New Mechanism FS for Energy Saving at Buildings by Utilising Geothermal Heat Pump and Other Technologies in Mongolia

23rd January, 2012

Shimizu Corporation

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Shimizu's accomplishment on CDM, JI, and new mechanism

Year	Project Name	Host Country	Scheme	Sponsored by	UN Registration
2000	Study of Energy Saving for Improving Thermal Energy Efficiency in the Republic of Uzbekistan	Uzbekistan	CDM	NEDO	
2001	Energy Conservation and Efficiency Improvement by Introducing The Co-Generation System in Samarkand,	Uzbekistan	CDM	NEDO	
2001	Renovation and Rehabilitation of Didi Digomi District Heat Supply Plant in Tbilisi (Feasibility Study)	Georgia	CDM	NEDO	
2002	Introduction of Co-Generation System into District Heating System in Yerevan, Republic Armenia	Armenia	CDM	NEDO	
2002	Utilization of Mathane(CH4) Gas and Power Generation of Municipal Wastes in Yerevan Armenia	Armenia	CDM	NEDO	
2002	Feasibility Study on Development of Hydro Power Plant Project in Republic of Armenia	Armenia	CDM	JETRO	
2003	FIntroduction of Co-generation System into District Heating System in Dnepropetrovsk, Ukraine	Ukraine	JI	NEDO	
2003	Feasibility Study on Modernization of District Heating System in Bukhara, Republisc of Uzbekistan	Uzbekistan	CDM	NEDO	
2004	Feasibility Study on effective using of Landfill gas in Dnepropetrovsk, Ukraine	Ukraine	JI	NEDO	
2004	Nubarashen Landfill Gas Capture and Power Generation Project in Yerevan	Armenia	CDM	GEC	28-Nov-05
2004	Utilization of Mathane (CH4) Gas from sewage sludge and introdution of Co-generation in Dalian, China	China	CDM	GEC	
2005	Feasibility Study on Effective Using of Landfill Gas in Lugansk, Ukraine	Ukraine	JI	GEC	
2005	Akhangaran Landfill Gas Capture Project in Tashkent	Uzbekistan	CDM	NEDO	19-Dec-09
2006	Feasibility Study on Effective Using of Landfill Gas in Poltava, Ukraine	Ukraine	JI	NEDO	
2006	Feasibility Study on Effective Using of Landfill Gas in Gyumri and Vanadzor, Armenia	Armenia	CDM	NEDO	
2006	Effective Using of Methane Gas from Sludge Field at the Waste Water Treatment Plant in Kiev, Ukraine	Ukraine	JI	GEC	
2005	Landfill Gas Capture and Power Generation Project in Tbilisi	Georgia	CDM	NEDO	06-Apr-07
2006	Feasibility Study on Effective Using of Landfill Gas in Amman, Jordan	Jordan	CDM	GEC	
2006	Feasibility Study on Effective Using of Landfill Gas in Skopje, Macedonia	Macedonia	CDM	GEC	
2006	Feasibility Study on Effective Using of Landfill Gas in Zhitomir, Ukraine	Ukraine	JI	GEC	
2007	Feasibility Study on Effective Using of Landfill Gas in Al Akidar, Jordan	Jordan	CDM	GEC	
2007	Feasibility Study on Effective Using of Landfill Gas in Belaya Tserkov, Ukraine	Ukraine	JI	GEC	
2007	Feasibility Study on Effective Using of Landfill Gas in Indonesia	Indonesia	CDM	NEDO	
2008	Dir Baalbeh Landfill Gas Capture Project in Homs, Syria	Syria	CDM	-	16-Mar-09
2008	Tal Dman Landfill Gas Capture Project in Aleppo, Syria	Syria	CDM	-	25-Sep-09
2008	Piyungan Landfill Gas Capture Project in Yogyakarta	Indonesia	CDM	-	01-Jan-10
2008	Effective use of the waste gas emitted from ammonia production plant in Syria	Syria	CDM	GEC	
2009	Catalytic N2O abatement project in the tail gas of the nitric acid production plant in G.F.C, Syria	Syria	CDM	-	4-Apr-11
2010	Programme CDM for Palm Oil Mills Waste to Energy Project under the Ministry of National Companies, Indonesia	Indonesia	CDM	NEDO	
2010	Sustainable Peatland Management in Indonesia	Indonesia	NAMA	GEC	
2011	Program exploration research of Biomass Boiler Power Generation Project in State-owned Palm Oil Mills , Indonesia	Indonesia		NEDO	
2011	New Mechanism FS for Avoidance of Peat Aerobic Degradation and Rice Husk-based Power Generation in Jambi Province, Indonesia	Indonesia		GEC	
2011	**New Mechanism FS for Energy Saving at Buildings by Utilising Geothermal Heat Pump and Other Technologies in Mongolia**	**Mongolia**		**GEC**	

Shimizu's real CDM projects in Armenia and Uzbekistan

ARMENIA

"NUBARASHEN LANDFILL GAS CAPTURE AND POWER GENERATION PROJECT IN YEREVAN"
REF. NO. 0069

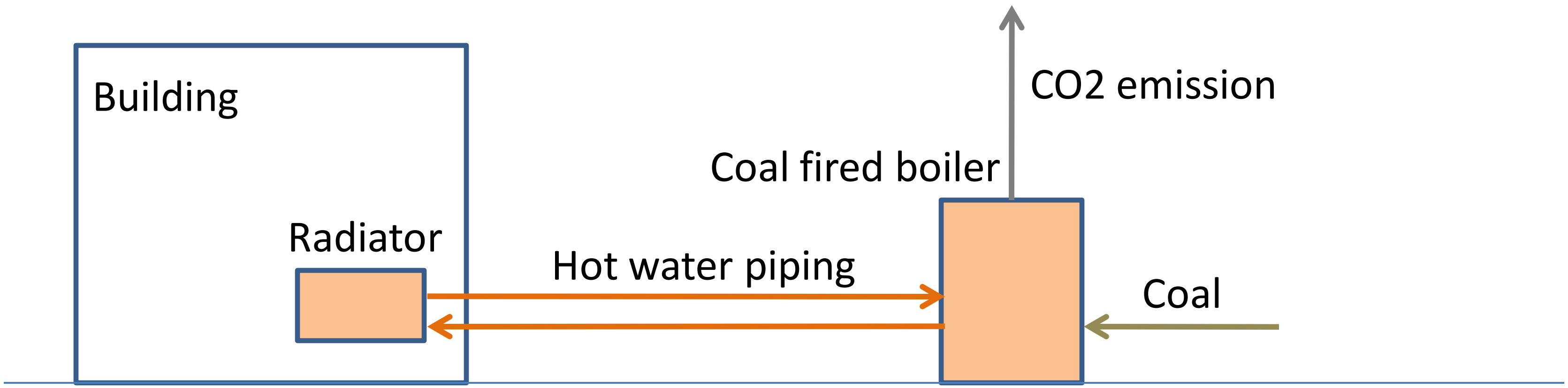
UZBEKISTAN

"AKHANGARAN LANDFILL GAS CAPTURE PROJECT IN TASHKENT"
REF. NO. 2750

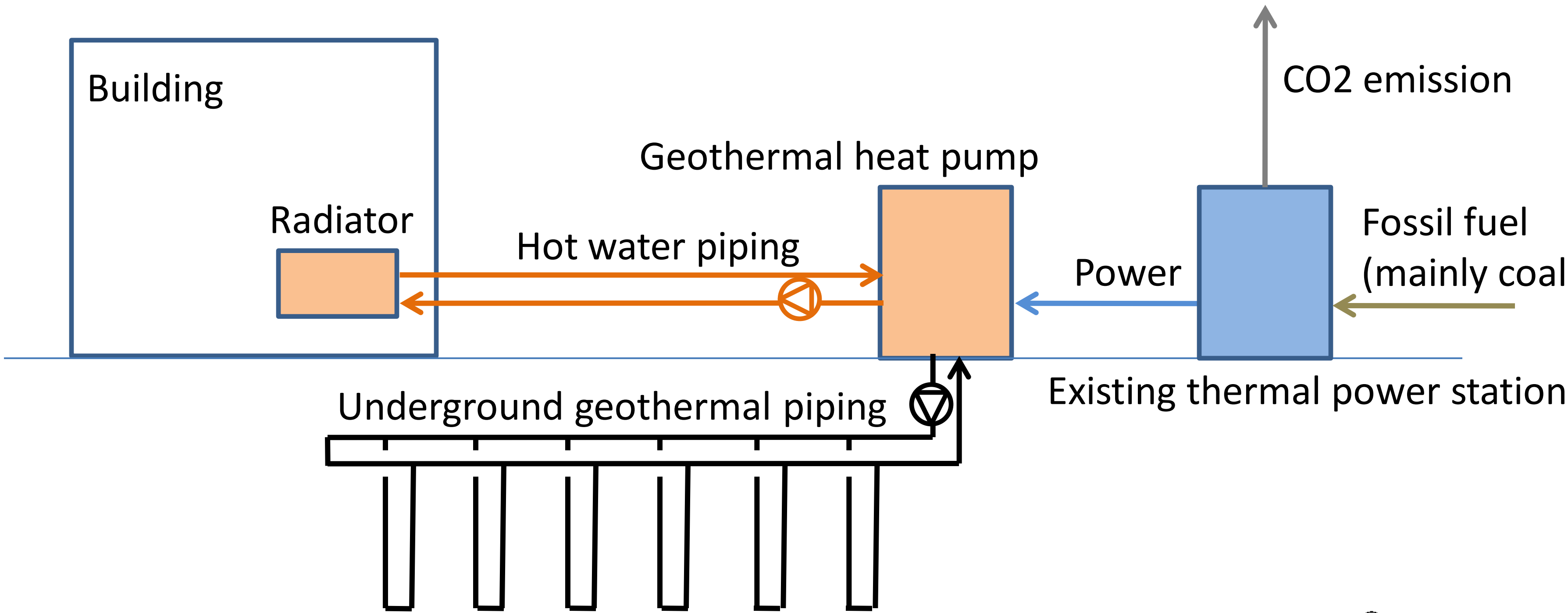
Project activity and scope of the FS

This study intends to find out the feasibility of projects that applies Japan’s energy saving technologies such as **geothermal heat pump and solar power generation** to, especially, **public buildings** at soum and aimag center through new credit mechanism (“New mechanism” or “**Bilateral mechanism**”).

Planned technology to be applied (present situation)

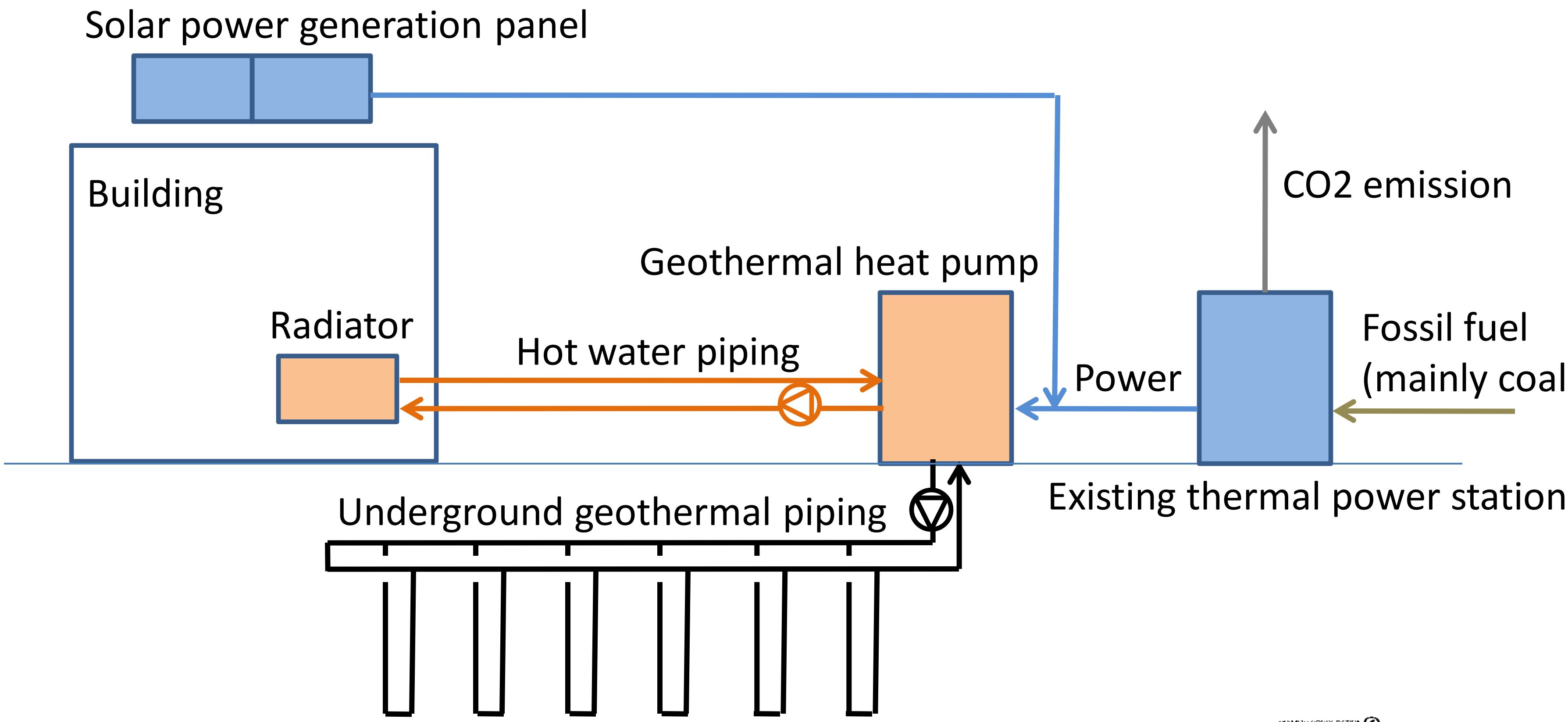


Planned technology to be applied (option 1)



Project activity and scope of the FS

Planned technology to be applied (option 2)



Why emission is reduced?

- **<u>Target buildings</u>**: public buildings at aimag/soum centers, such as administration, school, kindergarten, hospital, dormitory, etc.
- **<u>Present practice of heating system</u>**: heat only boilers (HOBs) fueled by coal are used. Their thermal efficiency is quite low (40-45%).
- **<u>Project activity envisaged (option 1)</u>** : replacing HOBs with geothermal heat pumps with high efficiency.
- **<u>Project activity envisaged (option 2)</u>** : replacing power generated by coal fired thermal power plants with power generated by solar energy.
- **<u>Why emission is reduced?</u>**: Both option 1 and 2 can reduce coal consumption.

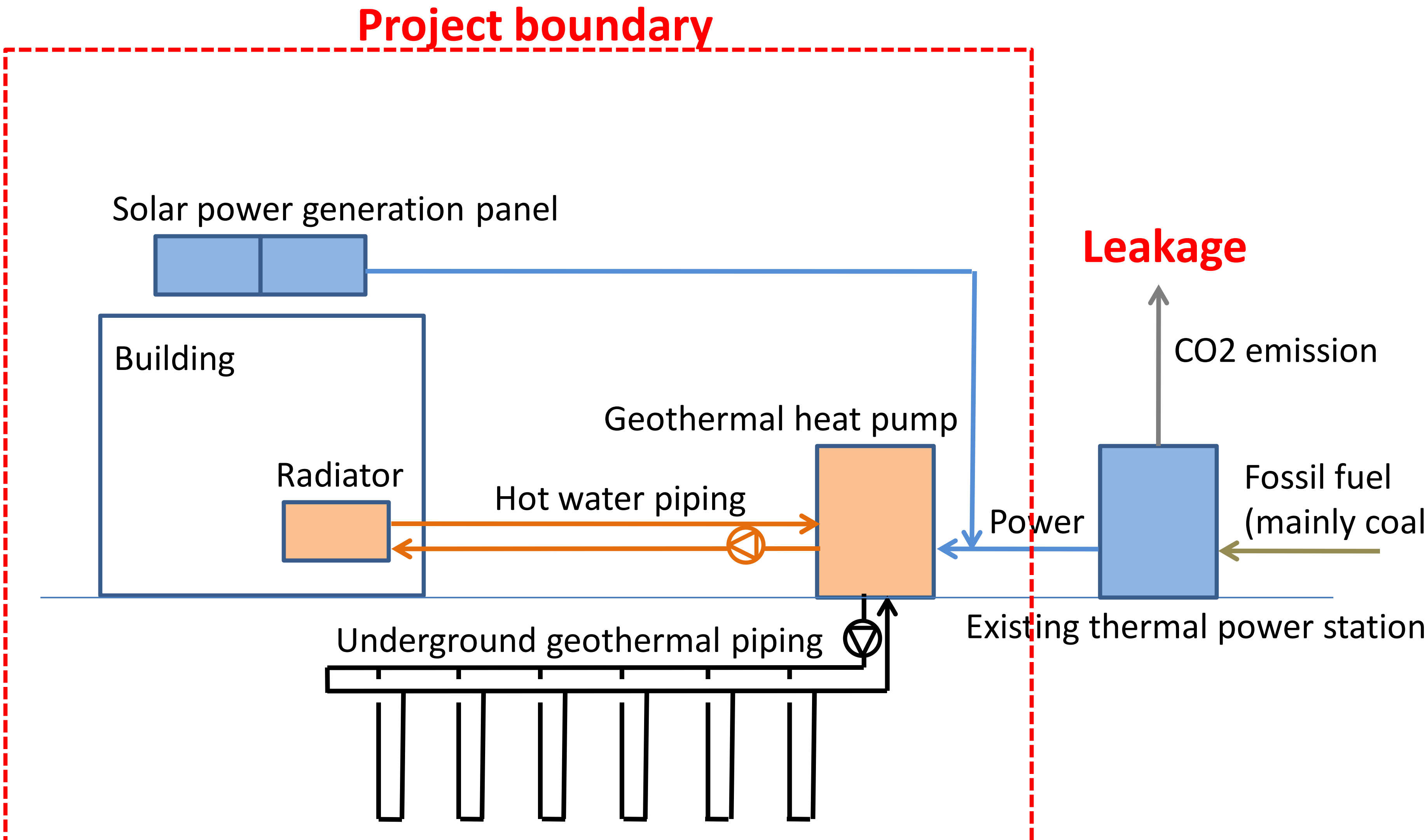
Reference scenario, Scenario analysis

- **Scenario analysis**: In order to show the present practice is the reference (baseline) scenario, scenario analysis was implemented. Some candidate scenarios was on the table, and was analyzed. Not only qualitative but also quantitative analysis such as economic analysis and reflection of policy was implemented.
- **Identification of reference scenario**: After the analysis, continuation of present practice was identified as the reference scenario.

Reference scenario, Scenario analysis

No.	Scenarios	Result of scenario analysis
1	Maintaining the status quo (=continuing using inefficient coal fired boilers (efficiency=40%))	There is no particular barrier. This is the reference scenario.
2	Replacing present inefficient coal fired boilers with efficient ones.	There is an investment barrier, because IRR of this scenario is not acceptable.
3	Replacing present inefficient coal fired boilers with district heating from TPP.	District heating is not available in local towns we are focusing on.
4	Replacing present inefficient coal fired boilers with electric heaters.	There is an investment barrier, because price of power is higher than that of coal.
5	Replacing present inefficient coal fired boilers with oil fired ones.	There is an investment barrier, because price of oil is higher than that of coal.
6	Replacing present inefficient coal fired boilers with gas fired ones.	Generally, gas is not available in Mongolia.
7	Replacing present inefficient coal fired boilers with biomass fired ones.	Wood and livestock excretion may be available, but they are not enough for heating public buildings.
8	Replacing present inefficient coal fired boilers with air source heat pumps.	There is a technological barrier, because it is too cold in Mongolia for air source heat pumps to be operated.
9	Replacing present inefficient coal fired boilers with water source heat pumps.	There is a technological barrier, because rivers and lakes freeze in winter season.
10	Replacing present inefficient coal fired boilers with soil source (geothermal) heat pumps.	There is an investment barrier, because price of power is higher than that of coal.

Project boundary

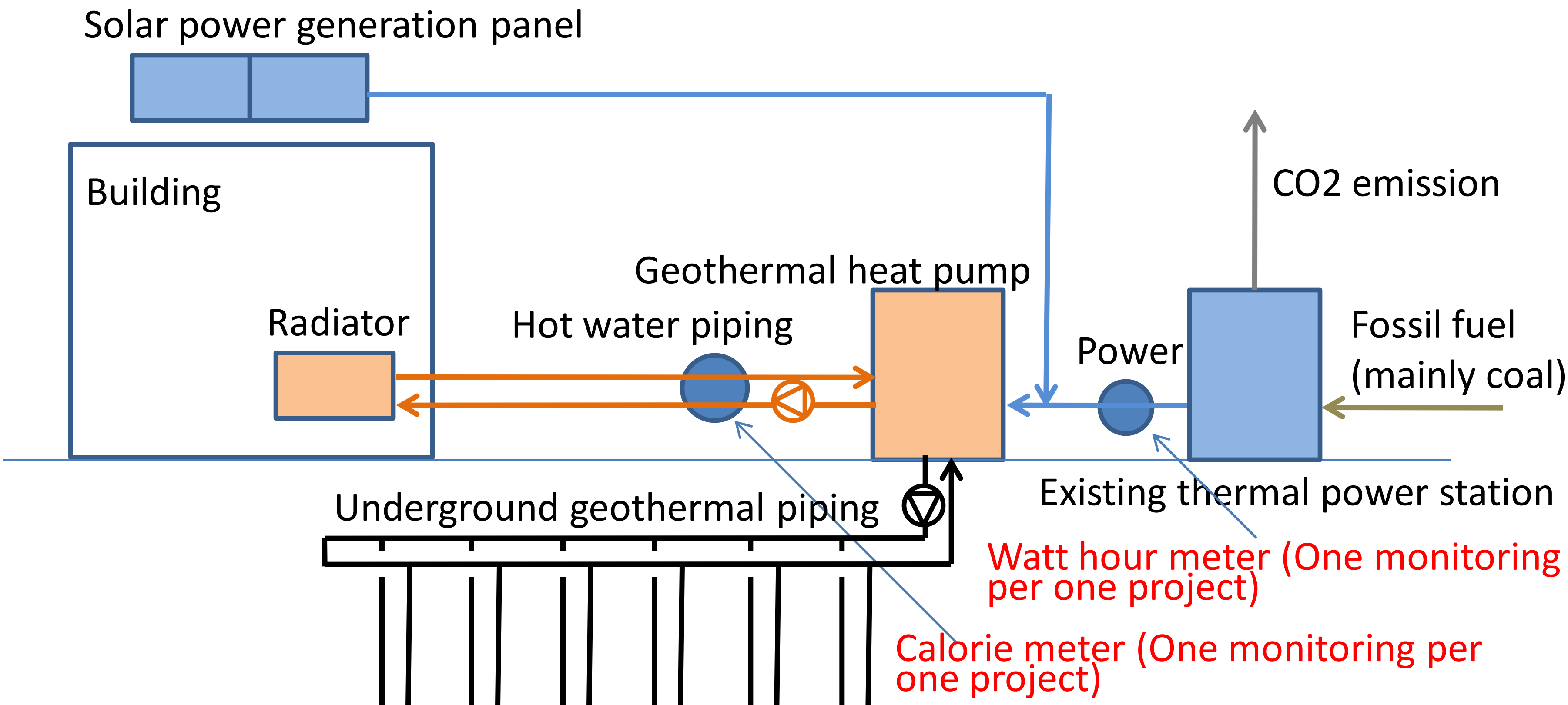


Monitoring plan

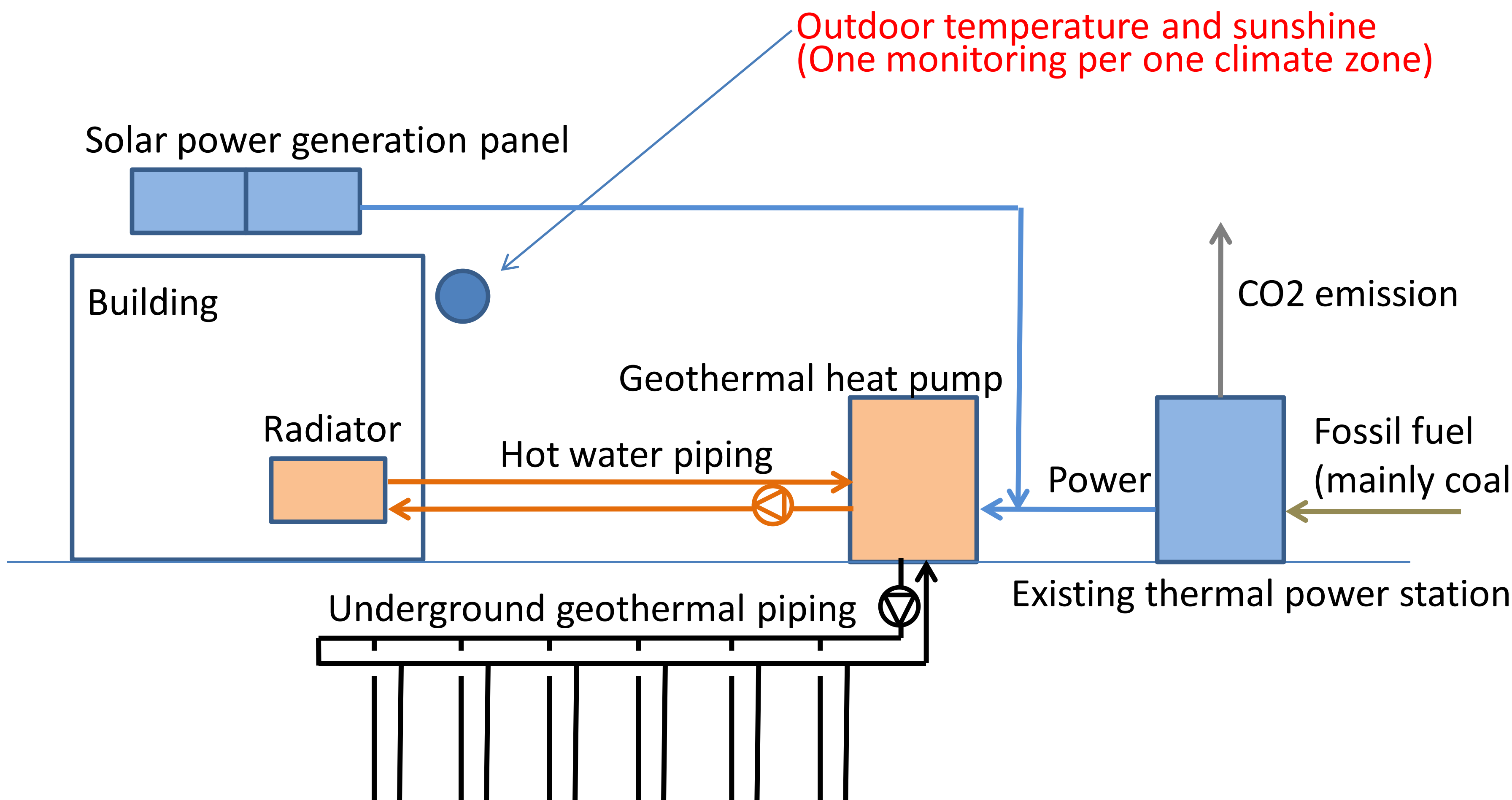
Plan	In case of option 1	In case of option 2
A: Strictest monitoring Most accurate, but most expensive (We don’t recommend this plan.)	Monitoring calorie of heat pump output and gird power consumed by heat pump at all sites	Same as on the left
B: Easiest monitoring Most inaccurate, but cheapest	Emission reduction is as same as application documents (No actual monitoring is implemented)	Same as on the left
C: Moderate monitoring Less accurate, but better than B	Monitoring outdoor temperature at each climate zone Emission reduction is calculated based on “degree-day”	Monitoring outdoor temperature and sunshine at each climate zone Emission reduction is calculated based on “degree-day” and sunshine
D: C modified by A Less accurate, but better than C	Emission reduction is calculated based on plan C, but modified conservatively based on actual monitoring data (based on plan A) at each climate zone	Same as on the left

Monitoring plan

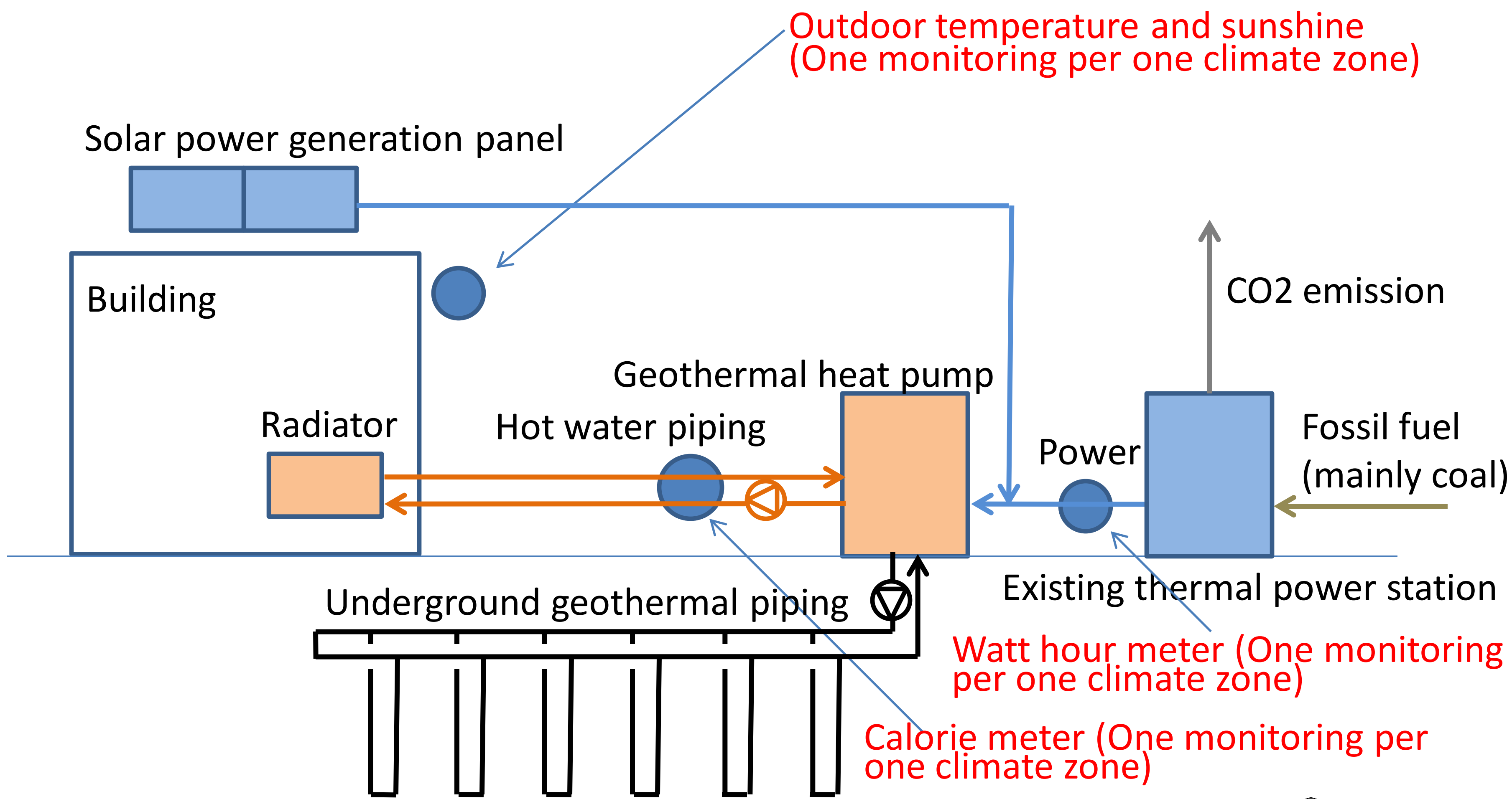
A: Strictest monitoring



C: Moderate monitoring



D: C modified by A



Monitoring plan
(How to calculate emission reduction based on monitored data)

Plan	In case of option 1	In case of option 2
A: Strictest monitoring Most accurate, but most expensive (We don't recommend this plan.)	Baseline emission =calorie/boiler efficiency*emission factor of coal Project emission =consumed power*emission factor of grid	Baseline emission= calorie/boiler efficiency*emission factor of coal Project emission =net consumed power*emission factor of grid
B: Easiest monitoring Most inaccurate, but cheapest	Equal to the emission reduction that is calculated ex-ante and indicated in the application form *(No actual monitoring is implemented)*	Same as on the left
C: Moderate monitoring Less accurate, but better than B	Baseline emission =degree day*standard baseline emission/standard degree day Project emission =degree day*standard project emission/standard degree day *(Standard emission shall be calculated ex-ante.)*	Baseline emission =degree day*standard baseline emission/standard degree day Project emission =degree day*standard project emission/standard degree day-sunshine/standard generation/standard sunshine*emission factor of grid *(Standard emission shall be calculated ex-ante.)*
D: C modified by A Less accurate, but better than C	If the emission reduction based on A (ERA) is smaller than the emission reduction based on C (ERC) at the site where both A and C are applied as the representing value of each climate zone, emission reduction of all the other sites in the same climate zone shall be reduced conservatively as is indicated below. Reduced mission reduction=emission reduction based on C*ERA/ERC	

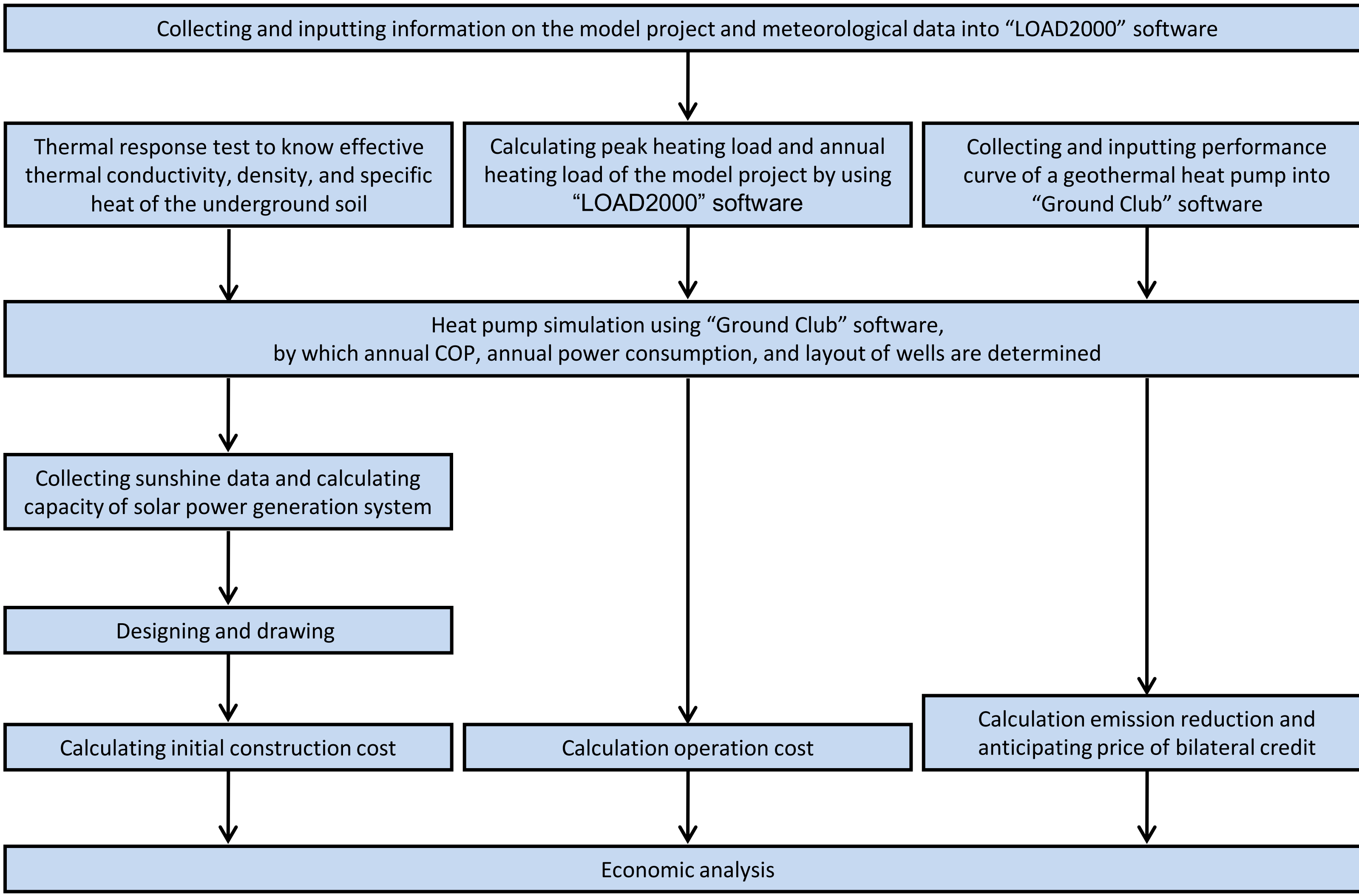
Study on MRV system

➢**Existing MRV system**: CDM and ISO has their own MRV system that is in place.

➢**Future MRV system**: COP will discuss and decide a guideline on MRV system for developing countries who would like to be supported by developed countries. But there seems no noticeable progress.

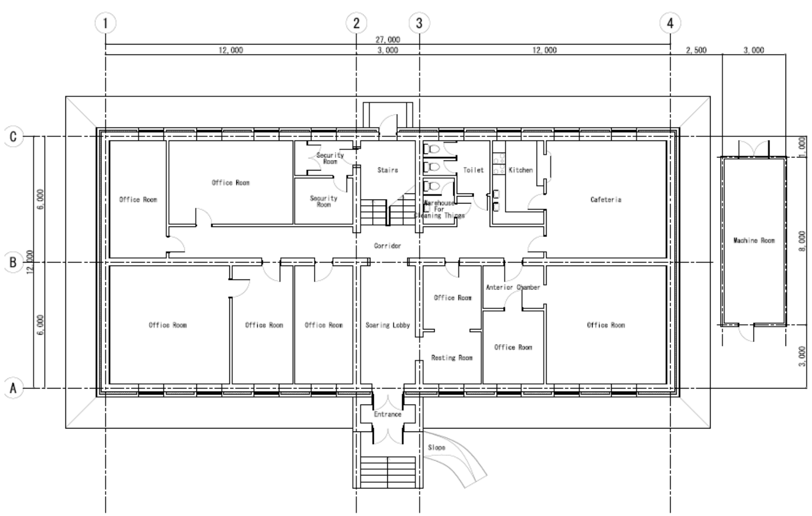
➢**MRV system for bilateral mechanism**: MRV system for bilateral mechanism shall be simpler than MRV system for CDM. In this regard, concept of ISO can be applied to bilateral mechanism. For example, a project shall identify baseline scenario, monitoring plan, and how to calculate emission reduction. And a project shall be validated and verified by a third party such as DOE/AIE for the purpose of securing transparency.

Planning of a model project/How to plan

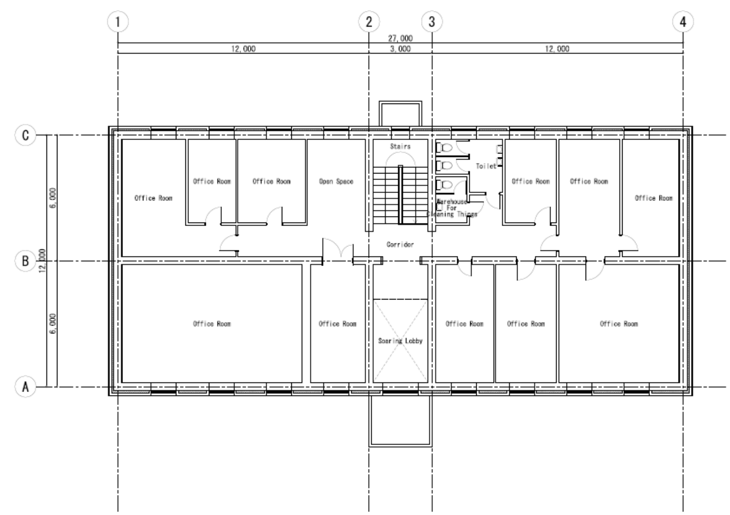


Planning of a model project/Calculation of heating load

Item	Value per one model project
Total floor area	657m^2
Number of floors	2floors
Heating period	from 16th September until 15th May
Room temperature	20degree C
Peak heating load	48.4kW
Annual heating load	143,807kWh/year=218.9kWh/yearm^2



First floor plan)



Second floor plan S:1

Planning of a model project/Thermal response test

Item	Value of the model project
Period	from 3rd October, 2011 until 12th October, 2011
Density of soil	2,200kg/m^3
Specific heat of soil	712J/kgK
Effective thermal conductivity	2.403 W/mK

Drilling work

Thermal response test

Planning of a model project/Heat pump simulation/solar power

Item	Value per one model project
Annual average COP	2.6
Annual power consumption excluding antifreeze liquid circulation pump	55,909kWh/year
Annual power consumption including antifreeze liquid circulation pump	56,840kWh/year
Number of wells and depth	100m*14
Distance between wells	10m
Specification of underground pipe	outer diameter 27mm, inner diameter 21mm, high density polyethylene pipe
Annual average sunshine	4.95kWh/m^2/day
Power generation capacity	50kW
Number of panels (module)	230W*220module

Planning of a model project/Emission reduction

Item	Value per one soum/aimag center	Potential value all over Mongolia
Typical heating load in Mongolia	218.9kW/m2/year	218.9kW/m2/year
Typical efficiency of coal fired boiler in Mongolia	40～45%	40～45%
COP of heat pump	2.6	2.6
Emission factor of coal	0.0258tonC/GJ	0.0258tonC/GJ
Emission factor of power grid in Mongolia	1.15tonCO2/MWh	1.15tonCO2/MWh
Total area of public buildings in rural area in Mongolia	3,940m2	1,300,000m2
Baseline emission	218.9/0.40～0.45*0.0258*44/12 *3,940*0.0036GJ/kWh =653～734tonCO2/year	218.9/0.40～0.45*0.0258*44/12 *1,300,000*0.0036GJ/kWh =215,000～242,000tonCO2/year
Project emission (option1)	218.9/2.6*1.15*3,940 /1,000kWh/MWh =332tonCO2/year	218.9/2.6*1.15*1,300,000 /1,000kWh/MWh =126,000tonCO2/year
Project emission (option2)	0tonCO2/year	0tonCO2/year
Emission reduction (option 1)	**321～402tonCO2/year**	**90,000～116,000tonCO2/year**
Emission reduction (option 2)	**653～734tonCO2/year**	**215,000～242,000tonCO2/year**

Planning of a model project/Economic analysis

	OPTION 1 Value per one model project	OPTION 2 Value per one model project	UNIT
Running Cost (Baseline)	1,421	1,421	US$/Year
Running Cost (Project)	3,533	3,533	US$/Year
Electric Power Sales Income	0	8,526	US$/Year
Reduction of Running Cost	▲2,132 (Increase)	6,394	US$/Year
Initial Investment Cost	456,190	982,371	US$
Reduction of GHG Emission	57	122	t-CO2e/year
Supposed Price of Bilateral Credit	7.0	7.0	US$/ton
Credit Sales Income	400	857	US$/Year

Co-benefit effects

➢**Co-benefit**: Other than CO_2 emission reduction, air pollutants can be reduced, because this project can reduce consumption of coal. Here is the potential co-benefit effect all over Mongolia.

Scenario	Pollutant	Emission factor	Consumption of coal	Pollutant emission	Emission reduction
-	-	kg/ton	ton/year	ton/year	ton/year
Reference scenario	PM10	16.20	179,949	2,915	-
	PM2.5	9.72	179,949	1,749	-
	SO2	10.90	179,949	1,961	-
Project scenario	PM10	1.87	93,468	175	2,740
	PM2.5	0.75	93,468	70	1,679
	SO2	10.00	93,468	935	1,027

Contribution to sustainable development

➢ **<u>National Renewable Energy Program</u>**

It is stipulated to gradually implement goal in increasing percentage share of renewable energy production and reach 3-5 percent share in the national energy by the year 2010, 20-25 percent share by 2020.

➢ **<u>National Action Program on Climate Change</u>**

It is stipulated to exploit solar, geothermal energies in heating of houses and hot water supply.

➢ This Project will contribute to achieve the above mentioned goal and implement the program.

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