INDUSTRIAL ENERGY EFFICIENCY IMPROVEMENT IN IRAN

DRAFT Management Report: EnPIM mission of March 2017

Prepared for
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Executive summary

The following activities were completed during the mission:

- Site visits to the 3 pilot plants participating in the EnPIM program to review progress and plan next steps for each.
- 2 day EnPIM training with IFCO personnel in the IFCO offices in Tehran.
- Meetings with UNIDO Iran PMU (Ms. Nasim Shekari and Mr. Mahdi Shakouri).

Even though the logistics were complex, they were very well planned. The organization of the events was very good. The hospitality of the 3 plants and IFCO are appreciated.

Interaction between trainers and participants was very good. This was helped a lot by Mahdi and Nasim, so there was no language problem.

Objectives of the mission

The objectives of the mission were:

1. Visit the 3 participating EnPIM pilot plants to check progress and develop detailed plans for the program in each plant.
2. Build on the previous EnPIM training with IFCO through the latest version of the 2 day EnPIM training.

The international experts believe that these objectives have been met over the mission period.

Summary of the 3 pilot plant visits

This section describes the data collection needs for the 3 pilot plants for measurement and monitoring of energy consumption, energy performance and associated variables. The purpose of this data collection is to enable the development of Energy Baselines (EnBs) and Energy Performance Indicators (EnPIs) for the plants. These EnBs and EnPIs will be developed for each of the total factories and for electrical and thermal significant energy uses (SEUs).

It is based on the UNIDO EnPI training program and the UNIDO pilot project on energy performance monitoring in large scale industry in Iran, specifically for the cement and petrochemical sectors.

Visit 1 – Sarooj Cement – Isfahan

The onsite meetings and information exchange were held on 28 February and 1 March 2017 in the plant.

Plant personnel were trained by PMU and are very well motived and very knowledgeable on the topic. We feel they understand the potential benefits that effective energy performance monitoring will bring them. They also have very good data available in electronic format. They are an ideal plant to pilot the topic and if the current enthusiasm and success continues, their participation will bring significant benefits to the plant in terms of improved energy efficiency and to the development of the UNIDO EnPI program globally.

Data requirements

Energy data and data for relevant variables for the total plant and for each SEU are required. The data will be stored on the energy server located in the main station control room at one minute intervals in the form transferred from the Siemens PLC. There will be a daily export of this data using WinCC as a CSV file which will be imported into MS Excel. This Excel file will have data collected with a daily interval and stored indefinitely (minimum of 5 years' duration). It is very desirable that all this data transfer, export and import be automatic.

Selection of SEUs

There may be SEUs at 3 levels in this plant as follows:

1. Total site electricity and total site heat (gas+oil)
2. The largest energy uses e.g. cooling, kiln, calcinor, etc. These are groups of equipment with a single purpose.
3. Individual large motors, e.g. the 6 fan motors of the cooling grate.

Plant measurement and data collection layout

Main Station

The main station has electricity meters (IMC) connected to a Siemens PLC located in the local control room. The totalised value of MWh for each electricity meter should be transferred to this PLC and collected on the PC server in the control room with a collection interval of 1 minute. There is already data collected for the past 3 years.

Production area PLCs

There are many different parameters collected in the production area. They are collected to a network of Siemens PLCs. These PLCs and related CCR server are on a separate network from the main station Siemens PLC.

Currently production parameters including feed rates and other parameters are transferred to the Siemens PLCs and from there via a hub to the CCR server. Natural gas (and fuel oil) consumption are also collected with this method and transferred to the CCR server. Electricity meter data for the production areas is collected in the same Siemens PLC network and routed via the same hub to a dedicated energy data server based on a PC in the main station control room. This PC also has WinCC software.

Data storage and security

The energy data and the variable data associated with this work are very critical and have significant financial value to the plant. This valuable data will eventually reside on the energy server. This server does not currently have a backup. It is recommended that this PC have a UPS power supply and a backup mechanism. Low cost backup solutions are available including an external hard drive with automatic daily backup. This backup should be regularly checked to ensure that it is reliable and up to date.

We have seen more than one case where all plant energy data has been lost and the collection and analysis process must start again. It would take some months and in some cases a full year to collect the data to enable the process to start again by re-establishing EnBs.

Potential uncertainty related to measurement and data collection

See issues common to all plants later in this report.

Energy Baselines and Energy Performance Indicators:

Some regression tests were done by Sarooj staff before the visit. The results were not good due to the use of 15 minute consumption data. Although 15 minute data is very valuable to detect saving opportunities, it is not recommended to use them for EnB and EnPIs calculation.

A second test was developed during the visit using daily data. The results were interesting and show that daily data is the right timing.

Next Steps:

Past data to establish models and baselines

1. Based on the potential data requirements discussed on the visit, for each SEU, collect daily data for the past 9 months for electricity, gas, fuel oil, production rates and other relevant variables into an excel spreadsheet.
2. Build models for above based on the previous training and these 2 days' work. Discuss the models with Luis and Mahdi and finalise the baseline models for the past 9 months based on daily data. This assumes the past 9 months are typical production periods.
3. Do the same for total plant electricity and heat (gas+oil)
4. Luis will provide a template for monitoring performance against the baselines developed above.
5. Start to monitor progress using the EnPIs against the baselines and against energy saving targets.

Future data collection

1. Transfer data from the main station WinCC PC on a daily basis for total electricity consumed by each meter in MWh/day. This transfer should happen daily and may require a physical cable connection.
2. Transfer data daily from the CCR server for gas, oil, production rates and other relevant variables.
3. The above 2 will result in consolidated daily data for all energies and all relevant variables in one place. That place is the energy server and ideally the daily transfer will be automatic.

NOTE: the work to set up the automatic transfer of data from the production meters, gas meters, main station electricity meter, etc. should happen at the same time as collecting and analysing the past data and testing and building the regression models to be used as the baselines.

We suggested an initial target of one month from the visit to finish the regression models and to complete the automated collection of future data in the same month if resources allow. A complete timeline with milestones has been developed by Mahdi and Nasim after the visits.

Visit 2 – Regal Petrochemicals

This part is based on the onsite meetings and information exchange on 4th March 2017 in the Regal Petrochemical plant.

The plant is already certified to ISO50001 as a result of the work carried out as part of the UNIDO EnMS program. During that process, they identified some energy savings opportunities from good analysis of energy data, for example the optimum extruder to operate depending on production rate.

Plant personnel were trained by PMU and are very well motived and very knowledgeable on the topic. They understand the potential benefits that effective energy performance monitoring will bring them. They also have very good data available in electronic format. They are a very good plant to pilot the topic and if the current enthusiasm and success continues, their participation will bring significant benefits to the plant in terms of improved energy efficiency and to the development of the UNIDO EnPI program globally.

Data Requirements

Energy data and data for relevant variables for the total plant and for each SEU are required.

Currently process data including process flows and relevant variables are connected to the Emerson PLC system and collected daily to the PI database. Electrical meters are manually collected daily and stored in Excel. This data is the basis for the EnBs.

There is plan to connect the electrical meters to the Emerson system and to transfer data from there to the plant ERP Oracle database. Then all energy data and relevant variable data will be stored in one

location and available for analysis. This analysis will be carried out and monitored and reported using Qlik. Qlik will use the models developed in Excel by regression and other analysis.

During the upgrade process ensure that existing historical data is moved to the new database.

Consider increasing the data collection interval to 15 minutes instead of daily.

Selection of SEUs

An updated list of SEUs was developed during the visit.

There may be SEUs at 2 levels in this plant as follows:

1. Total site electricity and total site heat (gas+oil)
2. The largest energy uses e.g. cooling, extrusion, compression, etc. These are groups of equipment with a single purpose.

Some recommendations about SEUs were made:

1. Consider the losses from the steam system as an SEU for the gas/oil energy source. This SEU can then be controlled and monitored as all others.
2. Consider a meter to measure the quantity of make-up water to the boiler deaerator. This can be used to calculate condensate return rate which should be monitored as an EnPI.
3. Test the concept of separate and combined SEUs for some cases, e.g. extruders and compressors.

Data storage and security

The energy data and the variable data associated with this work are very critical and have significant financial value to the plant. This valuable data will eventually reside on the plant ERP database. Ensure this data is routinely backed up. This backup should be regularly checked to ensure that it is reliable and up to date.

We have seen more than one case where all plant energy data has been lost and the collection and analysis process must start again. It would take some months and in some cases a full year to collect the data to enable the process to start again by re-establishing EnBs. This is less likely in this case as the data is integrated in the main plant business database and these are usually well protected.

Potential uncertainty related to measurement and data collection

See issues common to all plants later in this report.

Energy Baselines and Energy Performance Indicators:

Due to the lack of data at that point, it was not possible to review regression analysis during the visit. The staff showed a good understanding about relevant variables affecting each SEU during the SEU review.

Next Steps:

Past data to establish models and baselines

1. The data already exists to allow the development of most of the required EnPIs.
2. Develop and improve the baseline models for above based on the previous training and this project. Discuss the models with Luis and Mahdi and finalise the baseline models.
3. Do the same for total plant electricity and heat (gas+oil)
4. Luis will provide a template for monitoring performance against the baselines developed above that will be used as a base to build the required formulae to monitor performance in Qlik.
5. Start to monitor progress using the EnPIs against the baselines and against energy saving targets.

NOTE: the work to set up the automatic transfer of data from the production meters, gas meters, main station electricity meter, etc. should happen at the same time as collecting and analysing the past data and testing and building the regression models to be used as the baselines.

We suggested an initial target of one month from now to finish the regression models and to complete the automated collection of future data in the same month if resources allow. A complete timeline with milestones has been developed by Mahdi and Nasim after the visits.

ECO Ideas

These minor observations were made during the site tour.

1. Control the supply temperature from the cooling towers instead of the quantity of cooling. Introduce a variable set point based on the actual wet bulb temperature.
2. Vary the cooling water flow based on production (user) needs. Either control valves or manual adjustment.
3. Variable speed drive for one cooling water pump.

Sequence

1. Finalise SEUs
2. Data collection in ERP (from Emerson PLC)
3. Regression analysis in Excel
4. Monitoring and reporting in Qlik using data from ERP and models from Excel.

Visit 3 – Behbahan Cement

This is based on the onsite meetings and information exchange on 5th March 2017 in the plant. This was attended by 6 factory people from electrical, calibration, automation, statistics and production departments.

Plant personnel are very well motived and very knowledgeable on the topic. They understand the potential benefits that effective energy performance monitoring will bring them. They also already have

very good data available in electronic format. This data has been collected manually and entered into a spreadsheet. They have already done some work in analysing this data. They are a very good plant to pilot the topic and if the current enthusiasm and success continues, their participation will bring significant benefits to the plant in terms of improved energy efficiency and to the development of the UNIDO EnPI program globally. It is particularly interesting to have 2 cement plants in the pilot program. They both share very similar technology, though of different ages. This plant is older than Sarooj. It will be interesting to compare, and possibly benchmark, their EnPIs against each other. This can be done without compromising either plant's data confidentiality.

This plant was not previously part of the UNIDO EnMS program but they have recently completed the EnPIM training.

Data Requirements

Energy data and data for relevant variables for the total plant and for each SEU are required. This data is already being collected manually and there are plans to automate the collection process through the Siemens PLC system.

During the automation process ensure that existing historical data is moved to the new database.

Consider using a data collection interval of 15 minutes for the automated data collection process. Even though the data models will be built and monitored using daily data intervals, it will be advantageous to have 15 minute data available to allow investigation of anomalies and deviations from expected consumption.

Selection of SEUs

An updated list of SEUs was developed during the visit.

There may be SEUs at 2 levels in this plant as follows:

1. Total site electricity and total site heat (gas+oil??)
2. The largest energy uses e.g. kiln, calcination, cooling, etc. These are groups of equipment with a single purpose.
3. Individual large motors may also be tested and considered for monitoring.

Data storage and security

The energy data and the variable data associated with this work are very critical and have significant financial value to the plant. This valuable data will eventually reside in a data server. Ensure this data is routinely backed up. This backup should be regularly checked to ensure that it is reliable and up to date.

We have seen more than one case where all plant energy data has been lost and the collection and analysis process must start again. It would take some months and in some cases a full year to collect the data to enable the process to start again by re-establishing EnBs.

Potential uncertainty related to measurement and data collection

See issues common to all plants later in this report.

Energy Baselines and Energy Performance Indicators:

Some regression tests were done by Behbahan staff before the visit. The results were interesting and useful. The people seemed to be comfortable with the concepts. This is remarkable, given that Behbahan was not previously part of the UNIDO EnMS program and they had only recently completed the EnPIM training.

Some data problems were discovered during the regression analyses review. These problems explained some of the abnormal results and will need to be resolved.

Next Steps:

1. Document the decisions about SEU's, energy data and relevant variable data. Based on photos of the whiteboards.

Past data to establish models and baselines

1. The data already exists to allow the development of most of the required EnPIs.
2. Develop and improve the baseline models for above based on the previous training and this project. Discuss the models with Luis and Mahdi and finalise the baseline models.
3. Do the same for total plant electricity and heat (gas+oil)
4. Luis will provide a template for monitoring performance against the baselines developed above.
5. Start to monitor progress using the EnPIs against the baselines and against energy saving targets.

NOTE: the work to set up the automatic transfer of data from the production meters, gas meters, etc. should happen at the same time as collecting and analysing the past data and testing and building the regression models to be used as the baselines.

We suggested an initial target of one month from now to finish the regression models and to complete the automated collection of future data in the same month if resources allow. A complete timeline with milestones has been developed by Mahdi and Nasim after the visits.

Potential uncertainty related to measurement and data collection

These items below apply to all 3 plants and also potentially to other organsiations. They are all related to potential measurement and data inaccuracy, uncertainty and potential errors.

1. Accuracy of the measurement instrumentation for both energy meters and relevant variable measurement.
2. Timing of the collection of the data for both energy meters and relevant variable data.
3. The method of totalising values. For example, with electricity there are often both MW and MWh data available. A totalisation of the MWh data will be the most accurate value for total consumption over a period of time, e.g. MWh per day. If the MW value is used and is collected, say, every hour, then there is an error due to variation in MW loads between the data collection instances. If MW values are collected every minute, this error is reduced. But it is most accurate to collect MWh values.
4. The same applies to collecting production quantities. Measured data is available for production rate, i.e. Tonnes/hour. If Tonnes/hour is collected every hour and then totalled for a day, there will be inaccuracies due to variation in production rate between the collection instances. It is better to have a totaliser function to know the number of tonnes produced during the whole hour. This totaliser should take into account the T/h value at least every minute. This totaliser often already exists and accuracy should be checked.
5. Regarding relevant variables that are analogue values, such as O2, temperatures, pressures etc., it needs to be understood the effect of what is collected as data. For example, if the average temperature is collected, how often is it averaged? If the actual value is collected, is there an inaccuracy due to variations in between the collection instances? Again, if data is collected every minute this inaccuracy will probably be acceptable. Note: averaging of these values should only occur over the time periods that the energy use is operating. This means that if there are out of operation hours, they should not be averaged.

EnPIM training in IFCO

This 2 day training was held in the IFCO offices on 7th and 8th April. It was based on the previous one day training delivered there also by Luis and Liam with assistance from Mahdi.

The two-day EnPI training material has been fully updated recently. This was the first time that the new material was delivered. The timing and flow in this updated version seemed to be better, which is very beneficial for trainers and trainees.

There is a high level of interest from IFCO on this topic. There is also a good understanding among most of the participants. Even when most of them are working on the policy level, they understand the barriers caused by traditional indicators (such as Specific Energy Consumption) and they understand the potential of statistical analysis to set Energy baselines and Energy Performance Indicators.

IFCO showed a special level of interest on how regression analysis can help them to develop energy policies at a national level. They are open to test different statistical approaches in certain sectors to improve the current energy national regulations. This is very remarkable, as Iran is one of the countries where reporting using Specific Energy Consumption is a legal requirement.

Recommendations

About EnPIM program:

- Insist on the importance of accurate and proper data collection and storage. Data is the basis of all the work that will be developed in the following months. The staff in the 3 plants understood the UNIDO EnPI methodology. A second training will be developed, and it will help to ensure that all the concepts are clear. But it is essential to insist on the importance of collecting and storage all the relevant data accurately, using appropriate timing and units. We recommend reviewing the progress on data collection process and data storage, energy baselines (EnBs) development, energy saving targeting during the upcoming national expert's (Mahdi) monthly visits and consultancy.

About IFCO EnPI training:

- Take advantage of the interest showed by IFCO to test the potential of regression at a national level. The national level is very different from the plant level, and the statistical approach can be different. Conclusions from these tests could show ways of improving national indicators using regression analysis. This opportunity is unique, as IFCO has a huge amount of data about all the plants in each sector, and they are very open to collaborate.
- Incorporate these concepts into the updated versions of the national standards for benchmarking energy intensive industries in collaboration with IFCO.

IFCO are also interested in collaborating with UNIDO in delivering lead auditor certification training tp improve the standard and profiency of Iranian certification auditors and bodies.