National Toxics Network Inc.

working towards pollution reduction, protection of environmental health and environmental justice for all

The Heavy Oil Power Deal
A Dark Cloud over East Timor's Bright Future.

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Introduction

National Toxics Network (NTN) is a NGO (non-government organisation) network working for pollution reduction, protection of environmental health and environmental justice for all. As the Australian focal point for the International POPs Elimination Network (IPEN), NTN works towards the full implementation of the Stockholm Convention on Persistent Organic Pollutants (POPs) 2001 and other relevant international and regional chemical treaties. NTN has a particular focus on children's environmental health.

The recent announcements by the Government of Timor-Leste regarding plans to 'electrify the nation' with a national power grid and 2 to 3 power generation plants are of interest to NTN. While the objective of providing reticulated electricity to all population centres in Timor–Leste is commendable, (and indeed essential for sustainable development) the proposed energy generation technology is a major step backward for the world's newest nation.

The announcement that the electrification of Timor-Leste would be powered by up to three heavy oil power plants has major environmental and economic implications for current and future generations in Timor-Leste. This report outlines the key environmental impacts that can be expected from the operation of heavy oil power burners and questions the economic logic of creating an energy distribution system dependent on foreign supplies of heavily polluting residual fuel oil.

NTN has a focus on environmental issues which involve persistent organic pollutants (POP's) which are now internationally recognised as some of the most toxic and damaging chemicals which pollute our global environment. Heavy Oil power plants are renowned for their high levels of air pollution including the release of extremely toxic PCDD and PCDF, otherwise known as dioxin and furans. These chemicals are known to deposit in soils for kilometres around the emission source (i.e., the power plants) as well as drifting through the atmosphere for thousands of kilometres to contaminate other countries. The transboundary nature of the pollution impacts from dioxin has led to global restrictions on activities which produce them.

In addition to dioxin contamination, heavy oil power plants contribute heavily to atmospheric acidification, heavy metal contamination and a significant risk to marine and coastal environments due to oil contamination of cooling water effluent discharge. Moreover as developed countries race to de-carbonise their economies in the face of accelerating climate change, Timor-Leste will be committed to decades of energy production with one of the highest carbon footprints. While heavy oil may currently appear to be a 'cheap' fuel for energy production, international carbon accounting and trading may soon place a heavy price tag on such dirty fuel.

NTN would urge the government of Timor-Leste to seriously reconsider their technology choice for their national energy generation needs. The pressing issues of the unavoidable pollution impacts, carbon generation and economic pitfalls of heavy oil based power plants, must be addressed.

It has been reported that considerable controversy surrounds the tendering and contractual arrangements between the Government of Timor Leste and the successful tenders for the project to supply energy production and a national power grid for Timor Leste. These issues fall outside of the scope of this report except in instances where the tender documents supplied by the Chinese Nuclear Industry 22nd Construction Company Ltd (CNICC) address matters that have environmental impacts. This report addresses the key features of environmental impacts arising from heavy oil based power plants and examines some of the claims raised by the Chinese engineers.

Pollution associated with a national economy dependent on heavy oil energy is not necessarily limited to point source emissions from stacks and effluent releases. There is a very real risk that tanker transport of heavy oil can result in spills and accidents causing long term environmental impacts and secondary economic impacts upon tourism and commercial fishing. The recent spill of heavy oil by the container freighter Pacific Voyager in south east Queensland is a case in point.

Above: Heavy oil fuel fouls beaches in south-east Queensland - March 2009

The Heavy Oil Power Plant Proposal

On 17th June 2008 the Timor Leste Ministry of Finance published a request for interested parties to submit an 'Expression of Interest and Proposal' to construct a national power supply grid and power generating plants sufficient to power all major population centres in Timor Leste.

The tender bid was unusual in at least two respects. Firstly, the time permitted to submit an expression of interest *and* a proposal for this major capital works programme was only around three weeks. This is a very short period of time for potential proponents to generate serious proposals for such an expensive and complex project. Initially around 300 million dollars were earmarked for purchase and construction of the power plants and distribution grid.

The second unusual aspect of the tender documents were that they specified that all bids must be based on the provision of power plants that burned heavy oil, also known as Oil Number 6, residual fuel oil (RFO), bunker oil or Navy special. This fuel type contains high levels of contaminants and required special management to allow it to be used as a fuel for power production. The environmental impacts of heavy oil burning are outlined in the section below.

In general terms tender processes for power supply do not specify a specific energy generation technology unless a process has already been conducted by government to evaluate the social, economic and environmental costs associated with a range of energy generation technologies. There is no evidence available to indicate that such a comparative assessment had taken place prior to issuing the expression of interest documents. While, the Power Sector Development Plan (ADB 2004) carried out a broad brush analysis of the power generation technologies that might best fit the development needs of Timor Leste it did not consider the comparative environmental impacts or sustainability issues associated with various modes of energy production.

If such a process had taken place it would have concluded that electricity generation based on the importation, storage and burning of heavy oil would have comparatively high environmental impacts compared to all other energy generation technologies. Economically, heavy oil is a relatively cheap imported fuel compared to imported distillate, coal or even gas. However, Timor Leste has significant reserves of both gas and oil that could be developed through joint venture partners to provide fuel for a national power grid. The proposal by CNICC indicates that heavy oil for the power plants would have to be imported for up to thirty years.

An economic comparison between energy generation from burning imported foreign-owned heavy oil versus oil or gas from Timor-Leste reserves could only result is a significant economic advantage for the latter assuming technology transfer and investment in infrastructure from a joint venture partner.

The *Power Sector Development Plan for Timor Leste* (Asian Develop Bank 2004) confirms that government policy documents and legislation developed in recent years demonstrate a clear ‘preference for development of indigenous resources’ (p.5). The contract to import heavy oil for energy production rather than utilise local fossil fuel is clearly at odds with national policy – even without due consideration of non-fossil fuel alternatives.

The development plan also rules out coal/-oil fired steam powered generation, offshore gas and nuclear power as being too large in scale for the needs of Timor-Leste. Heavy oil based plants are specifically ruled out at this point.

Timor-Leste's off-shore gas reserves from the Greater Sunrise field are not considered practical for energy production unless the current developer progresses a LNG plant on-shore in Timor-Leste. This does not appear likely at this point. However, there are numerous on-shore gas seeps that could be developed to supply the modest power production needs of Timor- Leste. Until recently exploration of these on-shore sources was being expedited by the government. The current position on these resources is not clear. The potential for renewable power generation are discussed at a later point in this report.

The Chinese Nuclear Industry 22nd Construction Company (CNICC) was awarded the contract to build the heavy oil power plants and transmission grid on 24th October 2008. It is clear from the company documents that they intend to install second-hand refitted Sulzer heavy oil generator engines that have previously been used in China. As such the lifespan of the power plant would be significantly less than new models and are unlikely to meet modern emission standards for developed countries.

The ADB forecasts Timor-Leste will require around 108 MW by the year 2025 to meet all of its development and growth needs. Currently Timor Leste uses around 18.6 MW with forecast demand of 37.5 MW by 2010 and 75MW by 2020.

By comparison the CNICC power plants will generate 180MW within two years vastly exceeding Timor-Leste demand even assuming full connection of all inhabitants to a new transmission grid. Spending hundreds of millions of dollars on such large amounts of redundant power production is questionable from any economic perspective.

The Dangers of Heavy Oil – a hazardous and dirty fuel.

Operating a power grid dependent on heavy oil can be a technically difficult and hazardous undertaking. Under many regulatory circumstances in developed countries heavy oil fulfils the criteria that would see it classified as hazardous waste. Indeed the viscosity and contamination levels in heavy oil are so great that its use in society is essentially restricted to combustion for energy.

Heavy Oil is the highest boiling fraction of all the heavy distillates from petroleum and form about 5-8% of the original crude oil it is refined from. The quality and molecular composition of heavy oil or Number 6 oil is very complex and variable and this in turn affects the types of emissions that evolve from the oil when it is combusted to generate energy.

Many of these substances are hazardous contaminants when released to the environment as spills or converted to air emissions. They include;

- Asphaltenes
- Poly aromatic hydrocarbons
- Naphthalene aromatics (dimethyl and trimethyl)
- Aromatics
- Saturated hydrocarbons
- Sulphur
- Nitrogen
- Metals

While all batches of heavy oil have their own chemical fingerprint it can be assumed that No. 6 oil contain around 15% paraffins, 45% napthalenes, 25% aromatics and 15% non-hydrocarbon compounds.[1] Napthalene is a recognized human carcinogen.

Because heavy oil is blended with cracked and uncracked hydrocarbon residues it contains elevated levels of polyaromatic hydrocarbons (PAH) of up to 5% in total. Many PAH's have been identified as carcinogenic in humans and animals. A typical analysis of heavy oil reports the following concentrations of PAH's[2]

Hydrocarbon	Concentration (ppm)
Phenanthrene	482
2-Methylphenanthrene	828
1-Methylphenanthrene	43
Fluoranthene	240
Pyrene	23
Benz(a)anthracene	90
Chrysene	196
Triphenylene	31
Benzo(a)pyrene	44
Benzo(e)pyrene	10
Perylene	22

Benzo(a)pyrene is listed as a Class A carcinogen by the USEPA and is known to cause cancer in humans. To put these levels in perspective heavy oil contains more than 15 times the levels of Benzo (a) pyrene found in Kuwaiti crude oil and 73 times more Benzo(a)pyrene than No. 2 fuel oil.

PAH's are difficult to break down and when combusted are partially released to atmosphere creating carcinogenic air emissions. They are likely to also be

[1] Irwin R.J. (1997) US National Park Service. Environmental Contaminants Encyclopedia. Fuel Oil number six. Entry p.25
[2] ibid

present in the solid waste residue left after combustion which in most cases is dumped at local landfills.

Sulphur and Nitrogen also lead to toxic air emissions and are found in large concentrations in number 6 oil at levels of between 1 and 4% by weight. While their combustion by-products can impact on human health (particularly nitrous oxides and sulphur dioxides) they have a very serious impact on the environment which is discussed below.

Heavy oil also contains metals such as nickel (89ppm), vanadium (270ppm), Magnesium (23) and copper (1.2). These metals either change to a gas phase and are emitted with other gases from the exhaust stack of the power plant or adhere to fine particles are also emitted to atmosphere. Recent research demonstrates that contaminated fine particulate from industrial emissions represents one of the main health risks to modern populations from air pollution.

This means that the heavy oil has toxic characteristics in its own right which require special attention in transport and storage to prevent leaks and spills. However, the burning of the heavy oil generates a whole new range of problems with toxic air emissions, hazardous solid waste and liquid effluent emissions.

Due to its inherent toxicity to humans and the environment heavy oil must be handled with great care to avoid spills to the environment – particularly in coastal areas

Therefore the key risks associated with heavy oil power generation are;

- Environmental damage from spills of toxic heavy oil
- Toxic air emissions
- Very high greenhouse gas emissions

The Hidden Costs of Choosing Heavy Oil for Energy Production?

The only reason to choose heavy oil as the fuel for a national power generation and transmission grid is because it Is cheap. On every other factor such as ease of handling, toxicity, environmental impacts and plant maintenance costs, heavy oils fails to compete with other fossil fuels such as coal, gas and distillate. When compared against renewable energy sources the gulf widens even further.

Heavy oil is essentially the cheapest, dirtiest fuel on the market for generating electricity with perhaps the exception of burning municipal waste. The costs for this fuel are so low because there is not a lot of demand. Most developed countries have environmental air pollution regulations that heavy oil fired power plants find very difficult to comply with. In order for them to comply they must

invest millions of dollars in pollution control equipment which is often better spent on converting the power plant to cleaner fuel sources.

While the off-the-shelf price of heavy oil may appear to be cheap compared to other fuels there are trade-offs and hidden costs that actually reduce the comparative economic advantages of heavy oil. For heavy oil there are greatly increased costs over gas fired plants from;

- Oil Storage- Large storage tanks are required and must be kept full to prevent moisture build up from condensate. Moisture converts the high sulphur content of the fuel to an acidic form which rapidly corrodes metal tanks.
- Heating of stored oil- because heavy oil is so viscous it cannot be pumped without pre-heating to allow it to be pumped more readily throughout the pipe work of the power plant. Heat exchangers based on steam pipe work are often used but the contaminated condensate is dumped to the effluent stream.
- Fuel oil additives – Sulphur and vanadium are present in high concentrations in heavy oil and require the addition of special treatment chemicals to reduce the corrosion effects on boilers and storage tanks.
- Oil pumping – increased energy costs associated with continual circulation of the oil in the storage tanks to maintain viscosity.
- Fuel oil atomization – the oil cannot burn in its normal form but must be atomised into droplets through steam or compressed air which requires high energy inputs.
- Soot blowing of boiler tubes – The build-up of soot on the fire-side of the boiler reduces heat transfer to the boiler and must be removed daily to maintain efficiency with steam or compressed air and regular manual soot removal must be conducted.
- Additional boiler makeup water – water must be preheated before addition to the boiler to prevent thermal shock and reduce oxygen corrosion of metals.
- Additional maintenance – higher maintenance costs are the prime economic disadvantage of heavy oil over gas powered plants. Dirty fuel translates to dirty machinery and soot removal and general maintenance costs are high.

When all is considered the cost of running heavy oil plants compared to running gas fired plants is around 2.7% higher, without even considering the hidden environmental and human health costs.. Nor does this include the capital investment costs associated with air pollution scrubbing equipment, which is much higher than for gas plants. The rapid corrosion of heavy oil engines due to high sulphur and vanadium content in the oil should be carefully considered in relation to the Timor-Leste proposal where some reports suggests that the second hand power plants being purchased by Timor-Leste may be up to twenty years old.

The increasing global recognition that heavy oil power plants are dirty and expensive to run with serious greenhouse gas emissions, has led to many developing countries closing these types of power plants converting them to cleaner fossil fuels such as natural gas.

Wärtsilä is a Finnish manufacturer of engine and boiler systems for power plants. They are increasingly being commissioned to convert older model Wärtsilä engines that run on heavy oil to gas and light oil/gas hybrids to help power plants meet their environmental regulations and provide more fuel flexibility and cheaper running costs. These include three is Brazil, four in Pakistan three in Portugal, three in Turkey, one in Germany and sixteen in Indonesia. Others in India and South America have already been converted to gas.[3]

China has recognized the problems associated with polluting thermal power plants and has shut down 46 small but 'heavy polluting' plants. China has also decided to shut down oil-burning units from 7,000 to 10,000 megawatts.[4]

The conclusion that must be drawn is that heavy oil fired power plants are becoming obsolete due to high running costs, toxic pollutants and high Greenhouse Gas emissions. Timor-Leste should do everything in its power to avoid this outdated and problematic form of energy production if they are to achieve reliable and ecologically sustainable power supply.

Environmental Impacts of burning heavy oil.

Burning heavy oil for electricity generation causes both local and international environmental and human health impacts. Depending upon wind directions and speed many parts of Timor-Leste could be impacted by the black smoke and sulphurous pollution associated with heavy oil burning.

Local atmospheric impacts that can be expected would be high levels of sulphur dioxide (SO_2) emissions and oxides of nitrogen (NO_x) as well as fine particulates.

Oxides of nitrogen (NO_x)

Oxides of nitrogen are a group of highly reactive gases generated from burning fossil fuels. It is one of the main ingredients in the formation of ground level ozone which can trigger serious respiratory problems. They also react to form particles and acidic aerosols which can further damage human respiratory systems. NO_x contributes to the formation of acid rain and deposits nitrogen into waterways causing nutrient overloads which in turn can lead to algal blooms.

[3] Diesel and Gas Turbines Worldwide. 2007
[4] *China Daily* November 5, 2007

In the air NO_x reacts quickly with organic chemicals and ozone to form toxic byproducts including the nitrate radical, nitroarenes and nitrosamines. It also reacts with ammonia and moisture to form nitric acid and related particles. The particles behave in the same way as described for PM2.5 (see below) and can lead to emphysemia, bronchitis and can aggravate existing heart disease.[5]

Sulphur dioxide (SO_2)

Due to the very high content of sulphur in heavy oil it can be expected that sulphurous emissions from the power plants will be high. This may lead to serious environmental impacts for Timor-Leste due to the frequency of inversion layers in the atmosphere over the island and the low wind speeds (particularly in coastal areas of the island where the power stations are likely to be sited.

SO_2 is created when burning materials high in sulphur content such as crude oil and coal. It dissolves easily in water and when emitted from a smokestack it dissolves into water vapour to form acid. Like NO_x it contributes to respiratory illness particularly in children and the elderly, and aggravates existing heart and lung diseases.[6]

From an environmental perspective SO_2 is particularly damaging due to its role in forming acid rain which damages trees and crops and makes soils, lakes and streams acidic which in turn can kill off all organisms in those water bodies.

PAH's and particulate.

PAH's as discussed earlier have the capacity to cause cancer in humans. They are present in the heavy oil in high concentrations and can survive the combustion process where they migrate and adhere to fine particles and ultrafine particles known as PM10 and PM2.5 respectively (the 10 and 2.5 refer to the size of the particles in microns).

PM2.5 is especially dangerous as the ultrafine particles have been found to penetrate deeply into the lungs of humans and cause damage to the respiratory system. These particles may or may not have contaminants adhered to them. If they do have contamination present or if they are particles of toxic material such as nickel dust then the contaminants are believed to be able to cross the tissue barriers in the lungs to the blood carrying the toxins with them. PM2.5 levels can be monitored by modern stack and ambient air monitoring equipment.

[5] USEPA website – Common Air Pollutants. http://www.epa.gov/air/urbanair/nox/hlth.html
[6] ibid

Dioxins and Furans

One of the most toxic substances ever assessed is polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/ PCDF) - also known as dioxins and furans. Dioxin and furans are extremely toxic even at extremely trace levels. These toxins are unintentionally created by combustion of carbon and chlorine together. Brominated dioxins and furans are created by burning carbon and bromines (including salts) together.

As one of the most toxic persistent organic pollutants (POP's) it is heavily regulated under international law through the Stockholm Convention on Persistent Organic Pollutants.

Burning heavy oil is a known source of dioxin and furan formation. A scientific team in Taiwan published recent demonstrating the presence of dioxin in heavy oil power plant emissions but did not specify the type of pollution scrubbing devices used to control emissions. They found the mean emission concentration and I-TEQ concentration of total PCDD/Fs were 0.292 ng/N m^3 and 0.016 ng I-TEQ/N m^3, respectively.[7]

Dioxins persist in the environment for long periods of time contaminating soils around point sources such as power stations and biomagnifying through the food chain until they reach humans where they deposit in the fatty deposits in the body.

The Marine Environment

Heavy oil power plants such as those proposed for Timor-Leste can have significant impacts on the coastal and marine environment. The impacts can be separated into spill related impacts and long term effluent disposal impacts.

Heavy oil spills

Spills of heavy oil through shipping accidents, pipe bursts or tank failures have a high level of impact on coastal environments that can linger for decades. Heavy oil contains many pollutants (see above) that can contaminate coastal sediments and poison wildlife well after the visually obvious blobs of oil have been cleaned up. Timor-Leste faces the possibility of major oil spills along its southern and northern coasts if port facilities for heavy oil delivery are collocated with power plants proposed for Manatuto and Hera on the north coast and Manufahi on the southern coast. Land clearing for construction at Hera has already begun.

[7] Ya-Fen Wang et al (2008) Emissions of polychlorinated dibenzo-p-dioxins and dibenzofurans from a heavy oil-fueled power plant in northern Taiwan.

(Left) Heavy fuel oil on the beach at Mishaum Point Massachusetts during April 2003.
The oils spills around Mishaum Point and Buzzard Bay resulted in the closure of lucrative local shellfisheries for a number of years

Oil in the rocks on Smith Neck (Mishaum Point)
April 29, 2003
photo credit Aria Brisette, BBP

According to the national Oceanic and Atmospheric Administration (NOAA) of the US Department of Commerce, "Adverse effects of floating No. 6 fuel oil are related primarily to coating of wildlife dwelling on the water surface, smothering of intertidal organisms, and long-term sediment contamination. No. 6 fuel oil is not expected to be as acutely toxic to water column organisms as lighter oils, such as No. 2 fuel oil. Direct mortality rates can be high for seabirds, waterfowl, and fur-bearing marine mammals, especially where populations are concentrated in small areas, such as during bird migrations or marine mammal haulouts."[8]

Spills of heavy oil in the near shore environment can be very difficult and expensive to break up due to the nature of the material. Most clean-ups are based around removal of visible oil from beaches, rocky shorelines and mangroves but even after these preliminary cleaning measures more persistent contaminants from the oil such as PAH's can have ongoing impacts within the sediments for years. Contamination of sediments with PAH's and heavy metals

[8] National Oceanic and Atmospheric Administration of the US Department of Commerce (NOAA). *Fuel Oil (Bunker C) Spills.* November 2006.

from the heavy oil have been responsible for past cases of shellfish contamination. Heavy metals and PAH's have a tendency to bioaccumulate up through the food chain with shellfish passing their toxic burden on to the fish and birds that eat them. In turn humans eating these fish or birds (or shellfish) will be exposed to the cumulative toxic loads that have built up in these creatures.

As the NOAA note *'shorebirds, which feed in intertidal habitats where oil strands and persists, are at higher risk of sublethal effects from either contaminated or reduced population of prey.'* [9]

Vegetation can also suffer heavy damage. In December 1978 the barge Peck Slip released 440,000-460,000 gallons of Bunker C fuel oil into Bahia Medio Mundo, Puerto Rico, oiling at least 10km of mangrove-dominated shoreline. The heaviest defoliation of mangroves, seedling mortalities, and mortalities of canopy-dwelling animals were observed where the heaviest oiling had occurred. In the inner fringe impact, oil was concentrated on the inner mangroves, which are located on the inner berm of the forest. The affected inner berm site became heavily defoliated within 2 months of oiling, and remained so 18 months later, with the substrate and prop roots remaining oiled even after Hurricane David in 1979. [10]

In December 1968, the tanker Witwater ran aground off the Caribbean coast of Panama, releasing 20,000 barrels of diesel oil and bunker C fuel oil. Injury to mangrove habitats was assessed qualitatively approximately 2 months after the discharge. The pneumatophores of black mangroves were thickly covered with a mixture of mud and oil. Prop roots of red Mangroves were coated with a thick layer of oil. Red mangrove seedlings were covered with oil and suffered massive mortality. Populations of crabs, Uca sp., were reduced relative to non-oiled areas.[11]

Because the danger of spills from supply tankers will be an ever present problem if the heavy oil power plants proceed, Timor-Leste will have to make significant budgetary provisions for environmental emergency response and oil recovery programmes including personnel, training, dedicated equipment and provision to fly in specialist expertise in the event of a major spill.

The marine environment also faces a more pervasive threat from the power plants which directly relates to liquid effluent discharges from each of the power stations. According to the proposal CNICC *'Major pollution generated by heavy fuel generator plant is waste gas pollution of exhaust smoke and release of waste water containing oil or oil leak pollution to the sea.*[12]*"*

[9] NOAA (2006) ibid
[10] Op. cit. Irwin (1997) at 22.
[11] ibid. 23
[12] CNICC (2008) Proposal from Chinese Nuclear Industry 22nd Construction Company, Ltd. to the Government of Timor‐Leste for Heavy Oil Power Plants and Nationwide Electric Grid. P.29

The environmental protection commitments attached to the CNICC proposal are extremely scant and provide little or no detail as to how emissions will be controlled (i.e., there are no references to emission scrubbers or wastewater treatment plants). Each power plant will require large volumes of cooling water, which the Chinese engineers intend to source from coastal marine waters and then *'seawater after cooling process of the units will be concentrated into a drainage channel to sea'*[13]. For this purpose each power plant will have a seawater retention pond of around 2000m^3.

No indication is given about the contaminant concentration within the effluent water or any possible environmental effects. In the US effluent from cooling processes of oil based power stations are heavily regulated. Some of the contaminants that are regulated in the waste waster are oil and grease, Total Suspended Solids (TSS), chlorine, copper and chromium. List of 126 other priority pollutants are also managed under the US EPA Industrial Wastewaters programme.

While CNICC have offered to install oil/waste separators in the 'drainage system' of the plant it is not clear if this refers to the marine water cooling discharges or storm water runoff or both. In any event cooling waters have to be chemically treated to reduce corrosion within the boiler area of the power plant. Using sea water which has high bromine/salt content will exacerbate this problem and require a higher level of chemical additives in make-up water to prevent corrosion. Oil and water separators in the drainage system will not filter these additive chemicals, which will discharge directly to seawater in the coastal environment. If it is claimed that cooling water is discharged 'clean' to the marine environment, then the question must be asked as to why the water is not recycled back through the cooling process of the power plant.

Greenhouse Gas Emissions

Apart from the localized impacts of pollution from toxic air emissions and wastewater discharge due consideration must be given to the emission of Greenhouse Gas (GHG) in the form of CO_2 from the oil fired power stations

According to USEPA statistics oil fired power plants emit on average of 758.6 kg of carbon dioxide per megawatt hour. This makes oil fired power plants one of the most polluting energy forms in existence in turns of GHG production.

As climate change accelerates rapidly, countries all over the world are turning away from oil fired power stations due to their high GHG emissions. Most developing countries are shutting down or converting such plants to run on natural gas.

[13] ibid p.7

The Table below compares the comparative GHG intensity (in carbon terms) of coal, gas, heavy oil and light fuel oil. The comparison involves carbon output after combustion as well as the total carbon equivalent output including carbon emitted during the processing of the fuels to make them suitable for combustion. Clearly heavy oil has the highest CO_2 emissions and highest emission factors of any fuel type[14].

The estimates in the table above do not include the carbon emissions generated by transport of bulk heavy oil by sea. It should also be a consideration that the extraction and processing of heavy oil are GHG intensive with some industry estimates suggesting that lifecycle emissions for heavy oil vary from roughly 15 percent above conventional oil use levels to over 50 percent or more.

If Timor- Leste is to assume a degree of global responsibility in efforts to control climate change then its leaders could not have started with a worse choice of electricity production. There must be serious consideration of renewable energy proposals for the long-term sustainable energy supply of Timor-Leste. The $300 million that the government intends to spend on these power plants may well be sufficient to establish renewable power generation with natural gas as a transitional energy source.

[14] These CO2 emission factors are based upon data provided by the *Carbon Dioxide Information Analysis Center* of the government of the United States and the *Canadian Association of Petroleum Producers* (*CAPP*): (*Carbon Dioxide and Climate - Third Edition (ORNL/CDIAC-39), Edited by: Fred O'Hara Jr., Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1990 (www.cdiac.ornl.gov/pns/convert.html); A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry / Volume 1, Overview of the GHG Emissions, Canadian Association of Petroleum Producers, Calgary, September 2004.)*

Table 1. Relative Carbon Intensities of fossil fuel.

Fuel type	**Carbon content per ton (or 1000m^3)**	**CO2 after combustion of 1 ton of C (tons)**	**Emission factor per ton/ 1000 m^3 combusted**	**CO2 generated in production/ processing (per ton)**	**Total CO2 emission factor inclusive of burning and prodn**
Light and medium crude or NGL	0.85 ton	3.664	3.114 ton CO2 per ton crude oil or NGLs.	0.21 ton of CO2 per ton of light/med or NGL	**3.324 ton**
Heavy oil	0.85 ton (once converted to light and medium)	3.664	3.114 ton CO2 per ton. Of heavy converted to light/med (0.078 kg CO2 per MJ)*	0.746 ton CO2 per ton crude oil or NGLs.	**3.860 ton**
Natural gas	0.525 ton per 1000m^3	3.664	1.924 ton CO2 per thousand m3 of natural gas. (0.056 kg CO2 per MJ)*	0.191 ton CO2 per thousand m3 of natural gas.	**2.115 ton**
coal	0.746 ton	3.664	2.733 ton CO2 per ton coal. (0.093 kg CO2 per MJ)*	? unavailable	**>3 ton**

Timor-Leste is mountainous country with hydropower and solar/wind power potential (apart from its on-shore oil and gas). For a country with relatively low power needs the pursuit of ecologically sustainable development through renewable energy sources would appear to have great potential. The ADB Power Sector report supports development of a range of renewable power sources including hydropower, solar and wind power in suitable locations.

Timor-Leste should also be wary of the contractual obligation to source heavy oil from foreign entities. As climate change accelerates and global carbon trading/taxation regimes emerge those using high carbon intensity power generation will pay a high price. The carbon pricing may be reflected in the cost of the oil which currently may seem cheap but which may be relatively expensive and a burden on economic growth of Timor-Leste.

One of the key Timor-Leste policy problems that has emerged during the debate over the power stations is the lack of a coordinated environmental assessment process for industrial proposals.

NTN strongly recommends the adoption of a detailed (if ad hoc) public environmental assessment process for the proposed power stations to address community concerns and to investigate the long-term ecological and financial costs of this from of energy production. Ideally Timor-Leste would soon create a statutory public environmental assessment process conducted by a dedicated independent environmental authority resourced by government to consider all other projects that may have an impact on the environment of Timor-Leste. There are many models globally on which to base an assessment process.

Conclusion

The current proposal to establish 180MW of heavy oil-fired power generation in Timor-Leste is environmentally unacceptable and carries many hidden costs.. The proposal is fraught with dangers for the population and government. It is clear that what is being offered are old and polluting power units that are being phased out in the rest of the world due to their high service costs, high emission levels and extremely high GHG intensity.

The fuel for the power plants is essentially hazardous waste from oil refining that contains high levels of PAH's sulphur, vanadium and nickel. Combusting these materials along with the oil will generate atmospheric contamination that includes dioxins and furans. Any spill of these materials during delivery of the fuel could have very serious long-term impacts on the environment, fishing and tourism industry of Timor-Leste.

The proposal by the Chinese Nuclear Industry 22nd Construction Company, Ltd contains very little information on environmental management of the proposal and no data on the emissions that will be expected from the power plants. Similarly there is virtually no information of fate of toxic ash and other solid wastes that will arise from the power plant.

This proposal should be subject to an immediate and thorough Environmental Impact Assessment that fully investigates any potential impacts and their consequences for Timor-Leste. It would also be appropriate to reopen the tender process and to allow for proposals that use fuels other than heavy oil (including renewable energy proposals) to bid for the contract.

NTN strongly urges the Government of Timor-Leste to halt this process and re-consider alternative energy sources for their people and to avoid decades of commitment to polluting old technology that other countries are already phasing out.

This report was facilitated by the Australian Conservation Foundation to assist Timor-Leste civil society in analyzing and educating about the proposed heavy oil power project.