Nam Con Son Gas Project - Gas to Power – Bringing Clean Energy to Vietnam for Economic Development

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1 Introduction

1.1 Nam Con Son Gas Project

The Nam Con Son Gas Project (NCSGP) is a US$1.2 billion investment, comprising upstream, midstream and downstream projects, being managed by BP for the extraction of gas from the Nam Con Son basin for use in power generation in Vietnam (refer to Figure 1). The Nam Con Son basin lies some 370km south east of Vung Tau on the southeastern Vietnamese coast in 125m of water.

The upstream project is the development of the Lan Tay and Lan Do non-associated gas reservoirs, containing around 2 x 10^{12} scf (standard cubic feet), in licence block 6.1, with partners: BP, ONGC Videsh Ltd and PetroVietnam (PV). It comprises 5 subsea wells, subsea manifold, 13% Cr in-field flow line and the Lan Tay PLQ platform for dehydration and compression.

The midstream project is the Nam Con Son Pipeline, a regional pipeline, with partners BP, Pv and Conoco-Phillips. It comprises a 26" two phase trunk line to the shore, a short 9km onshore pipeline, a liquids extraction gas processing terminal and 25km 30" pipeline to a gas distribution center at the Phu My power complex. The offshore pipeline has provision for the tie-in of pipelines from future developments in the basin, such as BP's block 5.2/5.3 discovery and the Korea National Oil Company's (KNOC) block 11.2 reserves.

The downstream project is the development of Phu My 3 power station in partnership with Sembcorp Utilities Pte Ltd, Kyushu Electric Power Co Inc and Nissho Iwai Corp Machinery Co. This

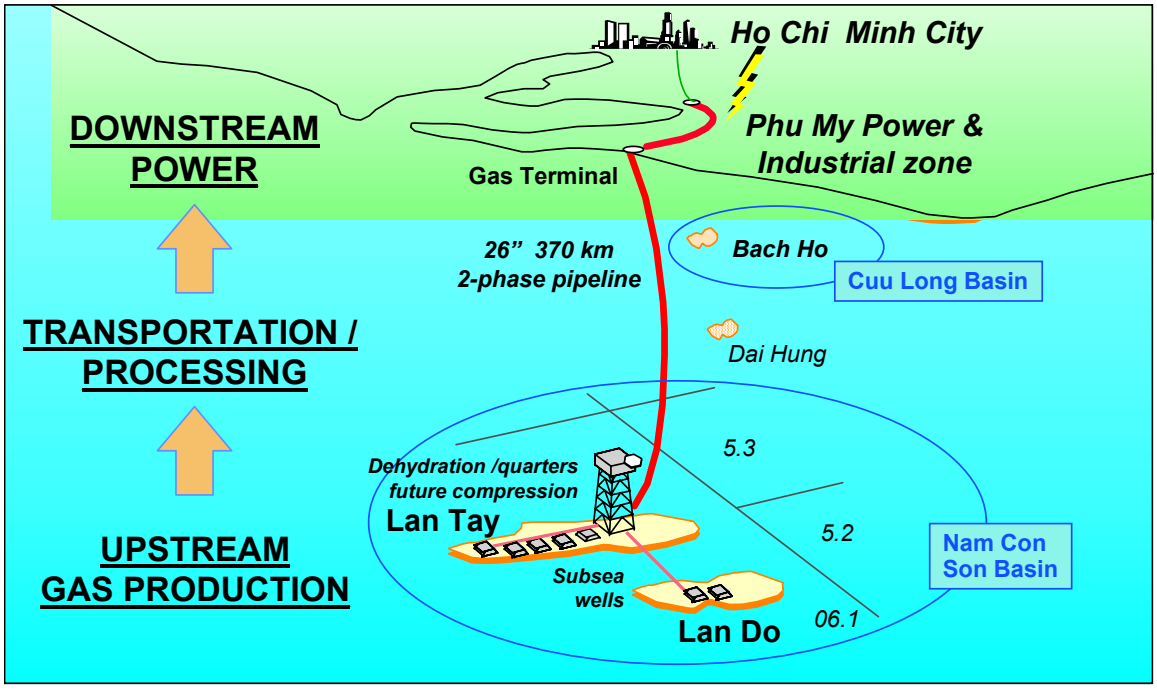

Figure 1 - Development Schematic

is a combined cycle 715 x 10^6 watt electricity generation plant, which will use the Lan Tay gas, thus encompassing BP's "Gas-to-Power" involvement in Vietnam.

	Block 06.1	NCSP	Phu My 3
Business	• Sell Lan Tay/Lan Do gas to PV for use by power plants	• Transport & Process Lan Tay/Lan Do and other gas for tariff	• Buy Lan Tay/Lan Do gas from PV, supply power capacity to Electricity of Vietnam.
Legal Form	• Production Sharing Contract (PSC) • Unincorporated JV	• Business Cooperation Contract (BOC) • Unincorporated JV	• Build – Operate – Transfer Agreement • Unincorporated JV
Operator	• BP	• BP (to be transferred to PV after 5 years of Operation)	• BOT Company
Partners	• BP 35% • ONGC 45% • PetroVietnam 20%	• BP 32.67% • Conoco 16.33% • PetroVietnam 51%	• BP 33.33% • Sembcorp 33.33% • NI/Kyushu 33.33% • No Vietnamese investor
Development	• Platform & five wells • Capacity: 360mmscf/d	• 26” dia, 360km rpipeline: 680 mmscf/d • Terminal 360mmscf/d - expandable for other gas and LPG at later phase	• 700MW Combined cycle gas turbine power plant • Siemens “F” technology

Figure 2 – Commercial Details

This paper describes the key drivers for the project: -

- Assisting Vietnam’s economic growth agenda with clean fuel, and using environmentally friendly technology.
- Delivering expertise, technology and training into Vietnam through successful facilities development and operation.
- Designing safe facilities, then constructing and operating them safely.

Vietnam has an aggressive economic growth agenda. The importance of providing significant quantities of low cost and clean energy is fundamental to this agenda. Currently much of Vietnam’s electrical power comes from burning expensive, imported diesel fuel. The Nam Con Son Gas and Phu My 3 Power Projects are to develop Vietnam’s natural gas resources to existing and new power stations, and deliver large quantities of electrical power into the rapidly expanding market.

The offshore, onshore and power station facilities have been designed to meet or exceed the emission standards of Vietnamese regulations and the BP global expectations. It should be noted that BP applies the same HSE standards in every country in which it operates. Examples of the BP’s efforts to minimize the impact of its operations on the environment of Vietnam include the following:

- The provision of oily water treatment at the terminal to reduce oil in water to < 5 ppm.
- The use of water based mud for drilling of the development wells on Lan Tay.

- The use of low emission gas turbines at the Phu My 3 power station (two Siemens advanced, energy efficient and low emission 94.3A Gas Turbines)
- The provision of waste management systems during construction of the terminal and power station.
- Waste heat recovery on the power generation on the platform and terminal to provide heat for gas treatment.

BP has made significant investment in Vietnam and has a long-term commitment to continue to build the company here in Vietnam into a highly reputable and quality business that fully embraces BP's brand values - performance, innovative, progressive, green. Aligned with this commitment, BP has been actively delivering technical knowledge and expertise with the objective of developing a self sustaining Vietnamese BP Company managed by national staff. BP has recruited over 150 Vietnamese technicians to operate the offshore platform, onshore terminal and Phu My 3 power station, and currently employs some 200 other Vietnamese professional, technical, and administrative staff in support functions. BP has created comprehensive training programs for these staff to build their competency levels and develop them to a degree of skill and expertise comparable with that of BP's operations in other regions of the world. The training of a large pool of relatively inexperienced technicians to the requisite level continues to be very successful and rewarding.

Safety is key to BP's business. Good safety is good business. Our goals are simply stated: - no harm to people, no harm to the environment and no accidents. Meeting these objectives starts with the design of safe facilities and continues with building and operating these facilities safely. BP use comprehensive management assurance processes during the design, procurement, construction and commissioning of the facilities, to ensure that they are as safe as reasonable practical. This starts in the design stage with state of the art safety engineering processes, including: hazard identification, quantitative risk assessment, risk mitigation and residual risk management. It is reviewed regularly, with thorough verification and assurance processes applied during the latter construction and commissioning stages. BP has, and continues, to work very closely with the various Vietnamese government and legislative agencies to provide the necessary assurance at national level, and in some cases helping the authorities to amend inappropriate regulations. By bringing in international experience from both within BP and contracting independent verification and inspection services from Det Norske Veritas, BP has enabled high levels of safety assurance, technical integrity and confidence in the safety of the offshore and onshore facilities.

The construction phases have brought particular risks. BP has invested heavily in personnel training, safety awareness, toolbox talks, protective equipment and safety behavioral coaching, for BP, Partner and contractor staff. Safety coaching has been conducted with all personnel on the Project - from the most senior level of contractor's management to the men and women at the workface – in order to drive the risk of personal injury to the lowest possible level. BP's senior management has been personally delivering the safety message all over the world, and especially wherever there have been Project related activities that carried significant risk. This includes not just Vietnam but also many other countries, including Korea, Singapore, Australia, Malaysia, Indonesia, US and UK. Results to date, after 10 million man-hours, show measurable improvement in safety in the contracting organizations working on the Nam Con Son Project with a DAFWC frequency well below industry averages**.** The safety success in the HHI's Korean fabrication yard, and the Vietnam construction sites Dinh Co and Phu My are particularly noteworthy. During the execution of this project BP has never knowingly compromised safety in the interests of cost or schedule.

2 Impact on Vietnam's Economy

"The Nam Con Son Gas Project is the most important in Vietnam. It will lay a foundation for the country's natural gas industry. The Government of Vietnam considers this project as the impetus for the southern economic area."[1]

The Nam Con Son Gas Project will commercialise the Lan Tay/Lan Do gas reserves in Block 06.1. This significant gas resource (2×10^9 scf) will form the foundation for the development of the gas industry in Vietnam and will make gas, as a sustainable national resource, equally as important as oil.

For Vietnam, the development of indigenous gas resources offers a major opportunity to boost the economy in a manner similar to many other SE Asian countries. This will be achieved through the utilisation of the gas to produce low cost electricity to provide the foundation for sustainable industrial and economic growth. Natural gas is viewed in Vietnam as a clean, reliable and affordable source of energy that, together with combined cycle power generation technology, will enable Vietnam to generate electricity:

- More quickly (development times of 1.5 years for CCGT vs. 3 years for conventional thermal power stations)
- More cleanly (substantially less air pollution than conventional thermal power stations)
- More efficiently (30% less energy input for the same electricity generated)
- More cheaply (circa 4c/kWh vs. 6c/kWh thermal; fuel cost approximately half that of imported diesel; capex $450/kW vs. $900/kW thermal)

NCSGP is a billion dollar infrastructure investment to produce and transport gas to the power market and fuelling some 40% of Vietnam's current power demand. In addition to this very tangible contribution to the gas industry, a wide range of regulatory, commercial, technical and operational aspects of the NCSGP are all notable contributors to the progress being made in Vietnam.

The Vietnamese regulatory system has had to undergo significant changes in order to secure the gas deal. Use of the gas-to-power chain was a valuable, visual tool, which was used extensively to petition the benefits of bringing gas to power as quickly as possible to displace imported diesel products. Phu My 1, 2.1e and 3 power stations can each use diesel in the single cycle gas turbine process if gas is not available. However, this is less efficient than generation using the gas fired combined cycle gas turbine process. The net effect of this, combined with the revenue benefits, is that Vietnam receives 35% of all gas revenues and would save Vietnam well in excess of US$1 million per day if gas is used in preference to diesel (using current pricing levels). In addition, gas is cleaner and would help to build a new industrial base, whereas virtually all the funds used to purchase diesel leave Vietnam, since at this time the country does not have oil refining facilities.

"Markets will only conclude transactions and develop themselves if the industry supplying them is seen to be robust and stable"[2]. The NCSGP's economic viability, commercial agreements, and the ongoing implementation will deliver this foundation. NCSGP delivers 58 x 10^6 m^3 to market at a plateau rate of $2.7x10^6$ m^3 per year, fuelling some 2,200 x 10^6 watt of power generation through an inter-linked gas to power chain. Constructing this chain has required skilled management and close co-operation across the Vietnam Government, PetroVietnam, Electricity of Vietnam and foreign investors.

Subsequent gas industry activity will proliferate, expand and diversify the gas market's commercial opportunities. The gas industry will develop with, potentially, other forms of investment and greater commercial flexibility stimulating the delivery of gas to a diversifying gas market.

3 Safety

3.1 BP's Commitment to Safety

Everybody who works for BP, anywhere, is responsible for getting HSE right. Good HSE performance and the health, safety and security of everyone who works for us are critical to the success of our business.

Our goals are simply stated - no accidents, no harm to people, and no damage to the environment.

We will continue to drive down the environmental and health impact of our operations by reducing waste, emissions and discharges, and using energy efficiently. We will produce quality products that can be used safely by our customers.

We will:

- ✓ ***Consult, listen and respond openly to our customers, employees, neighbours, public interest groups and those who work with us***
- ✓ ***Work with others - our partners, suppliers, competitors and regulators - to raise the standards of our industry***
- ✓ ***Openly report our performance, good and bad***
- ✓ ***Recognise those who contribute to improved HSE performance***

Our business plans include measurable HSE targets. We are all committed to meeting them.

Lord Browne
Group Chief Executive

3.2 Safety by Design

3.2.1 Process and Technical Risk Assessment

The design of both the onshore and offshore facilities was risk based. Process and technical risk assessment addressed hazards to personnel and the general public associated with the operation of the facilities. Risk Acceptability Criteria were defined for the project to ensure that the workforce and surrounding population are not exposed to unacceptable risk levels. The risk acceptability criteria were defined in terms of Individual Risk, and acceptability was demonstrated by means of a Formal Safety Assessment (FSA) process, as described below.

3.2.2 Formal Safety Assessment

The FSA process addressed process and technical risk. Hazards and possible accident scenarios associated with the operation of the facilities were identified and ranked by way of a formal review process in line with BP guidelines.

Starting with a base case design, the risk reduction measures already in place (including hazard prevention, hazard detection, hazard control and hazard mitigation features) were identified and their performance defined. On this basis, recognized risk analysis methods were applied to quantify the likelihood and possible consequences of the identified hazards to evaluate the predicted risk levels against the Risk Acceptability Criteria.

From this starting point, additional risk reduction measures and improved performance requirements were iteratively investigated until the risk levels were shown to be As Low As Reasonably Practicable (ALARP). The demonstration of ALARP was achieved when it was proved that the cost of further risk reduction is grossly disproportionate to the corresponding benefits in terms of safety of life.

Throughout this FSA process, Hazard Registers were maintained. These registers present the hazard management features in place to prevent, control and mitigate each hazard, present the main characteristics of each hazard, and provide a basis for the development of the Safety Management Systems for the operations phase.

3.2.3 ALARP and Design Decisions

As discussed above, the demonstration that the risks are ALARP was based on formal safety assessment. This implies that design decisions with a significant impact on safety were justified on the basis of the formal safety assessment.

Throughout the design phases of the Project development, design decisions with a significant impact on safety were justified by way of qualitative and/or quantitative risk assessment, as appropriate, documented in the form of study reports, technical notes or other traceable means.

The demonstration of ALARP provides links to the documentation justifying the design decisions that have led to the final design solutions.

3.2.4 Risk Assessment as Part of Approval Documentation

The FSA as described above formed part of the approval documentation through the Certificates of Fitness issued by the designated Independent Verification Body (IVB). The Certificate of Fitness for a facility is issued when the IVB is satisfied that the Performance Standards for Safety Critical Elements defined for this facility are acceptable and satisfactorily implemented as part of the design, procurement, fabrication and commissioning activities. The acceptability of the Performance Standards for Safety Critical Elements is demonstrated through the FSA process.

Risk assessment also forms part of the approval documentation since a risk assessment report is required by the Regulations on Safety Management of Petroleum Operations – Socialist Republic of Vietnam.

Final approval and the issue of a Certificate of Fitness to operate the facilities was given by DNV and the Vietnam Register of Shipping (VIRES) in the case of the offshore facilities, and DNV and the Ministry of Construction in the case of the onshore gas facilities. Electricity of Vietnam (EVN) will certify the Phu My 3 power station.

3.2.5 Up to Date Risk Assessments

The Formal Safety Assessment process described above was repeated to reflect each phase of the Project development. Any changes to the design or operating philosophy of the facilities was justified and recorded through the mechanisms established to meet the formal management of change process. Each update of the FSA studies addressed all changes identified as having and impact on safety of the facilities.

3.3 Construction Safety

3.3.1 Laying the Foundations

The underlying philosophy BP applied to construction safety was that cost, schedule, quality and safety had equal status, until safety came into conflict with one of these imperatives, then safety came first.

The safety plan for the project started with contractor pre-qualification. Contractors with poor safety management systems or poor safety statistics were disqualified from bidding for NCSGP contracts. Following development of a bid list, the contractors were invited to a town hall meeting chaired by BP. At this meeting the BP safety expectations and the consequences of non-compliance with the expectations were clearly explained to the contractors in advance of them submitting tenders for the work.

Specific clauses were written into the conditions of contract giving BP the ability to suspend or terminate the contract, at no cost to BP, due to poor safety performance on the part of the contractor. These suspension clauses were used to good effect on a number of occasions during the life of the project. Also, one contract was terminated prior to commencement of work due to the poor standard of the contractor's facilities and the low priority given to safety by the contractor's management.

3.3.2 Safety Leadership

Within BP it is recognized that the leadership is accountable for safety. All levels of the Business Unit and Project leadership exhibited the highest level of visible safety leadership at all times. In particular, the business unit leader devoted at least 25% of his time to safety related meetings with and visits to the project's contractors. This both gave the freedom for the project leaders to give safety priority and visibly reinforced BP's commitment to safety.

Safety professionals were assigned to each of BP's contract management teams. Their role was to act as consultants and facilitators to the contractor and team. In some cases BP and the contractors agreed to merge their respective safety resources into one integrated unit, providing common safety training, coaching, standards and assurance for the whole site.

3.3.3 Contractor Selection

The technical evaluation of the contractors' bids ensured that the contractors had an acceptable safety management system and that the contractors had fully understood the BP safety expectations. Each contractor's submission was given a score, the safety score being around 25% of the total technical evaluation score. At this stage any contractors who failed to achieve the minimum requirements were eliminated. The cost needed to bring all the remaining contractors to the same acceptable safety standard were estimated and included in the commercial evaluation phase.

3.3.4 Post Award Conditioning

Prior to commencement of work a safety gap analysis of the contractor's safety management system, organisation and facilities was undertaken and any shortfalls in relation to the project safety requirements identified. An action plan to close the gaps was agreed with the contractor, together with a schedule to closeout the actions. Construction activities were not allowed to commence until those actions agreed as required prior to commencement were verified as closed out by the business unit leader or project director.

Safety Performance Contracts were signed between the senior management of the contractor and BP. The contracts outlined the personal commitments of the managers to achieve exceptional safety performance.

3.3.5 Support during Execution

The BP management teams were encouraged to develop strong relationships with the contractor's leadership, and to openly discuss safety issues with them. They were also encouraged to attend safety related events such as award ceremonies and toolbox talks, and to carry out safety, inspections, observations and audits on a regular (daily) basis.

All employees were given a safety induction prior to them being allowed to work on the BP contract.

BP ensured that all the contractor's employees received adequate safety training to carry out the specific activities relating to his job. This included both general and job specific training.

Incentives to encourage the contractor's workforce to work safety were developed for each contractor. The incentive schemes varied to suit the culture and customs of the individual contractors and the country in which they were working. The incentives ranged from tee shirts for individuals who showed good safety performance, to electrical goods for safety improvement suggestions and donations to charity for overall good safety performance.

Job safety analysis was carried out for all activities. In the case of abnormal operations, such as heavy lifts and diving operations, specific engineering was carried out and the contractor developed procedures. BP's specialist engineers or third party consultants reviewed such engineering and procedures before the work was allowed to commence.

The safety input metrics such as safety observations, near misses, training, for each contractor were recorded and tracked, to ensure that sufficient attention was being given to safety by the contractors.

3.3.6 Assurance

A quarterly assessment of each contractor was carried out against the BP safety expectations such as "Getting HSE Right" and The Eight Golden Rules of Safety". The results of these assessments were used to identify gaps and action plans for the contractors.

4 Protecting the Environment

4.1 BP's Environmental Expectations

Environmental performance within BP Exploration is driven by the goal " No Harm to the Environment". The more specific drivers are the Upstream Environmental Expectations 2001. These are:

- **No Halocarbons** in new Projects
- **Extended well tests** will be by exception and must be fully justified
- **Greenhouse Gas emissions** will be maintained at the 10% below 1990 level until 2012
  - ✓ Eliminate continuous venting
  - ✓ Eliminate continuous flaring
  - ✓ A 15% energy efficiency improvement on 2000 by 2010
- **Air emissions** - significant local air emissions will be targeted by business units
- **Discharges to Water**
  - ✓ Discharge of oil based muds are prohibited
  - ✓ Discharge of all drilling muds and cuttings will be prohibited by 2005
  - ✓ All projects will have a target of zero routine discharges
- **Disposal to land**- all waste disposals must be justified by demonstrating the difficulty of reuse or recycling
- **Local environmental protection**
  - ✓ Minimising physical footprints of projects
  - ✓ Mitigating visual impacts
  - ✓ Restoring sites to original state
  - ✓ Involving stakeholders
  - ✓ Protecting local resources
  - ✓ Using an environmental management system

As shown by in figure 3, BP is targeting for a continuous reduction to the impact of our operations on the environment. BP's targets exceed those laid down in the Kyoto Protocol.

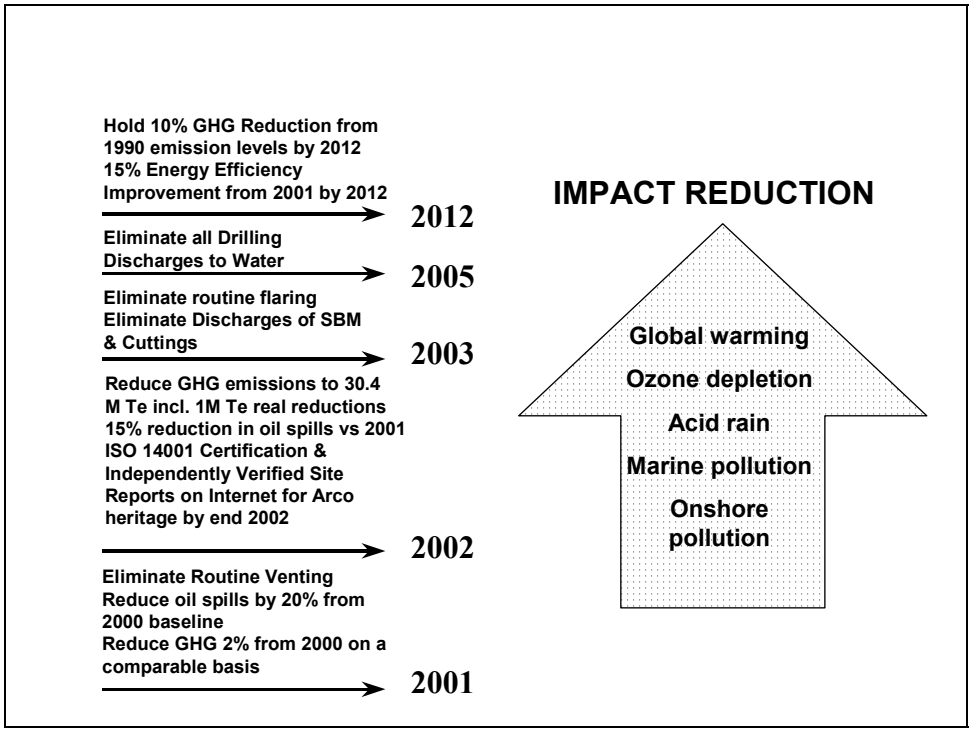

Figure 2 - BP's Environmental Expectations and Targets

4.2 The NCSGP Contribution

To comply with BP's expectations and Vietnamese regulations, the project prepared a Detailed Environmental Impact Assessment (DEIA) for the development of the offshore and onshore gas facilities, and for the Phu My 3 power station. The DEIA considered the potential impacts of all phases of project such as drilling, construction and commissioning, production and decommissioning. It also assesses the potential environmental impacts that might result from accidental events.

The following summarises the measures taken by the project to minimize the impact of the new facilities on Vietnam's environment.

- ✓ ***No Halons***

No Halons or CFCs have been used in any of the three parts of the Nam Con Son Project.

- ✓ ***Greenhouse Gas and Air Emissions***

Waste heat oil recovery has been used on the industrial turbines on Lan Tay platform and at Dinh Co Terminal; this has increased the thermal efficiency of the turbines from 30% to 50%. The recovered heat is used for gas processing. The Lan Tay turbines will be able to produce an additional 2 MW of power from the same fuel and the Dinh Co turbines will produce an additional 3.3 MW of power. The increased efficiency will lead to dramatic reductions in fuel use and hence CO^2 production and NO^2 (NOx) production.

The combined cycled power generation used in Phu My 3 Power Plant will result in a 66% increase in efficiency from the same volume of fuel, so will result in a corresponding drop in CO^2 and NOx.

Dry Low NOx technology has also been used at the Phu My 3 plant to reduce NOx emissions to below 50ppm and when the power demand increases on the Lan Tay platform, provision has been made to install Dry Low NOx turbines.

Sulphur dioxide and particulate matter are minimal when gas is burnt.

- ✓ ***No Flaring***

High pressure flaring on the Lan Tay platform and at the Dinh Co terminal have been eliminted during routine operations. The low pressure flare is used to prevent routing hydrocarbon venting from certain low pressure systems such as the glycol regeneration unit.

- ✓ ***No Venting***

All systems on the terminal and on the platform are routinely depressurised to the flare to prevent venting during maintenance and nitrogen purges are used where possible rather than hydrocarbon purges. The only routine venting will occur in very smll amounts from the open drains caisson offshore.

- ✓ ***No Fugitive Emissions***

Fugitive emissions can never be entirely eliminated from valves however they have been considered during valve selection and any valves in severe service are of low fugitive emission design.

- ✓ ***No Discharges to Water***

Water based drilling muds were used at all times, the mud being recycled as much as possible to minimise discharge to the environment.

Produced water from the Dinh Co terminal will comply with discharge specifications of less than 5ppm at all times.

Black and grey water for the terminal has been designed for zero discharge in the dry season. The water will be treated to 1 Coliform count/litre and used for irrigation purposes.

The temperature rise for the cooling water at the Phu My 3 Power Plant has been minimized to 7^{o}C. The outlet is 13 m deep and has a difuser to minimize the thermal impact on the river.

Oil interceptors are found in all the key areas of drainage around the Phu My 3 site

Wastewater will be continuously monitored before discharge to prevent the Phu My 3 site exceeding its discharge limits.

✓ ***No Discharges to Land***

There are effective waste management policies and procedures in place at all three sites. Recycling is encouraged and local waste contractors are supported in environmental improvement projects.

Measures are in place at all sites to prevent oil or chemical spills contaminating the land or sea. All chemicals and oils are bunded in drip trays able hold 110% of the liquid volume. Spill kits are available at areas of high risk and staff are trained in their use.

✓ ***Local Environmental Protection***

A number of local environment protection measures have been incorporated in the construction phase of the project including:

- Dust control measures.
- Traffic routing to prevent heavy traffic through residential areas.
- Public consultation meetings.
- Reinstatement of disturbed land and landscaping of onshore sites to minimize visual impacts.
- Monitoring of noise levels to ensure that they stay within acceptable limits.

4.3 Ongoing Environmental Responsibility

In order to achieve all of our expectations and to achieve the best environmental performance in the long term, each of the Nam Con Son Gas facilities will develop an environmental management system. This will ensure that every aspect of the environment is considered and that all the mitigation measures are implemented. The aim of an environmental management system is to achieve continuous improvement in our environmental performance. In order to ensure that the environmental management systems are of the highest standard they will be certified under the international ISO14001 standard. ISO14001 requires commitment to the environment at all levels of the company and an independent authority must audit us twice yearly to ensure that the management system is performing as it should and driving improvement.

4.4 Environmental Benefits of Gas Powered Electricity Generation

4.4.1 Gas Compared to Diesel Fuel for the Existing Power Stations

CO2 emissions per year

Table 1 details the comparative amount of carbon dioxide (CO^2) produced by the Phu My power stations whilst burning diesel fuel oil or NCS gas. It can be noted that when fired on gas there is an approximate 4 x 10^6 reduction in annual CO^2 emissions. This benefit will increase when the Phu My 2.2 and Phu My 4 power stations come on stream during 2004.

Power Station	Oil Fired (te/yr)	Gas Fired
Phu My 1	5.34×10^6	3.29×10^6
Phu My 2.1	2.32×10^6	1.43×10^6
Phu My 3	3.22×10^6	2.02×10^6
Total	**10.88×10^6**	**6.74×10^6**

Table 1 - Comparison of CO^2 Production[3]

Assumptions

- ✓ All the power plants are working at full capacity at all times
- ✓ The ratio of gas to oil used in the PM1 and 2.1 is the same as PM3
- ✓ The diesel fuel oil and gas used are of a standard composition.
- ✓ All the plants were totally oil fuelled previously

Sulphur Dioxide emissions per year

Assuming that all the plants were working on diesel fuel oil containing normally amounts of sulphur (i.e. not low sulphur fuel) the three Phu My power stations would produce 18.91×10^4 tonnes of sulphur dioxide per year. Using gas fuel the amount of sulphur is so small as to be negligible.

4.4.2 Gas Compared to Coal as a Fuel for Power Generation[4]

When compared with gas, coal has very few environmental advantages but numerous environmental impacts, such as:

- Coal will produce approximately 30% more CO^2 per year than gas
- Depending on the sulphur content of the coal a significant amount of sulphur dioxide (SO^2) will be produced in a coal power plant whilst a negligible amount will be produced when burning gas (27.3 84×10^3 tonne/year of SO^2 for a coal fired 720 MW power station equivalent to Phu My 3)
  SO^2 is responsible for a significant proportion of acid rain which impacts significantly on forest growth (for example in Europe, Scandinavian and German forests have been impacted by sulphur emissions from their Western neighbours) and a reduction in sensitive freshwater fish species. At high enough concentrations SO^2 affects bronchial functions in humans and animals.
- Coal produces a significant amount of particulate matter (84×10^3 tonne/year for a 720 MW power station equivalent to Phu My 3)
  Particulate matter results in pulmonary difficulties, increased illnesses of all descriptions and increased mortality rates in humans and animals.
- Coal also produces more nitrogen dioxide (Nox) per unit of electricity generated than gas
- Coal has a higher cooling water demand, land demand and building time than gas per unit electricity produced
- Coal cannot be piped therefore it must transported by road, rail or water.
  Road, rail or water transport, in its self, increases the energy required to generate a watt of electricity, there is also the pollution associated with transport and the local impacts of heavy road and rail traffic.
- Coal can be a significant source of heavy metals including mercury, lead and arsenic.

Heavy metals are known to accumulate in the food chain and have significant effects on human health.

- Coal mining is often open cast and hence heavily destructive to the environment, leaving huge scars and heavily contaminated spoil heaps.

- Coal power stations produce large amounts if solid waste that is heavily contaminated with heavy metals and must be land filled.

4.4.3 Gas Compared to Hydropower as a Fuel for Power Generation[5,6,7]

Although hydroelectric power stations offer significant environmental benefits, in particular the almost total lack of gaseous, liquid and solid waste and emissions, there are also some major environmental disadvantages as shown in Table 2.

Environmental Advantages	Environmental Disadvantages
• No solid or liquid wastes and no SO^2 , NO^2 or CO^2. • Can also help with flood control, drinking water supplies, fishing and wildlife habitat • Although hydroelectric reservoirs in tropical climates do produce significant amounts of methane due to the breakdown of plant matter, the overall CO2 equivalent is calculated to be about 20% of a coal fired power station and 30% of a gas fired power station.	• Hydroelectric dams destroy river habitats, altering the flora and fauna found there and in some cases destroying rare habitats. • The up and downstream movement of migrating fish species is prevented. • The reduced water flow can have a negative effect on water quality and hence on the health and diversity of fish populations • Deep reservoirs can cause increased heavy metals and reduced dissolved oxygen levels downstream of the damn, affecting fish populations and possibly human health. • During the dry season in Vietnam, hydroelectric power seriously reduced. • Often large numbers of people are displaced when dams are built to produce hydroelectric power, e.g. Pak Moon Village in Thailand[8].

Table 2 - Environmental Advantages and Disadvantages of Hydroelectric Power Stations

5 Developing the Vietnamese People

5.1 Technician Training & Development

5.1.1 The Strategy

The strategy is designed to ensure BP Vietnam can operate and maintain its operational facilities with national Vietnamese technical personnel who are safe, well trained, experienced and competent. The strategy not only addresses training requirements but also the assessment techniques employed to ensure staff can demonstrate their competence and knowledge in a practical work environment. Key elements of this include:

- The adoption and implementation of the Competence Management Assurance System (CMAS) as a framework for our formal skills identification, assessment and assurance process for operations and maintenance staff.

- Recruitment of qualified and experienced expatriate staff in key management and supervisory positions to provide coaching & mentoring to Vietnamese staff

- A top down commitment to development of *critical safety and technical skills* through an exceptional on-site coaching capability, to supplement both foundation and specialised training. A structured coaching model enables this for coaches and technicians, supporting developmental training, and an HR policy that recognizes the value of coaching, encouraging qualified staff to pursue this as a core career development experience.

- Access to a shared set of BP Group wide learning tools to assist those tackling organizational development, with practical tools, shared services with 3rd parties and a single integrated set of training and learning materials.

- Assessment of and proactive co-operation with our partners, vendors and local market place capability in the area of training design and delivery utilising existing resources and materials where possible

- A commitment to develop Vietnam as a centre of learning excellence, with direct access to BP international resources, to underpin learning pace and introduce new staff to our desired culture and behaviors.

- Use of BP's Competence On Line model to provide developmental frameworks for discipline engineers, Operations and maintenance supervision and Operations management. BP's online resource, "Competency On Line" will be primary tool through which gap analysis and development programs will be established.

The training program for technical operations staff has several key components:

- Induction & Safety Training
- English Language
- Technical Training
- Discipline specific skills
- Specialised skills
- Vendor Training
- Active involvement in Factory Acceptance Test's, Site Acceptance Test's and commissioning activities
- On the Job Training and experience on site in Vietnam and at other BP facilities where required
- CMAS - individual gap analysis and training programs

There is ongoing competence assessment through CMAS to ensure candidates are able to demonstrate not only knowledge and understanding of the material, but also practical ability to perform tasks effectively. The CMAS program defines two levels of competence:

- The individual is competent.
- The individual is not yet competent, (this may include situations where there is insufficient evidence to make a judgment).

The purpose of competence assessment is to ensure that only competent staff are employed to carry out tasks at their operating sites. The program ensures that staff are trained and assessed in the workplace on a regular basis. Assessment is carried out in accordance with the guidelines given in the CMAS procedures and is recorded in an online CMAS database.

The CMAS job profiles for each position at an operating facility clearly identify those skills or tasks an employee needs to demonstrate competence in along with the required training associated with that skill or task. The Vietnam CMAS profiles are customised to reflect the specific operational

requirements of the Vietnam BU.

5.1.2 The Future

As one of the major employers in the process industry in Vietnam, BP is faced with the ongoing challenge of recruiting suitably skilled staff to operate and maintain its operational facilities. In the next few years BP will have recruit further skilled staff to accommodate its own aggressive succession plan targets and staff in future expansion projects. Over the past 2 years BP has worked extensively with local institutions both in Vietnam and overseas to provide appropriate technical training for our staff. Throughout our recruitment, selection and subsequent training programs we have developed a clearer understanding of the skills and training available in Vietnam.

In November 2002 BP took the lead in setting up a Vietnam Process Industry Consortium. The main reason for establishing such a Consortium was to discuss and establish our collective needs, and work with educational and vocational training institutions to help Vietnam develop a suitably skilled workforce that can staff the process industry competitively in years to come.

The anticipated need for technical workers in Vietnam's oil, gas, process, manufacturing and power sectors will lead to a dramatic skills shortage unless more Vietnamese can receive the technical training needed to prepare them to fill these positions. We believe the Consortium can help to:

- Define industry specific workforce and skill needs, both now and in the future.
- Define the skill standards required by workers for specific jobs in the process industry
- Give Vietnamese educational institutions industry information to help them develop effective training and education programs;
- Provide opportunities for collaboration between industry and education in developing and delivering industry specific curriculum
- Connect state and local initiatives to promote education and training of Vietnamese for jobs in the process industry.

5.2 Professional Training & Development Strategy

For the past 4 years BP Vietnam has recruited a number of graduates, both technical and commercial, from the leading universities in Vietnam and overseas. The recruitment process starts with BP staging "Job Fairs" at the universities to present to final year students the career opportunities available in BP Vietnam, the competencies BP are looking for and the recruitment process. The BP presenters at the fair include both HR specialists and technical and commercial professional staff.

Following the fairs a 5-stage recruitment process is followed.

Stage 1 - Job vacancies are advertised in Vietnamese national newspapers and on the Internet. The latter media allows Vietnamese students studying at overseas universities to apply.

Stage 2 - Applications are screened and applicants are selected for initial interview.

Stage 3 - Human resource and discipline staff conduct interviews, and applicants are selected for further assessment.

Stage 4 - A two-day assessment event is held with all the remaining applicants. During this event the applicants are assessed through interviews, English language tests and collaborative and competitive team games.

Stage 5 - The assessors meet and agree on a score for each applicant.

Successful applicants are offered a graduate position with BP. On joining the company they enter Upstream Challenge Early Development Program consisting of both on the job, internal and external training. The program is designed to stretch the graduate and rapidly bring the graduate to professional status. For Vietnamese graduates the program includes intensive English language training.

The program provides for the development of an individual's discipline skills combined with a broad awareness of all aspects of the Upstream business. The program is;

- the basis for resourcing and renewing a large proportion of the professional disciplines from which, in the fullness of time, the future technical and business leaders may emerge.

- competency based with graduation linked to attainment of defined competency levels, while also providing broad exposure to all aspects of the Upstream business.

- individual Challengers managing their own development with appropriate support processes and networks, so that they are fully marketable in their primary discipline and beyond.

- based on real jobs, supported by a structured learning program and appropriate field experience.

The overall program intent is that by the end of Challenge, individuals should be fully functional contributors in their chosen discipline with sufficient competency in related areas to ask the right questions and know when to seek help.

Fully functional is defined as the individual meeting a set of competency criteria for their discipline. As with the technician training, the BP Competency Framework is used as the basis for skills development. Specific expectations are set as to what skills and to what level a Challenger should develop during their time on the program. These will help frame development discussions as well as training needs.

Competency is developed through real, on-the-job experience predominantly within discipline, field experience where appropriate, and a structured program of formal training.

Breadth across the Upstream business is a key element of the program. It provides Challengers with an appreciation of the totality of the business and the importance of working in multidisciplinary teams. The Induction Event is critical in providing broadening exposure and in developing an individual's international network. Breadth can also come from coursework, networking, multidisciplinary team working, and job assignments.

The principal accountability for a Challenger's development and assessment lies with the Line Manager and the Challenger.

Challengers are responsible for creating a Personal Development Plan. Each Challenger will have a Mentor to assist them in their development planning and to coach them on their competency development. All development assignments will be agreed and worked within a discipline-directed process involving the Line Manager, Mentor, Staff Network Leader, and the local Challenge Network.

Challengers will be assessed regularly on their performance and on their progress in attaining the required competencies.

In the last year of the program, the Challenger will be assigned a project to demonstrate the skills/competencies required of the discipline.

A number of Vietnamese graduates are given the opportunity to study for masters degrees at UK universities or by distance learning.

6 Conclusion

The upstream and midstream parts of the Nam Con Son Gas Project have been successfully completed, with first gas being delivered to the point of sale in December 2002. The project was

completed on time, below budget and with an excellent safety record. Since start-up the quantity of gas delivered has been steadily increasing as our customer gains confidence in the reliability and quality of BP's operation. The successful execution of the project has laid the foundation of the gas industry in Vietnam, and is beginning to contribute to Vietnam's future growth with clean and affordable energy. Over the coming years it is fully expected that this development will accelerate investment both onshore and offshore Vietnam, and will give confidence to other foreign investors considering Vietnam.

During the life of the project many thousands of Vietnamese workers have been employed on the gas processing and power station sites. We are confident that the high quality and safety standards deployed by BP will be carried forward by these workers, and set the standard for future developments in Vietnam.

Meanwhile, construction of the Phu My 3 power station proceeds on schedule to achieve commercial operation during 1Q 2004.

7 References

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