Office for the Improvement of Productivity and Economy of Electricity and Energy
Ministry of Energy
Islamic Republic of Iran

DEVELOPMENT STUDY FOR INSTITUTIONAL CAPACITY DEVELOPMENT ON ENERGY MANAGEMENT IN THE BUILDING SECTOR IN THE ISLAMIC REPUBLIC OF IRAN

Final Report

December 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

MITSUBISHI RESEARCH INSTITUTE,INC
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Other
Annex11 Comparison of Inst. Of Higher Education and Research Complex

List of Abbreviations

ADEME	The French Agency for Environment and Energy Management
AHERC	Azerbaijan Higher Educational and Research Complex
AHU	Air Handling Unit
BAS	Building Automation System
BC	Building Code
BEMS	Building Energy Management System
BHRC	Building and Housing Research Center of Iran
BMS	Building Management System
CC	Combined Cycle
CDM	Clean Development Mechanism
CHP	Combined Heat and Power Generation
CNG	Compressed Natural Gas
DG	Distributed generation
DNA	Designated National Authority
DoE	Department of Environment
DOE	Designated Operational Entity
EB	Executive Board
EBRD	European Bank for Reconstruction and Development
ECO	Environmental Conservation Organization
EE&C	Energy Efficiency and Conservation
EIC	Energy Information Center
EMF	Energy Management Fund
EPC	Engineering, Procurement and Construction
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCO	Energy Service Company
FMS	Facility Management System
FOB	Persian Gulf Free On Board
GDP	Gross Domestic Product
GHG	Grennhouse Gas
HERI	Higher Educational and Research Institute
HVAC	Hearting Ventilation and Air-conditioning
ICT	Information and Communication Technology
IDB	Isramic Development Bank

IEHT	Institute for Energy and Hydro Technology
IFCO	Iranian Fuel Conservation Company
IHERC	Isfahan Higher Educational and Research Complex
IMF	International Monetary Fund
IrCEO	Iranian Construction Engineering Organization
ISIRI	Institute of Standards and Industrial Research of Iran
JICA	Japan International Cooperation Agency
kWh	Kilowatt hour
Mboe	Million Barrel of Oil Equivalent
MJ	magajoule
MOC	Ministry of Commerce
MOE	Ministry of Energy
MOF	Ministry of Finance
MOFA	Ministry of Foreign Affairs
MOHUD	Ministry of Housing and Urban Development
MOI	Ministry of Industry
MOIM	Ministry of Industry and Mine
MOJEA	Ministry of Jihad-e-Agriculture
MOP	Ministry of Petroleum
MORUD	Ministry of Roads & Urban Development
M/P	Master Plan
MRT	Ministry of Road and Transportation
MTOE	Million Tonne of Oil Equivalent
NBRO	National Building Regulation Office
NCCO	National Climate Change Office
NEDO	New Energy and Industrial Technology Development Organization
NIGC	National Iranian Gas Company
NIOC	National Iranian Oil Company
NIOPDC	National Iranian Oil Products Distribution Company
NIORDC	National Iranian Oil Refining and Distribution Co.
NRI	Niroo Research Institute
NTCEM	National Training Center for Energy Management
OIPEEE	Office for the Improvement of Productivity and Economy of Electricity and Energy
OJT	On-the-Job Training

PDD	Project Design Document
PIN	Project Idea Note
PMI	Project Management Institute
PVC	Polyviny Chloride
PWUT	Power and Water University of Technology
R&D	Research and Development
SABA/IEEO	Iran Energy Efficiency Organization
SCI	Statistics Center of Iran
SFM	Special Finance Mechanism
S/W	Scope of Work
TOE	Tonne of Oil Equivalent
TWh	Terawatt hour
UNDP	United Nations Development Program
UNESCO	United Nations Education and Science Organization
UNFCCC	United Nations Framework Convention on Climate Change
uPVC	unplasticized polyvinyl chloride

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Chapter 1. Introduction

1.1. Background and Objective of the Study

1.1.1. Background of the Study[1]

The Islamic Republic of Iran (hereafter referred to as the "Iran") is one of the world's most eminent oil-producing countries, producing 90 billion barrels that accounts for 9% of oil deposits in the entire world. Since the country is very rich in oil, about 80% of the foreign exchange earnings depend on the export of the oil products. As the total domestic energy consumption has reached 44% of the total energy production, the domestic consumption of the oil, however, has been increasing. Efficient utilization of energy is becoming the key issue in terms of securing the volume of oil for export that brings economic growth to the country because there is a working hypothesis that Iran will become energy importing country by 2018 if the total energy consumption remains at the annual rate of 6 %.

JICA carried out the technical cooperation project, "Project on Energy Management Promotion in the Islamic Republic of Iran" (from March, 2003 through March, 2007) and implemented the system to train experts for the efficient use of equipment such as boilers and fans that are regularly used in the factory in order to promote energy conservation in the industrial world.

On the other hand, the energy used for heat, light, and ventilation, and etc, in the general buildings is assumed to be more than 40% of the total energy supply of the country. Therefore, introducing energy conservation measures in construction and public welfare is the next step to the efficient utilization of energy.

Based on these backgrounds, Iran made a request to our country, known for possessing one of the world's top energy conservation technology and with actual experience and great success providing cooperation in energy conservation in Iran's industry, to conduct technical cooperation in the form of development studies " Development Study for Institutional Capacity Development on Energy Management in the Building Sector" for energy conservation measurement and related legislation in construction (particularly for building[2]). Based on the request, detailed research study on the full-scale study was conducted along with the discussion with related organizations in Iran was carried out in January, 2009. As a result, Scope of Work (S/W) was signed and exchanged in August, 2009.

1.1.2. Objective of the Study

The objectives of the Study are:

(1) To Support Institutional Development for Energy Efficiency & Conservation (EE&C) Promotion in the Building Sector;
(2) To Draft the Master Plan for Energy Conservation Promotion in the Building Sector;
(3) To Draft the Action Plan for Human Resource Development for Energy Conservation Promotion in the Building Sector; and
(4) To Enhance the Capacity of Counterpart through Energy Audit and Workshop.

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1 Statistic is based on the request statement from Iran.

2 At the beginning of study, buildings with more than 2,000 m^2 space are subjects to be studied. However, it is assumed that studied coverage may change based on related laws in Iran.

1.2. Studied Area

The Study will cover the whole area of Iran. The Study is carried out for 17 months between June, 2010 and October, 2011.

1.3. Counterpart (C/P)

The counterpart of the Study is Office for the Improvement of Productivity and Economy of Electricity and Energy (OIPEEE) of the Ministry of Energy (MOE).

OIPEEE assigned persons in charge for Japanese experts on eight fields mentioned as Table 1.3-1.

Table 1.3-1 Persons in Charge

Field	Name of person in charge/Organization
Team Leader / EE&C Policy	Mr. Shirazi from OIPEEE
Legal Framework and Organization	Mr. Kashian from OIPEEE Dr. Effatnejad from OIPEEE
Architecture	Dr. Kari from BHRC[3]
Energy Management Technology (BEMS/BAS) and ESCO Business	Mr. Zarbakhsh from SABA[4]
Energy Audit Technology	Mr. Amani from SABA
Capacity Development	Dr. Banan from IEHT[5]
Statistics / Database	Ms. Mashhoodi from OIPEEE Dr. Eskandariun from OIPEEE
Market Research and CDM	Dr. Eskandariun from OIPEEE Mr. Shirazi from OIPEEE
Energy Capital Management	Dr. Eskandariun from OIPEEE

1.4. Study Team Member

The organization of the study is shown in Figure 1.4-1. Wide-ranging study of eight fields is covered with a total of fourteen persons and a team leader. Moreover, a local consultant is assigned in order to carry out business efficiently and smoothly.

3 Building and Housing Research Center of Iran
4 SABA is abbreviation in Persian, which is described as Iran Energy Efficiency Organization（IEEO ） in English.
5 Institute for Energy and Hydro Technology

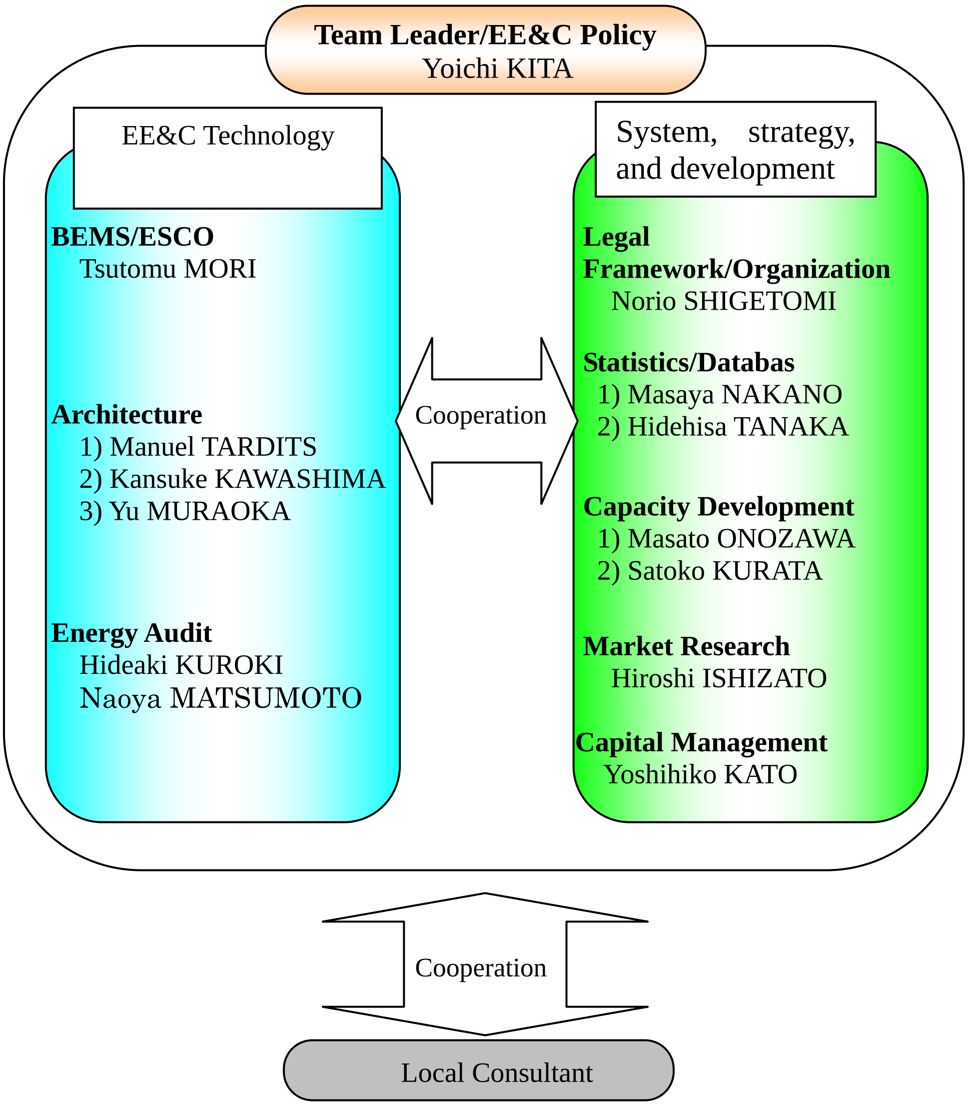


Figure 1.4-1 Organization of the Study

1.5. Local Consultant

On October 26, 2010, the local consultant contract was concluded with Dr. Mohammad Ameri who belongs to Power and Water University of Technology (PWUT) upon the approval by MOE. Outline of the tasks assigned is as follows:

(1) Basic Study (Energy and Building) and generating a report
(2) Preparation for workshop (during the third and fifth field survey)
(3) Support research on the candidate sites for EE&C training center and assist energy audit
(4) Assist during the field surveys (explanation from the study team to C/P), follow up after returning to Japan
(5) Confirmation of documents in Persian and abstraction of important parts, generating an abstract, translation, review of translation

1.6. Overall Study Schedule and General Work Flow

Overall schedule and general work flow is shown in Figure 1.6-1.

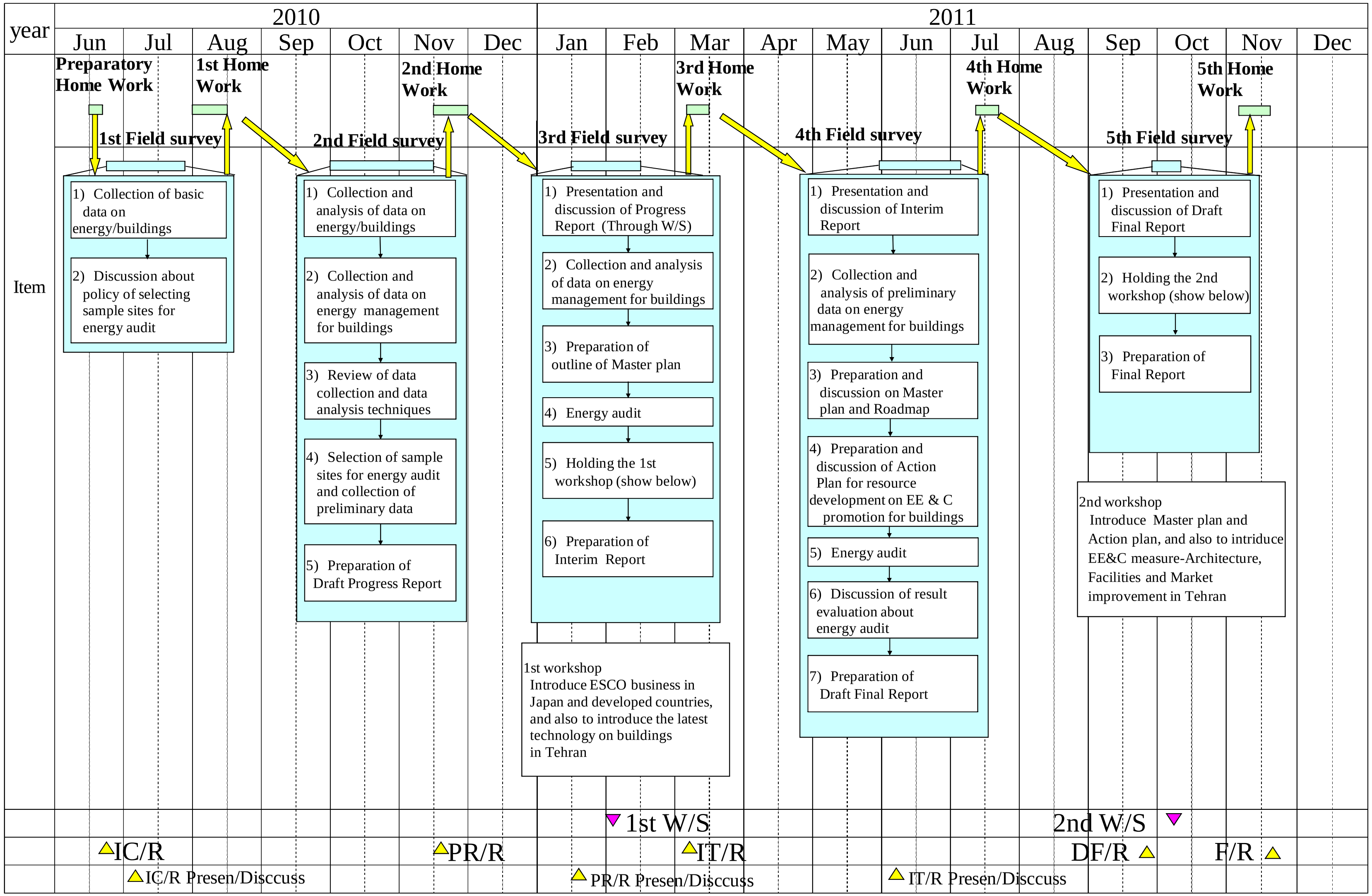


Figure 1.6-1 Overall Schedule and General Work Flow

Chapter 2. Basic Information of the Studied Country

2.1. Geography and Natural Environment

2.1.1. Geography

Iran is in the southwest part of Asia, and the most northwest of the Middle East. Iran shares a common border with Azerbaijan (boarder length is 432 km) and Armenia (35 km) in northwest, with Turkmenistan (992 km) in northwest, with Pakistan (909 km) and Afghanistan (936 km) in east and with Turkey (499 km) and Iraq (1,458 km) in east. Also Iran is bordered on the north by the Caspian and on the south by the Persian Gulf and Oman Gulf (Figure 2.1-1).

Source: The Central Intelligence Agency (CIA)

Figure 2.1-1 Location of Iran

2.1.2. Climate

The climate of Iran has a generally continental climate and extreme temperatures since altitude is high. Especially in winter season, it has severe cold in the almost whole area expect for the coast of the Persian Gulf and Oman Gulf. Most area in Iran is an arid zone or a semiarid zone.

The climate is classified into five zones as it is shown in Figure 2.1-2 and Table 2.1-1. It seems that there is a difference in some by climate zones, such as an energy consumption tendency, energy consumption equipment, the energy saving technique, and energy saving potential.

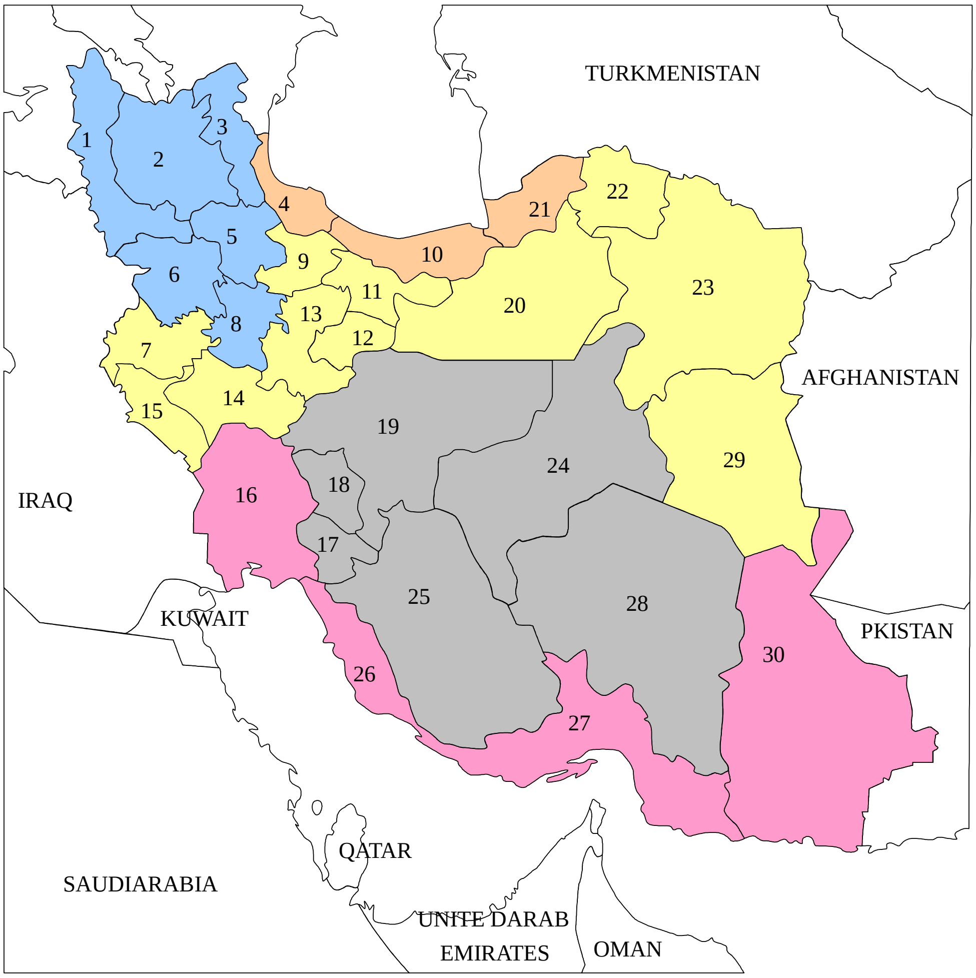


Figure 2.1-2 Distribution Map of the Climate Zone

Table 2.1-1 Climate Zone of the Provinces in Iran

No.	Province	Climate
1	West Azarbaijan	Cool
2	East Azarbaijan	Cool
3	Ardabil	Cool
4	Gilan	Humid & Normal
5	Zanjan	Cool
6	Kurdistan	Cool
7	Kermanshah	Warm
8	Hamadan	Cool
9	Qazvin	Warm
10	Mazandaran	Humid & Normal
11	Teheran	Warm
12	Qom	Warm
13	Markazi	Warm
14	Lorestan	Warm
15	Ilam	Warm
16	Khuzestan	Humid & Hot
17	Kohgiluyeh and Boyer-Ahmad	Dry & Hot (Desert)
18	Chaharmahal and Bakhtiari	Dry & Hot (Desert)
19	Isfahan	Dry & Hot (Desert)
20	Semnan	Warm
21	Golestan	Humid & Normal
22	North Khorasan	Warm
23	Razavi Khorasan	Warm
24	Yazd	Dry & Hot (Desert)
25	Fars	Dry & Hot (Desert)
26	Bushehr	Humid & Hot
27	Hormozgan	Humid & Hot
28	Kerman	Dry & Hot (Desert)
29	South Khorasan	Warm
30	Sistan and Baluchestan	Humid & Hot

2.1.3. Weather

(1) Cool Zone

The western area including Tabriz belongs to the subarctic from steppe climate, and has very severe cold because of high altitude. It has a heavy snowfall in mountainous area in winter. Especially in Hamadan located in the altitude of 1,850m, the lowest temperature may amount to -30 degree C.

(2) Humid and Normal

The north area of the Caspian Gulf Plain belongs the Mediterranean climate. Although the temperature in winter falls till around 0 degree, it is moistness throughout the year and rare to be exceed 29 degree C in summer. The annual precipitation becomes 680mm in the eastern plain, and becomes 1700mm or more in the western part.

(3) Warm

The inland and highland area including Teheran belongs to the desert from steppe climate, and has cold and snow in winter. The lowest temperature may fall to near freezing. On the other hand, it is dry and hot in summer.

(4) Dry and hot

The central basin in the central part is dry climate and desert area. The annual precipitation is less than 200mm, and the average temperature of summer exceeds 38 degrees C.

(5) Humid and hot

The south area of the Persian Gulf and Oman Gulf coast is mild climate in winter. The temperature and humidity become high very much in summer. The annual precipitation is between 135mm and 355mm

2.2. Social and Economic Condition

2.2.1. Social Condition

(1) Calendar

There are three calendars in Iran, “Christian Era”, “Iranian Calendar”, and “Islamic Calendar”. The length of one year in Iranian Calendar is the same as Christian Era, and Vertical Equinox is New Year’s Day in this calendar. From March 21, 2010 to March 20, 2011 is the one full year of 1389. Islamic Calendar (Hijra) is the lunar calendar and the length of one year is 11 days shorter. Religious events are held based on the Islamic Calendar.

(2) Population

The population of Iran is 74.73 million as of the fiscal year of 2010. It increased at about 16.4% during the ten years since 2000 at the average annual rate about 1.5%. As for the population density of urban and rural, the population density of urban area is increased from 64.5% in 2000 to 71.8% in 2010, concentrating the population in urban area.

Iran has thirty provinces. By taking a look at the population by the province, Tehran has the largest population with 14.79 million people. The second largest is Khorasan-e-Razari where the state capital of Masshad is located with 5.94 million and the third one is Isfahan with 4.8 million. As for the population of East Azarbayejan with the province capital of Tabriz where the industrial energy efficiency & conservation center was set up is 3.69 million.

Table 2.2-1 Change in Population of Iran

Description	Total		
	Total	Male	Female
*1996	60,055,488	30,515,159	29,540,329
1997	61,070,425	31,074,593	29,995,832
1998	62,102,514	31,565,637	30,536,877
1999	63,152,048	32,102,088	31,049,960
2000	64,219,319	32,647,965	31,571,354
2001	65,301,307	33,201,477	32,099,830
2002	66,300,418	33,713,360	32,587,058
2003	67,314,814	34,233,497	33,081,317
2004	68,344,730	34,761,738	33,582,992
2005	69,390,405	35,298,812	34,091,593
*2006	70,495,782	35,866,362	34,629,420
2007	71,532,063	36,377,302	35,154,761
2008	72,583,587	36,896,344	35,687,243
2009	73,650,566	37,391,312	36,259,254
2010	74,733,230	37,957,953	36,775,277

* Result of Census
Source: Statistical Center of Iran,
http://www.amar.org.ir/Upload/Modules/Contents/asset0/siteengilsh/75-89n3-2.xls

Table 2.2-2 Population of Iran by Province

	Province	Total					Urban	Rural and Unsettled
		2006	2007	2008	2009	2010	2010	2010
	Total country	70,495,782	71,532,062	72,583,586	73,650,566	74,733,230	53,637,652	21,095,578
1	East Azarbayejan	3,603,456	3,624,046	3,645,555	3,667,968	3,691,270	2,571,167	1,120,103
2	West Azarbayejan	2,873,459	2,908,186	2,943,567	2,979,604	3,016,301	1,915,277	1,101,024
3	Ardebil	1,228,155	1,231,369	1,234,913	1,238,778	1,242,956	781,308	461,648
4	Esfahan	4,559,256	4,619,022	4,679,806	4,741,615	4,804,458	4,206,798	597,660
5	Ilam	545,787	550,727	555,799	561,001	566,332	363,595	202,737
6	Bushehr	886,267	900,300	914,519	928,930	943,535	670,885	272,650
7	Tehran	13,422,366	13,761,967	14,103,853	14,448,184	14,795,116	13,882,892	912,225
8	Chaharmahal & Bakhtiyari	857,910	866,355	875,004	883,856	892,909	487,745	405,164
9	South Khorasan	636,420	646,308	656,332	666,493	676,794	382,458	294,336
10	Khorasan-e-Razavi	5,593,079	5,678,186	5,764,490	5,852,010	5,940,766	4,246,167	1,694,599
11	North Khorasan	811,572	818,078	824,782	831,684	838,781	439,200	399,581
12	Khuzestan	4,274,979	4,322,620	4,371,252	4,420,874	4,471,488	3,104,449	1,367,039
13	Zanjan	964,601	968,921	973,493	978,310	983,369	619,535	363,834
14	Semnan	589,742	598,233	606,852	615,601	624,482	485,305	139,177
15	Sistan & Baluchestan	2,405,742	2,487,081	2,568,741	2,650,768	2,733,205	1,401,022	1,332,183
16	Fars	4,336,878	4,383,268	4,430,672	4,479,087	4,528,514	2,865,862	1,662,651
17	Qazvin	1,143,200	1,160,142	1,177,331	1,194,771	1,212,464	889,151	323,312
18	Qom	1,046,737	1,066,664	1,086,798	1,107,145	1,127,713	1,075,208	52,505
19	Kordestan	1,440,156	1,446,457	1,453,135	1,460,180	1,467,585	920,265	547,321
20	Kerman	2,652,413	2,725,471	2,798,955	2,872,902	2,947,346	1,804,041	1,143,305
21	Kermanshah	1,879,385	1,885,248	1,891,612	1,898,464	1,905,793	1,317,760	588,033
22	Kohgiluyeh & Boyerahmad	634,299	642,797	651,435	660,216	669,140	346,186	322,954
23	Golestan	1,617,087	1,634,019	1,651,329	1,669,019	1,687,086	893,389	793,698
24	Gilan	2,404,861	2,416,089	2,427,941	2,440,405	2,453,469	1,403,288	1,050,181
25	Lorestan	1,716,527	1,726,302	1,736,515	1,747,159	1,758,226	1,092,334	665,892
26	Mazandaran	2,922,432	2,950,114	2,978,495	3,007,570	3,037,336	1,720,092	1,317,244
27	Markazi	1,351,257	1,361,052	1,371,183	1,381,645	1,392,435	1,040,403	352,032
28	Hormozgan	1,403,674	1,442,117	1,480,786	1,519,700	1,558,878	773,886	784,992
29	Hamedan	1,703,267	1,701,638	1,700,493	1,699,815	1,699,588	1,053,624	645,964
30	Yazd	990,818	1,009,285	1,027,948	1,046,816	1,065,893	884,361	181,532

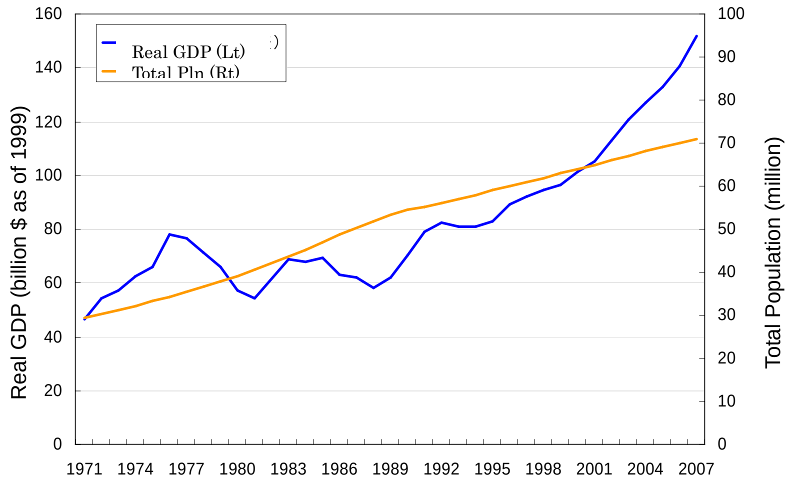
Source: Statistical Center of Iran,
http://www.amar.org.ir/Upload/Modules/Contents/asset0/siteengilsh/population4-2.xls

2.2.2. Economic condition

(1) GDP

The real GDP of Iran keeps growing at the average annual rate of 6% since 2000 and it reached 151.8 billion[6] dollars in 2007 as shown in Figure 2.2-1 (GDP is 2,137 dollar/person).

According to International Monetary Fund (IMF), the GDP growth rate of Iran is unable to move upward since the financial crisis with 2.3% for 08/09 fiscal year, and 1.8% for 09/10 fiscal year. IMF is expecting to see the growth rate in the 3% range in the next five years.



Source: Created off of "World Development Indicators", The World Bank

Figure 2.2-1 Change in Real GDP and Total Population

Moreover, as for GDP, the numerical values up to fiscal year 2005 (year 1384 in Iranian Calendar) are publicized by Statistics Center of Iran (SCI). According to SCI, the nominal GDP in the fiscal year 2005 was 1,931,304 (in billion rials), and it is about 193 billion US dollars with the conversion rate of 1 rial = 0.0001 US$. Additionally, the GDP growth rate in the fiscal year 2005 compared with the previous year was 24.7 % for nominal and 5.3% for actual.

Looking at the composition ratio of GDP in the numerical values in the fiscal year 2005, the ratio is 22.4 % (the largest) for the mining including petroleum, 8.6 % for the agriculture, 12.5% for industry, 13.9% for commerce, 6.7% for transportation/communication, 10.7% for housing/real estate, 3.8% for education, 3.8% for health/medical treatment and well-balanced industrial structure is displayed.

Table 2.2-3 Change in GDP in Iran

Year	at current price (Bln rials)	at constant 1376 price (Bln rials)
1,380(2001)	733,909	366,599
1,381(2002)	952,563	398,003
1,382(2003)	1,185,192	428,695
1,383(2004)	1,547,991	455,653
1,384(2005)	1,931,304	479,974

Source: Statistical Center of Iran

[6] US dollar standard in 1999

(2) Trade with Japan

According to the statistics of Ministry of Finance (MOF) in Japan for year 2010, the amount of import from Iran was about 980 billion JP yen (13% increase compared with the previous year), the amount of export to Iran was about 182 billion JP yen (19% increase compared with the previous year), and both export and import indicate steady growth.

On the other hand, the impact from the economic sanction since the later half of 2010 started to surface such as the announcement of withdrawal from Azadegan Oilfield Development project by INPEX Corporation, and indefinite suspension of exporting the finished car of Toyota to Iran.

2.3. Current Status related to Energy

2.3.1. Primary Energy Demand and Supply

Iran is one of the world's most eminent countries rich in energy resources with 90 billion barrels (9% of the entire world) and 29.6 trillion m3 (16.0%) of proved reserves of oil and natural gas respectively. And, oil is the most important export product of Iran, and more than 75% of foreign exchange earnings are generated by the export of the oil. As the economy grows and the population increases, the total domestic energy consumption has reached 44% of the total energy production (323.1 million TOE[7]) that is 144.7 million TOE, and the domestic consumption of the oil has also been increasing.

If the energy consumption continues to increase, it makes significant impacts on the national economy of Iran. Therefore, securing the volume of oil for export by introducing efficient energy use (energy efficiency and conservation) is the key issues for the country.

2.3.2. Energy Supply Structure

The primary energy supply of Iran is shown in Table 2.3-1. 68% of the total production of crude oil that is 1,629Mboe was exported and 618Mboe was supplied domestically. The natural gas on the other hand, out of 774Mboe produced, almost all were domestically consumed. Other primary energy supplies were extremely small.

Table 2.3-1 Primary Energy Supply in Iran (2007)

(Mboe) (میلیون بشکه معادل نفت خام)

Description	Oil (1) نفت (۱)	Natural gas گاز طبیعی	Coal زغال سنگ	Solid biomass زیست توده جامد	Hydro انرژی آبی	Renewables انرژی های تجدیدپذیر	Electricity برق	Total کل انرژی	شرح
Production	1629.3	774.3	8.0	5.6	10.6	0.08	-	2427.8	تولید
Import	114.0(2)	38.9	1.7	-	-	-	1.1	155.7	واردات
Export	-1113.9(3)	-35.4	-0.1	-	-	-	-1.5	-1150.8	صادرات
Intl. marine bunkers	-7.9	-	-	-	-	-	-	-7.9	سوخت کشتی های بین المللی
TPES	**617.8**	**777.8**	**9.0**	**5.6**	**10.6**	**0.08**	**-0.4**	**1420.5**	**عرضه کل انرژی اولیه**

Note: The part of primary energy supply was excerpted from the energy balance sheet
Source: Iran and World Energy Statistics and Figures (2007)

2.3.3. Energy Consumption Structure

The final energy consumption of Iran is shown in Table 2.3-2. 41.1% of the final energy consumption (1,053Mboe) that is 432Mboe was used for household and commerce, followed by transportation (265Mboe, 25.2%) and industry (238Mboe, 22.6%). As for the types of energy, the consumption of the petroleum product (480Mboe, 45.6%) and the natural gas (472Mboe, 44.8%) was large, and the consumption ratio of the electricity (265Mboe, 25.2%) was relatively small. Gas price is relatively lower than electricity price. So, the consumption ratio in building and housing field is 20 % as for electricity and 80 % as for gas.

[7] ton of oil equivalent = the 9th power of 10 calories (41.86 GJ)

Table 2.3-2 Final Energy Consumption in Iran (2007)

(Mboe) (میلیون بشکه معادل نفت خام)

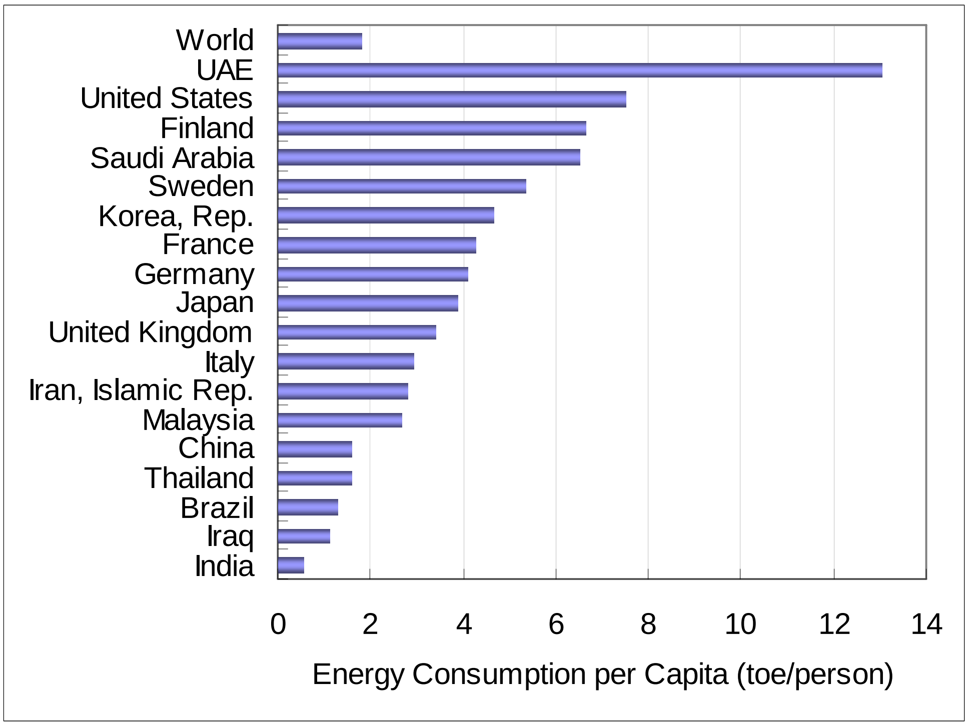
Description	Oil (1) نفت (1)	Natural gas گاز طبیعی	Coal زغال سنگ	Solid biomass زیست توده جامد	Hydro انرژی آبی	Renewables انرژی های تجدیدپذیر	Electricity برق	Total کل انرژی	شرح
TFC	**480.3**	**471.8**	**3.8**	**5.6**	**-**	**-**	**91.2**	**1052.7**	**کل مصرف نهایی**
Residential & commercial	90.2	289.0	0.07	5.6	-	-	47.5	432.3	خانگی، عمومی و تجاری
Industry	65.0	140.9	1.0	-	-	-	30.6	237.5	صنعت
Transport	258.5	6.6	-	-	-	-	0.1	265.2	حمل و نقل
Agriculture	26.1	1.1	-	-	-	-	10.4	37.6	کشاورزی
Other uses	-	-	-	-	-	-	2.7	2.7	سایر مصارف
Non-energy use	40.6	34.2	2.8	-	-	-	-	77.5	مصارف غیر انرژی

Note: The part of final energy consumption was excerpted from the energy balance sheet
Source: Iran and World Energy Statistics and Figures (2007)

Figure 2.3-1 and 2.3-2 show respectively energy consumption per capita and GDP in Iran, which compare with other countries.

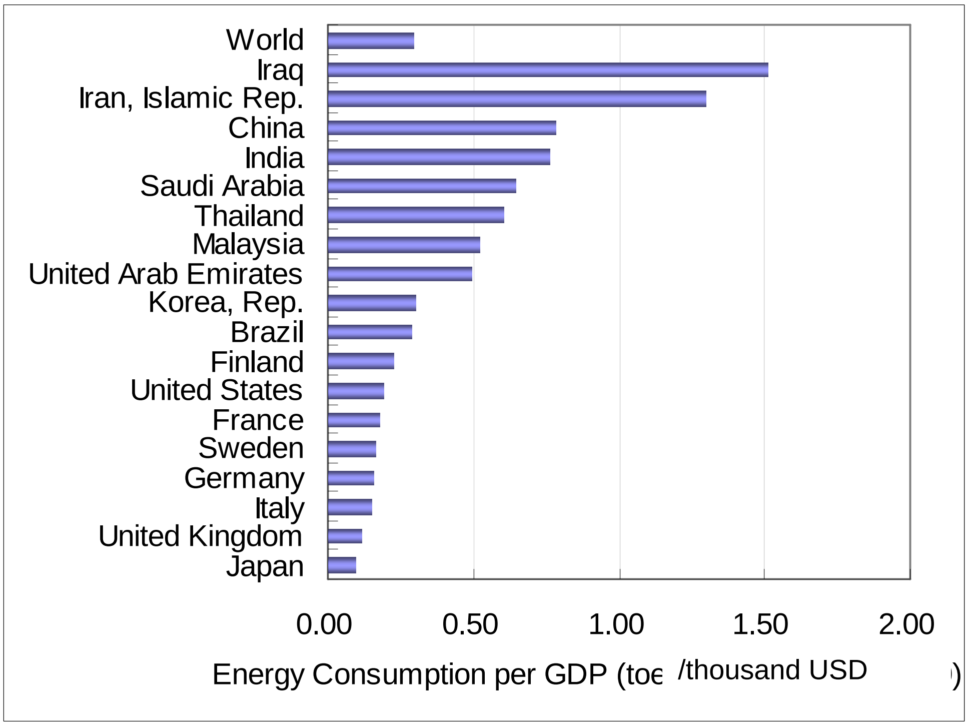
As for energy consumption per capita, Iran is 2.808TOE/capita. This is relatively larger than China, Thailand and Brazil, and almost equivalent with Malaysia and Italy.

As for energy consumption per GDP, Iran is 1.30 TOE/1,000 US $. This is the second largest after Iraq. Also, this is fairly large compared with 0.79 TOE/1,000 US $ of China, 0.77 TOE/1,000 US $ of India, and 13 times larger than 0.10 TOE/1,000 US $ of Japan. From this point, it is considered that Iran has a large potential for energy conservation.



Source：Edited from WDI Database, The World Bank

Figure 2.3-1 Comparison of Energy Consumption per Capita in Iran（2008）

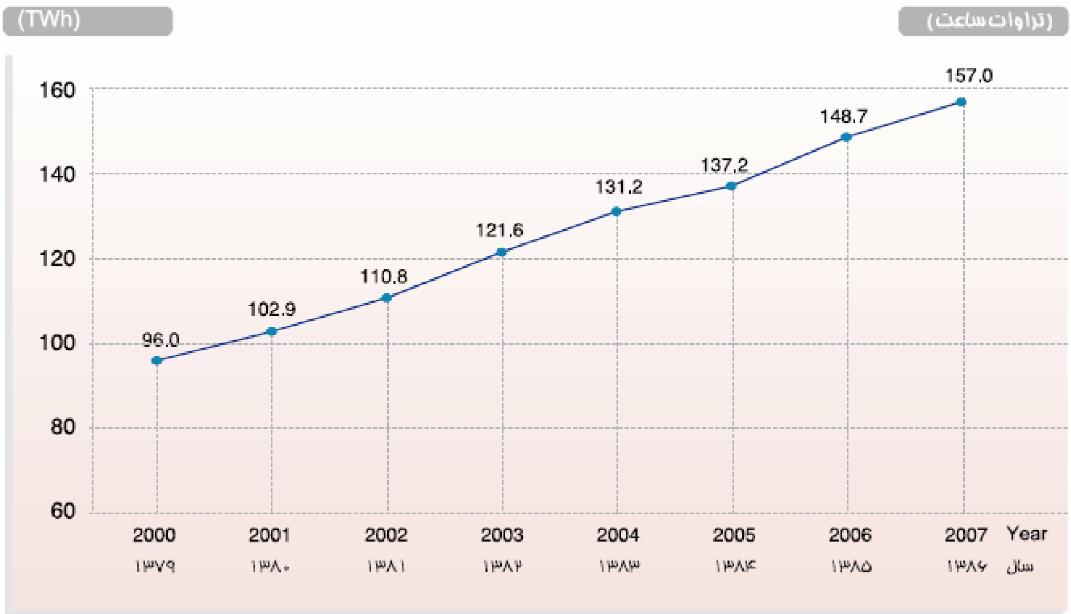


Source：Edited form WDI Database, The World Bank

Figure 2.3-2 Comparison of Energy Consumption per GDP in Iran (2008)

2.3.4. Status of Energy Conversion Section

The electricity demand of Iran increases steadily as GDP grows up. It increased by 5.6% compared with the previous year, and reached 157TWh in the fiscal year 2007. As for the power supply, the share of the natural gas had increased drastically with the rapid expansion of CC (Combined Cycle) since 2000. The natural gas (including CC) with 48.0% and the petroleum (including steam) with 34.0% accounted for more than 80% of the power supply composition (installed capacity) in 2007. The hydraulic power was the third largest with 16.9%.



Source: Iran and World Energy Statistics and Figures (2007)

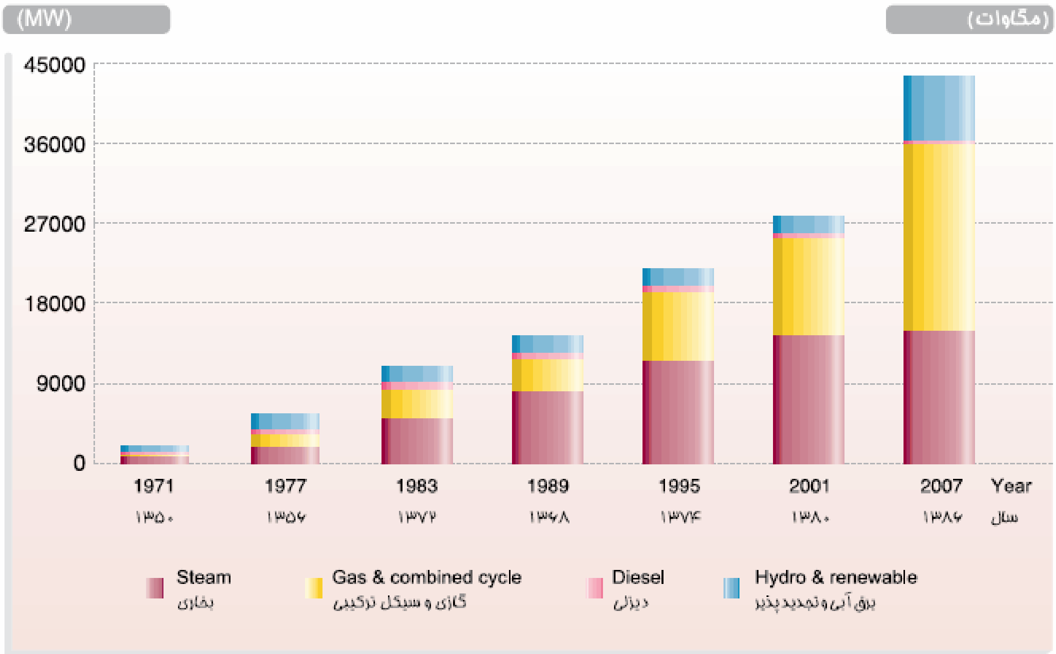
Figure 2.3-3 Change in Electricity Consumption in Iran

Table 2.3-3 Change in Power Generation Capacity in Iran

(MW) (مگاوات)

Year	Steam بخاری	Gas گازی	C.C سیکل ترکیبی	Diesel دیزلی	Hydro برق آبی	Wind & solar بادی و خورشیدی	Total جمع	سال
1974	1587	410	-	414	804	-	3215	۱۳۵۳
1978	1719	2887	-	614	1804	-	7024	۱۳۵۷
1989	8086	3600	-	803	1953	-	14442	۱۳۶۸
1995	11557	7746	-	658	1953	-	21914	۱۳۷۴
2000	13752	6243	3760	533	1999	-	26287	۱۳۷۹
2005	14890.4	9906.3	6831.7	493.1	6043.9	47.7 (1)	38213.1	۱۳۸۴
2006	14890,4	11281,9	7835,5	417,9	6572,2	58,9 (2)	41056,8	۱۳۸۵
2007	14935.0	10589.73	10478.5	417.9	7422.3	74.1 (3)	43917.443	۱۳۸۶

Source: Iran and World Energy Statistics and Figures (2007)



Source: Iran and World Energy Statistics and Figures (2007)

Figure 2.3-4 Change in Power Generation Capacity in Iran

Looking at the production of the petroleum product in Iran, there were gasoline with 16,454m^3, gas oil with 29,765m^3, and fuel oil with 26,652m^3 and it accounted for 77.7% of the total production only with these three types of oil. As for the import/export, gasoline and gas oil were imported in the amount of 6,953m^3 and 2,540m^3 respectively while fuel oil of 10,216m^3 was exported. In other words, 27.9% (6,953/(16,454+6,953)) of gasoline and 7.9% (2,540/(29,765+2,540)) consumed in Iran was imported while 38.3% of fuel oil (10,216/26,652) produced was exported. This indicates that the introduction of the secondary machinery for the oil refinement equipment in Iran is not advanced and meeting with the demand for the transportation fuel (gasoline and gas oil) where the demand for the petroleum product is the largest is necessary.

Table 2.3-4 Change in Production of Petroleum Product in Iran

(10^{3}m^3) (هزارمترمکعب)

Year	Kerosene نفت سفید	LPG گاز مایع	Gasoline بنزین	Gas oil نفت گاز	Fuel oil نفت کوره	Aviation fuel سوخت های هواپیما	Other سایر	Total جمع	سال
1974	3397	1646	3856	6547	15313	2774	2804	36337	۱۳۵۳
1978	4857	1257	5268	9125	15898	2155	3039	41599	۱۳۵۷
1989	6812	1809	7007	12753	15214	470	2495	46560	۱۳۶۸
1995	8700	2772	10327	20331	23701	840	5396	72067	۱۳۷۴
2000	9842	3041	13296	25600	30091	1102	6992	89964	۱۳۷۹
2005	7647	2994	15454	28913	27789	1069	7767	91634	۱۳۸۴
2006	7764	3024	16340	29373	27905	1314	8460	94178	۱۳۸۵
2007	8111	2914	16454	29765	26652	1250	8619	93766	۱۳۸۶

Source: Iran and World Energy Statistics and Figures (2007)

Table 2.3-5 Change in Import/Export of Petroleum Product in Iran

(10^{3}m^3) (هزارمترمکعب)

Year	Import واردات				Export صادرات			سال
	Gasoline بنزین موتور	Kerosene نفت سفید	Gas oil نفت گاز	LPG گاز مایع	Kerosene نفت سفید	Gas oil نفت گاز	Fuel oil نفت کوره	
1971	-	-	-	-	-	-	-	۱۳۵۰
1978	-	256	365	-	-	-	-	۱۳۵۷
1989	614	2397	4628	-	-	-	2720	۱۳۶۸
1995	1200	1791	1413	-	-	329	9161	۱۳۷۴
2000	1922	-	-	-	296	827	16056	۱۳۷۹
2005	9056	-	106	506	117	533	13458	۱۳۸۴
2006	10037	-	1857	420	99	-	14184	۱۳۸۵
2007	6953	-	2540	499	51	80	10216	۱۳۸۶

Source: Iran and World Energy Statistics and Figures (2007)

2.3.5. Energy Price

The sales price of the petroleum product, the natural gas, and the electricity is shown in table 2.3-6～2.3-8. The energy price in Iran is controlled at the low price. For example, 1,000 rial (about 10 JP yen) for the gasoline per litter, 113 rial (about 1 JP yen) for the natural gas for household use per 1m3, and 125 rial (about 1.1 JP yen) for the electricity for household use per 1KWh (all as of 2007).

The low price of energy was kept due to the subsidy provided by the government. However, the subsidy is becoming the huge financial burden to the government. So the subsidy has began to be reduced from December 2010.The government plans to abolish subsidy at the end of 2015 and increase energy price up to equivalent to export price with assessing energy price increase carefully.
As of June 2011, gasoline price per litter is 7,000 rial (about 70 JP yen). Gas price also increase by 2 to 3 times, electricity price rise suddenly in conjunction with gas price.

Table 2.3-6 Price of Petroleum Product in Iran

(Rial/Liter) (ریال/لیتر)

Year	LPG گاز مایع	Fuel oil 180 Cst نفت کوره	ATK سوخت سنگین جت	Gasoil نفت گاز	JP4 سوخت سبک جت	Kerosene نفت سفید	Super gasoline بنزین سوپر	gasoline بنزین	سال
1974	-	1.2	-	2.4	-	2.5	-	6	۱۳۵۳
1978	-	1.2	-	2.4	-	2.5	-	10	۱۳۵۷
1989 (1)	-	2	5	4.72	5	4.0	-	42.72	(1) ۱۳۶۸
1995	-	10	100	20	100	20	140	100	۱۳۷۴
2000	24	55	412.5	110	412.5	110	550	385	۱۳۷۹
2005	31.7	94.5	1400	165	1400	165	1100	800	۱۳۸۴
2006	31.7	94.5	•	165	•	165	1100	800	۱۳۸۵
2007	30.8	94.5 (2)	•	165 (2)	•	165	1400	1000	۱۳۸۶

Source: Iran and World Energy Statistics and Figures (2007)

Table 2.3-7 Price of Natural Gas in Iran

(Rial/m^3) (ریال بر متر مکعب)

	1971 ۱۳۵۰	1978 ۱۳۵۷	1989 ۱۳۶۸	1995 ۱۳۷۴	2000 ۱۳۷۹	2005 ۱۳۸۴	2006 ۱۳۸۵	2007 ۱۳۸۶	
Residential	1.5	1.5	5.0	15.6	55.0	80.0	80.0	111.3	خانگی
Commercial & Public	2.2	2.2	5.0	24.0	-	-	-	-	تجاری و عمومی
Education Centers	-	-	-	-	73.7	70.0	70.0	90.0	مراکز آموزشی
Public Centers	-	-	-	-	121.0	200.0	200.0	404.6	مراکز عمومی
Commercial Centers	-	-	-	-	121.0	200.0	200.0	250.0	مراکز تجاری
Special commercial purposes	-	-	-	-	16.5	25.0	25.0	48.8	مراکز ویژه تجاری
Charities	-	-	-	-	5.0	70.0	70.0	90.0	خیریه‌ها
Religious purposes	-	-	-	-	5.0	35.0	35.0	90.0	ویژه مذهبی
Sport Centers	-	-	-	-	73.7	70.0	70.0	90.0	مراکز ورزشی
Industry	**0.6**	**0.6**	**3.0**	**24.0**	-	-	-	-	**صنعتی**
Oil Pump Staition & Refineries	-	-	-	-	20.0	35.0	35.0	55.1	پالایشگاه ها و تلمبه‌خانه های نفت
Petrochemical Complex Industry	-	-	-	-	60.6	90.0	90.0	110.0	مجتمع های پتروشیمی
Feedstocks of Petrochemical	-	-	-	-	104.5	138.5	138.5	159.9	مصارف صنعتی
Complex for urea fertilizer Production	-	-	-	-	20.0	40.0	40.0	60.0	خوراک مجتمع‌های پتروشیمی و تولید کود اوره
Transport	-	-	-	-	55.0	60.0	60.0	80.0	حمل و نقل
Power Plants	1.3	1.3	2.0	7.2	20.0	29.3	29.3	49.4	نیروگاه ها

Source: Iran and World Energy Statistics and Figures (2007)

Table 2.3-8 Price of Electricity in Iran

(Rial / kWh/) (ریال / کیلووات ساعت)

Year	Residential خانگی	Public عمومی	Commercial تجاری	Industry صنعتی	Agriculture کشاورزی	Total Average متوسط کل	سال
1971	3.00	1.37	1.37	1.51	1.34	1.82	۱۳۵۰
1978	3.67	1.25	1.45	1.90	1.80	2.28	۱۳۵۷
1989	5.52	6.72	6.72	3.70	4.85	5.40	۱۳۶۸
1995	20.45	53.12	74.05	53.05	7.83	38.82	۱۳۷۴
2000	65.11	83.54	247.00	121.00	12.81	89.36	۱۳۷۹
2005	102.74	176.81	539.74	201.57	21.56	152.08	۱۳۸۴
2006	102.92	181.70	541.16	200.41	21.25	152.78	۱۳۸۵
2007	124.67	159.61	507.95	205.86	20.97	164.98	۱۳۸۶

Source: Iran and World Energy Statistics and Figures (2007)

Change in energy price after subsidy reduction is shown in table 2.3-9.

Table 2.3-9 Change in Energy Price in Iran

categories	price（Rials）(~2010)	amount	price（Rials）(2011~)
Gasolin	1,000/L	Less than 60 L/month	4,000/L
		More than 60 L~/month	7,000/L
Electricity (home use)	162/kWh	—	450/kWh
Natural gas (home use)	$100/m^3$	—	$700/m^3$

Note: Electricity price is estimated value of average price.

Electricity price is set by use and consumption amount. Regulation of electricity price from 2011 is shown in Table 2.3-10.
Also, gas price is different largely according to regions. In the south where is hot and humid, price is one - tenth of the north. This is a policy to make utility costs equal regardless of use volume.

Table 2.3-10 Regulation of Electricity Price in Iran

【1- Home Use】

1-1- Tariff for ordinary regions and non-hot months of tropical regions

Average monthly energy consumption (kWh/month)	**Base Price (Rial/kWh)**
0-100	**300**
Over 100-200	**350**
Over 200-300	**750**
Over 300-400	**1,350**
Over 400-500	**1,550**
Over 500-600	**1,950**
Over 600	**2,150**

1-2- Tariff for hot months in tropical regions# 4

Average monthly energy consumption (kWh/month)	Base Price (Rial/kWh)
0-100	240
Over 100-200	280
Over 200-300	500
Over 300-400	800
Over 400-500	1,150
Over 500-600	1,500
Over 600	1,800

1-3- Tariff for hot months in tropical regions# 3

Average monthly energy consumption (kWh/month)	Base Price (Rial/kWh)
0-1,000	350
Over 1,000-1,500	650
Over 1,500-2,000	1,150
Over 2,000-3,500	1,250
Over 3,500-4,500	1,350
Over 4,500-6,000	1,450
Over 6,000	1,550

1-4- Tariff for hot months in tropical regions# 2

Average monthly energy consumption (kWh/month)	Base Price (Rial/kWh)
0-1,000	220
Over 1,000-2,000	500
Over 2,000-3,000	850
Over 3,000-3,500	1,050
Over 3,500-4,500	1,250
Over 4,500-6,000	1,350
Over 6,000	1,450

1-5- Tariff for hot months in tropical regions# 1

Average monthly energy consumption (kWh/month)	Base Price (Rial/kWh)
0-1,000	100
Over 1,000-2,000	110
Over 2,000-3,000	120
Over 3,000-3,500	500
Over 3,500-4,,500	900
Over 4,500-6,000	1,150
Over 6,000	1,250

【2- Public Use】

Tariff code		With over 30 kW power				With a power of 30 kW and less			
		Power price (kW/Rial)	Energy price (Rial/kWh)			Power price (kW/Rial)	Energy price (Rial/kWh)		
			Shoulder peak	Peak	Off-peak		Shoulder peak	Peak	Off-peak
2-A	1	30,000	1,100	2,200	550	-	1,300	2,600	650
	2	25,000	340	680	170	-	440	880	220
2-B		12,000	190	380	97	-	240	480	120

Classification of public use

2-A	1	Ministries and their affiliated offices, Municipalities and all governmental organizations that are not managed like a company, Diplomatic places, lighting of special passageways, common consumptions of non-residential buildings, tombs, cemeteries, lighting of the roads and flashing lights, Tunnels, and foggy areas
	2	All research institutes, the Parliament, Judiciary, CNG and gas stations, hospitals and other healthcare centers, Physicians' offices, parks, green areas, and other city beautification activities, common uses of residential buildings, common uses of residential towns,
2-B		Cultural centers (e.g. libraries, museums, historical places, etc.), cinemas, training centers (i.e. kindergartens, schools, universities, training hospitals, etc.), dormitories, mosques, holy shrines, sacred places for religious minorities, sport centers, welfare centers, care centers for the disabled and old people, public baths, gyms, military and police centers, bakeries, jungle parks, water desalination installations

Note: Edited by translation from Persian

Source：http://www.tbtb.ir/organization-nerkh90-fa.html

http://pieee.moe.org.ir/_power/Documents/Tariff%2090_20110427_114711.pdf

2.4. Energy Policy

2.4.1. Organization and System in the Energy Sector

Ministry of Energy (MOE) and Ministry of Petroleum (MOP) are two major ministries responsible for the energy conservation. The former mainly supervises the electric energy related field and the latter supervises on the oil and the gas energy related field. Looking at the energy base, 90 % of the energy is supervised by MOP, but MOE has been leading the energy conservation policy. Besides, Ministry of Commerce, Industries & Mining (MOIMT)[8], Ministry of Roads & Urban Development (MORUD)[9], Ministry of Jihad-e-Agriculture take parts in the energy conservation (Figure 2.4-1).

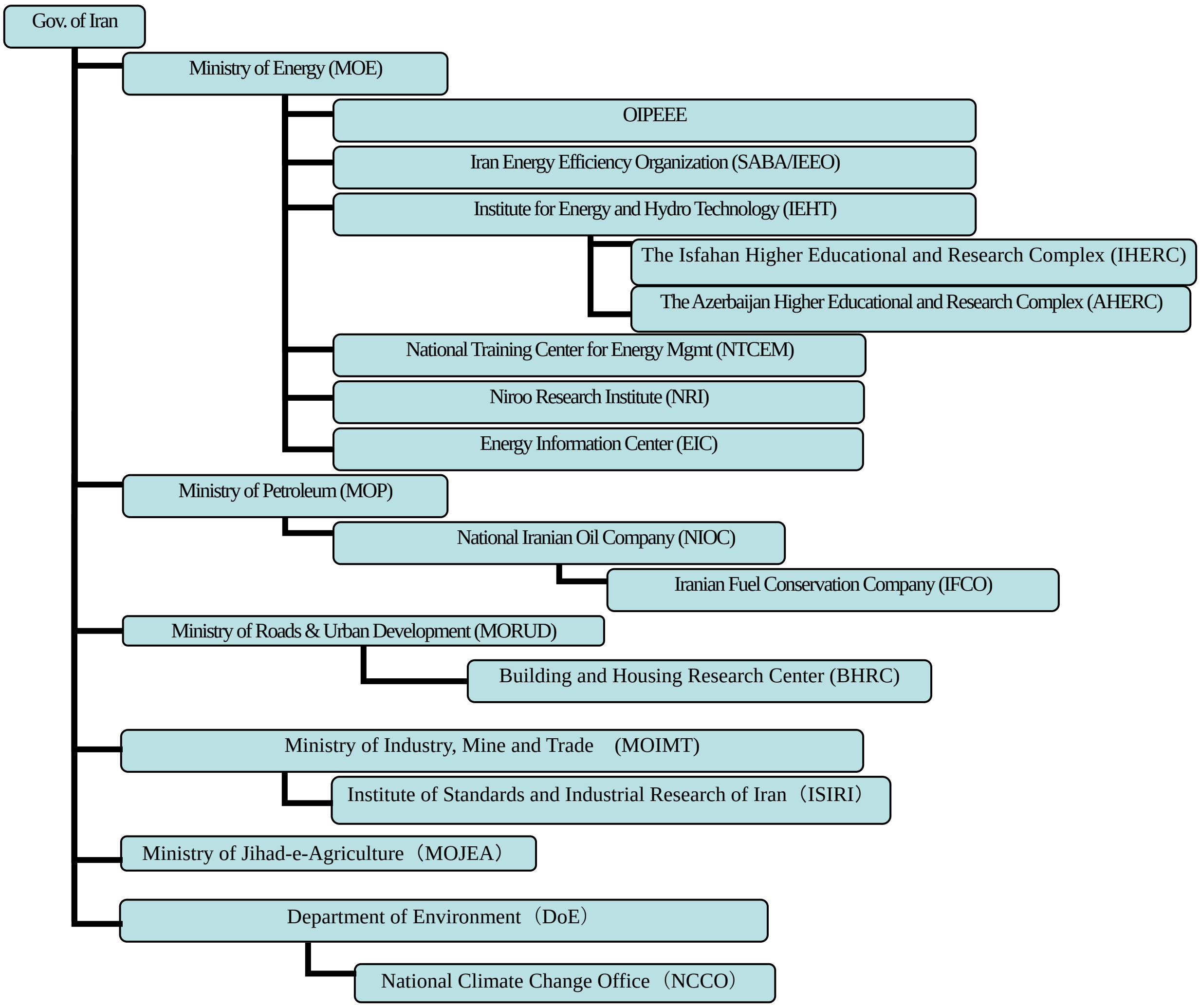


Figure 2.4-1 Main Government Offices to Supervise Energy Management

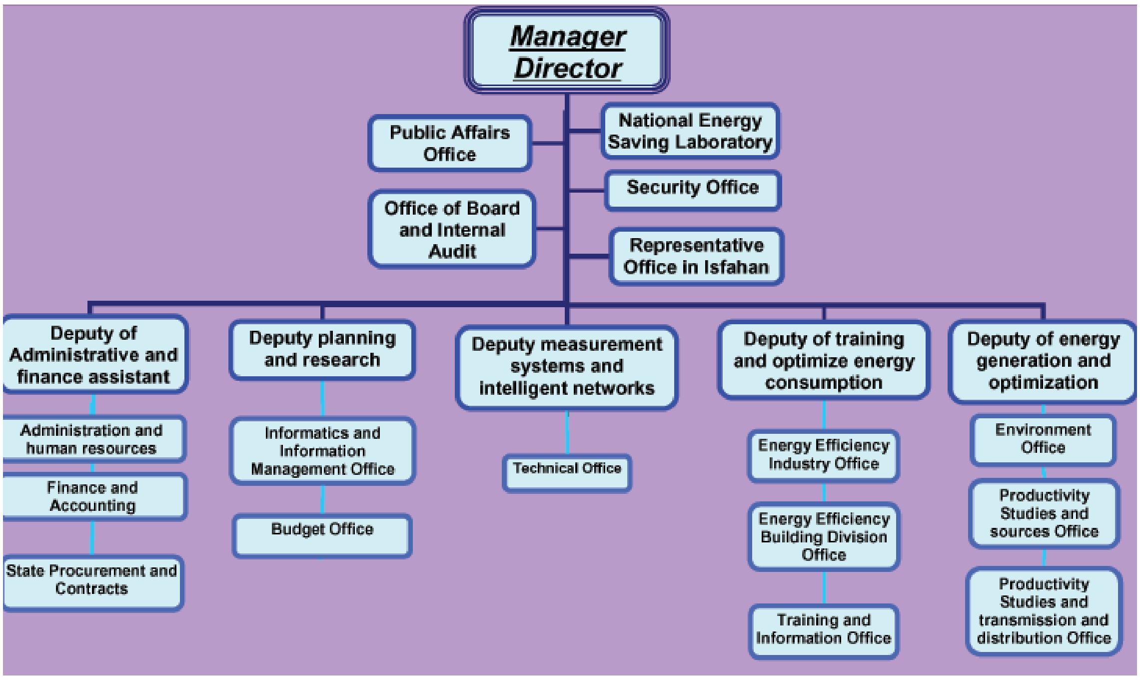
8 Ministry of Commerce (MOC) and Ministry of Industry and Mine (MOIM) have integrated in 2011.

9 Ministry of Housing and Urban Development (MOHUD) and Ministry of Road and Transportation (MRT) have integrated in 2011.

(1) Iran Energy Efficiency Organization

Iran Energy Efficiency Organization (SABA/IEEO[10]) was established under MOE in 1996. Its main responsibilities include energy audit of factories, consultation, education and public campaign on energy conservation, and research and development of efficient utilization of electric power and heat recycling.

The organizational chart of SABA is shown in Figure 2.4-2.



Source: SABA website,http://www.saba.org.ir/saba_content/media/image/2010/09/775_orig.gif

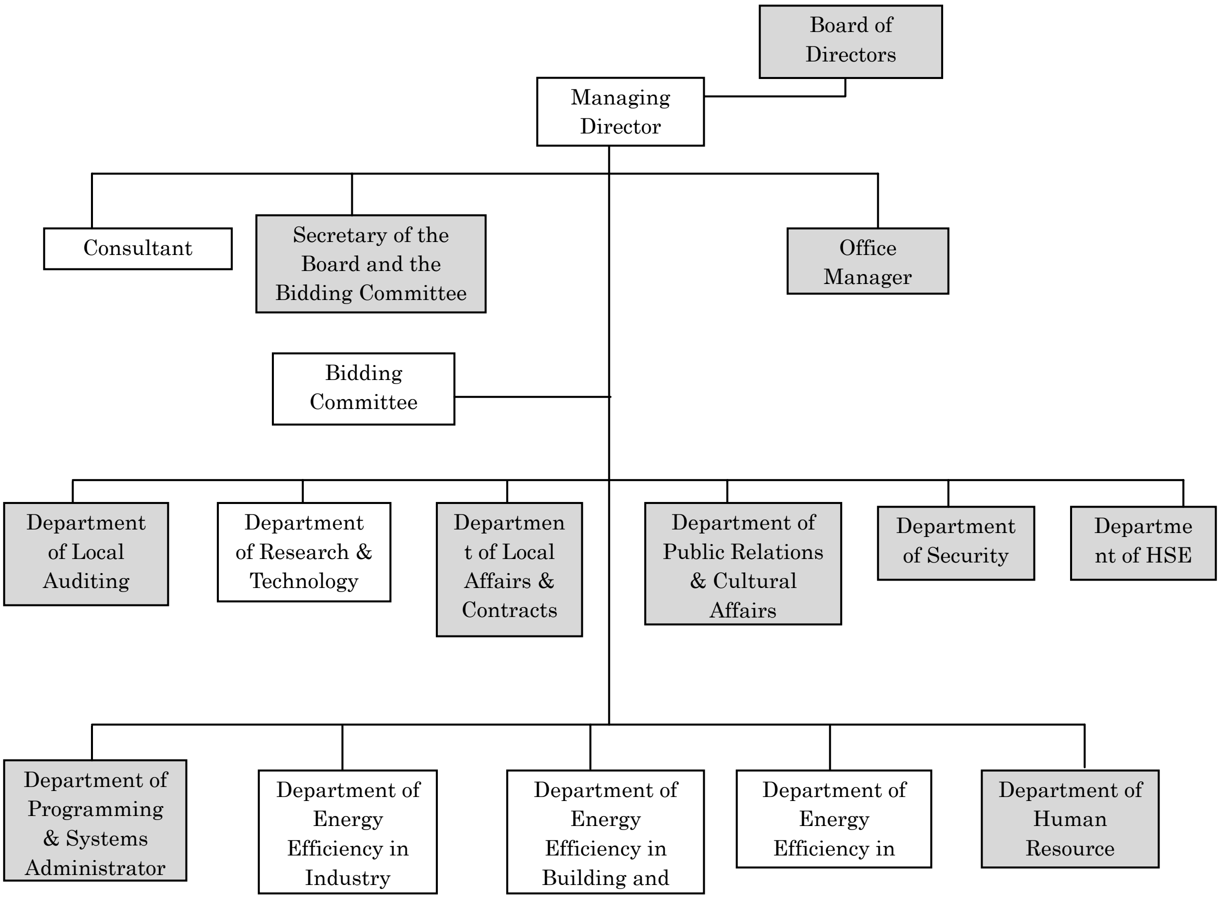
Figure 2.4-2 Organizational Chart of SABA

10 Iran Energy Efficiency Organization : IEEO. SABA is abbreviated expressions in Persian

(2)Iranian Fuel Conservation Company

Iranian Fuel Conservation Company (IFCO) was established in 2000 under the authority of MOP as a subsidiary of National Iranian Oil Company (NIOC). Recognizing domestic energy usage, IFCO aims at promoting energy conservation throughout the nation by their various activities. In addition, it carries out a program to convert fuel to compress natual gas (CNG) in the transportation sector.

The organizational chart of IFCO is shown in Figure 2.4-3.



Source: http://ifco.ir/images/top-chart1.gif

Figure 2.4-3 Organizational Chart of IFCO

(3) Other Authorities

Many governmental ministries and organizations directly or indirectly involves with energy conservation policy and implementation due to diverse forms of energy usage and the characteristics of universal usage in the country. Energy Consumption Pattern Reform Law which was approved in March 2011 also stipulates ministries responsible for promoting energy conservation in each field.

2.4.2. Policy and Law related to Energy Efficiency & Conservation

(1) Long-term Development Plan

There are two long-term development plans in Iran namely The Future Outlook of the Islamic Republic of Iran in the Horizon of the Next Two Decades and Draft Iran Fifth Development Plan. Both plans are developed mainly by Management and Planning Organization and to be the foundation for the various policies of Iran.

1) The Future Outlook of the Islamic Republic of Iran in the Horizon of the Next Two Decades

This is twenty-year plan from 2005 to 2025 and the future social image of Iran is expressed. It was formulated in 2005.No numeric figure for the economic target or for the energy efficiency and conservation is described in this plan. Below is the brief summary.

The Iranian society will have the following characteristics under the horizon of the outlook:

- To be developed in accordance with its cultural, geographical and historical circumstances
- To have advanced science, capable in producing knowledge and technology
- To have secured, independent and powerful defense
- To have favorable living environment
- To be proud Iranian
- To gain the economic, scientific and technological first position in the region of the South West Asia
- To be inspirer, active and effective in the world of Islam
- To have constructive and effective interaction at the world

2) Iran's Fifth Five-year Development Plan

This plan is for the next five years 2011-2015, formulated in 2011. The deliberation of this plan at the Parliament has already been finished and the approval by higher-level council also has been made.

This plan sets the annual economic growth target as 8 % at the lowest. In addition, as for energy saving, the article 134 stipulates that in order to maintain energy resources and protect the environment, MOE, MOP and old MOIM are going to practice financial incentives for observing energy consumption status and producing energy efficient equipments based on the guideline (which will be formulated in the first year of the Five-year plan).

Article 134- In order to save energy and encourage and support energy users to rationalize and reform the energy and electricity consumption pattern, maintain national energy resources and protect environment, Ministries of Energy, Petroleum and Industry and Mines are allowed to practice financial incentives for observing consumption pattern and energy efficiency and producing energy efficient and high standards equipments according to a guideline which must be approved by the Economy Council at most by the end of the first year of the Plan.

Source: Abstraction of the Fifth Five-year Development Plan, translated by the study team.

Also, the article 133 explains the roles of the Ministry of Energy (such as providing subsidies or formulating incentive policies) which are necessary for having variety in energy supplying ways, optimizing power plants, reducing energy losses and developing combined heat and power generation (CHP).

(2) Energy Consumption Pattern Reform Law

The deliberation in the parliament was finished and approved in March 2011.This is the law composed of about seventy five articles in eleven chapters.

The purpose of this law is to manage and optimize energy usage. Specifically, it aims to prevent energy loss, increase its efficiency and productivity, help sustainable development and environmental protection without reducing the level of national production and social welfare. Basic courses and executive policies include energy supply and demand management, energy consumption reduction to its optimum level, efficiency increase of conversion, transmission, distribution and consumption of energy, and energy loss prevention. Policy-making in the energy sector is undertaken by the government and confirmation by the parliament and by the president is necessary for implementation.

Ministry of Petroleum (MOP) and Ministry of Energy (MOE) play specific roles in implementing these policies. Each ministry's responsibility is described as follows.

Table 2.4-1 Items of Ministries in Charge in Energy Consumption Pattern Reform Plan

MOP/MOE	forecast and update it every year on energy supply and consumption of the country for the next 30years.
MOP	optimization of energy consumption, development and application of new energy conversion technologies, reduction in long-term expenses resulted from energy optimization, and etc.
MOE	development and application of various energy supply sources including renewable energies, promotion of energy efficiency and conservation (EE&C), conservation of environment, and etc.
ISIRI	formulate national standard (equivalent to JIS) on building materials working with old MOHUD
Old MOHUD	Formulate regulations on building EE&C working with MOE and MOP Prepare educational material on building EE &C
Ministry of Education and Training Ministry of Labor and Social Affairs	Prepare curriculum on EE&C working with MOE and MOP and execute education
Ministry of Science , Research and Technology	Execute education on energy management in universities.

As for the energy usage in the building and urban development, Ministry of Housing and Urban Development (old MOHUD) in cooperation with MOE and MOP is in charge of implementing Building Engineering and Control System's law. Old MOHUD mainly provides principles and regulations toward "green building" while MOE and MOP develop the standard and criteria of energy consumption for "green building".

(3) Subsidy Rationalization Law

In Iran, energy had been provided at fairly lower price than international price by governmental subsidy.

Subsidy Rationalization Law enacted in 2010 is set to reform the local sales prices of fuels to be no less than 90% of delivery price and the average local sale price of natural gas is set to be equivalent to 75% of exporting price in Persian Gulf Free On Board (FOB) by the end of Iran Fifth Five-Year Development Plan. Earnings obtained by raising the price of energy will be used as follows:

1) 50%: compensation to public welfare (subsidies to households, enhancement of social insurance and medical service, financial support on housing and employment, social support program, and etc.)
2) 30%: promotion of EE&C in the industrial world (improvement of EE&C, reforming technology structure of manufacturing, improving and extending public transportation system, supporting industrial and agricultural sectors, and etc.)
3) 20%: revenue of the government (which will become 0 % in the future)

(4) Article No. 19 of Building Code

Article No.19 of Building Code (effective since 2000), regulation on the EE&C in the building sector in Iran, consists of text and annex. The text contains five chapters and the contents of each chapter are as follows:

Chapter 19-1: Generalities (Scope of application and definitions)
Chapter 19-2: General regulations for designing and implementation
Chapter 19-3: Building external envelope
Chapter 19-4: Mechanical installations
Chapter 19-5: Lighting

Annex: heating and cooling energy demand in the regions according to climate, as well as thermal conductivity of building materials and insulation performance of envelope.

1) The chapter 19-3 of the current regulation relates two calculation methods of thermal performance of building: “prescriptive method” and “system performance method”. Both methods categorize buildings into 4 groups depending on their need for energy saving and set required thermal performance for buildings of each group, though the basic idea of those methods differs. On one hand, the “system performance method” consists of calculating referential thermal loss value of a building in designing based on referential thermal transmittance value of its components (e.g. roof, walls, floors), and design value of thermal loss based on actual material, construction method and surrounding environment, then compare referential and design thermal loss values so that design value remain lower than referential value[11]. The basic idea of this method can be described as “performance standards”. On the other hand, the “prescriptive method” applied to building lower than or equal to 9 floors whose floor area is less than or equal to 2,000 square meters, set thermal resistance values which each building components should satisfy. The method is based on “specification standard”.

a) 4 groups of building according to need of energy saving

Article No. 19 of Building Code (hereinafter “BC 19”), classifies buildings into group I to IV according to building types, citywise need of energy for cooling and heating, as well as site location (large city and others), and energy saving need according to total floor area of building.

i) Classification by building types

BC 19 sets following building type classification. As the classification goes from A to D, sojourn time of building users would diminish.

[11] Quantity of heat flowing through a unit area of building component separating inside and outside of building, between which temperature differs of 1 ˚C. Lower thermal transmittance is, higher thermal performance of the component of building.

Table 2.4-2 Classification of building types by BC 19

A	Dwelling, hospital, hotel, inn, dormitory, etc.
B	TV station, communication station, bank branch office, subway control room, office, educational facilities, post office, police station, fire station, restaurant, building complex consisting of office and shopping mall, bookstore, etc.
C	Attraction facilities, airport terminal, stadium, car repair shop, industrial factory, exhibition hall, theater, conference hall, movie theater, etc.
D	Small repairing facility, small factory, small car factory, multi level parking, aircraft hangar, vegetable and fruit market, subway station, train terminal, abbatoir, etc.

Source: BC19, Annex 4

ii) Classification by citywise need of energy for cooling and heating

BC 19 Annex 3 classifies cities in Iran by need of energy for cooling and heating into three categories “high” “medium” and “low”. Following is an example of different classification:

Table 2.4-3 Exemle of citywise classification by need of energy for cooling and heating

City	Need of energy for cooling and heating	Need of heating (O/-)	Need of cooling (O/-)
Jask	High	-	O
Chabahar	High	-	O
Teheran	Medium	O	-
Ramsar	Low	-	-

Source: BC 19, Annex 3

iii) Classification by site location and total floor area of building

In BC19, besides to classifications by building types and city wise need of energy for cooling and heating, site location and floor area of building define building group for energy saving defines building groups. According to site location (large city (population more than or equal to 1,000,000) and other cities) and total floor area of building (more than or equal to 1,000 square meters and others), buildings are classified into groups I to IV. The need of energy saving for these groups is described as follows:

- Group I: Building with high requirement of energy saving
- Group II: Building with modest requirement of energy saving
- Group III: Building with slight requirement of energy saving
- Group IV: Building with no requirement of energy saving

Following table shows classification of buildings according to building types, citywise need of energy for cooling and heating, site location and floor area of building

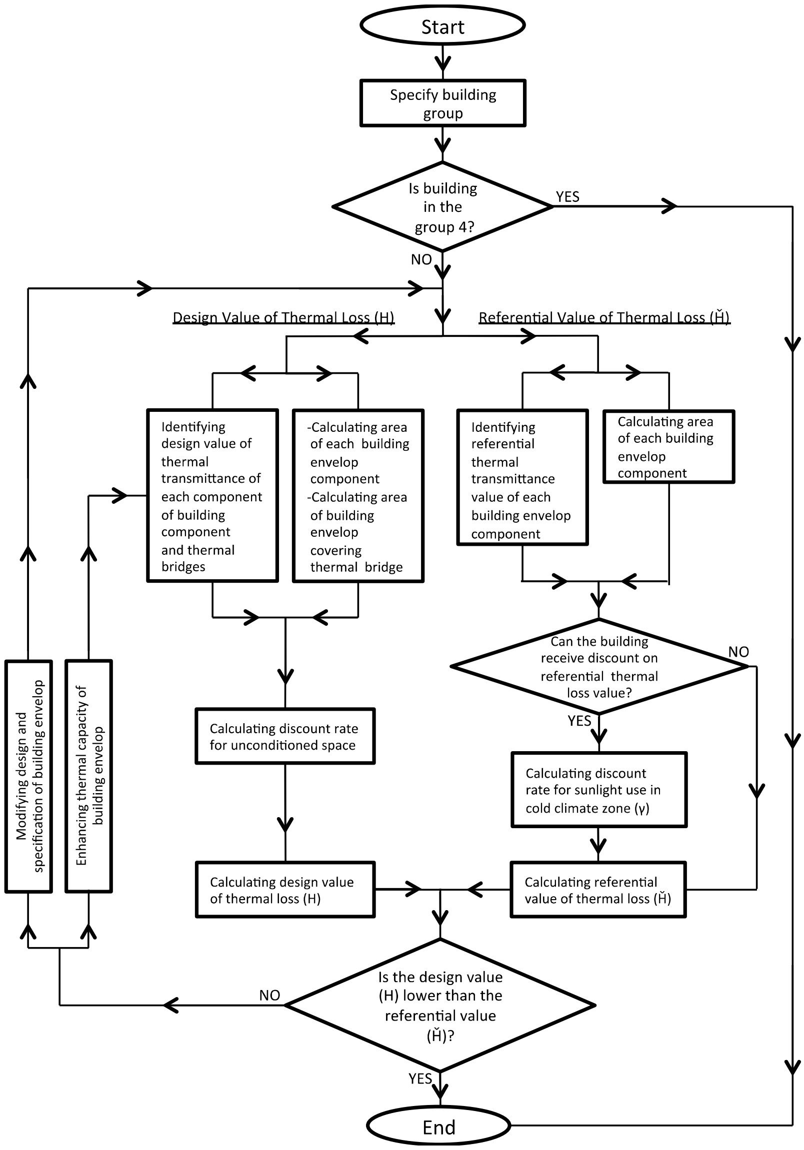
Table 2.4-4 classification of buildings according to need of energy saving

Building types	Citywise need of energy for cooling and heating	Large cities (capital of regions, cities with population more than or equal to 1,000,000)		Other cities	
		Floor area less than 1,000 square meters	Floor area more than or equal to1000 square meters	Floor area less than 1,000 square meters	Floor area more than or equal to1000 square meters
A	High	Group I		Group II	
	Medium	Group II		Group III	
	Low	Group III		Group IV	
B	High	Group II	Group I	Group II	
	Medium	Group III	Group II	Group III	
	Low	Group IV	Group III	Group IV	
C	High	Group II		Group II	
	Medium	Group III		Group III	
	Low	Group IV		Group IV	
D	High	Group IV		Group IV	
	Medium	Group IV		Group IV	
	Low	Group IV		Group IV	

For instance, in a case of housing in Tehran city, as housing belongs to building type A, and Tehran city is a large city with medium need of energy for cooling and hearing, this house will be classified into "Group II". Furthermore, because buildings in groups IV are considered to be without requirement of energy saving, no thermal standard is set in either "System Performance method" or "Prescriptive method".

b) Outline of building envelope design based on "System Performance method"

This method consists of calculating referential thermal loss value of a building in designing based on referential thermal transmittance value of its components (e.g. roof, walls, floors), and design value of thermal loss based on actual material, construction method and surrounding environment, then compare referential and design thermal loss values so that designed thermal performance can be better than referential thermal performance. The design flow of the method is as follows:



Source: Edited from BC 19 by JICA study team

Figure 2.4-4 Design flow of “System Performance method”

A set of referential value of thermal transmittance for each components of building is established for each group of building[12]. As example, table 2.4-5 shows referential thermal transmittance for components of detached individual dwelling in Group I to III. Besides detached individual dwelling, standard thermal transmittance values for “Attached Building with continuous application” and “Attached building with discontinuous application” are available in BC 19. The referential value of thermal loss of a building in designing is obtained as the sum of products of surface area of each envelope component of building (as for perimeter of erthen soil contiguous floor, total perimeter length) and its referential thermal transmittance.

[12] For more detail, see 19-3-1-2, BC 19 in Annex 1

Table 2.4-5 Referential Thermal Transmittance for individual detached dwelling (System Performance method)

Component	Referential Thermal Transmittance ($W/m^2.K$) by building categories		
	I	II	III
Wall	0.70	0.88	1.02
Flat or pitched roof	0.30	0.38	0.44
Earthen air-contiguous floor	0.45	0.57	0.66
Perimeter of erthen soil-contiguous floor*	1.45	1.83	2.12
Translucent layer	2.7	3.4	3.94
Door	3.5	4.41	5.11
Partitions adjacent to unconditioned space	0.55	0.69	0.80

* unit for "Perimeter of erthen soil-contiguous floor": W/m.K
Source: Building Code 19

Moreover, the actual design value of thermal loss H is obtained as a sum of product of surface area of each building envelope component, its actual thermal transmittance value and "heat transfer reduction coefficient of unconditioned space[13]".

"System Performance method" claims the H value to be lower than ・.

c) Outline of building envelope design based on "Prescriptive method"

This design method is a simplified method applied to building lower than or equal to 9 floors whose floor area is less than or equal to 2,000 square meters. It sets minimum thermal resistance values which each building components should satisfy. These thermal resistance values vary according to classification of sash and glazing of opening defined 19-3-2 of BC 19. The classification of sash and glazing are as follows:

Table 2.4-6 Qualitative ranking of windows in building thermal insulation according to prescriptive method*

Rank		Sash Window material	Glass type	Widow quality
Super	1	UPVC	Ordinary or low-E double-layer	With technical license
		Aluminum thermal break	Low-E double layer	With technical license
	2	UPVC	Ordinary or low-E double-layer	-
		Aluminum thermal break	Ordinary double-layer	With technical license
		Wooden	Ordinary or low-E double-layer	With technical license
Ordinary	3	All kinds	All single-layer types	-

* this categorization is only based on heat transfer but not air leakage.
Source: 19-3-2, BC 19

A part of minimum thermal resistance values for each building component, based on the classification of sash and glazing, in the Prescriptive method is shown on the following table[14]. Prescriptive method claims each component of building to provide higher thermal resistance than these values. Furthermore, no minimum thermal resistance values are given for buildings classified in the Group I with "Ordinary window" and application of "Super Window" is

[13] "Heat transfer reduction coefficient of unconditioned space" represent smaller temperature difference between unconditioned space (a space inside a building but not air-conditioned, such as an attic) and interior space of building, compared to difference between exterior and interior space of building. This coefficient is defined as proportion of heat flow between an unconditioned space and neighboring air-conditioned space, and total heat flow of the same unconditioned space. If a wall faces only to exterior space (i.e. not to unconditioned space), heat transfer reduction coefficient of unconditioned space of the wall will be 1. For more detail, see 19-3-1-3-5, BC 19, Annex 1.

[14] For more detail, see 19-3-2-5, BC 19, Annex 1

mandatory.

Table 2.4-7 Minimum Thermal Resistance (Prescriptive method)

Component			Standard Thermal Resistance ($m^2.K/W$) by building categories		
			I	II	III
With super window	Interior thermal insulation method	Wall adjacent to outdoor space	2.3	1.5	1.2
		Roof or ceiling adjacent to outdoor space	2.1	1.6	1.4
		Floor adjacent to outdoor space	2.1	1.5	1.3
	Exterior thermal insulation method	Wall adjacent to outdoor space	1.2	0.9	0.8
		Roof or ceiling adjacent to outdoor space	3.0	2.1	1.7
		Floor adjacent to outdoor space	3.2	2.2	1.7
With ordinary window	Interior thermal insulation method	Wall adjacent to outdoor space	-	4.9	2.4
		Roof or ceiling adjacent to outdoor space*	-	1.6	1.7
		Floor adjacent to outdoor space	-	1.5	1.7
	Exterior thermal insulation method	Wall adjacent to outdoor space	-	1.7	1.2
		Roof or ceiling adjacent to outdoor space*	-	2.1	1.7
		Floor adjacent to outdoor space	-	2.2	1.7

*In case the proportion of opening to the entire wall surface is 11 to 15%. For other cases, see Annex 1.
Source: BC 19

d) Review on energy saving level of BC 19

i) Overview of "Next Generation Energy Efficiency Standard" of Japan

Here BC 19 would be reviewed in comparison with Housing Energy Efficiency Standard (March, 2006) of Japan, so called "Next Generation Energy Efficiency Standard".

"Next Generation Energy Efficiency Standard" consists of "Criteria for Clients and Owners of Building" and "Design and Construction Guidelines on the Rationalization of Energy Use for Houses" (hereinafter "Design and Construction Guidelines"). The former Criteria set standard of thermal insulation performance for a house in terms of cooling load, thermal loss and summertime solar gain. And the latter Guideline specifies thermal performance which each component of house should satisfies. If a house either one or the other standard, this house is considered satisfying Next Generation Energy Efficiency Standard.

In the following chapters BC 19 will be compared to "Design and Construction Guidelines".

ii) Thermal transmittance and thermal resistance of building components according to "Next Generation Energy Efficiency Standard"

"Design and Construction Guideline" of Japan divides the country in 7 climate zone based on heating degree-day (18-18) and set target level of thermal transmittance of building components in each region. The climate zones are as follows:

Table 2.4-8 Climate zone according to Next Generation Energy Efficiency Standard

Zone	Heating Degree Day (18-18)（HDD）	Example (prefectures*)
I	HDD > 3,500	Hokkaido
II	3,000 < HDD ≤ 3,500	Aomori, Iwate, Akita
III	2,500 < HDD ≤ 3,000	Miyagi, Yamagata, Fukushima, etc.
IV	1,500 < HDD ≤ 2,500	Ibaraki, Tokyo, Kyoto, Yamaguchi, Oita, Kumamoto
V	500 < HDD ≤ 1,500	Miyazaki, Kagoshima
VI	HDD ≤ 500	Okinawa

*Zones are set on the municipality level actually, a prefecture can comprise more than one climate zones.

For each climate zone, a set of standards value of thermal transmittance are established as following table:

Table 2.4-9 Standard Thermal Transmittance by Climate Zone in Japanese Regulation

Type of house	Heat-Insulation method	Component		Standard Thermal Transmittance ($W/m^2.K$) by Climate Zone					
				I	II	III	IV	V	VI
House with a reinforced concrete structure	Interior thermal insulation method	Roof or ceiling		0.27	0.35	0.37	0.37	0.37	0.37
		Wall		0.39	0.49	0.75	0.75	0.75	1.59
		Floor	Exposed to open air	0.27	0.32	0.37	0.37	0.37	-
			Others	0.38	0.46	0.53	0.53	0.53	-
		Periphery of earthen floors	Exposed to open air	0.47	0.51	0.58	0.58	0.58	-
			Others	0.67	0.73	0.83	0.83	0.83	-
	Exterior thermal insulation method	Roof or ceiling		0.32	0.41	0.43	0.43	0.43	0.43
		Wall		0.49	0.58	0.86	0.86	0.86	1.76
		Floor	Exposed to open air	0.38	0.46	0.54	0.54	0.54	-
			Others	-	-	-	-	-	-
		Periphery of earthen floors	Exposed to open air	0.47	0.51	0.58	0.58	0.58	-
			Others	0.67	-0.73	0.83	0.83	0.83	-
other houses		Roof or ceiling		0.17	0.24	0.24	0.24	0.24	0.24
		Wall		0.35	0.53	0.53	0.53	0.53	0.53
		Floor	Exposed to open air	0.24	0.24	0.34	0.34	0.34	-
			Others	0.34	0.34	0.48	0.48	0.48	-
		Periphery of earthen floors	Exposed to open air	0.37	0.37	0.53	0.53	0.53	-
			Others	0.53	0.53	0.76	0.76	0.76	-

Source: Design and Construction Guidelines on the Rationalization of Energy Use for Houses (1999)

As example, a house of reinforced concrete, with interior thermal insulation in Tokyo (Zone IV) is claimed to have a wall whose thermal transmittance is less than or equal to $0.75W/m^2.K$.

Minimum standard thermal resistance values required to each building component are as follows:

Table 2.4-10 Minimum Heat Resistance (m^2.K /W) for Insulation Materials by Climate Zone in Japanese Regulation

Type of house	Heat-Insulation method	Component		Standard Thermal Resistance (m^2·K /W) by Climate Zone					
				I	II	III	IV	V	VI
House with a reinforced concrete structure	Interior thermal insulation method	Roof or ceiling		3.6	2.7	2.5	2.5	2.5	2.5
		Wall		2.3	1.8	1.1	1.1	1.1	0.3
		Floor	Exposed to open air	3.2	2.6	2.1	2.1	2.1	-
			Others	2.2	1.8	1.5	1.5	1.5	-
		Periphery of earthen floors	Exposed to open air	1.7	1.4	0.8	0.8	0.8	-
			Others	0.5	0.4	0.2	0.2	0.2	-
	Exterior thermal insulation method	Roof or ceiling		3.0	2.2	2.0	2.0	2.0	2.0
		Wall		1.8	1.5	0.9	0.9	0.9	0.3
		Floor	Exposed to open air	2.2	1.8	1.5	1.5	1.5	-
			Others	-	-	-	-	-	-
		Periphery of earthen floors	Exposed to open air	1.7	1.4	0.8	0.8	0.8	-
			Others	0.5	0.4	0.2	0.2	0.2	-
Wooden Houses	Fill insulation construction method	Roof or ceiling		6.6	4.6	4.6	4.6	4.6	4.6
		Wall		5.7	4.0	4.0	4.0	4.0	4.0
		Floor	Exposed to open air	3.3	3.3	2.2	2.2	2.2	2.2
			Others	5.2	5.2	3.3	3.3	3.3	-
		Periphery of earthen floors	Exposed to open air	3.3	3.3	2.2	2.2	2.2	-
			Others	3.5	3.5	1.7	1.7	1.7	-
Houses made with the framework wall construction Method	Fill insulation construction method	Roof or ceiling		1.2	1.2	0.5	0.5	0.5	-
		Wall		6.6	4.6	4.6	4.6	4.6	4.6
		Floor	Exposed to open air	5.7	4.0	4.0	4.0	4.0	4.0
			Others	3.6	2.3	2.3	2.3	2.3	2.3
		Periphery of earthen floors	Exposed to open air	4.2	4.2	3.1	3.1	3.1	3.1
			Others	3.1	3.1	2.0	2.0	2.0	-
Wooden houses, houses made with the framework wall construction method, or steel frame houses	Exterior lining insulation construction Method	Roof or ceiling		3.5	3.5	1.7	1.7	1.7	-
		Wall		1.2	1.2	0.5	0.5	0.5	-
		Floor	Exposed to open air	5.7	4.0	4.0	4.0	4.0	4.0
			Others	2.9	1.7	1.7	1.7	1.7	1.7
		Periphery of earthen floors	Exposed to open air	3.8	3.8	2.5	2.5	2.5	-
			Others	-	-	-	-	-	-

Source: Design and Construction Guidelines on the Rationalization of Energy Use for Houses (1999)

iii) Comparison of BC 19 and “Design and Construction Guidelines” of Next Generation Energy Efficiency Standard

The referential values of Thermal Transmittance in “System Performance method” of BC 19 and the minimum thermal resistance value of “Prescription method” of the same regulation will be compared to “Design and Construction Guideline”. Each of these legal texts, however, has particular background and definition of some elements differ in these texts. Therefore, values in following tables will be compared.

Table 2.4-11: Comparison between "System Performance Method" and "Design and Construction Guideline"

Component	Components of System Performance Method in Building Code 19	Components in "Design and Construction Guideline"
Wall	Wall	Wall
Roof	Flat or pitched roof	Roof or ceiling
Floor (earthen)	Earthen air-contiguous floor	Periphery of earthen floors (Exposed to open air)

Table 2.4-12 Comparison between "Prescriptive Method" and "Design and Construction Guideline"

Component	Components of Prescriptive Method in Building Code 19*	Components in "Design and Construction Guideline"
Wall	Wall adjacent to outdoor space	Wall
Roof	Roof or ceiling adjacent to outdoor space	Roof or ceiling
Floor	Floor adjacent to outdoor space	Floors (Exposed to open air)

Next Generation Energy Efficiency Standards stipulates standards for reinforced concrete structure with interior thermal insulation method and exterior thermal insulation method, as well as wooden houses, framework wall construction method and steel frame houses. Taking into consideration common building methods in Iran, reinforced concrete structure and steel frame houses will be compared (comprised in "Other houses" in the standard thermal transmittance of Next Generation Energy Efficiency Standard). On the other hand, the "Prescriptive method" of BC 19 stipulates different standard thermal resistance values according to classification of window sash and glazing. Here, standard thermal resistance value for building with "ordinary window", whose proportion to the wall is between 11 to 15 % will be compared.

As for climate zone, detached individual dwelling of Group II of BC 19 of Iran and climate zone IV of Next Generation Energy Efficiency Standard of Japan will be compared. Building Group II of BC 19 comprises detached individual dwelling with medium energy need for cooling and heating. Tehran, as example of cities with medium energy need for cooling and heating, registered 1,534 heating degree days from June 2010 to May 2011[15] and would be classified in the climate zone IV of Next Generation Energy Efficiency Standard. Although he heating degree days of Tehran remains almost at the lower limit of the Zone IV, this Japanese standard stipulates similar minimum standard thermal resistance values for building components in zone IV and zone V, which is climate zone with lower heating degree day after zone IV.

Comparison of referential and standard values of thermal transmittance in BC 19 and Design and Construction Guidance of Next Generation Standard of Energy Efficiency is as follows:

[15] Source: http://www.degreedays.net/, this figure is based on climate data near by Mehrabad airport.

Table 2.4-13 Comparison of Standard Thermal Transmittance ($W/m^2.K$) for individual detached dwelling

Component	Iranian Standards (group II)	Japanese Standards (Climate Zones IV and V)		
		House with a reinforced concrete structure		Other houses
		Interior thermal insulation method	Exterior thermal insulation method	
Wall	0.88	0.75	0.86	0.53
Roof	0.38	0.37	0.43	0.24
Floor (earthen)	0.57	0.58	0.58	0.53

On the other hand, comparison of thermal resistance of these regulations is as follows:

Table 2.4-14 Comparison of Standard Thermal Resistance ($m^2.K/W$) for individual detached dwelling

Component	Iranian Standards (group II)		Japanese Standards (Climate Zones IV and V)		
			House with a reinforced concrete structure		Wooden houses, houses made with the framework wall construction method, or steel frame houses
	Interior thermal insulation method	Exterior thermal insulation method	Interior thermal insulation method	Exterior thermal insulation method	
Wall	4.9	1.7	1.8	0.9	1.2
Roof	1.6	2.1	2.7	2.2	3.5
Floor	1.5	2.2	2.6	1.8	4.0

Except for the standard thermal resistance value for roof and floor in BC 19, which are significantly lower than "Design and Construction Guidance", those two standards remains approximately at the same level, or, BC 19 claims a higher thermal performance (e.g. outer wall with interior thermal insulation method). Under the restricted condition in which this comparison was made, thermal performances claimed BC 19 and Japanese Next Generation Energy Efficiency Standard are comparable level[16].

2) Outline of Mechanical installations (Chapter 19-4)

The regulation about installation of equipment is mentioned in article No.14 of Building Code. In addition to article No.14 of Building Code, the measure required for EE&C is indicated in Chapter 19-4. Chapter 19-4 consists of 4 Sections, a) General regulations, b) Heating and cooling institution, c) Air conditioning systems, d) Hot-water supply system.

a) General regulations

The general regulations, e.g. adoption of renewable energy, adoption of energy label products, the standard of temperature setting (20 degree C in winter, 28 degree C in summers), etc. are prescribed in this section.

[16] For reference, "Minergie P" of Switzerland, which is seemed as one of most advanced energy efficiency standards for building, claims thermal transmittance of outer wall to be less than $0.15W/m^2.K$.

b) Heating and cooling institution

Regulations about heating and cooling institution, e.g. introduction of control system for heat source, adoption of heat source with high efficiency (not less than COP=5), the standard value of insulation coefficient of insulator, insulating for piping, are prescribed in this section.

c) Air conditioning systems

Regulations about air conditioning systems, e.g. sealing in order to reduce energy loss by crevice wind, introduction of automatic controller for air supply fan, are prescribed in this section.

d) Hot-water supply system

Regulations about hot-water supply system, installing a hot-water supply system independently with the system of air-conditioning (in Iran, heat exchange of warm water and cold water for air-conditioning is carried out, and it is used for hot-water supply in many cases), carrying out temperature control (60 degree C), insulating for piping, are prescribed in this section.

3) Outline of Lighting (Chapter 19-5)

The regulation about installation of equipment is mentioned in article No.13 of Building Code. In addition to article No.13 of Building Code, the measure required for EE&C is indicated in Chapter 19-5. Chapter 19-5 consists of 6 Sections, a) Lighting systems and equipments, b) Lighting control systems, c) Lighting intensity and spaces, d) Lighting of the surroundings and outside area of the building, e) Electric power counter, f) Motors.

a) Lighting systems and equipments

Regulations about lighting systems and equipments, e.g. using high efficiency lamps with the minimum efficiency of 55 lumen/ watt, introduction of light reflector, are prescribed in this section.

b) Lighting control systems

Regulations about lighting control systems, e.g. installation of lighting switch on location easily viewable, adoption of schedule control, are prescribed in this section.

c) Lighting intensity and spaces

Regulations about lighting control systems, e.g. keeping intensity indicated in No.13 of Building Code, are prescribed in this section.

d) Lighting of the surroundings and outside area of the building

Regulations about lighting of the surroundings and outside area of the building, e.g. using high efficiency lamps with the minimum efficiency of 55 lumen/ watt, introduction of control system by intensity or schedule, are prescribed in this section.

e) Electric power counter

Regulations about electric power counter, e.g. each independent unit to be equipped with a separate counter for separate measurement of electricity consumption rate, are prescribed in this section.

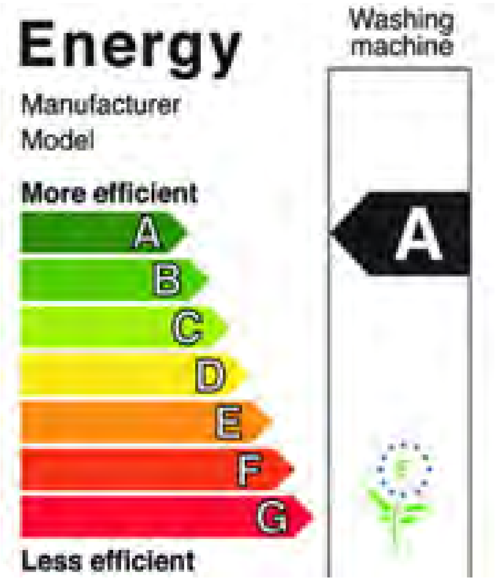
f) Motors

Regulations about motors, e.g. introduction of variable speed control to pumps and fans, are prescribed in this section.

(5) Energy labeling system for appliances

In Iran, the energy labeling system against household appliance is introduced from about 15 years before. The energy label has been introduced against 17 kinds of household appliance now. The standard for labeling is prepared by the Criteria Approval Committee that consists of SABA, maker and MOI. SABA carries out a primary examination and ISIRI carries out a secondary examination, "energy ranking" or "energy label" is given against appliances that met the standard. This system is relative valuation type and consumers can know what energy efficiency a certain product is compared with other products.

Image of the energy labeling in Iran is shown in Figure. 2.4-5.



1. Trademark
2. Name of company
3. Name of model
4. Energy efficiency grade
   7 grades :
   Most efficient is A,
   Worst efficient is G
5. Rated energy consumption
6. General information
   Capacity of appliance,
   Registration to ISO, etc

Figure 2.4-5 Image of the energy labeling in Ira

Chapter 3. Status and Issue of EE&C

3.1. Energy Efficiency & Conservation related Organization

3.1.1. SABA

It is estimated that nearly one third of total energy consumption used in the commercial sector is wasted in Iran due to lack of technological measures and a clear EE&C policy to prevent the situation. SABA (aka Iran Energy Efficiency Organization = IEEO) was established in 1996 under the Energy Affairs Department of the Ministry of Energy for promoting rational use of energy and promoting EE&C in Iran. As of July 2010, total number of its staff is 70 and the most of the staff member holds either undergraduate or graduate degrees with highly specialized engineering fields.

SABA provides a variety of services such as research and development (R&D), implementation of energy projects such as load management and energy recovery, economic and technical support, and training and capacity development of the private sector. From the establishment up to today, SABA has a network of EE&C promoting entities overseas such as ADEM (France), ESCAP, NEDO (Japan), etc.

SABA's main focus is promotion of energy management to industrial sector. SABA provides energy audit services by experienced engineers with a state of art measuring devises. In the past few years, SABA offers technical consulting services and successfully completed about 200 energy audits with a financial support from the ministry; consisting of 35 cement factories, 40 textile factories and 45 casting industries and 100 miscellaneous industries. SABA experts provide factory energy managers a benchmark of energy consumption of similar industrial segment for comparison.

SABA carries out a variety of educational and technical training programs ranging from school children to advanced industrial engineers. Of those, the most significant role that SABA plays in training and development is support to National Training Center for Energy Management (NTCEM) in Tabriz. Representatives from SABA evaluate audit reports and examinations submitted by the participants and certify the achievement . Among 992 trainees participating the training program at NTCEM from 2004 to 2009, 150 trainees completed successfully and received the certificate[17].

SABA, collaborating with the Ministry of Education, publishes an instructor's guide on EE&C for school education in such major provinces as Khuzestan. The program is expected to extend to integrate one or two hour-long EE&C class in curriculum. Other educational program includes public announcement on EE&C through TV programs, seminars for housewives on EE&C of home appliances

3.1.2. BHRC

(1) Description of BHRC

Building and Housing Research Center of Iran (BHRC), is a national center for research and accreditation of HVAC systems in building and housing affiliated with the Ministry of Housing and Urban Development (old MOHUD).

Activities of BHRC originally carried out by the United Nations Development Program

[17] According to SABA, the completion rate is relatively low, because of several reasons. Some participants from the same factory are shy to submit the final report analyzing the same factory facility. The participants from governmental institutions fails to submit the final reports due to confidential requirement.

(UNDP) between 1971 and 73 which eventually led to the launch of various research activities by then the Department of Building Studies and Regulation, Ministry of Housing and Urban Development (old MOHUD). In 1971, the duty was transferred to BHRC based on an agreement between old MOHUD and UNDP. In 1973, BHRC started its formal activities after completion of construction activities of BHRC administrative building and laboratories for physics and chemistry of materials. The proposed statute of BHRC was approved by the parliament in 1977, and BHRC commenced its research activities.

The total number of personnel is 340, which includes 27 scientists and 58 engineers specialized in building construction and architecture. The organizational chart of BHRC is shown in Figure 3.1-1.

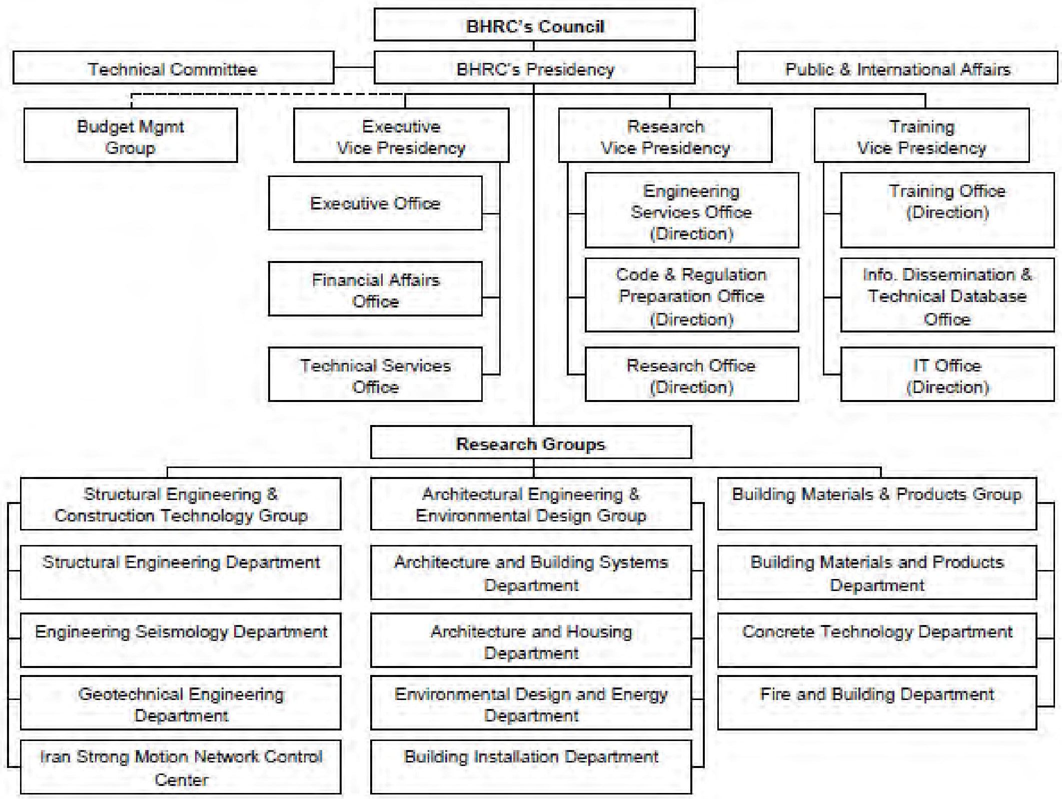


Figure 3.1-1 Organizational Chart of BHRC

(2) Mission and Objectives of BHRC

BHRC as a national institute committed to "research" and "information" to recognize the relevant problems and inadequacies in the field of building and housing development, to improve quality and quantity of its scientific and specialized capacities and capabilities through execution of theoretical and applied research projects. The objectives of BHRC are (i) to provide and to execute centralized research programs on building and housing by innovation of new methodologies and techniques, (ii) to provide and publish of codes of practice and their applied instructions, (iii) to issue technical certificates for building products, (iv) to provide technical guidance in construction and housing taking into account of national requirements, climatic and local considerations, and the need for industrialization of the construction sector.

(3) Activities of BHRC

1) Research

Applied research in various fields of building and housing requirements is one of the major activities of BHRC. Some of the most important research areas include: evaluation of physical and mechanical properties of building and housing materials, exploring new building materials, developing new constructional technologies for building and integration of traditional and cultural heritage of both urban and rural areas to cope with economic growth and prosperity. There are currently eleven research departments in BHRC and are equipped with advanced research lab and computer systems.

BHRC works on a joint research project in Hashtgerd with Berlin University from Germany. The project, named Megacity of Hashtgerd, aims at to create an environmentally-friendly model city with an energy-efficient building in a city 80km from Tehran.

2) Education

The main educational activities of BHRC consist of (i) to hold international and domestic conferences and seminars to share the latest research outcomes, (ii) to organize and participate in many exhibitions in and out of the country, (iii) to collaborate with national and international research centers, universities and other relevant organizations, and (iv) to hold short courses and workshops for engineers and professionals working in the field of EE&C.

3) Quality Assessment and Certification

Ensuring the quality of the building materials manufactured in Iran as well as certifying these materials are another important function of BHRC. Assessment and certification are granted by the relevant departments such as Fire-Research Laboratory for protection against fire, and Building Materials and Products Department for overseeing and coordinating.

4) Preparation of Regulations

Under the supervision of the National Building Regulation Office (of old MOHUD) and the Standard and Industrial Research Institute of Iran, BHRC compiles and prepares a variety of regulations such as codes of practice, standards and design criteria. It also provides standards on building materials and guidelines for testing quality control, coordinates the standards to concerned authorities for approval, and finally, gives certifications on technical approvals of building products and installed systems. BHRC currently undergoes revision of the article 19 of the Building Code for the National Building Regulation Office of old MOHUD. In addition, BHRC carries out development of manuals complying with the code, and dissemination of the guidelines and regulation through provision of mock-ups showing the construction methodologies and technique.

5) Dissemination of Scientific Information

Results of researches and laboratory work on building and housing conducted by BHRC are published in a various forms such as books, periodicals, and articles. Publications of these reports help MOE dissemination of new technologies for EE&C. The collection of BHRC Library includes a variety of periodicals and articles published overseas. It covers a wide range of subjects including social sciences such as social developments and economics in addition to engineering.

6) Technical Consulting Services

BHRC closely works with research and educational institutions, universities, industry, etc. Engineers of BHRC provide consulting services such as: new building and housing design, site selection, preparation of specifications based on specific technical standards, testing for quality assurance, etc to the public and private sector.

3.1.3. Institute for Energy and Hydro Technology (IEHT)

(1) Roles of IEHT

The Institute for Energy and Hydro Technology (IEHT) in Tehran, established in 1980, is the largest energy institute under MOE in Iran. Its mission is to provide technical training to experts and employees (engineers and technicians) of MOE as well as those of the electric power and water industries. The role of IEHT is similar to that of Power and Water University of Technology (PWUT), another educational institution under MOE, whose description will be discussed in separate section. IEHT provides in-services practical training while PWUT focuses on academic training. Each regional Higher Education and Research Institute has a strong tie with local industries.

(2) Organization and Structure

IEHT has the following five campuses (provincial branches) and a total of 65-acre campuses. Its maximum training capacity is up to 50,000 persons per month. IEHT, in Tehran, plays a central role for promoting education and training of MOE over five campuses in other cities as follows:

- Azerbaijan Higher Education and Research Campus (Tabriz),
- Isfahan Higher Education and Research Campus (Isfahan),
- Khorassan Higher Education and Research Campus (Mashhad),
- Quarb Higher Education and Research Campus (Kermanshah), and
- Fars Higher Education and Research Campus (Shiraz).

Among these five campuses, the institute in Tabriz, Isfahan, and Mashhad are major campuses in terms of size and capacity. Each of these campuses is located strategically to ensure the nation-wide coverage. Along with other nine training units[18], educational and training needs of the energy and hydro industries in both public and private sectors are located to meet by the nation-wide coverage. IEHT and its affiliated campuses are equipped with laboratories and workshops, workshops, libraries, computers, dormitories as well as other facilities for student service.

[18] The nine training units are locate at Orumiyeh , Bonab (under administration of Azerbaijan), Qeshm, , Taft (under Isfahan), Bojunord, Birjand (under Khorassan) , Sanandaj, Arak, (under Quarb), and Bushehr (under Fars).

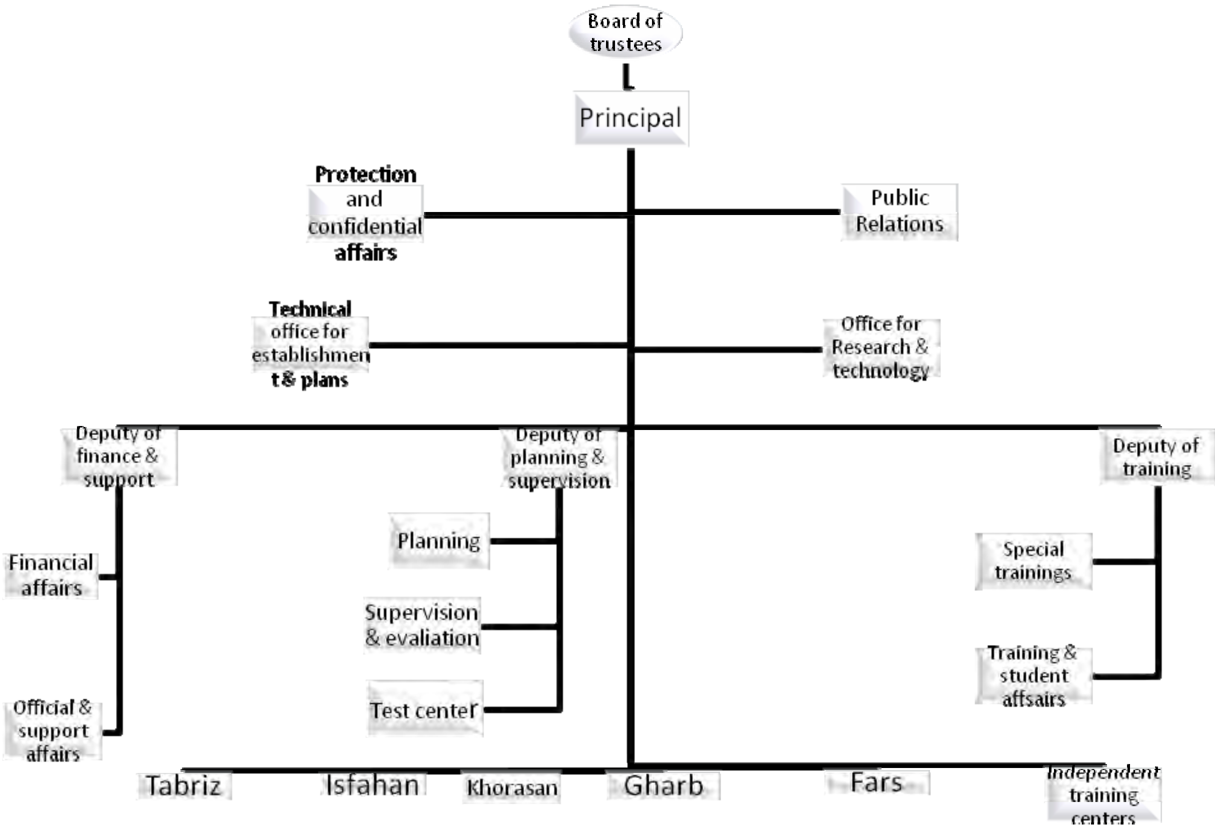


Figure 3.1-2 Organizational Chart of IEHT

(3) Education and Training Programs of IEHT

IEHT offers the following education and training programs:

- Water and wastewater technology,
- Environment, health and safety,
- Karez (or qanāt: traditional underground irrigation system)
- Electrical power plants,
- Power transmission and networks,
- Process automation and control systems,
- Information technology (IT), and
- Energy Management (at National Training Center for Energy Management (NTCEM) in Tabriz)

The institute offers two types of programs, short-term course and long-term course.
The long-term course is degree program. Depending on the yeas attended and credit takes, bachelor degree (four year) and junior degree[19] (two years) are offered. Number of student enrolled in the bachelors degree program is approximately 6,000. Short-term courses are in-service training for practitioners. Prospective trainees include officers of MOE, engineers and technicians of the private sector. The trainees to the short-term courses accounts 12,000 participants per annually in 2006. The number is increasing steadily.

The training of IEHT is discussed in 3.2.1

3.1.4. Power and Water University of Technology (PWUT)

A higher educational institution affiliated to MOE is Power and Water University of Technology (PWUT). It consist of the main 700,000 ㎡ campus in Tehran, satellite campuses in Kerman, Zanjan, and Hormozgan and a training office in Dubai.

The university offers undergraduate, masters and doctoral programs in addition to short-term program for businessmen and international programs. It also carries out applied research and technical consultation services. PWUT was originally established as a training center affiliated to MOE to provide in-service training for MOE employees. It was reorganized by Ministry of Science, Research & Technology as higher education institution in 1990 to offer an undergraduate program.

The university consists of Faculty of Energy Engineering, Economy & Management, Electric Engineering, and Hydro Engineering, and five research centers. There are 125 full-time faculty members and 600 adjunct faculty members from public and the private sectors. Total number of students in the undergraduate program in 2009 was 850 in five courses. The graduate students offering ten courses were 250. It hosts total of 23,194 in the short-term program. In addition, it dispatched 3,337 to international conferences organized by such institution as UNESCO[20], World Bank and Shell between 1992 and 2005

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[19] Junior degree is placed between bachelors degree and high school diploma.

[20] An international program on waste water treatment between UNESCO and IHE is currently in progress: (URL= http://www.unesco-ihe.org/Project-activities/Project-Portfolio/Training-and-Capacity-Building-for-the-Water-and-Wastewater-Sector-in-Iran)

3.1.5. IFCO

Iranian Fuel Conservation Company (IFCO), a subsidiary of National Iranian Oil Company (NIOC) established in 2000 has a mission to regulate fuel consumption in different sectors through monitoring and reviewing the current consumption patterns and promoting conservation measures in Iran. While SABA promote EE&C in electricity, IFCO promotes that of thermal energy. IFCO introduces a variety of modern energy management measures to Iranian economic subsectors to assist industries complying with conservation targets set by the government. Currently IFCO promotes wider use of CNG by motor vehicles to substitute petrol. And in the commercial sector, housing and commercial building consume more energy than any other economic sectors in Iran. This consists of 20% of oil products, 66% of natural gas and 12% of electricity and 3% of others (e.g. solar energy, coal, non–commercial fuels, etc)[21].

A challenge facing IFCO today is inefficient home appliances widely used in the market. Another is that majority of home builders lack appropriate insulation because they do not comply with the EE&C design principles. A survey covering whole country indicates that a typical house in Iran consume three times as much as that of a typical European houses. IFCO projects 1/3 of energy will be an energy-saving potential in houses when IFCO's EE&C programs will be carried out. Even the program was carried out, however, the energy efficiency in Iranian housing would be still low compared to European norms.

The Building Department of IFCO lists three important areas for achieving EE&C in the building sector in Iran. They include improvement of energy efficiency; building energy consumption reduction; and introduction of renewable energies. Specific strategies for promoting EE&C in Iran IFCO carries out are: (i) provision of subsidies to energy projects, (ii) enforcement of Article No.19 of Building Code, and (iii) carrying out research projects for promoting EE&C.

(1) Energy Subsidies Projects

IFCO provides subsidies (e.g. setting up low interest loans, etc.) for production of advanced building materials and home appliances including high efficient absorption chillers, high efficient induction cooking appliances, double glazing windows, UPVC and thermal brake standard window frames, thermal insulation materials for building, thermostatic valves, and high efficient gas water heaters.

(2) Collaboration for the Building Code Article 19

Article 19 of Building Code was approved in 1991 and enacted immediately. It was revised several times since 2002. On behalf of Iranian government, IFCO carries out some activities for implementation of Article No.19 of Building Code. They include: (a) preparation, compilation and implementation of guidelines and procedures (b) support of new construction materials such as thermal insulation producers by provision of low interest loan facilities. Currently 35 production lines of building materials are supported by the facility, (c) training for experts, engineers, technicians, workers; design training course to more than 5,000 skilled workers, (d) grant assistance to cooperative housing projects, (e) raising awareness and promotion of safe building construction for children and adolescents, youth, professionals, planners and decision makers, (f) development of energy laboratories: more than 8 laboratories for building material testing, (g) collaboration with other governmental companies for energy savings, NIOPDC, municipalities in other cities, etc.

[21] http://www.ifco.ir/english/building/build_index.asp

(3) Research Projects for Promoting EE&C

The Research and Technology Department of IFCO was established on 2007 to conduct research and technology development in architecture, according to the article 12 of the law regarding the petroleum industry research system. Examples of energy research project in building sector include: standard setting for radiators energy label, technical and economic evaluation of heat pumps and heat recovery systems, provision of energy certificates for governmental buildings in Tehran, design and construction of buildings outer layers, designing heat recovery system from sewage, and classification of energy service companies (ESCO). Other example is listed in their web page[22].

3.1.6. Organization for Engineering Order of Building

The Organization for Engineering Order of Building (Hereafter "Engineering Organization") is an agency of the Ministry of Housing and Urban Development (old MOHUD). It was established in accordance with the Law of the Organization for Engineering Order of Building. It certifies qualified design engineers in architecture, civil engineering, electrical engineering, mechanical engineering, traffic engineering, urban design, and geological survey. Engineers with three years working experience and a bachelor's degree in engineering on at least one of the seven disciplines are eligible to apply. In addition, s/he must pass the exam provided by the old MHOUD to be admitted.

The organization, headquartered in Tehran, has a coverage of membership nationwide and classification of memberships. It ensures the quality of building design, to meet the regulations. The classification of certificates and membership to the organization varies based on the applicants' competency and experiences. The certified engineers may, in accordance with the classifications, involve with different types and sizes of the buildings. Construction permits from municipalities are only granted to the plans prepared by the qualified engineers.

The organization pays strong attention to EE&C: providing a 32 hour-long training course for the members to acquire skills and knowledge complying with Article 19 of Building Code. Contents of the training include such subjects as installation of double glazing windows for schools in communities with poor infrastructure, and application procedures for governmental grants supporting EE&C projects.

[22] http://www.ifco.ir/english/building/energy/research_project.asp

3.2. Implementation of Energy Efficiency & Conservation

3.2.1. Education and Training

In this section, technical education and training for promoting EE&C in the building sector will be discussed.

(1) Higher Education

Importance of EE&C is a general topic covered in a variety of courses in the university education. EE&C with a specific focus on the building sector is not taught in relevant engineering disciplines of technical university education. Promotion of EE&C in the building sector to engineers requires multi-disciplinary research, training and education through collaboration of the field of architecture, and mechanical/electrical engineering. Only few master's level graduate programs in architecture (e.g. University of Tehran, Beheshti University, Khajeh-Nasir University, and the University of Applied Science and Technology) begun recently to cover relevant subjects in EE&C for building. SABA proposes Ministry of Education integration of relevant EE&C subjects into university curriculum. It is still yet materialized.

MOE has a variety of accredited training programs by the research institutions affiliated to the ministry. They include Power and Water University of Technology (PWUT), Institute for Energy and Hydro Technology (IEHT), along with other regional Higher Education and Research Institutes (HERIs).[23] These receive accreditation as higher educational institutions and grant diploma, junior[24], bachelors, and graduate degrees when the students fulfill respective requirements. The primary focus of the educational programs at the MOE affiliated institutions currently are EE&C in the industrial sector. In these institutions, EE&C for the building sector is not covered. Azerbaijan Higher Education and Research Institute in Tabriz where NTCEM locates, a master's level program on industrial EE&C started in 2007. Isfahan Higher Education and Research Institute further plans to start a course on EE&C granting junior degree expected July 2011.
It was stressed that a multidisciplinary study integrating management, architecture, heating, ventilation and air control (HVAC) is a fundamental characteristic of EE&C for the building sector as academic discipline.

(2) Training Programs for Engineer and Technician

1) MOE

A variety of training opportunities and framework are offered to officers of MOE as well as the engineers and technicians of MOE affiliated state-own companies (e.g. state-own hydro power plants, power companies, etc.) The framework is planned, developed, implemented and evaluated by the Office for Training, Research and Technology of MOE under the leadership of Deputy of Research and Human Resources based on the Managerial Classification Framework of MOE. (Figure 3.2-1). The staff of MOE as well as the state-own companies receives training carried out by IEHT and its provincial Research Campuses based on the Managerial Classification Framework. The program covers a variety of training program for initial training for newly employed officers to high-ranking officers and managers. (IHET offers long-term courses aiming at granting degrees and short-term courses for practitioners. Further detail on education and training is discussed in 3.1.3) The

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[23] The frameworks of the curricula of PWUT, IEHT, and HERIs are planned by the Office for Training, Research, and Technology under the Deputy of Research and Human Resources of MOE with the proposals/requests from each institute.
[24] "junior degree" is an Iranian degree ranking between diploma and bachelor in higher education.

short-term courses offers a variety of level (from entry to advanced) all year around.

The training program for the engineers and technicians of the private sector aims at employees of companies MOE has special relations (e. g. electric power installation, etc.). These companies dispatch the employees to the short-term and energy-related training provided by IEHT. Other clients include a variety of major local companies where five local Higher Education and Research Campus are located. IEHT (for example, there are many petro-chemical and ceramic companies located in Tabriz.) Azerbaijan Higher Education and Research Campus offers EE&C training program at NTCEM based on the four-year technical cooperation project by JICA. Other training program offered in Tabriz includes EE&C for the building manager, a six-days, 42 hours training program.

The participants of these short-term courses accounts by 18,119 in 2009 at all IEHT facilities. Training for officers accounts 14,640. The training course at NTCEM and practitioners other than MOE officers accounts 3,479.

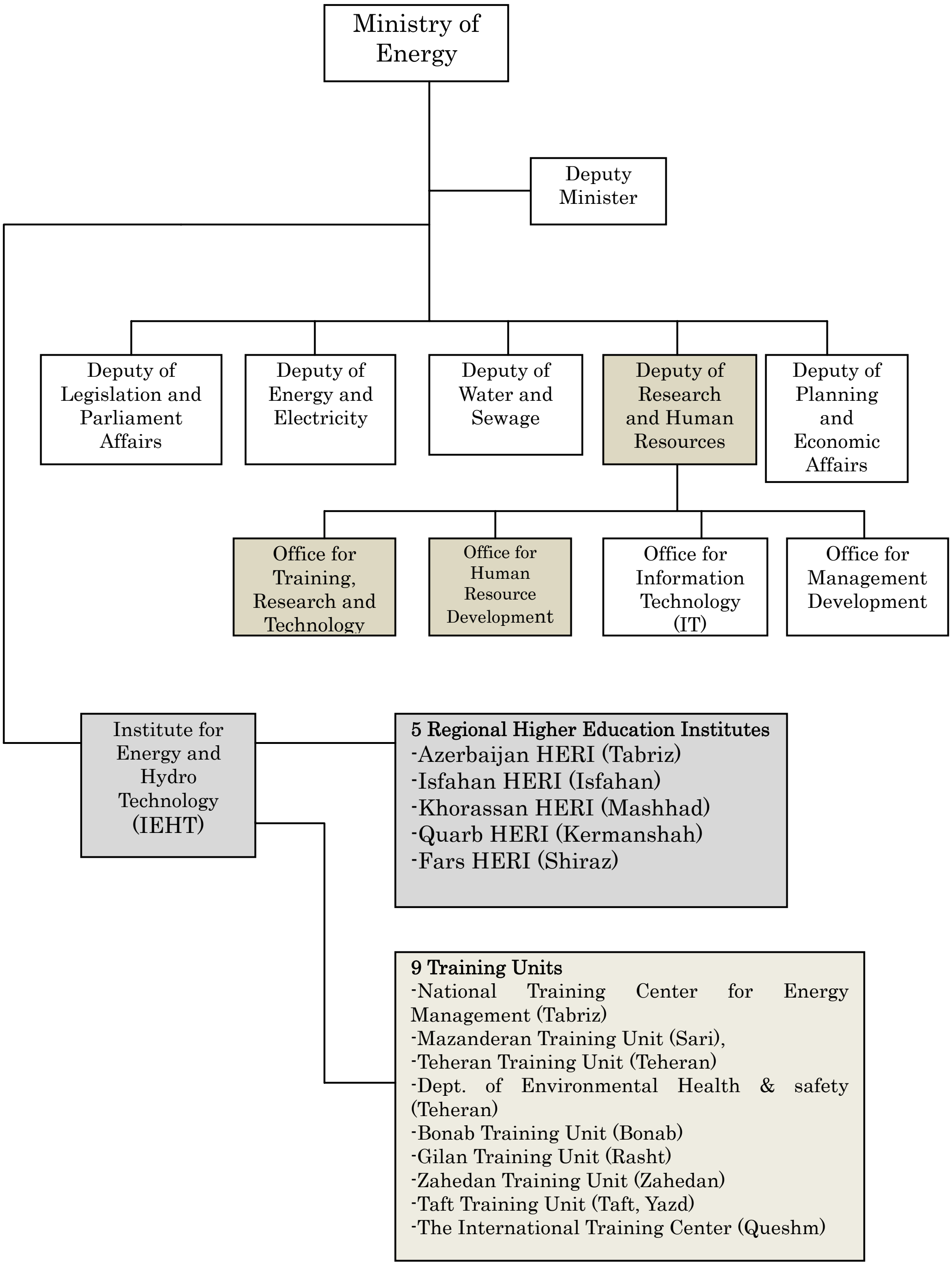


Figure 3.2-1 Organizational Chart of HR Development Dept., MOE[25]

[25] Based on the interview at MOE and the "Report of JICA Preparatory Study Mission on the Development Study for Institutional Capacity Development on Energy Management in the Building Sector in Islamic Republic of Iran (Japanese Version)" , March 2009, JICA.

2) SABA

SABA coordinates technical training with relevant organizations and institutions because it has limited facilities available for training. SABA no longer provides technical training by them. SABA asks an ESCO company to provide technical training when an industry requested. SABA focuses on EE&C of electricity, while IFCO focuses on heat. Therefore the roles of these two organizations complement each other. SABA plans to organize seminars on EE&C for building over 100 locations in Iran. The seminars are tailored for local ESCOs and contractors of maintenance of government-own buildings.

3) BHRC

The first courses for the introduction and dissemination of knowledge in EE&C in the building sector (BC19) was introduced by BHRC with the approval from the National Building Regulation Office (NBRO). BHRC has accomplished 80 EE&C courses designed for architects, civil, and mechanical engineers in Tehran and other locations. Each course consists of 32 hour lecture approximately 30 to 40 participants attend and sometimes 100 participants attend in rural provinces. The fee for the training course costs about US$100. After a few years, private educational companies, approved by NEBRO have promoted similar training courses.

Table 3.2-1 Example of BC19 Training Course

The curriculum of "Introduction of National Building Code 19" training course

16/07/2007- 18/07/2007, BHRC Meeting Hall

Date	Topic	Time	Subject
Monday 16/07/2007	Architecture-Installations	8:00-10:00	Heat transmission (Basic Subject)
	Architecture-Installations	10:20-12:00	Reviewing specific major and minor factors in energy saving rate
		12:00-13:30	
	Architecture-Installations	13:30-15:00	Heat transfer from building crust (Solving Numerical Examples)
		15:00-15:30	
	Architecture	15:30-17:00	Analyzing building elements in the plan & cross exterior shell
Tuesday 17/07/2007	Architecture-Installations	8:00-10:00	Controlling regulations of designing building exterior shell with functional & prescriptive methods
		10:00-10:20	
	Architecture-Installations	10:20-11:50	Introduction of materials used for building thermal insulation
		11:50-13:30	
	Architecture-Installations	13:30-15:00	Selecting thermal insulations and executive methods considering fire dangers
		15:00-15:15	

Date	Topic	Time	Subject
	Architecture	15:15-17:00	Introduction of energy checklist and how to control & fill it up
Wednesday 18/07/2007	Architecture-Installations	8:00-9:30	Condensation and its' consequent dangers
		9:30-9:45	
	Architecture-Installations	9:45-11:00	Introduction of modern installation systems and equipments
	Architecture	11:00-12:30	
		12:30-13:30	Break
	Architecture	13:30-15:30	Executive details for insulation of building exterior shell
		15:30-15:45	Break
	Architecture	15:45-17:00	Recommendations in designing building architecture and paying attention to climatic zoning
Thursday 19/07/2007	Architecture-Installations	8:30-10:00	

The curriculum of "Introduction of National Building Code 19" training course
20/12/2006- 21/12/2006
Place: Kerman Management & Planning Organization- Meeting hall
Held By: BHRC, and Kerman Management & Planning Organization

Wednesday 20/12/2006

Time	Subject	Instructor
8:00-8:30	Registration and opening ceremony	
8:30-9:30	Heat transfer from building shell	Dr. Behrouz Kari
9:30-10:30	Heat transfer from building shell	Dr. Behrouz Kari
10:30-10:45	Break	
10:45-11:45	Categorizing buildings and the way of completing the energy checklists	Dr. Behrouz Kari
11:45-12:15	Calculating source heat transfer coefficient and specifying economic optimum	Dr. Behrouz Kari
12:15-13:30	Lunch and praying break	
13:30-14:30	Regulations related to mechanical installations and lighting in building code 19	Dr. Shahram Delfani
14:30-15:30	Introduction of systems used in building thermal insulation	Dr. Behrouz Kari
15:30-16:00	Break	
16:00-17:30	Selecting thermal insulations and executive methods considering fire dangers	Mr. Saeed Bakhtiari

Thursday 21/12/2006

Time	Subject	Instructor
8:30-10:00	Introduction of materials used for building thermal insulation	Mr. Sohrab Viseh
10:00-10:30	Break	
10:30-12:00	Executive details for insulation of building exterior shell	Dr. Mohammad Taghi Hariri
12:00-13:30	Lunch & Praying break	
13:30-15:00	Executive details for insulation of building exterior shell	Dr. Mohammad Taghi Hariri
15:00-15:15	Break	
15:15-16:15	Executive details for insulation of building exterior shell	Dr. Mohammad Taghi Hariri

The curriculum of "Introduction of National Building Codes 19" training course
29/07/2006- 2/08/2006, BHRC Meeting Hall

Date & Time		Topic	Instructor
Saturday 29/07/2006	8:00-10:00	Heat transfer from building shell (basic facts)	Dr. Behrouz Kari
	10:00-10:20	Break	
	10:20-12:00	Heat transfer from building shell (Solving Numerical Examples)	Dr. Rima Fayyaz
	12:00-13:30	Selecting thermal insulations and executive methods considering fire dangers	Mr. Saeed Bakhtiai
	13:30-14:30	Lunch & Praying break	
Sunday 30/07/2006	8:00-10:00	Analyzing building elements in the plan & cross section of exterior shell	Dr. Rima Fayyaz
	10:00-10:20	Break	
	10:20-11:50	Introduction of materials used for building thermal insulation	Mr. Sohrab Viseh
	11:50-13:30	Condensation and its' consequent dangers	Dr. Sepeht Ganji
	13:30-14:30	Lunch & Praying break	
Monday 31/07/2006	8:00-10:00	Workshop (materials, energy, acoustic)	Dr. Behrouz Kari-Mr. Sohrab Viseh-Mr. Mohammad Jafar Hedayati
	10:00-11:00	Categorizing buildings and the way of completing the energy checklists	Dr. Rima Fayyaz
	11:00-11:30	Break	
	11:30-13:00	Calculating source heat transfer coefficient and specifying economic optimum	Dr. Behrouz Kari
	13:00-14:00	Lunch & Praying break	
	14:00-16:00	Introduction of systems used in building thermal insulation	Dr. Behrouz Kari
	16:00-16:20	Break	
Tuesday 01/08/2006	8:00-10:00	Executive details for insulation of building exterior shell	Dr. Rima Fayyaz
	10:00-10:20	Break	
	10:20-12:00	Executive details for insulation of	Dr. Rima Fayyaz

Date & Time		Topic	Instructor
		building exterior shell	
	12:00-13:30	Introduction of modern heating, cooling, air conditioning and other systems used in buildings	
	13:30-14:30	Lunch & Praying break	Dr. Shahram Delfani
Wednesday 02/08/2006	8:00-9:00	The role of insulation in building acoustic issues	Mr. MohammadJafar Hedayati
	9:00-10:00	Energy efficiency in housing and buildings	Representative of IFCO
	10:00-11:00	Introduction of IFCO projects	Representative of IFCO
	11:00-11:20	Break	
	11:20-12:20	Regulations related to mechanical installations and lighting in building code 19	Dr. Shahram Delfani
	12:20-13:30	Lunch & Praying break	
	13:30-15:30	Examination	

4) IFCO

IFCO finances EE&C training carried out by other institutions. For instance, it provides a grant to finance the training program on BC19 carried out by Organization for Engineering Order of Buildings (see details in the next section).

5) Organization for Engineering Order of Buildings (referred as "Engineering Organization")

Engineering Organization plays an important role in promoting EE&C for building by improvement of skills and knowledge of engineers who are certified to design buildings and facilities.

Since 2005, Engineering Organization has been conducting the training course of 32 hours for their member engineers to meet the requirements of Article 19 of Building Code. IFCO provides the fund. 15,000 engineers have participated. The Organization grants the certificate when the participants submit the qualified report based on their building energy audit which is the requirement of course completion. Completion of the courses is requirement of becoming upper level of memberships. The classifications of membership include four levels, premier, first, second and third grades. The classification determines the size of building that the member can design.

The training covers such subjects as electric/mechanical design, climatic design, insulation, BMS, etc, as described in the Building Code. However, the required energy audit for certificate is focused only installation and effectiveness of insulation. The audit procedure is a standardized by old MOHUD using energy-audit checklists. Because of some short-comings, the Engineering Organization would like to revise the checklist in near future.

6) Private Sector

Private sector provides in-house training for engineers and technicians to meet immediate needs of skill training to operate their products/systems. The training, therefore, has direct impact for improving the capacity of human resources in EE&C for buildings.

a) Example of a foreign-capital BMS company

Iranian subsidiary of a foreign-capital BMS company, that provides sophisticated BMS equipments and control systems for the large commercial buildings has staff training program. The engineers of the company are given a chance to participate in training in Europe for one month. A participant of the training interviewed by JICA Study Team told that the training was effective and he was able to apply the knowledge and skills acquired from the training to solve some problems encountered in his duties.

b) A case of a local ESCO

A local major ESCO cum heating control device manufacturer provides training for technicians. The company is increasingly aware of necessity of providing training to technicians. The training is financed by their own along with its affiliates overseas, not by the government. The certificates are not recognized as official qualification because it does not have official recognition from the government.

Because even an advanced BMS does not perform as planned if technicians do not know how to operate the system effectively. One example of a building in the University of Teheran the company shows that training is integral part of realizing EE&C. The company has a service agreement with the university. The initial energy-saving when the company installed a new EE&C under the contract was merely 20%. The figure was much smaller than it was anticipated level of 30% saving. The company then provided training to their employees, mainly technicians working with the university. It turned out that the total energy-saving after the training rose as much as 32%.

The company acknowledges the importance of capacity development to all level of employees including technicians. It believes that “the technician is a key for achieving EE&C for operation and maintenance of a building.” The company found that the technicians who are working in the maintenance and operation section are often not supportive of BMS, because they tend to believe that BMS jeopardizes job security. In some cases, technicians who have a long working history have influences over building owners on installing BMS, because some employees won trust from employers.

A strategy of the training is “Treat the technicians with respect and friendliness.” They believe that the training should be attractive and educational (i.e. providing better training environment and handouts with illustrations), so that less educated and reluctant technicians can understand the importance of EE&C of buildings.

c) Industry

Some technicians attend the specific technical training courses on absorption chiller, thermo-counters, equipments manufactured by EBARA, etc., funded by industry (e.g. a major petrochemical company). Such training opportunities is increasing. In these cases, the training is recommended to technicians by the chief of the section to attend. Though these training are limited to in scope (e.g. specific machinery of specific manufactures, etc.) , it contributes to strengthen the technician’s skill to promote EE&C in the building.

7） Vocational Training Schools

Many technicians undertaking operation and maintenance of building received training in vocational training school system and similar training facility in the private sector. Old generation of technicians become apprentices of master technicians after completing middle school education. The new generation of technicians receives such subjects related to energy such as electricity, heat and cooling in vocational school system.

3.2.2. Building Design, Construction and Supervision

From an architectural point of view, one of the most important factors of EE&C in building is the insulation of newly constructed building, because heat loss through building envelope resulted from incomplete insulation takes away from expected energy saving effect of equipment tuning. Furthermore, insulation work of existing building is quite difficult to realize, because of its cost and decreasing habitable floor area caused by thicker wall, therefore hardly undertakable for building owner and user. In consequence, execution of insulation in accordance with the regulations for new constructions is one of key issues of EE&C from architectural approach.

Effort in building design, construction and supervision is fundamental so that buildings are conform to regulations – in other words, designer designs based on the regulation, and supervisor supervise so that constructor construct based on this design. From this point of view, this chapter describes building design, construction and supervision system in Iran.

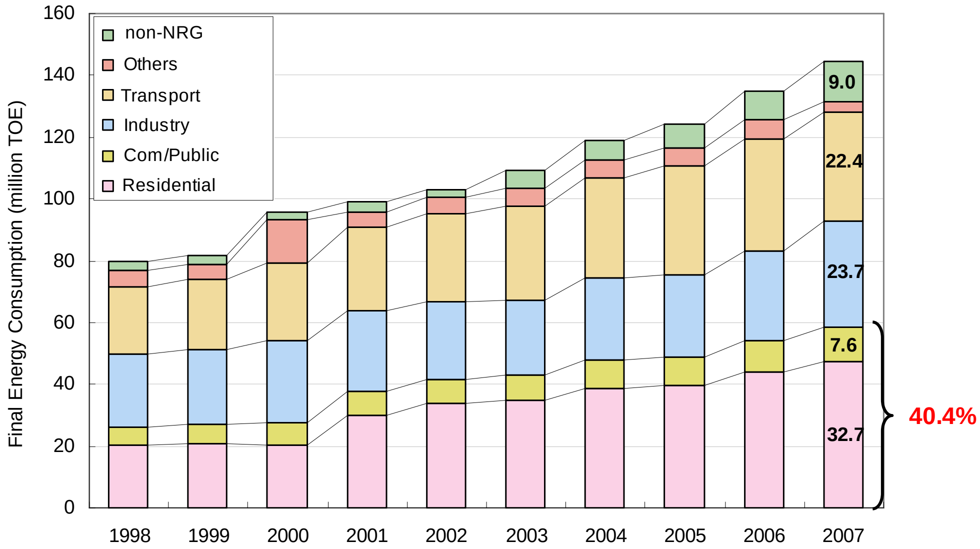
The construction authorization is delivered by the municipality where the building site in question situates. For the authorization, the municipality receives a checklist based on Building Code article 19 from the future owner of the building, thermal transmittance (K value) of the new building calculated by IFCO and detailed data of the specification of envelope and mechanical installation. The municipality checks whether they conform to regulations.

After issuance of the construction authorization, an engineer registered to Building Engineering Organization is nominated as supervisor engineer to take charge of the supervision of execution and to report on the construction of the building to municipality. There are 6 compulsory reports to the municipality according to the construction process of building.

The supervisor engineer takes not only the charge of the supervision, but also the support for the building owner and constructor regarding the construction and design. In addition, its fee is paid by building owner. That means supervisor engineer whose mission is to supervise ther construction, is not independent from client. This position of supervisor engineer seems to be one of the reason of none respect for regulations such as Building Code Article 19, and low execution accuracy. Further more, some interviewees attested that in Iran, a land owner often contract directly constructor and control building process by itself in order to cut the construction cost. If it is really case, it may abase even more the level of construction supervision.

3.3. Implementation of Energy Efficiency & Conservation by Sector

The final energy consumption that was 79.8 million TOE in 1998 increased at the annual average rage of 6.8 % and reached 144.7 million TOE in 2007. As for the final energy consumption by sector in 2007, residential for 47.3 million TOE (32.7%) was the largest, then transportation for 35.2 million TOE (24.4%) and industry for 34.3 million TOE (23.7%) follow. Moreover, the public sector including business was 11.1 million TOE (7.6%).



Source: Prepared by MRI off of "Energy Balances of Non-OECD Countries" IEA

Figure 3.3-1 Final Energy Consumption by Sector

Looking at the transition of the consumption from 1998 to 2007, it was the residential sector where the consumption was increased the most and its average annual rate of increase was 10.0%. It is followed by the public sector with the rate of 6.9%. The sum of the final energy consumption from these two sectors accounts for 40.4% of the final energy consumption of the whole country of Iran.

There is a working hypothesis that Iran will become energy importing country by 2018 if the total energy consumption of Iran is kept increasing at the annual rate of 6%. Therefore, as the energy conservation is becoming a pressing issue in Iran, the energy conservation of the buildings particularly in the residential and business/public sectors is a very important key.

3.4. Current Situation on Energy Efficiency and Conservation Market

3.4.1. Energy Efficiency & Conservation Business

(1) Present Situation of Energy Saving business

It is possible to purchase the energy saving devices for the building, such as building materials and the high efficiency equipment, in Iran. Because the energy price is held very low, energy users have no mind to save energy. Especially in private companies, there is almost no company which carries out even energy audit. Therefore, the companies which specialized in energy-saving business are very few, and their business is almost from a government organization.

There are 102 companies which have registered as ESCO in SABA as of March 2011. The main companies are listed in the table 3.4-1. The many are the consultant or engineering company of the energy field. The ESCO companies have no experience ESCO business with a performance contract such as Japan or ESCO advanced countries. SABA resisters the companies which have the ability to perform energy audit as ESCO, and SABA has commissioned the energy audit to the companies. Moreover, many of the companies which have registered in SABA do not understand correctly the ESCO business which has become popular in Europe, the United States and Japan. SABA has been holding
the work shop and session about ESCO business with a performance contract through a seminar etc., and is making efforts on the ESCO business more recognized.

Table 3.4-1 Main energy saving companies registered to SABA

No.	Company Name	Field of specialty
1	Asia Watt	Energy audit in sugar, brick, ceramic, and building industry
2	Ehdas Control	Non-metal inorganic industries- Food industries- Building hat installations- and Electrical industries (production, transmission, distribution)
3	Energy No-andish	Training energy management, fossil & electrical energy audit in process industries (esp. oil, gas, & petrochemical)- Automotive industry_ Steel
4	Barin Energy Sepahan	Energy audit and studies in steel & alloy industries, intelligent systems for energy management in buildings, & Traffic management
5	Parto Behineh Isattis	Load management-Energy training, equipments, and audit
6	Sabz Research center (University of Science and Industry)	Energy audit in big & small industries- Energy management training
7	Pajoheshgaran-e-sabz-e- Niroo	Load management in small industries
8	Persia Energy Gostaresh	Energy audit in metal industries and energy management training
9	Pishran Energy	Energy efficiency in building, and manufacturing equipments
10	Sepahan Training Facilities	Manufacturing equipments for energy efficiency and BMS systems
11	Khoozestan and Fars Cement Engineering Services	Energy audit in cement industries
12	Samen Niroo Pishtaz Technical & engineering services	Systems and networks of electrical energy distribution, & load management
13	Sman Energy	Energy audit in steel, sugar, cement, and building industries
14	Saramad Niroo	Energy audit and energy management in big and small industries
15	Environment and Energy Research and study Center	Environmental studies in power plants and big and small industries- Energy and environment trainings
16	Fararharvan Sanat	Energy management training
17	Yekta Behineh Tavan	Studies on the quality of electrical power and energy in sugarcane, steel, and automotive (car) industries
18	Tabesh Rayan Energy	Energy audit in building
19	Novian Behineh	Audit and awareness in building and small

		industries
20	Energy & Industry Consulting Engineers	Environment and auditing projects-implementing solutions in oil, gas, and petrochemical process industries
21	Behsaz Energy Sanat CO.	Energy audit in different industries and energy management training
22	Behrad Consulting Engineers	Studies on the quality of electrical power and energy and UPS manufacturer

JICA Study Team visited to the following eight energy saving companies registered in SABA for the hearing about the energy saving business in Iran.

1) EHDOS Control
EHDOS Control is engineering company of the energy field, and their main business is EPC (Engineering, Procurement and Construction) work of cement plants. They have experience of energy audit of about 50 cement plants for making specification of energy consumption benchmark under contract with NIOC. As for energy audit of buildings, they have six studies for energy saving of the lighting system under contract with SABA

2) ASIA WATT
ASIA WATT is engineering company of the energy field, and their main business is EPC (Engineering, Procurement and Construction) work of heavy user plants of heating such as brick plans and sugar plants. Especially they are skilled at energy efficiency by utilization of waste heat and have experience of energy audit of about 200 plants. Fifteen percent (15%) of their works are order from a government organization such as SABA and IFCO, other are from private companies.

3) NOANDISH
NOANDISH is consulting company of the energy field. They have not only experience of energy audit in the industrial field, but in the building field such as TV building, hospital and commercial complex. Now, they have curried energy audit for making specification of energy consumption benchmark of gas refinery plants under contract with NIOC.

4) PISHURUN ENERGY
PISHURUN ENERGY has energy saving business used by control device it has developed for heat source equipment. They are performing not only sale of the device but the contract similar the ESCO business which collects introductory costs from the reduction cost by energy saving.

5) SAMAN ENERGY
SAMAN ENERGY is engineering company for energy heavy users such as petrochemical plant, steel and iron plant, food plant and brick plant. They have experience of the consulting of SABA on the setting bench marks of home electronics. As for energy audit, they have curried the audits for about ninety percent of steel and iron plants in Iran, and also the audits for some buildings in various climate areas. Most of their audits are ordered by SABA and IFCO, not by the facility owners.

6) ENERGY & INDUSTRY CONSULTANTS (EIC)
EIC is a major engineering company of the energy sector in Iran. Their main businesses are engineering and energy audit for the industry. They have carried the energy audit of about ten industries. All of their audits were directly ordered by the facility owners. They

propose the measures for energy saving to the customer based on the audit, but they have never implemented the proposed measures for the customer.

7) YEKTA BEHINEH TAVAN

YEKTA BEHINEH TAVAN is consulting company of the power sector. Most of their consulting works is offered by SABA. As for energy audit, they have curried the audits of 1,500-1,600 facilities. The fee paid by the customer for the audit is about several million-dollars per order.

8) BEHSAN SANAT PAYDAR

P BEHSAN SANAT PAYDAR has energy saving business used by control device it has developed for heat source equipment such as boiler and chiller. They have carried many energy audits of the industry sector and government buildings. They develop the control system to improve efficiency by monitoring exhaust gas component and temperature of the boiler for the industry, but it is no function of monitoring energy consumption data in the system.

(2) Present Situation of ESCO business

DANA ENERGY is going to carry ESCO business which includes performance guarantee and financing arrangement in Iran. The company is an ESCO company established in 2010 by the capital of DANA Group which is a major company group of Iran, and is not registered in SABA. They have fifteen (15) contracts to introduce ESCO, and they are going to carry the energy audit for their customers. Most of their customers are auto parts manufactures. Their solution's target is not only the facilities of process line but office buildings in the factory. The investment cost in connection with ESCO enforcement is due to receive fund offer from DANA Group which is a parent company. Since many business risks will be taken, they have proposed the ESCO contract which can collect the investment cost in three years.

From now on, with the rise of energy prices, many energy saving companies are considering the participation to the ESCO business. And also SABA is holding the ESCO seminar for energy saving companies. Moreover, the government has a plan of establishment of ESCO Association to promote the ESCO business vigorously under the energy management low.

(3) Issue on Energy Saving business

The company concerned with energy saving has understood the subject to the popularization of energy-saving business in Iran as follows.

1) Low price of energy tariff
2) Lack of the enough attention to energy saving of a company
3) High investment cost to energy saving
4) Lowness of financial credit to energy service companies
5) Lack of financial and educational supports by the government organization to energy service companies
6) Shortage of the portable measuring instrument and system since there no mind of energy management

As for energy tariff, the reduction of subsidies for energy price has caused electricity and gas prices to go up. So the raising prices of energy generate a sense of expectancy in the energy saving business for the energy service companies.

The energy service companies expect the following requests and solution to the above mentioned subjects.

1) Legal status for energy service companies, and financial support such as finance and preferential interest treatment by the government organization
2) Institutionalization of the promotion for energy efficiency and conservation
3) Subsidy to the investment for energy saving
4) Establishment of the authorized person in charge for energy efficiency and conservation in organizations
5) Provision of measuring instrument to energy service companies
6) Study of the standard condition in ESCO contract
7) Classification and ranking of energy service companies
8) Education for raising of public awareness for energy efficiency and conservation

Especially, for the spread of the ESCO business, it is necessary to establish ESCO Association at an early stage. The ESCO Association must lead to educate ESCO Companies, to promote the ESCO, and to make the various manuals for ESCO business. The support of government is important for creation and expansion of an ESCO's market such as providing of a soft loan for ESCO and implementation of the pilot ESCO projects to government buildings.

3.4.2. CDM

(1) Basic Information Regarding CDM in Iran and the External Factors

1) Policies and Institutions relevant to CDM

Up to now, the Iranian government has approved the following two regulations regarding CDM.

(i) Approval of "Executive Regulation for the Climate Change Convention and Kyoto Protocol"

The member ministers of The Commission on Industrial and Environmental Foundations passed the "Executive Regulation for the Climate Change Convention and Kyoto Protocol" on February 22, 2009.

(ii) Approval of "Regulation for Approving Projects of Clean Development Mechanism within the Framework of Kyoto Protocol by the Designated National Authority (DNA) of Islamic Republic of Iran"

The council of minister approved the "Regulation for Approving Projects for clean development Mechanism within the Framework of Kyoto Protocol by the DNA of Islamic Republic of Iran" on December 21, 2009, which has become the basic regulation governing activities of the concerned field.

2) Current Status of Major Concerned Stakeholders

(i) DNA

DNA (Designated National Authority) of Iran is the Department of Environment (DoE). The contact information of DoE is as follows:

Table 3.4-2 Contact Information of NCCO

Item	Information
Address	National Climate Change Office, Pardisan Park, Hakim Exp., Tehran, Iran
Post Code	P.O.Box: 5181
Tel.	+9821 88264002
Email	m.soltanieh@climate-change.ir
Current Representative	Dr. Mohammad Soltanieh (National Project Manager of Environmental Research Center)

Source: NCCO of DoE

(ii) The Other Government Agencies Related to CDM
The other government agencies related to CDM include not only the central ministries like MOE, MOP, MOIMT, MOJEA, Ministry of Foreign Affairs (MOFA) etc., but also administrative organizations and research institutes report to the central ministries.

(iii) Facilitators in CDM Enlightenment and Information Transmission
At the governmental level, DoE functions as the lead office in charge of CDM enlightenment and information transmission, promoting this kind of activities either alone or with the collaboration of foreign agencies. In addition, the central ministries like MOE, MOP, MOI, MOJEA, and MOFA are also getting involved in various kinds of relevant activities such as holding workshops, seminars and conferences, opening websites, publishing relevant books and booklets, participating in workshops held in foreign countries, and so on.

Meanwhile, at the business circle's level, some private consulting companies and companies affiliated to respective central ministries like MOE are also engaged in the CDM facilitating activities.

(iv) Private Companies Engaged in CDM Related Activities
At present, major private companies actively engaged in Iran's field of CDM can be cited as follows:

- Karbon Tejarat Electronic
- Mehr Renewable Energies
- Arian Jahan Energy
- Iran Ofogh

(v) Other Relevant Information
There is no Iranian DOE (Designated Operational Entity) currently. Accordingly, all the CDM projects have been conducted by some foreign operative agents such as SGS United Kingdom Limited, Korean Foundation for Quality, TÜV NORD CERT(Germany) and Bureau Veritas Certification Holding SAS (UK) . Also, NGOs involved in CDM related activities have not yet appeared in Iran.

3) Current Status of Iranian CDM Projects
The present status of CDM project formation in Iran is as follows:

(i)Iranian CDM Projects Registered in CDM Executive Board (EB)
Currently, there are altogether five Iranian CDM projects being registered in CDM EB. Among them, the project of "Soroosh & Nowrooz Early Gas Gathering and Utilization" was registered as the first Iranian CDM project in CDM EB on the date of November 23, 2009, with the Iranian Offshore Oil Company as the host party, the Norwegian Carbon Limits AS company as

the foreign party, and SGS United Kingdom Limited as the DOE. All the other four projects were registered on the same date of April 2, 2011 and share the same features in terms of sector, project participants and the company functioning as DOE. All the four projects are of fuel switching for sugar plant, conducted jointly by Iranian Mehr Renewable Energies company and Swiss Climate Protection Finance AG, and entrusted to Korean Foundation for Quality the DOE for validation and registration related service.

It is noteworthy that although there was hardly any progress in CDM project registration during the period from 2009 to the end of 2010 in that only one project succeeded in getting CDM EB's approval within this period, the fact that there have been as many as four projects getting such approval recently shows that the situation regarding CDM promotion in Iran have been gradually improved either in terms of people's awareness or capacity.

The following table gives further details about the five registered CDM projects.

Table 3.4-3 Iranian CDM Projects Registered in CDM EB (as of July 18, 2011)

Title	Host Parties	Other Parties	DOE	Reductions ($t\text{-}CO_2/y$)	Date of Registration
Soroosh & Nowrooz Early Gas Gathering and Utilization Project (S&N project)	Iranian Offshore Oil Company	Carbon Limits AS (Norway)	SGS United Kingdom Limited	463,122	23 Nov 09
Fuel Switching of Imam Khomeini Sugarcane Plant	Imam Khomeini Agro Industry Co. Mehr Renewable Energies Co.	Climate Protection Finance AG(Swi.ss)	Korean Foundation for Quality	31,525	02 Apr 11
Fuel Switching of Salman Farsi Sugarcane Plant	Salman Farsi Agro Industry Co. Mehr Renewable Energies Co.	Climate Protection Finance AG(Swiss.)	Korean Foundation for Quality	32,985	02 Apr 11
Fuel Switching of Amir Kabir Sugarcane Plant	Amir Kabir Agri Industrial Co. Mehr Renewable Energies Co.	Climate Protection Finance AG(Swi.ss)	Korean Foundation for Quality	55,885	02 Apr 11
Fuel Switching of Debal Khazaei Sugarcane Plant	Debal Khazaei Agro Industry Co. Mehr Renewable Energies Co.	Climate Protection Finance AG(Swiss.)	Korean Foundation for Quality	55,107	02 Apr 11

Source: UNFCCC website

(ii) Iranian CDM Projects at the Stage of Requesting Registration and Requesting Review
Meanwhile, as of July 18, 2011, there are two CDM projects which are respectively at the stage of requesting Registration and requesting review. These two projects are also belonging to the sector of fuel switching for sugarcane plant, conducted by the same domestic and foreign developers, and the same foreign DOE.

Table 3.4-4 Iranian CDM Projects at the stage of Requesting Registration and Requesting Review (as of July 18, 2011)

Project Title	Host Party	Foreign Party	DOE	Reductions ($t\text{-}CO_2/y$)	Period for Comments
Fuel Switching of Mirza Kuchak Khan Sugarcane Plant	Mirza Kuchak Khan Agro Industry Co.. Mehr Renewable Energies Co.	Climate Protection Finance AG(Swiss)	Korean Foundation for Quality	25,496	11 Aug 10 – 09 Sep 10
Fuel Switching of Hakim Farabi Sugarcane Plant	Hakim Farabi Agro Industry Co. Mehr Renewable Energies Co.	Climate Protection Finance AG(Swiss)	Korean Foundation for Quality	56,345	11 Aug 10 – 09 Sep 10

Source: UNFCCC website

(iii) Iranian CDM Projects at the Stage of Validation

Furthermore, as indicated by the table below, there are six Iranian CDM projects remaining at the stage of validation as of July 18, 2011. Among them, one is of landfill gas to energy, one is of efficient gas power plant, and the remaining four projects are of switch from single cycle to combined cycle (CC).

Table 3.4-5 Iranian CDM Projects at the Stage of Validation (as of July 18,2011)

Project Title	Host Party	Foreign Party	DOE	Reductions ($t\text{-}CO_2/y$)	Period for Comments
Mashad landfill gas to energy project	Recycle Organization of Mashad Municipality	Ecair Holding PV (N.L)	SGS United Kingdom Limited	27,315	29 Jun 10 – 28 Jul 10
Rudeshur Efficient Gas Power Plant	Iarian Mah Taab Gostar Co	Energy Changes Projektentwicklung GmbH(Swi)	TÜV NORD CERT (Germany.)	179,038	29 Jul 09 – 27 Aug 09
Switch from Single Cycle to Combined Cycle (CC) CDM Project at Shirvan Power Plant	Iran Power Development Company (IPDC)	Swiss Carbon Assets Ltd Energy Changes, Projektentwicklung GmbH(Swi)	Bureau Veritas Certification Holding SAS (UK)	645,324	14 Apr 11 – 13 May 11
Switch from Single Cycle to Combined Cycle (CC) CDM Project at Jahrom Power Plant	Iran Power Development Company (IPDC)	Swiss Carbon Assets Ltd Energy Changes, Projektentwicklung GmbH(Swi)	Bureau Veritas Certification Holding SAS (UK)	1,330,330	15 Apr 11 – 14 May 11
Switch from Single Cycle to Combined Cycle (CC) CDM Project at Shirvan Power Plant	Iran Power Development Company (IPDC) (Islamic Republic of Iran)	Swiss Carbon Assets Ltd Energy Changes, Projektentwicklung GmbH(Swi)	Bureau Veritas Certification Holding SAS (UK)	645,324	15 Apr 11 – 14 May 11
Switch from Single Cycle to Combined Cycle (CC) CDM Project at Sanandaj Power Plant	Iran Power Development Company (IPDC) (Islamic Republic of Iran)	Swiss Carbon Assets Ltd Energy Changes, Projektentwicklung GmbH(Swi)	Bureau Veritas Certification Holding SAS (UK)	830,383	15 Apr 11 – 14 May 11

Source: UNFCCC website

(iv) Iranian CDM Projects at the Stage of Review by DNA

Besides the above-mentioned projects, there are more than fifty CDM projects being under the review by the Iranian DNA i.e. the National Climate Office of DoE. But, unlike those to be submitted to the CDM EB to apply for registration, a CDM project submitted to DNA for review does not need to be accompanied by a PDD (Project Design Document). Therefore, projects were submitted to DNA together with a PIN (Project Idea Note) only.

4) Activities of JICA and Other International Aid Agencies in Iran's CDM related Field

(i) Activities of JICA
JICA conducted a technical assistance project entitled "Dispatch of Advisory Expert in CDM to the Islamic Republic of Iran" starting from the year of 2008 through to March, 2010. The project was divided into two phases, with Phase 1 assigned for the activities of field study on CDM potential, discussions with various kinds of stakeholders of CDM and identification of promising CDM projects and Phase 2 for CDM awareness and technical training program. Activities of Phase 1 were conducted within a period of several months in 2008, while Phase 2 started from May 2009 to March 2010.

Regarding activities in Phase 2, a Japanese expert was dispatched by JICA to carry the training program focused on CDM issue. Participants in the training program consist of 47 officials and experts from government agencies such as the Department of Environment (DoE), Ministry of Energy (MOE), Ministry of Petroleum (MOP), and from research institutions and private companies. All of them are persons in charge of energy and environment in respective organizations. Achievements of this project include drafting of the following 6 PIN (Project Idea Note) and 1 PDD (Project Design Document):

- "9.2 MW Mini Hydropower Generation Project in Jareh"（PIN）
- "MoE Building CHP (Combined Heat and Power) Project"（PIN）
- "PV Combined Cycle Generation Project in Yazd"(PIN）
- "4.7MW Wind-power Generation Project in Majil"(PIN）
- "Maroun Oil-drilling Field Gas Recovery and Utilization Project"(PIN）
- "Maroun Oil-drilling Field Exhaust Heat Recovery and Utilization Project"（PIN）
- "Fuel Switching Project of Ahvaz Sugarcane Plant」(PDD)

(ii) Activities of Other International Aid Agencies
With the cooperation by DoE of Iranian Government, UNDP conducted a four-day workshop entitled "National Workshop on Kyoto Protocol: Challenges and Opportunities for Sustainable Development" from October 25 to 28 in 2003. There has been no other CDM related activities by foreign governments or international organizations so far apart from the above-mentioned.

(2) Utilization of CDM Mechanism for the Promotion of EE&C Market

2) More Effective Incentive Needed for the Promotion of EE&C Market
In Iran, immediately after the abolition of energy subsidy (by the Subsidy Rationalization Law approved in the Parliament on January 5, 2010, submitted to the government for implementation on January 16, 2010, and enforced on December 18, 2010), the Energy Consumption Pattern Reform Law was approved in the open session of the Parliament on February 23, 2011 and submitted to the government for implementation on March 8, 2011 (but has not yet been enforced), stating that MOE and MOP will make regulations to incorporate suitable executive strategies supporting and encouraging R&D system of new technologies through providing annual budgets for pilot projects as well as their commercialization and the regulations will be approved by the council of ministers. Also, it stipulates that MOE can take measures to establish an organization of independent legal entity in the framework of five-year development plan and State Services Management Law in order to promote energy efficiency and the use of renewable resources as much as possible. This shows that the Iranian government is resolved to promote EE&C by enforcing a "Stick and Carrot" policy, that is to say, a policy of cutting energy subsidy to punish over-consumption of energy on the one hand, and increasing budgets for R&D to

reward those willing to drive for EE&C on the other.
Regarding the effect of the above-mentioned policy having been observed so far, the policy's part of "Stick" or "punishment" has compelled people to pay higher cost of energy consumption, and hence made one aware of the urgent need of saving energy. But, as for the part of "Carrot" or "Reward", the government needs to give more incentives to stimulate people, especially major energy consumers, to embark on essential EE&C reformation, and meanwhile, the major energy consumers need substantial money to make it possible the EE&C reformation. The central issue here, however, is that where the money will come from to serve these purposes. It is likely that part of the money available as a result of the abolition of energy subsidy might be utilized as the source of fund, but such kind of government budget alone is still thought to be far from enough considering the cost of investment for energy-efficient equipment and the size of Iran's economy.

2) Significance of CDM Mechanism for the Promotion of EE&C Market
Then, what might be considered as a promising source of fund is the introduction of CDM mechanism. As illustrated by the figure below, supposed the size of EE&C market before the introduction of CDM mechanism is the round shape colored gray, which is determined by factors of government policy of EE&C, energy demand and supply, and the effect resulted from the abolition of energy subsidy, this market will probably expand to the size of the oval figure with the utilization of CDM credit as the major source of fund for EE&C after the introduction of the CDM mechanism. But how large will the size of EE&C market be expected to increase after the introduction of CDM mechanism? At this point, although it is hard to tell the extent of market expansion with the utilization of CDM credit for all sectors in Iran, it would be possible to work out the amount of money as an additional source of fund created by utilizing the CDM credit in the building sector.

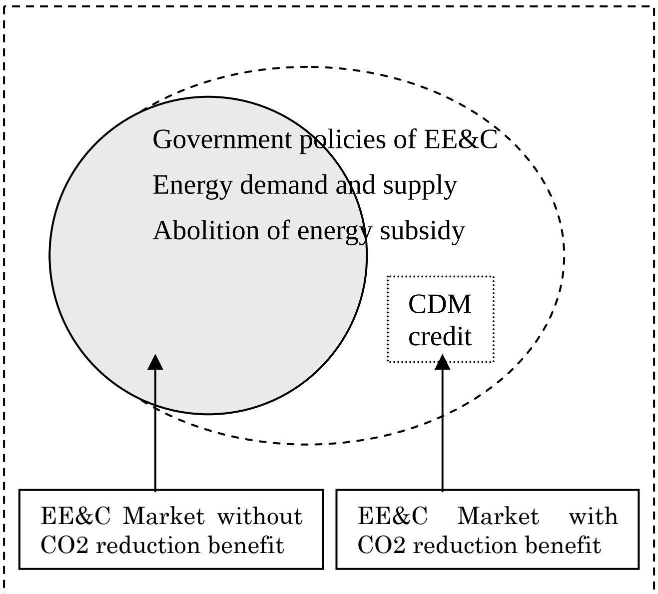


Figure 3.4-1 EE&C Incentives and Market Size

This additional source of fund could be expected to function as a far more effective stimulus for EE&C, and the scale of it could be figured out by estimating the potential of energy saving in the building sector through work of energy audit and the relevant survey activities conducted by the JICA Study Team. It goes without saying that the work of estimation is done on the premise that CDM market is highly developed in Iran and all the EE&C projects are successfully approved by the CDM EB.

According to the result of the above-mentioned work of energy audit and the relevant survey activities, the potential volume of energy saved by EE&C in the building sector consisting of government office buildings, the other office buildings, hotels, hospitals, shopping centers and residential buildings is estimated to be 20,000,000 kL-oil/y, which is around 30% of the total annual energy consumption in this sector. Based on this figure, the total volume of CO2 emission reduction in the building sector is worked out as 57.5 million ton/year, which can be converted to the money value of 1.1 billion$/year. This means that there exists the possibility for Iran to gain an additional EE&C market value of 1.1 billion$/year in the building sector by introducing the CDM mechanism. This result can be yielded through the following formula:

$$M_{cer} = ES_{oil} \times CF_{oth} \times EF_{CO2} \times P_{cer}$$

Where

M_{cer} = Money value of CDM credit or CER (Certified Emission Reduction)

ES_{oil} = Potential volume of energy saved by EE&C expressed in unit of oil (here in KL-oil/y)

CF_{oth} = Conversion factor of oil-to-heat (here in GJ/KL)

EF_{CO2} = CO_2 Emission factor (here in t-CO_2/GJ of diesel oil)

P_{cer} = Unit price of CER (here in euro/t- CO_2, or $/t- CO_2)

ES_{oil} = 20,000,000 KL-oil/y	CF_{oth} = 38.46GJ/KL-oil	EF_{CO2} = 0.0748/ t-CO2/GJ-diesel oil	P_{cer} = 14.52euro/t-CO_2 = 19.55$//t-$CO_2$**
Estimation through energy audit and survey	With reference to similar JICA study	With reference to PDD of CDM project in Iran*	With reference to the market rate as of July 6,2011***

Note: * PDD of “Switch from Single Cycle to Combined Cycle (CC) CDM Project at Sanandaj Power Plant” (at the stage of Validation by CDM EB)

** The price in $ was converted from the price in euro with the rate of 1euro=1.446$ as of July 6,2011.

*** Website of “Point Carbon”

Using the above parameters, the additional sum of money expected to be created by the potential volume of energy saved through EE&C activities in the building sector can be figured out as shown by the following calculation process:

M_{cer} $=20,000,000 \times 38.46 \times 0.0748 \times 19.55$

$=769,230,769 \times 0.0748$

$= 57,538,462 \times 19.55 \quad = 1,124.87$ million$/y

3) Necessity of Further Strengthening the CDM Awareness and Capacity

In spite of the fact that there exists such a huge potential source of fund which ought to be fully exploited for EE&C purpose, the total number of Iranian CDM projects successfully getting approval from the CDM EB remains trifle as compared with other major non-Annex I countries of United Nations Framework Convention on Climate Change (UNFCCC). As of July 18, 2011, there are only five Iranian CDM projects being registered in CDM EB, and no EE&C project is included, not to mention EE&C project in the building sector. But ironically, building sector in fact contains a very large potential CDM market, with is CO2 emission volume accounting for 30% of the total of Iran[26].

This undesirably slow progress in CDM project formation may be attributed to two major reasons. One is the lack of awareness of the significance of CDM mechanism for Iran's national development strategy, the other is the relatively fewer CDM well-versed experts. Although the first enlightenment workshop on CDM was held by UNDP early in 2003, and JICA has conducted a technical assistance project of CDM capacity building starting from the year of 2008 through to March, 2010, awareness enlightenment and technical training regarding CDM expertise need to be strengthened in the business circle in general and in the building sector in particular, since the enlightenment and training activities so far have actually covered only a small fraction of the whole business circle. Moreover, as pointed out by the chief official of the DNA, it would be significant and of vital importance to extend the target of awareness enlightenment to those Members of Parliament and heads of all the government agencies relevant to CDM.

(3) The Mechanism of NAMA and Its Implication to Iran

With relevance to CDM, in the light of the recent development of NAMA known as a new mechanism intended for developing countries, an overview of this new development and its implication to Iran is added below.

1) The Background for the Usher of NAMA

The Kyoto Protocol concluded in 1997 and put into effect in 2004 comparatively requires more responsibility from the developed countries (here referred to Annex I Countries) with respect to the issue of GHG effect by imposing stricter targets and their fulfillment with legally binding clauses, To be more specific, the developed countries have to strictly follow the respective national GHG inventory system in practicing the system of quantitative targets for absolute emission volume and the Kyoto Protocol mechanism. For this purpose, the Quantitative Assessment has been strictly conducted so far in a way of independent assessment.. Contrastingly, with regard to the developing countries (here referred to the Non-Annex I contries), the requirement for national GHG inventory has been relatively easy-going, and the quantitative assessment regarding climate change countermeasures has not been required.

As a policy to reinforce the countermerasures against climate change issue in the developing countries, consensus was reached at the Cancun Conference held at the end of 2010 to embody the Paris Action Plan issued at the Paris Conference of 2007. With respect to the mitigation actions of developing countries in particular, adoption of the new mechanism known as NAMA (Nationally Appropriate Mitigation Actions) was decided.

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[26] Interview with Dr. Mohamad Soltanieh, National Project Manager of National Climate Change Office, DoE (July 3,2011)

2) What is NAMA?
NAMA is a kind of domestic policy to be issued and enforced by the developing countries in a 'voluntary' manner for the purpose of sustainable development. It is required that this kind of policy be enforced with the principle of 'quantification of policy effect', which is specifically defined as the process of MRV (measurement, reporting, verification), though the details were not specified either in the Paris Action Plan or in the Cancun Agreements. Accordingly, the incorporation of MRV into the NAMA mechanism is necessary.

So far, although there have been countries submitting the list of NAMA consisting of their respective domestic counter-measures to the Convention's Secretariat, many countries including Iran have not submitted this kind of list.

Regarding NAMA, the following points are worthy of noticing.

(i) Types of NAMA
NAMA can be classified as 'Unilateral NAMAs' and 'Internationally supported NAMAs' as follows:

- Unilateral NAMAs refers to the NAMA confined to the scope of the country itself, which allows the country to establish its own MRV mechanism freely.
- Internationally supported NAMAs refers to the NAMA which, as requested by the submitting country, needs international support in terms of finance, technology, capacity building and so on. Accordingly, an international system called 'NAMA Registry' has been set up in response to this need. However, the submitting country of this type NAMA is then required to provide information such as the cost of NAMA, the estimation of emission reduction, and the timeframe. Moreover, in addition to the domestic MRV, an international MRV together with its implementation guideline is also needed.

(ii) Submission and Review of NAMA Report
The NAMA Report including the type of Unitateral NAMA is required to be prepared and submitted to the Convention Secretariat once every two years. A process known as ICA (International Consultation and Analysis) has been adopted to deal with this kind of report, which could be seen as a process of evaluation to ensure transparency, though it might not be as rigorous as that of an examination. As for the specific way of its operation, an internationally accepted guideline is to be formulated.

(iii) Content of the Submitted NAMA
As the definition of NAMA is not very clear at present, there many differences among the NAMAs submitted so far in terms of content. But they can generally be divided into the following two types:

- The NAMA with Established Macro Targets

  The targets include two kinds of reduction rate, i.e. the reduction rate of GHG (CO_2) intensity against GDP, and the reduction rate of GHG (CO_2) emission reduction against the BaU (Business as Usual) emission volume. This approach is adopted by the larger developing countries like China, India and South Africa.

- The NAMA with List of Climate Change Counter-measures

With regard to the above-mentioned two types, the latter is more desirable in that it makes it easy to observe the effect of respective counter-measures.

(iv) Regarding MRV
The establishment of MRV system is considered imperative to NAMA. Although no countries have established this mechanism so far, and it is still not clear about the exact ‘elements’ required by MRV at this point, it is sure that the MRV for NAMA refers to the reduction of GHG emission.

An example of the mechanism with MRV system designed for GHG emission reduction is CDM. CDM, as the mechanism of Kyoto Protocol (not UNFCCC), requires compliance to very strict rules. This kind of rules consists of aspects of formality and way of calculation such as baseline mechodology, while CDM requires rigid compliance in both aspects. The biggest reason is that, as this is part of the emission trading scheme, the overcounting will result in the increase of emission by the developed country which perchases the Certified Emission Reduction (CER).

But, notice needs to be taken that NAMA is a mechanism witiin the framework of UNFCCC instead of the Kyoto Protocol, and it is a kind of domestic policy or counter-measure taken by the developing countries. Furthermore, it is not a mechanism for the generation of CER. Therefore, the adoption of an MRV system as rigid as CDM cannot be expected on the NAMA mechanism; rather, expectation should be placed on its important functions in effectively promoting the formulation of domestic counter-measures as well as ensuring transparency.

3) The Implication of NAMA Mechanism to Iran

(i) What Is Required of Iran with Regard to the Issue of NAMA
So far, Iran has not submitted the NAMA list. In the near future, however, as one of the contracting parties, Iran will be required to prepare and submit the NAMA list. On such an occasion, the following points need to be discussed:

- Are there any policies or measures considered to be linked with the reduction of GHG emission in the national vision of sustainable development or the country’s 5-year development plan?
- Among them, which are the policies accompanied with an MRV system, or the policies considered to be suitable for the introduction of an MRV system?
- Are there any issues regarded necessary to be solved with support from developed countries? What types of support are needed?
- Among these issues, which one could be established as a standard case for

implementation?

This could be used as an opportunity to establish a new performance-check system, and the establishment of system with which the PDCA cycle can properly work is desirable. Also, in some cases, this system might be upgraded to a kind of NAMA Crediting, or a kind of system where the approach to render a program to CDM requirement can be utilized, though it could be more restricted than NAMA Crediting.

By the year 2012, various kinds of guidelines relevant to NAMA are expected to be formulated, though the preparation of the list would be possible to be fulfilled earlier (and it would also be possible to revise it later) than the target year. Moreover, if the Iranian government could give full consideration to the design of MRV system for respective NAMA beforehand, it would be possible to prevent the parts of new rules infavorable to Iran from being adobted in the process of international guidelines formulation.

At any rate, it would be advisable to consider NAMA as an ‘opportunity’ rather than an ‘additional burden’.

(ii) Concept about NAMA in EE&C of Building Sector

With regard to the Study, it is necessary to focus our consideration on the EE&C of building sector. In the designing the government policies and measures, the elements (or dimensions) to be considered are rendered to the following table.

Table 3.4-6 Concepts Regarding the Introduction of NAMA into the EE&C of Building Sector

Issues to Be Discussed	Elements to be Discussed
(A)Type of Policies and Measures	Establishment of standards or codes regarding heat insulation, adoption of subsidy or low-interest loan system, adoption of energy audit system, training of experts, and information dissemination, etc.
(B)Types of Buildings Targeted	Business, (further classified by floor space, purpose, etc.) or household, existing or newly constructed buildings.
(C)Technological Sectors Applicable for NAMA	Lightning, airconditioning, hot-water supply, BEMS, fuel swithching, renewable enegy, etc.
(D)Major Players in Promoting the Adoption of NAMA	Functions of government and private sectors

This way classification alone includes 4 dimensions. It would be better to calculate all the factors of the formulation, (A)×(B)×(C)×(D), so that the effect of the respective policies could be well understood. However, as this is very difficult, the configulation of NAMA, as illustrated below, can be expressed as one single action by binding up several actions, which is considered more realistic.

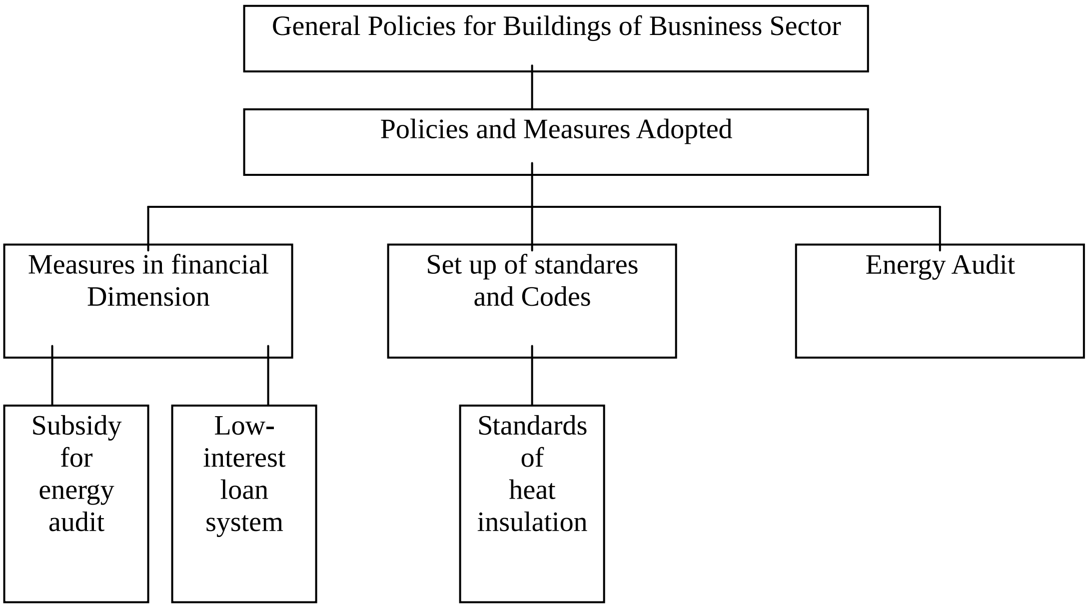


Figure 3.4-2 NAMA as a Single Action Formulated by Binding up Several Actions

In this case, it would also be important to combind the respective MRV systems into one system, which have been set up to effectively monitor the respective results, to conduct analysis and to establish it as a source of information to be available for possible policy revision.

3.4.3 Financial Market on Energy Efficiency & Conservation

(1) A Mechanism to Fill the Financial Gap in EE&C Business

EE&C can be promoted in various ways, by various stakeholders. One way, which has been taken so far by the Iranian government, is to conduct energy audit in various industrial sectors to identify issues as well as to set benchmarks for energy efficiency in each of the industrial sectors. The measure taken by the government has been successful in developing necessary knowledge, skills and experience in energy auditing not only within public and academic fields but also in business sectors, notably in ESCOs. These ESCO business entities, which have been commissioned to conduct energy auditing in various occasions, are now willing to make use of their expertise in their business activities.

There are, however, some aspects which are inhibiting the deployment of energy efficiency services on the basis of private business activities. First, the energy tariff in Iran, which has been purposely set at low level, makes it difficult to gain enough profit out of energy saving measures. Second, the end users are usually reluctant to bear any upfront payment prior to the profit from saved energy actually becoming visible. The third aspect is that energy EE&C service, in general, pertain some risks of payback money collection. Among these three aspects, the first is typical to Iran, while the other two are applicable aspects in general terms.

1) EE&C measures becomes profitable only when certain conditions are met

Energy tariff, for electricity, gas and even petrol are set at artificially low rate, being subsidized by the government. This subsidy is costing the country more than 25 billion USD every year, and is gradually being abolished[27].

With a subsidized tariff of energy, profit from energy saving will also add up to limited amount of money. Payback period of initial cost, i.e. cost of auditing / consulting, installation of meters, sensors and other equipment, will inevitably take longer period. EE&C service will become profitable only when saved amount is significantly high, with the case of inefficient industrial facilities. As for buildings, it will be in limited cases that the project will become profitable for a private company and a private end user to be carrying out. This has been the main reason why EE&C services have been conducted only in industrial sectors in Iran.

Energy cost subsidy is, as from December 2010, being gradually abolished. The energy cost subsidy is seen to be totally abolished in a few years time. Nevertheless, EE&C services in most of the oil producing countries are seldom profitable when it comes to small scale projects.

2) End users are usually unwilling to pay for initial cost

End users of energy in buildings shared by many dwellers and lessees are, in many cases around the world, not suitable target for EE&C service provision by ESCOs. It will mostly be in a large-scale complex owned and / or managed by a single entity which will be an appropriate environment for EE&C services. This is because there is a need for a decision maker for a whole building to request for EE&C service to be carried out. EE&C service requires initial cost for energy auditing / consulting and installation of meters, sensors or other equipment to enable energy savings.

These end users, in many of the cases and in common throughout the world, are usually unwilling to pay for such costs prior to the realization of profit from energy savings. End users often prefer payment from actual profit from energy savings (shared savings scheme). On the other hand, EE&C service provision by ESCOs will require immediate reimbursement

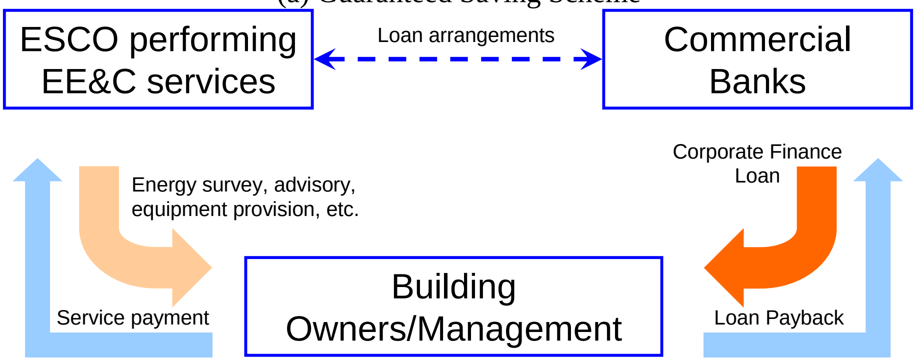
[27] Calculation by IEEJ, Current Situations and Issues on Oil Refinery in Iran - Economic Reform and Policy on Subsidizing on Petroleum Products, 2007.

for their service provided. This is where requirement for financing becomes apparent.

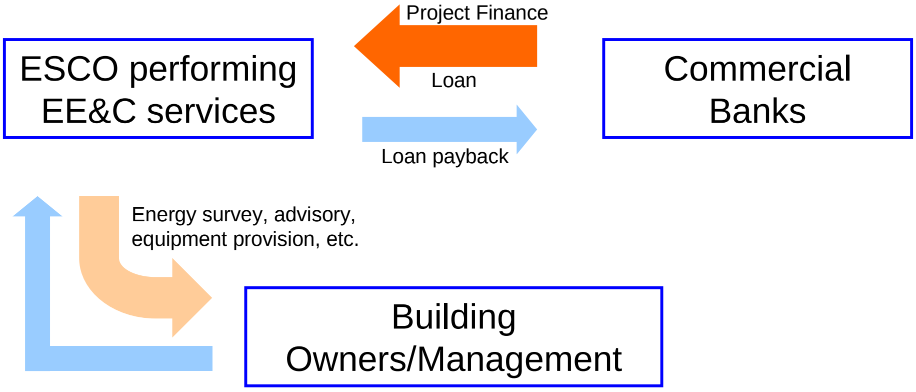
Two representative patterns of financial mechanism to fill the gap between the ESCOs and the end users are: guaranteed saving scheme and shared saving scheme. In guaranteed saving scheme, the end user borrows money to pay the ESCO for the initial cost of EE&C measures. Loan is paid back from the end users as profit from energy savings realize. The ESCO will have to guarantee for the performance of their energy conservation measures. Banks lend money to the end users with recourse to the end user's assets.

Another pattern is shared saving scheme, in which the ESCO takes the responsibility of borrowing money to compensate for the cost of initial audit / consultation and measures such as installation of equipment. Banks will have to lend money on non-recourse basis, usually in the form of project finance. This scheme is employed in limited cases in which significant energy saving profit can be expected; for projects carried out by financially robust ESCO and the end users.

(a) Guaranteed Saving Scheme



(b) Shared Saving Scheme



Source: JICA Study Team

Figure 3.4-3 Representative Patterns of Financing Mechanisms for EE&C services by ESCOs

3) Three risks in EE&C business

In the cases in Iran, EE&C services are carried out in forms of energy auditing and presentation of recommendations. Remunerations for these services are done in one off payment after the consultation work; this can be said to be a risk-free business scheme. However, if EE&C service is to be provided against payment from actual profit from energy savings, there will be greater risks for all of the stakeholders. Such risks can be categorized into three groups or risks.

The first category is the "performance risk". If energy saving measures recommended by ESCOs that are performing EE&C services are found to be ineffective, then energy saving will not be realized, resulting in no profit for any stakeholders. ESCOs, most of the cases, guarantee the performance of their recommendations. Although, with the case of small scale ESCOs, there will be a limit in guaranteeing their performances, resulting in limited capacity to conduct their businesses.

The second risk is the "end user risk". Energy saving is anticipated under condition that the end user will conduct their businesses as planned. For example, a hotel not attaining planned occupancy rate will not achieve planned energy savings. Moreover, if the hotel will have to cease its operation due to circumstances like bankrupt or accidents, planned energy savings will not be realized, either.

The third, risk is the "external risk", also including force majeure. If, for example, the energy tariff is to be reduced, then the planned profit from energy savings will also be reduced. If there is to be deflation, then, the value of borrowed money will increase, resulting in difficulty in paying back. Sharp increase of interest rate will also result in adding burden on loan payback. As these risks are most beyond control of the subject of EE&C services, they are categorized as external risks.

(2) Existing Supportive Measures in Iran and Issues

Iranian government has proactively been encouraging energy saving measures in industrial sectors. Subsidy instruments to promote the industries to implement energy efficiency measures are already existent.

1) Subsidy for energy auditing

According to interviews with the Ministry of Energy and SABA, there are already supportive measures for promoting EE&C in Iran. They are: subsidy for conducting energy audit, investment loan subsidy by public sector, and interest discount scheme. Actual applications of these measures are explained in the followings:

The scheme has also contributed to developing the capacity of private sector companies in conducting energy auditing and consultations. As the result more than a hundred private companies have been registered with SABA as the ESCO (energy service companies). The scheme can be said to have been effective in developing an EE&C industry in Iran.

2) Investment loan subsidy by public sector

Another EE&C promotional scheme is the loan scheme for purchase of higher efficiency equipment. Industrial facilities intending to invest into equipment to improve their energy efficiency are eligible to apply for loan subsidy by public sector. According to interviews conducted with the industries and the Ministry of Energy, the scheme has rarely been implemented due to lengthy and application procedures.

3) Interest discount scheme

There is also an interest discount scheme, in which companies can apply for subsidy against loan payback, when they claim that energy saving has actually been realized. This scheme, as with the investment loan subsidy, has not been implemented due to difficulty in proving that the energy reduction has actually been observed.

(3) Issues Specific to Iran that inhibits EE&C Businesses

As already mentioned with the aspects that inhibits EE&C service businesses in general, low price of energy in Iran is the most significant factor that has been inhibiting the practice of EE&C businesses in the country. Further, there are also other issues, especially in financial dimension that are not being favorable for the business environment.

1) Energy prices are still low to gain profit out of EE&C

Low price of energy results in low profit from energy savings. With the gradual abolition of energy price subsidy, this aspect of impediment is expected to be relieved. However, even with the abolition of subsidy, energy cost tends to remain relatively low in oil producing countries, compared with that of the developed economies. Financial benefits from applying EE&C measures will therefore be anticipated to remain minimal if the energy price were to be kept low.

2) Financial institutions extend loans only under high interest rate and short period

Iran's financial industry is supervised by the Central Bank of the Islamic Republic of Iran. Financial institutions are categorized into five categories: commercial government -owned banks, specialized government banks, non-government -owned banks Gharzolhasaneh banks (interest-free banks), and near-banks (functions to fund the government).

Table 3.4-7 List of Financial Institutions in Iran

Commercial Government – Owned Banks	
	Bank Melli Iran
	Post Bank of Iran
	Bank Sepah
Specialized Government Banks	
	Export Development Bank of Iran
	Bank of Industry & Mine
	Bank Keshavarzi
	Bank Maskan
	Cooperative Development Bank
Non-Government-Owned Banks	
	Eghtesad Novin Bank
	Karafarin Bank
	Parsian Bank
	Pasargad Bank
	Saman Bank
	Sarmayeh Bank
	Sina Bank
	TAT Bank
	City Bank
	Day bank
	Ansar Bank
	Bank Mellat
	Bank Refah
	Bank Saderat Iran
	Bank Tejarat
	Hekmat Iranian Bank
	Tourism Bank
Gharzolhasaneh Banks	

	Gharzolhasaneh Mehr Iran Bank
Near-banks	
	Credit Institution for Development

Source: Central Bank of the Islamic Republic of Iran

Despite the foundation background of most of government owned and specialized banks, the demarcation of the roles of these banks are no longer rigidly specified, and therefore most of the existing banks are eligible to finance EE&C businesses (except for Gharzolhasaneh bank and near-bank).

Although there exist 25 financial institutions as potential financers for EE&C service businesses, these institutions are not in competitive environment under the supervision of the central bank. The central bank operates a monetary policy with high importance on controlling the bank's profit.[28] This system of monetary policy has been introduced based on a preference to control the monetary status with least link to market conditions.

In controlling the banks' profit the central bank sets standards for borrowing and lending rates. These standard rates were initially introduced as referential information, but they have currently become regulations imposed on all of the banks. By setting minimum lending rates and maximum borrowing rates the banks are left with limited allowance for competition. Under these circumstances the banks Iran are on the prudent side on lending money, offering high interest rates and only short period loans.

Iran has always been facing inflation pressure. The economy has constantly been experiencing high borrowing costs. Commercial loans are only available with high interest rate and short maturity period, which is not a suitable form of loans for EE&C businesses. According to the results of interviews with the Representative of Islamic Development Bank (IDB) in Iran and managers of two Iranian local companies[29], although the present minimum lending rates (as July, 2011) set by the central bank are within the range of 11-15%, the actual lending rate the commercial banks could possibly offer to an ordinary private company climbs to the level of 25-28%. In view of this reality, a designated policy fund that will enable extending low-interest and longer period loans will be desired, if EE&C business is to be promoted by the government.

[28] Central Bank of the Islamic Republic of Iran operates a monetary policy by means of two direct instruments (banking profit rates, credit ceiling) and three indirect instruments (reserve requirement ratio, CBI Participation papers, open deposit account (ODA)).

[29] Tacwin Resaneh Building System and Housing Investment Company

Table 3.4-8 Lending Rates for Transaction Contracts
(Minimum expected lending rates for participatory contracts)

(%)

Year	Manufacturing and mining	Construction and housing	Agriculture	Trade and services	Exports
1363	6-12	8-12	4-8	8-12	-
1364	6-12	8-12	4-8	8-12	-
1365	6-12	8-12	4-8	8-12	-
1366	6-12	8-12	4-8	8-12	-
1367	6-12	8-12	4-8	8-12	-
1368	6-12	8-12	4-8	8-12	-
1369	11-13	12-14	6-9	17-19	-
1370	11-13	12-16	6-9	18 (minimum)	-
1371	13	12-16	9	18 (minimum)	18 and over
1372	16-18	12-16	12-16	18-24	18
1373	16-18	15	12-16	18-24	18
1374	17-19	15-16	13-16	22-25	18
1375	17-19	15-16	13-16	22-25	18
1376	17-19	15-16	13-16	22-25	18
1377	17-19	15-16, 18, 19*	13-16	22-25	18
1378	17-19	15-16, 18, 19*	13-16	22-25	18
1379	17-19	15-16, 18, 19*	13-16	22-25	18
1380	16-18	15, 16, 17, 19**	14-15	23 (minimum)	18
1381 (1)	15-17	14, 15, 16, 18***	13-14	22 (minimum)	17
1382 (2)	16	15, 18, 21****	13.5	21 (minimum)	16∆
1383 (3)	15	15, 18, 21****	13.5	21 (minimum)	14
1384 (4)	16	15-16	16	16	16
1385 (5)	14	14	14	14	14
1386 (6)	12	12	12	12	12
1387 (7)	12	12	12	12	12
1388 (8)	12	12	12	12	12
1389 (9)	12	12	12	12	12

* Banks' lending rates for construction and housing sector during 1377-79 were as follows:
- Lending rates, with due observance of provisions and regulations of social housing, were 18 percent and, without observance of social housing regulations, 19 percent.
- Lending rates for housing loans and facilities to faculty members and judicial staff up to Rls. 40 million were 15 percent, with due observance of provisions and regulations of social housing and, without observance of social housing regulations, 16 percent.

** Banks' lending rates to the housing sector in 1380 were as follows:
- Housing: Within the framework of the provisions and regulations of social housing, 17 percent
- Housing: Without observance of social housing regulations and in construction sector, 19 percent
- Housing Savings Fund: Within the framework of social housing regulations, 15 percent
- Housing Savings Fund: Without observance of social housing regulations, 16 percent

*** Housing: Within the framework of the social housing regulations, 16 percent; Construction and housing: Without observance of social housing regulations, 18 percent; Housing Savings Fund: Within the framework of social housing regulations, 14 percent; Housing Savings Fund: Without observance of the social housing regulations, 15 percent

**** Housing without depositing, 18 percent; Housing Savings Fund, 15 percent; and construction, 21 percent

∆ As of 14.08.1382, lending rates on loans and facilities declined to 15 percent (Circular No. MB/1496 dated 20.08.1382).

(1) Effective 15.06.1381

(2) Effective 29.03.1382

(3) Effective 09.03.1383

(4) Effective 16.03.1384. In the manufacturing sector, 15 percent from the customer and one percent government subsidy; in the agriculture sector, 13.5 percent from the customer and 2.5 percent government subsidy; in the exports sector, 14 percent from the customer and 2 percent government subsidy; and in the trade sector, banks are authorized to determine lending rates up to 2 percent higher (18 percent). Meanwhile, as of 27.06.1384, lending rate for the housing sector was 15 percent within the framework of social housing regulations, and 16 percent without observance of the social housing regulations.

(5) Effective 06.01.1385. Lending rate for private banks and credit institutions was 17 percent.

(6) Subject of Circular No. MB/1189 dated 02.04.1386. Lending rate for private banks and credit institutions was 13 percent.

(7) Based on Article 6 of the Supervisory-Policy Package of the Banking System for 1387. Lending rates on banking facilities for prioritized projects of Small and Medium Enterprises (SMEs) and agriculture sector would be 10 percent and the remaining 2 percent would be paid through government subsidy. In case the objectives of this project are not realized, the mentioned subsidy will not be paid and the principal and profit of facilities will be paid by the customer.

(8) Effective 01.02.1388. Based on Note 1 of Article 2, the Supervisory-Policy Guidelines of the Banking System for 1388, extension of banking facilities at a lower lending rate is conditioned on the payment of subsidies by the government and realization of the project objectives according to government priorities.

(9) Lending rates for transaction contracts with a maturity of less than 2 years would be 12 percent, and for more than 2 years, 14 percent. Lending rates for facilities extended through installment sale contracts in the housing sector would be 12 percent.

Note: Until end-1384, private banks and credit institutions faced no limitations in setting lending rates.

Source: Central Bank of the Islamic Republic of Iran

3) Credit risks of end users and ESCOs are relatively high

There are also risks on the borrower side. Borrowers in EE&C businesses will either be the end users or the ESCOs, who will conduct auditing / consultations and implementing the recommended measures. These potential borrowers are not necessarily robust financially. Recourse is required in extending loans to these borrowers, and it will commonly be assets such as real estate or equipment. Valuation of these assets tends to be carried out prudently, resulting in such loans being risky.

With the aim to promote EE&C, there will be a need for introducing a designated financial mechanism to enable extending loans also to those with limited recourse means. Such mechanism needs to have low threshold for risk-taking of end-user operation risk as well as ESCOs performance and operation risks. Public initiative will be essential to have this EE&C promotional financial mechanism put into place. A partnership between public sector, which will create a business enabling environment, and private sector which will perform their activities in this environment will be a desirable scheme for promoting EE&C businesses in Iran.

(4) Required Functions for Financial Mechanism to Suit the Needs in Iran

EE&C for buildings should be promoted by private sector business activities. To pursue this promotional policy, a designated financial mechanism to support EE&C services by ESCOs will have to be introduced. Typical situation in Iran was found to be unfavorable for EE&C services mainly due to low energy price, unavailability of low interest rate long term loans, and relatively high credit risks with ESCOs and the end users. Requirements for a designated financial mechanism will therefore be to extend low interest and long term loans, under fair risk sharing structure, and an arrangement to ensure loan payback by the end user.

1) A policy-driven credit line to offer low interest loans

A financial mechanism which enables extending low interest and long term loans will have to be introduced separately from ordinary commercial financing scheme. A designated governmental fund to specialized create credit lines will be a realistic option to realize such mechanism. Existence of the government's strong commitment and clear policy to encourage EE&C will be an essential background for this proposal.

Creating these specialized policy-driven credit lines means that the banks will merely conduct administrative procedures to extend loans from assigned credit lines. The banks therefore will not have to bear credit risks by themselves. Reluctance to extend loans will be solved by creating the credit lines. Government will also have autonomy to fix conditions on utilizing these credit lines. Low interest rate and long term loan will be possible, if the government desired to do so.

2) Risk sharing by public sector

There exist three categories of risks, i.e. ESCO performance risks, end user operation risk, and external risks. In order to promote EE&C businesses, the government will have to bear some of these risks. Among the three risks ESCO performance risk can be allocated to government, but offset by accreditation system of either organizations or methodologies. Introduction of accreditation will enable risk to be relieved from businesses, and reduced and averted to certain extent by prior supervision by the public sector.

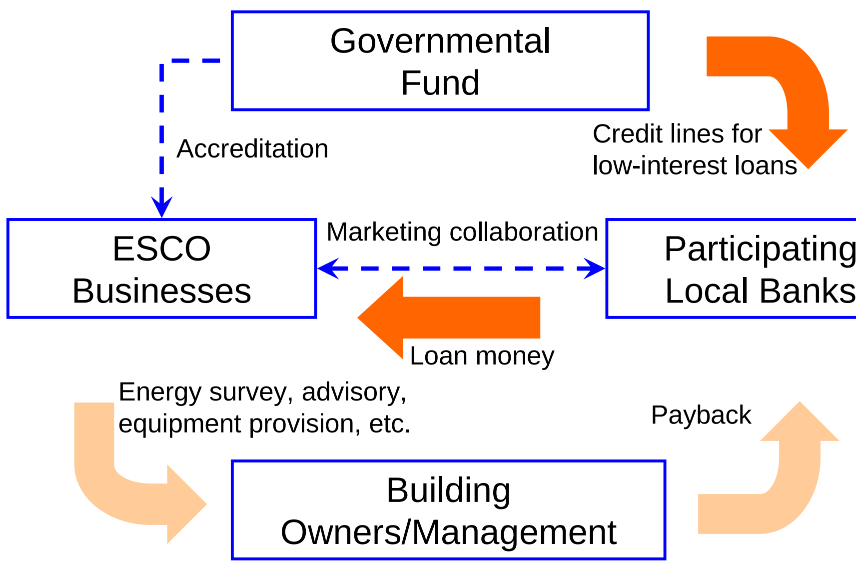
End user risks are, in many of the cases in other countries, are borne by Banks and ESCOs. This allocation of risk tends to make the stakeholders reluctant to conduct EE&C projects, and therefore, insurance is sometimes applied. With government taking a part of the end user risks, ESCO can positively explore markets for EE&C services. Another consideration to relieve end user risk is to have the loan money paid directly to ESCOs, or to the actual component procurers and / or service providers, and not to the end users. This will prevent loans to be spent to any other purposes.

A prototype financial mechanism with the following risk allocation can be proposed. Compared with the reference with shared saving scheme and guaranteed saving scheme, the prototype, with risk allocation to government, ESCOs can be expected to be encouraged to explore their EE&C business opportunities.

Table 3.4-9 Proposed Risk Allocations undera Designated Financial Mechanism

Risks		Bearer of Risks		
			Reference	
Categories	Examples	I Prototype	II Shared saving scheme Project finance	III Guaranteed saving scheme Corporate finance
1. ESCO performance risks	- ESCO measures turned out to be ineffective.	- Government (risks reduced by accreditation)	Shared among: - ESCO - End user	- ESCO
2. End user operation risks	- Operation ratio of the building turned out to be low.	Shared among: - Government - End user	- End user	- End user
3. External risks	- Energy tariff was reduced, - Deflation occurred	- Government	Shared among: - ESCO - End user - Bank	Tariff reduction: - End user Deflation: - Bank

Source: JICA Study Team



Source: JICA Study Team

Figure 3.4-4 Prototype Financial Mechanisms for EE&C services by ESCOs in Iran

(5) Considerations for Operation of Financial Mechanism to Support EE&C

Establishment of a government-supported financial mechanism can promote EE&C activities on private business basis. Requirements for such financial mechanism is are as explained in the previous section. In parallel with the establishment of the financial mechanism, tips to ensure proper operation of the mechanism will also be pointed out, as follows:

1) Consideration for ensuring loan payback

To ensure that the loan will be paid back promptly from the saved energy profit, a payback structure will have to be carefully considered. One proposal is to introduce the structure of "utility payback" scheme, in which profit from savings will be once reaped by utility companies within bill payments. The utility company, in conjunction with the banks, will then allocate the collected profit to payback as well as to shared profit to ESCOs. From interviews conducted with the ESCOs in Iran, ESCOs are, in many cases, not confident about payback money collection due to the power balance between the end users. This is because end users tend to be more influential in the business relation between ESCOs. Many of the ESCOs have expressed their concern about the payback structure, and the introduction of utility payback scheme has been endorsed by most of the ESCOs.

2) Introduction of third-party verification and monitoring to protect interest of the fund provider

Credit lines created by virtue of the government policy will have to be better protected, so as to avoid decline in capital due to negligence and even moral hazard. In reference to the EE&C promotion credit lines introduced by EBRD (European Bank for Reconstruction and Development), a verification system can be introduced so as to protect the interest of the fund provider (government) and the payer (end users)[30]. To secure the operation of financial mechanism in which the government takes various risks of EE&C businesses, such third party verification and monitoring will become essential. However, this verification and monitoring mechanism tend to become costly and time consuming, resulting in discouraging and slowing down EE&C businesses. Third party verification and monitoring process should be simple, transparent and easy to be carried out, perhaps by systemizing procedure into manual documents.

(6) Action Items

Designated financial mechanism to promote EE&C business by ESCOs in Iran cannot be introduced without development of a proper operational structure. First the government will have to allocate a fund for creation of credit lines. The source of the fund may be sought from various options including anticipated additional allowance from abolition of energy price subsidy.

Operation of the mechanism will have to be prepared by developing clear and transparent operational guidelines and manuals. These guidelines and manuals should also be disclosed to public to ensure fair operation. Technical preparations include the followings:

- Creation of credit line operation manual
- ESCO accreditation criteria and operation
- Designing Payback collection scheme
- Introducing a third party verification mechanism

Development of such technical guidelines and manuals may require inputs from those countries and organizations which possess experiences in extending policy driven loans. Experience not only in EE&C area but also other sectors such as SMEs promotion, regional development and

[30] EBRD Sustainable Energy Financing Facilities (SEFF) Scheme.

industrial promotion can also become valuable inputs.

Nevertheless, strong commitment by the government to encourage private sector to carry out EE&C business will be crucial to have these measured put into practice. As technical considerations will require certain period of time, the government is suggested to address such positive commitment at the soonest convenience.

3.5. Issue on Energy Efficiency & Conservation Promotion

Following is some challenges in Iran for promoting EE&C based on the analysis carried out by the Study Team.

3.5.1. Technical Aspect

The role of the private sector in EE&C-related business is significantly important to promote EE&C for building. Overall technical capacity of conducting energy audit was identified high through the observation and the collaboration of selected companies and the Study Team. Capacity in carrying out energy audit and methodologies and approaches that Iranian companies propose are confirmed mostly advanced. Such technical standard, however, are not fully utilized and benefited to promotion of EE&C to whole society in Iran. Propulsion means of EE&C differs greatly between the building sector and industrial sector. There is no expertise engineer and no investment cost for energy saving in the building. Therefore, even if it enacts a low, rules and regulations, it is not so easy to implement energy saving in the building sector. The following issues are some of challenges for promoting EE&C related business in Iran.

- Some rooms for improvement of making good proposals for submission to building owners on EE&C based on the energy audits conducted,
- Shortage of data and information to figure out energy saving potential of the building
- Availability of broader knowledge and opportunities for acquiring skills on EE&C methodologies and approaches, and
- Weakness in such capacities as monitoring, verification and performance guarantee for energy saving.

3.5.2. Skills for Adopting Technology

For promoting EE&C for the building sector, the roles of energy related businesses (especially ESCO) are significantly important.

Through the energy audit and other collaborations carried out during the Study,the Team found that Iranian energy businesses possesses generally high level of EE&C capabilities for auditing and proposing clients EE&C technology. Such high level of capability, however, is not fully utilized for promoting EE&C to Iranian society as a whole.

Unlike EE&C for industry, EE&C multiple constraints, such as absence of investment to EE&C technology, lack of skilled human resources of EE&C technology, etc. causes smooth dissemination. Establishment of regulations and guidelines alone cannot support dissemination of EE&C.

In order for healthy growth of EE&C as business, the following are identified as technical issues:

（1）Capacity to propose EE&C to Investors (Owners, financiers, etc.) ;
（2）Lack of information and reliable data to estimate EE&C potentials
（3）Need of acquiring wide range of EE&C technology, and
（4）Weak capacity in measuring and verifying EE&C potential, and providing EE&C performance guarantee.

3.5.3. Institution, Organization and Human Resources Aspect

The following is an overview of issues for promoting EE&C for the building sector in Iran with a perspective of human resources and organizational development.

(1) Lack of measures for Human Resources Development aiming at EE&C

For promotion and dissemination of EE&C, It is necessary to strengthen the capacity of such targets as (i) administrators and agents who plan and implement EE&C policies, (ii) planners, architects and contractors (especially ESCO, construction companies, installers of manufacturers, etc.) of energy efficient building projects, (iii) investors of energy efficient building projects (owners, developers, renders, etc.). The Government of Iran acknowledges high level of priority on carrying out such human resources development. To do so, an effective framework to realize human resources development led by the state is necessary.

For the officials who plan and implement EE&C policies, one of their important mandates is to promote and integrate strategically a variety of EE&C measures simultaneously carried out by various ministries and agencies (e.g. MOE, old MOHUD, MOF, etc). In reality the specific measures and integrated activities is still expected, although EE&C is listed as one of priority for the national development policies stipulated in various laws including the EE&C Law. Better coordination, specific measures to collaborate among various ministries and agencies are necessary. To do so, measures for human resources development specifically designed for policy planners and implanters to acquire knowledge and skills to promote EE&C is necessary.

The second item, training for architects, HVAC engineers, contractors, etc is necessary. Absence of system in such areas as development of new EE&C technology, establishment of technical standards, guidelines and certification mechanism, etc becomes persistent constraints of EE&C promotion. Effective measure currently available and functioning in Iran is enforcement of the building code 19. Additional measures to promote human resources development for enforcement of these guidelines, quality control for construction and installation, establishment of quality certification for materials and equipment, etc are necessary.

Lastly, investors and financiers are another important target for capacity development. It was identified that investors in Iran do not have opportunities to learn importance of EE&C, and to gain capacity of judging relevancy, evaluating the risks and benefits, and proper attitude to supply money when necessary. Those investors with such capability are limited because linkage of EE&C and finance is relatively new idea in Iran. Providing such opportunities to investors to learn prospect of investing EE&C, risks and benefits is effective measures for human resources development

(2) Issue on higher education institutions for EE&C promotion

1) University as Training Institution

The roles of university-level training in Iran to fulfill the human resources needs for EE&C promotion as listed (1) are significant. There is, however, no university-level program for promoting EE&C for the building sector except few graduate-level courses covering general energy management at some graduate schools in Teheran. University programs covering energy management are divided vertically into different engineering disciplines, architecture and electric & mechanical engineering, which have little contact with each other. Conventional higher education lacks multi-disciplinary approach and collaboration among different faculties to support complexity of EE&C for the building sector.

The university-based training for engineer heavily depends on overall capacity of faculty members who tend to have limited experiences outside academic world. Faculty members have limited access to human resources needs. In reality, most contents taught at universities are geared toward to theoretical ones. In addition, most universities put priority to academic research while EE&C promotion should be carried out by the “institution for practitioners” mot by the ivory tower.

2) University as Research and Development Institution

For the technology development and research on EE&C, universities in Iran need to clarify the functions of academic research and applied research. This is particularly important because in EE&C and architecture because the fruits attained from academic research do not benefit the related industry seamlessly in a timely manner. It is particularly true in the cases of architecture: results from academic research shall practices in planning, design and construction shall be utilized. To do so, more collaboration between university laboratory and industry is expected.

3) Training for Professionals

EE&C for the building sector is a simple practical technology performed in the building. The EE&C technology is a combination of identifying problems, development of practical site-based EE&C measures, application and utilization of such measures to the actual building projects. To ensure such cycle, the development of EE&C technologies require high-level of practicality. Knowledge of field practitioners should be systematically evaluated, collected and utilized in order to develop EE&C technology effectively. In many universities, the focus is concurrent students and they do not have specific training programs to the graduated professionals including architects, electric & mechanical engineers, ESCO engineers, O&M engineers and technicians. The Study Team found that some private sector companies provide training aiming at in-house engineers and technicians. Most of these training, however, do not receive any public support, etc, while the Engineers Association organizes training for architects and building engineers on the building code 19.

NTCEM in Tabriz has a proven record of providing EE&C training for industry. The center, however, does not have significant experiences on EE&C for the building sector. Its capacity to develop training curriculum for a variety of trainees, and to secure capable core instructors are still unknown. The center, in the other hand, has training experiences of EE&C for industry, of which some component technology in thermal and electrical engineering are common to those of EE&C for the building sector. The center, therefore, may utilize the past experiences to capacity development for EE&C for the building sector.

(3) Duplication of Training Resources and its Quality

It was fond that the existing training programs mostly taught at universities are not fully effective for promoting EE&C for the building sector in terms of quality and quantity. University-level courses and programs specialized on architectural EE&C are only beginning at some universities in Iran. It will take sometimes for students just enrolled in these universities this year to complete the programs. It will further take even some more years to assure appropriate number of professionals with relevant qualifications, who graduated from these universities.

Currently, institutions such as IEHT, PWUT and others under MOE and MOP provide training programs on EE&C. Despite each institutions have own missions and different purposes, these institutions have been extending their activities from industrial EE&C to EE&C for the building sector. It seems that the demarcation between research institutions under jurisdiction of old MOHUD and those under MOE was not clarified. Lack of clear demarcation as well as duplication may have impact on effective use of scarce resources for EE&C in Iran.

(4) Disparity Between the Roles of EE&C Engineers and Technicians

For promoting EE&C requires collaboration among EE&C engineers and technicians. The roles of EE&C engineers include plan, diagnose, analyze and propose energy use of a building. Those of technicians include operation and maintenance (O&M). Proper facility management requires cost-saving while not compromising maintenance of comfortable and productive environment such as temperature, humidity and brightness. Most importantly, proper O&M is a benefit to not only the owners but also tenants of the building. But for the owner of the building (as well as technician), tenants are the most important (and critical) stakeholder of proper O&M. How to communicate with the tenants is complex and the most challenging issue for realization of EE&C in the building. In many buildings, such roles are assumed by O&M technicians.

The professional status of technicians in Iran is relatively low due to the difference of technical, educational and societal background. The roles disparity between engineers and technicians are very obvious. In addition, day-to-day tasks and the responsibilities assumed by O&M technicians in Iran are undervalued. During the Study, the Study Team observed repeatedly that most building owners are attracted by new EE&C technology which requires long-term investment. Many owners and engineers expressed strong interest on such investment over importance of improving day-to-day operation and maintenance.

The Study Team has insisted Iranian side on practicing continuous small improvements (a.k.a Kaizen) based on emphasizing on O&M. While technology necessary for EE&C is those effectively practiced in the building, not in the laboratory, it is, therefore, very important to accumulate knowledge and experience owned by O&M technicians.

The Team believes that such disparity may not be changed immediately because it is rooted by traditional employment practices, etc. The Team, however, addresses that such disparity causes the smooth access to technical information between engineers and technicians. This situation is considered one of major obstacle for promoting EE&C in the building sector.

(5) Limitation of Development Opportunities for Technicians

In relation to the item (4) above, there is few opportunities for career development for technicians even though such needs is recognized high. This is because of professional status of conventional work places, lack of incentives for investing human resources, unclear return on investment, etc. Especially, return on investment to such education and training cannot be recognized by building owners or managers because measuring of energy use is hardly a routine task for proper facility management in Iran.

(6) Lack of Support to Technical Supports to the Private Sector Employees

Situation of engineers and architects, in terms of various technical assistances, is as same as technicians. The opportunities of in-services training is still limited because of lack of incentives.

3.5.4. Financial Aspect

The issue of EE&C promotion in terms of financial aspect centers on how to secure the source of fund needed for the establishment of financial mechanism with an eye to promote EE&C projects. In this regard, financial contributions from the government and utilization of CDM credit are two possible ways of solution.

(1) Financial Contributions from the Government

Financial contributions can be expected to function as the capital dedicated to low interest rate loan intended to support the development of ESCO projects. Since the 1990s, Iran has always been subjected to high inflationary pressure, with the figures climbing to the level as high as double-digit. The CPI of Iran in 1999 and 2008 even reached 30% and 25.6% respectively. Although this figure has fallen dramatically since 2009, it still remained at the level of 13.5% and 11.8% in 2009 and 2010 respectively. Under this circumstance, the policy interest rate has always been kept at very high level, which has resulted in the commercial lending characterized with high interest rate and short maturity period, a situation undesirable for the promotion of ESCO business. Accordingly, the capital needed for the promotion of EE&C projects can only depend on the government's financial contributions.

With respect to this, it would be feasible to utilize part of the money arising from the recent government decision to demolish the policy of energy subsidy which has kept down energy prices in Iran so far. To be more specific, as the energy subsidy has constituted a great burden to the national treasury, the Iranian government and Parliament at last enacted the Subsidy Rationalization Law in December 2010 and started to reduce subsidy provision. The government has made it clear to phase out energy subsidy in a few years while keeping an eye on the situation of energy price rise. Therefore, the money available from the reduction and the final abolition of energy subsidy will undoubtedly become an important source of fund for the establishment of financial mechanism dedicated to the promotion of EE&C.

(2) Utilization of CDM Credit

As commonly practiced by international organizations, provision of CDM credit does not work as an incentive because the credit itself bears relatively low price. As for , the price of energy in Iran, although it has not been considered a drive to promote EE&C due to the fact that the energy price in Iran so far has been low compared to other country, with the enforcement of the Subsidy Rationalization Law starting from December of 2010, the domestic energy price is expected to get close to the international price gradually, and hence will become a stimuli to EE&C. In addition to this, if the arrangement is properly made, CDM credit may create a huge value[31].

Moreover, as stated previously in 3.4.2 (2) 2), the potential volume of energy saved by EE&C in the building sector consisting of government office buildings, the other office buildings, hotels, hospitals, shopping centers and residential buildings is estimated to be 20,000,000 kL-oil/y. Therefore, under the premise of a highly developed CDM market in Iran and the approval of all the Iranian CDM projects relevant to EE&C by EB, the total volume of CO2 emission reduction in the building sector is expected to reach 57.5 million ton/year, which can be converted to the money value of 1.1 billion$/year. Whatever the case, the utilization of CDM credit will be no doubt a significant solution for the financial issue of EE&C

3.5.5. Creating Positive Attitude toward EE&C

Promotion of EE&C requires a long-term process and continuous efforts for development. As seen in many private sectors in the industrialized nations, eco-friendly business or socially responsible corporation are perceived positive in their society. Public sector may assist such initiatives by setting up favorable market condition such as tax incentives, etc. Examples, but not limited to, include:

[31] According to the cap and trade proposed in Tokyo Metropolitan Government, GHG credit that may be available for purchase is subject to purchase only from local sources and the price of the credit is much exceeding those of credit traded in the regular market (approximately US$200 from Tokyo whereas average market price between US$12 to 25). If the proceed from the cap and trade program may be effectively used to support further EE&C development.

- Eco-friendly business as a corporate icon,
- Emphasis on Corporate Social Responsibilities, and
- Provision of tax incentives for carbon foot-print, etc.

These actions seem to be not taken actively in Iran.

Chapter 4. Energy Related Information in the Building Sector

4.1. Basic Information

4.1.1. Legal system

There is no system or law which is reported about the amount of the energy used of the buildings in Iran. Energy Consumption Pattern Reform Law, which was approved in March 2011, includes a provision about measurement of the amount of the energy used and management

4.1.2. Statical data of buildings

Statical data of buildings (In Teharan) is shown in Table 4.1-1. Generally, it is so dificult that statical data of buildings in Iran is got periodically, Table4.1-1 is offered as current data by Tehran municipal government.

Accorgding to Table 4.1-1, there are about 1,077,000 buildings in Tehran as total number of buildings, and 1,766 buildings as governmental office, about 23,000 buildings as private office, 396 buildings as hotel, 117 buildings as hospital, about 160,000 buildings as shopping center.

Table 4.1-1 Statical data of buildings (In Tehran)

Number of buildings by type of building use and classifiration of floor area（Tehran city）

Type of building use	Classification by floor area (㎡)			
	Less than 1,000 ㎡	More than 1,001 ㎡ Less than 5,000 ㎡	More than 5,001 ㎡ Less than 10,000 ㎡	More than 10,001 ㎡
Governmental office	911	681	90	84
Private office	12860	8405	616	458
Hotel	168	179	26	23
Hospital	20	40	22	35
Shopping center	146711	12171	726	648
Collective housing	830060	59532	1920	1102

Total floor area by type of building use and classifiration of floor area（Tehran city）

Type of building use	Classification by floor area (㎡)			
	Less than 1,000 ㎡	More than 1,001 ㎡ Less than 5,000 ㎡	More than 5,001 ㎡ Less than 10,000 ㎡	More than 10,001 ㎡
Governmental office	420,713.02	1,452,090.15	611,094.77	3,023,858.62
Private office	6,728,000.81	16,163,287.39	4,214,635.84	18,423,587.91
Hotel	71,439.33	380,096.22	170,833.23	525,513.13
Hospital	7,630.04	110,747.77	170,936.65	813,303.19
Shopping center	42,473,825.00	22,240,163.31	5,002,506.62	25,679,415.30
Collective housing	220,930,165.00	102,762,595.30	12,919,464.41	35,337,196.95

Source: Tehran municipal government

4.2. Current Status of Energy Management in the Building Sector

4.2.1. Related Organization

There are no unitary organizations which have managed the data about the buildings in Iran. The construction application for new building, extension and alteration of a building is made to the city government in charge. Therefore, the city has managed the data of the number of ridges of a building, a kind, architectural area, and etc. On the other hand, since the data about the energy used of the buildings does not have report duty, it cannot be managed in the government.

The above data is required to estimate the energy saving potential and to know specific energy consumption of the building. But it is difficult to collect and analyze the organized data of the building under the present circumstances.

Furthermore, the visualization of the energy consumption is very important to promote energy saving.

Governing structure including construction of a database will be examined in future study.

4.2.2. Management System and Technique

(1) Management System

Outline of Energy Management of the Building in Iran, based on hearing from government related organization and private cooperation, is shown in Table 4.2.1

Table 4.2-1 Outline of Energy Management of the Building in Iran

Item	Situation
Collection and preservation of energy data	It seems that collection and preservation of the energy data for energy management is not done. However, the energy-saving diagnostic example currently collected by two years and six months also has electricity and monthly consumption data of gas. Therefore, it is assumed that bills are kept to some extent.
Operating record of facilities.	There are few buildings which have taken the operating record of facilities. In the collective housing which is carried out energy audit in the 3rd field survey, the operating record of the heat source for air conditioning (turbo chiller) was taken every day. (however, with heat source for heating, no record.) It is assumed at some buildings that the operating record of apparatus is taken.
Specification of facilities, a drawing diagram	There are few buildings which have stored the specification of facilities and drawing diagram. There is energy audit report in which the construction drawing of the wall of a building and the system diagram of air-conditioning are attached. Therefore, it is assumed that it is managed to some extent.

Source: Prepared by JICA Study Team

Although the engineers or operators for operation and maintenance of the facility are in the building, they don't check and manage the energy consumption of the building. They are confined to equipment maintenance such as breakdown maintenance, and their conscious to use energy efficiently are not so high at present. In respect of building management, although the building owners are keeping energy cost with the bill base, they do not have any organization which manages it systematically, and arranges and analyzes it.

In the field survey, JICA Study Team visited following two facilities which have used building management system (BMS), and confirmed the condition of the energy management in the facilities.

・Research Institute of Petroleum

・MOE Head Building

Although building management system (BMS), which made from TAC-WIN Company, is introduced in the both building, the monitoring system of the energy consumption is not included in the BMS. The main purpose of the BMS is to supervise indoor environment, and control and operate equipment for optimal performance. Moreover, the BMS of Research Institute of Petroleum is being interlocked with the security system.

In Atiyeh Hospital which carried out the energy audit by JICA Study Team, BMS was introduced one year ago. The BMS in Atiyeh Hospital does not have the function of monitoring system of the energy consumption.

In building sector, it's not customary to monitor and manage of the energy consumption by the low awareness against energy saving.

(2) Develop and Market of BMS/BAS in Iran

1) TAC-WIN Company

TAC-WIN introduced the technology of TAC which has the head office in Sweden. They have placed two bases (Teheran, Shiraz) in Iran. They have introduced BMS into 30 or more facilities in Iran such as the follows.

・Imam Khomeini Airport

・Research Institute of Petroleum of Iran

・Kish Convention Center

・Mellat Complex

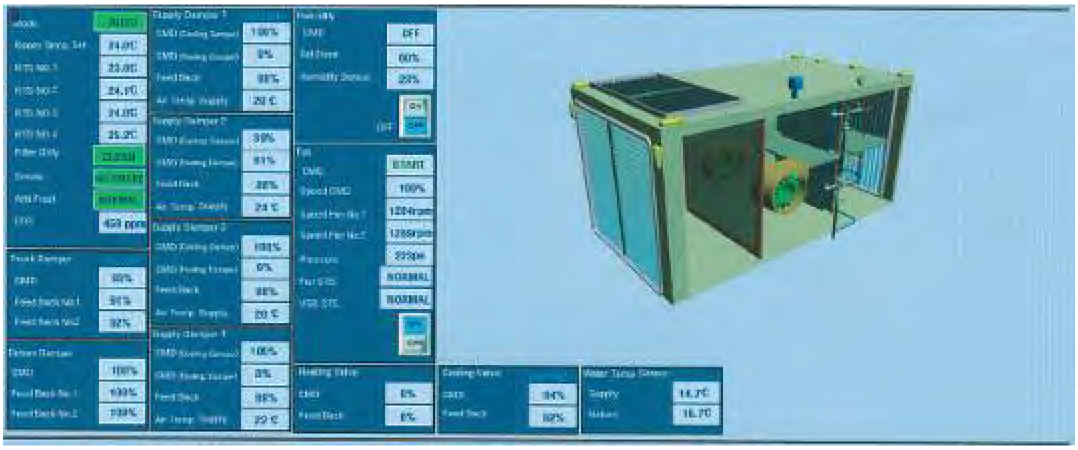
・Shiraz IT Tower

・EN Bank

・Yazd Telecommunication Building

Their BMS performs the surveillance and control in connection with air conditioning equipment, electric equipment, fire-fighting equipment, and security equipment. TAC-WIN has described the energy management system aiming at energy saving as facility management system (FMS). Therefore, energy management system is not contained in their BMS.

The following figure is a sample screen (management of AHU) of BMS of TAC-WIN.



Source: Screen print of display of BMS of TAC-WIN

Figure 4.2-1 Sample Screen of BMS of TAC-WIN

2) PISHURUN ENERGY

PISHURUN ENERGY has energy saving business used by control device it has developed for heat source equipment such as boiler and chiller. The device has functions of ON/OFF control of heat source equipment with monitoring the temperature of outside and supply water. Then, the device can record the data of operation status and verify the results of energy saving by the control. On the other hand, since the device is specializing for control of heat source equipment, it cannot manage and control the whole building. They have already installed 15,000 units in the Iran whole country

Control Device

Installation

Measuring of outside temperature

Measuring of supply water temperature

Source: Web page of PISHURUN ENERGY

Picture 4.2-1 Energy Saving Equipment by PISHURUN ENERGY

3) BEHSAN SANAT PAYDAR

P BEHSAN SANAT PAYDAR has energy saving business used by control device it has developed for heat source equipment such as boiler and chiller. They develop and sale the control system to improve efficiency by monitoring exhaust gas component and temperature of the boiler for the industry.

(3) Energy management in field of industry

In Iran, energy management of the industrial field is advanced systematically. Energy audit is carried out the whole type of industry for setting the benchmark in connection with energy consumption of the industry type. The benchmark is specified in Institute of Standards and Industrial Research of Iran (ISIRI).

ISIRI 8664	Specification and criteria for electrical energy consumption in processes of aluminium production
ISIRI 8667	Specification and criteria for thermal and electrical energy consumption in the process of glass production
ISIRI 7873	Specification and criteria for electrical and thermal energy consumption and energy grades in the process of cement production
ISIRI 9648	Specification and criteria for energy consumption in plastics in primary forms and synthetic rubber production processes
ISIRI 9652	Specification and criteria for thermal and electrical energy consumption in vegetable oil (vegetable oil refining & oil crushing) production process

This standardization is advanced to the type of industry with much heat demand (fuel consumption), and it seems that the type of industry which continues to be standardized increases.

4.3. Current Status of Energy Consumption of Buildings

4.3.1. Energy Consumption by Building Type

(1) Specific energy consumption

When evaluating the energy conservation situation of buildings, there is the method of comparing by specific energy consumption. It is annual amount of the energy consumption (MJ) divided by floor area (m^2). The average specific energy consumption (MJ/m2) of the building in Japan is shown in Table 4.3-1 at reference.

Table 4.3-1 Specific Energy Consumption of Building in Japan

Use of building	Number of sample	Average of floor area	Specific energy consumption
	(Buildings)	(m^2)	(MJ/m2·year)
Office for governmental	427	15,600	1,230
Office for private company	588	28,400	1,920
Hotel	331	21,100	2,970
Hospital(Generally)	289	30,500	3,110

Source: The Guidebook of Energy Conservation of Building 2010-2011 Energy Conservation Center, Japan

It is general to express an amount of energy by MJ (megajoule) in Japan. However, in the energy audit report in Iran, since the amount of energy is expressed by kWh, therefore, in this report, KWh is converted into MJ so that it can be compared with specific-energy-consumption in Japan. 1 kWh=9.76MJ is used in Japan. It seems that it is being referred to as 1 kWh=10.8 MJ in Iran if it guesses from the data of an energy-saving diagnostic report. It is needed to consider for the power generation and transmission loss in case of converting kWh into MJ, and it is different from each country.

Specific energy consumption of the building which Energy Conservation Center Japan exhibits is shown in Table 4.3-2.

Table 4.3-2 Energy Conversion Factor

	Energy conversion factor		Remark
	Iran	Japan	
Electric Power	10.8MJ/kWh	9.76 MJ/kWh	From electric power to primary energy(Heat)
	3.6MJ/kWh	3.6MJ/kWh	From primary energy(Heat) to electric power
Natural Gas	37.34MJ/m3	45.0 MJ/m3	Supplied by Tokyo Gas Co., Ltd.

Source: Prepared by JICA Study Team

(2) The feature of consumption of the energy by building

The example of the energy consumption of an office building, a hospital, a hotel, and collective housing is shown from the Table 4.3-3 to the Table 4.3-6. According to the result which carried out the hearing from SABA in the 3rd field survey, many energy audits in Iran are carried out for governmental office buildings. However, there is little implementation of the energy audit for private buildings.

Specific energy consumption of the buildings in Iran is smaller than the specific energy consumption of the building in Japan. About this reason, it analyzes after the third field survey. Moreover, since there are still few samples, the feature of the energy consumption by the classification of a building is not caught.

Table 4.3-3 The Feature of Consumption of Energy of Office Building

Type	Location	Floor Area (m^2)	Specific Energy Consumption（MJ/m^2）		
			Fuel	Electric[*1)]	Total
Office Bldg. (13Fl.)	Tehran	9,230	1,200	1,188	2,388
Office Bldg.	Fars	6,960	539	1,282	1,822
Office Bldg.	Azerbaijan	7,536	1,000	774	1,774
Office Bldg.	Khorasan	6,000	852	962	1,807
High Efficiency Bldg. (14 Bldgs.)	Tehran	50,400	1,400	216	1,616
CTC Building	Tehran	1,950	515	1,082	1,596
SB Call Center	Tehran	3,217	447	4,784	5,230
Isfahan Electricity Bldg.	Isfahan	8,400	548	2,326	2,874
Ahvaz Electricity Bldg.	Ahvaz	4,700	—	2,838	2,837
Bakhtar Electricity Bldg.	Bakhtar	7,500	1,230	1,952	3,182
Construction & Development Bldg.	BandarAbas	2,626	—	4,064	4,064
Urban services Bldg.	BandarAbas	1,904	—	2,309	2,309
HSE Bldg.	BandarAbas	510	—	1,342	1,342
Maskooni Bldg.	Tehran	325	242	635	877
Audio & Visual Department	Tehran	1,800	638	1,008	1,645
Edari	Tehran	4,400	1,808	500	2,308
Average value in Japan(Reference)					1,230

Source: Iran and World Energy Facts and Figures 2008

*1 In the source, although the electric amount of consumption was written by kWh/m2, the JICA Study Team changed the electric amount of consumption into MJ/m2. The conversion coefficient of electric power is 1 kWh=10.8MJ, as shown in Table 4.3-2.

Table 4.3-4 The Feature of Consumption of Energy of Hospital

Type	Location	Floor Area（m^2）	Specific Energy Consumption（MJ/m^2）		
			Fuel	Electric*1)	Total
Hospital (600beds)	Tehran	38,601	3,000	1,404	4,404
Hospital (400beds)	Tehran	33,621	2,049	1,199	3,248
Average value in Japan(Reference)					3,110

Source: Iran and World Energy Facts and Figures 2008

*1 In the source, although the electric amount of consumption was written by kWh/m2, the JICA Study Team changed the electric amount of consumption into MJ/m2. The conversion coefficient of electric power is 1 kWh=10.8MJ, as shown in Table 4.3-2.

Table 4.3-5 The Feature of Consumption of Energy of Hotel

Type	Location	Floor Area（m^2）	Specific Energy Consumption（MJ/m^2）		
			Fuel	Electric*1)	Total
Hotel (5Fl., 60rooms)	Tehran	3,781	1,000	648	1,648
Average value in Japan(Reference)					2,970*2)

Source: Iran and World Energy Facts and Figures 2008

*1 In the source, although the electric amount of consumption was written by kWh/m2, the JICA Study Team changed the electric amount of consumption into MJ/m2. The conversion coefficient of electric power is 1 kWh=10.8MJ, as shown in Table 4.3-2.

*2 The reason why SEC for Hotels in Iran is lower than Hotels in Japan (around 1/2) is because Floor Area is very different. SEC for Hotels in Japan is based on large hotel (which has from 12,000m2 to 155,000m2 floor area). They have party hall, big bath, pool and restaurant which consume much energy. On the other hands, SEC for Hotels in Iran is based on small hotel (which has less than 4000m2 floor area). This is about equal to the collective housing's energy consumption.

Table 4.3-6 The Feature of Consumption of Energy of Collective Housing

Type	Location	Floor Area（m^2）	Specific Energy Consumption（MJ/m^2）		
			Fuel	Electric*1)	Total
Residential Bldg. (4Fl.)	Tehran	1,568	1,500	653	2,153
Apartment (20 Bldgs.)	Tehran	15,979	1,101	322	1,417

Source: Iran and World Energy Facts and Figures 2008

*1 In the source, although the electric amount of consumption was written by kWh/m2, the JICA Study Team changed the electric amount of consumption into MJ/m2. The conversion coefficient of electric power is 1 kWh=10.8MJ, as shown in Table 4.3-2.

According to the energy audit report received from IFCO on the second field survey, the energy consumed of building is shown in Table 4.3-7.

Table 4.3-7 Energy Consumption Data of Building in Iran (Reference)

Building	City	Floor area	specific energy consumption	Energy consumption
		m2	MJ/ m2･year*[1]	MJ/year
		A	B	C=AxB*[2]
2 administrative site-Construction and Development	Booshehr-Asalooyeh	2,626	4,342	11,401,042
Administrative site 2-urban services	Booshehr-Asalooyeh	1,604	2,309	3,703,698
2 administrative site-building HSE	Booshehr-Asalooyeh	510	1,531	781,034
Customs and vehicles	Booshehr-Asalooyeh	1,642	2,029	3,332,146
8 mall unit	Booshehr-Asalooyeh	2,652	3,283	8,707,046
Airport terminal	Booshehr-Asalooyeh	7,450	7,889	58,776,030
Perdis sports	Booshehr-Asalooyeh	5,353	1,476	7,902,954
Residential camp 2.	Booshehr-Asalooyeh	11,918	1,876	22,357,696
Residential camp 4.	Booshehr-Asalooyeh	―	740	―
CentralⅣ	Tehran	4,947	2,365	11,700,644
CentralⅤ	Tehran	5,500	2,095	11,523,600
CentralⅥ	Tehran	8,303	1,868	15,513,325
CentralⅦ	Tehran	6,100	825	5,033,232
CentralⅧ	Tehran	7,510	3,035	22,791,348
CentralX	Tehran	825	893	736,862
Echymose building	Tehran	2,205	1,178	2,598,113
Hasko Building	Tehran	2,076	847	1,757,786
First central	Tehran	20,650	8,910	183,991,500
New central	Tehran	17,500	10,876	190,323,000
Central broadcasting	Tehran	6,453	6,600	42,589,022
Spring building	Tehran	11,272	11,739	132,316,600
The second	Tehran	4516	3,601	16,260,847
The building Iranshahr	Tehran	1,977	4,966	9,817,470
The building Khaghani	Tehran	834	8,635	7,201,256
Educational complex Vanak	Tehran	1,378	4,350	5,994,626
Complex technical training	Tehran	2,415	9,205	22,229,694
Cypress structure	Tehran	759	4,196	3,184,618
The building geisha	Tehran	1,823	5,099	9,294,890
Mirdamad Building	Tehran	145	4,638	672,440
Babolsar's training complex	Tehran	1,000	4,893	4,893,480
Caspian oil company	Tehran	1,743	4,783	8,337,330
The building language learning	Tehran	1,800	3,205	5,769,014
The building of the oil	Tehran	400	1,515	605,837
Guard building	Tehran	640	4,839	3,096,857
Tondguyan Building	Tehran	3,094	7,923	24,514,056
Technology building	Tehran	1,050	3,419	3,589,790

The building consultation	Tehran	150	3,840	576,072
The Basij	Tehran	1,000	5,075	5,075,460
Shana's building	Tehran	2,500	—	—
Auditing building	Tehran	3,300	4,909	16,199,449
Infected building	Tehran	600	4,644	2,786,465
The building inn	Tehran	2,625	3,683	9,669,056
Warehouse martyr Goldsmith	Tehran	620	—	—
Parking Shiraz	Tehran	3250	4,842	15,736,734
College of Tehran's oil	Tehran	2,064	10,773	22,234,802
Tehran university dormitory	Tehran	2,700	6,297	17,002,613
college dorm oil	Tehran	1,750	4,716	8,252,690
Stir 2 adjoining conex club	Tehran	380	4,120	1,565,471
faculty research center	Tehran	1,600	2,339	3,742,848
University staff	Tehran	—	—	—
Laleh Tower	Mahmoodabad	8,770	6,534	57,303,180
tulips tower		14,685	7,636	112,128,786
Tower Narges		14,685	7,528	110,542,806
Tower disappointment		8,770	5,864	51,430,788
Normal villa (a monogamous relationship.		38	8,521	323,806
Villa normal (two bedroom without kitchen)		42	8,510	357,437
Villa normal (two bedroom with kitchen)		56	9,385	525,571
Vip villa (a)		145	6,307	914,544
		175	5,735	1,003,590

Source: Countries' energy audit and the governmental and non-governmental organizations

*1 In the source, although the electric amount of consumption was written by kWh/m2, the JICA Study Team changed the electric amount of consumption into MJ/m2. The conversion coefficient of electric power is 1 kWh=10.8MJ, as shown in Table 4.3-2.

*2 JICA Study Team calculated the data (C) of the column of energy consumed by the Floor area (A) x specific energy consumption of the source.

4.3.2. Energy Audit

(1) Current condition of the energy diagnostics of Iran.

As stated above, there are two energy conservation organizations, IFCO and SABA, in Iran, and each is carrying out energy audit. However, neither energy audit of IFCO and SABA is conducted by themselves, but each organization just offers funds. The energy-related company is performing actual data collection, analysis, and report writing. JICA Study Team received the explanation material of the history of energy audit funded by IFCO and six energy audit reports funded by IFCO fund. Moreover, JICA Study Team receives 4 energy audit reports funded by SABA.

The evaluation about energy audit in Iran that is judged from the report received from IFCO is shown in Table 4.3-8.

Item	Contents		Comment
Questionnaire	Outline of applicant (Name of person in charge, Contact information)	○	In performing energy audit, it is mostly covered about the contents which should be grasped in advance.
	Outline of building (Use, Structure, Floor area)	○	
	Energy consumption	○	
Collecting data at walk through	Check of the specification of construction (Window or wall, Material, Thickness, Square meter of area)	○	Data, such as specification of apparatus, the number, and a distribution diagram of air-conditioning, are collected by the field survey, and what should be grasped in a field survey is covered mostly. It is not shown by the report whether operating record is checked.
	Check of the specification of facility (Rated value, Number of installation)	○	
	Check of air-conditioning system (Diagram)	○	
	Check of record in operation	–	
Measurement	Measuring of electric power consumption	○	Measurement of power consumption, measurement of the combustion flue of a boiler, and measurement of illumination are performed. Regarding the natural gas, since the suitable meter is not installed in existing facilities, measurement of gas is not realistic.
	Measuring of natural gas consumption	–	
	Measuring of energy efficiency of facility	●	
Calculation of energy conservation amount	Architecture	○	Many techniques from architecture field are proposed. Moreover, heat insulation of a building is an important subject and is based on the present condition in Iran. But, techniques from mechanical field are few, high efficient operation of a heat source and proposals about heat insulation of piping is desired.
	Mechanic	●	
	Electric	○	
Analysis・Suggestion	Energy consumption for every energy use	×	Although suggestion of energy conservation is classified as mechanical and electric, it is appropriate to analyze for each energy use (hot-water supply, air-conditioning, lighting). Although, there are many energy audit reports available regarding office buildings, however, there is little energy audit reports available for buildings which consume energy very much, such as a hospital and a shopping mall. And it is important to make the proposal based on the use of the building to a hospital etc
	Proposal suitable for a building use	×	
	Energy conservation potential and cost	○	

.

JICA study team understood that energy audit level in Iran is high. Because energy auditor in Iran measure almost of the survey contents should be carried out in energy audit.

Nevertheless, there is an important issue that the building use is not considered in energy audit of the buildings in Iran.

It can be said that the level of the energy audit in Iran is high. However, there are many energy conservation proposals from view point of construction, but few energy conservation proposals from view point of facility. It is possible to make a proposal from the Japan side about enriching the contents of the energy conservation proposal. In addition, it is very important to prevent heat dissipation in the present condition of the building of Iran, since there is much heat dissipation from a wall or a window. Therefore, at present, it is appropriate that it is mainly concerned with a construction energy conservation proposal. Hereafter, if heat insulation of a wall and a window progresses based on Article No. 19 of Building Code, the energy conservation proposal about equipment will increase.

Table 4.3-8 The Evaluation about Energy Audit in Iran

Item	Contents		Comment
Questionnaire	Outline of applicant (Name of person in charge, Contact information)	○	In performing energy audit, it is mostly covered about the contents which should be grasped in advance.
	Outline of building (Use, Structure, Floor area)	○	
	Energy consumption	○	
Collecting data at walk through	Check of the specification of construction (Window or wall, Material, Thickness, Square meter of area)	○	Data, such as specification of apparatus, the number, and a distribution diagram of air-conditioning, are collected by the field survey, and what should be grasped in a field survey is covered mostly. It is not shown by the report whether operating record is checked.
	Check of the specification of facility (Rated value, Number of installation)	○	
	Check of air-conditioning system (Diagram)	○	
	Check of record in operation	−	
Measurement	Measuring of electric power consumption	○	Measurement of power consumption, measurement of the combustion flue of a boiler, and measurement of illumination are performed. Regarding the natural gas, since the suitable meter is not installed in existing facilities, measurement of gas is not realistic.
	Measuring of natural gas consumption	−	
	Measuring of energy efficiency of facility	●	
Calculation of energy conservation amount	Architecture	○	Many techniques from architecture field are proposed. Moreover, heat insulation of a building is an important subject and is based on the present condition in Iran. But, techniques from mechanical field are few, high efficient operation of a heat source and proposals about heat insulation of piping is desired.
	Mechanic	●	
	Electric	○	
Analysis・Suggestion	Energy consumption for every energy use	×	Although suggestion of energy conservation is classified as mechanical and electric, it is appropriate to analyze for each energy use (hot-water supply, air-conditioning, lighting). Although, there are many energy audit reports available regarding office buildings, however, there is little energy audit reports available for buildings which consume energy very much, such as a hospital and a shopping mall. And it is important to make the proposal based on the
	Proposal suitable for a building use	×	
	Energy conservation potential and cost	○	

			use of the building to a hospital etc

Source: JICA study team

(2) Energy audit by JICA study team

Energy audit of two buildings were performed in the third and fifth field survey.
The outline and schedule of the building are shown in Table 4.3-9.
Summary of result of energyaudit is shownin Table 4.3-10.

Table 4.3-9 The Outline of Building and Schedule of Energy Audit

Name of building	Outline of building	Schedule of energy audit
Atieh Hospital	■Outline of building Location:Northwest Tehran Land area: 4,300 square meter Floor area: 24,000 square meter Start period:1999 April Architecture: above the ground 12 Stories Total capacity of patients :350 beds Surgery rooms :15 rooms ■Outline of facilities Heat source: 2 Steam boiler 6t/h, 1 in operation, 1 stand-by : 2 Steam absorption chiller 450 USRT, 1 in operation, 1 stand-by BEMS: measuring about 250 point Steam pressure, steam temperature, natural gas pressure of boiler	Jan 19th Meeting Installation of measuring instrument Jan 23rd Withdraw of measuring instrument
Ekbatan collective housing	■Outline of building Start period:1983 Architecture: above the ground 12 Stories Total capacity of patients :520 esidences ■Outline of facilities Heat source: 2 Water boiler 16,738,000Btu/h, 1 in operation, 1 stand-by : 2 Turbo chiller 640 USRT, 1 in operation, 1 stand-by	Jan 23rd Meeting Installation of measuring instrument Jan 29th Withdraw of measuring instrument
SANA building (NIROO institute)	■Outline of building Location:Northwest Tehran Start period: About 10 years ago Architecture: above the ground 7 Stories Floor area: 8,000 square meter ■Outline of facilities Heat source: 2 Water boiler unknown Btu/h, 1 in operation, 1 stand-by : 3 Turbo chiller 150 USRT, 1 in	Jun 18th Installation of measuring instrument Jun 19th Withdraw of measuring instrument

	operation, 2 stand-by	
Supermarket	■Outline of building Location: Tehran Start period: About 35 years ago Architecture: above the ground 4 Stories Floor area: 2,000 square meter ■Outline of facilities Heat source: 2 Water boiler unknown Btu/h, 1 in operation, 1 stand-by : 3 Turbo chiller 150 USRT, 1 in operation, 2 stand-by	Jun 20th Installation of measuring instrument Jun 22th Withdraw of measuring instrument
Hotel	■Outline of building Location: Central Tehran Start period: About 40 years ago Architecture: above the ground 4 Stories Floor area: 2,000 square meter ■Outline of facilities Heat source: 2 Water boiler unknown Btu/h, 1 in operation, 1 stand-by : 3 Turbo chiller 150 USRT, 1 in operation, 2 stand-by	Jun 22th Installation of measuring instrument Jun 19th Withdraw of measuring instrument

Source: JICA study team

Table 4.3-10 Summary of result of Energy Audit

Type of building use	Floor area	Current energy consumption		Promising technologies	potential
		Electric power	Natural gas		
		MJ/year	MJ/year		MJ/year
Hospital	24,000	51,524,000	50,140,000	Heat insulation to non- covered piping.	112,000
				Exchanging existing steam trap	149,000
				Replace of heat source	20,521,065
Collective housing	66,000	28,929,000	42,778,000	Reduction of water leak from boilers	2,000
				Replace of heat source	18,090,000
Shopping center	2,000	6,972,000	Not got	Reduction of the number of the fluorescent lamp	456,000
				Introduction of controller of number of pump	291,000
Hotel	2,000	4,575,000	Not got	Strengthen O & M	128,000
				Installation of partition	71,000
				Changing drinking water pump	360,000
Office	8,000	Not got	Not got	Strengthen O & M	–
				Measuring energy data periodically	–

Source: JICA study team

4.4. Energy Efficiency & Conservation Technology

4.4.1. Construction(Architecture)

Based on IFCO's energy audit reports, interview and observation *in situ*, the table 4.4-1 shows EE&C technologies which are already present in Iran or which are expected to be introduced in the future (in terms of operation method of a building, or along with replacement of an equipment, and rehabilitation of a building). The items in this table, which are EE&C technologies and techniques adopted in Japan, are classified according to their state of introduction or their possibility of introduction to Iran.

Table 4.4-1 Already-introduced and Applicable Technologies in Construction Field against standard EE & C technologies in Japan

Item		**Phase**			**Pos**
Large classification	**Small classification**	**O/M**	**Rep**	**Rehab**	
Insulation	Enhancement of roof and envelope insulation			○	■
	Insulating paint (roof insulation enhancement)		○		×
	Insulating glass and film		○		■
	Insulated sash			○	
Insolation control	Opening and closing of blind	○			■
	heat-absorbing and reflecting glass		○		
	Shielding from insolation by grass establishment		○		×
	Prevention of heat reflection by grass		○		×
	Shading (e.g. canopy)			○	■
Prevention of draft	Opening, closing of doorways	○			■
	Opening, closing of windows	○			
	Enhancement of window air-tightness		○		
	Enhancement of wall air-tightness		○		■
	Enhancement of staircase air-tightness		○		
	Enhancement of doorway			○	■
	Installation of airlock space			○	■
Daylighting and lighting	Zoning of workspace according to necessary illuminance	○			
	Use of light color in interior space		○		
Ventilation	Natural ventilation			○	
	Window with a venetian blind and an air-exhaust system			○	
Others	"Cool Biz" style[32]	○			
	Enhancement of air circulation	○			
	Air-flow window			○	
	Air-curtain			○	

O/M: The measure performed by reexamination of the operating method of apparatus or a system, strict-izing, thoroughness of management, etc.
Rep: The measure performed when equipment becomes close to a life duration or updates completely to a new one
Rehab: The measure implemented in accordance with repair of construction at superannuation of the whole building.
Pos: Possibility of introduction
■: The item already proposed in the report of IFCO
×: Based on the construction situation of Iran, it is difficult to introduce .
○: The item expected introduction

(1) Technology already introduced

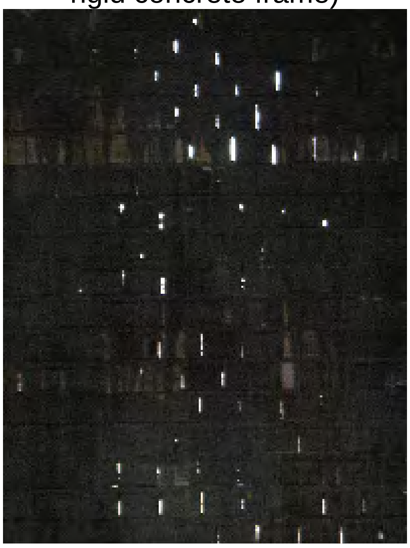
From the point of view of the EE&C approach by building technology, thermal insulation of new buildings is crucial. In fact, thermal insulation of building envelope seems to be the

[32] Dressed down clothing code in summer time, often without jacket and tie.

most challenging part in the current situation in Iran. One of most popular construction method in the Islamic Republic of Iran is concrete rigid frame filled with hollow bricks wall, with plaster finishing for interior wall and tile or stone finishing for exterior wall, on mortar basement (picture 4.4-1 and 4.4-2). From the point of view of energy saving, the problem of this method is the lack of insulation and the low air tightness of hollow bricks. As for the lack of insulation, hollow bricks thermal conductivity remains very high (0.62W/(mk)) compared with plate-form polyurethane foam (0.028W/(mk), one of most popular insulation in Japan), that is, thermal performance of such wall is quite low[33]. Regarding the low air tightness, as manual wet working of hollow brick wall causes gap between bricks (as seen in picture 4.4-3), the decline of air tightness is inevitable.

Picture 4.4-1 Example of Construction Method in Iran (hollow bricks filled into rigid concrete frame)

Picture 4.4-2 Example of Popular Building Material in Iran (hollow bricks)



Picture 4.4-3 Look of Hollow Brick Wall in Execution from Inside (light leaks from the gap between bricks)

[33] That is, to obtain the insulation performance equal with the urethane foam, the brick needs 20 times or more thickness than the polystyrene needs. The thermal conductivity of the brick used here is not of a hollow brick. Therefore, the insulation performance of a hollow brick wall is expected to be better. A detailed examination shall be carried out after the reception of an English translation of the Article no.19 of building code. The source of the thermal conductivity values: “Explanation of energy conservation standard of house” (Institute for Building Environment and Energy Conservation, Japan)

The following section, therefore, shall describe, at first, thermal insulation technologies of building envelope and openings on the table 4.4-1, which are already introduced or expected to be introduced in Iran. Secondly, this section shall describe the state of introduction of passive design – key building technologies and techniques for EE&C along with insulation, including insolation control (shading such as canopy) and ventilation (natural ventilation).

1) Thermal Insulation

(a) Insulating material

Some buildings have introduced insulation such as polystyrene inside its walls. Insulation materials are often in plate-like form, and JICA Study Team observed construction method such as insertion of insulation between two layers of hollow bricks. There is also pre-fabricated wall insulation with built-in base of reinforcing steel for mortal finishing.

(b) Double glazed PVC sash

In the Islamic Republic of Iran, double glazed PVC sash is available and often adopted in relatively new buildings. In spite of its high insulation performance, double glazing window can not prevent thermal gain from insolation. Therefore, its use requires consideration especially on the climate conditions.

(c) Pre-insulated hollow bricks

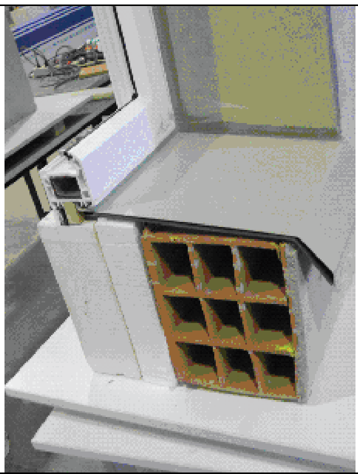
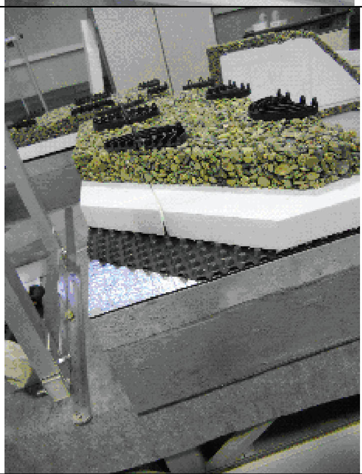
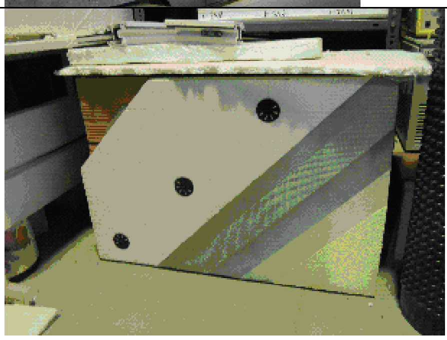
There are attempts to improve the thermal performance of hollow bricks, one of most popular building materials in Iran. Specifically, the middle part of the three hollow interior layer of a brick is filled with polystyrene insulation. Although this material shows higher thermal performance than normal hollow bricks, it can not compensate shortcoming of execution. In addition, as the insulation is inserted inside a brick, the material can not prevent heat bridge.

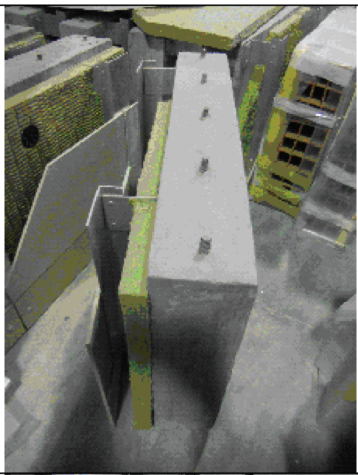
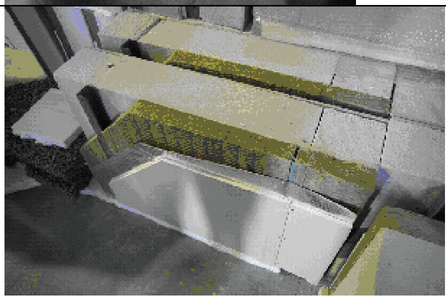
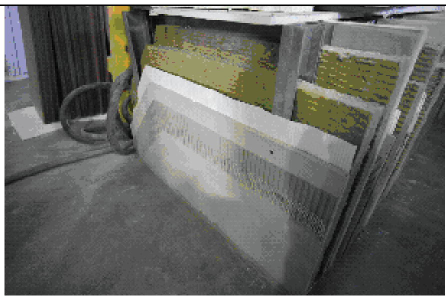
Picture 4.4-4 Pre-insulated Hollow Brick

(d) Thermal insulation construction methods promoted by BHRC

BHRC devised building methods for building envelope in compliance with Article 19 of Building Code. The organization has been distributing mockups to Iranian municipalities for the purpose of demonstrating these building methods and promoting EE&C. The thermal insulation construction methods promoted by BHRC are detailed on the table 4.4-2.

Table 4.4-2 BHRC's Mockups of Building Parts conforming to Art. 19 of Building Code

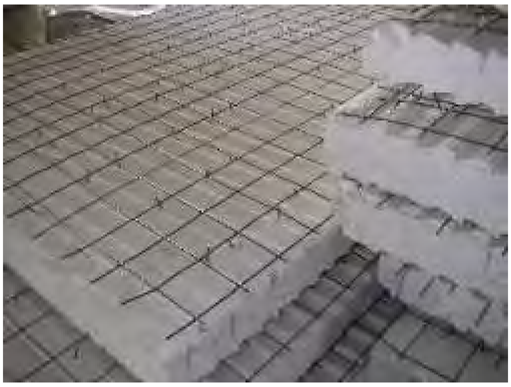
Building part	Picture	Description
Opening (window)		Detail of wall: hollow brick + inside insulation + double glazed PVC window sash From outside: thin mortar coating, hollow bricks, insulation (Styrofoam), cement panels
Roof		Roof detail: exterior insulation + tile finish RC slab + gradient mortar + Rubberized Asphalt water proof+ drainer sheet + Insulation (Styrofoam) + natural stone paving + terrazzo tile Terrazzo tile can be replaced by marble concrete tile.
Outer wall		Detail of wall: hollow brick + outside insulation + double glazed PVC window sash From outside: paint finishing, base painting, thin mortar coating, PVC mesh, thin mortar coating, insulation (Styrofoam), supported by hollow brick Interior finishing : thin mortar coating, plaster board (gypsum lining method)

Outer wall		Detail of wall: dry wall + outside insulation Glasal board + aluminum base + insulation (glass wool) + RC structure Exterior finish can be replaced by metal panel, etc.
Outer wall		Wall detail: Foam concrete block + outside insulation + board finishing From outside: Glasal board + heat reflective sheet + light steel base + insulation (glass wool) + foam concrete block Interior finish: plaster board (gypsum lining method)
Outer wall		Wall detail: light steel base + insulation filling From outside: Thin mortar coating + PVC mesh + thin mortar coating + cement board + waterproof sheet + double layered light steel base + insulation (glass wool) + double layered plaster board The interior finishes can be replaced with other boards

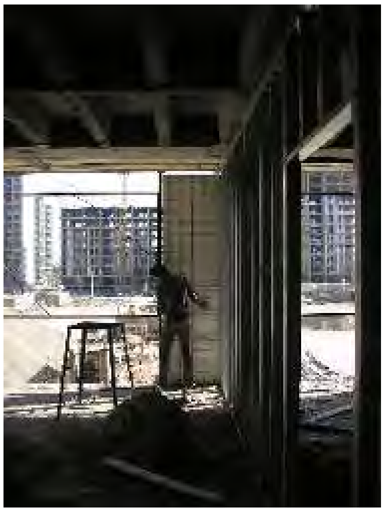
(e) Other technologies expected to be further propagated
JICA Study Team observed *in situ* two types of energy-saving insulating material.

i) Polystyrene plate with built in reinforcing steel for finishing base, which is build in C-channels frame and finished with mortar (picture 4.4-5 and 4.4-6).

ii) Three types of wall material of polystyrene: ceiling and non-bearing wall insulation which can be also used as finishing base, and load-bearing wall material with built-in reinforcing steel which can be use as concrete formwork (Product name: SuperPanel)



Picture 4.4-5 Insulation with Reinforcing Steel Base



Picture 4.4-6 Execution of Insulation (inserting into C-channel frame)

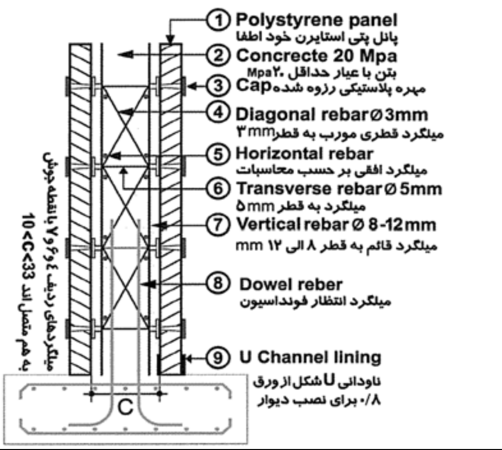
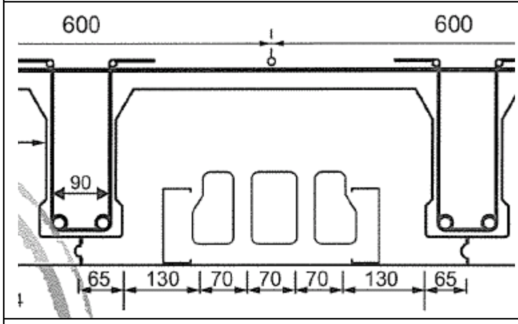
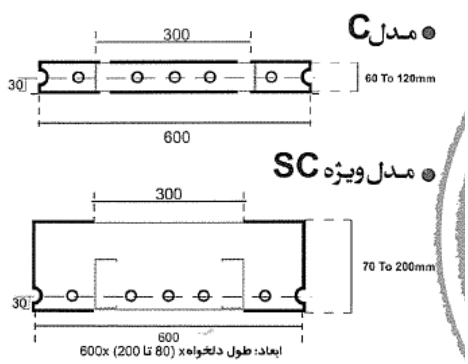
Advanced Building Products Company manufactures this SuperPanel in the Islamic Republic of Iran, under license by a Swiss company. Members for load-bearing wall, non-bearing wall or ceiling are available. These members are sold either as package or separately for each part of a building.

This system costs around 600 U.S. dollars per square meter, which is almost the same level as the conventional construction method. In addition, the system offers advantages such as shortening the construction period (one week per floor), or weight saving of building (300 kg of weight saving per floor area compared with conventional construction method).

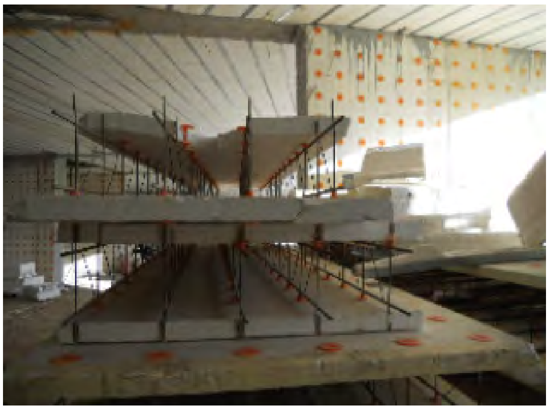
Furthermore, a subsidy of 100,000 Rial per floor area is allocated to the use of energy efficient wall material.

The features of each member are as following table:

Table 4.4-3 Feature of Each Member of SuperPanel

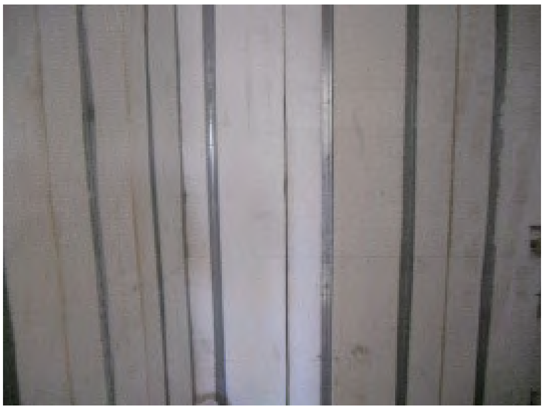
<table>
<tr>
<td>
</td>
<td>For load-bearing wall use
Reinforcing steel is build and fixed between two polystyrene plates by form-ties. Depositing concrete directly between the plates makes it a load-bearing wall. The form-ties are made of plastic so as to prevent heat bridge.
(Picture 4.4-7)</td>
</tr>
<tr>
<td>
</td>
<td>For ceiling use
Depositing concrete on these materials directly allows to construct floor slab and collar beams. The built-in C channels can be used as base for finishing or lighting fixture. The holes are for piping purpose. The covering depth of polystyrene can be adjusted according to the height of the beams
(Picture 4.4-8)</td>
</tr>
<tr>
<td>
</td>
<td>For non-bearing wall use
Built-in C-channels for base of wall finishing, with adjustable polystyrene cover depth
(Picture 4.4-9)</td>
</tr>
</table>

Source: Created by JICA Study Team base on docments provided by Building Products Company



Picture 4.4-7
SuperPanel for Load Bearing Wall

Picture 4.4-8 SuperPanel for Ceiling (adjustable polystyrene covering depth)



Picture 4.4-9 SuperPanel for Non-load Bearing Wall

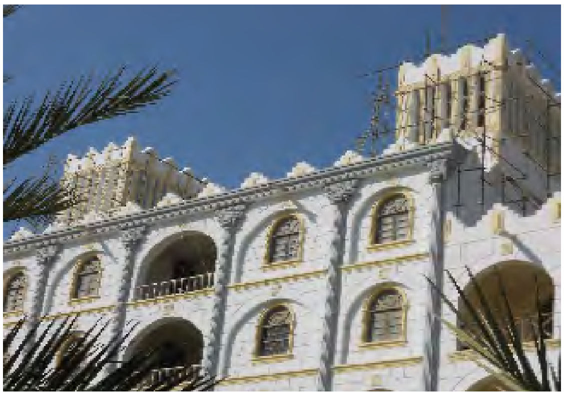
2) Introduction of passive energy-saving technology

Passive energy saving technology in building sector is categorized into 1) insulation (including insulation of opening), 2) airtight, 3) insolation control, 4) thermal inertia and 5) ventilation. JICA Study Team observed introduction of passive energy saving technology for the purpose of better thermal insulation and air-tightness in governmental new town development projects and high value-added luxury apartments projects, although the technology still remains less visible in small- or medium-sized building common in urban area[34].

Although insolation and ventilation control is not common in modern buildings, related know-how is accumulated in traditional building and its application is attempted in some contemporary buildings For example, in humid and hot area in the south of the country, some buildings try passive technology such as insolation control with canopy (Picture 4.4-10), or ventilation control with traditional “wind tower” to introduce wind into the building (Picture 4.4-11). However the latter shall need carefully considered design and a detailed study of the effect.

34 About these thermal insulating building methods, see the previous paragraph “Other technologies expected to be further propagated”.

Picture 4.4-10 Insulation control by Canopy



Picture 4.4-11 Modern Example of "Window Tower"

4.4.2. Equipment

EE & C technologies are classified into operation and management (O/M), replace, rehabilitation.
O/M is the measure performed by reexamination of the operating method of apparatus or a system, strict-izing, thoroughness of management, etc. Replace is the measure performed when equipment becomes close to a life duration or updates completely to a new one. Rehabilitation is : the measure implemented in accordance with repair of construction at superannuation of the whole building.
Already-introduced and Applicable Technologies in Equipment Field against standard EE & C technologies in Japan is shown in Table 4.4-4.

Judged based on Iranian energy audit reports, the hearing from private corporations, and the inspectionagainst some buildings, it will be thought that they are EE &C technologies which can apply introduction of heat insulation strengthening of piping or speed control of a pump, introduction of cogeneration (CHP), etc.

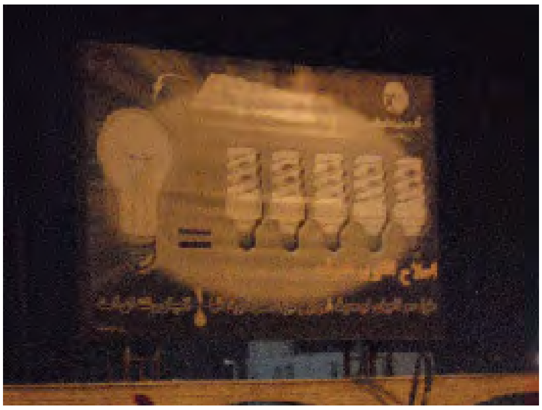
Table 4.4-4 Already-introduced and Applicable Technologies in Equipment Field against standard EE & C technologies in Japan

Item		**Phase**			**Pos**
Large classification	**Small classification**	**O/M**	**Rep**	**Rehab**	
Heat source/heat convey	Adjustment of air ratio in combustion equipment (e.g. Boiler, absorption chiller)	○			■
	Adjustment of the operating pressure of steam boiler	○			○
	Control of outlet temperature of cold water from chiller depending on the season	○			○
	Repair of a steam leak (exchange of piping, valve)		○		○
	Insulate Steam Distribution		○		○
	Variable Speed Drive on Airconditioning System Chilled Water Pump and Condenser Water Pump		○		○
	Replace to high efficiency heat source equipment			○	○
air ventilation	Change of the preset temperature and humidity of air-conditioning	○			■
	Reduction of volume of fresh air	○			■
	The stop of fresh air at pre-cooling operation in summer or at pre-heating operation in winter	○			×
	Shortening of air-conditioning / ventilation time	○			○
	Outdoor Air Cooling during midnight	○			×
	Outdoor Air Cooling	○			×
	Reduction of the mixing loss that heating-air and cooling-air meet.	○			×
	Shortening of ventilation time	○			○
	Schedule operation of parking lot ventilation equipment	○			×
	The air-conditioning stop at the room	○			×

	unused				
	Exchange to high efficiency fan belt.		○		○
	Replace to high efficiency motor		○		○
Water supply	Shortening of a hot-water supply period	○			○
Receiving and transform	Cut-off of a no-load transformer	○			×
	Cut-off of the transformer at no-load period	○			×
Lighting	Cleaning of light	○			○
	The lighting stop at the room unused	○			■
Other	Combined Heat and Power (Co-generation)			○	○

O/M: The measure performed by reexamination of the operating method of apparatus or a system, strict-izing, thoroughness of management, etc.
Rep: The measure performed when equipment becomes close to a life duration or updates completely to a new one
Rehab: The measure implemented in accordance with repair of construction at superannuation of the whole building.
Pos: Possibility of introduction
■: The item already proposed in the report of IFCO
×: Based on the construction situation of Iran, it is difficult to introduce .
○: The item expected introduction

Iran promotes the usage of energy efficient lighting fixture such as compact fluorescent light bulbs. In this domain, the subsidies for energy efficient appliance manufacturer and publicity to consumers are the main measures.



Picture 4.4-12 Compact Fluorescent Light Bulbs Promotion Campaign

4.5. Energy Conservation Potential

In the future study, energy saving potential of the building sector in Iran will be analyzed on the following data and information.

- Building data such as the number, kind, scale, and area
- Existing energy audit report done by SABA and IFCO
- Result of energy audit done by JICA Study Team

4.5.1 Construction(Architecture)

(1) Energy Conservation Potential by Compliance of BC 19

One of most popular construction method in the Islamic Republic of Iran is rigid frame filled with hollow bricks wall, with plaster finishing for interior wall and tile or stone finishing for exterior wall, on mortar basement. After observation *in situ*, a model wall can be assumed as following table and figure.

Table 4.5-1 Specification of a assumed wall

		d_i (mm)	λ_i (W/m.K)	R_i (m^2.K/W)
Plaster[1]		10	0.62	0.016
Mortar[1]		10	1.5	0.007
Hollow brick[2]		200	-	0.390
Mortar[1]		10	1.5	0.007
inishing	Granite[2]	13	2.2	0.006
	Tile[2]	30~40	-	0.030

Thickness of component、λ_i: Thermal Conductivity of component
R_i: Thermal Resistance of component
Source: 1 Ministry of Trade and Commerce of Japan (currently Ministry of Economy, Trade and Industry), "Need of thermal insulation for house and insulating material" (1989)
2 BC 19 Annex

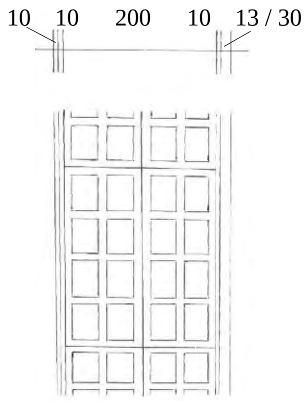


Figure 4.5-1 Specification of a assumed wall

Thermal resistance (R) and thermal transmittance with finishing either of granite or tile are as follows[35].

[35] Thermal resistance and thermal transmittance are calculated by the following formula

$$R = \frac{1}{\alpha_i} + \sum \frac{d_i}{\lambda_i} + \frac{1}{\alpha_0}$$

α_i = 23 W/m^2.K (interior surface thermal conductivity), α_0 = 9 W/ m^2.K (exterior surface thermal conductivity)
(source: Ministry of land, infrastructure, transport and tourism, "building equipment design calculation sheet")

$$U = \frac{1}{R}$$

Table 4.5-2 Resulting thermal resistance (R) and transmittance (U)

Exterior finishing	R (m^2.K/W)	U (W/m^2.K)
Granite	0.58	1.72
Tile	0.60	1.66

Referential thermal transmittance values for wall ($\hat{U}_W$) in BC 19, used for the calculation of referential thermal loss value of building in designing, are as follows[36].

Table 4.5-3 Standard Thermal Transmittance ÛW (W /m2.K)
by "System Performance Method" of Building Code 19

	Individual detached Dwelling	Attached Building with continuous application	Attached Building with discontinuous application
Group II	0.88	1.01	1.39
Group III	1.02	1.17	1.61

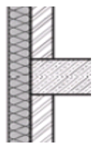
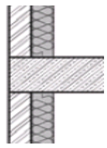
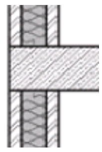
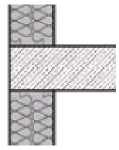
Source: Building Code 19

In comparing these referential values with assumptive thermal performance calculated on the table 4.5-2 (Resulting thermal resistance (R) and transmittance (U)), by observing BC 19, 50% of heat loss from wall (except for opening) could be reduced for an individual detached dwelling (Group II), 30 to 40% for attached building with continuous application, 3 to 20% for attached building with discontinuous application.

On the other hand, standard for thermal resistance in "Prescriptive method" of BC 19 is as follows[37].

[36] As buildings in Tehran city are categorized into group II to IV according to BC 19, referential thermal transmittance values for these building groups are compared (no referential value exists for group IV).
[37] As buildings in Tehran city are categorized into group II to IV according to BC 19, standard thermal resistance for these building groups is compared (no standard exists for group IV).

Table 4.5-4 Standard Thermal Resistence (m^2.K / W)
by "Prescriptive Method" of Building Code 19

Window type*	Building Type	Percentage of translucent layers' area to external walls (a)	External thermal insulation	Internal thermal insulation	Central thermal insulation	Equal thermal insulation
						
Wall with Super window	Group II		0.9	1.5	1.5	1.4
	Group III		0.8	1.2	1.2	1.1
Wall with Ordinary windows	Group II	16 ≤ a ≤ 20	2.5	N/A	N/A	N/A
		11 ≤ a ≤ 15	1.7	4.9	4.9	4.1
		a ≤ 10	1.4	3.2	3.2	2.8
	Group III	21 ≤ a ≤ 25	1.8	5.7	5.7	4.6
		16 ≤ a ≤ 20	1.4	3.2	3.2	2.8
		11 ≤ a ≤ 15	1.2	2.4	2.4	2.1
		a ≤ 10	1.1	2.0	2.0	1.9

*: See Building Code 19, Table 6 (19-3-2)
source: Building Code 19

In comparing these standard values with assumptive thermal performance calculated above, by observing BC 19, 30 to 60% of heat loss from wall (except for opening) could be reduced for a building of Group II, 25 to 50% for a building of Group III, both with "Super Window" class opening. As for building with "Ordinary Window" class opening, by observing BC 19, 55 to nearly 90% of heat loss from wall (except for opening) could be reduced for a building of Group II, 45 to 90% for building of Group III.

This result is based on thermal performance of building method observed in building site in Tehran City and only applicable to thermal loss through outer wall except for opening. Therefore, not all building in Iran has such potential for energy conservation and these figures can not represent precise energy conservation potential of buildings in Iran. However, the result would imply that a thorough compliance to BC 19 would be the key for EE&C promotion of buildings in Iran.

Furthermore, according to old MOHUD, only 30% of new buildings in Iran comply with BC 19. Compliance to BC 19 and EE&C promotion based on this regulation would be all the more promising since 70% of new buildings in Iran have insufficient thermal performance as assumptive thermal performance calculated above.

4.5.2 Equipment

Estimation of specific energy consumption and EE &C potential was carried out for every use of a building.
In Iran, central air-conditioning is adopted fundamentally also at the comparatively small-scale building. In Japan, individual air-conditioning and central air-conditioning are compared based on initial investment and energy cost, more advantage system is adopted. Generally, individual air-conditioning is better on small scale building, central air-conditioning is better on middle and large scale building. In Iran, it seems that such comparison was not carried out since the energy price was cheap.

Air-conditioning system is the simple composition which installs just two pumps (for usual operation and for emergency) with just capacity of water flow (flow volume and lifting head).
Since an air-conditioning system is simple composition and is not controlled in almost all buildings, either, the tendency of energy consumption of buildings is same irrespective of the scale of a building. About this point, after a database is built from now on, it should be verified.

(1)Condition for estimation

It presumed on every use of buildings (hospital, collective housing, office, hotel, shopping center).
The source of input data is the data obtained by a JICA study team's energy audit mentioned above in 4.3.2 clause, and Chapter 9 of Energy balance sheet 1387.
The average value of input data was adopted.
And, Chapter 9 of Energy balance sheet 1387 is included summary of Iranian eneergy audit thatcarried out based on fund of SABA or IFCO. Just total energy conservation potential that included both side technologies from archtecture field and equipmentfield is shown, but detail of each teqnologies, e.g. type or potential, is not shown.

(2)Estimation of specific energy consumption and EE & C potential in hospital

Estimation of specific energy consumption and EE & C potential in hospital is shown in Table 4.5-5.
Specific energy consumption is set to 3,958 MJ/m2 as an average of the data obtained from three buildings. Moreover, EE & C potential per m2 is set to 1,127 MJ/m2 since the specific energy consumption after introduction of EE & C is 2,831MJ/m2.

Table 4.5-5 Estimation of specific energy consumption and EE & C potential in hospital

Description	Usable building floor area (m^2)	Consumption before taking energy conservation measures		Predicted consumption after taking energy conservation measures	
		gigajoule	megajoule/m^2	gigajoule	megajoule/m^2
Hospital with 600 beds, Tehran	38,601	169,998.50	4,404	111,171	2,880
Hospital with 400 beds, Tehran	33,621	109,193.90	3,248	68,530	2,038
Atieh hospital (350beds)	24,000	101,664.15	4,236	92,687	3,862
Average	32,074	126,952	3,958	90,796	2,831

Source：Energy balance sheet 1387

(3) Estimation of specific energy consumption and EE & C potential in collective housing

Estimation of specific energy consumption and EE & C potential in collective housing is shown in Table 4.5-6.
Specific energy consumption is set to 1,329 MJ/m2 as an average of the data obtained from three buildings. Moreover, EE & C potential per m2 is set to 343 MJ/m2 since the specific energy consumption after introduction of EE & C is 986MJ/m2.

Table 4.5-6 Estimation of specific energy consumption and EE & C potential in collective housing

Description	Usable building floor area (m^2)	Consumption before taking energy conservation measures		Predicted consumption after taking energy conservation measures	
		gigajoule	megajoule/m^2	gigajoule	megajoule/m^2
14 sample 12-storey residential buildings, Tehran	50,400	81,446.40	1,616	48,485	962
20 sample residential buildings, Tehran	15,979	22,732.10	1,417	12,123.20	759
Ekbatan	66,000	71,706.60	1,086	69,918.86	1,059
Average	44,126	58,628	1,329	43,509	986

Source：Energy balance sheet 1387

(4) Estimation of specific energy consumption and EE & C potential in office

Estimation of specific energy consumption and EE & C potential in office is shown in Table 4.5-7.

Specific energy consumption is set to 2,453 MJ/m2 as an average of the data obtained from 14 buildings. Moreover, EE & C potential per m2 is set to 997 MJ/m2 since the specific energy consumption after introduction of EE & C is 1,460MJ/m2.

Table 4.5-7 Estimation of specific energy consumption and EE & C potential in office

Description	Usable building floor area (m^2)	Consumption before taking energy conservation measures		Predicted consumption after taking energy conservation measures	
		gigajoule	megajoule/m^2	gigajoule	megajoule/m^2
13-storey office building, Tehran	9,230	22,041.20	2,388	11,058	1,198
Office building, Fars province [south/south-western Iran]	6,960	12,677.90	1,821.50	8,319	1,195.20
Office building, East Azerbaijan province [north-western Iran]	7,536	13,369.10	1,774	7,552.30	1,002.10
Office building, Khorāsān province [north-eastern Iran]	6,000	10,882.90	1,807.10	6,220.20	1,036.70
4-storey building, Tehran	1,568	3,375.80	2,153	1,624.90	1,036
Educational complex, Tehran	28,582	75,554.40	2,645	54,530.10	1,904
District 6 telecommunications building, Tehran	1,950	3,113.20	1,596.30	1,483.80	760.7
Telephone centre building, Tehran	3,217	16,827	5,230.20	13,198.60	5,035.40
Power centre building, Isfahan province [central Iran]	8,400	24,142.20	2,874	8,217.20	978.2
Power centre building, Khūzestān province [south-western Iran]	4,700	13,338	2,837	3,575	760.3
Power centre building, Markazi province [north-central Iran]	7,500	23,886.40	3,182.20	11,967	1,595
Energy Affairs Branch building, Tehran	6,500	10,871.90	1,672.60	8,909.50	1,370.70
Tavanir management building, Tehran	4,000	5,767.50	1,441.90	3,709.40	927.3
Average	7,396	18,142	2,453	10,797	1,460

Source：Energy balance sheet 1387

(5) Estimation of specific energy consumption and EE & C potential in hotel

Estimation of specific energy consumption and EE & C potential in hotel is shown in Table 4.5-8.

Specific energy consumption is set to 1,648 MJ/m2 as the data obtained from one building. Moreover, EE & C potential per m2 is set to 580 MJ/m2 since the specific energy consumption after introduction of EE & C is 1,068 MJ/m2.

Table 4.5-8 Estimation of specific energy consumption and EE & C potential in hotel

Description	Usable building floor area (m^2)	Consumption before taking energy conservation measures		Predicted consumption after taking energy conservation measures	
		gigajoule	megajoule/m^2	gigajoule	megajoule/m^2
5-storey hotel with 60 rooms, Tehran	3,781	6,231.50	1,648	4,040	1,068

Source：Energy balance sheet 1387

(6) Estimation of specific energy consumption and EE & C potential in shopping center

Since there is no data of complex building for commercial use in energy handbook and the data of supermarket in energy audit has not been received, energy consumption is unreckonable.
However, it seems that shopping has so large EE & C potential.

However, Judged based on energyaudit by JICA Study Team, EE &C potential that be easy generally to introduce, e.g. replace to high freqency fluorescent, is about 456,000MJ/year., and it means about 250MJ/m^2 as EE & C potential per m2.

4.5.3 Estimation of the floor area of buildings in Iran whole land

Data of floor area of building in Teharan city was obtained as mentioned in 4.1.2 clause. Therefore, the floor area of the building in other cities is estimated.

(1)Condition for estimation

Data of floor area of building in Tehran city is shown in Table 4.1-1 mentioned.
It was assumed that the floor area of buildings other than Tehran city was proportional to population. Moreover, it assumed that the building existed in urban areas, and applied the population of Urban in Table 2.2-2.

(2)Estimation of number of building in Iran whole land

The total floor area of the building of the urban areas in Iran whole land (estimation by a population ratio) is shown in Table 4.5-9. It is calculated based on condition for estimation mentioned.

Table 4.5-9 The total floor area of the building of the urban areas in Iran whole land (estimation by a population ratio)

(Unit:m^2)

Building use	Floor area of building（㎡）				Total floor area
	Less than 1,000㎡	1,001㎡～5,000㎡	5,001㎡～10,000㎡	More than 10,001㎡	
Governmental office	1,625,458	5,610,265	2,361,013	11,682,917	21,279,653
Private office	25,994,164	62,448,140	16,283,579	71,180,990	175,906,873
Hotel	276,012	1,468,532	660,028	2,030,362	4,434,934
Hospital	29,479	427,883	660,427	3,142,261	4,260,050
Shopping center	164,100,984	85,926,631	19,327,580	99,214,453	368,569,648
Collective housing	853,581,178	397,031,420	49,915,373	136,528,057	1,437,056,028

Source:Estimation by JICA Study team

Since population at urban area in Tehran city on 2010 is 13,882,892 persons, and population in Iran whole land on 2010 is 53,637,652 persons, based on Table 2.2-2, it is assumed that 3.86 times building against building in Tehran city is in Iran whole building. Therefore it is calculated by multiplied 3.86 against floor area in Tehran city.

4.5.4 Estimation of EE & C potential in Iran whole land

EE & C potential is estimated based on EE & C potential per floor area mentioned in 4.5.2 clause and floor area of building in Iran whole land mentioned in 4.5.3clause.
Estimation of EE & C potential in Iran whole land is shown in Table 4.5-10. EE & C potential is about 20,000,000(kL/year) by crude oil equivalent.
On the other hand, according to index of Residential & Commercial in Table 2.3-2, whole energy consumption in building sector is 432.3 (Mboe : Mega barrel of oil equivalent). When unit conversion is carried out on 1barrel=159L, whole energy consumption in building sector is about 68,700,000(kL/year).
Therefore, it is assumed that EE & C potential ratio against energy consumption in building sector is 30 %.

Table 4.5-10 Estimation of EE & C potential in Iran whole land

Type of Building use	Total floor area	Energy conservation potencial per square m	Energy conservation potencial
	(m2)	(MJ/m2/year)	(MJ/year)
	A	B	C=A*B
Governmental office	21,279,653	997	21,215,814,041
Private office	175,906,873	997	175,379,152,381
Hotel	4,434,934	580	2,572,261,720
Hospital	4,260,050	1127	4,801,076,350
Shopping center	368,569,648	250	92,142,412,000
Collective housing	1,437,056,028	343	492,910,217,604
		SUM	789,020,934,096
		clude oil equivalent(kL/year)	20,654,998

Source: Estimation by JICA Study Team.
Office includes both governmental office and private office.
Energy conversion factor against heavy oil is 38.2GJ/ｋL.

Chapter 5. Master Plan for EE&C in Building Sector

5.1. Basic policies of the Master Plan designing

5.1.1. Target period of master plan

In developing a master plan, it is necessary to set goals and develop time.
In Iran, the law is implemented already to reduce energy subsidies, which causes higher energy prices. EE&C promotion has become a critical issue that must be carried out quickly and urgently promote energy conservation measures in this surroundings. MOE agreed that target period of master shall be set to five years (seven years long), considering not only obtaining short-term achievement but also EE&C's sustainable promotion, and the goal is to develop energy-saving market.

Figure 5.1-1 is an overview prepared for understanding the steps to the goal.
Period of short, medium, and long-term has some years time-span, when human resources are introduced to promote energy conservation in Iran, because the time required to reach the goals is affected by the allocated resources of human and funding. And market development will be a goal of master plan to promote EE&C sustainably in 5-7 years target period. In the future, EE&C will be recognized by society in general, as more cases of EE&C implementation. Energy and Environmental conscious enterprises will be evaluated and admired by the society with growing awareness of energy saving energy saving and environmental protection of the people.

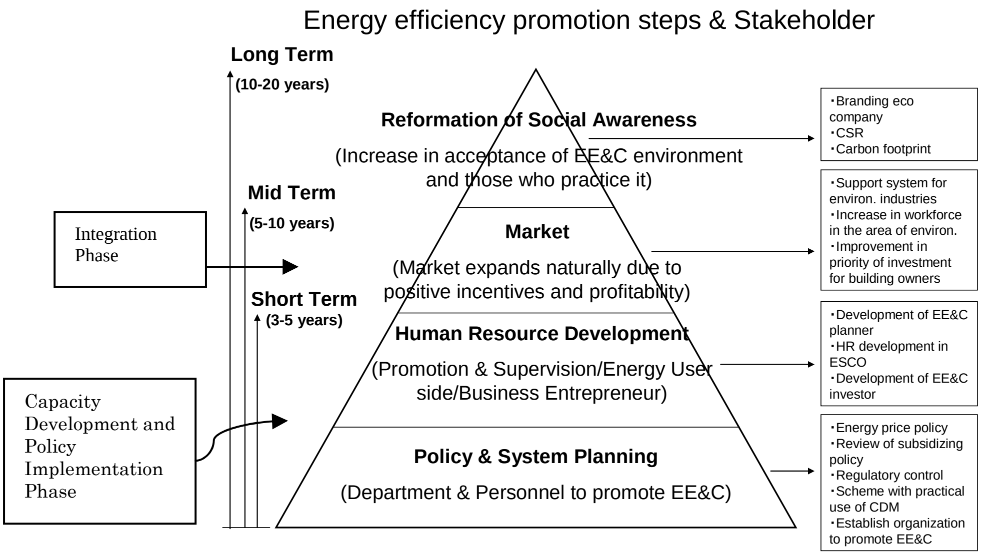


Figure 5.1-1 Steps to the EE&C goal

5.1.2. Scope of target buildings

When planning the promotion of energy conservation in buildings, it is necessary to define the target building. The reason is the difference of applied measures and players for EE&C in existing buildings and new buildings.
Table 5.1-1 shows the difference between the new buildings and existing building energy-saving techniques.
Energy efficiency of new buildings is mostly determined at the design stage, and also greatly influenced by the presence of appropriate construction control and commissioning after completion of construction.

Meanwhile, the energy efficiency of existing buildings is greatly changed by operation and maintenance of building facilities. Advanced tuning (Set-point review of the facility operation) by the EE&C experts is another factor which influences the operating energy efficiency.
Energy saving service company (ESCO) can increase energy efficiency through aggressive energy conservation implementation based on the energy studies.

Table 5.1-1 EE&C measures for new buildings and existing buildings

[Existing Bld.]	[New Bld.]
EE&C by O&M （energy-saving rate: 10ー20%）	Design compliant for EE&C （energy-saving rate: 20ー30%）
EE&C by Tuning （energy-saving rate: 20ー30%）	Supervision of construction （energy-saving rate: 10ー20%）
EE&C by Renovation （energy-saving rate: 20ー30%）	Commissioning after completion （energy-saving rate: 0ー50%）

O&M: Operation and Maintenance

The Master Plan also consider whether it is necessary to focus on either.
Figure 5.1-2 indicates the percentage of total number of new buildings to total building as a base at some point.
Nearly 90 percent in 30 years if the age of about 30 buildings built in the new buildings will be changed. This figure shows that at least the first five years the vast majority of existing buildings energy savings potential of less than 85% of the existing buildings more energy-saving buildings worked from existing results of short-term energy saving It can be seen to be raised.

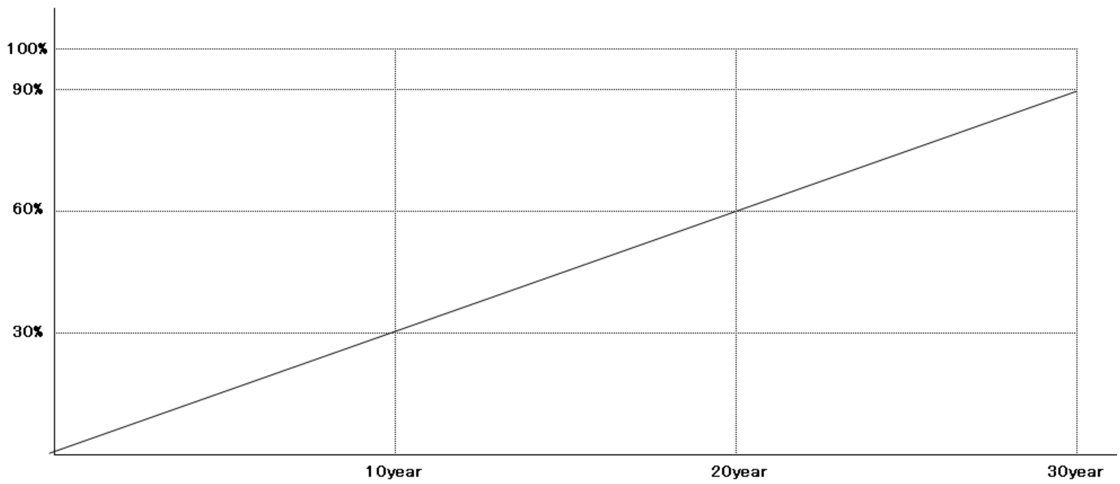


Figure 5.1-2 Percentage of new buildings

Source :JICA study team

5.1.3. Skills and talent needed to be promoted

Conservation of existing buildings and new buildings people will need to develop their human resources so different. Demonstrating the ability to wear the type of training to personnel of the table 5.1-2.

New buildings, existing buildings are common in people of the blue, people in existing buildings are mostly pink, but mostly people of the new buildings colored in green, often overlapping ranges.

Table 5.1-2 Definition of Human resources for EE&C and Necessary capabilities for the HRs

[Human Resources to be developed]	[Capability to be developed]
Regulatory Framework	
Development of Regulartory Framework	Capability for creating of framework or plans on EE&C promotion to combind Laws, Tarrif, Regulation on GHG gas emissions and award & recognitions
Law enforcement administration	Capability for supervising the status fo compliancewith the laws & regulation for EE&C
EE&C Database	
Development of Database	Capability for defining necessary monitoring data to evaluate EE&C status of the buildings and establishing data gathering ways
Detabase operation and maintenance, Database benchmark setting (DB utilization)	Capability for acurate updating of database and utilising the data for setting the benchmark of each building categories
EE&C marketing development	
EE&C Market study, EE&C market planning (including market establishment, etc.)	Capability for feasibility study of ESCO business by legal and economical manners
EE&C finance for renovation (promotion of financial mechanism for EE&C)	Capability for developing and establishing financial mechanism for ESCO projects
Design house, construction companies & HVAC and Electric Utilities contractor	
Architects, Designer and Construction & Installation Engineers (HVAC, electric, BMS, etc.)	Capability for planning, designing, managing, and supervising constuction project to choose appropriate building materials and equipment, to install EE&C systems, to choose optimal control systems
Engineering Association	
Examiners for Architecture, Electrical and Mechanical design for new building	Capability for examination of building application for building permission in the view of compliance of EE&C related regulations
Supervisors for building construction, installation of electrical and mechanical facilities	Capability for supervision of building construction and facilities instalation of EE&C systems
ESCO business	
ESCO Engineer (including planning of HVAC, Electric and BMS)	(s) can conduct bldg. energy audit can propose EE&C measures, can develop budget plan for EE&C measures, can conduct F/S for EE&C, can evaluate EE&C infestmen, etc.

CDM and New Financial Mechanism business	
CDM Projects developing engineers on EE&C of buildings	Capability for conducting estimation and verification of EE&C saving and the GHG reduction, preparing feasibility study of CDM investment
Verification institutions for EE&C	
Validation/Verification Engineers for inspect calculating/monitoring measures to ensure fairness and properness of EE&C acievemnt	Capability for performing energy audit, proposing measures for EE&C, estimating EE&C investment, conducting feasibility study of investment plan, simulating ROI (retun on investment).
Financial Institutions	
Commercial Bank (EE&C Loan)	Capability for evaluating EE&C loan application, judging adequacy of loan repayments, evaluating risks of lending, etc.
EE&C Technologies (Manufacturing, Installation, Opearation and Maintenance, etc.)	
Designer for BMS Systems (ESCO Engineers, Energy Managers, EE&C consultants)	Capability for choosig optimal EE&C system (machinery and equipment, capacity and performance etc.).
BMS systems operator (Operation and maintenance of utitilies of building)	Capability for monitoring and anlyzing operation data, taking necessary action based on the result of analysis.
Operation and Maintenance of BMS systems (engineers of manufacturers of BMS systems)	Capability for conducting survey on the system capacity, inspecting the system for wear and tear, carrying out maintenance and repair)
Designer of HVAC systems (ESCO engineers, energy mangesr of bldg, EE&C consultants)	Capability for selecting EE&C systems (selection of optimal systems, calculation of capacity and performance, etc)
Opearation and Maintenance of HVAC systems (Operation and Maintenance of Bldg utilitiy systems)	Capability for monitoring and analyzing operation and performance data, calculating energy efficiency of the system improving operation.
Maintenance of HVAC systems (engineers of manufacturers)	Capability for estimating the current performance, judging wear and tear of the systems, repairing the systems.
Designers of electric systems (ESCO, energy managers of the buildings, EE&C consultants, etc.)	Capability for selecting optimal systems for EE&C (Evaluatoin each systems and technologies in EE&C manners, including calculation of system capacity, etc.)
Operation and Maintenance of electric systems (operators of building utilities sytems)	Capability for gathering data from monitoring sytems, analyzing data, maintain optimal operation condition of facilities
Maintenance of the building electic systems (engigineers of manufacturers	Capability for judging and estimating present performance, judging wear and tear, repairing the system.
Designer of system control systems (Manufacturer of System control equipment)	Capability for designing and installing control system for EE&C operation (selection of optimal control systems, selection of control equipment, etc.)
System optimazation (tuning) of the building control systems (consultants specialized in	Capability for collecting and analyzing data, monitoring and evaluating efficiency of operation, recommending optimal operation procedures, etc.)

commissioning of building systems.)	
Maintenance of control systems (engineers of manufacturers)	Capability for judging wear and tear of the control systems, undertaking trouble shooting and repairing
Reseach and development of new machinery and equpment (manufacturers of control system, sensors, automation sytems, measuring devises, etc.)	Capability for develop innovative EE&C equipments/systems

Figure 5.1-3 shows an overview of an anticipating path to develop the Master Plan for promoting energy conservation and provide scenarios for existing buildings and new construction. As indicated in the section 5.1.1, the interim goal of the master plan study is defined as "to develop energy-saving market" within a timeframe of five to seven years to make sustaining EE&C attained in Iran. The plan for EE&C promotion is divided into three phases: the first phase which begins immediate future up to three years, aiming at capacity development of implementing agencies. The second stage (three to five years timeframe) is considered as policy implementation stage. The third phase (five to seven years of timeframe) is the period of societal integration of EE&C. The figure also shows the key- players in each phase (stakeholders), and their respective roles briefly.
The interim target year of the Master Plan, first period, "carried out capacity development stage," as were about five years from now. And the second term, "policy implementation period" to 10-year framework of a plan that can achieve a majority by roughly midway. Phase III (fiscal consolidation) is set to 10 to 15 years, running various measures autonomously towards the conservation society as a whole through various policies so far, and during that phase everyday energy conservation. This stage is the ultimate goal of this project. In order to promote energy conservation energy saving potential of large existing buildings, the ESCO to implement the first phase trial project is a lot of sense.

The first phase of Iran to promote energy conservation in buildings (up to 3 years for completion), is already started. Iranian government developed legal systems for EE&C promotion and is preparing to get worldwide assistance for EE&C promotion including this study. After the master plan is set, "EE&C trainer (technical core)" shall be trained by the eligible experts from domestic or foreign countries in order to disseminate energy-saving technologies. In addition, Government shall prepare and provide various kinds of energy efficient equipment by supporting developing or importing such equipment. Clearinghouses are also required for the one-stop information service of EE&C related information as technologies, EE&C companies, etc. There are many other issues that employment of technical experts for professional training, development of policies and institutions to implement the action plans for EE&C promotion, setting standard as energy management, establishing mandatory energy management and reporting of energy consumption, energy conservation award system, tax system to promote EE&C investment, and greenhouse gas emissions trading system development.

At the second phase (about three to five years from now), it is important to enhance practice for EE&C by utilizing capability strengthened by capacity development in the various activities through trained facility managers. Also, Energy service companies or consultants propose effective EE&C plans to building management (including building owners). At the same time the government is required to address development and dissemination of energy saving standard and procedures. It gathers a conservation success story, it is necessary to further expand the clearinghouse for energy conservation and infrastructure construction in order to spread knowledge of other approaches to further approach.

At the third stage (about five to seven years from now), the energy-saving initiatives to broader stakeholders, to ensure that energy conservation is promoted throughout society. In technical training institutions such as universities and specialized governmental training institutions must be sustained so that the training of future energy-saving technology. The government such as emissions trading, such as labeling and certification systems, is expected to be able to develop an institutional framework and economic incentives to energy conservation activities.

Building owners will allow more low-risk investments in energy-saving advantage of using these frameworks will work hard to save energy in order to increase the added value of the building due to the award system.

The energy-saving technology has advanced expertise (such as ESCO businesses) is the best energy-saving renovation to do on behalf of building owners. In addition, financial institutions, will be to supply funding for these energy conservation projects. In addition, tenants and other residents will change the life patterns to promote energy conservation through education and training routine for the general public to promote energy conservation by the government.

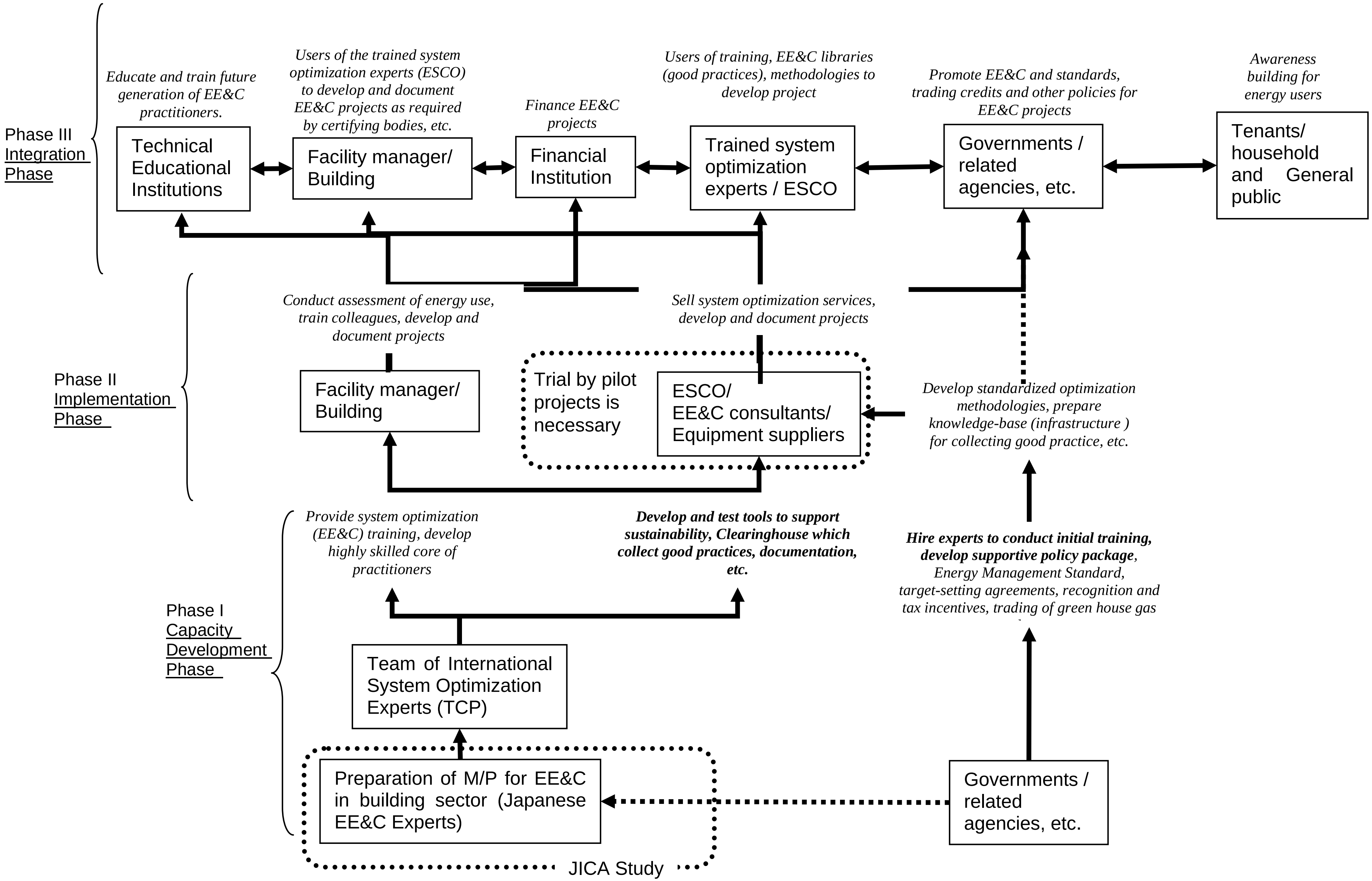


Figure 5.1-3 Institutional Framework for the Capacity Development for EE&C in the Building Sector in Iran

5.1.4. Priority Programs

Based on the above concept, the first stage (implementation capacity development stage) are shown in Table 5.1-3 in the 10 priority programs.

Table 5.1-3 The proposed priority programs

Category	No.	Program	Possible Actions	Responsible Ministry and Agency
EE&C Policy	1	Setting a national goal for EE&C in housing and building sectors	Enforcement, in effect ➢Iran outlook in the year 2025 ➢Iran's Fifth Five-Year Development Plan Law ➢Energy Consumption Pattern Reform Law	MOE
	2	Subsidy rationalization and energy prices control	Enforcement, in effect ➢Subsidy Rationalization Law	MOE
	3	Establishment of certification system and Amendment tax and subsidy system for EE&C	EE&C certification system for eco-friendly (green) building, materials, equipments and home electrical appliances Tax break for the incentives for EE&C-related investment including R&D -Reduction of fixed asset tax/Corporate income tax/individual tax Tax break for investment for human resources development on EE&C -Reduction of corporate income tax/individual tax -Subsidies for developing human resources	MOE
	4	Energy audit training for ESCO and ESCO engineers	Capacity building for EE&C technology through audit skill and knowledge, etc. Standardized audit methodology and its dissemination in Iran (e.g. through one-day preliminary audit, etc.) Provide preliminary audit for free of charge to selected building, etc. (with a government financial support, etc.) Compiling the audit data to the database (when public funding received). Benchmarking of EE&C efforts by classification of type and usage of the facility, etc.	MOE SABA
	5	Establishment of Award Program	National EE&C Architecture Design Award based on comprehensive architectural judgment, not only on EE&C technology but also on architecture design and	MOE SABA

Category	No.	Program	Possible Actions	Responsible Ministry and Agency
			planning point of view. National EE&C Award for materials, equipment, home electrical appliances etc.. Database for EE&C equipment, household appliances, etc. A third-party committee to oversee these programs (establishment of evaluation procedures to above)	
	6	Publishing basic data. Continuation of policy research on EE&C.	Publishing annual report of EE&C. Compulsory reporting requirement of energy usage (target-setting agreement program), Study on energy usage of large users (shopping malls, large offices, hotels, etc.) . Load patterns, and daily, monthly and annual patterns of energy use. EE&C good practices of users, etc. Survey on current conditions of O&M, etc. in building.	MOE
Construction and Architecture, etc	7	Enforcement of Building Codes	Enforcement of supervision of building codes (incl. BC19) by government or public organization, Clarification of penalty and responsibilities of owner, designer and contractors. Definition of labeling of all building usage. Enforcement of supervision of building code and construction quality by architect. Establishment of architects' obligation and authority to observe building codes and to control building qualities. Guideline for compliance of BC19 for architects, electric and mechanical engineers. Simple building code or guideline for small and rural buildings which are not covered by BC19 EE&C Label for eco-friendly (green) buildings (Guideline, Valuation basis, Promotion, Publicity)	MOE Min. of Housing and Urban Development（old MOHUD） BHRC
	8	Dissemination of EE&C construction technology and design, etc.	Compilation of "Iranian Building Design Standards" and " Iranian Building Construction Standards" for references, for architects and contractors Up-grading or creation of lecture on "Energy and Architecture" in existing architectural and civil	BHRC

Category	No.	Program	Possible Actions	Responsible Ministry and Agency
		EE&C labeling on construction materials and equipment, etc.	engineering schools (bachelor and masters programs) EE&C Label for eco-friendly (green) building materials (Guideline, Valuation basis, Promotion, Publicity) Establishment of Clearinghouse (Collecting and Disclosing of Building EE&C information) EE&C Label for eco-friendly (green) home appliance (Valuation basis, Publicity) Promoting EE&C facility design (Facility design for EE&C. (BEMS, energy management through block HVAC systems, passive solar design etc.)	
	9	Practical EE&C design program	Pragmatic design training program on real building projects (new building or renovation) through design workshop with Iranian design team and Japanese experts (architect, facility designer, structural designer, engineers…) Training center as training device itself. (Machinery room as laboratory, Classrooms for insulation survey, etc.)	MOE
Finance	10	Financial System	New loan schematics developed and introduced Introduction of CDM financial mechanism and its promotion.	MOE

The following provides an overview of the priority programs that have been implemented.

1. Setting a national goal for EE&C in housing and building sectors

Long-term and medium to short-term goal are set in “Iran outlook in the year 2025” and “Iran's Fifth Five-Year Development Plan ”.

Detail design for EE&C promotion is defined in “Energy Consumption Pattern Reform Law”

2. Subsidy rationalization and energy prices control

Energy price optimization program is started at the end of last year.

Furthermore, the subsidy for energy will be reduced by Subsidy Rationalization Law.

Energy price will be close to international market price gradually.

Following priority plans will be discussed later

3. Establishment of certification system and Amendment tax and subsidy system for EE&C

4. Energy audit training for ESCO and ESCO engineers

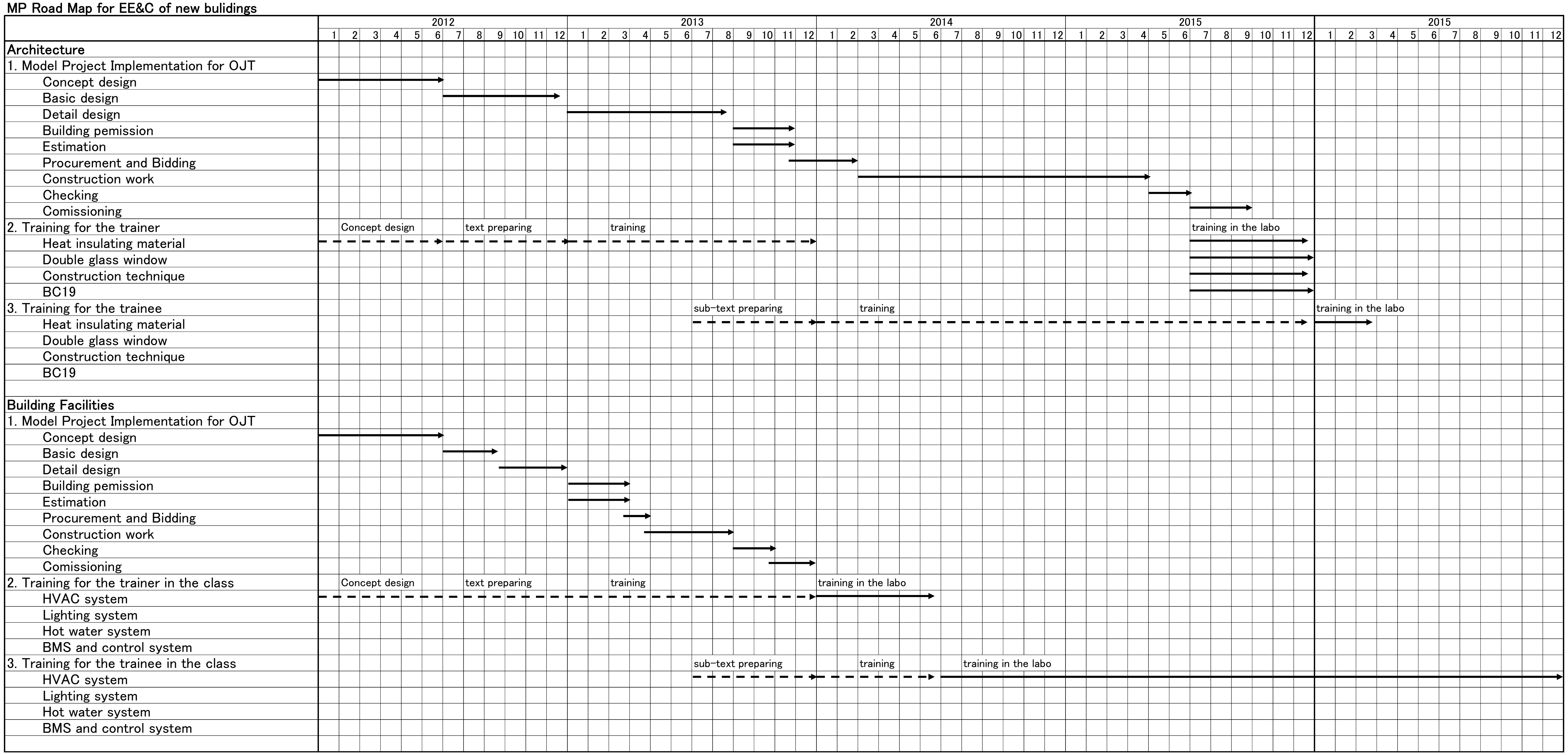
5. Establishment of Award Program

6. Publishing basic data. Continuation of policy research on EE&C.
7. Enforcement of Building Codes
8. Dissemination of EE&C construction technology and design, etc.
   EE&C labeling on construction materials and equipment, etc.
9. Practical EE&C design program
10. Financial System

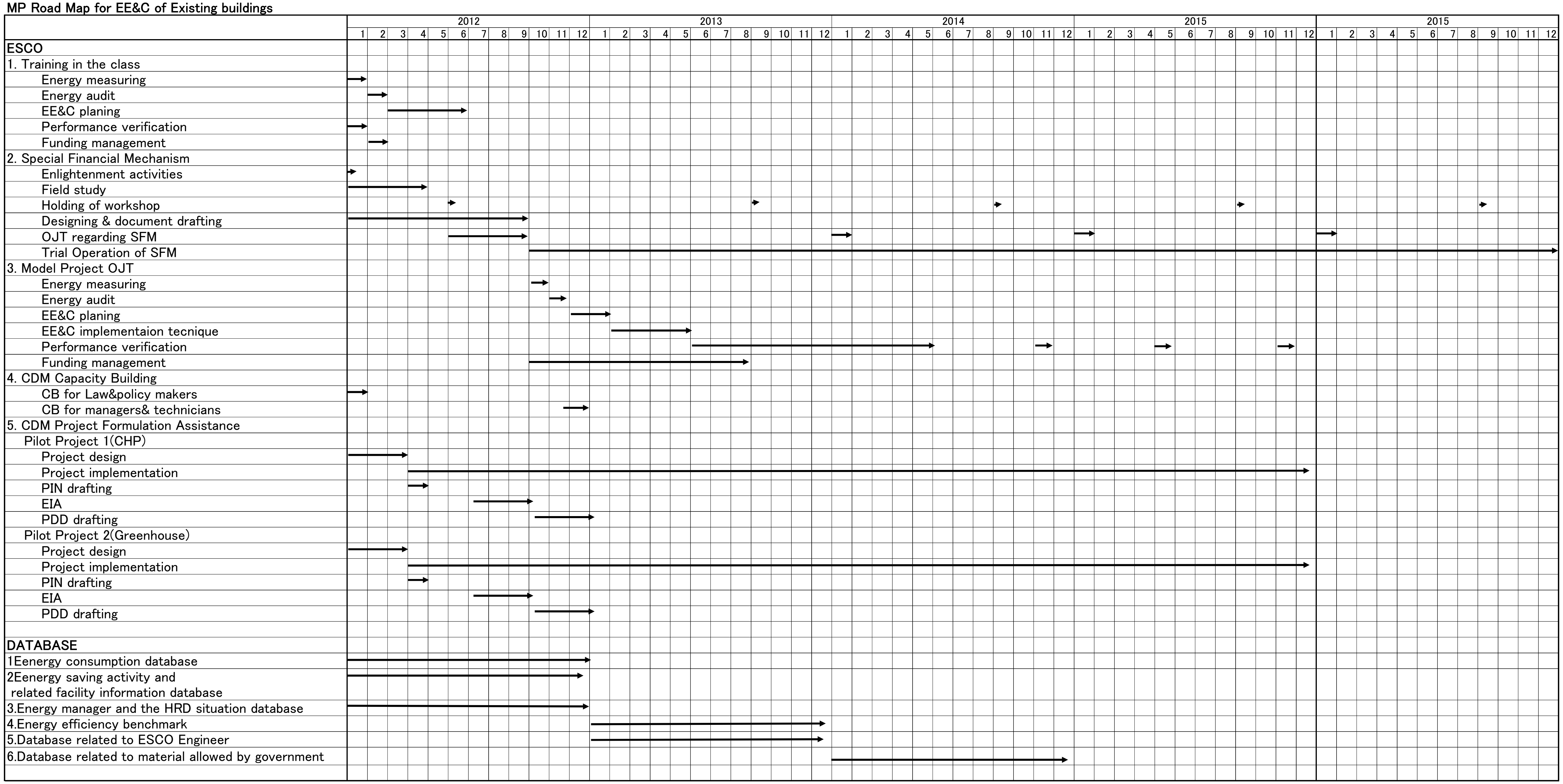
5.1.5. Roadmap with Action plan

The following pages show Roadmap with Action plan for the Priority programs.

MP Road Map for EE&C of new bulidings



MP Road Map for EE&C of Existing buildings



5.2. Approach from policy and institution

5.2.1. Product certification, and taxation reform for EE&C investment

The low awareness of demand side in energy conservation is often pointed out as one of the challenges in promoting energy conservation in building sector. Iran is not an exception.
It is necessary to convince senior management how EE&C enhances corporate profits and increases corporate value.
Following measures assume effective for awareness enhancement.

- To educate building owners, including senior management
- To establish the reporting system of energy consumption
- To establish the rating system that classifies and provides guarantee of buildings, materials and facilities by their energy performance.
- Renovation subsidies for energy saving measures such as tax-free assistance

In these measures, rating system must be first priority, because it is visible and easy understanding to senior management. Earning from energy conservation of buildings is smaller than factories and less effective to improve profit increase.
Just benefits of energy conservation can not atract the interest of senior management, there is the need to be combined with other means.
One of the rating systems is the labeling system for the buildings, building materials and facilities, which specify the energy saving performance.

(1) Significance of the introduction of rating system

By publishing a publicly authenticated, you can reveal the energy saving performance of each building will be widely known and became very popular, increasing profitability because building owners of the building would have an interest.
In Iran, the evaluation of very high excellence, public labeling is expected to contribute to brand building. It is also easy to imagine scenarios where a building has become popular by installing branded absorption chillers of certain Japanese manufacture.
Following items are recommended as the rating system for building.

- Certification system for energy-efficient buildings(for large scale buildings) (Labeling, Benchmarking, Standardization)
- Certification of energy-saving building materials (Labeling, Benchmarking, Standardization)
- Certification system for energy saving devices (residential appliances) (specifying the target model, benchmark setting).
- Incentives for certified ones(tax, energy prices and interest rates)

(2) Preferential treatment for the building renovation of energy saving or the research and development activities

For the dissemination of energy conservation it is considered necessary to introduce incentives for promoting research and development of energy effective facilities. In particular, renovation subsidies for improving energy efficiency of existing buildings or funding aid for research and development of energy effective facilities/equipment will be good measures for this purpose. Corporate tax and property tax cuts for corporation and income tax and property tax cuts for individuals are another option.

(3) Incentives to investment in human resource development (corporations, individuals)

For the dissemination of energy conservation it is considered to be effective incentives for investments in human resource development related to energy conservation. Corporate tax cuts for education of human resources for energy conservation of the building can be considered subsidy. Also, grant as an individual training at private expense relating to energy conservation can be considered subsidy.

Reference material of related programs to certification systems or aid for research and development are shown in Annex 2 and 3.

5.2.2. Establishment of EE&C Awards

In order to advance EE&C in building sector, it is required that excellent product in the EE&C performance is in circulation, many engineers well versed in EE&C are trained and the building owner utilize both. It is so useful that the excellent activities are commended officially and are announced widely, in order to raise makers, engineers and Building owners' awareness of EE&C. The outstanding activities are as follows, for example, e.g. the excellent product in the EE&C performance, the engineer done excellent activities about EE&C through O&M and maintenance to equipment and the building which actually introduced EE&C measures and achieved high EE&C effect.

(1) EE&C Awards

1) Awarding of Excellent Energy Conservation Manager
   The remarkable engineer of distinguished services who strove for promotion of EE&C over many years is commended.
2) Awarding of Excellent Energy Conservation Building
   Energy saving in the whole building commends a remarkable building.
3) Awarding of Successful Case of Energy Conservation in Building
   The successful case about the technology and the method that the EE&C effect is expected very much is commended. Moreover, the successful case about the EE&C activities and EE&C result in a school, a building, a hospital, a department store, a supermarket, an amusement park, etc. is commended.
4) Awarding of Successful Case of Energy Conservation in Home & Grass Roots Activities
   The energy-saving practice activities which are tackling in the place of work and the school, and the community are commended. Target is an individual, a group, or an organization. In addition, in Iran, the poster contest for water saving, etc. have already been performed, and serve as a developed type of such an existing measure.
5) Awarding of Excellent Energy Conservation Appliance
   By developing appliance and providing for practical use, the company accepted to contribute to promotion of the efficient utilization of energy is commended.
6) Energy Conservation Grand Prize for excellent energy conservation equipment
   The excellent one among consumer appliance already produced commercially is commended.

(2) Setting up independent committee

In order to guarantee that EE&C Awards will become just and upright, it is important that a member of the selection committee does not have an interest with a candidate or an organization of the Awards, and can judge the superiority or inferiority of each section with sufficient knowledge and experience. Moreover, it is important to specify the evaluation points for calculating of the points by the applicant himself and for eliminating arbitrary selection.

Reference material of related programs to EE&C Awards is shown in Annex 4.

5.2.3. Fostering ESCO Business

Unlike situation for promotion of EE&C to industrial sector, 2 important situations for promotion of EE&C to building sector is insufficient, the first one is many engineers (human resource) who can suggest appropriately EE&C, the second one is adequate investment to introduction of EE&C. Therefore, even if a statute and a standard are enacted, EE&C is not promoted simply.

Although the more than 100 companies related with EE&C business are registered into SABA as ESCO companies now, the track record with which they are actually carrying out ESCO is seldom known. In order to spread ESCO from now on, it is effective that independent ESCO Association is founded, make ESCO recognize socially, and activity for spread is performed.
Some main causes by which an ESCO market was not formed in Iran are mentioned below.
1) It does not become business with a cheap energy price
2) There is few possibility of financing from a financial institution
3) ESCO contract is complicated and risk management is difficult (knowledge and experience are insufficient)
The situation is changing about the first reason, and since the consumer energy price doubled in connection with the subsidy abolished to the energy price in last year, the present situation is suitable for EE&C business. In order to form the ESCO market in such a situation, various managements are required. The following management policies have been performed in ESCO advanced nations including Japan.

(1) Estimate of ESCO Potential, feasibility study for ESCO
(2) Capacity development for ESCO companies
(3) Enlightenment and spread
(4) Project development
(5) Financial support
(6) Introduction of ESCO for governmental building

In Japan, ECCJ and JAESCO take the central role in developing of ESCO market, capacity development of ESCO companies and promoting of ESCO business. Also in Iran, it is important to establish ESCO Association at an early stage, to raise an ESCO market ESCO Association oneself with playing a central rol in, and making proposal to government actively, and to establish the business model of Iran's ESCO.

Reference material of related programs to fostering ESCO business is shown in Annex 5.
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5.2.4. Basic EE&C Data Collection and Development of Database

(1) To promote the energy conservation, gather the energy consumption data of exist large scale building, department etc.

To collect the data, make the questionnaire and send it to building owner.
It is impossible to do the research to all of the buildings, we need to have the static data of for what use and how large the floor area. And if there is no such data of existing building, we will ask local government (Tehran Municipality) and government organization.
We will gather many kinds of data such as follows.
The name of the key person, address, The completion year, purpose, annual electric and gas consumption(each month), activity of energy saving.

(2)Research the activity of energy saving and the introduction of energy saving data of procurement.

For the purpose of the reporting to a building manager and an ESCO engineer, collect concrete information of the actual situation of the energy saving activity in the building concerned and introduced energy-saving technology at the time of the fact-finding such as (1) energy consumptions.

(3) Research the Actual situation of contract and capacity building of Building Manager and officer

For the energy efficiency improvement of the large-scale building, a building manager who improves the energy management of the building is necessary using (1) based on various information.
Therefore we investigate the employment actual situation of the building manager in the large-scale building and the actual situation of the ability reinforcement by the education training.

(4) Benchmark using the database

Calculate the energy consumption standard unit of the buildings such as large-scale building, commercial facilities from a database and have an owner and the user of the building recognize an energy saving degree by showing it.

(5) Construction and the disclosure of a database (benchmarking) affecting ESCO

To spread ESCO business, compile the information about a success example (the best practice) such as a concrete improvement method, the effect into a database and give information to ESCO engineers.

(6) A prize for energy saving architecture, energy saving award (including energy saving building materials, energy saving apparatus, energy-saving home appliance) construct database and disclosure

Make the commendation system about building materials, an apparatus, the household appliance with superior energy-saving performance and compile it into a database and, about the technique that won the prize, open it to the public.

The program about database construction is shown in Annex 6

5.3. Approach from Building and Equipment

5.3.1. Consolidate implementation of Building Code and clearer EE&C criteria

As for approach from building and equipment, consolidating implementation of building code and making clearer EE&C criteria are important. For this purpose, the following four points are listed.
-Consolidate surveillance of Building Code as well as its implementation, and concretizing its punitive clauses
- Consolidation of construction work supervision by designer
- Formulation of designer's guideline on BC19
- Establishment of standard for small scale buildings not covered by BC19

(1) Consolidate surveillance of Building Code as well as its implementation, and concretizing its punitive clauses

It is necessary to consolidate surveillance system of legal standard at execution phase as well as implementation of this system, and concretize punitive clauses in order to promote compliance to BC19 in Iran. For this purpose, cost for supervision of legal standard at execution phase, which is currently paid directly from client to Supervising engineer should be reviewed and punitive clauses against illegal architecture should be concretized.

・Reviewing the direct payment of inspection fee from client to Supervising engineer

To construct a system which allow a clear separation of those who inspect and those who are inspected in regard to compliance to low, such as local municipality or Building Engineering Association taking charge of collection and distribution of inspection fee.

・Concretizing punitive clauses against illegal architecture

Punitive clauses against illegal architecture's clients, designers and constructors as well as supervisor who tolerate illegal architecture, should be concretized and diffused. Penalty such as charge and fine for client, in addition, suspension and cancellation of qualification for designer and Supervising engineer, furthermore nomination suspension measure for constructor would be possible. In conformity with current regulation in this field, these punitive clauses should be concretized by IrCEO. Whereas designers are not invested with neither charge nor competence of supervising construction work in current situation, designers will be in charge of violation in design modification in execution phase, once designers' charge and competence in construction work supervision are established by the next action plan.

(2)Consolidation of construction work supervision by designer

It is necessary to establish designers' charge and competence in construction work supervision, in order to consolidate designer's construction work supervision in Iran. For this purpose, designers' and/or third parties' charge and competence in construction work supervision shall be spelled out in a building regulation and a standard contract for architectural design and for construction work, which stipulate designers' charge and competence in construction work shall be established.

・ Spelling out designers' charge and competence in construction

Designers' and/or third parties' charge and competence in construction work supervision in a building regulation and to diffuse them.

[Reference] Certified Architect Act of Japan

Article 18 (General Provision)

In designing, an architect shall design a building conform to standard set by State low and Local regulation.

2 In designing, an architect shall work to give adequate explanation about design work to the consigner of the design work.

3 In supervising construction work, when an architect recognizes that construction works do not follow design documents, the architect shall point out this fact promptly and claim the constructor to execute the said construction works based on design documents, as well as the architect shall report to the client in case the said constructor do not follow the claim.

・Establishment of contract for architectural design and for construction work

To establish a prototype of standard contract between a client and an architect for commission of design and supervision as well as between client and constructor for commission of construction work, whose clauses comprise charge and competence of designer in construction work supervision. Those standard contracts for commission of design and supervision, and for commission of construction work shall be diffused to designers and constructers, and recommend them to adopt these standard contracts for a contract with their clients.

(3)Formulation of designer's guideline on BC19

It is necessary for designer to understand the principle and objective of BC19, as well as skills and procedure conform to BC19, in order to promote compliance to BC19. In this purpose, a guideline about BC19 for designers shall be formulated and diffused, as well as a seminar for building design conform to BC19 shall be held.

・Formulation of designer's guideline (guidebook) on BC19 and its diffusion

A guideline (guidebook) shall be formulated and diffused, which explains, following standard design flow, both the thermal loss calculation method based on building components such as outer walls and roofs, and simplified standard based on combination of possible compositions of outer walls and roof, in an understandable way.

・Holding a seminar for designer on building design conform to BC19

To hold a seminar in order to communicate understandably to designers across Iran, basic knowledge and skills for EE&C of buildings, as well as design procedure and technique of building conform to BC19, using the guideline (guidebook) above.

(4)Establishment of standard for small scale buildings not covered by BC19

The EE&C promotion of small scale buildings (with floor area less than 2,000 square meters) which are currently not covered by BC19 would be crucial for EE&C promotion of buildings in Iran. For this purpose, legal standards should be established for small scale building not covered by BC19. However, designer and constructor of small scale buildings might tend to possess less knowledge and skills than those of large scale buildings. Therefore, legal standards for small scale buildings shall be simplified. Furthermore, parallel with these legal standard, should be provided a system that derives construction authorization for a building not perfectly conform with the standards but satisfying certain level of thermal performance and EE&C standard.

・Establishment of standards for major components of building

To list up a number of standard compositions for outer wall, roof and the lowest floor satisfying certain level of thermal performance and to enable designers to design easily buildings conform to certain level of certain performance by combining these standard components. If the specification of major components of building is chosen from these standards, complex procedure and documents submission shall be dispensed. Also, specifications developed by manufacturers and constructers, which are conform to certain standard of thermal standard shall be certified and the standards shall allow these specifications to be adopted on equal terms with standard specifications established by public administration. Furthermore, it will be preferable that the standards can be combined with the following prescription on quantity of thermal insulation.

・Prescription of insulation thickness for majors components of building

To prescribe standard thickness of a number of type of insulating material for outer wall, roof and the lowest floor. As the prescription refers only to insulation material thickness and does not restrict neither other structural member nor building material, a wide choice of finishing material will be available. If insulation is thick enough at each building component, complex procedure and documents submission shall be dispensed. In case existing documents (e.g. design guidelines) contain such prescriptions about insulation material’s thickness, related regulation might be revised so that complex procedure and documents submission shall be dispensed regarding a building designed in conformity with these documents. Furthermore, it will be preferable that the prescription can be combined with the previous standard specifications.

・Prescription on material of opening

For openings of building, such as window, entrance, use of double glazing, double sash window, airtight sash and door, insulating sash (to prevent thermal heat bridge) and door shall be prescribed. If material of openings has adequate insulating specification, complex procedure and documents submission shall be dispensed. In case existing documents (e.g. design guidelines) contain such prescriptions about insulation specification of building openings' material, related regulation might be revised so that complex procedure and documents submission shall be dispensed regarding a building designed in conformity with these documents. Regarding prescription for air-tightness, thermal heat bridge and thermal conductivity, a qualification program of building material will be necessary, which should be established in accordance with EE&C building material labeling program.

5.3.2. Diffusion Promotion of Architecture Technology on EE & C

(1) Establishment of standard design specification and standard construction specification

Promotion of design technology and improvement in construction technology and quality control are indispensable for EE&C promotion of buildings in Iran. For this purpose, a standard specification conform to climate, building related law, EE&C standard and construction technology, which can serve as design and construction reference handbook for designers, constructors and students in architecture shall be established. By reference to current situation in Iran and examples of other countries, this standard specification shall be edited mainly by Iranian people related to building research, architectural education, practical design and construction technicians.

・Editing standard design specification

To edit a design reference book, which organizes systematically building related law, building method conform to EE&C standard, structure, module, material, as well as environmental planning, mechanical planning, and design method according to building types and examples, usable both as architectural education and practical design handbook.

・Editing standard construction specification

To edit a building construction reference book, which organizes systematically execution procedure of each construction method, quality control standard and its procedure, safety control standard and its procedure, specifications of building material, specification of building equipment, module of building materials (e.g. steel stock, makeshift materials) and equipment materials (e.g. sanitary ware, plumbing), usable as practical design and construction supervision.

(2)Improvement of educational program for EE&C building design in existing faculties of architecture

In existing faculty of architecture in Iranian universities except for Tehran University, do not provide a class or a courses with a comprehensive approach to building design and energy planning. Though, as mentioned above, Tehran University project to create a Ph.D. course of "Architecture and Energy" course, whose graduate students will be expected to teach building design and energy planning with a comprehensive approach at faculty of architecture of other universities across Iran, this project will require an extended period of time. For this purpose, educational program for EE&C building design in existing faculties of architecture in Iran shall be improved.

・Holding a special lecture on EE&C building design

To hold a short period or one-shot special lecture for all students in order to diffuse basic knowledge on building design and energy planning as well as to rouse their interest in EE&C building design. Faculty teacher and researcher involved in education and research on architecture and energy, building environmental engineering, and EE&C building design shall take charge of the course.

・Creation of credit exchange program among subjects related to EE&C building design

To create credit exchange program for students of a faculty of architecture without a class about EE&C design, which enables them to participate in a specific class on EE&C design in another faculty of architecture, as well as to include the credit of this class to needed credit for graduation.

・Creation and opening classes related EE&C building design

To create classes and a course about EE&C building design at faculties of architecture, as soon as they can secure adequate personnel to direct building design and energy planning in a comprehensive manner, such as Ph.D. holders from "Architecture and Energy" course of Tehran University, as well as those who had experience in teaching EE&C building design in a foreign country. At the opening of a class or a course of EE&C building design at a faculty, this faculty shall open the class to its neighboring faculties of architectures which have not opened their class of EE&C building design by establishing credit exchange program.

(3)Creation of a clearinghouse

An integrated information releasing system is necessary in order to diffuse architectural technology related to promote EE&C of buildings. For this purpose, a clearinghouse that is a system to collect EE&C related information of buildings and release it toward consumer (building owner) and technician (constructor).

・Examples of EE&C related information of buildings collected and released by a clearinghouse

Basic information about design and construction of EE&C buildings / information on building material, equipment and hope appliance conform to EE&C standard / information on designer and constructor capable of EE&C building design and construction / information on EE&C related companies such as ESCO / labeling and prizes for EE&C related technologies (building, building material, equipment, home appliance)

5.3.3. Development of Training Program through Actual Design Process

• A training program which consist of execution of design and supervision of new construction or renovation of actual buildings (public facilities such as a training center) through workshops with Japanese designers and engineers shall be established. Technologies, techniques and information about energy-saving building design shall be transferred through the actual design process.

• In case a training center is intended, the building of this training center its self shall be material of practical design work.

Programs related to architecture and equipments are shown in the Annex 7.

5.4. Approach from Finance

5.4.1. Improvement and Development of Funding Scheme

Efficient use of a limited fund will be possible if the Iranian government is to make use of the public money to establish a designated fund; the fund is expected to facilitate private businesses to conduct EE&C on private business basis. As to have such financing mechanism for private businesses to function there are conditions to be met, which are (i) to develop capacity of the professionals to identify and to quantify risks associated with EE&C, (ii) to develop a system for verification and assurance for EE&C businesses, and (iii) existence of a third party that is capable of conducting such verification and assurance activities.

As for the necessity to develop the capacity of professionals, it will be the capacity to assess and to quantify risks associated with EE&C business that will most likely be possessed by financial institution that will operate the financing mechanism. Capacity will be in a form of standards and manuals and database. These skills and methodology for risk assessment and quantification are already common in the developed countries. Transferring of such skills and methodology existing in already developed financial institutions will be a rational solution.

A system for verification and assurance of EE&C activities will be necessary to avoid the fund being disadvantaged from improper use. Structuring a system that will verify that the information provided by the applicants is correct, under fair and transparent criteria will be required. For this purpose, some of the existing technical certification schemes are expected to be applied to EE&C business verification.

Furthermore, an effective and widely-available operation of the created verification and assurance system will be possible if a third party will function to authorize the EE&C businesses were to be introduced. Recommendable verification entity is not the government itself, as such may result in the governmental organizations becoming complex, slowing down the process. Third party verification will be required to be introduced from the initial stage of the funding scheme as it will be a key to realize the efficient operation of the whole financing mechanism.

5.4.2. CDM

Judging from the experience of Japan during the oil shocks, energy price hike is not necessarily tied to energy savings in civilian sector (buildings, houses).
Therefore, alternative or additional proposal should be considered a separate policy.
One is the total emission regulation of greenhouse gas (such as the Tokyo Metropolitan Ordinance on Environmental Preservation) and the other is to promote the country, such as programmatic CDM.

5.4.3. Financing Mechanism and Financial Aid program

Iranian government has an option to establish a fund to be used to a financing mechanism that will encourage the private sector to proactively deploy EE&C businesses. If the mechanism would function to take some of the risks associated with EE&C business, it will enable the government to effectively utilize the limited financial resource to make the most of the promotion effect. There are, however, conditions for such financing mechanism to be effectively operating. First, capacity to identify and to quantify risks associated with EE&C business will be required. Second, a system in which verification and assurance for EE&C businesses will have to be structured. Third, entities that can conduct such verification and assurance activities as the third party will have to be operative.

First, capacity to assess and to quantify risks associated with EE&C business activities will be required with commercial banks who will deal with the financing mechanism. Capacity which will be required is not necessarily the knowledge of the individuals, but rather, a systemized standards and manuals which will enable related organizations to conduct the risk assessment and quantification tasks by means of routine procedure. Database and information processing system will also be required to have the system actually operated. Skills and methodology for risk assessment and quantification are commonly deployed in financial sector and other various economic sectors in most of the developed countries. Therefore, the most straightforward way to develop risk assessment and quantification capacity will be to transfer such skills and methodology from economies in which risk assessment is already well established an applied in daily routine operations.

Next, a system for verification and assurance of EE&C businesses will be required, so as to prevent fraud and omissions against utilization of the fund resource. A system for verification and assurance of entities that will benefit from the financing mechanism will therefore be requisite for sound operation of the mechanism. The system is expected to ensure that information provided by the applicants is credible, for screening to be conducted under fair, simple and transparent criteria. Many of the certification schemes in various technology products and services are applicable models also for EE&C business verification and assurance.

Additionally, operation of the created verification and assurance system will be more effective and efficient if it were to be conducted by authorized entities, compared with when it is done by governmental organizations. To have such third party verification system operating, a policy to encourage verification services to be voluntarily introduced, underpinned by existence of skilled certifiers. Under an environment where verification and assurance procedures are conducted by authorized third party, the procedure is less likely to become impediments to quick and transparent verification activities. As the result, EE&C projects will be promoted without verification becoming a bottleneck. Therefore, introduction of the third party verification will be desired from the start of the financing mechanism to promote EE&C business.

Program according to the financial (funding program for projects ESCO), which is shown in Annex 8.

Chapter 6. Development of Action Plan for Human Resource Development

6.1. Preparation of Action Plan

6.1.1. Action Plan in the Master Plan Study

The objective of the master plan study is, "…To Draft the Action Plan for Human Resource Development for Energy Conservation Promotion in the Building Sector…"by reviewing the necessity and relevance of establishing the center aiming at EE&C for building. In the following, the relationship between the Master Plan and the Action Plan is explained.

(1) The relationship between the Action Plan and Master Plan

The Master Plan shown in the Chapter 5 is prepared based on the issues to be resolved within 5 to 7 years of duration[38] to achieve EE&C in the building sector by Iranian side. The plan is listed by categories and importance. It shows descriptions of items to be done in general terms to promote EE&C in the given timeframe. Most items are paralleled with measures stipulated and recommended in the EE&C Law. The priority programs were reviewed and prepared in the view of , and were discussed with ministries and agencies concerned in the view of feasibility and relevance. In contrast, the Action Plan is more detailed plan aiming at relatively shorter timeframe. The timeframe used is 3 years beginning from 2012 to 2014, at maximum 5 years until 2016 to achieve or complete all outputs by then. Unlike the Master Plan and the priority programs, items listed in the Action Plan have objectives and timeframe to be completed. A comparison of the two plans is shown in the following Table.

Table 6.1-1 Comparison between Master Plan and Action Plan

Items	Master Plan	Action Plan
Timeframe	5 to 7 years (10 years for some actions)	3 years between 2012 to14 or 5 years
Contents of the Plan	Item to be carried out to achieve EE&C (Desirable course of action)	Objectives to be reached by the end of the planned term
End Results	Goal(s)	Objective: Specific, Measurable, Attainable, Realistic, Time-bounded

Source: JICA Study Team

6.1.2. Action Plan in Master Plan

The Action Plan proposed consists of a course of actions with the highest priority through screening by the strategy to achieve EE&C in the said timeframe. The plan is concise version derived from the Master Plan sorted by urgency, importance and relevance. As seen, some of them are much complex as some items listed in the priority programs are designed to be carried out by a variety of implementing agencies, and sometimes by multiple agencies. Whereas Action Plan is more specific one with higher priority for achieving designated objectives and goal (Figure 6.1-1).

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[38] Tentative target year for the master plan study was initially set as 10 years. This consists of "Capacity Development Phase" and "Policy Implementation Phase" (total of five years to achieve) and the third phase, "Integration" (completed in 5 to 10 years). It is expected that the majority of activities shall start or partially complete or achieved. This timeframe is consistent with Iranian requests on the timeframe.

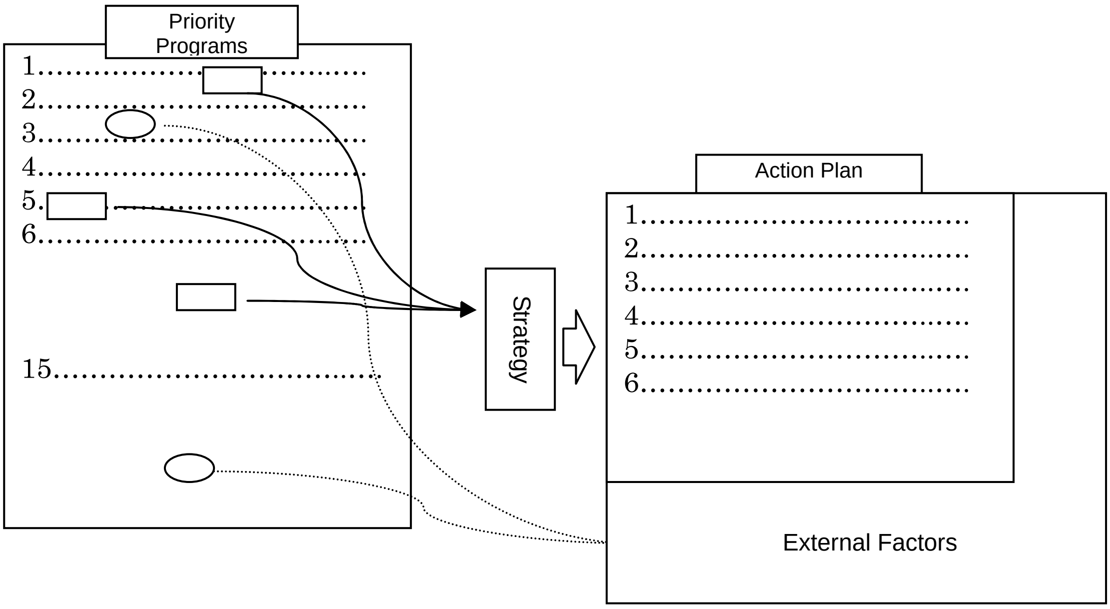

Figure 6.1-1 Action Plan in Master Plan

The strategy is defined (i) to show the direction to achieving the Objective within the given timeframe, (ii) to over look the overall plan, and (iii) to distinguish "do not" from 'do" by taking available resources into account. By limiting small number of activities, optimal use of available resources is expected. While the priority plan in the Master Plan aims at relatively long timeframe of 10 years, Action Plan is focused on development of human resources and items that should be allocated available resources with the highest priority. Among many activities listed in the master plan, external factors are listed based on the controllability of MOE. The external factors listed are excluded from the action plan. They are, however, important factors (and are external risks) for Iran to achieve overall goal of EE&C. The external factors are risks for Action Plan. If the external factors are not fulfilled, the achievement of the Action Plan will be threatened. Therefore, in the course of the implementation, the progress and fulfillment of the external factors should be carefully monitored. As discussed, the external factors are not controllable by actions done by MOE, each items in the external factors should be monitored. If there is a bottleneck for fulfillment, MOE must initiate others to carry out these item as planned.

6.1.3. Preparation of Action Plan by Bottom-up Approach

During the data collection phase, the Team has made an effort to collect relevant information on the policy goal and objectives and the indicators (including numeric policy indicators, etc.). The team contacted a variety of EE&C-related institutions and organizations. In addition, the team conducted a survey on the reports of energy audit results previously carried out by Iranian organizations. The team carried out two preliminary energy audits of its own to gain firsthand knowledge and experience on energy management in Iran. Based on these surveys, the team attempts to analyze energy-saving potentials in the building sector in Iran. These information will be utilized as a basis for preparing the EE&C master plan study and useful for identifying a set of strategy to achieve energy efficient buildings in Iran. The survey, however, is still on-going and is still in process of estimating the EE&C potentials of buildings with a various use. The policy objectives and the indicators (including the target year, etc.) for EE&C policy in Iran has not yet fully identified.

The planning approach for the preparation of the master plan, therefore, is limited to so-called a bottom up one, to build upon the existing data and condition, instead of a top-down approach, which is prepared by setting clear target and timeframe because of lack of appropriate indicators and parameters necessary. It is believed that the data collected particularly the current condition of the EE&C in the building sector in Iran are vital source for preparing practical planning.

6.2. Assessment of the Existing Training Centers in Iran

6.2.1. How to Study and Result

By the completion of the third field survey to Iran, the team has submitted MOE a questionnaire to collect detailed information on IEHT and five regional training centers. The team visited three Higher Education and Research Complexes (Tabriz, Isfahan and Mashhad) as prospective sites for hosting the proposed facility for capacity development specialized for EE&C for the building sector. During the site visits, the team conducted a series of interviews to the instructors and lecturers of the complex for data collection attempting to assist Iranian side to decide basic specifications and requirements for the prospective training center. The original idea was that the submission of questionnaire may allow the team to further investigate by requesting additional information if the questionnaire is delivered prior to the site visit. In realty, the form was not sent to the interviewees because of administrative reasons of Iranian side. The collection of the sheet took long time. The filled sheets was contained only insufficient data, only three institutes (Tabriz, Isfahan, and Mashhad) returned the form The data provided were not complete and are difficult to read and analyze. Following is a summary of data collected and analysis using the data provided:

6.2.2. Locations of Higher Education and Research Campuses

Tabriz, Isfahan, and Mashhad, where these institutions are located, are major cities representing western, central and eastern region of Iran, respectively. Tabriz is a provincial capital of East Azerbaijan Province and is fourth largest city in Iran (population 1.4 million: 2006 Census). It is one of the major industrial cities in Iran. The research campus hosts NTCEM and it carries out training program specialized or industrial EE&C.

Isfahan the provincial capital of Isfahan province located in the central Iran. It is considered cross road of north-south and east-west bound transportation network in Iran. Isfahan is the third largest in Iran next following to Tehran and Mashhad. Its population is approximately 1.58 million according to the latest available census data in 2006. Tourism is one of the major industries in Isfahan. Education is another important industry. It is a home of eight four-year universities and colleges. For Isfahan is known for many important historical buildings, these universities are strong in architectural education.

Mashhad is the provincial capital of Razavi Khorasan, an eastern province situated to the borders of Turkmenistan and Afghanistan. It is the second largest city in Iran (population 2.42 million: Census 2006). Mashhad is known for one of the holiest cities in the Shia Muslim world. Many pilgrims visit Mashhad, therefore, tourism particularly hospitality business (hotels) is very important in Mashhad. Because of close proximate to Afghanistan and Turkmenistan, the Iranian side considers Mashhad is one of good candidate cities because of international exchange prospective.

6.2.3. Current Status of Prospective Sites of Proposed Training Center for EE&C for the Building Sector

(1) Azerbaijan Higher Education and Research Campus (Tabriz)

The research campus in Tabriz hosts NTCEM and has significant experience in EE&C training for industry. The campus is equipped with Japanese EE&C training facility similar to those of Sumitomo Metal Industries in Kashima. The EE&C training program covers both heat and electricity subjects. Other subjects include architecture, environment, water, electric power, transmission, electric power generation, etc.

While total area has not been provided in the questionnaire survey, there are many building in the campus. Adjunct building next to NTCEM has a small space is available for the prospective training center. Detail of other building, etc is not provided.

(2) Isfahan Higher Education and Research Campus (Isfahan)

According to an interview, Isfahan campus is the largest campus among all research campuses under MOE, It is considered that there is a space for new building designated to the new training program. The courses taught in the research campus include energy, computer and control, management, wast-water treatment, environmental engineering (civil, dam, river, ground water, and construction management), electric power and electronics, and architecture (structural, HVAC, geology). There are 28 full-time faculty members.

Current enrollment is approximately one thousand. The institution develops a close relationship with local business community. For example, the institution works closely with manufacturers of building materials (e.g. cement, brick, steel, precast-concrete, etc.) to strengthen research and development. Faculty members may take three to six months sabbatical holiday for collaboration. During that time, he/she will gain practical experience and technology. Such experience will be utilized to develop, prepare and revise educational curriculum at the institution In addition, the educational curriculum at the institution may be modified or establish a new program based on the education and training needs identified.

(3) Khorasan Higher Education and Research Campus (Mashhad)

The research campus holds approximately 10 hectare of land area. There are some large buildings spread all around the campus. The construction of a building originally built for dormitory was postponed and is ready for convert to other purposes. If necessary, the building may be used for the prospective training center. The existing facilities include four large education buildings, forty laboratories and fourteen workshops. Additional facilities include, computer center, library, reading room, etc. The current faculty members include twenty full-time and sixteen part-time instructors.
Because the mayor of Khorasan is a civil engineer and the speaker of city council is professor of the research campus, the government of Khorasan was the most supportive for building the proposed training center. The campus has provided training specifically designed for trainees from Afghanistan.

6.2.4. Analysis of Prospective Locations and Speculation

As discussed above, the three locations are the prospective sites are proposed training center for EE&C for the building sectors by MOE. Each site has different characteristics and unique advantages. The Study Team lacks enough information to decide one site over another. Therefore the Team does not endorse any sites.

The team found that there are five distinctive climate zones in Iran. The building design and usage in these climate zones have very different characteristics and features. EE&C methodologies depend on the characteristic of the climate zone. In the long-term plan, Iranian side may build an EE&C training center for building in each of five climate zones to develop climate-specific EE&C measures and technologies.

The information collected during the Study was summarized in the Annex-11.

6.3. Problem Analysis for the Human Resources Development (Preparation of Problem Tree)

The Tree diagram is a tool to analyze complex issues of problems in the real world. The tree diagram is prepared by organizing a variety of problems and issues in causal relationship. The items on the tree diagram are organized by “cause’ and ‘effect’ in one direction (from right to left, for example). One issue is a part of another cause of different consequences. At the same time, such a consequence is a cause of different consequence. In this analysis, “EE&C for the building sector (is) not promoted” is the issue to be analyzed. As discussed in the previous chapters, constraints of promoting EE&C are: 1) Institution (architecture, HVAC and electricity), 2) technology (architecture, HVAC and electricity), 3) Infrastructure and market (EE&C businesses, financial institutions, etc.), and 4) Lack of appropriate human resources. Among these four, only 4) can be controlled if appropriate policy and measures are established.

In the analysis using the problem tree, the statement is rephrased as “Effectiveness of existing Training and development programs questioned” and further analyzed. The causes of this problem include: 1) MOE affiliated training institutions do not have training programs focusing on EE&C for the building sector, 2) conventional higher education system in Iran does not provide professionals practical EE&C technology for building, 3) many training provider carry out similar EE&C training and the duplicating program exploits limited resources available in Iran. Figure 6.3-1 is the result of the analysis.

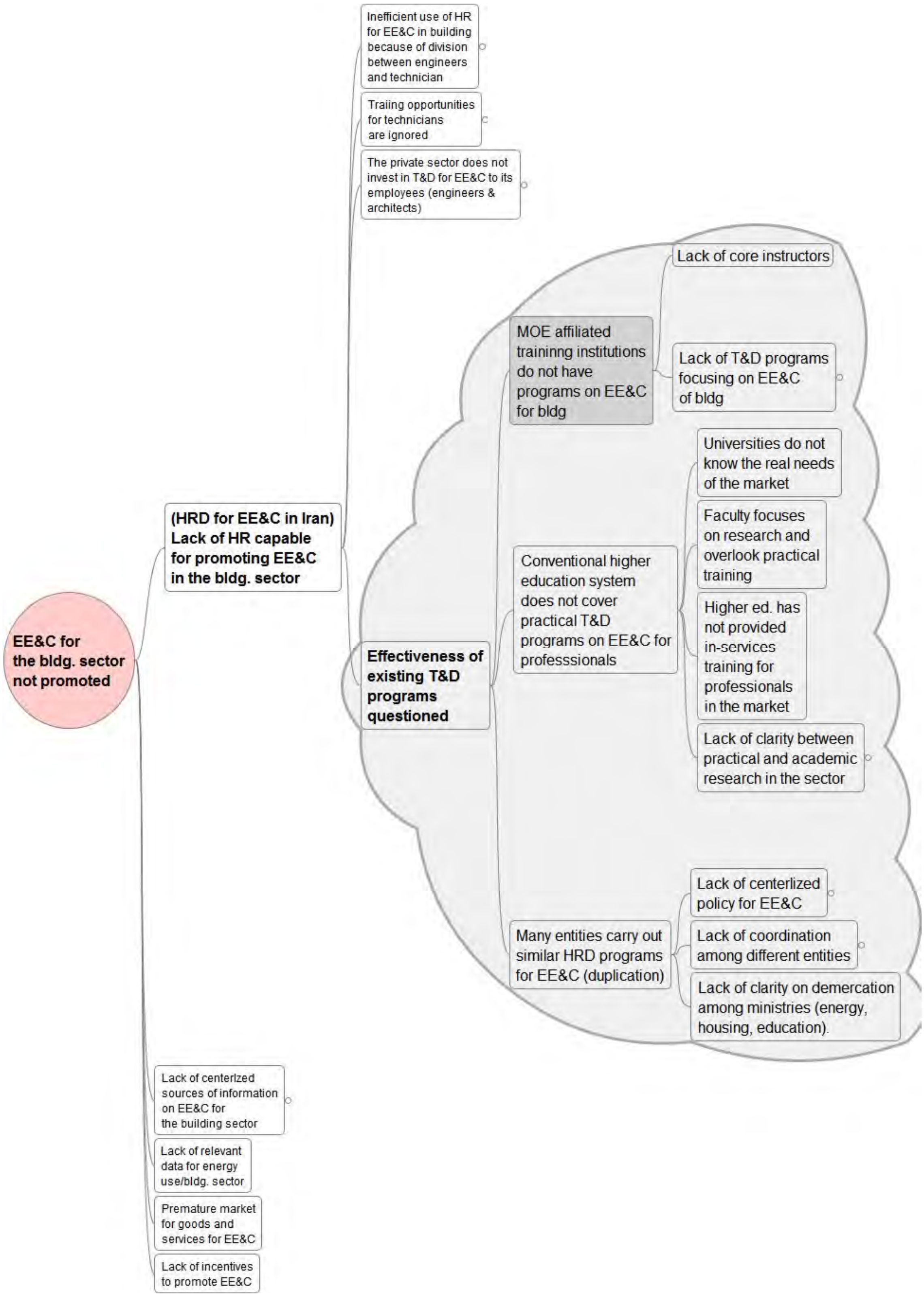

Figure 6.3-1 Problem Analysis on Human Resources Development

6.4. Action Plan and Strategy

A variety of issues, particularly the constraints for promoting EE&C were discussed in Chapter 4. In light of these constraints, the measures to promote EE&C were identified in the Master Plan and listed in the Priority Programs. The Study further analyze a set of actions to be carried out because Iranian side is in need of establishing so-called training center for human resources development. The Study, therefore, reviews the issues and constraints on promoting EE&C in Iran and relevancy of such training center. As discussed in the section 6.3, human recourses development for EE&C for the building sector has a variety of challenges. It is effective to improve the current situation and to resolve the issues for education and training to promote EE&C for the building sector in Iran. To do so, further analysis on approaches on human resources development (target population, methodology, contents of the training and availability of resources, etc.) is carried out.

6.4.1. Basic Strategy for Human Resources Development

The basic strategy for the human resources development is chosen from the various approaches listed in the Priority Programs (Table 5.1-1) especially by the priorities (e.g. 1) importance from the view of human resources development, 2) magnitude of impact to EE&C promotion, 3) ones that the government of Iran can leads, and 4) ones that complete within short period of timeframe). While MOE will assume overall responsibility for implementation of human resources development, many activities listed to the Action Plan shall be carried out by collaboration with a variety of training and research institutions affiliated with old MOHUD. Based on the idea above, the basic strategy for achieving EE&C for the new and existing building are defined as following:

- Overall Goal: Improvement of energy intensity of the building sector in Iran,
- Basic Strategy 1 (New Building): Capacity development to apply and adopt the Article 19 of the Building Code of Iran, and
- Basic Strategy 2 (New Building): Establishment of market-driven ESCO business in Iran.

6.4.2. Basic Strategy 1 (New Building):Human Resources Development for Promoting EE&C to New Building

The goal of the first strategy is to apply the Article 19 of the Building Code to all new building. To do so, the compliance of BC19 should be enforced at all phases (i.e. plan, design, construction, installation, inspection, commissioning, operation and maintenance) of any construction projects. In addition, necessary training should be carried out to such target population as 1) owners of the buildings or projects, 2) architects and engineers (HVAC, mechanical and electrical), 3) members of Engineering Association, and 4) architects and engineers who conducts final inspection. Actual trainees should be strategically selected because the total number of eligible trainees is projected uncountable if building owners of all sizes are included. One reliable data to estimate number of prospective trainees is a estimation of members of Engineering Association in Tehran Province surveyed by MOE conducted as of July 2011 (Table 6.4-1).

Table 6.4-1 Member of Engineering Association in Tehran Province

Category	Number	(%)
Civil Engineer	35,000	50
Architecture	10,000	17
Electric Engineer	12,000	19
Mechanical Engineer	13,000	14
Total	70,000	100

The target should be selected strategically based on an expected impact to the building sector. One way of selecting the prospective trainees is based on the size of energy consumption[39]. Based on the past experience of the Study Team, the prospective trainees should be invited from the owners of such building as 1) public buildings (central and municipal governments), 2) large-scale housing complex, 3) hotels, 4) hospitals, and 5) shopping malls. As development of database is one of the priority programs proposed in the Master Plan Study, the target building may be changed when further study on selecting priority buildings progresses.

6.4.3. Basic Strategy 2 (Existing Building):Human Resources Development for Promoting EE&C to Existing Building

Objective of promotion of EE&C to existing buildings is to achieve maximum optimization as habituating environment based on usage and purpose of the buildings. To do so, energy audit of these building as, as same as that of new buildings, 1) public buildings (central and municipal governments), 2) large-scale housing complex, 3) hotels, 4) hospitals, and 5) shopping malls, should be carried out. One-day long audit service should be carried out by dispatch of EE&C engineers funded by the government. The audit may be free of charge and is to promote the idea of necessity for EE&C. By doing so, the awareness of building owners, in-house engineers, technicians, etc. for EE&C should be raised. As the result of the preliminary audit, more precise audit services in commercial basis may be performed by ESCO. The preliminary audit is effective approach to promote EE&C and to develop related services in middle and long-term. To enhance the capacity of the service provider (for free audit), specific target for human resources development include 1) owners of large buildings or developers of large-scale housing complexes, 2) Engineers of ESCO business, and 3) Engineers of other EE&C services providers.

As explained above, the objective of the Action Plan for existing buildings is "to establish market-driven ESCO business in Iran". It is important to create successful examples and good practices of Iranian building at early stage of the implementation of the EE&C Action Plan. At the same time, the proposed clearinghouse may be a focal point to collect information on good practices to disseminate to general public and building owners who are interested in implementing EE&C measures.

6.4.4. External Factor for Implementation

The priority programs listed in the Master Plan was selected based on the importance of promoting EE&C in the building sector in Iran. Action plan for human resources development was developed by the criteria explained in 6.4.1. According to the criteria, the items relatively accomplished (within 3 to 5 years at longest) would be selected as external factors. The importance and priority of items not listed in the Action Plan are in great variety from the view point of human resources. They should be carried out along with others with highest priority. The Figure 6.4-1 is a diagram showing the relationship among Action Plan, Master Plan, strategy, and external factors.

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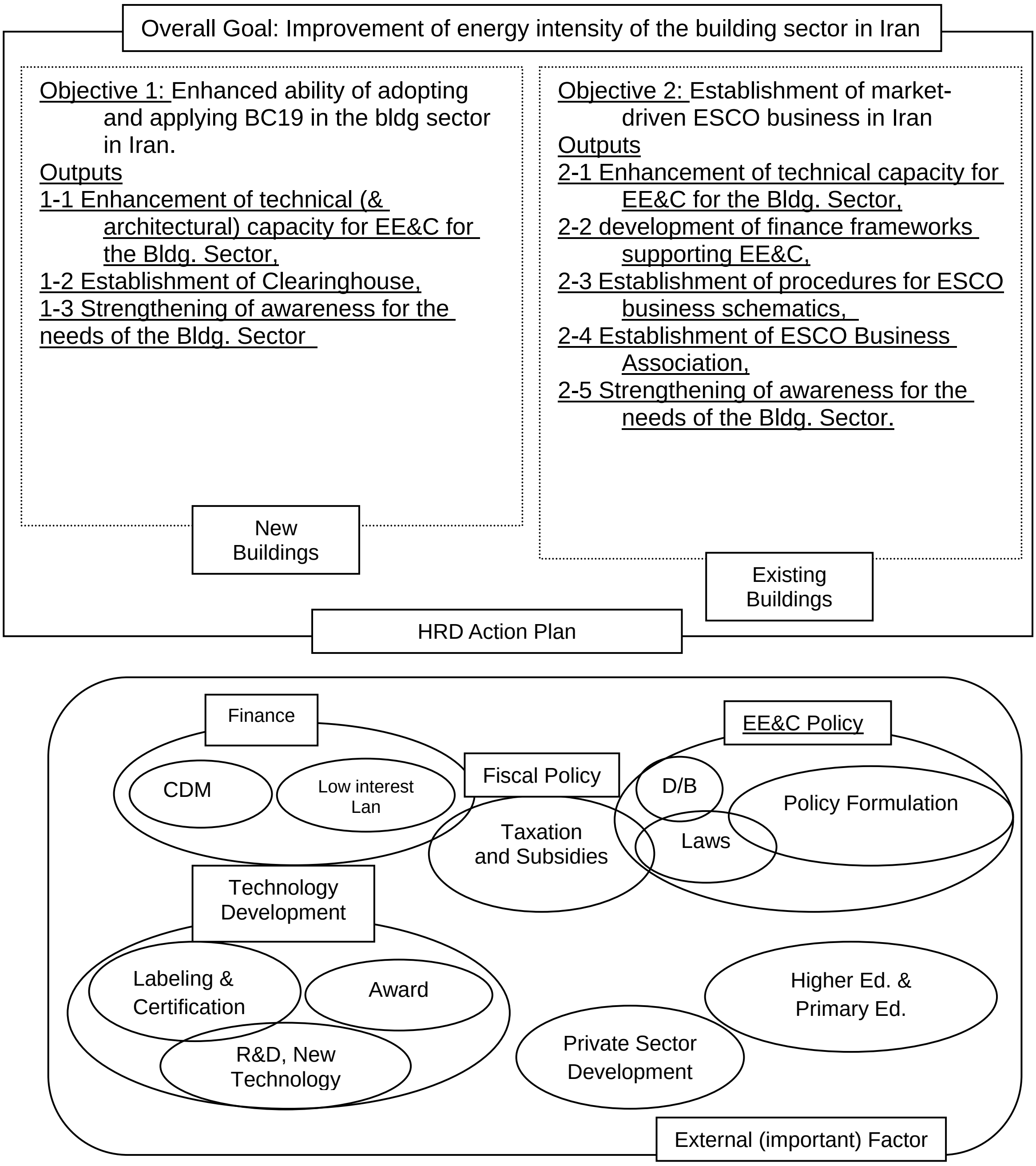

Figure 6.4-1 Diagram Showing Relationship Among Action Plan, Master Plan, Strategy, and External Factors

As discussed in 6.1.2, external factors are 1) important factor for achievement of Action Plan, 2) are not controllable by MOE through implementation of Action Plan,, and, 3) the fulfillment of the external factor is ambiguous. Whether or not these items fulfilled are important external risks that should be monitored to make sure for the achievement of the Action Plan. During the implementation period of the plan, MOE needs to keep eyes on the progress of these external factors, and from time to time, MOE should request other implementing bodies to facilitate the implementation of the external factors.

6.5. Prospective Target for Human Resources Development

6.5.1. Preparation of Human Resources Development Plan Using Competency Map

The questionnaire survey was not returned by the expected schedule during the initial two site visits. The Team shared the needs of gathering information by holding a meeting to generate a basic concept of capacity development for the team to propose. Two team meetings were held in November, 2010 and January, 2011 in Tokyo. The meeting aims at defining stakeholders of EE&C in Iran and their interests. The team also produced a basic training plan and its priority. Based on the concept, target of the training (trainees) are identified for dissemination of EE&C in Iran. By each prospective target of the training, the team defined tentative learning objective, and skills and knowledge necessary for attain. All information was studied to compile into the competency map （For further explanation on Competency Map, see 6.5.4）

6.5.2. Stakeholders for EE&C Promotion

The target of the capacity development is not only EE&C engineers but also broad range of stakeholders who has significant impact to promoting EE&C in Iran. The proposed training and development shall start as soon as possible. At the same time, the training and development shall be carried out along with other measures such as policy formulation and implementation simultaneously. As found in the problem analysis, on-going capability development mostly carried out by the private sector is not so effective because of its narrow scope and selection of trainees. It is, therefore, recommended such capacity development should be initiated and carried out by the government in order to accelerate promotion of EE&C in Iran.

As the result from the internal discussions, a set of stakeholders for promoting EE&C in Iran was identified. They are: (i) private companies, (ii) general constructor (and architects, etc), (iii) energy users, (iv) energy providers, (v) financial institutions, (vi) professional associations, (vii) EE&C engineers, (viii) accreditation bodies (in the future), (ix) government officials, and (x) educational and training institutions. In addition, the team analyzed a list of expected activities by each stakeholder for promoting EE&C in Iran. The result is this analysis is shown in Table 6.5-1.

Table 6.5-1 Result of Stakeholder Analysis
(Stakeholders for EE&C Promotion in the Building Sector)

Category	Stakeholder	Expected Actions to be Taken
Both Professional and Non-Professionals		Awareness for EE&C is high.
Private Firms	ESCO Construction Material Manufacturers EE&C Equipment Manufacturers (BEMS, etc)	Guaranteeing EE&C effect, Improvement of EE&C technology, Guaranteeing product quality, Increasing EE&C market, Proper pricing, Activation of market environment
General Contractor	Building designers (and firms) Installation firms Equipment firms	Guaranteeing quality, Understanding & following Building Code, Proper supervision of construction, High motivation of EE&C, High standard of technology
Energy users	Owners of buildings Tenants and residents Building management firms Servicemen (Technician) Residents' Association	High awareness of EE&C, Improving knowledge of EE&C, Paying energy cost independently (not collectively).
Energy suppliers	Power companies Power plants Power distributors	Awareness rising, Maintenance of supply infrastructure, Ensuring stable supply, Minimizing supply loss, Installation of independent meters.

Category	Stakeholder	Expected Actions to be Taken
	Gas and oil suppliers	
Financial organizations		Provide EE&C credit scheme/ project finance scheme, Improving assessment ability, Have assurances system.
Professional associations	Consulting Association Organization for Engineers Order of Building	Publishing technical guidelines and explanations
EE&C Engineers	Energy managers EE&C Consultants (Free-lance/ Employed)	Establishment of procedures for examination for prof. qualifications/licensing and , Issuing Energy Manager certifications. Improvement of EE&C–related knowledge, Sharing good practices and information of EE&C achievements
Accreditation bodies (in the future)		Capable to evaluate properly, Establishing certification system
Government	Policy makers (MOE, old MOHUD, NIOC, and other departments in charge of CDM promotion)	Comprehensive EE&C policy, Sharing information, Setting EE&C goals, Making EE&C promotion policies, tax system, subsidies.
	Implementing agencies (quasi-governmental agencies) (e.g. SABA, IFCO, BHRC)	Publishing commentaries, Awareness raising, Accumulation of EE&C technologies, releasing EE&C technologies, Setting bench marks based on the types of building, Commendation of Best EE&C Award", Compulsory reporting of energy usage
	Local governments	Approval/supervision of construction based on Building Code, Being committed to promotion of EE&C, Having building data open
Educational and Training Institutions	Research Institutions (e.g. IHET, IFCO, BHRC, SABA) Universities/Colleges Vocational Schools Private Companies Professional Organizations	Accumulation of research output, Research on latest technology, Technical development for Iranian climate, development of new methodologies of education/training for EE&C.

Source: Prepared by the Study Team in Jan., 2011

6.5.3. The Primary Target for Capacity Development

Among the stakeholders identified in the analysis above the ones with higher priority for capacity development in EE&C are analyzed. These stakeholders are, in another word, the one with the highest training needs. The priority is judged by a set of criteria. The first criteria is the magnitude of impact when Iranian government intervenes these stakeholders by carrying out a variety of capacity development activities to promote EE&C. Support for policy formulation, institutional development for EE&C are among the activities which create relatively large impact in the short period of time. In addition, general contractors (architects and building engineers) are to apply and promote advanced EE&C technologies. The possibility of creating significant technological impact is considered high.

Table 6.5-2 Primary Target for Capacity Development

No	Stakeholders	Evaluation Criteria			Priority	Note
		Impact	Rational for Support from Gov.	Relative Urgency		
(i)	Private Firms	medium	low	low	low	Private firms may invest in training and development when it is necessary for undertaking its business by own expenses
(ii)	General Contractors	high	medium	high	high	Have significant role in disseminating new technologies to new and existing buildings, etc.
(iii)	Energy users	high	high	high	high	Investors and owners of buildings make investment decisions on EE&C
(iv)	Energy Suppliers	high	low	medium	medium	Significance is acknowledged in the existing EE&C programs for the industrial sector
(v)	Financial Institutions	high	high	high	high	Have significant role in financing EE&C
(vi)	Professional Associations	medium	medium	medium	medium	It has a role in information sharing and training & development of engineers
(vii)	EE&C Engineers	high	high	high	high	Engineers play important roles in development, promotion of new EE&C technologies. Role of engineers for strengthening ESCO business has a great need.
(viii)	Accreditation bodies (Accrediting institutions)	low	high	low	medium	In the mean time, establishment of laws and procedures has a priority. The role of the bodies may be recognized once accreditation and verification needs became important.
(ix)	Government	high	high	high	high	There is a significantly important role for policy and institutional issues. Highest priority.
(xi)	Education and Training Institutions	medium	medium	medium	medium	Core human resources should be developed initially. May be strengthened incrementally.

The second is the rational for the government (or the public sector) to provide assistance for capacity development (e. g. institutional building, technical assistance, training and development, etc.). The private sector may want to train and develop its employees if it found such development is needed to sustain the business. Role of the public sector to provide assistance to the private sector should be limited and carefully examined. For the private firms in construction business, however, may need some technical assistance from the public sector because their business is highly regulated by laws and regulations.

The third and the last criteria is urgency. Especially the urgency for technical assistance to those who contribute to establishing institutions and social infrastructures for promoting EE&C has a higher urgency. From that perspective, assistance to construction-related business (general contractors, architects, and building engineers, etc), energy users, and governmental officials are with higher urgency of assistance.

Combining these analyses, the primary targets of the prospective capacity development are for general contractors (including architects and building engineers), energy users, financial institutions, engineers (including ESCO business) and governmental officials. The result is shown in Table 6.5-2.

6.5.4. Preparation of Competency Map

Based on the result of the Stakeholder analysis and its prioritization above, a set of capacity maps is prepared. The maps consist of general contractors, energy users, energy suppliers, financial institutions, EE&C engineers (ESCO business), and governmental officials. The CUDBAS[40] method was used to analyze desired professional capacities, a list of jobs, competency to fulfill and undertake such jobs. The result of analysis is shown in Annex and the explanation of the analysis is discussed in the following.

Competency map is an analytical table that shows one's capacity (skill, knowledge and attitude) based on the analysis of his job. One professional's work generally consists of five to ten jobs. The analysis lists these jobs in order of importance. The Competency Map further categorizes necessary capacity (skill, knowledge and attitude) to accomplish each job. The capacity is listed in order of importance based on the three categories; A: the ones everyone to do the job should know (do), B: the ones certain, but not fully, level of understanding (attainment) is necessary, C: minimal (basic) level of understanding (attainment) is necessary. Accordingly, the higher the importance the further the top of the table it placed.

In training design, review of available resources is one of the major tasks and it is based on the priority. Items with higher training needs may be allocated resources available. The competency map helps trainers to identify both priority of job and to develop training curriculum. The work analysis provide planners rational data for classifying the tasks of typical workers (or trainees). Table 6-5-3 shows priority areas of proposed trainees. The Study Team has discussed on the result of analysis with the Iranian side and are reflected to preparation of the master plan and action plan.

Energy audit and analysis requires a variety of skills and knowledge already attained in Iran. For example, calculation of energy saving potentials, knowledge in available EE&C measures in Iran, estimation of economic analysis including cost and benefit analysis, etc are technically established and practiced because these subjects are already available through the past EE&C experience including those available in NTCEM in Tabriz. This indicates that most technical and technological resources are already available in Iran. Additional challenge is how to disseminate EE&C by integrating technological resources and management scattered all over different players. In addition, development of Iranian specific technical contents and its dissemination is another issue to carry out.

[40] CUDBAS, Curriculum Development Based on Ability Structure, was a part of PROTS (Progressive Training System for Instructors), a instructional design training methodology developed in 1990 by then Japanese Ministry of Labor. It is a method to analyze vocational ability. This method makes it possible to analyze vocational ability easily and clearly with relatively short period of time.

Table 6.5-3 Preliminary Plan for Capacity Development

Target	Job with Importance	Learning Objectives	Approach and Methodologies
ESCO engineers	Propose	【1-1 A】Able to propose proper technologies to the building owners based on the facts and data	Training for linking analysis to technical proposals is high level of development needs in Iran.
	Execute	【2-1 A】Able to procure investment funds for saving energy 【2-2 A】Able to procure equipment and facilities with low prices 【2-3 A】Able to manage the project integrating makers and contractors	PMBOK (from PMI) may be the most suitable training and the qualification certificate for this area.
	Audit and analyze energy saving	【3-1 A】Able to forecast and guarantee the potential of energy saving 【3-2 A】Know a number of energy saving measures 【3-3 A】Able to calculate energy saving effects (energy reduction ratio, energy cost ratio) 【3-4 A】Able to analyze cost-benefit regarding energy saving measures	Many common technological subjects in industrial EE&C training which is available in Tabriz. Contents unique to building EE&C shall be identified and need to be developed in Iran.
Energy Users	Record the quantity of energy usage	【1-1A】Able to collect and file the energy data (building owners, tenant association, servicemen) 【1-2 A】Know prices, cost and quantities of electricity, gas and water usages	Ditto Technical contents for the training for O&M technicians which does not require high level of analysis may be developed in Iran
	Report the quantity of energy	【2-1 A】Able to report the energy usage quantity to the administration (Building owners) 【2-2 A】Able to show energy data available from the building owners to tenants 【2-3 A】Able to share energy data among stakeholders	
	Set goals for energy saving	【3-1 A】Know the problems of energy usage at one's own building (or household) 【3-2 A】 Have an attitude to make active efforts for energy saving 【3-3 A】Able to make goals for en energy saving 【3-4 A】Know that energy saving serves for national security	Regulations such as target-setting program and/or cap and trade program should be a drive to promote this task
Architects and Engineers of Construction Companies	Enhance work-related knowledge	【1-1 A】Know the necessity of energy saving (architects/mechanics) 【1-2A】 Know energy saving technologies (equipment) 【1-3A】Know the examples of energy saving technologies (construction) 【1-4A】Able to design in accordance with the Building Code Article 19th	Government's role in providing a large share of training is questionable. All the private sector (enterprises, individuals, etc.) shall train construction engineers of own.
	Develop, market, and install energy saving products	【2-1A】Know quality control methods 【2-2A】Able to control and secure quality in accordance with the specifications and plans 【2-3A】Keep compliance and abide by	OJT plays significant role in improving the quality of construction projects. QC must practice at all level of the industry.

Target	Job with Importance	Learning Objectives	Approach and Methodologies
		laws and regulations	Penalty is one of the incentives.
	Share knowledge and experience of energy saving designs	【3-1A】Know the size and details of the heating system of the building	EE&C design shall be promoted in Iran
Govern-mental Officials	Understanding current situation	【1-1A】Know EE&C related laws and regulations 【1-2A】Know situations and awareness of EE&C enterprises	Depending on the target, dispatch of policy advisor may be effective to achieve the outcome. Also training overseas is effective means for capacity development. (Risk is if Iranian side accepts such experts to their ministry, etc.)
	Analyze and plan	【2-1 A】Know effective policies for EE&C and conditions for implementation 【2-2 A】Understand the structure of EE&C legal institutions and utilize them 【2-3 A】Know the latest EE&C technology and assess its applicability to home country 【2-4 A】Have building data (floor size, amount of energy usage, capacity, time for use) for EE&C	
	Implement	3-1 A Allocate budget for EE&C promotion 3-2 A Understand economic impact of energy prices and set proper subsidies 3-3 A Establish credit scheme for EE&C investment 3-4 A Liaise and coordinate with other ministries/organizations 3-5 A Have an attitude of promotion of building EE&C as the state policy 3-6 A Local government: disapprove construction application that does not fit building code	
Financial Institutions	Assessing the feasibility of the project	【1-1A】Can evaluate and analyze the risks associated with the project 【1-2A】Can analyze payback period of investing to EE&C equipments	Knowledge of project finance is applicable. Introduction of EE&C technology for bankers without technical training may be needed. Such training may be common to other training activities.
	Managing credit of borrowers	【2-1A】Can set conditions (e. g. interest rate, etc) appropriate for the risks 【2-2 A】Can assess credit rating of borrowers 【2-3A】Can collect credit by necessary means when the loan payment is regularly made 【2-4A】Can prepare contractual agreement for EE&C project	
	Proposing EE&C projects	【3-1A】Can explain merits of installing EE&C equipments (leasing)	Seminars on new EE&C technology specifically tailored for financial institutions needs to be developed.

The table shows the prospective contents of capacity development for each target group. The information given in the table will be used as a basis for discussion to identify detail description of prospective capacity development activities. In the following, the description of the capacity development targeting ESCO engineers will be explained as an example. The information on other target groups was used for discussion with MOE. The result of discussions were reflected to preparation of the master plan and the action plan. As a result,, both sides were able to see the availability of resources, such as approaches, human resources, facility and equipment, etc.

The most important job for ESCO engineers is to propose the building owners proper technologies based on the facts and data. Most owners of the building who does not have technical background have stakes to decisions for investing EE&C. The EE&C must convince them with hard data and evidence to benefit out of the investment options proposed by the engineers. To do so, not only audit capacity but also capacity in communication and project management to make the proposal reality. It also requires technology that can be best suitable to Iranian situations. The technical contents as well as a set of action for capacity development shall be tailored to the conditions of Iran.

Next important area is project implementation. This covers such areas as project finance, procurement of relevant equipments and technology, supervision of installment, etc. The skills and knowledge, however, are not unique to managers for implementing EE&C. It is considered a fundamental competency necessary for a skilled project manager in any type of projects. The technical contents of the training may be developed in line with internationally-recognized qualification certificates based on the guidelines such as PMBOK[41].

The next important job is audit and energy saving analysis. The engineers shall be able to forecast and guarantee the energy saving potentials, and to propose a number of energy saving measures, to calculate energy saving effects (energy reduction ratio, energy cost ratio, etc.), and to analyze cost-benefit based on the energy saving measures recommended. Technical contents of these issues above are fully compatible and adoptable to those taught at the NTCEM in Tabriz as for the resources available for carrying out these training. This indicates that some technical resources are already available in Iran. The issue for further discussion is how to identify technical resources readily available and to integrate them into a recurrent training program for EE&C engineers with a specific technical expertise on buildings and facilities.

6.6. Action Plan for Human Resources Development

6.6.1. Establishment of the Training Center for EE&C Promotion

As discussed in the previous sections, it is justifiable for Iran to establish a training center that provides training program focusing on EE&C with an emphasis on the building sector. The need of such institution is high because training and development of human resources that promote and disseminate EE&C are one of effective approach for Iran to achieve more efficient EE&C policy on the ground. As discussed in the previous section, no existing educational institutions are providing adequate training program for practical EE&C training to professionals. In order to realize the objectives of EE&C Master Plan, establishment of a training center for EE&C for the building sector is necessary.

On-going efforts of Iranian universities to expand existing EE&C programs are one of positive signs of EE&C dissemination. EE&C, however, is practical discipline based on practices in industry. University education weighs on theoretical aspects of energy management which lacks on-site practices and trial that directly links to convenience of and immediate feed-back from end-users. Iranian higher education system was developed historically with an aim to educating younger elites to cope with needs of labor market. In contrast, it is complex for the conventional higher educational institutions to establish highly practical discipline of EE&C for the building sector to industry professionals who already trained in-services. The role of

[41] A Guide to the Project Management Body of Knowledge (PMBOK Guide) is a book which presents a set of standard terminology and guidelines for project management.

university is slightly different from such a specialized training. It is aimed at more broader and fundamental subjects of architecture, mechanical and electric engineering including heat dynamics, electrical circuit, electric facilities. In addition, such basic skills necessary for an engineer as analysis, presentation, and communication should be much strengthened.

IEHT affiliated with MOE is capable for providing in-service training to engineers and technicians in the electric power industry. It has a long history of similar in-service training to a variety of public services employees, engineers of the private sector. In addition, IEHT has a capacity in training management including, planning, recruiting, delivery, and evaluation. NTCEM in Tabriz, one of training institution under IEHT has the only training facility for EE&C for industry in Iran. Experience accumulated in IEHT may extend to the proposed training center for the building sector. It is, therefore the proposed training center for EE&C aiming at the building sector should be extended based on IEHT's experience.

6.6.2. Action Plan for Human Resources Development for Promoting EE&C for New Buildings

The objective of promoting EE&C for new building is Enhancement of the ability of adopting and applying BC19 in the bldg sector in Iran. The target, objectives of training, training approach (training methodologies), and prospective implementing organization and trainers are shown in the following (Table 6.6-1). There are some key persons in each stage of construction. The owners and developers, for instance, are the real stakeholder of making decisions regarding size of investments (i.e. the decision to invest in EE&C design, machinery, equipment, as well as operation and maintenance).

Table 6.6-1 Human Resources Development Action Plan for Promoting EE&C to New Buildings in Iran

Stages	Target of HRD Trainees	Approach/Training Contents	Training Methods	Implementation (Trainers)
Planning	Owners of building, Developers, etc.	Strengthening awareness on EE&C	Lecture on good practices found in Iran	Instructors of the Training Center
Design - (Examination) - Construction	Engineering Association (Architects, Mechanical & electrical Engineers)	New technology, new construction methodology, equipment, materials for EE&C buildings	Establishment of clearinghouse. Provision of information (contacts, etc.) of EE&C	Establishment of clearinghouse may be through strengthening of BHRC's functions
		Attaining techniques on practical design, construction, supervision for EE&C building	(1) Use of training module (simulation) by building process of the new training center building, (2) OJT using other building, etc.	Instructors of training centers, members of Engineering Association, private sector (for OJT)
Inspection – Commissioning	Architects	Quality control for construction of building envelop	(1) Use of training module (simulation) by building process of the new training center building, (2) OJT	Instructors of training centers, members of Engineering Association, private sector (for OJT)

Stages	Target of HRD Trainees	Approach/Training Contents	Training Methods	Implementation (Trainers)
			using other building, etc.	
	Commissioning Engineers (EE&C Engineers)	Assuring performance designated by specifications	Optimization of completed buildings	Instructors of the Training Center

The owners have stakes for investing to EE&C. They are heavily dependent by owners' awareness and understanding on necessity of EE&C. Building awareness for EE&C for the building sector is one of important approaches if EE&C is promoted. The training specifically designed for building owners and developers are, therefore, key component the training carried out at the proposed training center. The contents of the training should be introduction of good practices found in Iran. The lectures should be designed for business person with non-technical background in order to reach the message to all participants.

Key stakeholders of phases of design (including preparation of documents, etc.), building permit, and construction are architects and engineers associated to Engineers Association. They include architects, mechanical and electric engineers certified by the association. These architects and engineers are responsible for assisting municipalities for issuing building permit by providing technical support on review of construction plans and technical application of the projects. It is identified that these engineers should have the most updated knowledge and skill in building EE&C such as new building design, methodology, equipment and construction materials. The proposed clearinghouse would provide such information to anyone interested in EE&C. The work of clearinghouse should be concentrated to collect and publish such information, not to evaluate specific technologies. It is a one-stop center for information on EE&C and should cover broad topics and technology of EE&C information including contact information.

Another important training area is to provide practical (hands-on) experience of designing, building, and supervising EE&C building. In order to realize such training in Iran, the Study Team proposes to carry out OJT by architects and engineers when Iranian government builds the training center building. Full-scale building construction is the best training site for practical OJT program to experience whole stages of building design and construction. The center should be equipped with actual air-conditioning equipment that may be able to control for the purpose of providing training to trainees. The simulation is effective approach for learning practical control of the HVAC system of real building. The construction process of all stages of the construction is also the best opportunity for architects and engineers to learn design method suitable for the environment of Iran.

Common issues the Team identified are assurance of the construction quality of the building. Strengthening of inspection should is one key to the improvement. It is, however, more important to improve supervision during all phases of construction. Unlike manufacturing products, reproduction or replacement are almost impossible in construction of building when quality failure is found. The quality assurance of envelop of buildings is only achieved through improvement of supervision during the construction. Strengthening of one's capacity in supervision may be achieved only through OJT using actual building under construction. To do so, the construction phase of the proposed training is one of the ideal sites for training. In addition any buildings under construction may be arranged and used for further training on supervision.

Commissioning is a post-completion work of optimization of the building systems.

Commissioning engineers provides services to run the HVAC facility to see if designated performances are installed after operation of the building facility is started. The HVAC facility generally are designed and installed relatively higher than it should be built in order to ensure the performance of the facility. Commissioning engineers adjust the facility when it is operated with regular condition of operation. The proposed training center is an ideal site to carry out this training.

6.6.3. Action Plan for Human Resources Development for Promoting EE&C for Existing Buildings

One of the most important jobs for ESCO business as well as EE&C engineers who work with the ESCO is to propose and recommend the most effective EE&C measures to clients. It is probably the most challenging single capacity development item to develop because of the following reasons. First and foremost, the clients are, in many cases, business person with non-technical background in training. Effective communication skills using evidences based on the data collected and analyzed are important. Second, the skills and knowledge for data collection, analysis, as well as new technology for measures to improve clients' facility is essential. In order to develop market-oriented ESCO businesses, audit results should be communicated to clients to link to actual business. To do so, the training curriculum for ESCO business should be further developed by collaboration with Iranian ESCO leaders because the contents should be included the real business situation of Iran.

Table 6.6-2 Human Resources Development Action Plan for Promoting EE&C to Existing Buildings in Iran

Target of HRD Trainees	Approach/Training Contents	Training Methods	Implementation (Trainers)
Owners of building, Developers, etc.	Strengthening awareness on EE&C	Lecture on good practices found in Iran	Instructors of the Training Center
ESCO Business （ESCO Engineer）	Plan, propose, finance of EE&C Projects Strengthening Implementation Capacity	Lecture (Case Study)	Instructors of the Training Center ESCO companies (in-house training and OJT)
	Improvement of energy audit capacity	(1) Use of training module (simulation) by building process of the new training center building, (2) OJT using other building, etc. and (3) Lectures	
EE&C Engineers	Plan propose, implement and report of EE&C projects	Lecture (Case Study)	Instructors of the Training Center ESCO companies (in-house training and OJT)
	Improvement of energy audit capacity	(1) Use of training module (simulation) by building process of the new training center building, (2) OJT using other building, etc. and (3) Lectures	

The contents of the training include elements of the project management including finance, procurement, construction management, supervision and inspection. These topics are not specifically important for EE&C projects. They are very common elements of general project management. Therefore, the training of these topics should not be tailored for EE&C in Iran, rather international training program, such as PIMBOK[42] should be instructed.

The contents and description of the training to each target (trainee) are shown in Table 6-5. As did for the new buildings, the training for owners and developers of buildings and projects is designed to raise awareness of EE&C. The contents of the training include examples of good practice and return on investment for EE&C projects in Iran. The training for ESCO business and ESCO Engineers is to improve capacity of plan, implement, analyze, propose and finance EE&C projects on behalf of clients (owners, etc). When the construction of the proposed training center is in progress, lectures on case studies, and OJT using existing building may be carried out. When the center is completed, simulation using the facilities of the training center (training for manipulating operation parameters of the building facility and equipment, etc) will be carried out. In addition, OJT using existing building nearby as well as lecture on case study may be provided. Action Plan is shown in ANNEX 9.

6.7. Issues to be Considered for Implementation of Action Plan

The following is the issues to be considered for implementation of Action Plan.

6.7.1. Organizational Arrangement (Clarifying the Role of MOE, collaboration with other ministries, especially old MOHUD)

Jurisdiction of MOE is EE&C with a focus on electricity. MOE is responsible for coordinating with other ministries on different aspects. As discussed, the proposed training center consists of a variety of training subjects and contents; MOE's most important responsibility is coordination among different ministries. In particular, architecture and building is jurisdiction of old MOHUD. Heat with petroleum is that of Ministry of Petroleum (MOP). These ministries are responsible for research and development, as well as human resources development of the respective field. MOE takes overall responsibility of coordinating the establishment of the training center for EE&C of the building sector.

There are many seasoned instructors in electric power sector in the existing training centers affiliated to MOE. They do not have adequate experience in teaching EE&C for the building sector. The training, therefore, should be developed by collaborating with old MOHUD, especially its provision of human resources and technical support is pre-condition of the establishment of the training center.

6.7.2. The Role of the Experts in Architecture

The proposed EE&C training program for the building sector offers a diverse technical subjects. The technical contents include all aspects of planning to completion of building project as well as commissioning to operation and maintenance. The acquisition of such capacity is through experiential training method by utilizing newly developed training facility. The curriculum development must be undertaken when the description of training facility is completed mainly by the C/P who are knowledgeable to Iranian construction and EE&C market situation.

The specific technical contents of the training program may include such subject as land

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[42] PIMBOK: A Guide to the Project Management Body of Knowledge (PMBOK Guide) is a book which presents a set of standard terminology and guidelines for project management. The Fourth Edition (2008) was recognized by the American National Standards Institute (ANSI) as an American National Standard (ANSI/PMI 99-001-2008). The Third Edition (2004) was recognized as a standard by the Institute of Electrical and Electronics Engineers

selection, determining specifications of envelops, spatial design, HVAC system design, construction and installation, and inspection. The basic knowledge for EE&C shall be provided by experts, possibly dispatched from overseas in form of technical assistance. The knowledge should be localized by the counterparts to adopt Iranian environment and market situation. In addition technical adoption to meet with local regulations is necessary. Especially technical adoption such as interpretation of traditional passive design is integral part of the contents of the training. Therefore, the development of curriculum, textbook should be initiated by Iranian side.

6.7.3. Securing Counterpart Personnel

As discussed above, MOE's mandate is policy formulation and its affiliated institutions such as IEHT and SABA are responsible for policy implementation, MOE itself has limitation in terms of number of employees knowledgeable for EE&C for the building sector. It also has constraints to secure adequate number of core trainers who can instruct and teach the most up-to-date subject in building EE&C. The development of the teaching materials (including equipment, teaching curriculum, materials and instructions) at NTCEM in Tabriz was mostly based on a training package. The duration of such development took relatively short times (four years).

In other hand, the proposed training program for EE&C for the building sector employs experiential training methodology which helps participants to learn planning, completion, and commissioning of building. The development of teaching materials shall be initiated by Iranian architects and engineers who experienced and attained knowledge and skills from above development process of the training program. The contents of the training includes such a variety of subjects as site selection, specifications, envelop, space and architectural design, all engineering design (e.g. HVAC, information technology, etc), construction, installation, and inspection. The knowledge and skills provided through the training shall be digested by Iranian side and fully utilized for curriculum and teaching material development specifically designed for Iranian contexts.

6.7.4. Development of Textbook and Manuals

Technical cooperation to be carried out in each sub-component requires development of textbooks, manuals, guidelines, etc in a systematic manner. This should initiated by C/P because of above reasons.

6.7.5. Selection of ESCO Businesses

SABA currently accepts application from all kind of energy service providers as ESCO business without specific criteria. The problem is that the criteria for registration used by SABA are different from the type of ESCO Business the Japanese side envisions. Action Plan aims at establishment of ESCO Business entities which guarantee certain level of reduction of energy (i.e. performance guarantee contracts) with specific guidelines for business. The current registration schematics lack clarity in service level they provide. The technical level, particularly of energy audit capacity for ESCO business of the companies registered may vary one company to another. In addition, SABA's overall capacity of providing ESCO related services is not fully measured because SABA does not perform energy audit itself. Therefore, SABA's technical expectations to the fellow ESCO businesses are not so high as it should be. The effectiveness of ESCO Business Association depends on what type of membership it would. Accountability for such criteria and objectivities of such criteria are especially important when the associations are to be established.

6.7.6. Securing Training Sites for ESCO Business Establishment

As discussed in 6.6.1, the action plan consists of two different targets of new and existing buildings. Among these actions, training for ESCO business establishment takes place at utilizing many existing building. The training provides trainees energy audit experiences of existing building and technical recommendations for improving energy use. In the past technical cooperation projects overseas, the effectiveness of practical EE&C training utilizing existing building has been confirmed. Securing appropriate number of training sites using existing building, therefore, is one of keys for successful implementation of the proposed technical cooperation project. The proposed project depends on energy audit and reporting experiences based on data analysis from the audit results from diverse building and facilities. In the Study, however, the site selection for the audit activities was a challenge for the team. Securing audit sites took much longer than it was expected. Based on such experience, it is important to see if appropriate number of training sites would be secured prior to the start of the proposed training for ESCO business establishment.

6.8. Relevancy of Establishment of the EE&C Training Center

6.8.1. Conformity with the Human Resources Development Strategy on EE&C Policy in Iran

As discussed in 2.4.2 and 2.4.3 promotion of EE&C is one of the priority areas of implementation of national development plans as well as EE&C laws. Particularly, human resources development for EE&C is one of prerequisites for promotion and effective implementation of EE&C. MOE recognizes such importance and it stresses the importance of establishing human resources training center aiming at EE&C based on the success of the technical cooperation project carried out by the government of Japan to National Training Center for Energy Management in Tabriz from 2003 to 2007. For that reasons, the proposed plan for establishment of the training center for EE&C has high level of relevancy.

6.8.2. Conformity with the Human Resources Development Strategy on EE&C Policy in Iran

The challenges of promotion of EE&C in the housing sector was analyzed and discussed in 3.5.3. Human resources development and the related issues are among the major obstacles in Iran. For that reason, emphasis on accelerating human resources development along with institutional development for EE&C may bring about achieving EE&C in the sector. The analysis in the master plan stresses that human resources development is one of the most effective strategies to choose. (see Figure 6.4-1) . In addition, the past experience in supporting promotion and dissemination of EE&C by Japanese Technical Cooperation Projects indicates that human resources development is the most important single issue which comes with the provision of incentives (and disincentives). EE&C for the building sector would be promoted when human resources development is simultaneously carried out with institutional development.

6.8.3. Use of Available Technical Seeds for EE&C Promotion

The education and training for EE&C promotion in Iran begins from the technical cooperation project in Tabriz to establish National Training Center for Energy Management assisted by Japan from 2004. The project was well-received by Iranian side and its effectiveness and results were acknowledged. The proposed training for EE&C for the building sector would be built upon the outcomes of the previous technical cooperation project. It would utilize intellectual resources including experiences, learning and network from the previous. As such, the proposed training would be relevant for the assets from the previous project shall be effectively utilized.