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Socialist Republic of Vietnam
Ministry of Industry

United Nations
Industrial Development Organization

Integrated Programme of Cooperation between the Socialist Republic of Vietnam and UNIDO 2003-2005

Project # 8: Hazardous waste management

Technologies and procedures for the eco-friendly disposal of used oils and lubricants in Vietnam

Hanoi, August 2005

Project Brief

PROJECT TITLE	:	Technologies and procedures for the eco-friendly disposal of used oils and lubricants in Vietnam
COUNTRY	:	Vietnam
PROJECT NUMBER	:	XX/VIE/05/XXX
TOTAL BUDGET	:	1,785,400 US$ (including 13 % agency support cost)
DURATION	:	3 years
PROJECT START	:	January 2006
GVT COUNTERPART AGENCY	:	Centre for Environmental Protection and Chemical Safety Ministry of Industry
EXECUTING AGENCY	:	UNIDO
UNIDO TASK MANAGER	:	Cleaner Production and Environmental Management Branch Programme Development and Technical Cooperation Division

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The oil industry in Vietnam sells some 270,000 tons of lubricant annually. Of this it is broadly estimated that 50% is recoverable as used oil (e.g. 60-70% recoverable in gasoline engine oils and 30-60% in industrial lubricants). *This means that some 135,000 tons is generated annually in Vietnam. It is estimated that the* lubricant demand will grow annually at 15%.

Major industrial centres in Vietnam generate 2.6 mton/year of industrial waste. Industrial waste especially hazardous waste does not have necessary waste treatment facility. Wastes are not segregated at sources and urban environment companies collect 40-67% wastes while 20-40% in small towns. 80% of non-hazardous industrial waste is recycled. *(Economic Times Vietnam, May 2005)*

1 ton of used oil could damage 3 ha of soil or 10 km2 of surface water. Oil can persists for a long time in soil and water creating secondary adverse impacts to the ecosystems and ultimately entering the food chain. Simply reflect one oil change when improperly disposed of, can ruin one million gallons of fresh water. Used oils may contain hazardous compounds accumulated during their use, such as PAHs and heavy metals.

Branded engine lubricant is sold at 22,500 Dong/litre, non-branded (made from used oil) at 7500 Dong/litre and used oil at 1000 Dong/litre. Fuel oil is sold at 4000 Dong/litre and re-constituted fuel oil (made from fuel oil) at 3000 Dong/litre. These numbers indicates the high economic value of used oil in Vietnam to be re used rather than released into the eco-system.

The oil generators range from small motor/metal workshops who provide auto maintenance services, domestic industry, SME to large industries i.e. mining, shipping, government, transport industry, oil exploration & production etc. *There needs to be an accountability process to provide transparency to this complex network.* Yet there is at present no accounting system to ensure used oil is collected and disposed in an environmentally acceptable manner.

Against the above, it is key to manage used oil generators, transporters, collectors, keepers and treaters to ensure acceptable environmental protection measures are in-placed for sustainable development.

Responsible and effective used oil management seeks, in a structured manner, to minimize the risk of health and environmental liabilities and incidents, which may be caused by mishandled of used oil. This proposal provides structured guidelines for setting up a country plan for used oil handling and disposal operations, and proposes in some detail possible technical solutions.

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Abbreviations

CECS	Centre for Environmental Protection and Chemical Safety, Ministry of Industry
DOE	Department of Environment (Malaysia)
DONRE	Department of Natural Resources and Environment
EIA	Environmental Impact Assessment
GCA	Government Coordinating Agencies
HSE	Health, Safety and Environment
IIC	Institute of Industrial Chemistry
MFO	Medium Fuel Oil
MOI	Ministry of Industry
MPI	*Ministry of Planning and Investment*
MSDS	Material Safety Data Sheet
PAC	Polycyclic Aromatic Compound
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PPE	Personal Protective Equipment
RFO	Recovered Fuel Oil
RRBO	Re-refined Base Oil
SME	Small and Medium Enterprise
UNIDO	United Nations Industrial Development Organization
UNV	United Nations Volunteers
VNCPC	Vietnam National Cleaner Production Centre

Acknowledgement

This project was developed by the Institute of Industrial Chemistry, Ministry of Industry and UNIDO. The formulation process benefited in February and May 2005 from the technical support of two experts sponsored by Royal Dutch Shell plc under the UN Volunteers' scheme. The Ministry of Industry and UNIDO would like to express their sincere gratitude to Royal Dutch Shell and the UNV for the fruitful cooperation.

Part I. BACKGROUND AND DEVELOPMENT CONTEXT

1. Introduction: the UNIDO Integrated Programme for Vietnam

Small and medium enterprises (SMEs) account for over 90 percent of manufacturing employment in Vietnam and contribute an impressive 45 percent of the domestic creation of economic wealth. Operating at relatively low levels of skills and capital, they are also better distributed geographically and must play an instrumental role in spreading more evenly the benefits of growth between rural and urban areas.

With the current stagnation of larger State-owned enterprises and the limited prospects of the cooperative and household sectors, SMEs represent the backbone of future productive capacities in the country. However, they are faced with a host of constraints that severely curtail their contribution to the country's development efforts and the overarching goal of poverty eradication: a policy and regulatory environment under construction, weak institutional support, inadequate physical infrastructure, inefficient markets for goods, services and factors, low levels of productivity, insufficient investment in technology and skills development, limited exposure to foreign trade, etc.

The Government and the donor community are taking active steps to address these constraints: the Socio-Economic Development Strategy endorsed by the IXth Party Congress brushes a long-term vision of future challenges and opportunities, and charts the course of concerted efforts between Government and foreign partners along the Comprehensive Poverty Reduction and Growth Strategy.

Closer to the particular objective of SMEs promotion, the Government and the Party have produced in recent months two fundamental pieces of policy reform: Decree No. 90/2001/CP-ND of 23 November 2001 "Supporting the Development of SMEs", followed on 18 March 2002 by Resolution No. 14-NQ/TW of the Party's Central Executive Committee "Continuation of Renovating Policies and Mechanisms to Promote and Facilitate Private Sector Development".

The cornerstone of the Decree is the establishment of an SME Development Department within the Ministry of Planning and Investment, backed by an SME Development Council and assorted with a web of subsidiary promotion centres underscoring the participatory nature of the scheme. The Resolution for its part aims at erasing persisting distortions against private ownership in business, by a range of policy reforms on land tenure, labour rights, and access to finance, technology and information.

Within this broad framework, UNIDO and the Government of Vietnam have chosen to focus their *Integrated Programme of Cooperation 2003-2005* on three key areas, in which UNIDO has been actively involved for many years:

- Institutional aspects of SME promotion, building on the pioneering work initiated with the Ministry of Planning and Investment in 1996;
- The development of rural industry, through the development of physical and social capital;
- The promotion of cleaner production in manufacturing activity, at a time when Vietnam finds itself at the crossroads of major technology choices with long-term consequences.

Advisory services under these three broad categories will be delivered through a combination of:

- Technical assistance projects in Vietnam;
- Exposure of Vietnamese decision-makers —in Government and in industry— to lessons learned in countries facing similar challenges along their development path.

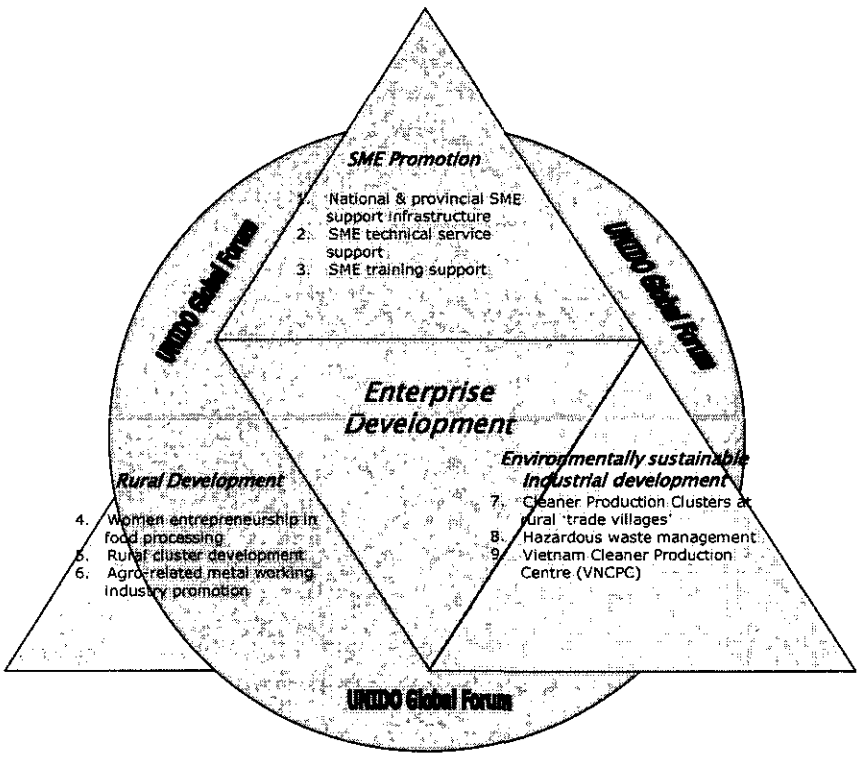
In addition, although not explicitly covered under the *Integrated Programme of Cooperation*, several concomitant initiatives by UNIDO at regional level will benefit the present exercise, namely:

- A programme on Trade Facilitation in Southeast Asia, geared primarily to the alleviation of technical barriers to trade by improving manufacturing standards and quality controls;
- The programme for development of agro-industries along the West-East Corridor region of the Greater Mekong, linking the Da Nang area of Vietnam to Lao PDR, Cambodia and Northeast Thailand;

- The regional programme in Lao PDR, Cambodia and Vietnam on the containment of arsenic contamination of ground waters in deltaic and alluvial areas caused by artisanal mining techniques.

The unifying theme across these diverse interventions is the sustainable development of entrepreneurship in Vietnam, where sustainable is to be understood in its three dimensions of economic, social and environmental concerns.

The *Integrated Programme of Cooperation 2003-2005* proposes a set of tightly interwoven initiatives around the theme. It does not supersede operations under way with UNIDO assistance in the country, nor will its completion mark an end in the history of cooperation with the Government of Vietnam. Simply, it provides a rigorous rationale and close integration for UNIDO's activities in the country, over the triennium 2003-2005.



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3. Government strategies for environment protection

The introduction of the Government's *Doi Moi* reforms in 1986 has triggered significant advances in the economic development of Vietnam. These are the result of the improved governance, the liberation of domestic production, the implementation of global integration, and the encouragement and utilization of external resources promoted by the reforms.

The Government realizes, however, that this economic transformation has been won at the expense of environmental degradation. Identified environmental problems include the depletion of natural resources – in particular forests; declining biological diversity; soil degradation; sea- and freshwater contamination; air pollution; and solid and hazardous waste management. Furthermore, the Government of Vietnam recognizes that, ultimately, these problems threaten economic growth and thus jeopardize its ultimate objectives of social improvement accompanied by increased prosperity, living standards and quality of life for Vietnamese.

To address these issues the Government of Vietnam has worked steadily to increase awareness of environmental issues and to incorporate their consideration into national, regional and local

legislation. Important 'milestones' reaffirming Vietnam's commitment to protect the environment are given below:

1986	Draft " National Conservation Strategy" prepared
1991	"National Plan for Environment and Sustainable Development in Vietnam, 1991-2000" formulated by the former Sate Committee for Science (now the Ministry of Science, Technology & Environment, MoSTE) with assistance provided by UNDP, UNEP, and SIDA, and formally approved by the Chairman of the Council of Ministers of Vietnam (now the Government)
1992	Vietnam participated in the UN Rio Summit Conference and committed itself to Agenda 21
1993	Environmental Protection Law adopted by the National Assembly and enacted in January 1994
1998	Directive 36-CT/TW "Strengthening Environmental Protection in the Period of Industrialization and Modernization of the Country" promulgated by the Politburo of Vietnam Communist Party
2000	"National Strategy for Environmental Protection, 2001-2010" formulated by MoSTE and submitted to Government for approval
Aug 2004	Adoption in August of Agenda 21, Vietnam's comprehensive Strategy for Sustainable Development
Dec 2004	First National Conference on Sustainable Development
2005	Roll-out of Agenda 21 to the 64 provinces and municipalities of Vietnam

3.1 Priorities to be addressed

The National Environmental Protection Strategy (NEPS) sets out a series of strategic objectives, in terms of pollution prevention, rational and sustainable resource use, and environmental quality improvement, for specific areas of concern. These include coastal and marine ecosystems; freshwater ecosystems, wetlands and groundwater; land and mineral resources; biological diversity; urban and industrial areas; rural ecosystems; and natural and cultural heritage.

The selection of actions of priority is regarded as very significant for the success of the NEPS. The selection of priorities is based "According to the content, locality and relation with time frame. The action plans of top priority are selected according to the content after identifying the prioritized objectives."

The NEPS then lists seven programmes of top priority:

1.	Work out and implement the comprehensive plan for sustainable industrial development covering the entire process from resource exploitation, production and waste management.
2.	Develop strategy and landfill plan for solid and hazardous waste treatment in the urban areas with high density of population
3.	Continue with the promulgation of regulations and standards for the protection and sustainable use of water resources, specially in the river basins, reservoirs and groundwater aquifers
4.	Upgrade the environmental management system and strengthen the capacity for the environmental management agencies at every level and of the ministries and branches.
5.	Combine environmental education in the curriculae of the schools and universities.
6.	Promote environmental movements of the mass organization such as the Father Front, Trade Union, Youth League, Woman Union, Veteran Association, Farmer Association etc.
7.	Consolidate the system for sustainable use and management of forestry resources through community participation.

These priorities are further subdivided, in an annex to the NEPS, into 21 programme of high priority and 49 programmes of priority.

3.2 Previous and continuing UNIDO assistance

Previous and continuing UNIDO assistance to Vietnam has addressed a number of the priorities identified above. Indeed, UNIDO technical cooperation has been geared to building institutions and capacity to be capable to express these concerns within the context of the NEPS, and to develop the related action programmes.

Since 1992, UNIDO has implemented in Vietnam over 20 projects focusing on environmental considerations, and invested over US$5.5 million in these operations. The projects fall into three principal categories: (i) the sustainable exploitation of mineral resources; (ii) the reduction of industrial pollution, and the upgrading of systems for its management; (iii) the substitution of Ozone Depleting Substances as required under the Montreal Protocol.

Work within the second of these categories specifically addresses priorities 1, 3 and 4 of the NEPS list, and also assists towards priority 2 by reducing the volume and pollutant loading of solid and hazardous waste requiring disposal. That work continues with national Cleaner Production initiatives through the VNCPC (US/VIE/04/064) and in Ho Chi Minh City with project TF/VIE/00/005 'Reduction of Industrial Pollution in Ho Chi Minh City'.

4. Background of the project: supply/demand of used oils and lubricants

4.1 Consumers

The market for the various lubricant oils is diverse. In general, it can be split into three categories.

- Private transportation (motorbikes and cars)
- Industry (large companies, using a lot of lubricant for machinery and transportation)
- Others (small farmers, family businesses and various other SMEs)

The number of motor vehicles in Vietnam is increasing steadily, as is shown in the table below:

Year	Motorbikes	Cars	Buses and trucks	Total four-wheel vehicles
1997	605,000	16,960	42,590	59,550
2000	805,000	24,420	55,000	79,420
2005	1,190,000	40,500	79,100	119,600
2010	1,550,000	64,000	110,000	174,000

However, it is estimated that 60% of trucks imported are second-hand vehicles from China or Japan. These are not registered in government statistics.

4.2 Producers

There are many Vietnamese and foreign producers who own lubricant oil blending plants in Vietnam. They blend various base oils and additives to meet specifications for the different lubricant products that are sold on the Vietnamese market. Each company distributes its own products. The table overleaf gives an idea of the way in which the market is divided between the different companies. The stated capacity is an approximate figure since most of blending plants operate only during normal office hours, instead of being operated 24 hours a day on a shift pattern – actual plant throughput will also depend on changing market demand, usually between 50 and 70% of the stated figure. It is also believed that cheap lubricant may enter the market illegally without being recorded in government statistics — this would lead to an underestimation of demand.

Company	Location	Stated maximum capacity, tonnes/yr
BP- Petco	Nha Be	50,000
ExxonMobil- Unique	Dong Nai	25,000
Castrol-SaigonPetro	Cat Lai	30,000
Shell Vietnam	Dong Nai	25,000
Petrolimex	HCM City	15,000
Vilube	Nha Be	25,000
Indochina	HCM City	10,000

Mekong Lube	Vinh Long	10,000
Bao Thanh	HCM City	10,000
PVPDC (PetroVietnam)	HCM City	5,000
Tan My	Tien Giang	5,000
Capacity in the South		**195,000**
Petrolimex	Hai Phong	25,000
Caltex	Hai Phong	15,000
Total	Hai Phong	10,000
APP	Hai Phong & Hanoi	10,000
PVPDC (PetroVietnam)	Hai Phong	5,000
Van Dao	Ha Tay	4,000
12/11- APP	Quang Ninh	4,000
Capacity in the North		**73,000**
Total Capacity		**268,000**

The following groups distribute gasoline and diesel in Vietnam, as well as lubricants to their own petrol stations. They also have a licence to import lubricants directly:

Group	Market share, %
Petrolimex	60-70
Petroleum Corporation of the Army	10-15
Companies of local government/ peoples' committees	10-15

4.3 Products

There are many types of commercial lubricants in Vietnam, including:

- Gasoline Engine Oil
- Diesel Engine Oil
- Railway and Marine Engine Oil
- Automatic Transmission Fluid
- Aviation Engine Oil
- Jet Engine Oil
- Turbine Oil
- Gear Oil
- Grease Lubricant
- Compressor Oil
- Hydraulic Oil

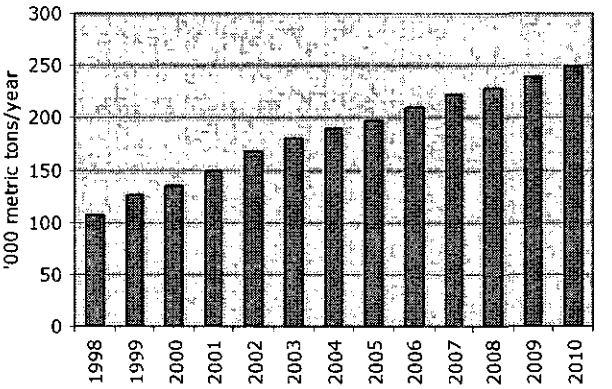
These products can be grouped into the following types:

	Types of oils	% Weight (*)
1	Engine Oils	60 – 70%
2	Industrial Oils and Hydraulic fluid	10 – 15%
3	Transformer Oils	5 – 10%
4	Grease lubricants	10%

(*): Percent weight is calculated by total amount of lubricants in Vietnam.

The following chart showing government forecasts for lubricant consumption can be used to help understand market trends at a very high level. However, it is very difficult to know exactly how much lubricant is sold in Vietnam every year and consequently to make accurate predictions for the future.

Figure 1 Lubricant demand forecast in Vietnam



5. The collection of used oils: current status

The Vietnamese government has set the following targets for collection of used oil. These represent an ambition for the future and are not for a particular year.

	Types of oils	Collection target, % weight (*)
1	Engine Oils	70%
2	Industrial Oils and Hydraulic fluid	70 – 80%
3	Transformer Oils	80 – 90%
4	Grease lubricants	Negligible

(*): Percentage is calculated by amount of each lubricant type sold.

In order to achieve these targets, there should be improvements in two key areas: (i) environmental awareness among all parties involved in the lubricants market, including end users, and (ii) infrastructure for collecting and transporting the used oil. It is believed that these targets are very high, given that developed countries with long established oil recycling programmes have recorded "actual collected oil" as a fraction of the total "collectable" oil. This can be seen, for example, in the following table from the EU re-refining association (http://www.geir-regeneration.org/en/key_figures).

Year 2002	Consumption (*)	Collectable		Collected (dry waste oil)	
	A (Tons)	**B/A** (%)	**B** (Tons)	**C/B** (%)	**C** (Tons)
Austria	109,000	49%	53,622	62%	33,500
Belgium	173,100	36%	63,105	95%	60,000
Denmark	71,718	65%	46,909	75%	35,000
Finland	88,809	56%	49,596	80%	39,677
France	841,356	50%	422,197	57%	242,500
Germany	1,032,361	45%	463,304	99%	460,000
Greece	87,800	46%	40,161	55%	22,000
Ireland	38,900	46%	17,794	86%	15,303
Italy	617,594	32%	196,737	96%	189,595
Luxembourg	10,170	46%	4,652	98%	4,564
The Netherlands	152,694	44%	66,468	90%	60,000
Portugal	102,000	52%	52,842	75%	39,620
Spain	510,980	50%	255,236	63%	160,000
Sweden	142,814	54%	77,232	80%	61,786
U.K.	840,834	48%	401,474	88%	352,500
E.U.	4,820,130	46%	2,211,329	80%	1,776,044

(*) source : Europalub

In the UK 87% of used oil is collected to be used as RFO recovered fuel oil – no re-refining takes place. In other EU countries lower collection rates down to 40% are known despite the presence of re-refining plants i.e. collection is driven by market forces.

At the moment, state general companies collect the used oil used by Vinacoal and Vietnam Railways, for subsequent use. Only state general companies and lubricant manufacturers have the right to handle the used oil. However, the companies or individuals who collect oil from garages and motorcycle shops appear to operate on an "informal" basis.

Apart from direct collection of used oil, in many countries e.g. USA and UK, the following components are also collected: used oil filters, oily rags, oily water, sumps, sludge and antifreeze, as well as other petroleum fuel products and materials that have been contaminated with used oil, water or solids. These materials, which are contaminated with used oil, should also be disposed of in an environmentally sound way.

5.1 Prevailing regulations governing hazardous wastes management

Hanoi City People's Committee Regulation 152/2004/QD-UB and Decision No. 155/1999/QD-TTg on promulgating "The Regulation on management of hazardous waste" issued by the President of Socialist Republic of Vietnam regulate the management of hazardous wastes in Vietnam. The list of hazardous waste is listed in Vietnamese Standard TCVN 6706:2000 where used oil is listed.

Definition of hazardous industrial wastes as described in the above regulations is "wastes that contain substances or compounds that have one of the hazard-causing properties (flammable, explosive, poisonous, corrosive, infectious and other hazardous properties) or may interact with other substances to cause hazards to the environment and human being."

In summary, the regulations are in-placed to regulate the following:

- The entire supply-chain of used oil i.e. collection, transport, transit, keeping, treatment and disposal. The supply-chain handlers must be permitted to carry out their activities. The generators must be registered.
- Violation where responsible party will compensate for damages and costs of remedying the consequences. No penalty standard.
- Responsibility of specific management agencies i.e. Department of Natural Resource, Environment and Housing, State management agencies

5.2 Current procedures for used oil collection

Field visits and interviews conducted in June 2005 (see Annex 7 page 29) revealed that used oil is collected covering a wide geographical area targeted at industry area and large towns, and not dumped into the environment. Transporters, collectors and most recyclers operate on non licensed basis. Documentation of used oil "transaction" is not administered. Rural area collection mechanism is not known. Awareness level is low.

The process of handling used oils can result in adverse environmental impacts in many ways from direct dumping, spills as a result of mishandling used oil, wastes from processing, releases into the air from burning without emissions controls and improper discharge of oily wastewater.

Licensing
The Department for Natural Resources and Environment (DONRE) licenses recyclers and treatment of used oil. Information on volume, total recyclers, transporters, recycling technology is not available. There are two license facilities known.

There is a lack of awareness of the requirements on regulation Decision No. 155/1999/QD-TTg among used oil generators, transporters and recyclers.

Collection mechanism
There are varies channels used oil is collected, transported, treated then trade in the market. Used oil demands market value of 1000—2000 Dong/litre; price fluctuates with crude oil prices. Thus, used oil generators store then sell to whichever party that pays the highest. There is no

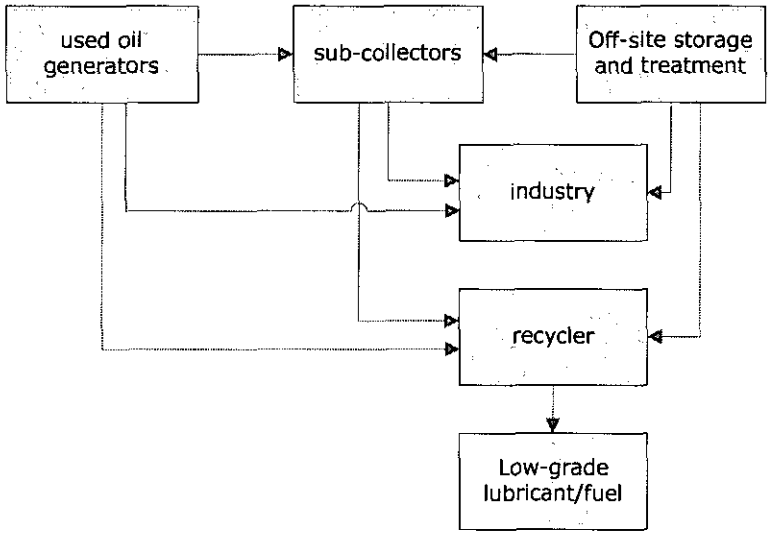
documentation or licensing practice. Total number of collectors and used oil generated not known. (Refer figure below)

The likely collection route is:

- A network of collectors/transporters buy used oil from generators. They sell to larger collectors or directly to users;
- Larger collectors may apply simple gravity treatment method to remove water and sedimentation prior selling the "treated" used oil to any interest party;
- Users buy directly from generators

Figure 2 Likely collection mechanism

with majority unlicensed operators and no accounting system



Used oil generator do not practice segregation by oil type and mix all used oil. Used oil is contained in many forms i.e. 20 litre plastic containers to 200 litre metal drums. These drums are not labelled nor stored on contained flooring.

Licensed used oil treatment facilities

A large used oil recycler has some 100 transporters/collectors supplying approx. 1000 tons/month used oil. This is estimated at 8% of total used oil generation in Vietnam. This recycler has collection centre in HCMC and other industry area which store then transport used oil by road to Hanoi. This facility is licensed by DONRE, aware of ISO 14001, obtained funding from the Environmental Provident Fund and technical assistance from Institute of Industrial Chemistry (IIC). The technology used to recycle used oil to lubricants generates minimum wastes. Re-constituted fuel oil and diesel is generated from a process of heating in an own-built incinerator and fuelled by wood.

Industrial waste treatment centre at Nam Son, Soc Son Industrial Waste Treatment Complex received large quantity of used metal cutting oil and other hazardous wastes. Currently, this centre is operating two incinerators and secured landfill to dispose treated hazardous wastes. However, hazardous waste where there is no suitable treatment is stored in a warehouse below ground. This facility is licensed by DONRE, and obtained technical assistance from JICA and VNCPC. Disposal cost of 5,000 Dong/kg thus, SME may be reluctant to use this option.

Non-licensed used oil treatment facilities

The used oil supply-chain is not documented, it is likely that small collectors supply to larger collectors. Small collectors may store used oil in their home. These collectors may apply simple treatment i.e. physical separation by gravity to remove water and sedimentation followed by basic filtration using sponge. The unwanted material is indiscriminately drained off polluting the environment. The treated used oil is sold to other recyclers or industries. Possibilities collectors sell untreated used oil to directly to users.

Used oil users are known in other countries and likely in Vietnam are brick as mould releasing agent and fuel in metal smelting, pottery, and cement and boilers operators. (refer to Appendix 4 for list of interviewee and questionnaire used).

Legal and Health, Safety and Environmental Awareness

Legal and HSE awareness among generators, collectors and recyclers is low. Poor practices i.e. no labelling hazardous wastes containers, spillages on ground, workers wearing unsuitable PPEs while handling hazardous wastes and lack basic safety practices i.e. safety signage, safety boots, polyvinyl gloves and emergency response contact numbers.

Licensed treatment facilities are aware of ISO14001, legislation and have expressed wishes to obtain accreditation however consultancy cost is exorbitant. The ISO 14001 industry is still in infancy stage thus demands for high fee. SMEs and mall scale motor workshops are not aware of the legislation on used oil.

5.3 Awareness

Training and information packages are not currently available for companies or individuals involved in handling of used oil. Successful information campaigns have proven critical to the success of oil collection programmes in other countries. The US Environmental Protection Agency (EPA) website (http://www.epa.gov/epaoswer/hazwaste/usedoil/index.htm) contains a large amount of posters and information packs in English. Such material could be used to inspire the organisation that will prepare the information packs for Vietnam. The training should focus on environmental impact of used oil, safety in handling and storage of it, best practices for used oil segregation and contact information for the collection companies. The Vietnam Cleaner Production Centre (VNCPC) at the Institute for Environmental Science and Technology has done a lot of training work on waste minimisation, or cleaner production (CP), for many industrial sectors in Vietnam and would be a suitable partner for the awareness raising. A major focus in VNCPC training is to "build capacity" in CP by training key people in companies, who can subsequently act as CP specialists and train more people.

In order to be most effective in collecting used oil, it is important to involve the people who are most involved in handling it already. A discussion with senior directors in companies that use and already capture large quantities of used oil indicates that there is a low level of awareness among their employees of how important collection is. This means that the capture of used oil is not as high as expected. Shops, garages and retail outlets that are involved in changing of oil for car and motorcycles could be reached through lists provided by oil producers, distributors or potentially the used oil collectors. However, it would be better if the publicity was facilitated by the Ministry of Information, as most companies may not have a budget for this activity.

5.4 Infrastructure

In Vietnam, there are some examples of where used oil is already collected from large industrial users and from small motorcycle shops in Hanoi. This practice should be regulated, expanded and improved to service the entire Vietnamese lubricants market. The ability to segregate different types of used oil is also desired, if it is to be processed for future use as lubricant oil. It would help to audit various types of companies in the supply chain from a cleaner production (CP) perspective early in this project and as it progresses to ensure that lubricant consumption, as well as used oil handling and treatment is optimised for CP. A VNCPC assessment would help to achieve this.

At the moment, small traders in Vietnam often do the collection of used oil on an "informal" basis. They sell the oil to operators of kilns to lubricate moulds for manufacture of bricks, ceramics and other construction materials. The oil is sometimes also sold as an alternative fuel for kilns and furnaces. Small roadside workshops servicing cars and motorcycles in the Cau Dien area of Hanoi receive between 700 and 1500 Vietnamese Dong per litre of used oil from these small traders. The oil is collected at least once per day. However, since this trade is not regulated, it is difficult to determine how much oil is gathered in this way or indeed if the oil is being handled in an environmentally responsible way. Some further survey work needs to be done to understand fully what is going on in this area. If the used oil were no longer available as a fuel for kilns, which fuel would be used there, would it be burnt in a cleaner way and would it be much more expensive? In any case, as a first step, the small traders should be encouraged to register their trade with local or central government and to report on the volumes that they collect and sell. They are currently important stakeholders in the trade of used oil. Secondly, the roadside workshops should be encouraged to sell used oil only to registered traders. This could be enforced by audits to check record-keeping. If larger distribution centres and collection companies are introduced to service large re-refineries, it is important that they are introduced in a way that does not seriously threaten the livelihood of the small traders and customers for used oil.

For large companies, such as Vietnam Coal (Vinacoal) and Vietnam Railways, used oil is collected in drums at central engine maintenance workshops. The oil is kept at the workshop from where it is sold by auction to other state general companies. In more remote areas, there is some indication that the used oil is not being collected and that it may be dumped directly to the

environment. In the large companies, it would be beneficial for the government to ask the company to report the percentage of oil that is recycled annually along with other environmental performance figures. This metric could be then used to drive continuously improving environmental performance. A "carrot and stick" approach would help reinforce efforts. Incentives, such as tax breaks, could be considered to drive improved performance. Fines could be used to make an example of major polluters as well as raising revenue for audits and promotional activity.

In remote areas, there is no information available on the infrastructure that exists to collect used oil from farms and smaller businesses. This should be investigated in the various provinces of Vietnam. Existing traders should be invited to register and additional resources, such as collection centres should be introduced throughout the country. This could be integrated with other local recycling initiatives if possible.

6. Problems to be addressed in the present project

Vietnamese enterprises are also having problems in treating industrial hazardous wastes. The Government of Viet Nam issued "the regulation regarding hazardous waste management" (Government Decision No155/1999/QD-TTg) in 1999 and started hazardous waste management administration. However, there is no hazardous waste treatment facility that can achieve the treatment standards provided by the regulation, which makes it difficult for local enterprises to comply with the regulation. Local enterprises are struggling to improve product quality to enhance their market competitiveness and at the same time to tackle with environmental issues especially hazardous waste management. It is urgently required to plan on a facility to properly treat hazardous wastes to meet regulatory requirements.

Many developed countries classify used oil as a hazardous waste. (Lubricant) oils and greases are used in many human activities at various scales: household, small business and large-scale production. In Vietnam in average the quantity of needed oils and greases is annually increased about 15%. For example, in 1995, the quantity of oil and grease was 150,000 tonnes, in 1998 it was 200,000 tonnes and 2001 it was 240,000 tons. Oil and grease discharged into the environment could severely damage the environment, especially soil and water: 1 ton of waste oil could damage 3 ha of soil or 10 km2 of surface water. Oil can persist for a long time in soil and water creating secondary adverse impacts to the ecosystems and ultimately entering the food chain. Used oils and greases may contain hazardous compounds accumulated during their use, such as PAHs (polyaromatic hydrocarbons) and metals. These chemicals are toxic to human beings and ecosystems, especially aquatic ecosystems. Due to the fact that oil is insoluble in water and is lighter than water, results in it floating on water surfaces, if released to the environment. This inhibits air and sunlight transmission into the water, and consequently makes the water become deficient in oxygen and light, thus killing flora and fauna in the water.

After being used, the needed properties of oils and greases are decreased or changed because of oxidation (by heat and by chemicals). In used oils and greases, there are impurities such as water, solid particles and oxidation products. Due to heat and time of services, important properties of oil and grease become worse until they no longer meet the requirements of application. Then, used oils and grease have to be removed and have to be replaced with new ones. If technically and economically feasible, then the removal of these impurities from used oil and grease may result in a source of new products.

Waste oil and greases have great potential for reuse or recycle. One of the easiest ways to recycle is to take back its heat value via combustion. Over 95% of the energy can be recovered in this way. Oil and grease are normally made of base oil and additives to achieve the required properties for different applications. If by some way, base oils and greases could be recovered from used oil, then by further processing and additives, it is possible to have new base oils and greases, possibly with the required properties of the original application. And by these oil recovery processes, the quantity of waste oil and grease will be reduced, and as a result, the potential for damaging the environment from used oil and greases would also be decreased, while the cost of purchasing oils and greases for certain applications will be dramatically reduced. Reused and recycled oils and greases have been important solutions in many developed countries for solving waste oil problems, and the technologies of processing used oil for recovery are by now well developed. Depending on oil categories, the recovery of used oils can reach 30 to 90% of collected used oils. In Vietnam, the amount of used oils and greases collected for reuse or recycle is limited, due to many reasons such

as public awareness and lacking facilities. Collection infrastructure, targets and procedures are important.

Actually, there have been some techniques to regenerate used oils and greases. A quite popular technique is coagulation. Essentially, coagulation is a technique of removing impurities in used oils. In this step, a coagulant, such as clay, could be added to cause the impurities to form agglomerates that are easier to separate physically. Some surfactants can be used for supporting the process of removing impurities from used oils as well as improving quality of used oils. Another chemical technique is to treat used oils and greases with alkali or acids. With treatment with alkali or acid, the impurities, especially the products of oxidation could be changed into other states that can be physically removed from used oils. Depending on the impurities and class of used oils, it is possible to use coagulation or chemical techniques or a combination of these two techniques in order to regenerate used oils. In Vietnam, if a facility to regenerate used oils and greases could be developed, it could be very useful for both objectives of economy and environment.

Traditional clay processes have often resulted in poor HSE performance of the re-refined oil, that is, poor HSE used oil => poor HSE re-refined oil + poor HSE waste!

Modern high-pressure hydrogenation processes (expensive capital + variable cost) results in poor HSE used oil => acceptable HSE RRBO (re-refined base oil). In other words, a study must be made of re-refining vs. RFO (recovered fuel oil) case plus study of RRBO options. Some plants in the world run in a subsidy system.

7. Institutional support

The Institute of Industrial Chemistry (IIC) is one of the oil and grease producers in Vietnam, and IIC have also conducted in recent years researches on technologies to regenerate used oils and greases. In these technologies, the above techniques have been addressed and explored, but these research activities are not systematic and integrated. IIC is an institute of the MOI, and IIC has a well-developed series of activities in the field of lubricant oils and greases for more than 20 years. In recent years, IIC has obtained a national certificate for the oil analytical laboratory (VILAB). IIC has also developed preliminary research on possibilities for regenerating used oils. There are also within IIC other professional centres and research groups working in the field of the environment and specifically waste management.

IIC has developed technologies to recycle used oil into industrial lubricant and has technology to remove PCB from used oil. IIC provides used oil recycling and lubrication application consultancy to SMEs. IIC operates "Research & Development Centre of Additive and Petroleum Products" which has received ISO 17025 certification since 2001. Technical resources supported by this laboratory in IIC make it a capable centre to improve used oil recycling technology and reliable testing of lubricants.

8. Project justification and concordance with government priorities

UNIDO has had a long-term cooperation programme with Vietnam, specifically with the MOI. This programme consists of some components dealing with cleaner production and hazardous waste management. Recycling and reusing used oil and grease in Vietnam is a critical step in this direction, and IIC could be a partner in this cooperation through setting up and carrying out a project for collection, recycle and reuse of used oil and grease in Vietnam. UNIDO has great potential for developing cooperation between Vietnam and other industrialized countries and/or international organizations in the field of environmental protection, cleaner production and chemical industry development.

9. Target beneficiaries

In the first period, Hanoi is selected as a pilot area for the project. Thus the direct beneficiaries of the project will be those exposed to used oils and lubricants at the production, transportation, storage and disposal stages. The urban community at large will benefit from the reduced environmental incidence of used oils and lubricants.

Alternative locations are:

- Ho Chi Minh City, in view of the forthcoming project under consideration by UNIDO and the PC on "Environmental Management of Industrial Activities";
- Quang Ninh coal refining area, in relation to the "Reducing industry impacts in areas of natural or cultural heritage—Ha Long Bay" initiative;
- Fishing ports, e.g. Ho Chi Minh City and Danang, due to high gasoline and lubricants consumption (based on 2000 statistics).

A subsequent phase, mostly driven by IIC and funded by MOI, will extend the benefits of this pilot experience to the whole country.

Part II. OBJECTIVES

Development Objective: to promote cleaner production in Vietnam by developing a cost-effective management of hazardous waste.

Immediate Objectives:

- To set up in Vietnam a nation-wide communication campaign to raise awareness on the environmental and health hazards linked to inappropriate disposal of used oils;
- To develop a system of regulations and procedures for the capture and transportation of used oils and lubricants;
- To demonstrate environmentally and economically sound technologies for the disposal and recycling of used oils and lubes.

Part III. PROJECT STRATEGY

Vietnam is currently in the process of rapid industrialisation with a high pace of economic development. This is expected to lead to a corresponding increase in hydrocarbon consumption for fuels and lubricants by industrial and individual consumers. Currently, there is no coordinated national strategy for collection or processing of used oils. A large amount of used oils are dumped directly to the environment resulting in pollution as well as loss of economically valuable material. The project strategy should address these problems in the most cost-effective way allowing for sustainable industrial and social development, and tightening environmental legislation to manage hazardous waste and vehicle emissions.

1. Country-wide used oil management plan and procedures

1.1 The management plan

Develop a country-wide used oil management plan to provide a systematic framework and coordinated strategy to manage and implement used oil collection, treatment and disposal. The Plan should be cost-effective, healthy business implication and practical allowing for sustainable development. It is important to recognize that no matter which recycling technology is employed, how its specific operators maintain pollution controls and good housekeeping practices is crucial.

In principle, the management plan would comprise blocks as demonstrated below:

Leadership and commitment. Relevant Ministry and Institutions could demonstrate leadership and commitment to used oil management in Vietnam. This can be demonstrated through public statement, visits, involvement with the process and communication to all involved in this process.

Policy and strategic objectives. Regulation 155/1999/QD-TTg sets the principles and governance of hazardous wastes management in Vietnam. Further the government has set used oil recycling target of 70—90% over the long term.

Responsibilities, resources and standards. The organisation responsible for the implementation must be clearly identified.

- Ministries, Local Council, IIC and UNIDO could work as a team to implement the Country Used Oil Management Plan.
- A working group could need a set of clear and realistic target and accountabilities.
- Recycling technology research could bring higher benefits using tie-up between IIC with industries to yield commercial application of research discovery.

Hazards and effects management. Identification of hazards and their potential effects to the environment and health and safety to workers should be documented. Thus, an inventory of the used oil generators, transportation, treatment and disposal needs to be in-placed. Control and recovery measure in the event of an incident should be implemented to reduce these risks via EIA and licensing.

Planning. Each year, programme for used oil control activities should be integrated into the plans of Ministries, Local Government and Institution, including the formulation of short and medium term improvement targets and action plans. These targets and action plans take into account a wide variety of factors including legal requirements, environmental expectations, technological options and the views of interested parties/stakeholders.

Implementation and monitoring. The working group communicates this plan to all relevant parties and monitors its effective implementation. The working group is responsible for the reporting and investigation significant issues related to its implementation and review system to improve effective of this plan.

Audit. Conducted using agreed standard by authorized party. Audit result should be a condition to license renewal.

Review. The working group and responsible organization carries out annual reviews of the used oil management processes and performance, identifies good practices, changes in fuel specification when/if the Clean Air Act is introduced in Vietnam and market requirement.

1.2 Increase Awareness

Awareness should be targeted for to the whole used oil supply-chain i.e. generators, transporters/collectors, keepers, processors/disposers, regulators and enforcers.

The awareness subjects should include topics on:

- hazards of used oil to human and environment
- regulation requirement and penalty system i.e. licensing requirement
- waste handling, minimization and disposal principles (see Annex 9 page 37 for details)
- process to obtain license from government
- timeframe given to obtain license and assistance providers i.e. IIC, Environmental Provident Fund
- best practice in health, safety and environmental practices i.e. housekeeping, labelling, waste reduction
- segregation of used oil and its recycling options (see Annex 6 page 34 for the type of used oil by industry)

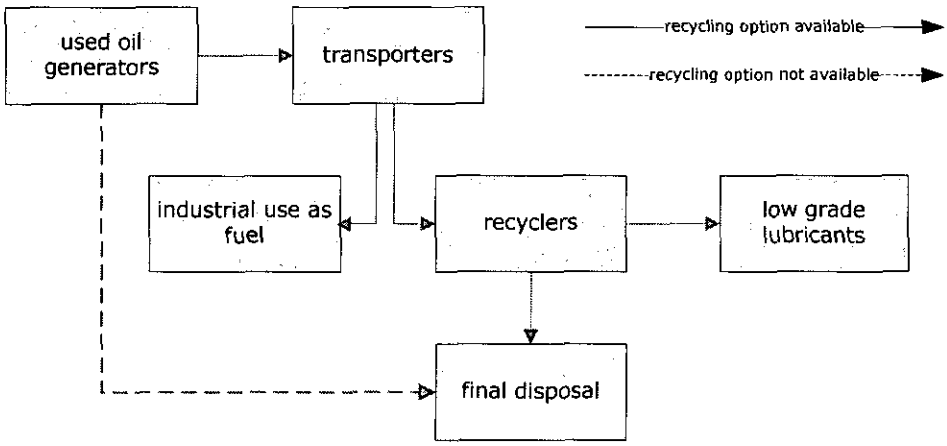
Road show and workshops, integrate and communicate Country Used Oil Plan. Targeted at used oil supply-chain operators, used oil generators and regulators. Joint workshop with regulators, enforcers, IIC and environmental management experts to obtain buy-in from all parties. The workshops should be conducted in stages first targeted for regulators then the used oil supply-chain mainly SMEs.

Promotion through posters, brochure and letter targeted at used oil generators. Working with the lubricant supplies would be able to integrate into the network of used oil generators (see Annex 8 page 36 for an example of information published in the brochure). Hold promotion campaign systematically.

1.3 Collection mechanism and infrastructure

Figure 3 Used oil collection mechanism

with clear chain of custody throughout the supply-chain



The proper handling, transferring, transportation and storing of used oil require specific safety procedures to ensure worker protection, accident prevention, and protection to the environment.

Identification: a successful used oil handling process required focus on quantities of used oil, giving priority to the collection process and prevention and minimization of used oil. Priority to the highly industrialise areas. The objective of this process is to:

- Identify opportunities to prevent and minimize used oil generation from operations and processes
- Identify and eliminate hazards to human health and the environment
- Minimize exposure to potential pollution using practical solutions adopting sustainable development principles

Note: used oil supply-chain i.e. generator, transporters, collector, keeper and processors.

Licensing: the government need to actively license the used oil supply-chain. The licensing process should have the following principles;

- Pollution prevention facilities in placed
- Practical and straight forward
- transparent administration
- minimum standard clearly identify
- provision for contravening license

Stage 1: 1—2 years after road show. The used oil supply-chain providers should register with the relevant government agencies and agree on an acceptable timeframe to improve practices to meet licensing requirement.

Stage 2: 2—3 years thereafter. Strictly enforce the legislation. Impose penalty to unlicensed operators and generators.

Licensing Minimum Standard. Recycler and keeper's facility would be required at least to:

- conduct EIA of the facility by registered EIA consultant;
- store the used oils in appropriate location, with proper containment ... and not inside the home or kitchen
- develop a procedure to operate and maintain environmental protection and crucial plant facilities i.e. pumps, storage tanks, pipelines;
- build an effluent/emission treatment facility;
- develop effluent/emission discharge standard;
- dispose of hazardous wastes to licensed facility;
- establish an emergency response procedure;

- to maintain, if provided in-house, a road-worthy transportation fleet that meet local legislation and a pool of drivers trained in road/spill emergency response;
- communicate health hazards to workers using MSDS for chemical and raw materials used;
- organize environmental awareness training for the staff;
- provide proper PPEs for workers;
- establish a continuous improvement plan;
- conduct health, safety and environmental meetings with staff regularly;
- maintain proper documentation, labelling and reporting of all used oil handled.

Transporters/collectors would be required at least to:

- store in approve location, with proper containment and not inside home or kitchen;
- develop an emergency response procedure;
- maintain a road-worthy transportation fleet that meet local legislation, and a pool of drivers trained in road/spill emergency response;
- communicate health hazards of used oil to workers using MSDS;
- organize environmental awareness training for staff;
- provide proper PPEs for workers;
- maintain proper documentation, labelling and reporting of all used oil handled.

Accountability. Good documentation administration is important to ensure traceability of used oil to reduce poor environmental practices and illegal operations. Recommended to adopt the Malaysian TWG form and 6th Schedule. In addition, the following is required from the used oil supply-chain:

- Used oil generators: to report at least quarterly to the government on type, volume of used oil generated and collector and recycler used.

- Transporters, collectors, keepers: to report at least quarterly to the government on type, volume of used oil collected and recycler used. Treatment is not permitted

- Recyclers: to report quarterly to the government on type, volume of used oil collected and volume of hazardous wastes generated.

- Final disposal facility: to report quarterly to the government on type and volume of used oil treated.

- Government: to develop a computerized system to monitor the entire process and publish licensed operators to public.

2. Technology choices for oil recycling

Recycling is the best way to dispose of used oils. Lubricants are essentially hydrocarbons that in addition to being fuels have lubricating properties. Used lubricating oils can be recycled either by regenerating their lubricating properties - as re-refined base oils (RRBO) - or by re-using their fuel properties in combustion -as energy feedstock. No single method is of general application and the most sustainable practices could vary based on local conditions (overall lubricants and fuels market, market uses, taxation rates, power production, industrial energy consumption, etc.) and ongoing technological development. A position statement from the European Petroleum Industry Association (EUROPIA) has been used to guide the formulation of this strategy.

The selection of a strategy for used oils management and disposal should be based on the following principles:

- *Public health and environmental protection*
- Sound science
- Cost effectiveness
- Overall sustainability

A number of options are outlined below for used oil recycling in Vietnam, focussing on their advantages and disadvantages. It is recommended that each of these options should be developed in greater detail to ensure that a suitable proposal is made for all areas and industries in Vietnam, where lubricant oils are used. The Institute of Industrial Chemistry (IIC) has a central role in all

these options to ensure that the best options are selected for each of the different regions of Vietnam. These options are not mutually exclusive.

The options are:

- Improve regulation and performance of all current channels for oil recycling. (The "Improvement" option)
- Incorporate used oil handling in one or more of the new oil refineries that is being developed for Vietnam, or in a foreign refinery. (The "Refinery" option)
- Open bidding for international oil re-refining companies to design one or more plants capable of handling all or most used oil in Vietnam to produce re-refined base oils (RRBO). (The "Licensing" option).
- Develop in-house technology at the Institute of Industrial Chemistry. (The "In-house" option)
- Make used oil a feedstock to produce Carbon Black. (The "Carbon Black" option)

2.1 The "Improvement" Option

Option: Improve regulation and performance of all current channels for oil recycling.

This involves the lowest capital investment at a central level and can be implemented with minimal foreign support. It should allow most support to be directed at training and auditing of end-users in selected regions or in all of Vietnam, with clear guidance for improved practices. The main disadvantage is that in current options where the used oil is burnt, the lubricating properties of the base oil are destroyed permanently.

There is no advantage in used oil being dumped to the environment—it is both an environmental and an economical loss. Even at the moment, some garages receive a minimum of 750 Dong/litre of used oil. End-users who buy it as an alternative fuel probably save a lot of money as diesel or kerosene cost 4,500 Dong/litre. New motor oil can cost up to 15,000 Dong/litre.

It is believed that customers for used oil in the Cau Dien area of Hanoi use it as a lubricant for moulds in manufacture of bricks and ceramics. This oil is then absorbed, burnt or leaked during the firing and subsequent processing of the bricks. In any case, this is not well controlled, so there are serious risks both to people handling the oil and to the environment. Audits and training from VNCPC and IIC would help in this regard. Used oil in Vietnam is also used to protect iron and steel, e.g. wire rope, from corrosion.

It is recommended that the Institute of Industrial Chemistry should conduct an audit of used oil collectors operating in the Cau Dien area of Hanoi and their customers to identify the main risks to personnel handling the used oil and to the environment from incorrect handling of the used oil. Corrective actions should be proposed and evaluated including:

- Better conditions for storage of used oil (e.g. labelling, appropriately sealed containers, spill clean-up and containment facilities)
- Availability of personal protective equipment (e.g. gloves and vapour masks)
- Better operating conditions and waste handling from kilns or furnaces
- Alternative fuels for kilns or furnaces
- Measurement, record keeping and registration for used oil collectors.

In some areas where the used oil is an alternative fuel for kilns, the kilns operate in batch mode, meaning that the operating temperature may not be high enough to ensure complete destruction of all toxic contaminants in the used oil. It is also suspected that people using the used oil for this purpose may not be fully aware of all the risks associated with handling and storing used oil. Other types of furnaces or kilns that operate in continuous mode with better containment of the used oil may be more suitable for burning it.

Studies by the British Cement Association have shown that potential used oil contaminants such as polycyclic aromatic compounds (PACs), chlorinated hydrocarbons (including PCBs), and heavy metals are destroyed or rendered harmless in the cement kiln process. This is due to the high combustion temperatures and residence times employed, the alkaline nature of materials in the kiln, and the incorporation of the metals into the klinker (cement) during the kiln process.
Combustion of used oils as substitute fuels in power plants with effective ash management and flue gas abatement approximates to cement kiln operations in this regard.

EUROPIA reviewed the published information on Life Cycle Analysis (LCA) for the disposal of used oils. All data were analysed on the same basis taking into account the refining and marketing of the oil products as well as production and consumption of base oils in the EU. The objective was to evaluate the crude oil needs and fuel consumption in refining for several disposal methods (three regeneration processes and recycling by combustion in cement kilns or power plants). The results show that combustion in cement kilns, or controlled combustion in power plants, is an attractive alternative to re-refining in terms of both crude oil consumption and carbon dioxide emissions. The differences in crude oil consumption among the disposal options analysed are in the range 6 to 13%.

At the moment, samples of base oils that are being imported to Vietnam for the first time are sent to the IIC or other state laboratories for testing of key characteristics. Subsequent imports are often accepted on the basis of a material safety data sheet (MSDS), with only occasional random sampling. Base oils that are being produced in Vietnam, e.g. by re-refining, are not tested for the state, only for company quality control. This is important to ensure that customers are protected from base oil that may result in damage to the environment through leakage from corrosion or reduced engine performance.

There is at least one example of a company that currently re-refines used oil in Vietnam, the Van Dao Group. This company can produce base oil and other fractions by batch distillation of used engine oil, as well as producing fuel oil and waste that can be used in various industries. This type of base oil is currently only used for tractors, ship and motor engines. It could also be used second-hand trucks and Chinese motorcycles that do not require high quality lubricant oil. While the company's capacity to handle used oil and produce base oil has dramatically increased in recent years, the technology is not state-of-the-art. While labour costs are low in Vietnam, it is possible that energy costs may limit the competitiveness of the process in the longer term. Continuous or semi-continuous processes are generally more energy efficient than batch processes. If the Van Dao Group wishes to produce base oil of a higher quality from re-refining, it would be necessary to invest in solvent extraction or hydrotreating equipment. The "Licensing" and "In-house" options could provide suitable technology to provide a real improvement in product quality and safety.

2.2 The "Refinery" Option

Option: Incorporate used oil handling in one or more of the new oil refineries that is being developed for Vietnam, or in a foreign refinery.

At the moment, some refineries are being planned for Vietnam. The first one will be built at Quang Ngai (south of Danang, in central Vietnam). Others are being considered for Vung Tau (in the Mekong delta) and Thanh Hoa (south of Hanoi). While it is not currently expected that these refineries will produce base oil for lubricants, they should have appropriate raw materials and utilities for processing used oil in an economical and environmentally sound manner. The main argument for locating near a refinery is the ability to use hydrogen from the refinery for hydrotreating the used oil to produce higher quality base oil. There are a few options for introducing the base oil to the refinery that should be evaluated on the basis of capital costs for new equipment and land usage, and operating costs primarily for energy consumption and logistics. Logistics is a major consideration as Vietnam is a large country. For example, it would be expensive to transport large amounts of used oil from Hanoi to Danang. Furthermore, used oil is a hazardous material and in most countries there are regulations controlling the routes on which such materials are transported to ensure that emergency response is available in the event of a leak. While the "refinery" option has advantages, it is of most attractive for industrial and urban areas located relatively close to the refinery. Key considerations are HSE, sustainability and quality for the whole operation. The required processing capacity is discussed in the next section (the "licensing" option).

Base oil blending: Treated or regenerated used oil could be blended with the lubricant fraction or base oil coming from crude oil fractionation. This has the following advantages:

- Reduced energy consumption compared to the first option
- It would be subjected to the same processing steps as fresh base oil so could meet the same product quality specifications. (However, extra additives would be required compared to virgin base oil.)

The disadvantage is:

- The impurities found in used oil are not always found in virgin base oil and will require further processing steps and routing of streams to other parts of the refinery.

On-site processing: A re-refining plant located adjacent to an oil refinery, is an option closely related to the "Licensing" and "In-house" Options. It would have several potential advantages:

- Availability of materials, e.g. hydrogen, waste treatment, heating and cooling media, nitrogen; technology, e.g. process automation and product logistics channels; and people, e.g. suitably experienced operators, maintenance staff and technologists.
- The plant would be custom-built to handle the impurities found in used oil.

The main disadvantage is:

- Increased capital costs, due to specialised equipment required for the re-refining plant, and potentially higher operating costs due to this.

Overseas processing: Overseas refineries and re-refineries may also have spare capacity that could be used to process Vietnam's used oil. This option could be explored while investigating the licensing option. The advantages are:

- No need for capital expenditure in Vietnam
- This may also be a source of income to the Vietnamese economy.
- The plant would be custom-built to handle the impurities found in used oil.

The main disadvantages are:

- Potentially higher labour and operating costs overseas that may be transferred to the Vietnamese customer, reducing the incentive to send the used oil for collection.
- Strict regulations (and environmental risk) in shipping hazardous waste on international waters

2.3 The "Licensing" Option

Option: Open bidding for international oil re-refining companies to design one or more plants capable of handling all or most used oil in Vietnam to produce re-refined base oils (RRBO).

Most oil refining and petrochemical companies in the world use licensed technology for many or all of the processes that they use. There are many advantages to this approach:

- Access to "proven" technology with potential for guarantees on capital, some operating costs, process performance and product quality.
- Reduced development cost and time to implementation compared to "In-house" option.
- Opportunity to benchmark own technology against the best competitors through the bidding process.
- Potential to look for a "Build-Operate-Transfer" (BOT) arrangement as is currently used for utility and power generation plants.

The disadvantages are:

- The "hidden costs" of licensing, such as, technical advice and license fees for future capacity increases.
- Risk of poor technology transfer and vulnerability to the licensor's financial performance.

Re-refining of used oil results in recovery of some the of used oil feedstock. Dependent on process / feedstock this can be as low as 40%. The quality of the product is generally feedstock dependent A (by)-product of the re-refining process is a concentrated 'toxic' stream requiring disposal possibly by burning in a hazardous waste incinerator, e.g. are cement kilns, steel works, hazardous waste incinerators, and possibly by use as a bitumen extender i.e. you need this type of infrastructure to deal with the by-products.

An important point is to have an efficient collection system: there is no point burning and /or re-refining if only a small amount of the used oil is collected. Also, modern re-refining plants generally only take specific used oils as feedstock (generally used engine lubricant – PCBs (from transformers), Chlorine are excluded above certain limits). Generally, to make the re-refined base oil HSE acceptable, a modern process containing hydrogen is required.

When opening a bid to tender for the contract, the objectives of the project should be clear:

1. **Capacity**: This should reasonably reflect the amount of oil that can be collected and sent for re-refining. Operational flexibility should also be allowed to ensure that the plant is still

economically viable while operating below maximum capacity. The ability to increase plant capacity in the future at a discounted cost should also be considered. The table overleaf reflects the most pessimistic and the most optimistic cases. Both cases are calculated based on the lubricant oil consumption in Vietnam being 200,000 tonnes in 2005. They also both require a successful effort to route used oil from its current uses as an alternative fuel or lubricant to the re-refineries.

The "pessimistic" case reflects that on average 30% of used oil is captured from the market – this reflects the minimum figure that is currently captured in some locations that have been visited, i.e. Vietnam Coal and some motorcycle shops. Such figures are not achieved in countries, such as Canada (22%) and the USA (12%), in which oil re-refining has been happening for several years. Most used oil in these countries is used as an alternative fuel. This also assumes that the volume of lubricants sold will remain at 2005 levels.

The "optimistic" case assumes that all oil collected in Vietnam (as per Ministry of Industry targets) will be routed for re-refining. Currently, this performance is only achieved in few countries, such as, Italy and Germany, where there has been strong government intervention to ensure that used oil is re-refined. This also assumes government forecast for 2010 figures.

	Types of oils	Minimum recycling capacity "pessimistic" (tonnes/ year)	Maximum recycling capacity "optimistic" (tonnes/ year)
1	Engine oils	36,000	122,500
2	Industrial oils and Hydraulic fluid	6,000	30,000
3	Transformer oils	3,000	22,500
4	Grease lubricants	-	-

2. **Number of plants**: Vietnam is a developing country with a largely agricultural economy. Most industry and large urban areas are located in harbour areas or reasonably close to the two largest cities, Hanoi and Ho Chi Minh City. Road infrastructure, while it is improving, is not sufficient to support a single oil re-refinery. It is suggested that several oil re-refineries would be required for Vietnam; with most capacity being located close to the main lubricant oil users and to lubricants blending plants of companies that would be prepared to buy re-refined base oil for their products. In Hanoi, for instance, there is about 18% of Vietnam's industrial capacity. This would amount to requiring re-refining capacity of 6,500 to 22,000 tonnes/yr. This could be served by 1-2 new plants in addition to the Van Dao Group plant.

3. **Product quality**: Most virgin base oil today is used to produce advanced lubricants that can lead to lower fuel consumption, longer drain intervals and therefore, less waste generation. Re-refined base oils should also meet standard API specifications to achieve good performance and to be competitive in the open market. There is sufficient market in Vietnam to use API group I base oil, so higher quality may not be required. All re-refineries should be equipped with a quality control laboratory for simple tests, such as, density, viscosity and flash point. This laboratory could be periodically inspected by the IIC, as well as sending weekly samples to the IIC for more detailed analysis.

4. **Guarantees:** Apart from the above requirements, the licenser should be able to give clear information on health, safety, environmental (HSE), and economic performance of the licensed process. There should also be, at a minimum, training and operational support during the first few months, preferably with support in translation of critical information to Vietnamese.

Although the invitation to tender should be made in a number of international trade journals and newspapers, there are foreign companies that have been operating used oil re-refineries for several years. They should be contacted directly by letter to ensure that they are aware of this opportunity. Some key examples from conference proceedings (REFIA, Moscow 2003) and the Internet are cited below. While some of these companies offer complete plants for handling used oil, others offer ancillary processes that may be useful for on-site oil regeneration for large users or handling of particular streams that contain high concentrations of toxic materials, such as, PCBs or heavy metals that may otherwise be difficult to treat. It is preferred if the detailed engineering and construction is done by Vietnamese companies, as they have a lot of experience in major projects in recent years with both good quality and low costs.

Operators and licensors of full-scale used oil re-refineries include:

- **Interline Resources Corporation**: This USA-based company has constructed a number of used-oil re-refineries in different countries, including the USA, UK, South Korea, Australia and Spain mainly in the late 1990's. This type of plant apparently requires a minimum of 27, 000 tonnes/year to break even. The plant uses solvent extraction rather than hydrotreating to achieve high quality base oil for lubricants. (http://www.interlineresources.com/introduction.html)

- **Baufeld Oel GmbH**: - This company operates two used oil re-refineries in Germany – in Chemnitz and Duisburg. Germany has the largest re-refining capacity in Europe and is capable of producing group II base oils. (www.baufeld.de)

- **Viscolube Spa** operates two used oil re-refineries in Italy – in Pieve Fissiraga (Lodi) and Ceccano (Frosinone). At least one of the facilities operates a continuous process consisting of vacuum fractional distillation followed by hydrotreating at 100 bar to produce group II base oils. This process also has amine and Claus units to handle the hydrogen sulphide produced during hydrotreating. In total, Viscolube handles 130,000 tonnes of waste oil every year to produce 90,000 tonnes of re-refined base oil. Their technology, named Revivoil, was developed jointly with Axens and is applied in several other countries (not named). (Further details are available on www.viscolube.it)

- **Meinken Engineering** in Germany also claim to have profitable and environmentally friendly means of re-refining used oil to produce high quality motor oils. Their process uses a Wiped Film Evaporator as the heart of the process. The processing steps consist of dewatering, predistillation, total evaporation, fractionation, filtration, blending and filling. They also have other processes for handling other waste streams containing hydrocarbons. Their email address is info@b-meinken.com. Currently, their website www.b-meinken.com does not contain further technical information.

- **Mineraloel-Raffinerie Dollbergen GmbH (MRD)** part of the Mustad International Oil Recycling group operates a re-refinery in Dollbergen, Germany, which processes 230,000 tonnes/year of used oil. The latest technology in this re-refinery is based on solvent extraction. Their own literature indicates that they produce "high-quality" re-raffinates from used oil. (http://www.mineraloel-raffinerie.de/)

- **Dunwell Group** in China has a lot of technology to treat used oil – a centrifuge to remove metal filings in-situ in power generation plants, a filter to purify oil at metal cuttings plants. They also operate an oil re-refinery in Hong Kong handling 18,000 tonnes/year. The re-refinery uses Wiped Film Evaporation among other steps such as pre-treatment, centrifugal separation, dewatering, light end removal and fractional distillation. The product oil is blended with additives to produce many lubricant products. (http://www.dunwellgroup.com)

Organisations or individuals that have technology for on-site solutions for regeneration of used oil or handling of specific contaminants are:

- **Aaron Oil Company**: This USA based company claims to use "the latest cutting-edge technology" for collection of oils, oil filters, oily water, sumps, sludges and antifreeze, as well as other petroleum fuel products that have been contaminated with used oil, water or solids. It is not clear whether the collected oil is subsequently routed for re-refining or used as an alternative fuel. Contact details are CustomerService@AaronOil.com and 1-800-239-4549 x 220.

- **Zimmark**: This Canadian company has developed technology for on-site regeneration of used oil. (British Rail developed the original technique). Their process uses precipitation to remove the contaminants that build up in diesel lubricating oil after prolonged use. They operate 6 units for Canadian National Railway, saving approx. CAD 0.50/litre or CAD 500,000 annually for 1 million litres of recovered oil. In addition to this, Zimmark operates 11 reconditioning facilities in Canada, recovering over 1.25 million litres of oil annually. Other installations are located in the United States, Mexico, and Asia. Zimmark does not sell its equipment to clients outright. Instead, it installs and operates it on a site provided

by the client, charging only for the reconditioned oil produced. Further details are available on their website, where there is also an enquiry form http://oee.nrcan.gc.ca/Publications/infosource/Pub/ici/caddet/english/R292.cfm?Text=N&PrintView=N

- **RLC Technologies, Inc.** has developed and successfully presented on the World market its Anaerobic Thermal Desorption Unit (ATDU), which has the capability of treating the following materials: Oily sludge, Refinery waste, Polyaromatic hydrocarbon's (PAH's), Polychlorinated biphenyl's (PCB's), Other contaminated materials & waste. This technology appears more to be for destruction of toxic compounds, rather than regeneration of useful hydrocarbons. *Such technology may be useful as an ancillary process in a used oil re-*refinery. http://www.rlctechnologies.com/industries.html

- The **US Naval Academy Environmental Division** has an in-house programme for collection of used oil, oily rags and oil filters. They recycle approximately 8,000 gallons of waste oil annually. They also manage to decontaminate the rags and filters for re-use. http://www.usna.edu/ENRP/complex.htm

- The Australian **Envirosmart** company has a range of microbial products for the biologically treatment of a range of wastes. They capable of treating waste oils (including PCBs and PAHs) http://www.envirosmart.com.au/company.htm

- A new process has also been developed for removing lead from waste oil by mixing it with nitric acid and treating the resulting solution with ultrasounds. After such treatment the oil is washed and recovered. Heavy metals, including lead, are precipitated with sulphuric acid and the nitric acid is regenerated. The article includes two flowsheets: a basic flowsheet for lead extraction, and a flowsheet for lead extraction with oil washing. "Ultrasonic Removal of Heavy Metals from Waste Oils", Fontana A., Braekman-Danheux C., Jung C.G., *Fuel Processing Technology* **1996**, 48, 107-113 (Eng.)

- **Enervac Corporation** in Canada has a number of technologies for treating used oil streams. (http://www.enervac.com) These include:

    - *Equipment designed for the decontamination of electrical insulating oils that have been* contaminated with low levels of polychlorinated biphenyls (P.C.B.'s). Oil containing up to 7000 PPM of P.C.B.'s can be processed lowering the P.C.B. level to below the detectable level (2 PPM). A small amount of molten metallic sodium dispersion is added to dehydrated and degasified insulating oil in a mixing tank. A reaction takes place converting the P.C.B.'s into harmless compounds, common salt and a few hydrocarbon residues. These are removed from the oil as sludge by a centrifuge. The sludge is non-P.C.B. and can be disposed of in any industrial waste disposal facility. The reclaimed insulating oil has excellent electrical properties, comparable to that of new Insulating Oil meeting the A.S.T.M. standard and can be used again in electrical equipment. "The technology used in Enervac's system has been used in Canada to reclaim over 25 million litres of contaminated oil since 1982. The process has approval of Environment Canada and the U.S. E.P.A.;

    - ENERVAC Waste Oil Recovery Systems that provide all the necessary components to properly reclaim and purify oil by removing all types of contaminants, which are formed or introduced into the oils, maintaining new oil specifications;

    - ENERVAC's Transformer Oil Regeneration Plant provides all the benefits of Fuller's Earth treatment without the associated problems of contaminated clay disposal or the high cost of replacing saturated earth. At the end of the useful lifetime of the regeneration media, normally 300 times longer than Fuller's Earth, it is simply disposed of in a normal landfill site. Ideally suited to large throughputs, the plant is available in either a mobile or stationary version.

2.4 The "In-House" Option

IIC is the national laboratory for refining and petro-chemistry research; it is also the only laboratory in this field in Vietnam. IIC has also got strong expertise and instruments to research,

test and develop waste oil regenerating technologies. IIC successfully developed the "Improvement of Efficiency of Lubricating Oil usage" with UNDP/UNIDO (VIE/86/034), which finished in 1993.

A lot of work has already been conducted at laboratory scale at the Institute of Industrial Chemistry (IIC) for re-refining of used oil such as heavily oxidised engine oils and lightly oxidised hydraulic fluids and cutting oils. There has also been some work on treatment of PCB-containing transformer oils. The following steps have been used to produce base oils of API group I from various types of used oil.

- Sedimentation by settling or centrifugation
- Atmospheric distillation
- Coagulation by different types of coagulants
- Vacuum distillation (only required for the heavily oxidised base oils)
- Decanting, filtrating
- Bleaching by absorbents

For the PCB-containing transformer oils, contacting with a reagent has been used to remove PCB from the oil by producing an insoluble sludge that does not contain free PCB, but a reaction product, as well as oil that is fit for reuse as a hydraulic fluid or cutting oil.

The key consideration when designing a full-scale plant is identical for the "in-house" option as for the "licensing option": capacity.

The IIC has also provided technical support to the Van Dao used oil re-refinery which produces base oil that are blended into lubricants for light tractors, boats and ships. At the moment, both the laboratory and industrial processes for oil re-refining in Vietnam cannot produce base oil of quality higher than API group I. This is mainly due to difficulties in achieving the specification of < 0.03% sulphur. Processes such as solvent extraction or hydro-treating under severe conditions are generally required to achieve this specification. At industrial scale, these processes must be designed to operate in continuous mode. A pilot plant would be needed to help develop these new processes, to understand the effect of feed composition and impurity accumulation.

The main advantages of the "in-house" option are that intellectual property rights will then be owned by the IIC and there may be potential to license the technology to other countries. Also, IIC has been involved in research in re-refining for a long time and in designing a new lubricants blending plant in Vietnam (now APP). The main disadvantage is the risk of not finding the most suitable cost-effective process, if there are better options available internationally by licensing. There is a strong academic understanding of refinery and petrochemical processes at the IIC, however operational experience is limited as there is currently no full-scale refinery in Vietnam and only a small number of re-refineries (e.g. the Van Dao plant).

2.5 The "Carbon Black" Option

Option: "Make used oil a feedstock to produce Carbon Black."

This option is another possibility for recycling used oil. This would convert the hydrocarbons into carbon black, which is a valuable feedstock in Vietnam for manufacture of rubbers. There would have to be sensitivity to the fact that not all the toxic contaminants in used oil would be destroyed by the carbon black manufacturing process. Rubbers produced using this process going into consumer goods would have to be evaluated for toxicology and ease of leaching of toxic components. The main advantage of this process is that carbon black is a valuable material in Vietnam. The disadvantage would be that lubricating properties of the base oil are lost.

Part IV. EXPECTED OUTPUTS AND ACTIVITIES

In general, since there are two key areas in this project, as outlined above: used oil collection and used oil recycling. These activities and outputs require different skills and can be executed in parallel to ensure maximum speed to implementation.

Output 1: A report of used oil generated in the industry in the project areas that include:

- Listing up of used oil generators
- Conducting of questionnaires and surveys for major generators
- Estimation of used oil generation by type and region
- Estimation of amount of used oil treated by existing methods in the project areas

	Activities	Timing
1.1	*List of possible generators*	*Months 01-06*
1.2	Survey in plants of main users, e.g. coal, railways, etc.	
1.3	Develop questionnaires	
1.4	Data processing	
1.5	Reporting and recommendation	

Output 2: Awareness-raising campaign for different used oil generators in order to:

- *Help the generator to reduce used oils discharged to the environment*
- Segregate used oils by type (where required)
- Handle used oils in a safe and responsible way

	Activities	Timing
2.1	Mass media campaign on used oils and environmental impacts	Months 07-12
2.2	Mass media campaign on used oils classification	
2.3	Mass media campaign on the project	
2.4	Training and audits for selected used oil generators in Hanoi	
2.5	Training and audits for selected used oil generators in other provinces ▪ In the field of oil and grease analysis (maximising usage life for oil) ▪ In the field of technologies (scope for on-site regeneration) ▪ In the field of personnel safety ▪ In the field of environmental protection.	
2.6	Development and implementation of measures and standards for enforcement of used oil management legislation	
2.7	A study tour to Malaysia. Malaysia is an ASEAN member as Vietnam. Malaysia is a developing country, which has, undergoes what Vietnam is experiencing now in used oil management. The Malaysian model, administration process, enforcement practices, resources, recycling options and its many best practices could be reviewed by Vietnam to "up-start" her used oil management system. The visiting team should comprise of relevant government agencies that administer/enforce regulation 155/1999/QD-TTg, local government, IIC, Consultants, UNIDO and other relevant parties.	

Output 3: Research in appropriate technologies for

- Collection of used oils
- Storage of used oils
- Recycling used oils for different purposes of application (see "Technology choices for oil *recycling", page 16*).

	Activities	Duration
3.1	Research on recycling technologies	18 months
3.2	Research on recycling oil applications	
3.3	Pilot studies for demonstration for on-site application, training and market development	
3.4	Reporting of research results and recommendations	
3.5	Calculate capacity the potential applications of the recycled oils and greases in the various regions and industrial user sites	

Output 4: Feasibility Study (FS) Report for selection of full-scale plants and infrastructure to recycle oil and grease in Vietnam (see "Technology choices for oil recycling", page 16).

	Activities	Duration
4.1	Develop outline of FS	06 months
4.2	Estimate costs for each technology option (capital and operating costs) for regions and industry type in Vietnam	
4.3	Develop draft FS	
4.4	Circulation of FS for comments	
4.5	Finalize FS and select best technologies	
4.6	Establish ventures and funding arrangements to develop and implement recycling projects (with associated used oil collection infrastructure)	

Output 5: A Market for recycled oils.

	Activities	Duration
5.1	Agree the minimum standards for recycled lubricant oils in Vietnam	06 months
5.2	Establish testing, handling and labelling requirements for recycled lubricant oils.	
5.3	Identify suitable markets for this oil	
5.4	Develop markets to match recycling capacity	

Output 6: Strengthened Capacities in the field of used oils and grease via providing opportunities for higher education to young researchers in this field (MSc and/or PhDs, as well as information campaigns in the field will be conducted for some years

	Activities	Responsibility
6.1	Higher education for young researchers fellowships	48 months
6.2	Site visits and exchanges for training and technology selection (in Vietnam and overseas)	
6.3	Develop professional courses in the field in the project implementing institute for MSc, PhDs and technical staff working in the field	
6.4	Provide lectures, information and data for public awareness raising campaign via mass media or other means (IT application) in the field of environmentally and economically sound management of used oils and greases in the production and household activities	

Part V. INPUTS

1. Government inputs

1.1 Assignment of counterpart personnel and administrative staff

1.2 Provision of buildings and facilities

1.3 Allocation of operating expenses necessary for the implementation of the project

2. Project inputs

In accordance with the planned activities, the project will provide the services listed in the following table:

No	Activity	Cost (USD)
1	Survey of used oils and greases generated in the project areas and develop a collection plan of action.	30,000
2	Conduct awareness-raising campaign (advertising, audits and training) in order to facilitate sound environmentally and economically used oils management	60,000
3	Review the capability of the project implementing institute, the Institute of Industrial Chemistry (IIC), and other related institutes, companies and universities in order to ensure sufficient facilities to fulfil the assigned tasks	10,000
4	Conduct research on technologies for used oil regeneration and re-refining (laboratory and office based)	
	4.1. research expenses	400,000
	4.2. research facilities	500,000
	4.3. consultation services	350,000
	4.4. miscellaneous expenses	50,000
5	Development of feasibility studies for the various options for used oil and greases recycling for Vietnam	20,000
6	Develop the market for re-refined oils and greases	50,000
7	Capacity building in the field of used oils and greases management for Vietnam	100,000
8	Evaluation of the project results	10,000
	Total cost, net of ASC	**1,580,000**
	Agency Support costs 13%	205,400
	Total costs, including ASC	**1,785,400**

Part VI. PROJECT MANAGEMENT AND IMPLEMENTATION ARRANGEMENTS

1. Project Management Board:

MOI and UNIDO (including donor)

2. Project implementing Institutes:

- Institute of Industrial Chemistry: The IIC is an institute of the MOI, and the IIC has a well-developed series of activities in the field of lubricant oil and greases in more than 20 years. In recent years, IIC has got a national certificate on oil analytical lab (VILAB). IIC has also developed preliminary research on possibilities of regenerating and re-refining used oils. Also, within IIC there are other professional centres and research groups working in the field of environment in general and waste management in particular. The planned tasks in the project are fit to the IIC capability and its functions.

- One institute or company from Donor country.

3. Associated agencies:

- Some oil production companies – Shell, BP, APP, Vietnam Refining Company and others
- Re-refining companies – Van Dao group and international operating and licensing companies.
- Industries, using a large amount of oil.
- DOIs and DONREs of the provinces in the project areas

Part VII. EXPECTED IMPACT OF THE PROJECT

Reduced pollution and economic waste from used oil being disposed and

Part VIII. TENTATIVE SCHEDULE OF IMPLEMENTATION

2-5 years

Part IX. PROJECT MONITORING, REVIEWS, REPORTING AND EVALUATION

Monthly meetings
Quarterly progress reports

Part X. OTHER RELATED PROGRAMMES

"Strategies for improved investment in Cleaner Production and Environmentally Sound Technologies";
"Reducing industry impacts in areas of natural or cultural heritage—Ha Long Bay";

Part XI. SUSTAINABILITY

Sustainability, from a social, economic and environmental perspective, is one of the most important considerations in this project. The used oil supply chain is complex and has many stakeholders and points of impact. All options for this project have costs as well as benefits.

Part XII. RISKS

Hazardous waste management, especially collection and recycling are big challenges for waste management work in Vietnam. It depends very much on government and people awareness on environmental and economic aspects of the wastes. Used oils and greases have been used and disposed of in an irresponsible way in many parts of Vietnam. The success of the project could be damaged or being threatened due to low awareness of different social layers. It is meant that

public and enterprises, especially SMEs' awareness and education should be very important. During the whole life of the project, an information, training and auditing campaign will be taken with significant resources (financial, man power and time) in order to minimise the risk.

Annex 1 Request from MOI

MINISTRY OF INDUSTRY
54 HAI BA TRUNG STREET, HOAN KIEM DISTRICT, HANOI, VIETNAM
TEL.: 84 – 4 – 8246762; FAX: 84- 4 8 265 303; EMAIL: HOPTACQUOCTE@HN.VNN.VN

Hanoi Aug., 29, 2003

TO: UNIDO Office in Vietnam

Dear sir,

First of all I would like to express my sincere thanks to all the support given by UNIDO to the Ministry of Industry in the field of industry development and environmental protection.

You may know that Vietnam is now in the process of Industrialization with high pace of economic development. In connection to that we also have to face with many environmental problems caused by industrial activities including pollution from waste oil. Having aware of that problems we have performed much effort for improvement of environment quality but there still much is not in our capacity.

By this letter I would like to sent a project proposal *"State of waste oil pollution in Vietnam and its solution"* to be disposed under your consideration. We will very acknowledge if UNIDO could seek potential financiers for the project realization.

Sincerely yours,

Dang Phan Thu Huong
Deputy Director General

Annex 2 Job description(s)

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

INTEGRATED PROGRAMME FOR VIETNAM 2003-2005

Component 3: Environment

Project # 8: Hazardous Waste Management

JOB DESCRIPTION
xx/VIE/05/yyy

Post title:

Duration:

Date Required:

Duty Station:

Counterparts:

Duties:

Main Duties	Expected Duration	Expected Results	Related Activity:
a)			
b)			
c)			
d)			
e)			

Qualifications

Languages

Background Information

Annex 3 The Malaysian model

Legislation
The Environmental Quality Act 1989 (Scheduled Wastes Regulation) regulates the administration, control, management, treatment facilities, spill preparedness, responsibilities of all related parties and penalty of max USD 140,000 and 2 years imprisonment. This Act applies the "cradle-to-grave" responsibility principle

The Department of Environment (DoE) administers and enforces this Act. Many fines been issued and illegal operations has been brought to court.

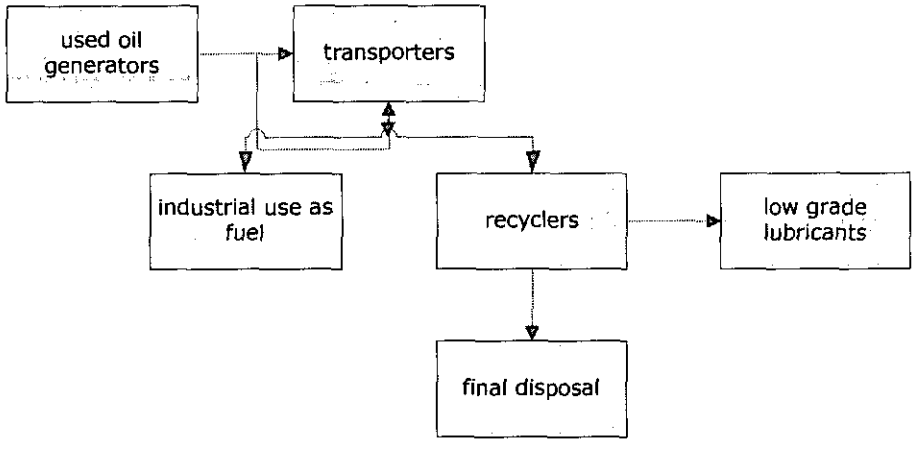
Collection mechanism
Majority used oil collectors and treatment facilities are licensed by the DoE however there are unlicensed operators. The yearly renewal license stipulates the limitation of the operator i.e. volume, wastes characteristics, vehicle registration, treatment method etc. Licensed facility to treat hazardous wastes from 3rd party, facility known as prescribed premises, the facility must undergo an EIA accordance to the EIA Guideline and conducted by an EIA registered personnel. This is to provide transparency to this process.

xx % of used oil is collected in Malaysia. There are xxx licensed transporters and xxx licensed recycler for used oil. Prescribed premises are permitted to collect hazardous wastes as stipulated in their license. Prescribed premises operate own fleet of transport and collection of used oil at USD 1/litre. There are licensed transporter that transport used oil to non prescribed facilities i.e. brick, pottery factory, although these routes are not favorable.

DoE has a department of hazardous wastes at Federal and State level where it admininisters, approves licenses, enforces the Act, increases awareness etc.

There are two licensed integrated facilities to dispose hazardous wastes located at Peninsular Malaysia and second in Kuching (East Malaysia). Disposal charge is between USD 200 - 900/ton depending on characteristics of hazardous wastes. Used oil disposal rate at USD 50 - 500/ton. One obtained ISO14001 accreditation and another in-progress.

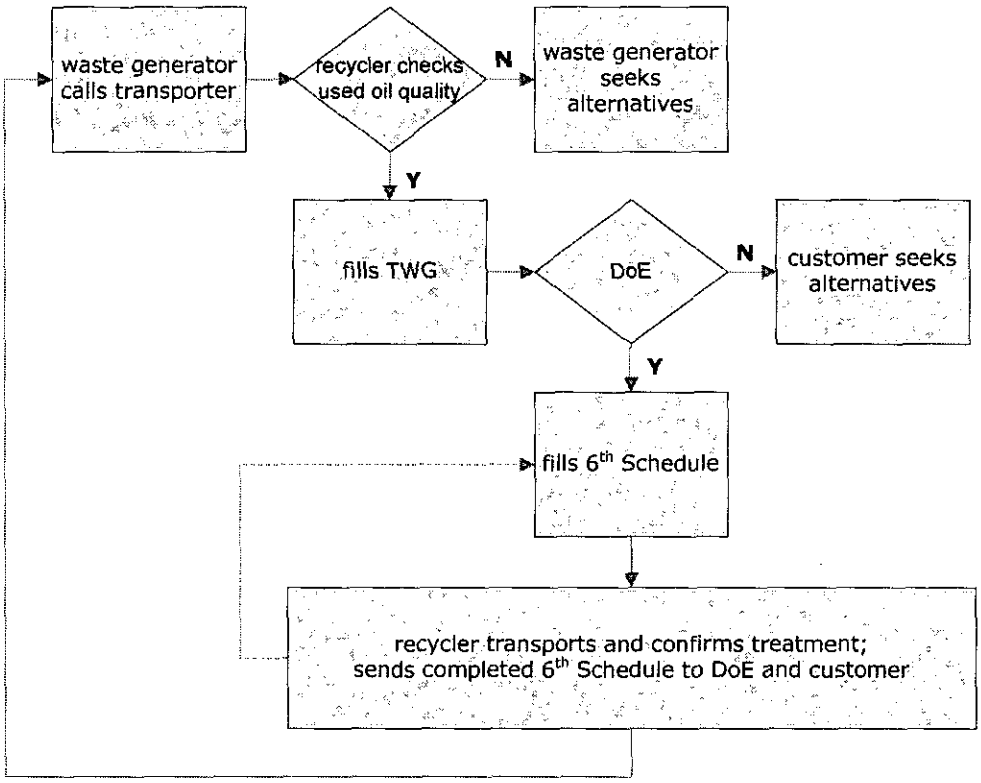
Figure 4 Collection mechanism by licensed operators with accounting system



TWG is a process recently introduced by the DoE to curb illegal operations. The waste generator need to apply to the DoE to ensure the transporter and treatment facility used by the waste generator is genuine. This process is a one-time application for an individual waste generator using specific recycler with no volume binding. If the waste generator decides to change recycler, this process needs to take place.

The 6th Schedule is the document that must be filled by generator, transporter and treatment facility indicating volume, wastes code, signature, date etc (see Appendix 1). Relevant copy of this filled document will be send to all handlers and the DoE to ensure accounting and administration of proper handling of hazardous wastes throughout the chain-of-collection. (Refer Appendix 1 for administration of 6th Schedule)

Figure 5 Administration process for traceability and accountability



Legislation and Health, Safety and Environmental (HSE) Awareness Level
Awareness level is high sharp end of the pyramid i.e. governmental level, multi-national and licensed facilities however some unscrupulous industries still dump hazardous wastes into the environment. It is common that multi-national companies conduct audits on their transporter/recycler to ensure proper licensing and continuous HSE improvement are committed by the management.

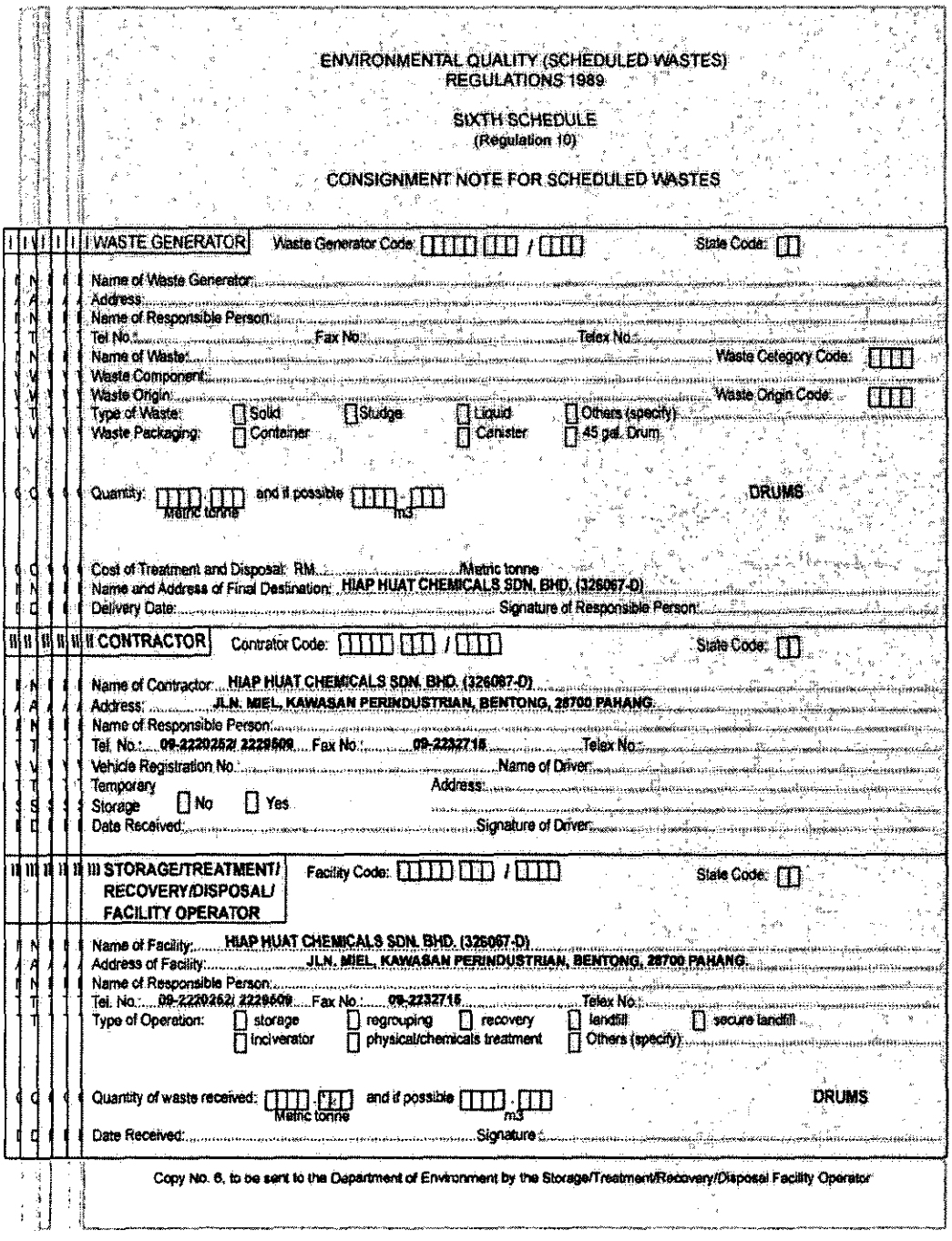
Source		**Awareness** low	medium	high
Waste Generators	multi-national companies			
	SMEs			
	small scale motor workshops			
Transporters	licensed			
	unlicensed			
Recyclers	licensed			
	unlicensed			
Integrated disposal facility				
Regulators				
Media				
NGOs				
Public				

Appendix 1: The 6th Schedule

All hazardous wastes "handlers" must document the process to ensure tracking and accounting of hazardous wastes. There are 6 copies of different colours for easy administration.

Part1: filled by waste generator; Part II: filled by transporter; Part III: filled by treatment facility

Copy 1: kept by waste generator;
Copy 2: sent to DoE by waste generator;
Copy 3: kept by transporter;
Copy 4: kept by treatment facility;
Copy 5: sent to waste generator by treatment facility;
Copy 6: sent to DoE.



ENVIRONMENTAL QUALITY (SCHEDULED WASTES) REGULATIONS 1989

SIXTH SCHEDULE
(Regulation 10)

CONSIGNMENT NOTE FOR SCHEDULED WASTES

I WASTE GENERATOR Waste Generator Code: [ ][ ][ ] / [ ][ ][ ] State Code: [ ]

Name of Waste Generator:
Address:
Name of Responsible Person:
Tel No.: Fax No: Telex No.:
Name of Waste: Waste Category Code: [ ][ ][ ]
Waste Component:
Waste Origin: Waste Origin Code: [ ][ ][ ]
Type of Waste: [ ] Solid [ ] Sludge [ ] Liquid [ ] Others (specify)
Waste Packaging: [ ] Container [ ] Canister [ ] 45 gal. Drum

Quantity: [ ][ ][ ] . [ ][ ] Metric tonne and if possible [ ][ ][ ] . [ ][ ] m3 DRUMS

Cost of Treatment and Disposal: RM /Metric tonne
Name and Address of Final Destination: HIAP HUAT CHEMICALS SDN. BHD. (326067-D)
Delivery Date: Signature of Responsible Person:

II CONTRACTOR Contrator Code: [ ][ ][ ][ ] / [ ][ ][ ] State Code: [ ]

Name of Contractor: HIAP HUAT CHEMICALS SDN. BHD. (326067-D)
Address: JLN. MIEL, KAWASAN PERINDUSTRIAN, BENTONG, 28700 PAHANG
Name of Responsible Person:
Tel. No.: 09-2220262/ 2229509 Fax No.: 09-2232715 Telex No.:
Vehicle Registration No.: Name of Driver:
Temporary Storage [ ] No [ ] Yes Address:
Date Received: Signature of Driver:

III STORAGE/TREATMENT/ RECOVERY/DISPOSAL/ FACILITY OPERATOR Facility Code: [ ][ ][ ][ ] / [ ][ ][ ] State Code: [ ]

Name of Facility: HIAP HUAT CHEMICALS SDN. BHD. (326067-D)
Address of Facility: JLN. MIEL, KAWASAN PERINDUSTRIAN, BENTONG, 28700 PAHANG
Name of Responsible Person:
Tel. No.: 09-2220262/ 2229509 Fax No.: 09-2232715 Telex No.:
Type of Operation: [ ] storage [ ] regrouping [ ] recovery [ ] landfill [ ] secure landfill [ ] incinerator [ ] physical/chemicals treatment [ ] Others (specify)

Quantity of waste received: [ ][ ][ ] . [ ][ ] Metric tonne and if possible [ ][ ][ ] . [ ][ ] m3 DRUMS

Date Received: Signature:

Copy No. 6, to be sent to the Department of Environment by the Storage/Treatment/Recovery/Disposal Facility Operator

Annex 4 Properties of used oil vs. Medium Fuel Oil (MFO)

Properties	Used oil (Typical values)	Medium Fuel Oil (MFO)
Density @ 15oC, kg/l	0.9016	0.9900 max
Viscosity @ 50 °C, cSt	83	180 max
Sulphur, %wt	0.6	3.50 max
Flash point, °C	133	66 min
Water content, %vol	0.30	0.50 max
Sediment by extraction, %wt	0.02	0.10 max
Ash content, %wt	1.10	0.10 max
Conradson Carbon Residue, %wt	2.0	13.0 max
Head of Combustion, gross, MJ/kg	42.7	43 min
Metal content	High	Low

Annex 5 Cement kiln vs. incinerator combustion conditions

Properties	Cement Kiln (Typical)	Hazardous Waste Incinerator (Typical)
Gas temperature, max °C	>2200	<1480
Solid temperature, max °C	1420 – 1480	< 1370
Gas retention time at 1100 °C, second	6 - 10	0 -3
Solid retention time at 1100 °C, min	20 – 30	2 – 20
Oxidising conditions	Yes	Yes
Reynolds number	>100,000	>10,000

Annex 6 Used oil by industry

Industry	Type of oil	Acceptable recycling?
Automotive industry	• Motor oil, automatic transmission fluid, power steering fluid, diesel fuel, gear oil,	Yes
	• Oil filter	No
Aviation industry	Turbine engine oil	Yes
General industry	• Hydraulic oil, gear oil, fuel oil, transformer oil	Yes
	• Oily waste water, engine coolant	No
	• *Chlorinated solvents i.e. metal working fluids,* degreasing solvents, dry cleaning solvents, Freon, Freon-contaminated refrigeration oil	No
	• Flammable liquids i.e. gasoline, naphtha, paint and paint thinner, fibreglass resin, parts cleaning solvent	No
	• Other i.e. transformer oil contaminated with PCB, brake fluid, engine coolant	No

Annex 7 List of interviewee and questionnaire used for recyclers, motor workshops and SMEs

(June 05)

Type of industry, location	Activity	Collection Mechanism	Documentation
5 small motor workshops. Cau Dien, suburban, poor 10km fm Hanoi	▪ Repair motorcycles, change engine oil ▪ Operated by 1-3 mechanics	▪ Used oil sold at 1000 Dong/litre. ▪ Collected by same collector on daily/weekly	No
Licensed used oil recycler. 50km fm Hanoi	▪ Recycle used oil to industrial lubricant, re-constituted fuel oil and grease. Operating for last 9 years. ▪ Employed 60 staff with 10 graduate ▪ Frequent visits by regulators	▪ 100 collectors "supplying" 1000 ton/mth used oil ▪ Pays 2000 Dong/litre to collectors ▪ Recycled products sold	Yes
Nam Son, Soc Son Industrial Waste Treatment Complex. 60km fm Hanoi	▪ Integrated hazardous treatment facility, operating for last 3 years ▪ Employed 3000 staff ▪ Frequent visits by regulators	▪ Operating two incinerators ▪ Charge 5000 Dong/kg for disposal ▪	Yes
Chemical manufacturer at 10km outskirts of Hanoi	▪ Manufactured silica based chemical used in tiles, detergent and fertilizer industry ▪ Operated for 30 years. ▪ Kiln is fuelled by re-constituted fuel oil to melt silica.	▪ Buy re-constituted fuel oil from recycler 3000 Dong/litre	No
Dump truck repair centre at 10km outside Hanoi	▪ Repairs 100 trucks/mth ▪ 50% new trucks (1-3 yrs), 50% old trucks (30 yrs) ▪ Employed 300 staff with 30 graduate	▪ Generates 700 litre of used oil/mth ▪ Used oil sold to construction, recycler and any interests party at 1500 – 2000 Dong/litre	No

Questionnaire used to interview a small sample size in the used oil supply-chain. A sample of the questionnaire is tabulated below:

1. What does your company do?
2. How much used oil does your company collect?
3. How many transporters/collectors supply used oil to your company?
4. How much does your company pay for used oil?
5. How many people working in your company? How many university graduates?
6. Does your company have an Environmental Officer responsible for environmental management?
7. How do you train your Environmental Officer to increase his/her environmental awareness?
8. Is your company planned to achieve ISO14001 in the near future?
9. How do you clean up spilled used oil on the ground?
10. What is your process to recycle used oil?
11. Is it easy to obtain license from DONRE? Did you have to conduct EIA for your treatment facility?
12. How many times do DONRE and other authorities audit your operation?
13. Are you aware of the Environmental Provident Fund?
14. Do you keep an inventory of used oil collected?

Annex 8 Information in brochure to generators and supply-chain

Section I: About used oil and legislation

1. What is used oil?
When the lubricant from engines, machinery, motorcycles, and buses is being changed, the dirty oil that is drained out is called used oil.

2. Who is a used oil generator?
Any motor workshop service centre or factory that produces used oil from its own operation is a used oil generator.

3. Why recycle used oil?
Lubricant does not wear out - it just gets dirty. If disposed improperly, it can cause harm to the environment, wildlife and human. Used oil can be reprocessed into fuel, lubrication oil, and grease and paint materials. By adopting a proper disposal practices, you are keeping the used oil out of rivers, lakes and ground that means keeping it out of your drinking water and maintaining a clean environment for your children.

4. Vietnam Law on Used Oil
Under the Vietnam law, the DONRE enforces the handling and disposal of used oil. It clearly states that used oil generator has the responsibility of handling and disposing used oil through a DONRE licensed contractor. Non-compliance with the rules and regulations pertaining to the proper disposal of used oil is a serious offence.

Why dispose to a DONRE licensed contractor?
5. This is a legal requirement.

A licensed DONRE contractor has the facilities to recycle or dispose the used oil safely with minimal impact to the environment.

Section II: Good practices — The "Do"s

1. On completion of task, wash exposed skin areas thoroughly using soap and water to remove traces of used oil.

2. All used oil should be disposed through a DONRE licensed contractor who has the facilities to recycle or dispose the used oil safely.

3. Wear protective gloves when handling used oil.

4. Label all used containers properly

Annex 9 Waste handling, minimisation and disposal principles

The key waste handling, minimization and disposal decisions of the waste management process are:

Inventorize
The first step is to prepare a list of used oil waste stream by origin and users i.e. type of industries. This should include quantities involved.

Characteristics
Identification properties of used oil

Segregate
Physical segregation at source to minimize disposal costs

Minimise
- Reduction at source, less waste through the use of more efficient practices and clean production technology
- Reuse used oil in their original form or after processing
- Recycling and recovery into safer products after some form of processing

Treatment
There is considerable amount of literature and practices available for recycling and disposal of used oil

Disposal
Responsible disposal is the final step of used oil management process. Disposal should meet specific requirements to avoid damage to health and the environment.