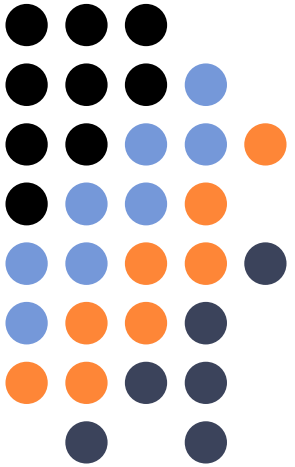
Fuel Switch & Energy Efficiency CDM Project Case Study

Prepared for 2nd Training Program Session

May 20, 2011

JICA CDM Expert Team



Objective & Content

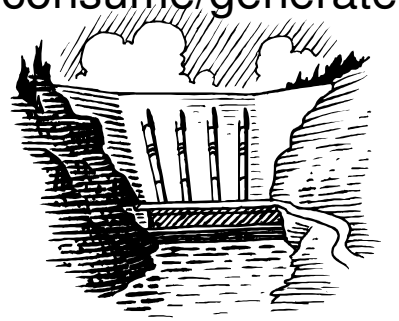
Content:

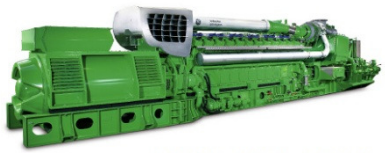
- Scale of Energy Saving & Fuel Change
- What is Fuel Change project?
- What is Energy Saving project?
- Case Study

Objective: **? & !**

0. Before Step Into CDM

Be familiar with the unit of energy to have a scale.
How much energy do they consume/generate??





	Fukushima 1	Hydro Power	Gas Engine	Household
Capacity	460,000 kW	25,000 kW	312 kW	0.48 kW
Runtime	6,000 hours	4,800 hours	4,000 hours	8,760 hours
Power	MWh	MWh	MWh	MWh
Heat (MJ)	x 10^6 MJ	x10^6 MJ	x10^6 MJ	x 10^6 MJ
Energy(TOE)	x 10^3 TOE	x 10^3 TOE	x 10^3 TOE	x 10^3 TOE

Calculate and fill the table.
1kWh =3.6 MJ
1 TOE =41.686 GJ
1kcal = 4,166J

kilo	mega	giga	tera	peta
k	M	G	T	P
10^3	10^6	10^9	10^{12}	10^{15}

Fukushima 1

460,000kW x 6,000 hours

= 276 x 10^7 kWh

= 276 x 10^4 MWh

(1MWh =1,000kWh = 10^3kWh)

= 2,760,000 MWh

276 x 10^7 kWh x 3.6 MJ/kWh

= 993.6 x 10^7 MJ

= 9,936 x 10^6 MJ

9,936 x 10^6 MJ ÷ 41.686GJ/TOE

= (9,936,000 x 10^3 GJ) ÷ 41.686GJ/TOE

= 238.353 x 10^3 TOE

Hydro Power Station

25,000kW x 4,800hours

= 1,200 x 10^5 kWh

= 120 x 10^3 MWh

1,200 x 10^5 kWh x 3.6MJ/kWh

= 4,320 x 10^5 MJ

= 432 x 10^6 MJ

432 x 10^6MJ ÷ 41.686GJ/TOE

= (432 x 10^3 GJ) ÷ 41.686GJ/TOE

= 10.36 x 10^3 TOE

Gas Engine

312kW x 4,000hours

= 1,248 x 10^3 kWh

= 1,248 MWh

1,248 x 10^3 kWh x 3.6 MJ/kWh

= 4,492 x 10^3 MJ

4,492 x 10^3 MJ ÷ 41.686 GJ/TOE

= (4.492 x 10^3 GJ) ÷ 41.686 GJ/TOE

= 107.9 TOE

= 0.108 x 10^3 TOE

Household

0.48 kW x 8,760 hours

= 4,204.8 kWh

= 4.20 MWh

4.200kWh x 3.6 MJ/kWh

= 15,120 MJ

= 0.015 x 10^6 GJ

= 15 x 10^3 GJ

15 x 10^3GJ ÷ 41.686 GJ/TOE

= 0.0032 x 10^3 TOE

1kcal =4,166J

SmartEnergy

0. Before Step Into CDM

Be familiar with the unit of energy to have a scale.
How much energy do they consume/generate??

	Fukushima 1	Hydro Power	Gas Engine	Household
Capacity	460,000 kW	25,000 kW	312 kW	0.48 kW
Runtime	6,000 hours	4,800 hours	4,000 hours	8,760 hours
Power	2,760,000 MWh	120,000 MWh	1,248 MWh	4.20 MWh
Heat (MJ)	9,936 x 10^6 MJ	432 x10^6 MJ	4.5 x10^6 MJ	0.015 x 10^6 MJ
Energy(TOE)	2,383.5 x 10^3 TOE	10.4 x 10^3 TOE	0.108 x 10^3 TOE	0.0032 x 10^3 TOE

Calculate and fill the table.
1kWh =3.6 MJ
1 TOE =41.686 GJ
1kcal = 4,166J

kilo	mega	giga	tera	peta
k	M	G	T	P
10^3	10^6	10^9	10^{12}	10^{15}

0.Emission Factors of Major Energy Sources

Fuel	Heat Value	COEF	EF	Gravity	
	TJ/MT	tCO2/TJ	tCO2/MT	t/m3:t/kl	
Furnace Oil	0.0410	77.4		0.972t/kl	tCO_2/kl
Diesel Oil	0.0433	74.1		0.846t/kl	tCO_2/kl
Residual Oil	0.0410	77.4		0.972t/kl	tCO_2/kl
Coal	0.0293	101.0		1.300t/m^3	tCO_2/t
LPG	0.0502	63.1	3.168		$3.168tCO_2/kg$
Natural Gas	0.0411	64.2	2.639		*$2.108kgCO_2/Nm^3$*
Grid Electricity					$0.686tCO_2/MWh$

Data source
1. Energy Data 2007, Sustainable Energy Authority
2. IPCC Guideline for National Greenhouse Gas Inventories, 2006, Table 1-4
3. Natural Gas's gravity data was not available and utilized Japanese data for reference purposes. Nm^3 is a unit of gas under normal state.

0.Emission Factors of Major Energy Sources

Fuel	Heat Value	COEF	EF	Gravity	
	TJ/MT	tCO2/TJ	tCO2/MT	t/m3:t/kl	
Furnace Oil	0.0410	77.4	3.173	0.972t/kl	3.264tCO_2/kl
Diesel Oil	0.0433	74.1	3.209	0.846t/kl	3.793tCO_2/kl
Residual Oil	0.0410	77.4	3.173	0.972t/kl	3.264tCO_2/kl
Coal	0.0293	101.0	2.816	1.300t/m^3	3.661tCO_2/t
LPG	0.0502	63.1	3.168		3.168tCO_2/kg
Natural Gas	0.0411	64.2	2.639		*2.108kgCO_2/Nm^3*
Grid Electricity					0.686tCO_2/MWh

Data source
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More Questions

Question A:

A volume of steel drum is 200litres.

① Calculate CO_2 emissions by combusting a full of furnace oil in steel drum . Also calculate heat value, one can derive from this combustion. heat value of fuel shall be derived as a product of unit heat value and gravity of fuel.

② Calculate how many kg of coal do you need to burn, if you earn same amount of heat? Also calculate CO_2 emissions from this coal combustion.

Still More Questions

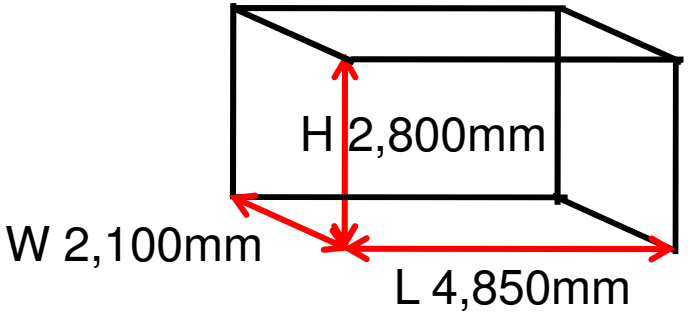
Question B:

A factory is introducing sawdust alternate for furnace oil.

A dimension of cargo box of 4 tone loading truck(photo) is shown in figure below. A density of saw dust is 1.51kg/m^3 and unit heat value is 2000kcal/kg.

① Calculate heat and CO_2 emissions by combusting full cargo load of saw dust.

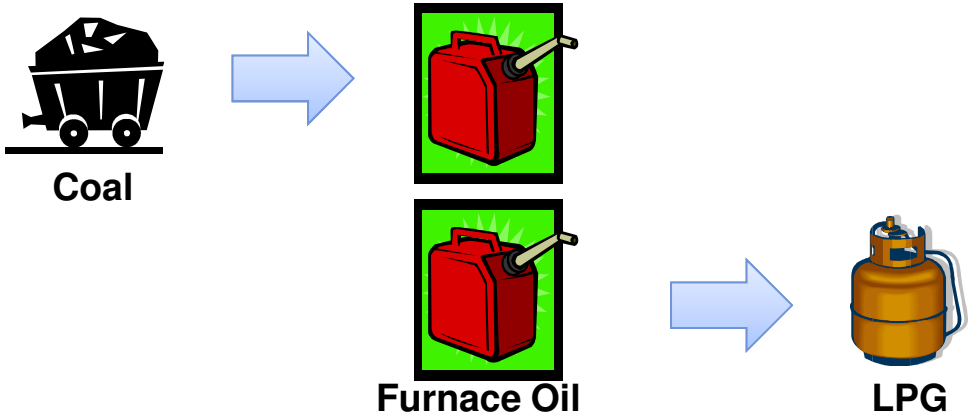
② Calculate how much furnace oil can replaced by amount of sawdust calculated in QB-1.

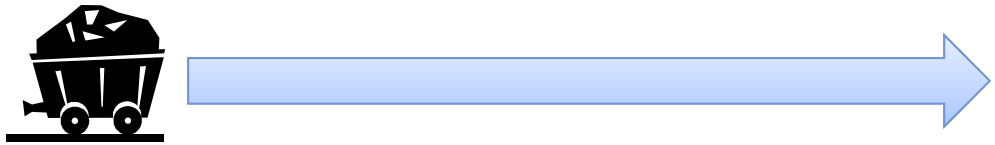


1. What is Fuel Switching?

Other Energy Efficiency Measures

Boiler Replacement, Efficient Motors





Fuel switch measures in this category will replace carbon-intensive fossil fuel with a less-carbon-intensive fossil fuel, whereas a switch from fossil fuel to renewable biomass is categorized as “renewable energy”.

Biomass Fuel

In Reality….

Number of CDM project registered and issued CER.

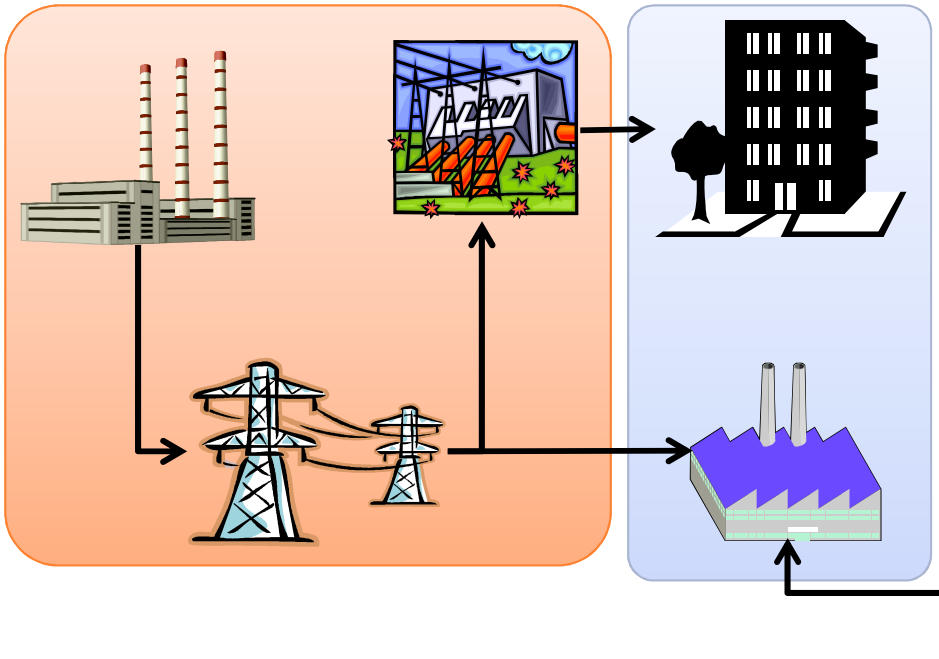
	On Track	Registered	Issued	CER %
Total	71	57	---	
Coal to NG	9	5	3	65%
Coal to Oil	0	0	0	
Lignite to NG	0	0	0	
New NG plant*	30	26	14	42%
New NG plant utilize LNG	1	8	3	74%
Oil to Electricity	2	0	0	
Oil to LPG	1	0	0	
Oil to NG	28	18	13	100%

*AM0029: Grid Connected electricity generation plants using natural gas is widely used in high performance combined cycle gas pwer generation projects in China and in India.

2. What is Energy Efficiency project?

Energy Efficiency Project

The category energy efficiency includes all measures aiming to enhance the energy efficiency of a certain system. Due to the project activity, a specific output or service requires less energy consumption. Waste energy recovery is also included in this category.



Supply Side Energy Efficiency

Power supplier and distributer implement energy efficiency measures, inc. auxiary power –gen.

Heat recovery Combined cycle

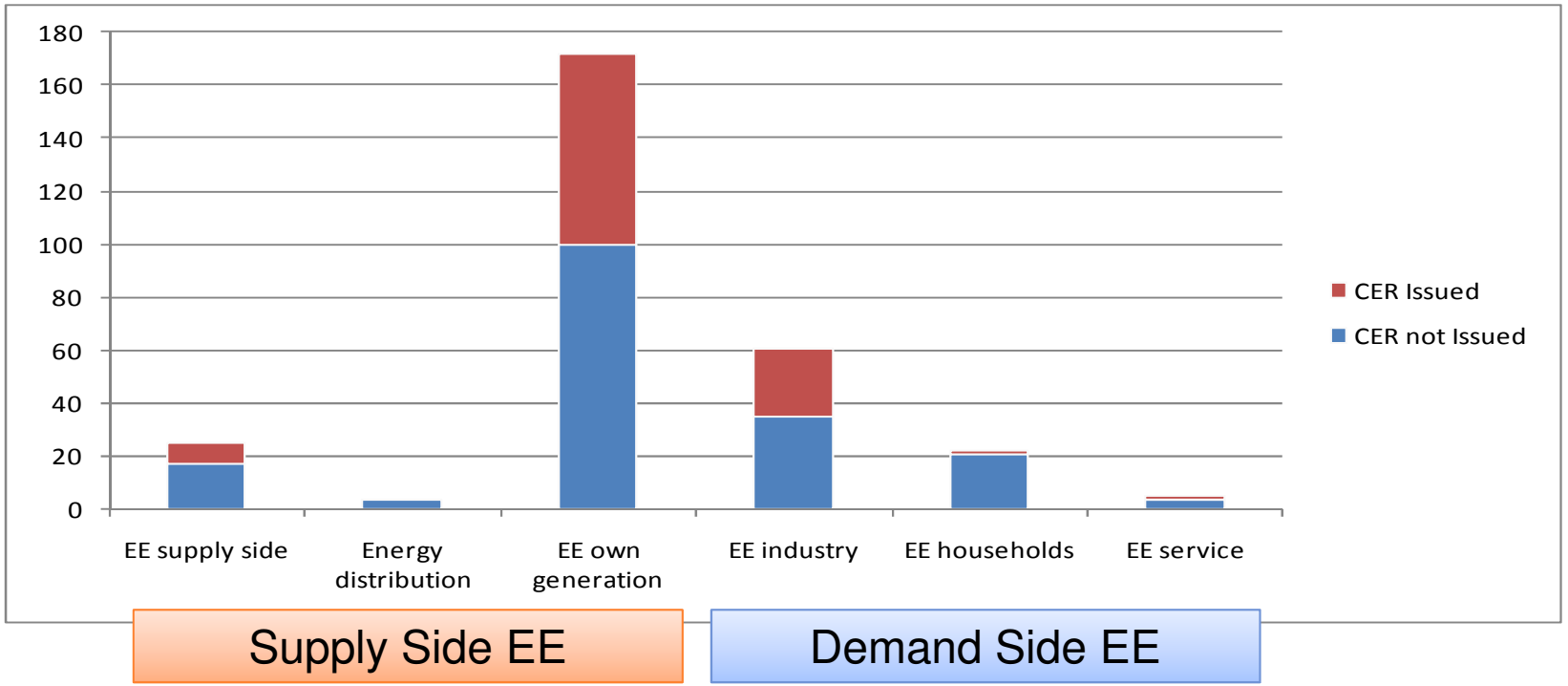
•Rehabilitation of power station Smart grid

Demand Side Energy Efficiency

the adoption of energy-efficient equipment, lamps, ballasts, refrigerators, motors, fans, air conditioners, appliances in many sites. inc. BEMS(building Energy management System).

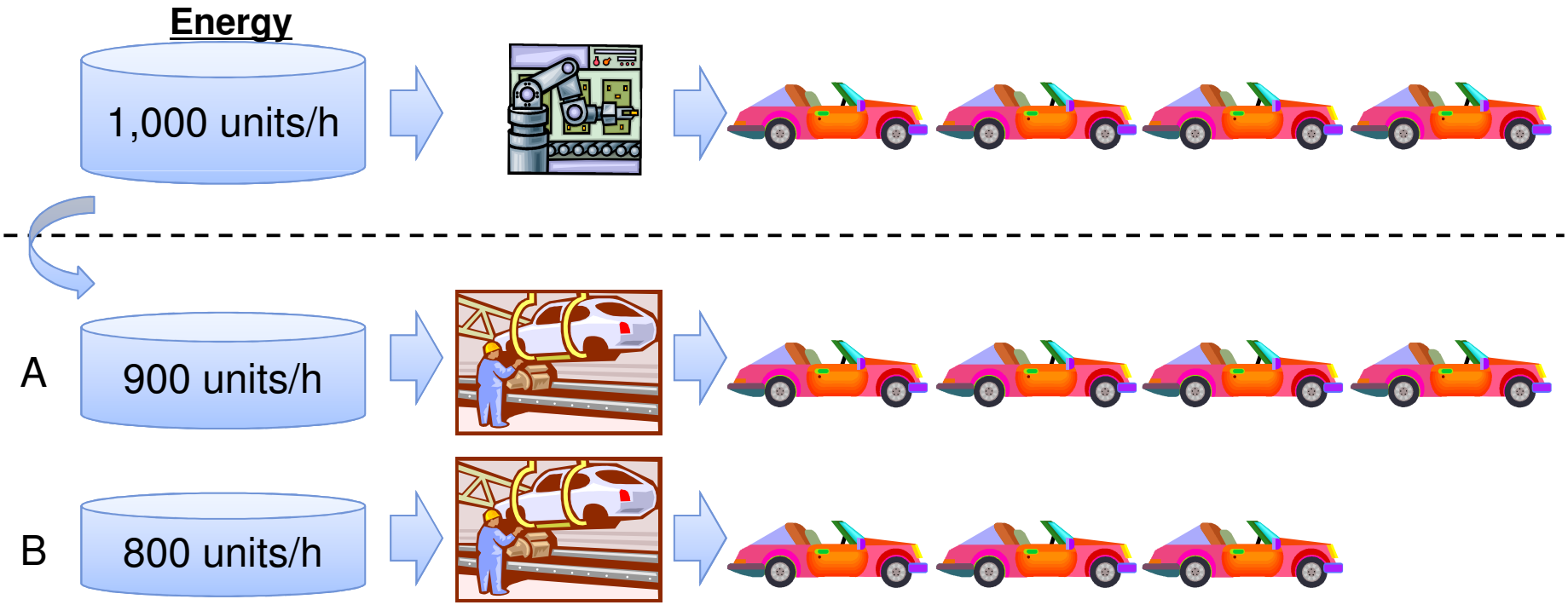
2. Energy Efficiency Statistics

- As of May 2011, there are 289 registered Energy Efficiency CDM projects.
- Of which 88 projects are demand side energy efficiency projects and the rest are supply side (including transmission) energy efficiency projects.
- Of all the registered energy efficiency CDM,108 projects have issued CER.



2. Key Insight of Energy Efficiency Project

In project, the output has to be maintained before and after the energy efficiency project



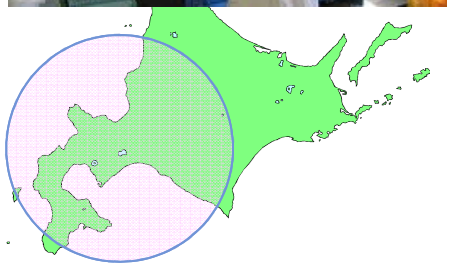
Which is “energy efficient”??

3. Case: Project in Laundromat Services

The company is locates in northern Japanese island. The facility receives linens and daily laundry through retail shops within 150km area's hotels, restaurants an households. The facility used heavy oil combustion boiler for 20 years. The regional natural gas catering company extends the pipeline to the neighborhood and connects to the company's facility.

The project has four components including,

a) Replacing fuel from heavy oil to natural gas.
b) Replace lamps to high efficient LEDs.

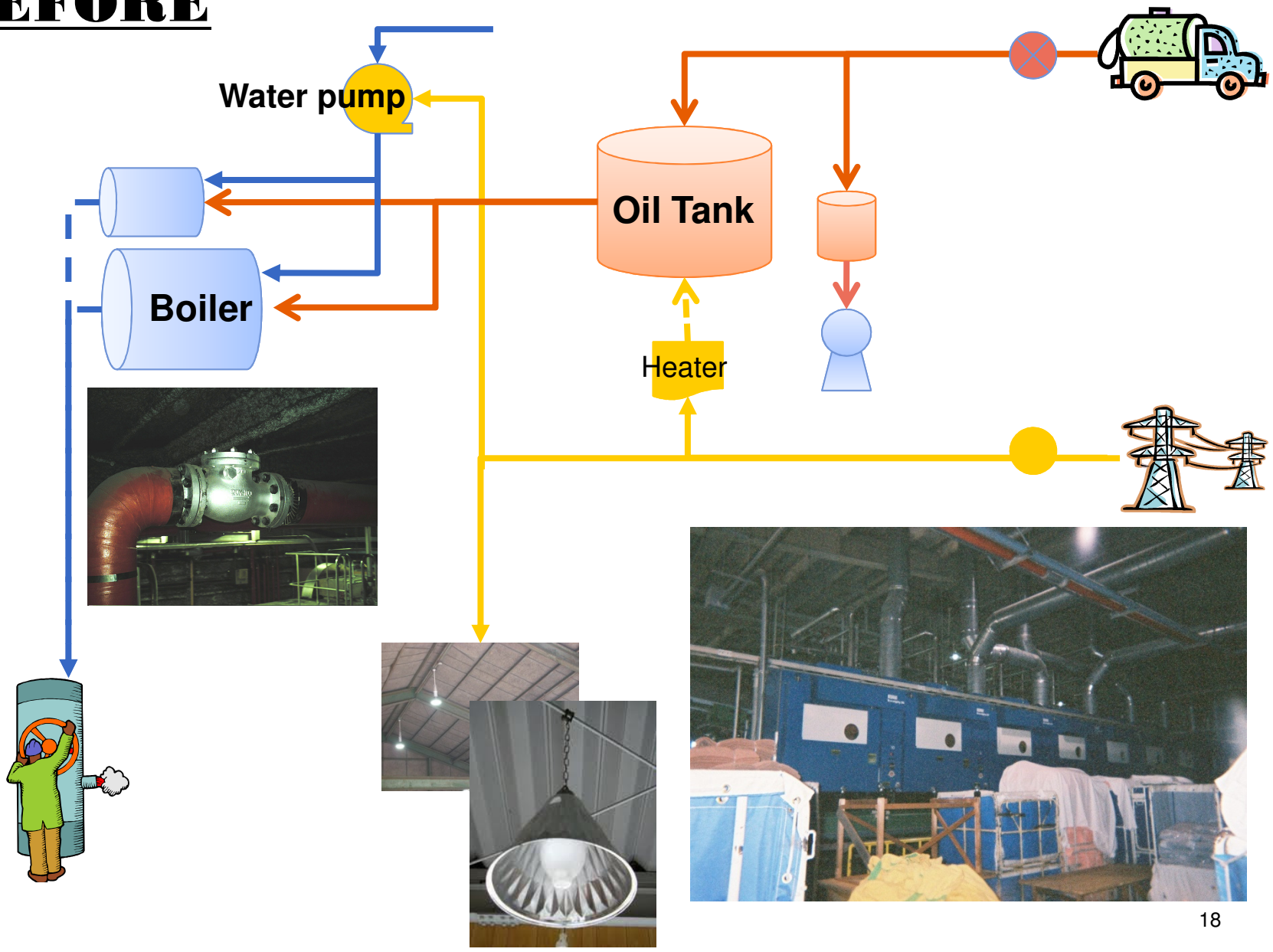


3. Case: Project in Laundromat Services (Cont'd)

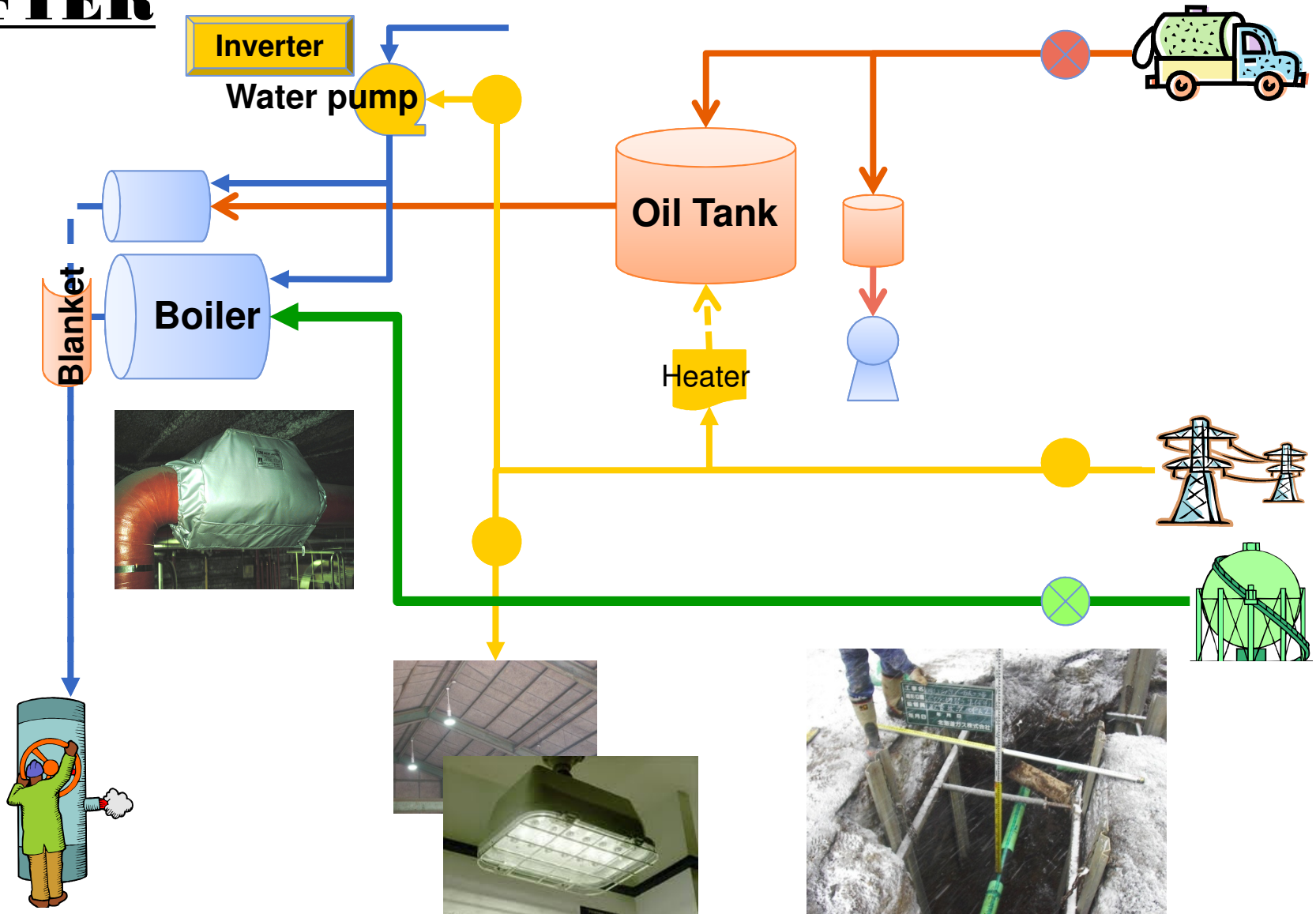
Feature of Energy Use

- Requires intensive energy for pressing (steam), laundry (hot water).
- Heat requirements varied with peripheral temperatures but stable for year-round.
- Outside temperature varies from 32℃ in August to -20℃ in February.
- Energy costs, electricity and fuel, occupies 50% of expenses.

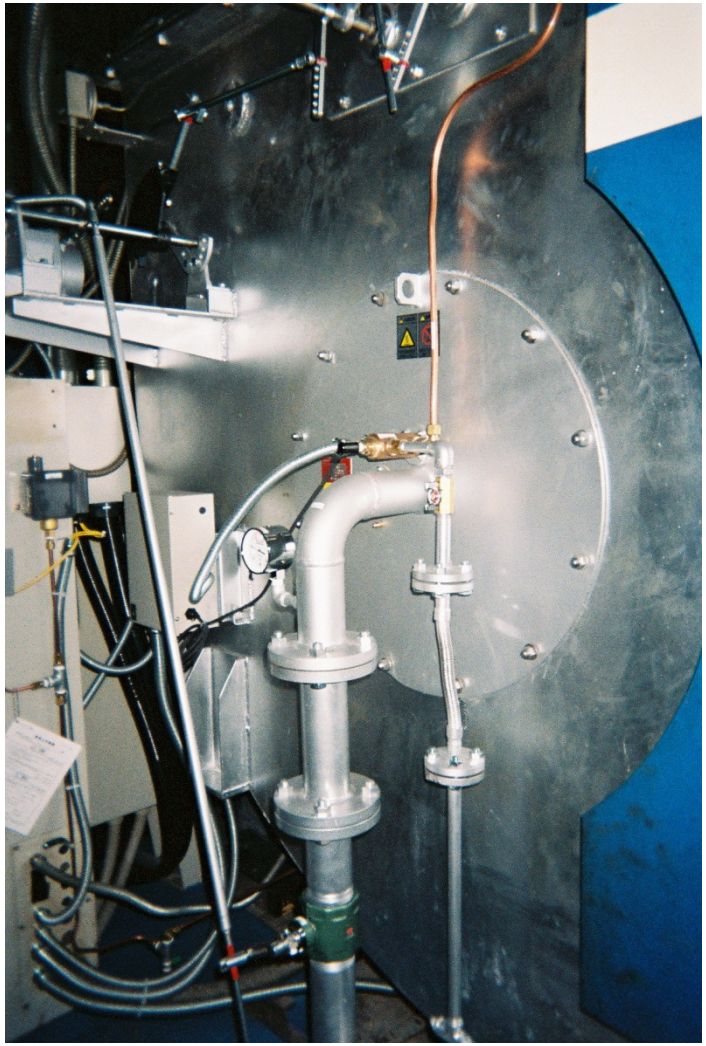
BEFORE

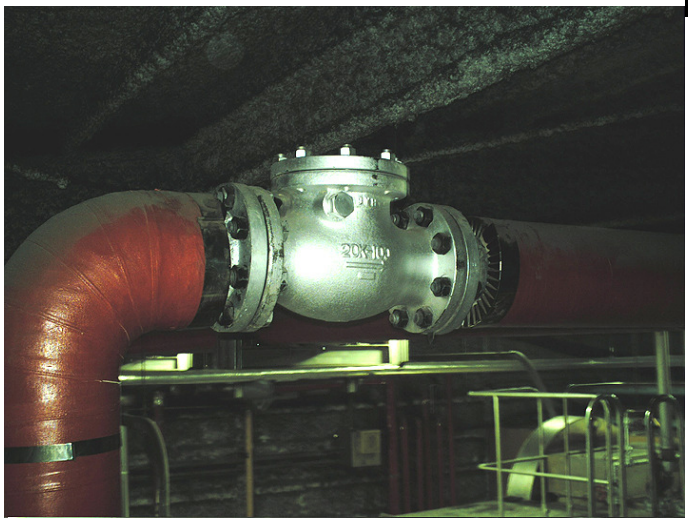


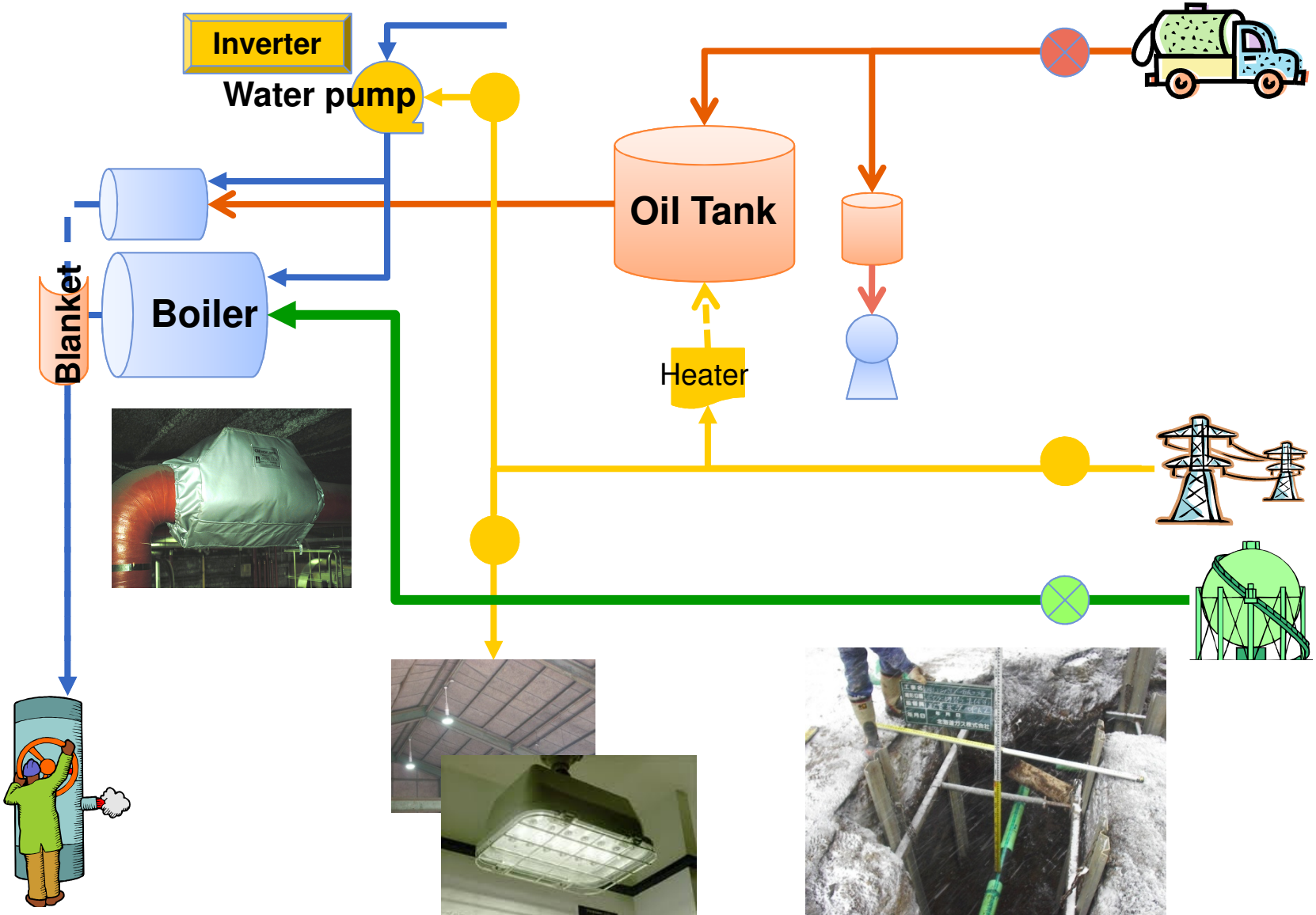
AFTER




IHI
呉ボイラ
工事件名
工事場所
バーナー更新前
年 月 日






Inverter
Water pump
Oil Tank
Blanket
Boiler
Heater

4. Project A: Boiler Fuel Change

The factory runs 1 x 2.0t boiler and 1 x 0.5t boiler for back up to generate steam and hot water for laundry machine and dry clanging.
Normally, only 2.0t boiler operates.

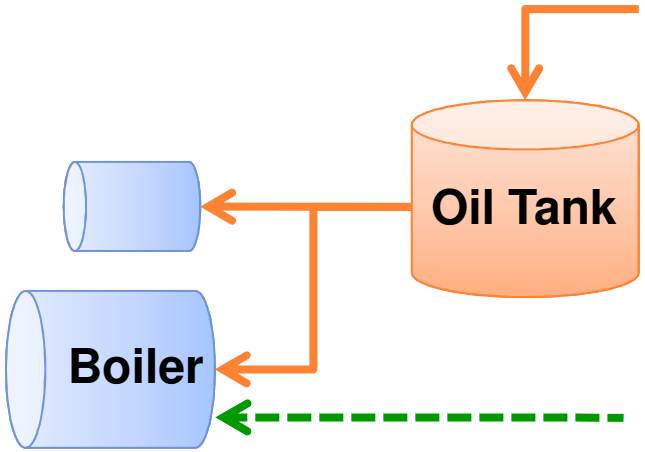
Both boiler uses heavy oil/furnace oil catered by a tanker truck of oil company upon order.

The project changes fuel only for 2.0t boiler from heavy oil to natural gas.

Fuel consumption	1,752	kl/year
Run-time	12	Hours/day
	264	Day/year

Monitoring parameters
- ◆Flow-meters at the heavy oil tank
- ◆Flow meters of the gas line
- ◆Invoice from gas/oil company

Project Baseline
Continuous use of carbon intensive fossil fuel.



4. Project B: LED Lighting

Light Emittng Diode (LED) is a lighting devices to alternate traditional lamps.

LED gives more concentrated lighting than conventional lighting thus uses less electricity to give a same illuminance.

The price of LED light is still expensive compared to usual lightings, but it lasts longer and economy in longer term.

Project replace old halogen lamps in factory and warehouse space to LED.

Elec. Power of Hg lamp	400	W
Number of Hg lamp	137	Units
Elec. Power of LED lamp	118	W
Number of LED	83	Units
Operating Hours	3,168	hours

Monitoring

- Electric Power of light bulb (W)
- Number of light bulbs
- Operating hours to turn on light bulbs (hours)
- Emission factor of the electricity consumed (tCO2e/MWh)

Project Baseline

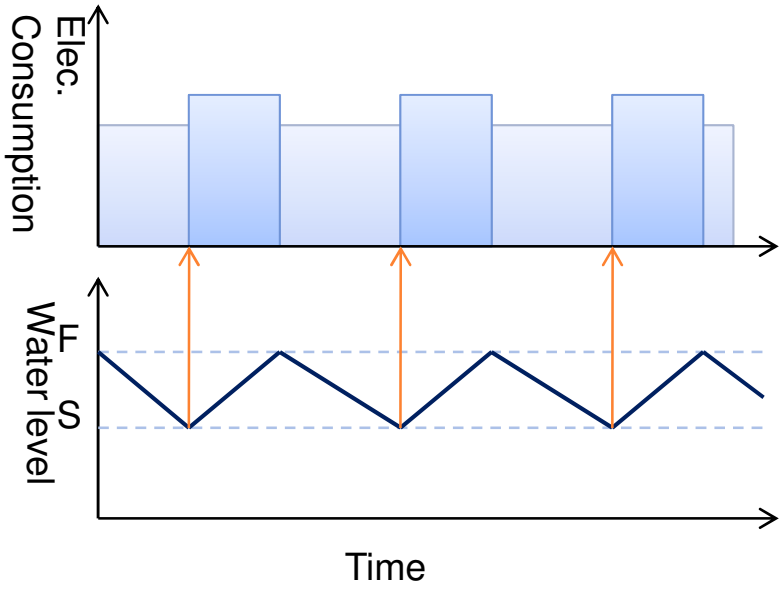
Continuous use of conventional lamps.

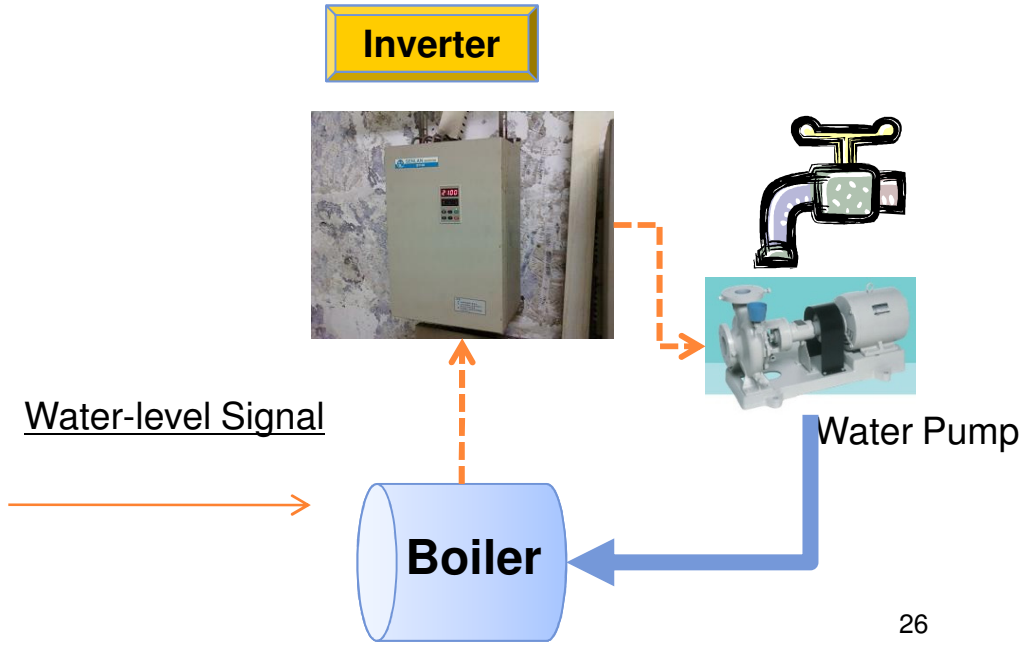
4. Project C: Inverter & Load Variable

Boiler water pump continuously pumping water, regardless water amount in the boiler tank.

Inverter technology on/off the pump be referring water level of the tank.
By reducing idle time of the pump, it reduces an electricity consumption.

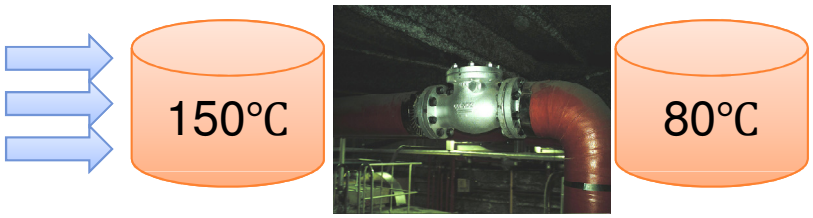
Monitoring
- ◆Power consumption of the system (kWh)
- ◆Number of operational hours (hrs)
- ◆Emission factor of the electricity (tCO_2e/kWh)

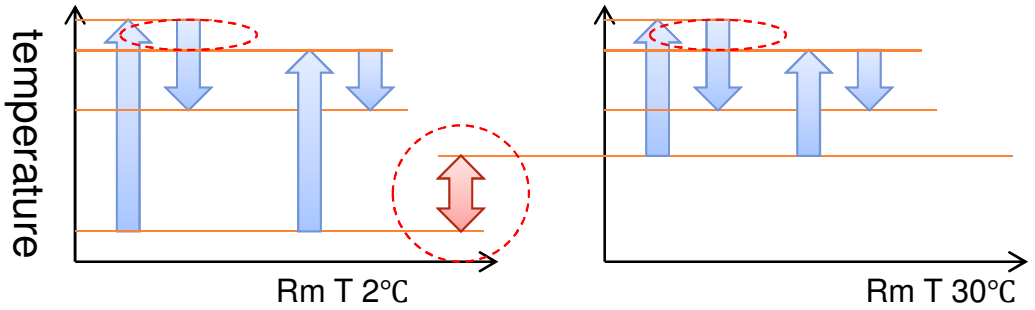




4. Project D: Pipe Blanket

Pipe Blanket is a method to cover pipe and high temperature parts by glass wool.





Monitoring

- ◆Temperature of in/outflow (℃)
- ◆External temperature (℃)
- ◆Flow rate (m^3/sec)
- ◆Consumption of fuel/electricity to generate steam(L of fuel or kWh of electricity)
- ◆Emission factors

Energy saving can achieved due to external temperature and other multiple variables. Blanket project is difficult to prove causality.

4. What can be done in CDM & what not?

	Project A: Boiler Fuel Change	Project B: LED application	Project C: Inverter Application	Project D: Blanket Application
AMS Methodology	III.B	II.E	II.C	---
Baseline	Keep using furnace oil.	Keep using mercury lamp	Keep operating pump regardless load/demand	Expose valve where heat are easily leak.
Project	Replace furnace oil to natural gas.	Replace mercury lamp to LED lamp to reduce electricity consumption	Control and limit pump action depends on water level of boiler.	Cover valve to avoid heat expose to atmosphere
Monitoring	Gas consumption with gas flow meter with gas company's invoice.	Electricity Consumption with metering devices and electricity bill.	Metering devices	Continuous monitoring of temperature of fluid and exposed environment.
CDM?				

5. Calculations: Fuel Change

Fuel Consumption before the Project

Furnace Oil Consumption	1,752	kl/year
HV of furnace oil		GJ/kl
Heat obtained with furnace oil		GJ
CO_{EF}		tCO_2/kl
$CO_{2\ Emissions\_before}$		tCO_2

Fuel Consumption after the Project

HV of natural gas		MJ/Nm^3
Amount of Natural gas needed		$Nm^3/year$
CO_{EF}		$kgCO_2/Nm^3$
$CO_{2\ Emissions\_after}$		$tCO_2/year$

5. Calculations: Fuel Change

Fuel Consumption before the Project

Furnace Oil Consumption	1,752	kl/year
HV of furnace oil	39.85	GJ/kl
Heat obtained with furnace oil	69,817.2	GJ
CO_{EF}	3.264	tCO_2/kl
$CO_{2\ Emissions\_before}$	5,718.53	tCO_2

Fuel Consumption after the Project

HV of natural gas	46.1	MJ/Nm^3
Amount of Natural gas needed	1,514 x 10^3	$Nm^3/year$
CO_{EF}	2.108	$kgCO_2/Nm^3$
$CO_{2\ Emissions\_after}$	3,194.51	$tCO_2/year$

5. Calculations: LED Application

Electricity Consumption before the Project

Unit Elec. Cons of Hg light	400	W/unit
Number of lights	137	Units
Daily Working hours	12	Hours/day
Annual Working days	264	Days/year
Electricity Consumption		kWh/year

Electricity Consumption after the Project

Unit Elec. Cons of LED	118	W/unit
Number of lights	83	Units
Annual Working hours	3168	Hours/year
Electricity Consumption		kWh/year
Electricity Saving		kWh/year
CO_{EF}	0.686	tCO_2/MWh
$ER_{\_LED}$		tCO_2

5. Calculations: LED Application

Electricity Consumption before the Project

Unit Elec. Cons of Hg light	400	W/unit
Number of lights	137	Units
Daily Working hours	12	Hours/day
Annual Working days	264	Days/year
Electricity Consumption	173,606.4	kWh/year

Electricity Consumption after the Project

Unit Elec. Cons of LED	118	W/unit
Number of lights	83	Units
Annual Working hours	3168	Hours/year
Electricity Consumption	31,027.39	kWh/year
Electricity Saving	142,579.0	kWh/year
CO_{EF}	0.686	tCO_2/MWh
$ER_{\_LED}$	97.81	tCO_2

6. Grand-Sum of Project

Fuel Change		
$CO_{2\ Emissions\_before}$	5,718.53	tCO_2/year
$CO_{2\ Emissions\_after}$	3,194.00	tCO_2/year
$ER_{\_Fuel\ Change}$	2,524.53	tCO_2/year
LED Application		
$ER_{\_LED}$	97.81	tCO_2/year
Total		
	2,622.34	tCO_2/year

!

The only thing we know about the future is that it will be different.

Peter Drucker

Status and Outlook of Carbon Market

Prepared for Training Program for CCD, MOE Sri Lanka
May 27, 2011

JICA Expert Team