Green Factory EMS
based on Renewable Energy and Energy Efficiency

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Case Study: LSIS Cheon-An Factory
I. Why F-EMS?

1) Enforcement of energy management by objectives

- Transglobal energy policies have focused on energy demand management rather than energy supply.
  - To follow this international trend, Korean government announce a long-term strategy related to energy policies, and announced a plan of energy demand management in June 2009.
  - Through those national policies, energy policy paradigm is changing into energy demand management.

Motivation

- Pilot project of energy management by objectives (‘09.11)
  - Subjects: 15 business fields, 47 factories (38 companies)* (11.20)

- The law of Green Growth Korea was enforced (‘10.04) the government appointed 374 organizations to implement energy management by objectives. (‘10.09)
  - They consist of 167 companies which consume energy usage more than 500TJ and emit 125,000tCO2 And 207 factories that consume more than 100TJ and emit 25,000tCO2.
  - Those appointed organizations have approximately 58.2% CO2 emissions of the Korea, and 85.1% of the industrial companies.

- Energy Management System (ISO 50001)
  - will be adopted by Korea Energy Management Corporation. (A, AA, AAA Rating)
  - In June 2011, international standards of EMS will be established

For example) CO2 emission & Energy Usage of factories in LS industrial systems

<table>
<thead>
<tr>
<th>Factory</th>
<th>‘07 TCO2</th>
<th>‘07 TOE</th>
<th>‘08 TCO2</th>
<th>‘08 TOE</th>
<th>‘09 TCO2</th>
<th>‘09 TOE</th>
<th>Average TCO2</th>
<th>Average TOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheon-an</td>
<td>7,587</td>
<td>1,904</td>
<td>10,458</td>
<td>2,094</td>
<td>7,864</td>
<td>2,437</td>
<td>8,636</td>
<td>2,145</td>
</tr>
<tr>
<td>Cheong-ju</td>
<td>17,186</td>
<td>8,436</td>
<td>16,490</td>
<td>8,095</td>
<td>15,772</td>
<td>7,741</td>
<td>16,483</td>
<td>8,091</td>
</tr>
<tr>
<td>SUM</td>
<td>25,119</td>
<td>10,236</td>
<td>23,516</td>
<td>10,189</td>
<td>23,636</td>
<td>10,186</td>
<td>25,119</td>
<td>10,236</td>
</tr>
</tbody>
</table>

1TJ ≈ 23.88TOE

Appointed Factory (2010): ≥ 2,400TOE & TOE ≥ 25,000tCO2
Appointed Company (2010): ≥ 12,000TOE & TOE ≥ 125,000tCO2
I. Why F-EMS?

- GHG-Energy management by objectives is the institution which set targets and manage energy usage, CO₂ emission of the appointed factories.
  - 374 organizations which are appointed by Korean government must adhere to the goal for energy saving and GHG emission reduction.
- To do this, it is essential to introduce Energy Management System.
- Since the criteria of GHG-Energy management by objectives is going to be lowered, then the appointed organizations will increase.

### 2) Appointed organizations

<table>
<thead>
<tr>
<th>Year</th>
<th>Company</th>
<th>Factory</th>
<th>Sum:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>167</td>
<td>207</td>
<td>374</td>
</tr>
<tr>
<td>2012</td>
<td>200</td>
<td>240</td>
<td>about 440</td>
</tr>
<tr>
<td>2014</td>
<td>280</td>
<td>290</td>
<td>about 570</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry</th>
<th>Usage (TJ)</th>
<th>GHG (tCO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company</td>
<td>≥ 500</td>
<td>≥ 125000</td>
</tr>
<tr>
<td>Factory</td>
<td>≥ 100</td>
<td>≥ 25000</td>
</tr>
<tr>
<td>Company</td>
<td>≥ 350</td>
<td>≥ 87500</td>
</tr>
<tr>
<td>Factory</td>
<td>≥ 90</td>
<td>≥ 20000</td>
</tr>
<tr>
<td>Company</td>
<td>≥ 200</td>
<td>≥ 50000</td>
</tr>
<tr>
<td>Factory</td>
<td>≥ 80</td>
<td>≥ 15000</td>
</tr>
</tbody>
</table>
EMS (ISO 50001) will be enacted as international standards (ISO PC242)
- EMS is the method for increasing energy efficiency which is approved internationally and officially.
- ISO PC242 is going to enact ISO 50001, it’ll be finished in June 2011.
- In Korea December 2007, KS A 4000 was enacted and Korea was performed EMS pilot certification on 14 large energy consumer companies.

Energy Management System
- EMS is enterprise energy improvement activity which develop principals and goals related energy saving and makes plans to implement.

Energy consumption monitoring
- Metering System
  - power
  - gas
  - water
  - hot

Energy consumption analysis
- Construct Energy Map by each process, by each equipment, and by each energy source
- Point out main control factors related to energy efficiency
- Correlation analysis between energy usage and control factors (Using statistic method)
- Detect an important main control factor

Energy improvement activity
- Related to Energy Management "PDCA"
  - Saving goal
    - Setting project/practice
  - Progress
    - Performance management
  - Analysis improvement effect
  - Continuous management
  - Improve energy saving and efficiency (saving cost)

※ PDCA: Plan Do Check Act
The objective of F-EMS is reducing the amount of energy usage and CO2 emission by managing energy efficiently.

- To achieve the objectives, quantification should be performed by monitoring and analyzing energy usage above all.
About 160kW photovoltaic generation modules are equipped, they can reduce 82 tons of CO2 per year.

3 Inverters have been installed to operate and control power efficiently.

F/C was equipped as power & hot water source of VIP, employee restaurants, and welfare building.

To monitor and analyze energy consumption of whole sites, 213 local sub meters based on power line technology have been equipped.
When we run the system, we can see the green energy generation status of the whole factory.

- By each building in the factory, display generated output a day, CO2 emission, also energy saving cost.

Linked with weather information

- Can see present temperature and weather information of the local factory.
This shows solar energy generation status among renewable energies.

- It displays the whole solar energy generation status and by each building current generating output, accumulated power generation, and energy saving cost.

- Displays inverter’s information in detail (inverter’s fault information, inverter power and measuring value)
III. F-EMS Main Functions

3) Operating status of AC Drive

- Shows current status of operating AC Drive
  - By installing 3 inverters on the Clean-Room air-conditioner, we can control power efficiently.
  - Displays inverter specifically which monitors reference frequency & current frequency, output voltage/current, motor velocity.
Smart cabinet panel real time monitoring display

- Smart cabinet panel contains total energy information device that can monitor and analyze **power quality**, **electricity safety monitoring**, **facility monitoring**, **demand control**, and **automatic meter reading**, and so on.
Smart Cabinet Panel (SCP) is composed of:
- Smart Meter
- DC & CB Tripping Unit
- Facility & CB Monitoring Unit
- Electricity Safety Unit
- AC Measuring Unit
- DC Measuring Unit
- AMR Unit
- DC PLC Unit
III. F-EMS Main Functions

5) Monitoring energy usage/CO\textsubscript{2} emission

- shows energy usage amount, CO\textsubscript{2} emission, energy source status, and amount of production by each building and by whole factory
  - By this, we can understand easily differences of the whole factory’s energy usage and CO2 emission between today and yesterday, and between last month and this month.
III. F-EMS Main Functions

6) Monitoring energy usage and CO$_2$ emission by each floor

- Displaying energy usage, production outputs and CO$_2$ emission by each floor.
  - By this, we can understand easily differences energy usage and CO2 emission between today and yesterday by each floor in a building.
  - It also provides energy usage trend for 7 days and current state of usage by each energy source.
See the whole energy flow based on local sensors, and review individual energy usage of the factory.

- displays partly energy usage amounts based on tree-formation energy map by the whole ratio, by relative ratio, by TOE.
- Can see the whole energy usage information, at a glance.
III. F-EMS Main Functions

8) Energy usage pattern analysis by each department

- This display can check energy usage trend by conditions in detail. For example, energy map, energy source and department,
  - And, we can check by each year, by each month, and by each day.
  - Furthermore, can compare above things by each condition.
It is possible that you can check greenhouse gas emission trend by each department, by energy map, and by energy source, etc.

- We can check by each year, by each times.
- Furthermore, we can compare those things by the condition.
Correlation regression analysis

- It investigates cause factor which influences major effect factor by using correlation regression analysis.
- It is possible that the degree of correlation between cause and effect factor can be expressed as quantity.
Energy Usage Forecast Analysis

- Energy usage forecast analysis method is statistic method to forecast based on the past data.
- Monthly forecasting output is presented and we can compare real value with forecast to verify.
- This graph shows forecast data as green line and real value as brown line.
GHG emission can be grouped into Scope 1 and Scope 2 and we can check them by each scope.

- GHG emission consists of direct emission which is generated when people do some activities, and indirect emission which is made by using electric generated from others.
- Like chart below, Cheon-an factory has 88% indirect emission and 12% direct emission.
We can compare factory’s performance with government goal by performing constrained GHG/energy management, by each month and by each year.

- Compare each department’s performance through degree of achievement (%) of their goals.
- Brown line is target line, green line is result line.
III. F-EMS Main Functions

14) F-EMS mobile service

- Provides mobile service based on Smart Phone
  - can monitor efficiency of each green energy generation in the cheon-an factory through android phone.
  - is possible to compare generation capacity of renewable energy with current generation output.
  - can monitor CO2 emission amount and energy saving cost by renewable energy.
  - In addition, we monitor detail information of inverter for AC Drive and Smart Cabinet Panel.
IV. F-EMS Effectiveness

1) Actions for constrained energy management

- As you know, constrained energy management is official institutions for reducing CO2 and saving energy efficiently in large factories.
- As I said before, 374 organizations which are appointed by Korean government must have the energy saving goal and comply with them. To do this, it is essential to introduce Energy Management System.

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**Milestones**

<table>
<thead>
<tr>
<th>Prev. Year</th>
<th>Base Year</th>
<th>Next Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation</td>
<td>Implementation</td>
<td>Submission of Implementation Plan</td>
</tr>
<tr>
<td>Target Setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submission of Report &amp; Corrective Statements</td>
<td>Evaluation</td>
<td>Action</td>
</tr>
</tbody>
</table>

**Target Company/Factory**

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- Time series Analysis → Forecasting Designated year and Target Value
- Implementation performance of Reduction target in Real-time monitoring
- Report/Print Monitoring results

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- Energy usage in business sites
- Energy facilities, Emission sources list
- Annual target, Implementation plan for next 5 yrs.
- Calculation method/Monitoring method
- Annual implementation/Reduction Performance
- A size of firm, output etc. statement
IV. F-EMS Effectiveness

1) Actions for constrained energy management

Our F-EMS helps setting energy saving strategy by monitoring and analyzing energy consumption, and can take an early action for the government policy.

F-EMS current situation analysis
→ GHG target management system strategy establishment

[Assumption] 2012 year Cheon-an Factory

• For 3 yrs. ('09~'11yr.) Average energy usage 90TJ excess
• For 3 yrs. ('09~'11yr.) Average GHG quantity of emission 20,000 TCO₂ excess

2013 year GHG reduction target setting and performance reporting target

Energy usage and GHG quantity of emission reduction strategy establishment

• renewable energy development and expand an application
• Production department energy reduction KPI enforcement
• Electricity supply efficiency improvement project development
• Steam supply efficiency improvement project development
• Green Factory item development

Energy Usage

CO₂ Emission
KS A 4000 (EMS) was announced in December, 2007, was verified by certification pre-test from 2008 to 2010. It will be implemented with international standards ISO50001_EmEnMS from June 2011.

- EMS certification system gives certificate by evaluating current state of EMS construction and energy saving performance.

EMS grade evaluation: evaluation score above 85% : AAA (The best), evaluation score above 70% : AA (Excellent), Standard Satisfaction : A (Normal)

1. Energy intensity (KPI) decrease (2~4 percent compared with the pre yrs.)
2. Energy saving by project performance (2~4% percent of the whole business usage)
3. Performance of purchasing high energy efficiency and low energy consumption equipment (Purchasing performance 50~90 percent)

F-EMS monitoring sector
- factory energy consumption
- facility energy consumption
- Energy intensity
- GHG emission by Mon./Yr.

1. Target → Project → Performance Mgmt. : PDCA establishment
2. Energy aspect analysis : Energy map/Main facility
5. Management of evaluation requirement: Verification checklist

EMS grade evaluation: evaluation score above 85% : AAA (The best), evaluation score above 70% : AA (Excellent), Standard Satisfaction : A (Normal)
It defines greenhouse gas emission sources and makes a list. To do this, we need to set organization and operation boundary, also, develop gathering form of GHG data.

We calculate the amount of GHG emission by considering energy usage and emission factors.
Thank you for your attention.