * 0.042 = 2,937 liter/y 2) Air damper of burner is adjusted by monitoring of oxygen contents (%) of exhaust gas with an oxygen analyser. An oxygen analizer is purchased. 3) Air damper control unit with oxygen analyser of Zirconia sensor is installed.	1) Fuel saving amount : 2,937 * 1.94 = 5,698 TL/y Investment cost: 6,000 TL (Purchase of 1 set of oxygen analyzer) Payback year: = 6000 / 5698 = 1.05 y
2. Performance management of refrigerating equipment - Coefficient of performance (COP) - Setting of chilled water outlet temperature - Setting of cooling water temperature - Descaling of heat exchange	1) Air-cooled chiller is installed and operated in summer season. COP of chiller is 2.07.	High efficient inverter air cooled chilling unit with COP 4.0 is to be installed at the timing of replacement.	

<table>
<tr><th>Check items and contents</th><th>The present condition and problems</th><th colspan="2">The measure against improvement, and the expected effect per year (kliter, kWh, TL)</th></tr>
<tr><td rowspan="2">3. Operational management and efficiency management
- Status of load factor and start-up/shutdown
- Control of number of units
- Heat efficiency, heat balance, and heat distribution</td><td>1) Reduction of operation hours of boilers
Operation of boilers start at 6:20 AM, but temperature in office rooms doesn’t rise until 8:30 AM.</td><td>1) Reduction of warming-up hour by 1 hour in the morning, because temperature of office room is not changed by 8:30.
Start time is to be changed from 6:20 to at 7:20
Fuel saving volume:
= 69,920*1/9 = 7,691 liter/y</td><td>1) Fuel saving amount:
= 7,691 * 1.94 = 14,921 TL/y
Investment cost: Free
Payback year = 0 year</td></tr>
<tr><td>2) Boiler operation pattern improvement
Load factor of boilers are 52% and 55%, which shows lower efficiency
Operation condition is not continuous but on-off operation.
On-off operation is 5% lower than continuous operation in thermal efficiency</td><td>2) Continuous operation of 1 set of boiler, except for the coldest season such as January.
Control of difference of water temperature between output and inlet of boiler is made.
High load factor of boiler is to be kept within boiler capacity of 500,000 kcal/h
Fuel saving volume:
= 69,920*0.05 = 3,496 liter/y</td><td>2) Fuel saving amount:
= 3,496 * 1.94 = 6,782 TL/y
Investment cost: Free
Payback year = 0 year</td></tr>
<tr><td rowspan="2">4. Operational management of auxiliary equipment
- Operational control of cooling towers
- Water quality management (electrical conductivity)
- Operational control of pumps (water volume and pump head)
- Improvement of routes</td><td>1) Cooling and heating system (Heat transmission system)
a) Flow rate control
- Damper of AHU (AC) is 100% open
- Valve of piping for AHU is 100% open</td><td>1) Energy saving by reducing flow rate
Refer to P18.</td><td></td></tr>
<tr><td>2) Insulation work of piping is almost good, but valves in the machine room are not insulated.</td><td>2) Enforcement of insulation of valves and pipes in the machine room
Insulation work of valves of more than 65mm diameter
Pack valves by insulation jackets
Fuel saving volume:
= 3994 * 2200h/y / 0.8 / 10200
= 1,077 kg/y = 1,267 L/y</td><td>2) Fuel saving amount:
= 1,267 * 1.94 = 2,398 TL/y
Investment cost: 2,400 TL for insulation work of 24 sets of valves
Payback year:
= 2400 / 2398 = 1 year</td></tr>
</table>

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kliter, kWh, TL)	
5. Operational management of heat-conveying equipment - Multiple unit control of pumps and fans - Control of rotation speed of pumps and fans - Status of opening and closing of valves (automatic valves, header bypass valves. etc.) - Flow rate and pressure - Improvement of routes (open and closed)	1) Variable speed control units are not installed in pumps and fans. 2) Flow-rate control of water and air is not implemented with valves. a) Thermal control of room temperature - All FCU have a thermal control unit	1) Energy saving by reducing flow rate Refer to P18.	

3. Air-conditioning and ventilating facilities

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kliter, kWh, TL)	
1. Operational management of air conditioners - Optimization of preset temperature and humidity - Appropriateness of humidified zones and methods - Appropriateness of reheating - Uneven distribution of temperature - Warm-up operation - Control of outdoor air intake volume - Review of operation hours - Switching-off of air conditioners in unused rooms - Outdoor air blocking	100% all fresh air intake and exhaust, no heat recovery. Effective heat for building heating and cooling is 23% of intake fresh air.	(Case1) Reduction of fresh air intake From 47,000m3/h to 30,000m3/h (36% Ventilation down) Fuel saving = 54,000 * 0.36 = 19,300 liter / year, Electricity saving of 35% for AHU by reduction of ventilation air volume by 36%= 47.5kW*0.35*2,200h/y = 36,600kWh/y	1) Fuel saving amount = 19,300 * 1.94 = 37,442 TL/y Electricity saving amount = 36,600 * 0.318 = 11,600TL/y Investment cost: Free (Refer to 2.2 a))

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kliter, kWh, TL)	
2. Reduction of fresh air intake and introduction of heat exchanger (HEX)	100% all fresh air intake and exhaust, no heat recovery. Effective heat for building heating and cooling is 23% of intake fresh air.	(Case2) Reduction of fresh air intake, introduction of HEX from 47,000m3/h to 20,000m3/h (57% Ventilation by AHU is down) Addition of Heat Exchanger (HEX) for ventilation: 500m3/h HEX (Efficiency 70%)* 20units, Fuel saving volume 27,400 liter / y Electricity saving volume of 70% for AHU by reduction of ventilation air of 57%:47.5kW*0.70*2,200h/y = 73,100kWh/y	2) Fuel saving amount = 27,400 * 1.94 = 52,000 TL/y Electricity saving amount = 73,100 * 0.318 = 23,200TL/y Investment cost: 49,900TL for 8 units of inverter, 5,000 TL/unit * 20 units = Total 100,000TL for HEX (Refer to 3.3.2 b)) Payback year: (49,900+100,000)/ (52,000+23,200)= 149,900/75,200 = 2.0 years
3. Replacement of AHU to heat recovery type	100% all fresh air intake and exhaust, no heat recovery. Effective heat for building heating and cooling is 23% of intake fresh air.	(Case3) Replacement of AHU 5 sets of AHU are replaced with new AHU of heat recovery type. Specifications and energy saving of new AHUs are shown in 2.2 c)	3) Energy saving amount: 66,000 TL / y Investment cost: 421,530 TL Payback year: 421,530/66,000 = 6.4 years
4. Introduction of energy-saving equipment - Control of heat-conveying speed (VAV.VWV) - Outdoor air intake control systems - Installation of total heat exchangers	100% all fresh air intake and exhaust, no heat recovery. Effective heat for building heating and cooling is 23% of intake fresh air.	1) Energy saving by installing VAV and VWV Refer to P18.	

4. Hot water supply, feed water and drainage, freezing, refrigerating, and kitchen equipment

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kliter, kWh, TL)	
1. Management of hot water Supply equipment - Hot water supply temperature - Improvement of hot water supply efficiency (descaling, etc.) - Use of solar heat	Hot water is supplied from 1-set of heat exchanger with hot water of water boilers in winter season.		

5. Power receiving/transforming facilities, lighting and electrical system

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kliter, kWh, TL)	
1. Management of power receiving/transforming facilities - Adjustment of electrical voltage - Management of power factor - Transformer capacity - Control of improvement of power factor - Low-loss transformers - Multiple unit control of transformers	1) Receiving transformers are supplied by electric distribution company. 2) Power factor control is implemented.		
2. Management of lighting systems - Management of optimum illumination - Turning off the lights during unnecessary time (use of daylight, etc.) - Cleaning and change of lighting apparatus - Mounting position of lamp fitting, and circuit partitioning - Darkening and extinction by automatic dimming control system - Local lighting - Use of energy-saving fluorescent tubes - Improvement of utilization factor (reflectance ratio) - Management of outdoor light - Turning off night-time guide light	Luminance survey was conducted (Refer to 3.4.1) - Lightings are turned off at unnecessary area - Some lighting circuits are separated Lighting equipment - CFLs (energy saving lamps) are used 1) Lightings with magnetic ballast are used	1) Reduction of ballast loss of fluorescent lamp Replacement of magnetic ballast with electronic ballast Electricity consumption of lamps = 4*18W type (80W)*100units + 2*36W type (80W)*32units =10.56kW Electricity saving rate by change of ballast = 10% Electricity saving volume: = 10.56kW*1,980h/y*0.1 = 2,091kWh/y	1) Electricity saving amount = 2,091 * 0.318 = 665 TL/y Investment cost: 3,267 TL for 132 sets of ballast Payback year: = 3,267 / 665 = 4.9 years

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kliter, kWh, TL)	
- Use of high efficiency lamps	2) Motion sensor at WC - Motion sensor is installed at WC, but lightings are kept turned on	2) Effective use of motion sensor for WC Changing set value of motion sensor for WC Electricity consumption of lamps: = 18W CFL*5 + 36W fluorescent lamp*24WC=3.12kW Electricity saving rate by change of set = 30% Electricity saving volume: 3.12kW*1,980h/y*0.3 = 1,853kWh/y	2) Electricity saving amount = 1,853 * 0.318 = 589TL/y Investment cost: Free Payback year: 0 year

6. Elevators

Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kliter, kWh, TL)	
1. Operational management of elevators - Use of inverter control	1) Inverter control is used. 2) Operation control is not implemented.		

7. Others

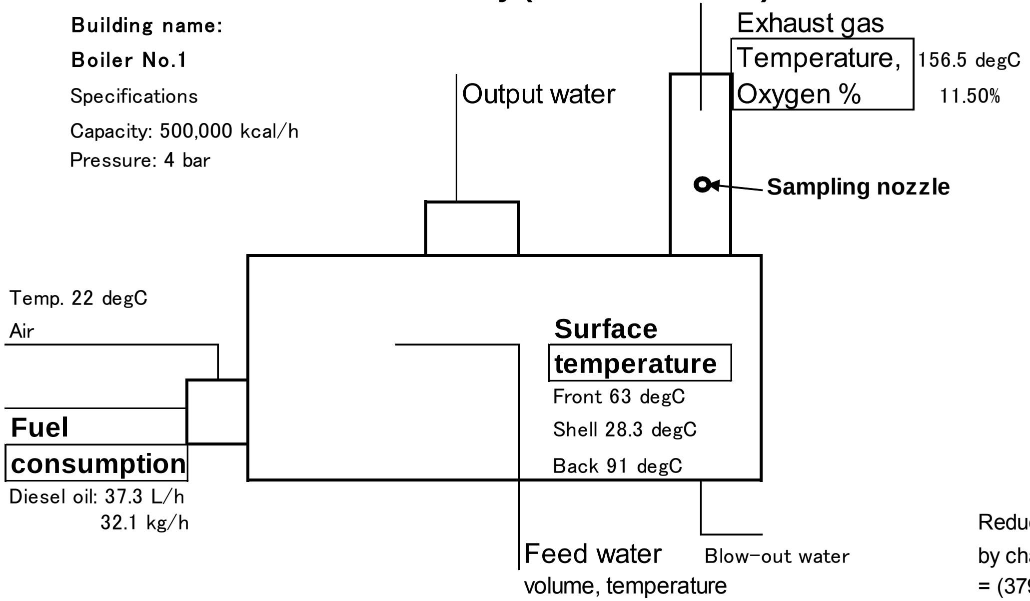
Check items and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kliter, kWh, TL)	
1. Load leveling measures - Review of operation forms (operation hours, operating rate, load factor, etc.)	Demand contract is not necessary for public buildings.		
2. Co-generation/tri-generation - Operational management (dependence rate, power generation efficiency, utilization rate of waste heat, total efficiency, etc.)	Co-generation/tri-generation equipment is not installed.	Not effective Refer toP24	
3. Renewable energies - Fuel cells- Photovoltaic power generation - Solar heat- Wind power generation - Installation of heat pump system	Renewable energy is not used.	1) Installation of 100kW PV system on the roof top Annual power generation = 143,000kWh/y (Refer to P25)	1) Reduction of electricity purchasing = 143,000 * 0.318 =45,500TL/y Investment cost: 1,100,000 TL for 100kW PV system Payback year: = 1,100,000 / 45,500 = 24 years
		2) Installation of Heat pump hot water and cold water supply system Heat pump hot water and cold water supply system is installed instead of the existing air-cooled chiller and water boiler. Assumption: 55^{0}C of hot water is applicable for heating system Effects: COP (Heating): from 0.79 of water boiler to 3.03 of Heat pump system COP (Cooling): from 2.07 of air-cooled chiller to 5.82 of Heat pump system 65,131liter/y of diesel oil is saved, 143,669kWh/y electricity is increased	2) Benefit: 80,667TL/y Investment cost: 1,322,222TL for 595kW capacity of heat pump system Payback year: = 1,322,222 / 80,667 = 16.4 years

Referential Information

1. Boiler

1.1 Air ratio improvement

Water boiler thermal efficiency (Indirect method)



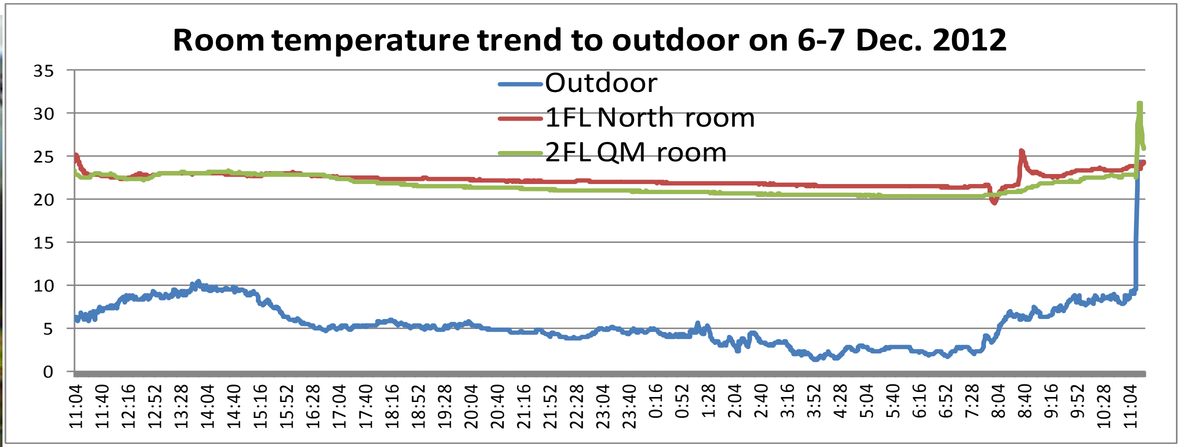
Reduction of exhaust gas heat loss
by change of air ratio 2.2 to 1.3
= (37900 - 23189) / 350404 * 100
= 4.2%

1	Input heat			Equation
a	**Fuel combustion heat**	**350,404**	**kcal/h**	= b * c
b	Fuel heat value	10,916	kcal/kg	
c	Fuel consumption	32.1	kg/h	
d				

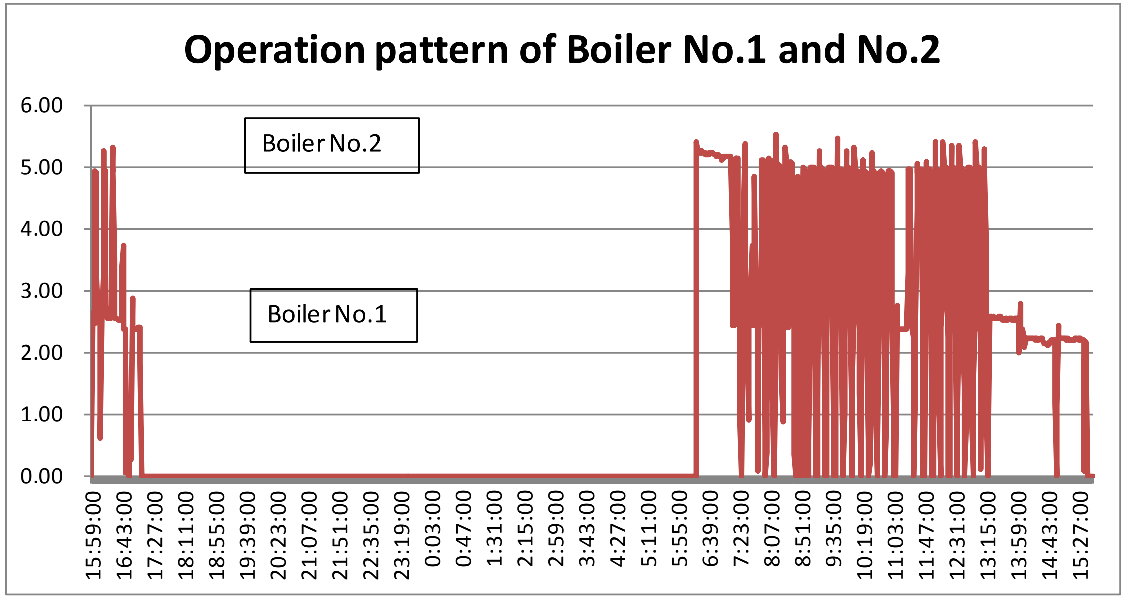
2	Heat loss	m=2.2		m=1.3	
e	**Exhaust gas heat loss**	**37,900**	**kcal/h**	**23,189**	**kcal/h**
f	Theoretical gas volume	13.3	m3N/kg	13.3	m3N/kg
g	Theoretical air volume	12.2	m3N/kg	12.2	m3N/kg
h	Excess air ratio	2.20		1.31	
i	Specific heat of ex. gas	0.315	kcal/m3NC	0.315	kcal/m3NC
j	Actual exhaust gas vol.	27.87	m3N/kg	17.05	m3N/kg
k	Exhaust gas heat loss	1,181	kcal/kg	722	kcal/kg
l	**Radiation heat loss**	**2,472**	kcal/h	**2,472**	kcal/h
m	Convection heat loss	1,212	kcal/h	1,212	kcal/h
n	Emission heat loss	1,260	kcal/h	1,260	kcal/h

1.2 Improvement of operation pattern of water boiler

Reduction of operation hours of water boiler



2 sets of boiler start operation at 6:20 AM, but room temperature doesn't rise.



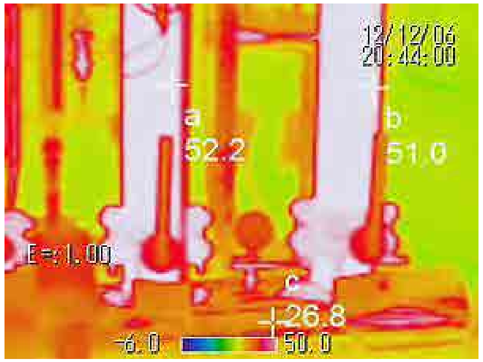
2 sets of boiler are in on-off operation.

1.3 Enforcement of Insulation of valves

Insulation of valves

Date of measurement: 2012/12/7

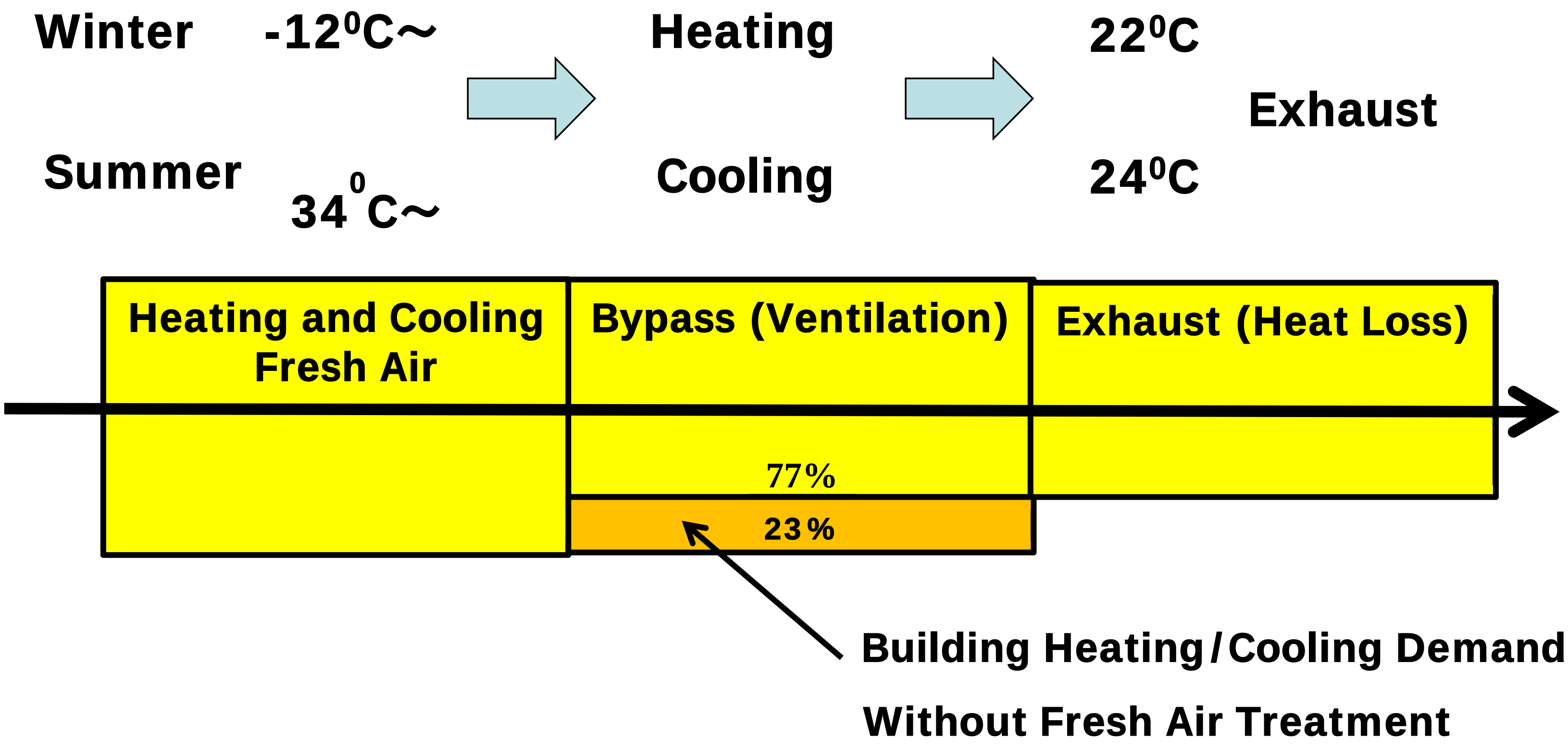
No.	Equipment name	Pipe size	Quantity	Surface temperature	Un-insulated length	Heat loss after insulation		Heat loss at un-insulation		Saving
				deg C	m	kcal/h/m	kcal/h	kcal/h/m	kcal/h	kcal/h
1	Boiler output valve	125A	2	55	1.4	25.9	73	182	510	437
2	Boiler input pipe	125A	2	52	1	25.9	52	182	364	312
3	Return water header valve	150A	2	52	1.5	30	90	214	642	552
4	Return water header valve	125A	1	52	1.4	25.9	36	182	255	219
5	Return water header valve	80A	1	52	1.25	17.8	22	122	153	130
6	Valve to AHU 1 to 5	125A	2	55	1.4	25.9	73	182	510	437
7	Fan coil (North, Center, South)	80A	6	55	1.25	17.8	134	122	915	782
8	Valve to Toilet	80A	2	55	1.25	17.8	45	122	305	261
9	Hot water valve	125A	2	55	1.4	25.9	73	182	510	437
10	Cooler header valve	125A	15	10	1.4	7.2			0	0
11	Cooler header valve	150A	6	10	1.5	8.4			0	0
12	AHU 1 to 4 valve	65A	4	55	1.23	15.1	74	102	502	428
13	Total		45				670		4664	3994



2. Air-conditioning and ventilating facilities: Fresh air intake reduction

2.1 Present condition

(1) 100% all fresh air intake and exhaust, no heat recovery >> Waste of energy and money



Heating: （Supply）47,000m3/h *0.28kcal/m3^{0}C*(22-(-12)) ^{0}C * 1.2(loss)*8,760h/y*0.1/10,200kcal/kg*(1l/0.85kg)=54,000L/y

= 77% of total heating load,

Fuel cost = 54,000 * 1.94 = 105,000TL/y

(Exhaust) 40,000m3/h * 24 ^{0}C

Cooling: (Supply) 47,000m3/h*0.28kcal/m3 ^{0}C *(34-24) ^{0}C * 1.1*8,760*0.075/2.0(COP)/(860kcal/kWh) = 55,000kWh/y

(Exhaust) 40,000m3/h * 26 ^{0}C

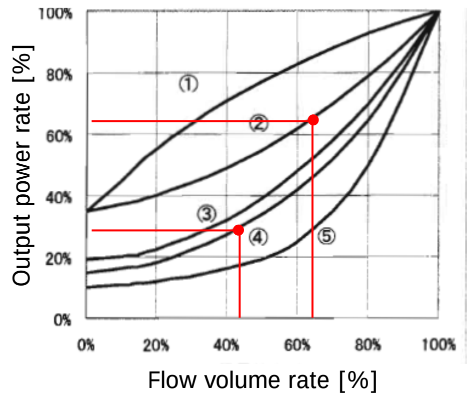
Operating electricity: 40kW*10h*220day = 88,000kWh/y

Electricity consumption in total = 55,000 + 88,000 = 143,000kWh/y, Electricity cost = 143,000 * 0.318 = 45,000TL/y

		
Damper of AHU (AC) is 100% open → Energy saving by reducing flow rate	Valve of piping for AHU is 100% open → Energy saving by reducing flow rate	Existing COP: 2.07 → High efficient HP chiller can save energy

2.2 Energy conservation measures

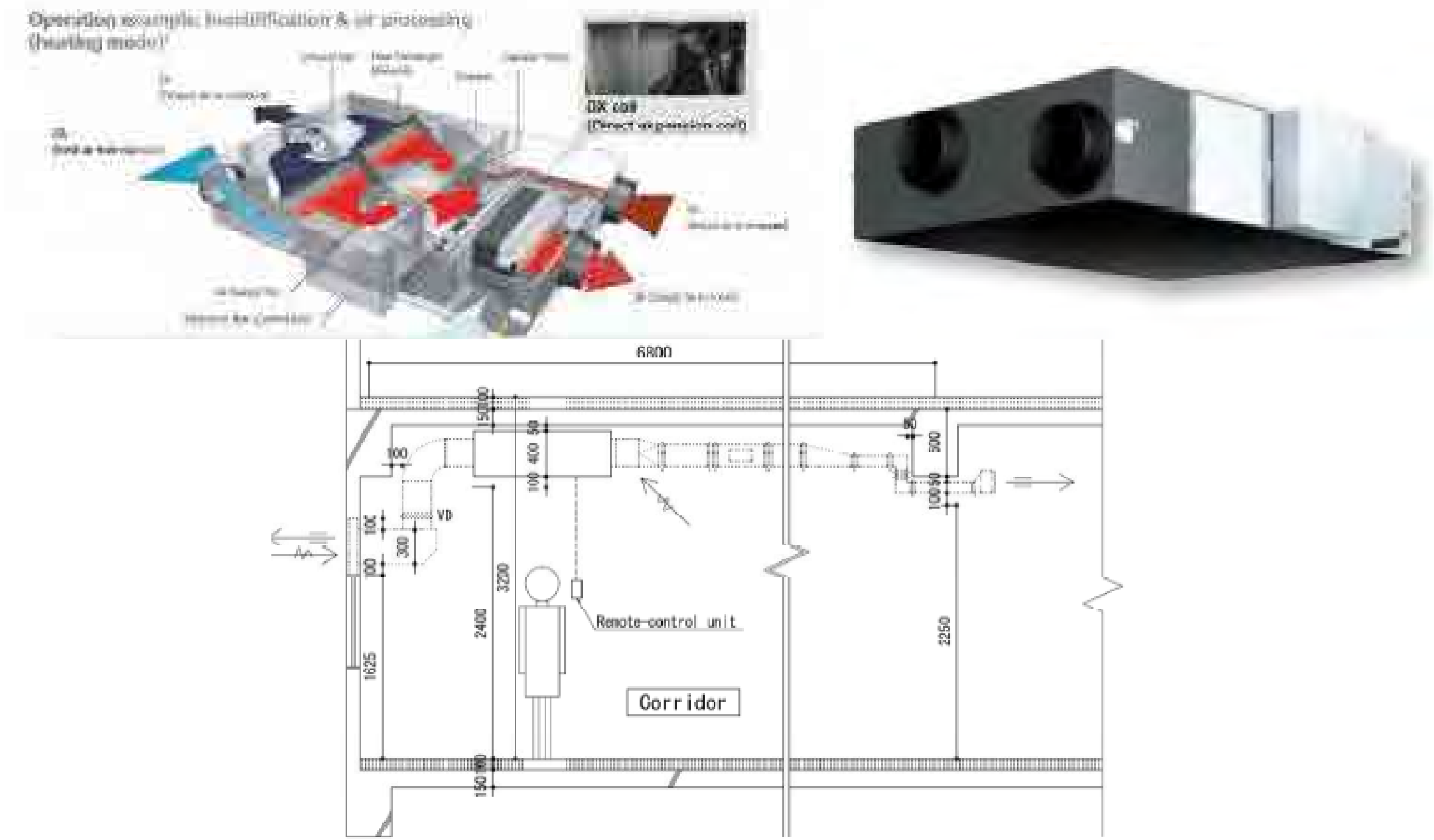
a) Reduce OA (fresh air) volume for air conditioning (Case 1)
Fresh air needed: 200-500 persons*30m3/h = 6,000-15,000m3/h << 47,000m3/h at present
Reduction of fresh air intake through AHU
From 47,000m3/h to 30,000m3/h (36% Ventilation down)
Fuel saving by reduction of heating and cooling demand or introducing more detailed control system for hot water, chilled water and air
= 54,000 * 0.36 = 19,300 liter / year
Fuel saving amount = 19,300 * 1.94 = 37,442 TL/y
Electricity saving of 35% for AHU by reduction of ventilation air volume by 36%:
= 47.5kW*0.35*2,200h/y = 36,600kWh/y
Electricity saving amount = 36,600 * 0.318 = 11,600TL/y
Investment cost: Free
(Damper operation system of AHU might be need to change)



b) Reduction of fresh air intake through AHU and introducing small heat exchanger (heat recovery system) (Case 2)
Reduction of fresh air intake through AHU from 47,000m^3/h to 20,000m^3/h
(57% Ventilation by AHU is down)
Addition of Heat Exchanger (HEX) for ventilation: 500m3/h HEX (Efficiency 70%)* 20units,
Fuel saving volume 27,400 liter / y

Fuel saving amount = 27,400 * 1.94 = 52,000 TL/y

Electricity saving volume of 70% for AHU by reduction of ventilation air of 57%:
47.5kW*0.70*2,200h/y = 73,100kWh/y
Electricity saving amount = 73,100 * 0.318 = 23,200TL/y
Investment cost: 49,900TL for 8 units of Inverter, 5,000 TL/unit * 20 units = Total 100,000TL for HEX
Payback year = (49,900+100,000) / (52,000 + 23,200) = 149,900 / 75,200 = 2.0 years



Heat Exchanger (HEX) for Ventilation

c) Replacement of Air handling unit (AHU) (Case 3)
5 sets of AHU are replaced with new AHU of heat recovery type.
Specifications and energy saving of new AHUs are shown in the following table
Energy saving amount: 66,000 TL / y, 69,920liter* 0.42=29.4kliter/y, 47,500kW*0.35*2,200h/y=36,600kWh/y

Investment cost: 421,530 TL
Simple payback = 421,530 / 66,000 = 6.4 years

				Actual AHU		New AHU			
Actual AHU	New AHU	Ventilation flow (m3/h)	Exhaust air flow (m3/h)	Cooling capacity (kcal/h)	Heating capacity (kcal/h)	Cooling capacity (kcal/h)	Heating capacity (kcal/h)	Cooling conservation (kcal/h)	Heating conservation capacity (kcal/h)
AHU-1 EF-1	GOLD RX-30	10,000	9,000	55,000	105,000	35,000	55,000	20,000	50,000
AHU-2 EF-2	GOLD RX-30	10,000	9,000	55,000	105,000	35,000	55,000	20,000	50,000
AHU-3 EF-3	GOLD RX-30	10,000	9,000	55,000	105,000	35,000	55,000	20,000	50,000
AHU-4 EF-4	GOLD RX-05	2,000	1,800	25,000	30,000	18,000	20,000	7,000	10,000
AHU-5 EF-5	GOLD RX-40	15,500	14,000	55,000	105,000	37,000	75,000	18,000	30,000
Total				245,000	450,000	160,000	260,000	85,000	190,000

Invesment of new situation

ACTUAL AHU	Heat Recovery Heating&Cooling Next AHU	Price Of Product(Euro)	Price Of Workers and other equip. (Euro)
AHU1- EF1-	GOLD RX-30	27.000,00	2.000,00
AHU2- EF2-	GOLD RX-30	27.000,00	2.000,00
AHU3- EF3-	GOLD RX-30	27.000,00	2.000,00
AHU4- EF4-	GOLD RX-05	21.800,00	2.000,00
AHU5- EF5-	GOLD RX-40	42.520,00	2.000,00
	TOTAL	145.320,00	10.000,00
	%18 KDV	26.157,60	1.800,00
	G.TOTAL	171.477,60	11.800,00

183.277,60 421.538 TL

3. Lighting facilities

3.1 Present condition

Survey for illuminance in the EM Hospital

Building	Floor	Place (Office room, Corridor, etc.)	Illuminance [lx]	Measured height from floor [cm]	Notes (Main lamp equipment etc.)
Outpatient	Z	Corridor	80	15cm	FL 18W*4
Outpatient	Z	WC	105	15cm	CFL 18W
Outpatient	Z	Blood inspection room	350	75cm	FL 18W*4
Outpatient	Z	Storage room of medicine	200	75cm	FL 18W*4
Outpatient	1	Entrance (Lighting is turned off)	130	15cm	CFL 18W
Outpatient	1	Entrance (Lighting is turned on)	440	15cm	CFL 18W
Outpatient	2	Office room (Lighting is turned off)	240	75cm	FL 18W*4
Outpatient	2	Corridor	250	15cm	CFL 18W

Turkish illuminous standard for Hospital
Work table: 400lx
General lighting: 150lx
WC: 50lx
Waiting room: 100lx
Conference room: 200lx
Cafeteria: 150lx

		
Lightings are turned off at unnecessary areas	Some lighting circuits are separated → Easy to select the lighting area	CFLs (energy saving lamps) are used
		
Lightings with magnetic ballast are used → Electronic ballast is more energy saving.	All FCU have a thermal control unit	Motion sensor is installed at WC, but lightings are kept turned on

4. Other energy conservation/ renewable measures

Ref. 1 Replacement of Fluorescent lamp into LED (In priority to long operation area)

Effects:

Existing Fluorescent lamp: 4 * 18W type (80W) * 100units, 2 * 36W type (80W) * 32units=10.56kW
→ 49% energy can be saved by installing LED
Electricity saving volume = 10.56kW * 1,980h/y * 49% = 10,581kWh/y
Electricity saving amount = 10,581 * 0.318 = 3,365TL/y
Investment cost: 41,867TL for 464units of LED lamps
Simple payback = 41,867 / 3,365 = 12.4 years

Ref. 2 Trial calculation to introduce tri-generation system

Checked by thermal demand/ electricity demand ratio:

Heating: 1,000,000kcal/h / (550 kW * 860kcal/kWh) = 2.0

Cooling: 436kW*2/ 550kW =1.8

Middle season: 0.0

Monthly Efficiency of tri-generation (Power, heat and chilled water supply)

Month	1	2	3	4	5	6	7	8	9	10	11	12
H/P ratio	2.0	2.0	1.5	0.0	0.0	0.5	1.8	1.8	0.5	0.0	0.5	1.5
Efficiency (%)	60	60	50	20	20	30	50	50	30	20	30	50

- Expected annual average total efficiency of tri-generation is 40% -45%
- Besides existing system efficiency is:

Power: 32.5% for 130kW*8760*0.4h*860kcal/kWh

Heating: 70% for 350,000,000kcal

Cooling: 32.5%*2.0 (COP)=65% for 60,000kWh*860kcal/kWh

Total efficiency is around 45%

>> Introducing tri (co)- generation is expected to be not effective

Ref. 3 Introducing 100kW PV system on the roof top

		Jun	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Global solar radiation	[kWh/m2/day]	1.75	2.16	4.27	5.62	6.05	7.83	7.54	6.82	5.89	3.81	2.31	1.96
Solar radiation (tilted 12deg.)	[kWh/m2/day]	2.11	2.45	4.74	5.87	6.06	7.70	7.49	7.04	6.52	4.51	2.86	2.53
Average temp.	[Deg.]	-2.46	-0.86	2.91	13.04	16.07	22.52	26.75	23.41	22.15	16.54	8.10	1.80
Power generation	[kWh/month]	5,086	5,798	12,228	14,059	14,795	17,675	17,413	16,619	14,994	10,979	6,984	6,568

$E_{pm} = C * P_{AS} * H_{AM} / G_s$

E_{pm}: Monthly energy production (kWh)
C: Monthly Basic design Coefficient
P_{AS}: Regulated output of modules under normal testing condition (kW)=100kW
H_{AM}: Monthly summation of solar radiation (kWh/m2/month)
G_s: Regulated solar radiation for normal testing condition (kW/m2)=1kW/m2

$C = C' * C_{pt}$

C': Basic design Coefficient=0.756
C_{pt}: Temperature Correction Co-efficient for each month

Annual power generation = 143,000kWh/y
Electricity saving amount = 143,000 * 0.318 = 45,500TL/y
Investment cost: 780,000TL for 100kW PV system on the roof top
Payback year = 780,000 / 45,500 =17 years

Ref. 4 Installation of heat pump hot water and cold water supply system

Existing system

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Outside air	Min temp.	℃	-4.0	-3.0	-1.0	4.0	8.0	12.0	15.0	15.0	10.0	6.0	1.0	-1.0	
	Max temp.	℃	4.0	6.0	11.0	17.0	22.0	26.0	30.0	30.0	26.0	20.0	11.0	6.0	
	Average temp.	℃	0.0	1.5	5.0	10.5	15.0	19.0	22.5	22.5	18.0	13.0	6.0	2.5	
Hot water	Supply hot water temp.	℃	55.0	55.0	55.0	55.0						55.0	55.0	55.0	
	Return hot water temp.	℃	50.0	50.0	50.0	50.0						50.0	50.0	50.0	
Cold water	Supply cold water temp.	℃					8.0	8.0	8.0	8.0	8.0				
	Return cold water temp.	℃					12.0	12.0	12.0	12.0	12.0				
Water boiler	Diesel consumption	L/month	13,566	12,293	10,460	5,947						3,040	9,073	12,046	66,424
	Heat value	kcal/L	8,670	8,670	8,670	8,670						8,670	8,670	8,670	
	Boiler efficiency		0.79	0.79	0.79	0.79						0.79	0.79	0.79	
	Heating load	kW.h/month	108,044	97,905	83,303	47,364						24,211	72,256	95,938	
	Fuel cost	TL/month	26,318	23,848	20,291	11,537						5,898	17,601	23,369	128,863
Chiller	Electricity consumption	kWh/month					1,173	8,815	21,459	21,442	0				52,889
	COP						2.07	2.07	2.07	2.07					
	Cooling load	kW.h/month					2,432	18,276	44,490	44,455	0				
	Electricity cost	TL/month					373	2,803	6,824	6,819	0				16,819

Proposed system

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Outside air	Min temp.	℃	-4.0	-3.0	-1.0	4.0	8.0	12.0	15.0	15.0	10.0	6.0	1.0	-1.0	
	Max temp.	℃	4.0	6.0	11.0	17.0	22.0	26.0	30.0	30.0	26.0	20.0	11.0	6.0	
	Average temp.	℃	0.0	1.5	5.0	10.5	15.0	19.0	22.5	22.5	18.0	13.0	6.0	2.5	
Hot water	Supply hot water temp.	℃	55.0	55.0	55.0	55.0						55.0	55.0	55.0	
	Return hot water temp.	℃	50.0	50.0	50.0	50.0						50.0	50.0	50.0	
Cold water	Supply cold water temp.	℃					8.0	8.0	8.0	8.0	8.0				
	Return cold water temp.	℃					12.0	12.0	12.0	12.0	12.0				
Heat pump system	Heating capacity	kW	467.6	489.7	543.4	625.8						625.8	560.5	504.4	
	Cooling capacity	kW					686.7	686.7	686.7	686.7	686.7				
	Power consumption	kW	174.3	176.1	180.4	185.5	118.0	118.0	118.0	118.0	118.0	185.5	181.5	177.4	
	Full load operation hours	h	219.5	190.0	153.3	75.7	3.5	26.6	64.8	64.7	0.0	38.7	128.9	190.2	
	Electricity consumption	kWh/month	38,260	33,458	27,648	14,040	418	3,139	7,642	7,636	0	7,177	23,404	33,738	196,558
	Electricity cost	TL/month	12,167	10,640	8,792	4,465	133	998	2,430	2,428	0	2,282	7,442	10,729	62,506
Water boiler	Load apportionment rate	%	5	5	0	0						0	0	0	
	Diesel consumption	L/month	678	615	0	0						0	0	0	1,293
	Heat value	kcal/kg	8,670	8,670	8,670	8,670						8,670	8,670	8,670	
	Boiler efficiency		0.79	0.79	0.79	0.79						0.79	0.79	0.79	
	Heating load	kW.h/month	5,402	4,895	0	0						0	0	0	
	Fuel cost	TL/month	1,316	1,192	0	0						0	0	0	2,508

○Effects

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cost reduction	TL/month	12,835	12,016	11,499	7,073	240	1,805	4,394	4,390	0	3,615	10,158	12,641	80,667

○Investment cost

Investment cost per cooling capacity	1,700	TL/kW	Diesel unit price	1.94	TL/L
Investment cost	1,011,500	TL/kW	Electricity unit price	0.318	TL/kWh

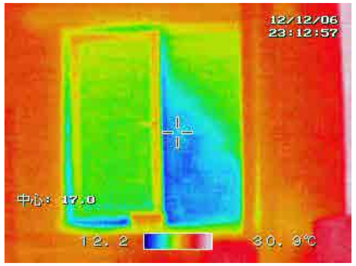
○Payback period

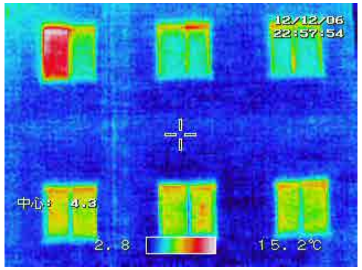
12.5 years

Cooling/Heating capacity 595 kW

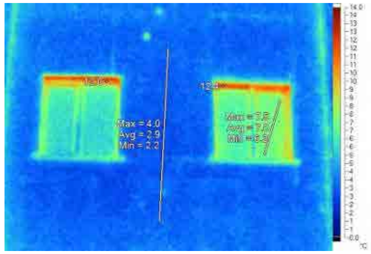
Ref. 5 Points for building wall and windows

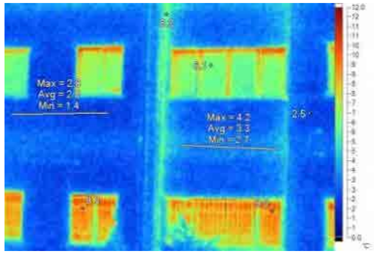
a) Some windows are opened to cool down the room temperature or for smoking





b) Upper part of windows, some leek of indoor air





c) A lot of windows' blinds are kept open in winter time

添付資料 7

トルコ国における建物省エネ技術

添付資料 7　トルコ国における建物省エネ技術

参考として、トルコ国における建物省エネ技術の適用状況の現状写真を技術要素別に示す。

(1) 建物デザイン（断熱、日よけ、昼光利用、ペアガラスまたは熱線吸収・反射ガラス、断熱サッシュ、自然換気活用等）

図 **7-1**　日よけ、高断熱壁、反射ガラス

図 **7-2**　昼光（高断熱大窓）、自然換気活用

図 **7-3**　ソーラーダクト

図 **7-4**　**Low-e** ペアガラス

図 **7-5**　高断熱外壁パネル

図 7-6　Low-e ペアガラス＋断熱サッシュ

図 7-7　バルブおよびパイプの断熱

図 7-8　高温水タンク、ボイラの断熱

(2) エアコン（高効率化；インバータ導入）

図 7-9　MENR ビル外観

図 7-10　MOF ビル群

図 7-11　環境保全ビル

図 7-12　高校

スプリット・ノンインバータエアコンが部分配置されている。（COP は 2.5-3.0 と低い。）

(3) 照明（高効率化；LED、CFL、T8/T5、反射板、電子式バラスト）

図 7-13　LED 照明

図 7-14　反射板付 T5 蛍光灯

図 7-15　昼光利用＋反射板付照明器具

(4) 吸収式冷凍機を用いたコジェネレーション

図 7-16　ガスコジェネレーション

図 7-17　吸収式冷凍機 (YAZAKI)

(5) BEMS およびセンサー

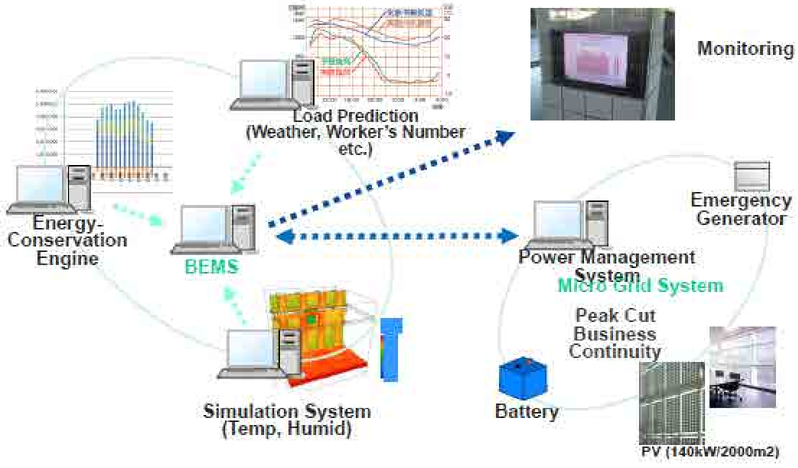


図 7-18　BEMS 概念図

図 7-19　自動制御センサー

人感センサーはトルコ国ではかなり普及しており、ある意味では本邦より進んでいる。

(6) 高効率事務機器（PC、プリンター等）

図 7-20　発熱が大きい旧式ブラウン管

非効率（高発熱）な事務機器（CRT PC、プリンター等）を高効率(低発熱)機器に更新することにより冷房負荷の低減が図れる。

添付資料 8

エアコン（AC） 実証試験

添付資料８　エアコン（AC）実証試験

1.　AC 実証試験の目的

建物内における最大の電力消費機器であるエアコンについて、イスタンブールにおける実際の事務室において電力消費実態調査を実施した。調査の目的は以下の通り。

① 既設事務室におけるインバータ AC とノンインバータ AC の電力消費状況を比較計測して、インバータ AC の省エネ効果を具体的に提示する（省エネ効果の見える化）。

② インバータ AC の性能評価のため、2013 年に ISO16358 として運用開始される予定の期間効率評価（冷房、暖房、年間の期間効率評価）導入の必要性を共有化する（期間効率評価の詳細は、本添付資料 8 末尾の参考資料を参照）。

2. AC 実証試験の概要

(1) 対象機器

実証試験対象室のサイズと熱負荷を考慮して、EER（冷房性能）および COP（暖房性能）が同じインバータ AC とノンインバータ AC を選定した。（表 8-1 参照）

表 8-1 選定 AC の仕様

タイプ	冷房能力		暖房能力	
	kW	EER	kW	COP
インバータ AC	3.5	3.21	4.0	3.62
ノンインバータ AC	3.52	3.21	3.7	3.63

(2) 計測期間

冷房計測期間：2012 年 7 月 31 日～2012 年 10 月 2 日

イスタンブールの冷房期間は 6 月から 9 月 。今回は半分の冷房期間で実測を行った。

暖房計測期間：2012 年 12 月 3 日～2013 年 1 月 4 日

1 月の報告取り纏めのため、暖房のピーク時期を含まない限られた期間（1 か月間）のデータの収集となった。

(3) 計測項目

計測項目は AC の電力消費量、室内外の温度および湿度。

(4) 計測場所

イスタンブール工科大学の 2 つの研究助手事務室（隣接し、かつ、大きさと形が同じ）を計測場所に選定した。（図 8-1、-2 参照）

図 8-1 事務室 No.1

図 8-2 事務室 No.2

(5) 計測システム

消費電力の計測にはトルコ ENTES 社製ネットワークアナライザーを使用、その概要を図 8-3 に示す。また、計測系統図を図 8-4 に示す。

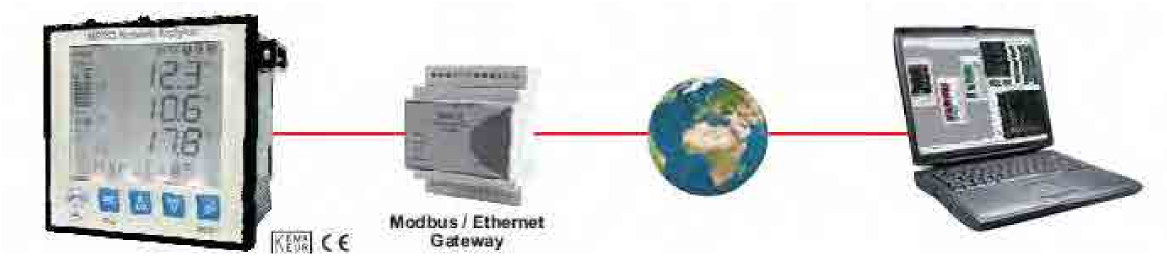


図 8-3 ネットワークアナライザーの概要

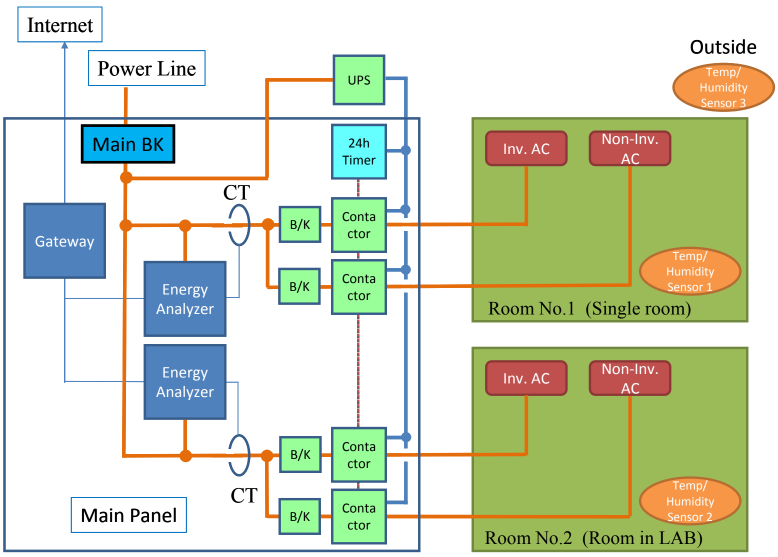


図 8-4 計測系統図

(6) 試験方法

実証試験の方法は以下の通り。

・ インバータ AC、ノンインバータ AC を 1 日毎にタイマーにて切替して使用する。

・ 事務室 No.1 と事務室 No.2 とでは、インバータ AC、ノンインバータ AC を逆に動作させる。

・ １分ごとの計測。

・ AC の温度設定は、初期値 27℃とし、変更する場合はその値を記録する。

3. トルコ国の気候

TS825 基準によれば、イスタンブールは、温暖と呼ばれる第 2 地域に区分される。（図 8-5 参照）

図 8-5 TS825 に基づくトルコ国の 4 つの地域区分

表 8-2 に TS825 に基づく 4 つの地域区分の月別平均気温を示す。

表 8-2 4 地域区分の月別平均気温 (°C)

	第 1 地域	第 2 地域	第 3 地域	第 4 地域
1 月	8.4	2.9	-0.3	-5.4
2 月	9.0	4.4	0.1	-4.7
3 月	11.6	7.3	4.1	0.3
4 月	15.8	12.8	10.1	7.9
5 月	21.2	18.0	14.4	12.8
6 月	26.3	22.5	18.5	17.3
7 月	28.7	24.9	21.7	21.4
8 月	27.6	24.3	21.2	21.1
9 月	23.5	19.9	17.2	16.5
10 月	18.5	14.1	11.6	10.3
11 月	13.0	8.5	5.6	3.1
12 月	9.3	3.8	1.3	-2.8
注: 1 日 24 時間の平均気温からの計算値				

(1) 冷房需要

ITU からのヒアリングでは、イスタンブールの冷房期間は 6 月から 9 月であり、この間の月別平均気温は 19.9℃から 24.9℃の間となる。このデータからはイスタンブールの冷房需要はそれほど大きくないことが予想される。

一方、夏の 1 日の温度変化をみると（図 8-6 参照）、そこには大きな日較差（23.5℃～34℃）があり、朝夜には冷房は必要ないが、日中には冷房ニーズがあることが読み取れる。

イスタンブールでは冷房需要はあるが、その需要量（冷房負荷×時間）は大きくないことがわかる。

注；Tout ：外気温、Rhout：外気湿度

図 8-6 実証試験サイトにおける夏期 1 日の外気温湿度の日変動

(2) 暖房需要

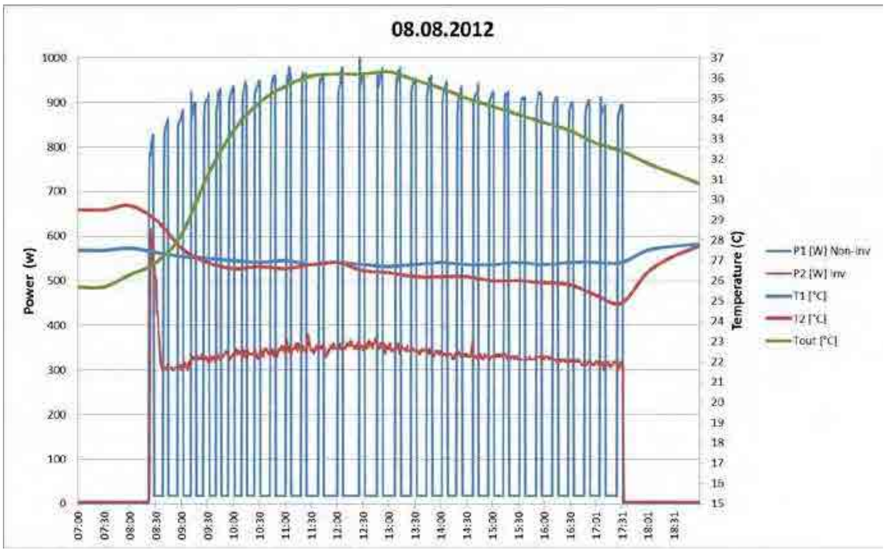
ITU からのヒアリングでは、イスタンブールの暖房期間は 11 月中旬から 3 月中旬であり、この間の月別平均気温は 2.9℃から 8.5℃の間となる。平均気温が低いため、イスタンブールでは確かな暖房需要が予想される。

4. 冷房データの分析

収集データを基に、3 つの分析（①電力消費量の分析、②平均消費電力の分析、③代表日の電力消費量の分析）および期間冷房電力消費量の予測を行った。

(1) 電力消費量の分析

代表日（8 月 8 日）のノンインバータ AC（事務室 1）とインバータ AC（事務室 2）の実測データを図 8-7 に示す。インバータ AC は継続的に低い電力で運転を続けているが、ノンインバータ AC は高い電力で発停を繰り返している。図 8-7 はインバータ AC の特徴をよく示している。



注；P1：事務室 1 消費電力、P2：事務室 2 消費電力、T1：事務室 1 室温、T2：事務室 2 室温、Tout：外気温

図 8-7 代表日における消費電力と温度の変動

事務室 1 および事務室 2 において、実測期間に計測された全電力消費量および AC 運転時間の電力消費量（待機電力を含まない）を表 8-3 に示す。コストについては ITU の電力単価 0.35 TRY/kW をもとに算出を行った。

この結果、実測期間で、インバータ AC はノンインバータ AC に比べて、実測期間内の全電力消費量で 21%、AC 運転時間内の電力消費量で 25%の省エネが確認された。

表 8-3 AC 実証試験における全電力消費量（E_{total}）、全運転時間電力消費量（E_{opr}）、およびそれらコスト（C_{total}・C_{opr}）（7 月 31 日～10 月 2 日）

	E_{total} (64 days) [kWh]	E_{opr} (43 days) [kWh]	C_{total} [TRY]	C_{opr} [TRY]
インバータ AC	66.4	63.5	23.2	22.2
ノンインバータ AC	87.0	84.4	30.5	29.5
削減率	21%	25%	21%	25%

(2) 平均消費電力の分析

平均消費電力 (Pcave)から計算された省エネ率を 表 8-4 に示す。平均消費電力は事務室ごとに AC 運転時間電力消費量を AC 運転時間で割ることにより算出したもの。

事務室 1 における省エネ率は 22%、事務室 2 における省エネ率は 24%となった。

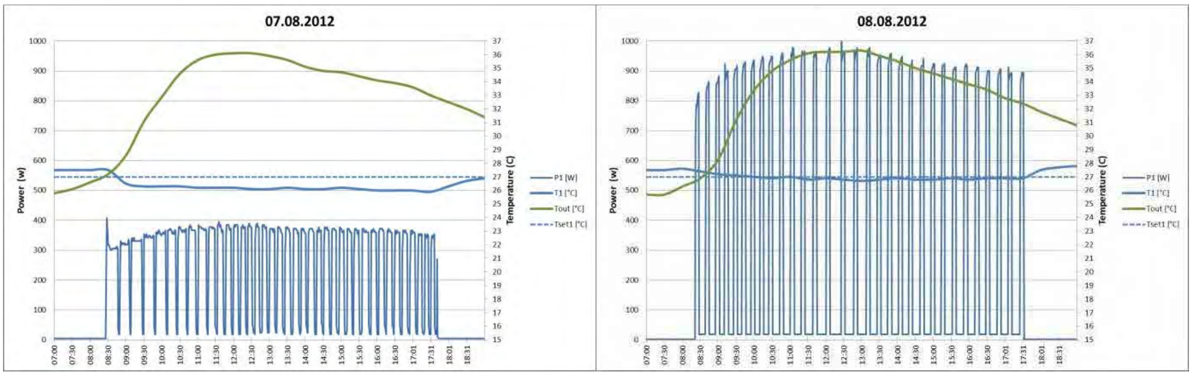
表 8-4 平均消費電力から計算された省エネ率

	Pcave インバータ [W]	Pcave ノンインバータ[W]	省エネ率 [%]
事務室 1	126.2	161.6	22%
事務室 2	225.4	294.5	24%

(3) 代表日の電力消費量の分析

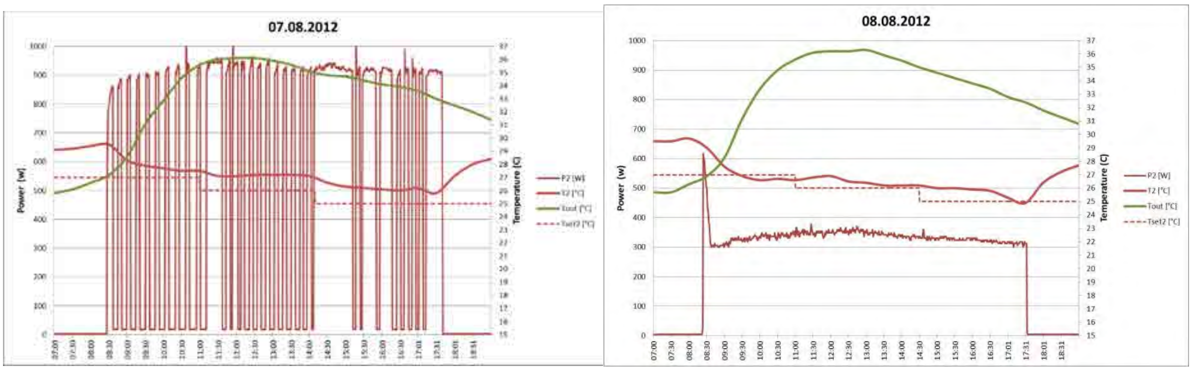
外気温および室温の類似した 2 日間（8 月 7 日と 8 日）における、各事務室のインバータ AC とノンインバータ AC の運転状況を図 8-8 および図 8-9 に示す。

図 8-8 と図 8-9 はインバータ AC とノンインバータ AC の特性をよく表している。なお、27℃と高い設定温度を選んだ事務室 1 では、冷房負荷がインバータの制御範囲より低くなり、インバータ AC も発停を繰り返すこととなった。この状況は、設定温度の高くしたときおよび 8 月の中旬以降外気温度が下がった場合には事務室 2 においても見られた。インバータ AC の省エネ効果を最大限に引き出すためには、過大容量とならない適切な設備能力の AC の選定および広い制御能力をもった AC の導入が有効と考えられる。



注；P1：事務室 1 消費電力、T1：事務室 1 室温、Tout：外気温、Tset1：事務室 1 設定温度

図 8-8 事務室 1 における 2012 年 8 月 7 日と 8 日の 比較



注；P2：事務室 2 消費電力、T2：事務室 2 室温、Tout：外気温、Tset2：事務室 2 設定温度

図 8-9 事務室 2 における 2012 年 8 月 7 日と 8 日の比較

また、8 月 7 日と 8 日の共通の運転時間帯における電力消費量によるインバータ AC の省エネ率を表 8-5 と表 8-6 に示す。インバータ AC の省エネ率は事務室 1 において 15%、事務室 2 において 38%となった。

同様の分析を 8 月 9 日と 10 日、16 日と 17 日についても実施、インバータ AC の省エネ率を表 8-5 と表 8-6 に取り纏めた。

各 2 日間の設定温度や外気温は必ずしも同じでないため、省エネ率にはばらつきがあるが、インバータ AC のノンインバータ AC に対する省エネ性がここでも確認された。

表 8-5 事務室 1 における各 2 日共通運転時間帯の平均消費電力（Pave）、電力消費量（Eopr）および省エネ率（Esaving）

日付	07.08.2012	08.08.2012	09.08.2012	10.08.2012	17.08.2012	16.08.2012
AC タイプ	ｲﾝﾊﾞｰﾀ	ﾉﾝｲﾝﾊﾞｰﾀ	ｲﾝﾊﾞｰﾀ	ﾉﾝｲﾝﾊﾞｰﾀ	ｲﾝﾊﾞｰﾀ	ﾉﾝｲﾝﾊﾞｰﾀ
共通運転時間	08:30-17:30	08:30-17:30	08:30-16:57	08:30-16:57	08:30-16:27	08:30-16:27
Pave [W]	267	316	255	293	191	215
Eopr [kWh]	2.41	2.84	2.16	2.48	1.52	1.71
Esaving [%]	15%		13%		11%	

注：事務室 1 の設定温度は通常 27℃

表 8-6 事務室 2 における各 2 日共通運転時間帯の平均消費電力（Pave）、電力消費量（Eopr）および省エネ率（Esaving）

日付	07.08.2012	08.08.2012	09.08.2012	10.08.2012	17.08.2012	16.07.2012
AC タイプ	ﾉﾝｲﾝﾊﾞｰﾀ	ｲﾝﾊﾞｰﾀ	ﾉﾝｲﾝﾊﾞｰﾀ	ｲﾝﾊﾞｰﾀ	ﾉﾝｲﾝﾊﾞｰﾀ	ｲﾝﾊﾞｰﾀ
共通運転時間	08:30-17:30	08:30-17:30	08:30-16:57	08:30-16:57	08:30-16:27	08:30-16:27
Pave [W]	543	335	379	313	405	261
Eopr [kWh]	4.89	3.01	3.20	2.64	3.23	2.08
Esaving [%]	38%		17%		36%	

注：事務室 2 の設定温度は 25℃～27℃（主に 25℃）

(4) 期間冷房電力消費量の推定

ITU にもっとも近い気象局の外気温データ、実測外気温、実測電力消費量との相関から期間冷房電力消費量の予測を行った。

冷房用の外気温モデルの作成には、2008 年から 2011 年の 4 年間の平均外気温を用い、冷房期間を 6 月から 9 月と想定した。

期間冷房電力消費量から算出したインバータ AC のノンインバータ AC に対する省エネ量、省エネ額を表 8-7 に示す。冷房については、インバータ AC はノンインバータ AC に比べ、20％の省エネになることが推定された。

表 8-7 冷房期間（6 月 1 日～9 月 30 日）におけるインバータ AC のノンインバータ AC に対する省エネ量、省エネ額の推定

	E_{total} [kWh]	C_{total} [TRY]
インバータ AC	194	68.0
ノンインバータ AC	244	85.3
削減量	50	17.3
削減率	20%	

5. 暖房データの分析

収集データを基に、3 つの分析（①電力消費量の分析、②平均消費電力の分析、③代表日の電力消費量の分析）および期間暖房電力消費量の予測を行った。

なお、今回の暖房に関する実測は、限られた調査期間のため、暖房のピーク時期を含まない短期の調査となった。

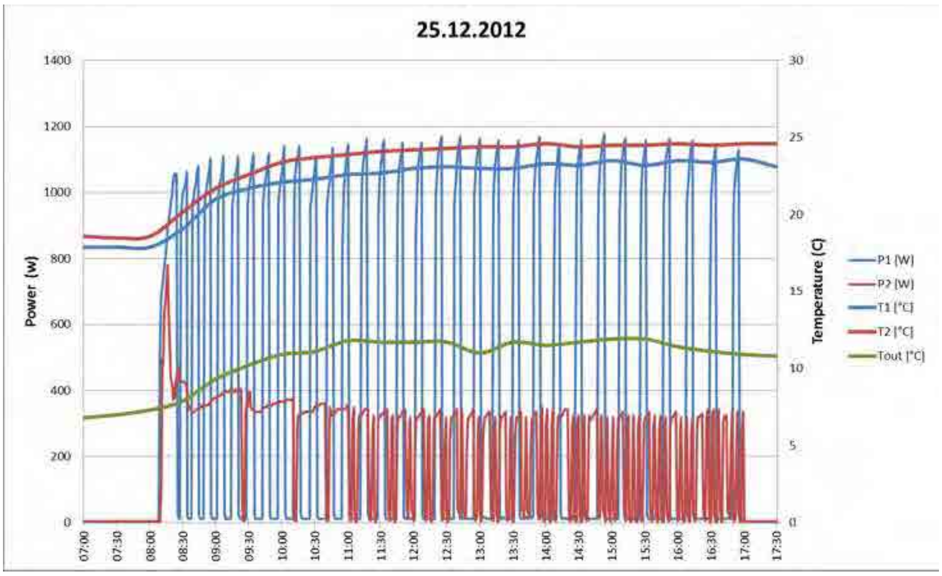
さらに、AC の機器特性として、機種ごとに設定温度と実際の制御温度（室温）に差が設定されており、今回採用したインバータ AC とノンインバータ AC では暖房におけるこの差が無視できないほど大きいことがわかった。このため、省エネ性能を正しく評価するため、インバータ AC とノンインバータ AC の実際の制御温度（室温）を同じするため設定温度を調整して、12 月 24 日から同一暖房負荷水準による測定を実施した。このため暖房データの分析については、12 月 24 日以降の 12 日間のデータのみを対象とすることとなった。

また、事務室 2 については暖房された隣室からの入熱の影響で暖房負荷が極端に少なくなり、インバータ AC とノンインバータ AC の制御の違いによる誤差が部分的にデータに影響を与える状況となった。このため、代表日の電力消費量の分析および年間暖房電力消費量の予測については事務室 1 のデータのみを対象とすることとした。

以上より、暖房データの分析については、冷房データの分析に比べ、かなりラフな分析となっている。暖房データの分析に関しては、さらなる継続調査が必要である。

(1) 電力消費量の分析

代表日（12 月 25 日）のノンインバータ AC（事務室 1）とインバータ AC（事務室 2）の実測データを図 8-10 に示す。ノンインバータ AC は高い電力で発停を繰り返している一方、インバータ AC においても、今回の実測が暖房負荷の少ない時期での実測であったため、発停を繰り返す状況が発生した。



注；P1：事務室 1 消費電力、P2：事務室 2 消費電力、T1：事務室 1 室温、T2：事務室 2 室温、Tout：外気温

図 8-10 代表日における消費電力と温度の変動

事務室 1 と 2 において、限定した実測期間に計測された全電力消費量および AC 運転時間の電力消費量（待機電力を含まない）を表 8-8 に示す。コストについては ITU の電力単価 0.35 TRY/kW をもとに算出を行った。

この結果、限定した実測期間で、インバータ AC はノンインバータ AC に比べて、期間内の全電力消費量で 32%、AC 運転時間内の電力消費量で 35%の省エネが確認された。

表 8-8 AC 実証試験における全電力消費量（E_{total}）、全運転時間電力消費量（E_{opr}）、およびそれらコスト（C_{total}・C_{opr}）（12 月 24 日～1 月 4 日）

	E_{total} (12 days) [kWh]	E_{opr} (9days) [kWh]	C_{total} [TRY]	C_{opr} [TRY]
インバータ AC	16.5	15.5	5.8	5.4
ノンインバータ AC	24.3	23.8	8.5	8.3
削減率	32%	35%	32%	35%

(2) 平均消費電力の分析

平均消費電力 (Pcave)から計算された省エネ率を 表 8-9 に示す。平均消費電力は事務室ごとに AC 運転時間電力消費量を AC 運転時間で割ることにより算出したもの。

事務室 1 における省エネ率は 39%、事務室 2 における省エネ率は 16%となった。

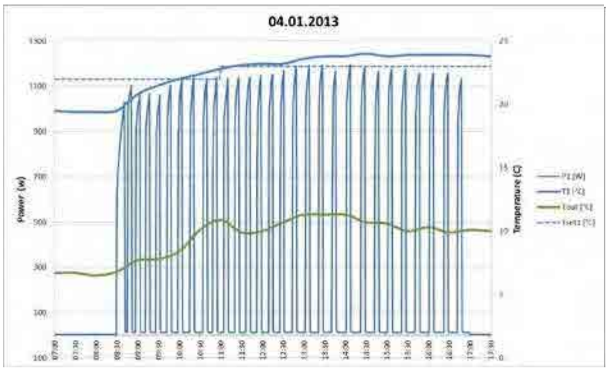
表 8-9 平均消費電力から計算された省エネ率

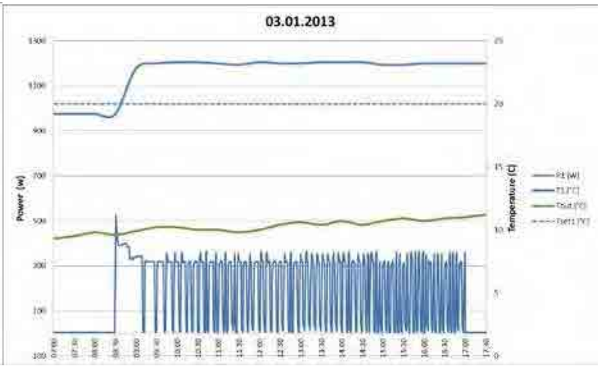
	Pcave インバータ [W]	Pcave ノンインバータ[W]	省エネ率 [%]
事務室 1	237.4	389.2	39%
事務室 2	172.0	203.4	16%

(3) 代表日の電力消費量の分析

外気温および室温が類似した 2 日間（1 月 3 日と 4 日）における、事務室 1 におけるインバータ AC とノンインバータ AC の運転状況を図 8-11 に示す。

既に(1)電力消費量の分析で述べたとおり、今回の実測が暖房負荷の少ない時期での実測であったため、ノンインバータ AC だけでなく、インバータ AC についても発停を繰り返す状況が現れた。





注；P1：事務室 1 消費電力、T1：事務室 1 室温、Tout：外気温、Tset1：事務室 1 設定温度

図 8-11 事務室 1 における 2013 年 1 月 3 日と 4 日の 比較

1 月 3 日と 4 日の共通の運転時間帯における電力消費量によるインバータ AC の省エネ率を表 8-10 に示す。インバータ AC の省エネ率は事務室 1 において 45%となった。

同様の分析を 1 月 3 日と 12 月 11 日および 12 月 19 日のデータについても実施、インバータ AC の省エネ率を表 8-10 に取り纏めた。

各 2 日間の設定温度や外気温は必ずしも同じでないため、省エネ率にはばらつきがあるが、インバータ AC のノンインバータ AC に対する省エネ性がここでも確認された。

表 8-10 事務室 1 における各 2 日共通運転時間帯の平均消費電力（Pave）、電力消費量（Eopr）および省エネ率（Esaving）

日付	03.01.2013	11.12.2012	03.01.2013	19.12.2012	03.01.2013	04.01.2013
AC タイプ	ｲﾝﾊﾞｰﾀ	ﾉﾝｲﾝﾊﾞｰﾀ	ｲﾝﾊﾞｰﾀ	ﾉﾝｲﾝﾊﾞｰﾀ	ｲﾝﾊﾞｰﾀ	ﾉﾝｲﾝﾊﾞｰﾀ
共通運転時間	08:30-17:00	08:32-17:00	08:30-17:00	08:34-17:00	08:30-17:00	08:30-17:00
Pave [W]	210	277	210	304	210	378
Eopr [kWh]	1,78	2.35	1,78	2.47	1,78	3.22
Esaving [%]	24%		31%		45%	

(4) 年間暖房電力消費量の推定

冷房同様に、ITU にもっとも近い気象局の外気温データ、実測外気温、実測電力消費量との相関から年間暖房電力消費量の予測を行った。

暖房用の外気温モデルの作成には、2008 年から 2011 年の 4 年間の平均外気温を用い、暖房期間を 11 月 15 日から 3 月 15 日と想定した。

年間暖房電力消費量から算出したインバータ AC のノンインバータ AC に対する省エネ量、省エネ額を表 8-11 に示す。暖房については、インバータ AC はノンインバータ AC に比べ、30%の省エネになることが推定された。

表 8-11 暖房期間（11 月 15 日～3 月 15 日）におけるインバータ AC のノンインバータ AC に対する省エネ量、省エネ額の推定

	E_{total} [kWh]	C_{total} [TRY]
インバータ AC	212	74.2
ノンインバータ AC	303	106.2
削減量	91	32.0
削減率	30%	

6. 冷暖房による省エネ効果

年間冷房電力消費量および年間暖房電力消費量の予測結果から、年間の省エネ量、省エネ額を算出、表 8-12 に示す・冷暖房全体でインバータ AC はノンインバータ AC に比べ 26%の省エネになることが推定された。

表 8-12 インバータ AC のノンインバータ AC に対する年間省エネ効果の推定

	冷房		暖房		冷暖房	
	E_{total} [kWh]	C_{total} [TRY]	E_{total} kWh]	C_{total} [TRY]	E_{total} [kWh]	C_{total} [TRY]
インバータ AC	194	68.0	212	74.2	406	142.2
ノンインバータ AC	244	85.3	303	106.2	547	191.5
削減量	50	17.3	91	32.0	141	49.3
削減率	20%		30%		26%	

7. 結論

イスタンブールにおいて、従来の省エネ効率評価値（EER および COP）が等しいインバータ AC とノンインバータ AC を実際の事務室に設置し、電力消費量の実測調査を行った。今回実測調査から得られた結果は以下のとおりである。

1) インバータ AC はノンインバータ AC と比較して、冷房で 20%、暖房で 30%、冷暖房全体で 26%の省エネが期待できることがわかった。

2) インバータ AC の省エネ性を評価するには、定格時の評価基準である従来の EER および COP による評価では難しく、新しい評価基準である期間効率評価（SPF および APF)の導入が必要であることが確認された。

なお、イスタンブールでは、夏期ピーク時の冷房ニーズは大きいものの、冷房対象期間の冷房需要量（kWh）はさほど大きくはないことがわかった。このような条件下で、インバータ AC を普及させ省エネ促進を図るためには、過大容量とならない適切な設備能力をもった機種の選定や制御範囲のより広い機器の導入が有効であることがわかった。

また、冷房需要が高く、ガスによる暖房が普及していない南部地域においては、冷暖房双方をカバーする機器としてインバータ AC の普及が期待される。

参考資料：期間効率評価

(1) 期間効率評価の動向

AC の性能評価には、従来、定格時のエネルギー消費効率を評価した EER（Energy Efficiency Ratio）および COP（Coefficient of Performance）が用いられてきた。しかし、実際の負荷変動に追随して運転を制御できるインバータ AC の普及に伴い、従来の EER および COP では、この可変運転の性能を評価することができないことが問題となっていた。

近年、我が国をはじめ各国で、期間および通年のエネルギー消費効率を評価する SPF（Seaonal Performance Factor）および APF（Annual Performance Factor）を整備し、AC の評価基準として採用する動きが始まっている。

SPF および APF は 2013 年に ISO16358 として基準化され、運用が開始される予定であり、欧州もこれに追随する予定であるため、トルコ国においても、この評価基準の導入を図り、インバータ AC による省エネ推進を図ることが望まれる。

(2) 期間効率評価の概要

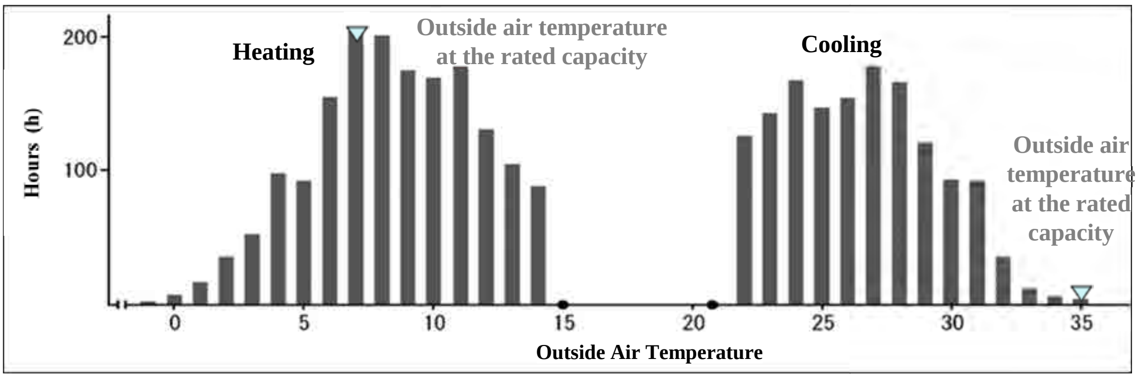
1) 従来の効率評価基準（EERおよびCOP）

従来の効率評価基準（EER および COP）は、定格値 1 点における性能の評価となっている。

$$\text{EER} = \frac{\text{冷房定格能力(W)}}{\text{冷房定格消費電力(W)}} \qquad \text{COP} = \frac{\text{暖房定格能力(W)}}{\text{暖房定格消費電力(W)}}$$

2) 冷暖房期間の外気温状況

我が国の店舗・事務所ビルの APF 算定に使われたモデルの外気温発生時間の分布を参考として図 8-12 に示す。実際の使用では、外気温の変化により冷房・暖房時に必要な消費電力が変化するため、EER および COP では実際の使用状態を評価できないことがわかる。また、EER および COP の定格値は必ずしも全体の代表値になっていないことがわかる。



出典：総合資源エネルギー調査会省エネルギー基準部会エアコンディショナー判断基準小委員会報告書

図 8-12 店舗・事務所ビルの APF 算定のための外気温発生時間

3) 部分負荷効率

AC の部分負荷効率を図 8-13 に示す。インバータ AC は部分負荷において高いエネルギー効率をもつ。図 8-12 の外気温の分布からもわかるように、実際の運転では、部分負荷での運転が多いため、インバータ AC はノンインバータ AC に比べ、高いエネルギー効率を実現することができる。

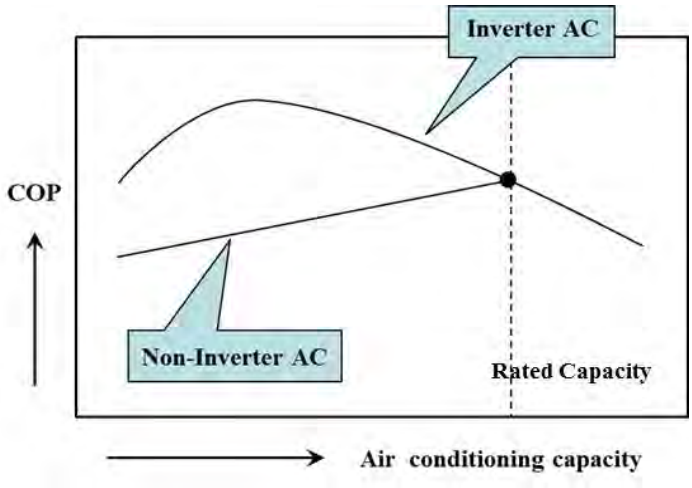


図 8-13 AC の部分負荷効率

4) ISO16358に規定される新しい効率評価基準（SPFおよびAPF）

実際の AC 使用時に近い状態での評価を行うため、冷房期間、暖房期間および通年の総合負荷と AC の消費電力特性より算出する以下の新しい効率評価基準（SPF および APF）が規定された。

① 冷房期間エネルギー消費効率（CSPF）

$$CSPF = \frac{冷房期間総合負荷（CSTL）（W）}{冷房期間消費電力量（CSEC）（W）}$$

② 暖房期間エネルギー消費効率（HSPF）

$$\mathrm{HSPF} = \frac{\text{暖房期間総合負荷（HSTL）（W）}}{\text{暖房期間消費電力量（HSEC）（W）}}$$

③ 通年エネルギー消費効率（APF）

$$\mathrm{APF} = \frac{\mathrm{CSTL}\text{（W）}+\mathrm{HSTL}\text{（W）}}{\mathrm{CSEC}\text{（W）}+\mathrm{HSEC}\text{（W）}}$$

なお、SPF および APF の算出にあたっては、消費電力量を実測するのではなく、ISO16358 に準拠し、トルコ国の各地域の気象データを考慮した総合負荷と、冷房については定格冷房能力および中間冷房能力から算出する消費電力量、暖房について定格暖房能力、中間暖房能力および低温暖房能力から算出する消費電力量を用いて、効率を算出することになる。

添付資料 9

公共建物省エネ改修事業推進スキーム

9-1 提案の概要

9-2 事業スキーム提案

添付資料 9-1　　提案の概要

Preliminary Draft Proposal for Effective Implementation of EE Retrofit Investments for Central Government Owned Buildings

October, 2012

JICA Study Team

Turkish rapid economic growth creates huge energy demands, and energy conservation is one of the most prioritized issues for its sustainable development. There are various possibilities to promote public buildings energy efficiency and conservation (EE&C) in Turkey. The JICA Study Team assumes that the target segment at the initial stage would be EE retrofitting of central government buildings, carrying forward the momentum of MOEU's 100 Buildings Project and the Government's Energy Efficiency Strategy Paper issued in February 2012.

JICA Study Team analyzed that there are three barriers for efficient implementation of EE retrofit investments for central government owned buildings, namely, 1) existence of a large number of small-sized projects scattered among ministries and their affiliated institutions; 2) the fact that each decision on EE retrofit investment has to be made by individual ministry/ institution; and 3) the fact that public procurement is based primarily on the lowest price.

In this preliminary draft proposal, JICA Study Team presents one implementation scheme, which seems feasible based on the acquired information as of end-September 2012, and explains critical factors for the implementation including the below:

1) Establishment of a powerful PMU with enforcement tools
2) Framework agreement* for the implementation of a large-number of small-scale sub-projects
3) Implementation of sub-projects by PMU for other ministries by delegation of authority to PMU
4) Evaluation of tender not by price of bids, but selecting the economically most advantageous tender by taking into account the factor other than price
5) Purchasing of only high energy efficiency equipments according to energy labeling regulations
6) Utilization of two implementation methods (energy audit method and bundling method)

* Framework Agreement means an agreement between one or more contracting authorities and one or more tenderers, which establishes the terms governing contracts to be awarded during a given period, in particular with regard to price and, where appropriate, the quantity envisaged.

Attached is the preliminary draft proposal for the new JICA financial and technical assistance project entitled, "Effective Implementation of **EE** Retrofit Investments for Central **G**overnment **O**wned **B**uildings (EEGOBs) Project" prepared by JICA Study Team.

END

添付資料 9-2　事業スキーム提案

Preliminary Draft Project Proposal

November 2012

JICA Study Team

Project name	Effective Implementation of EE Retrofit Investments for Central Government Owned Buildings (EEGOBs) Project
Objective	1) Goal: Achievement of EE improvement in public sector buildings in Turkey 2) Outcome: a) Reduction of energy budget of the Central Government b) Demonstration effect for private sector buildings 3) Output: Increase in the number of public sector buildings with EE&C improvements
Project period	2013-2018（5 years） Submit proposal following Turkish budgeting procedures 2013 Sub-project formation starting in 2013 Loan disbursement starting in 2014
Executing agency	MOEU (Project Management Unit / PMU will be established in MOEU upon the approval of the Prime Ministry/ High Planning Council)
Beneficiary	Government of Turkey
Funding sources	JICA and/or Other donor agencies
TA	Technical assistance to PMU to support the Project implementation and to EVD Association for the capacity development of EVDs through GDRE/ MENR
Main features	1) Utilization of two EE&C retrofit implementation methods: a) Energy Audit Method and b) Bundling Method 2) Establishment of a powerful PMU with enforcement tools 3) Utilization of framework agreement (Additional Article 2 of the Public Procurement Law (PPL) No. 4734 of 2002) for the implementation of a large-number of small-scale sub-projects 4) Implementation of sub-projects by PMU for other ministries by delegation of authority to PMU based on an entrustment agreement 5) Procurement via tender of economically most advantageous equipment and services by taking into account factors other than price (e.g. life-cycle costs) based on Public Procurement Law dated January 4, 2002 No.4734 (Revised version 2012 (Article 40) and Regulation Regarding the Increase of Energy Efficiency dated October 27, 2011 No. 28097 (Article 31) 6) Purchasing of high energy-efficiency equipment based on Regulation on Labeling of Products by Consumption of Energy and Other Resources dated 09/12/2011 No: 2011/2257 (Article 10)

1. Project Background & Objectives

In Turkey, the building sector is currently the largest energy consuming sectors surpassing industry, with a share of 35% in total energy consumption in 2010. At the same time, since more than 90% of existing 8.6 million buildings in Turkey was built before 2000, the year when the new thermal insulation regulations came into operation, it is assumed that 30% energy saving could be achieved in building sector without much difficulties.

The Government of Turkey (GOT), with the conviction that energy efficiency and conservation (EE&C) should first be promoted among public sector buildings to set a good example for the society, has been proactively promoting EE&C in public sector buildings since 2008 with the issuance of PM Circular 2008/ 2. There are currently two kinds of important legal and policy requirements in EE&C in public sector buildings. One is a legal requirement by the Regulation on Energy Efficiency of MENR of 2011 (En-Ver) under Energy Efficiency Law of 2007, which states that "The energy use of the buildings and enterprises belong to public sector shall be reduced by at least 20% in the year 2023 compared to the year 2010" in Article 31. The other is a policy requirement stipulated in the Energy Efficiency Strategy Paper 2012-2023 (EESP). According to Purpose 6/ Target 1/ Action1 (SP-06/ST-01/A-01) of EESP, "The efficiency improvement projects shall be prepared by making energy audits in the buildings and facilities of the public enterprises and the budget allowances of the maintenance shall be used for these projects with priority" so as to decrease annual energy consumption in the public enterprises buildings and facilities by 10% before 2015 and 20% before 2023.

MOEU, which is the ministry solely in charge of promoting EE&C in buildings, is currently conducting a pilot project involving energy audit and energy-improvement of 100 public-sector buildings in Ankara ("100 Buildings Project"). MOEU plans to 1) establish standard specifications through 100 Buildings Project, 2) guide (recommend) procurement for other ministries using thus established standard specification, and 3) make other ministries adopt the standard through the issuance of a PM Circular. After getting the lessons and feedback from this project, MOEU has another idea to extend similar studies to promote EE&C to 1,000 public sector buildings nationwide.

Thus, EE Retrofit Investments for Central Government Owned Buildings (EEGOBs) Project intends to support the achievement of GOT's purposes/ targets/activities set forth in EESP by providing a comprehensive financial and technical assistance to increase the number of public sector buildings with EE&C improvements, which will eventually reduce energy budget of the Central Government and foster demonstration effect for private sector buildings.

2. Barriers & Countermeasures

To overcome existing barriers (see the table below), a powerful Project Management Unit (PMU) will be created in the higher level of government structure or in MOEU with the support from and coordination with higher government authorities such as Prime Ministry. As well, "bundling method" will be introduced to implement EE&C retrofit investments of many small-sized sub-projects scattered across various ministries.

Principal Barrier	Counter Measure
Majority of sub-projects are "small," thus involves relatively high transaction costs	- To standardize investment decision and procedures of sub-projects so as to process easily - To use eligible equipment list for automatic sub-project approval - To bundle a large number of the same kind, small sized sub-projects into one large batch. At the same time, establish PMU for the entire project implementation, from budget handling, procurement, and contract, so as to avoid the implementation by each ministry.
Little interest for energy saving by building owner agencies (i.e. ministries), due to lack of financial benefits	- Not only raising awareness, educational, but also guidance, enforcement by authoritative power; - To set up a PMU in the highly recognized agency such as the Prime Ministry or in MOEU with support from and coordination with higher government authorities. - Another approach is to make compulsory by law, by regulation, or by the issuance of a Prime Ministry Circular so as to ensure that no agency could dismiss the implementation of EE&C improvements in buildings.

3. Project Components

1) Financial (ODA loan) assistance for implementation of EE&C of public sector buildings in Turkey

2) Technical assistance to PMU for a smooth, efficient and effective implementation of EE&C investments in sub-projects

3) Technical assistance aimed toward the broader capacity development for EE&C in Turkey, which would strengthen the prerequisites for the success of EE&C of public sector buildings (including Technical Assistance for EVD Associations via GDRE/MENR for the capacity development of participating EVDs)

4. Roles and Responsibilities of Interested Parties

Organization	Roles and responsibilities/ Inputs
High Planning Council / Prime Ministry, etc.	【Roles and Responsibilities】 - To mandate PMU to carry out the EE retrofit investments for all ministries by the High Planning Council Decision, Prime Ministry Circular, (or by the approval of higher government bodies such as EECB.) 【Inputs】 - To grant enforcement power to PMU - To give PMU the mandate to implement EE retrofit investments for ministries
PMU	【Roles and Responsibilities】 - To take charge of the entire project implementation - PMU will provide participating ministries with a comprehensive support for energy audit, budget provision (finance), preparation of detailed design and tender documents, tender and sub-project implementation. - Implement a part of or the entire EE&C retrofit investments on behalf of participating ministry/ ministries based on an entrustment agreement signed with each of the participating ministries - Procure EE&C equipment and services from selected contractors and suppliers for an extended period of time on behalf of participating ministries based on a framework agreement signed between PMU and suppliers, contractors, etc. 【Inputs】 - Donor agencies and MOEU shall dispatch experts who specialize in a) project management, b) finance, c) sub-project identification, d) government negotiation, e) procurement of EE&C equipment and services, f) technical assistance, etc.
MOEU	【Roles and Responsibilities】 - To promote EE&C in the buildings sector of Turkey - To achieve purposes/ targets/ activities outlined in the Energy Efficiency Strategy Paper - To take leadership in the implementation of the Project as the executing agency: prepare and submit the Project proposal to MOD, support the smooth implementation of PMU by assisting negotiation with ministries and providing necessary logistics to PMU. - To contribute in sub-project identification by formulating new projects such as 1000 Buildings Project, and coordinate its implementation with PMU 【Inputs】 - To dispatch experts to PMU from the Energy Efficiency Department - To provide logistical support to the PMU, including fully equipped office facilities, administrative support

Organization	Roles and responsibilities/ Inputs
	- To offer the list of potential sub-projects to PMU
MENR	【Roles and Responsibilities】 - To support capacity development of EVDs - To provide technical support to PMU 【Inputs】 - To provide technical expertise and resources to promote the participation of EVDs in the Project
MOD	【Roles and Responsibilities】 - To approve the Project Proposal and list it up on the Investment Program - To put finance for the Project and report to MOF for final approval 【Inputs】 - To authorize the implementation of the Project as a multi-year donor-funded investment project, enabling annual budget disbursement under the Project for the entire duration of the Project.
Individual ministries	【Roles and Responsibilities】 - To implement EE&C retrofit investments of the existing buildings under the jurisdiction of each ministry - To cut the total amount of energy consumption by each ministry 【Inputs】 - To sign an entrustment agreement with PMU regarding the delegation of authority to PMU for the implementation of a part of or the entire EE&C retrofit investments
EVD Association	【Roles and Responsibilities】 - To provide technical support to EVDs which are selected by PMU for the procurement of works, equipment and services for EE&C retrofit investments - To coordinate capacity development of EVDs with MENR and PMU 【Inputs】 - To provide technical expertise and resources to promote the participation of EVDs in the Project
EVD	【Roles and Responsibilities】 - To implement EE&C retrofit investments 【Inputs】 - To conduct procurement of works, equipment and services to ministries and PMU necessary for EE&C retrofitting
MOSIT	【Roles and Responsibilities】 - To align Turkish regulations with European Energy Labeling and Eco Design. 【Inputs】 To expand the energy labeling coverage to promote high energy-efficiency equipment

Organization	Roles and responsibilities/ Inputs
Donors	【Roles and Responsibilities】 - To support the Government of Turkey for capacity development of related authorities through technical cooperation schemes. - To promote EE&C retrofit of central government buildings through the provision of capital funds and technical expertise. - To support the Government of Turkey in achieving purposes/ targets/activities outlined in the Energy Efficiency Strategy Paper 【Inputs】 - To dispatch experts, provide funding and technical assistance to PMU, MOEU and participating and supporting ministries

5. PMU

PMU shall be established and given the mandate to implement EE retrofit investments for ministries by the approval of a) High Planning Council or b) Prime Ministry. The location of the PMU office would be in the head office of MOEU in order to assure a responsive coordination between the two organizations. The PMU management team will consist of government officials seconded from relevant ministries and experts recruited from outside the government.

Division of labor between PMU and participating ministry (ministries) is shown in the following table. After conducting preliminary and, if necessary, full energy audit for the identified sub-project, participating ministry/ ministries will sign Agreement for Implementation with PMU: 1) Under Energy Audit Method, PMU shall provide full technical support as well as finance to the ministry concerned based on an entrustment agreement, and 2) under Bundling Method, PMU shall implement sub-projects on behalf of all participating ministries based on the entrustment agreement signed with each one of them and conduct a lump-sum procurement of equipment and services based on a framework agreement signed with suppliers, contractors, etc.

Advantages of establishing a PMU include the below:

1. Central implementation ensuring more professional and less cost for government
2. Monitoring of all applications and EE strategy targets
3. Effective utilization of donor credits
4. Mass purchasing of EE equipment and construction materials facilitate quick EE market transformation, additional employment effect, etc.

Activity	Energy Audit Method		Bundling Method	
	PMU	Ministry	PMU	Ministries
Sub-project identification	Identification by PMU, through requests from any participating ministries, or from any other sources.			
Agreement for Audit	◆━━━━◆		◆━━━━◆	
Preliminary energy audit	PR		PR	
Full scale energy audit	PR		Not applicable	
Agreement for Implementation	◆━━━━◆ *Entrustment Agreement*		◆━━━━◆ *Entrustment Agreement +Framework Agreement*	
Design, tender docs	TS	PR	PR	
Tender evaluation	TS	PR	PR	
Contract	TS	PR	PR	
Supervision of works	TS	PR	PR	
Final acceptance	TS	PR	PR	
Payment	PR	(Request to PMU)	PR	
Operation/maintenance		PR		PR

PR: Primary Responsible
TS: Technical Support

6. EE&C Retrofit Implementation Methods

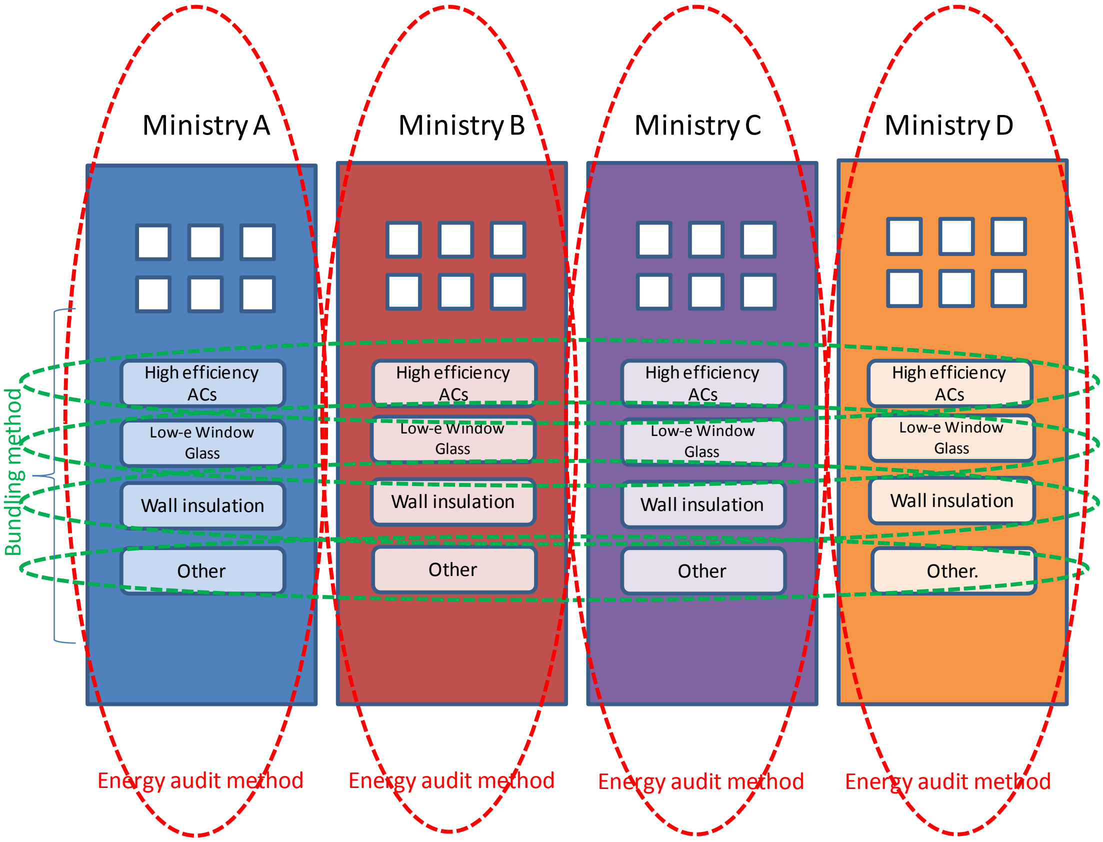
There are **two methods** for sub-project implementation:

1) Energy Audit Method:

Energy audits will be done for buildings having high energy saving potentials, based on which sub-projects consisting of several EE&C measures will be formulated. Sub-projects will then be appraised and approved by the PMU, if eligibility criteria are met. Approved sub-projects will be implemented by building owners (i.e. ministries, etc.), with comprehensive support from PMU for energy audit, budget provision (finance), preparation of detailed design and tender documents, tender and sub-project implementation. Since the primary responsibility to implement EE retrofit investments under this method lies with each building owner, it is important that the concerned ministry would take initiative by submitting a request to PMU for the participation in EEGOBs Project.

2) Bundling Method:

This is a single most promising EE&C measure, in which small scale but large number of thematic sub-projects, such as replacement of ACs, will be bundled across ministries and administrations, and implemented and financed by PMU. Information about the candidate sub-projects will be collected by PMU and MOEU, and each of the participating building owners shall sign an entrustment agreement with PMU regarding sub-projects implementation.



7. Implementation Steps and Agencies Involved in EEGOBs Project

EEGOBs Project implementation steps, from identification of sub-projects to outcome monitoring, are outlined in the following table. It is important that at the stages of identification of sub-projects (1) and request for participation (2), PMU/MOEU shall take leadership in collecting information from relevant stakeholders by interacting proactively with them. Nevertheless, for those building owners intending to implement EE retrofit investments under Energy Audit Method, identification of sub-projects and request for participation are expected to be made by them. At the tender stage (8), PMU shall conduct the screening of sub projects via energy audits for large-scale EE&C retrofit sub-projects utilizing Energy Audit Method, and via tender documents (which define standard specifications and the minimum procurement amount) for a batch of many small-sized sub-projects utilizing Bundling Method. Lastly, at the outcome monitoring stage (14), PMU/MOEU and JICA shall conduct strict monitoring so as to calculate the cost effectiveness and EE&C effects of the Project based on data provided in the reports submitted by participating ministries.

Procedure of Energy Audit Method

Project Implementation Steps	JICA	Ministries	PMU	MOEU	EVDs	Suppliers/ Contractors
(1) Identification of sub-projects	S	P	P	S	S	S
(2) Request for participation		P				
(3) Acceptance for participation			P			
(4) Initial energy audit by computer software			P		S	
(5) Agreement for investment		P	P			
(6) Appraisals for eligibility/approval	S		P			
(7) Agreement for sub-project implementation		P	P			
(8) Tender/ Tender documents		P	S		S	P
(9) Tender evaluation		P	S			
(10) Negotiation and signing of contract for supply/works		P			S	P
(11) Supervision of works			P		S	
(12) Final acceptance		P				
(13) Operation maintenance		P				
(14) Outcome monitoring	S	P	S	S		

P: Primaliry Responsible Agency
S: Supporting Agency

Procedure of Bundling Method

Project Implementation Steps	JICA	Ministries	PMU	MOEU	EVDs	Suppliers/ Contractors
(1) Identification of sub-projects	S	P	P	S	S	S
(2) Request for participation			P			
(3) Acceptance for participation		P				
(4) Initial energy audit by computer software					S	
(5) Agreement for investment		P	P			
(6) Appraisals for eligibility/approval	S		P			
(7) Agreement for sub-project implementation		P	P			
(8) Tender/ Tender documents			P		S	P
(9) Tender evaluation			P			
(10) Negotiation and signing of contract for supply/works			P		S	P
(11) Supervision of works			P		S	
(12) Final acceptance		P	S			
(13) Operation maintenance		P				
(14) Outcome monitoring	S	P	S	S		

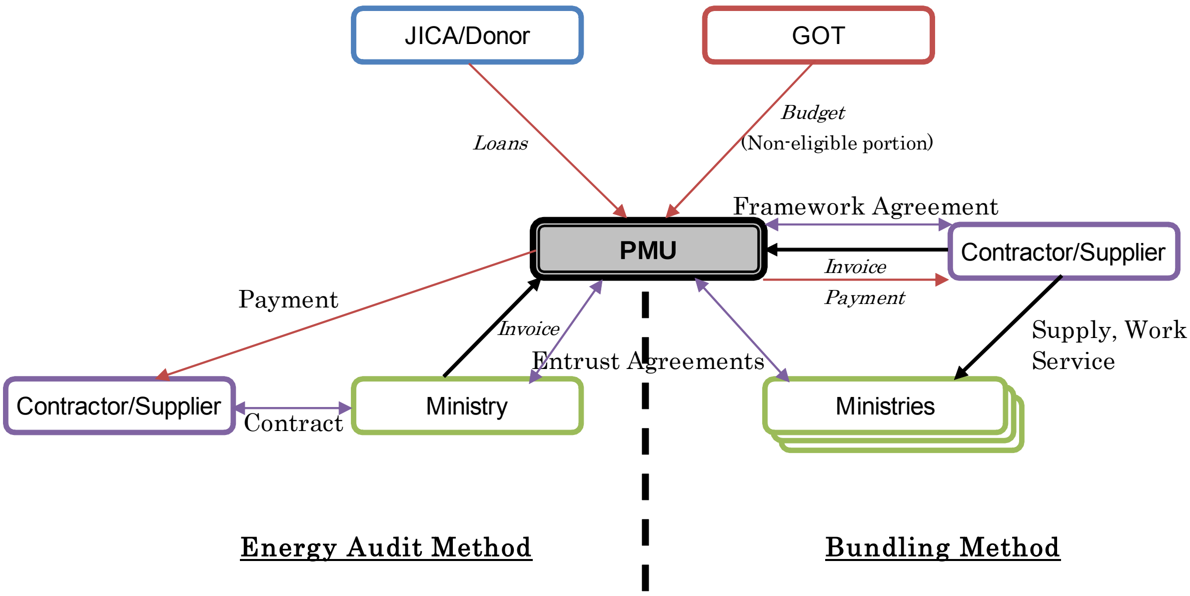
P: Primaliry Responsible Agency
S: Supporting Agency

8. Financial Mechanism under EEGOBs Project (Image)

The primary funding for the implementation of EE&C retrofit investments will come from JICA/ Donor agencies. Since the donor funds will cover only up to 75-85% of the cost of each sub-project, GOT will also provide funds to PMU from its annual capital investment budget. As a multi-year capital investment project, the total amount of funds approved and signed between GOT/UT and JICA/ Donor agencies under EEGOBs Project will be divided among the term (i.e. five years) to be disbursed each year to PMU. In practice, JICA/Donor agencies will transfer the funds to the Special Account established by GOT/UT for the sake of EEGOBs Project, to which the Director of PMU has the right of access throughout the Project term.

PMU will be responsible for the settlement of invoices submitted by EVDs, contractors and suppliers, but only upon request for Energy Audit Method which will be implemented primarily by each participating ministry with technical support of PMU.

Financial Mechanism



9. Timeframe for Preparation and Implementation of EEGOBs

The target timeframe for the preparation and implementation of EEGOBs Project is summarized in the table below. EEGOBs Project is a multi-year capital investment project, which requires an approval of MOD. To begin with, MOEU as the executing agency of the Project is expected to prepare and submit the proposal of the EEGOBs Project to MOD, with the assistance of JICA/ donor agency. According to the Turkish budgeting procedures, this shall be done prior to end-September 2013 when MOF should finalize and compile draft budget for the fiscal year 2014.

2012	➢ Project formation, and preparation of project proposal by JICA/ MOEU
2013	➢ Obtain approval at Energy Efficiency Coordination Board as the Project to implement an action of No. SP-06/ST-01/A-01 of Energy Efficiency Strategy Paper ➢ Obtain approval for the Project from the High Planning Council as inter-ministerial government priority project ➢ Obtain approval as Public Investment Program ➢ Negotiation between JICA/donor agencies and UT for project loan ➢ Budgeting (in bulk) as capital investment project in multi-year ➢ Identification and formulation of sub-projects
2014	➢ Implementation of the first series of sub-projects ➢ Continuation of formulation and implementation of sub-projects
2015 -	➢ Continuation of formulation and implementation of sub-projects

(Reference) With-Without-Comparison

1) With EEGOBs Project

PMU will be established to implement EEGOBs based on High Planning Council Decision/ PM Circular

Advantages

- Able to receive an abundant funding from donor agencies,
- Able to speed up implementation of EE retrofit investments by ministries

Disadvantages

- Need to establish and mandate PMU by the issuance of new government decisions

2) Without EEGOBs Project

MOEU would implement EE retrofit investments within the capacity of its Establishment Law + PM Circular

Advantage

- Able to conduct under the current law and regulation

Disadvantage

- Ministries have to use their own buildings maintenance budgets for EE retrofit investments
- Weak enforcement power over ministries
- Take longer time to implement EE retrofit investments by ministries (see the chart below)