ENERGY MANAGEMENT INITIATIVE AT PETRONAS LNG COMPLEX

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ABSTRACT

PETRONAS LNG complex in Bintulu, Malaysia comprises of MLNG Satu (1983), MLNG Dua (1995) and MLNG Tiga (2003) with total capacity of about 23 mtpa. The complex is designed with a total of eight (8) LNG processing trains and varied production capacities for each plant.

All LNG processing trains are designed with APCI liquefaction process of Propane Pre-Cooled with Main Cryogenic Heat Exchanger (MCHE). The drivers for the MR and Propane Compressors are steam turbines for MLNG Satu, whilst MLNG Dua uses GE Frame 6 and 7 gas turbines. MLNG Tiga trains employed GE Frame 7 gas turbines to drive the propane and mixed refrigerant compressors. Sea Water provides cooling requirement for MLNG Satu while MLNG Dua uses both Sea Water and Air Coolers. Both MLNG Satu and MLNG Dua share the utilities facilities and all three plants use common LNG rundown and storage facilities.

MLNG is striving to enhance its operational performance to be amongst the top quartile within the industry and one of the key areas is energy efficiency. Several energy initiatives have been implemented, including an on going initiative such as flare and losses program, Advance Process Control (APC), Boiler Economiser Cleaning and the latest initiative aptly called “Energise” program. The approach of “Energise” program is a deliberate and methodical undertaking to develop and sustain energy improvement initiatives as part of the plant operation performance continuous improvement program.

This paper briefly explains and shares the concept, findings of the study, implementation and update of on going energy initiatives at PETRONAS LNG complex. The paper will also discuss main challenges, critical success factors and potential for future applications within LNG and/or PETRONAS fraternities.

1.0 INTRODUCTION

PETRONAS LNG complex in Bintulu, Malaysia comprises of MLNG Satu (1983), MLNG Dua (1995) and MLNG Tiga (2003) with total capacity of about 23 mtpa. The complex is designed with a total of eight (8) processing trains and varied production capacities for each plant. MLNG Satu was commissioned in 1983 with total capacity of 8.1 mtpa. MLNG Dua comes to the stream in 1995 with total capacity of 7.8 mtpa. Latest, MLNG Tiga plant was commissioned in 2003 with total capacity of 6.8 mtpa. With all 8 LNG trains, Petronas LNG Complex is become world largest LNG producer in single site.

All processing trains are designed with APCI liquefaction process of Propane Pre-Cooled with Main Cryogenic Heat Exchanger (MCHE). The drivers for the MR and Propane Compressors are steam turbines for MLNG Satu, whilst MLNG Dua uses GE Frame 6 and 7 gas turbines. MLNG Tiga trains employ GE Frame 7 gas turbines to drive the propane and mixed refrigerant compressors.

For cooling requirement, MLNG Satu is cool by Sea Water while MLNG Dua uses both Sea Water and Air Coolers. MLNG TIGA plant is used Air Coolers for cooling requirements

Both MLNG Satu and MLNG Dua share the utilities facilities while MLNG Tiga has the their own utilities facilities. However, there are integrated between each other and all three plants use common LNG rundown and storage facilities.

Figure 1: Petronas LNG Complex Site comprises of MLNG Satu, MLNG Dua and MLNG Tiga

In global LNG businesses today, Energy utilisation and optimization is one of the key elements to achieve superior operating asset performances. Historically, the trend of energy bill for MLNG Satu & Dua plants showed an increase pattern over the past 4-year. Refer Figure-2. Subsequently, a plan was conceived to address the issue in combating rising cost of energy usage by optimizing operational efficiency. To that end, the goal is to systematically improve energy efficiency by about half a percentile point (0.5%) by the year 2008/2009. Refer Figure-3.

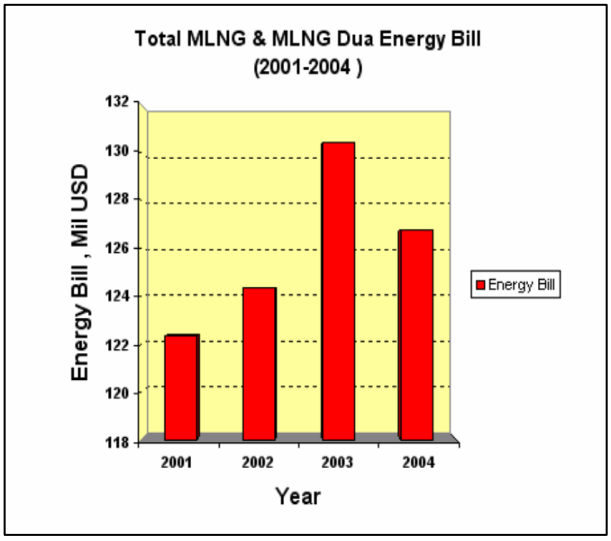

Figure 2: Energy Bill for MLNG and MLNG Dua profiles (2001-2004)

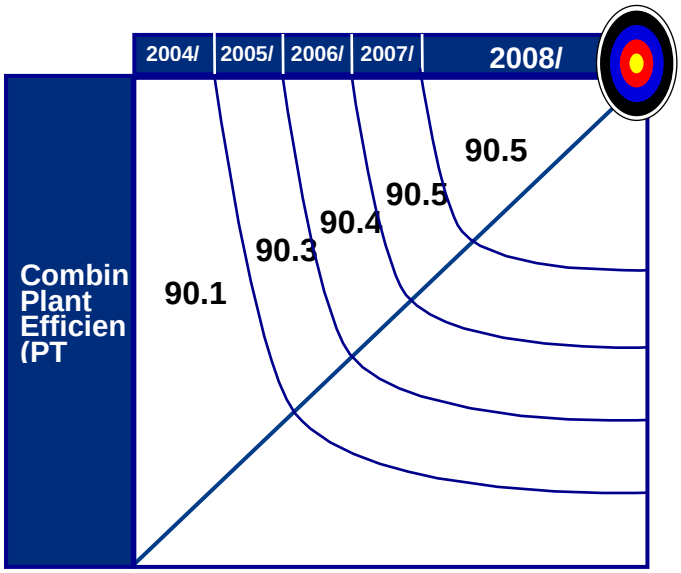

Figure 3: Plant Thermal Efficiency Target 2007-2008.

2.0 ENERGY IMPROVEMENT INITIATIVES AT PETRONAS LNG COMPLEX

The initiatives to improve operational and energy efficiencies has always been the domain of process/chemical engineers. However, the approach was always reactive in nature and requires concerted effort from all parties to consistently adopt an energy-sensitive method of operating the assets. Several initiatives have been implemented and on going activities in the site such as Flare & losses Reduction Program, improve boiler operational efficiency, implementation of Advance Process Control (APC).

- **Flare & Losses Reduction Program**

  For a large manufacturing site, flaring is always a concern. For PETRONAS LNG Complex, several initiatives has been implemented and on-going activities to minimize a flare and losses such as:

  (a) Improve or reduce start-up time by re-routing the unused gas to fuel gas system. This initiative was successfully implemented in MLNG Dua plant.

(b) Modification of Boil of Gas (BOG) compression system via suction piping configuration. Original line-up is prone to cause high suction temperature of the newly installed Boil of Gas compressor. Subsequently, this led to significant amount of quenching rate using LNG, and more often than not caused the unit to trip. Each quenching and/or tripping exacted high amount of flared gas which can be better recovered either as fuel or useful hydrocarbon products With the new piping configuration and proper mixing of the compressor suction, situations of flaring can be minimized.

- **Improve Boiler Performance and Operational Efficiency**

For plant Utilities, boiler unit is the main consumer of energy for high pressure steam production. An improved boiler performances vis-à-vis unit efficiency produce significant improvement on energy consumptions. There are several initiatives to improved boiler efficiency. As an example, boiler economiser chemical cleaning was conducted for one of the least performing boiler unit. The test results indicate that stack temperature can be lowered by about 40^{o} – 50^{o}C. Consequently, boiler efficiency increased by 2.1 % and reduces fuel demand by about 10,000 tonnes per annum. Figure-4 reflect the actual operating condition before and after the cleaning exercise.

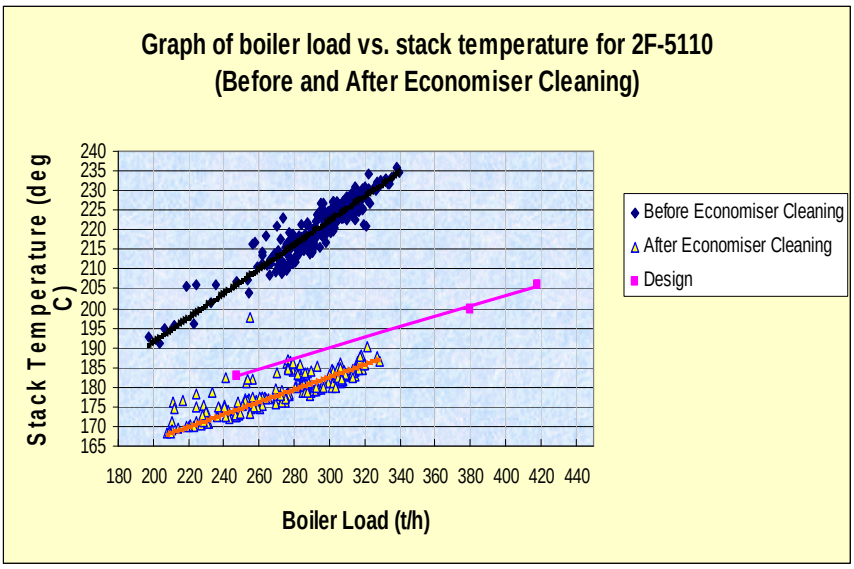

Figure 4: Boiler performance after economiser cleaning.

- **Implementation of Advance Process Control (APC)**

  To improve control system in the LNG plant, process control department has implemented Advance Process Control (APC) in main operating units such as MCHE, Fractionation, Stabilisation Unit. Although this intiative is focusing on the control optimization and production benefit, but it also claimed that about 10 – 20 % of potential energy saving could be realized from this initiative.

- **Implementation of ENERGISE**

  MLNG has embarked on the systematic approach called “Energise” to further review and improve energy usage in the plant. This program was originally developed by Shell Global Solution (SGS). The programs identifies and then implement opportunities for substantial energy saving which require low capital investment. First phase started in April 2004 and a dedicated and integrated team has been formed consists of SGSI, Petronas and MLNG personnels’ to look after potential energy saving opportunities with minor capital investment.

3.0 ENERGISE PROGRAM

Implementation strategy of ENERGISE program in Petronas LNG Complex can be divided into subsequent phases, namely:

- **WALKTHROUGH**

  WALKTHROUGH is the first phase of the Energise program and completed in April 2004. At this point, the team has performed preliminary feasibility study at site by interviewing plant personnel, observed, and analyse plant operating as well as design data. Several potential areas for improvement was identified such as:

  - Steam & Utilities System
  - Flare & Loss programs
  - Fire & Cooling equipments
  - Acid Gas Removal Unit

  An initial economic evaluation performed either by simulation and/or spreadsheet analysis to identified estimated potential energy saving of each area.

- **ASSESSMENT**

  Opportunities identified during the **WALKTHROUGH** will be assessed and analyse further. A dedicated team was formed and located at site for a period of about 2-3 months to focus on detail study of each opportunity as well as exploring new potential area for improvement. The activities primarily centered on plant operating data analysis, simulation/calculation and interviews of plant personnel. Twenty-three (23) technical opportunities for further development and **IMPLEMENTATION** were identified.

- **IMPLEMENTATION**

  IMPLEMENTATION stage follows after **ASSESSMENT** phase. It was estimated that the period needed to realize these potential will be about a year and a half. All identified opportunities deemed feasible for implementation went through series of plant/unit test run, additional modifications and operational adjustment. It required involvement from various discipline such Engineering, operation, process control etc. During this period, team will developed all the monitoring tools, parameters and operational KPI for **SUSTAINABLE** phase.

- **SUSTAINABLE**

  The final stage of Energise program is called **SUSTAINABLE**. At this phase, team or site's energy focal point will continue to monitor and keep track the energy project(s) to ensure sustainability of energy savings.

The concept can be best illustrated as per Figure-5 below.

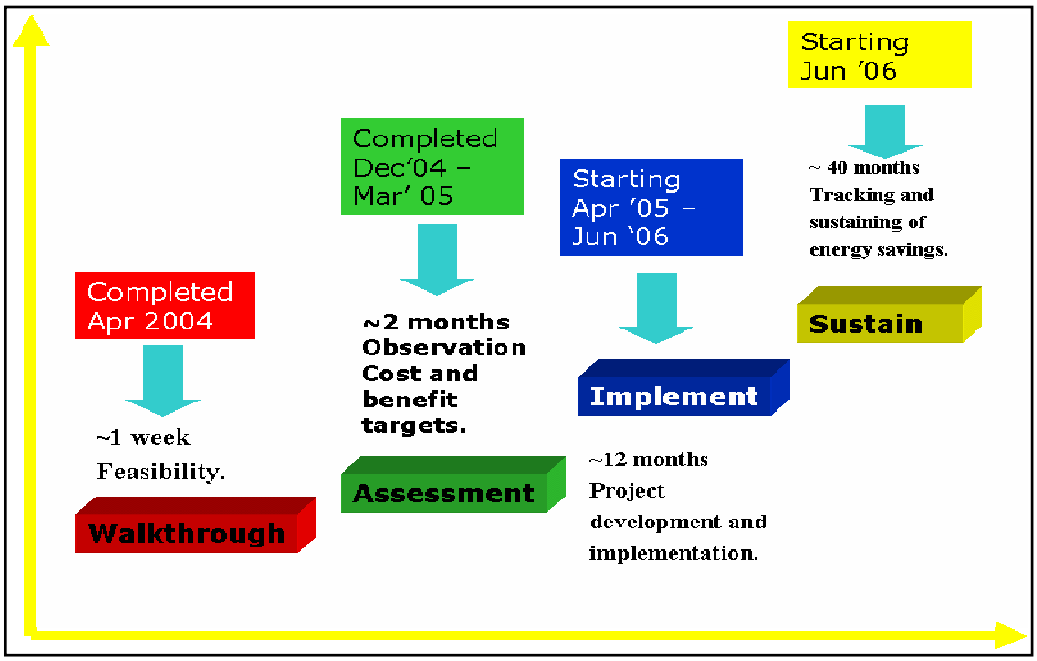

Figure 5: Implementation of Energise Program

4.0 ENERGISE IMPLEMENTATION

As team undergone **IMPLEMENTATION** phase, the original list was further refined to eighteen (18) projects which has been developed and classified. The actual implementation was phase-in within plant operation to minimize operational impact as well as build-up of confidence and buy-in by the operating personnel. Each implementation step was carefully selected and group together under wave of implementation.

WAVE 1

Focus on the operation aspect and "quick win" situation. Typical examples are:

- Optimise Incinerator and Boiler operations
- Adjusting steam operating condition i.e pressure and temperature

- Maximise condensate recovery and minimize LP steam bypass through LP turbo generator.
- Minimise fuel gas vent to flare

WAVE 2

Focused on process control optimization at identified operating unit such as in the acid gas removal unit, fractionation unit and cooler/condenser temperature control.

WAVE 3

Improvement project(s) with minor capital investment such as air cooler or fin fan cleaning.

From realization of these initiative, the contribution of energy saving can be categorise under several area namely control, maintenance, integration and operational procedure. Major contribution to the energy saving is project related to control modification (44 %) such as minimize fuel gas venting from V-2405 and De-Ethaniser bottom quality control. Maintenance project bring about 33 % of total savings and considered among the main contributor vis-a-vis as air cooler cleaning and steam trap replacement. Please refer Figure-6 below.

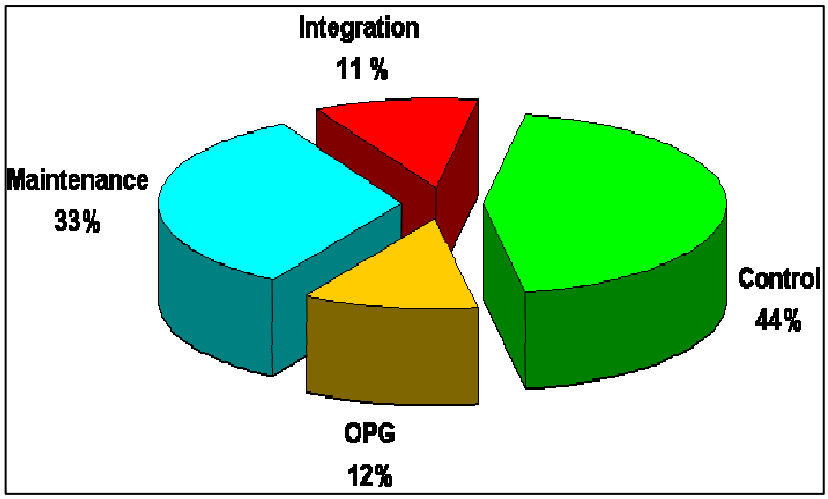

Figure 6: Opportunities area for Energy saving.

5.0 CONCLUSIONS

For an organization with a core business in energy production and supply, an efficient use of such commodity in its operation is highly critical to ensure cost competitiveness and minimizing impact to the environment.

During the development and course of the project, several challenges were encountered. Listed below are among the critical learning points in our pursuit to be a leading LNG supplier from energy efficiency perspectives:

- Commitment and support from top management is crucial
- Dedicated and focus team consist of multi-disciplinary background
- Continuously benchmarking oneself against others in the industry (ie. LNG/Gas) and to strive for operational excellence.

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