Survey on Fossil Fuel Consumption for Energy Efficiency Conservation to Promote the New Technology of Biofuel in Lao PDR

New Energy and Industrial Technology Development Organization

Lao Institute for Renewable Energy

SUGGESTION POLICY DOCUMENT ON BIOFUEL PROMOTION AND DEVELOPMENT IN LAO PDR

Final Report

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The Lao Institute for Renewable Energy, LIRE

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List of Abbreviations and Acronyms

AAHP	Association of Agriculture and Handicraft Promotion
ADB	Asian Development Bank
CIDSE	International Cooperation for Development and Solidarity
DoE	Department of Electricity
EU	European Union
FAO	Food and Agriculture Organisation
GoL	Government of the Lao People's Democratic Republic
INGO	International Non Governmental Organizations
Lao PDR	Lao People's Democratic Republic
LIRE	Lao Institute for Renewable Energy
LPOPA	Lao Promotion Organic Product Association
LSFC	Lao State Fuel Company
LUSEA	Lao Union of Science and Engineering Associations
MAF	Ministry of Agriculture and Forestry
MEM	Ministry of Energy and Mines
MIC	Ministry of Industry and Commerce
NAFRI	National Agriculture and Forestry Research Institute
NEDO	New Energy and Industrial Technology Development Organization
NFTP	Non Forest Timber Products
NPOL.ABC	Non Profit Organization Lao ABC
NSC	National Statistic Centre
NUoL	National University of Laos
PMO	Prime Minister's Office
RESDALAO	Renewable Energy for Sustainable Development Association (of Laos)
RETC	Renewable Energy Technology Centre
STEA	Science, Technology and Environment Agency
SNV	The Netherlands Development Organisation
TPLPA	Tree Plantation and Livestock Promotion Association
TRI	Technology Research Institute
UN	United Nations
WWF	World Wide Fund for Nature

PART 1 Introduction

The worldwide scarcity of raw mineral materials: petrol underground reserves sufficient for another 50-60 years, natural gas for about 150 years, and coal for about 200 years. International demand of fuels grows exponentially that affects high international prices and contributes to global warming. Therefore, it becomes time to move towards fuel savings strategies and substitute alternatives sources of energy development along with new adapted technologies.

Many countries support and promote new technologies that make use of other renewable resources that will not run out, called alternative energies. These include the use of biofuel in transportation in order to decrease the use of fossil fuels (gasoline) that are limited. Such alternate bio-energies offer multiple advantages: protecting the environment and fighting against global warming, generating new income sources and job creation while reducing the dependence to fossil fuels importations. This is especially true and exacerbated in a context where the domestic demand of fuels notably for transportation is rapidly expanding as it is the case of the Lao People Democratic Republic (Lao PDR).

The great developments that the Lao PDR is experimenting will continue to be accompanied with substantial increases of energy consumption. The growth of the average incomes of the population brings especially along new needs and associated expenses notably in transportation modes such as cars and motorbikes. In this context, the government of Lao PDR intends to develop a national policy to reduce its fossil fuel consumption with more use efficiency and to promote the production and use of biofuels as alternative energy sources, with the principal goal to better balance its dependency to fossil fuels imports, whilst maintaining inflation, sustaining economy growth and reducing poverty in line with the more general objective to move out from the United Nations list of the Least Developed Countries (LDCs) by 2020.

It is to understand that the Lao PDR is facing a new challenge. The country does benefit of strengths and opportunities such as suitable climate, land and labor force availability to initiate a veritable national strategy on this topic. But also weaknesses and threats do exist such as an emerging and insecure market and a lack of investments and technologies. The present study aims to provide significant insights in order to contribute to such a policy development.

The Lao Institute for Renewable Energy (LIRE[1]) has been assigned by the New Energy and Industrial Technology Development Organization of Japan (NEDO), representative office Bangkok, to "survey the fossil fuel consumption for energy efficiency conservation to promote the new technology of biofuel in Lao PDR".

The present document intends to first stimulate an exchange of knowledge within the keys stakeholders involved in this field (the workshop participants) and to secondly suggest strategic orientations that would assure the viability of such policy.

[1] The LIRE has been established under the agreement of the President of National Science Council, No. 447/NSC, dated 21 November, 2006; located at Ban Wat Nark, Lao-Thai road, Vientiane Capital, Lao PDR - Tel: (856 21) 353 430, Fax: (856 21) 314 045: Website: www.lao-ire.org

PART 2 Relevant Policy and Legal Framework in Lao PDR

There are currently several developments worldwide that focus on the implementation of policies and strategies to sustain the promotion of energy use efficiency and biofuels alternatives.

On the international scene, the United Nations (UN[2]), the World Bank (WB) and the Asian Development Bank (ADB) have drafted guidelines for bio-fuels strategies development. The United States of America (USA) and the European Union (EU) have set targeted policies for the development of bio-fuels. Another twelve African Nations had formed the Pan-African Non Petroleum Producers Association in 2006.

In Lao PDR, the Government of Lao PDR (GoL)'s Ministry of Energy and Mines (MEM) has just initiated to draft a strategy document on the development of biofuel and a policy document on fuel saving and promotion of biofuel production. To support these recent developments, it was found useful to provide in the following section a brief overview of the existing policies and laws but also studies that are of relevance for this topic.

2.1 *Recent Policy Developments on Biofuels*

- **Resolution of the VIII General Congress of the Lao Revolutionary Party, 2006 - Section 5.1. : Development Plan for Industrial Sectors (pp 114-116 Lao language).** This urged at promoting investments in feedstock crops for bio-diesel and ethanol production. To respond to this strategy, relevant sectors were requested to integrate this objective in their industrial development strategies; any public organizations, ministries and provincial authorities also need to define their own strategy focusing on bio-diesel and ethanol promotion.

- **Decree of the Prime Minister's Office on Fuel Saving No. 09/PMO, 25 May 2006 (English translation).** Article 1 stated that both public and private sectors should promote the reduction of fossil fuels consumption and fuels efficiency use through adequate awareness media campaigns. Article 2 urged close involved ministries that are the Ministry of Energy and Mines (MEM) and Ministry of Transportation and Construction (MTC), and the Science and Technology Agency (STEA) to create specific policies and development plans targeted on fuel alternatives based on renewable energies. This notably requested to actively participate, support and further cooperate with research and development organisations that are engaged in alternative fuels, biodiesel and ethanol production. The Ministry of Agriculture and forestry (MAF), the MEM, the Ministry of Planning and Investment (CPI), the banks, provinces and Vientiane capital must also endorse measures that support the planting of oil crops.

[2] UN April 2007: Sustainable Bio Energy: A Framework for Decision-Makers.

- **MEM Policy on Fuel Saving and Promotion of Bio-fuel Production in Lao PDR, Non official draft, 20 October 2006 (English translation).** This document is the first draft paper developed by the MEM on the promotion of bio-fuels; it is not official yet. It addressed issues, goals, targets and strategic objectives that aim to promote the use and development of biofuels production in Lao PDR. The MEM draft document notably targeted to achieve a 5% bio-fuel production share in the total fuel consumption by 2015 and to reduce by 5% the fossil fuel consumption from 2010 forward.

Also, the National Growth and Poverty Eradication Strategy in 2001 and the eight main goals of the GoL (Economic Theory, Transition and Alternatives: The Role of Government within the Transition Process, English version).

Other national policies of (direct and indirect) relevance: Agriculture, Forestry, Environment, Land Use, Transport, Industry and Commerce, Finance, Planning and Investment, Information and Culture.

2.2 *Relevant Laws and Regulations for Bio-fuels*

Several laws and regulations of Lao PDR are of direct or indirect influence on the energy use efficiency, fuels savings, and promotion and development of renewable energies of which biofuels. The following present a summary of the most relevant legislation those are the Electricity and Agriculture Laws[3].

1. The Electricity Law

The Electricity Law which became effective on August 1997 set out the regime for the administration, production, transmission, and distribution of electricity, including export and import, through the use of highly productive natural resources potential to contribute to the implementation of the national socio-economic development plan and to upgrade the living standards of the people (Article 1, Electricity Law). In addition it provided a suitable framework for the promotion and implementation of electrification.

The overall policy aim is to:

(1) Increase the household electrification ratio from the current level of approximately 45% to 90% by the year 2020, with intermediate targets of 70% in 2010; and

(2) *Reduce the use of imported fuels for electricity generation and other uses by substitute indigenous energy resources* principally hydropower but also solar, coal, and biomass energy.

[3] Quoted from the document available at www.dgs.de/uploads/medialPV _and_Biomass_Study_Laos.pdf

2. The Agriculture Law

Investment in agricultural production is divided into small, medium and large scale production and agri-business. The size of production is determined by the MAF in coordination with the Committee for Management and Promotion of Agriculture. In addition, the Promotion Fund for Agricultural Activities under the MAF is responsible for investing in efficient agriculture. The forms of investment in agricultural production are comprised of investment by family units, by means of cooperation by the public and private investment. The state may choose to invest when there are no interested parties but such investment is deemed important and necessary for the benefit of the people (Articles 46 and 47). There is also provision under the Law to develop Capital and Promotion Funds for the *promotion of new forms of agricultural production* (Article 50).

2.3 *Existing Related Studies*

Few studies have been found in the literature related to the biofuel topic in regards to the application to the Lao PDR context. Those are:

- EuropeAid 'Asia Pro Eco project TH/Asia Pro Eco/05 (101302)': Diagnostic Study on Renewable Energy Potential and Feasibility in South East Asia. Produced by RESDALAO and the Deutsche Gesellschaft fur Sonnenergie e.V. (International Solar Energy Society, German Section - DGS), November 2005. www.dgs.de/uploads/medialPV_and_Biomass_Study_Laos.pdf
- ADB, 2006: Promotion of the Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA), Lao PDR Country and Policy Report. Draft Final Report, May 2006.
- National Science Council (NSC): The Environmental Impacts of Trade Liberalization on the Bio-diesel Sector of the Lao PDR, by Paychith Sengmany, June 2007. Paper presented at the national workshop on achieving sustainable development in the GMS: A Rapid Trade and Environmental Assessment of the Lao People's Democratic Republic, hosted by the Committee for Planning and Investment on 21st of June, 2007.
- MAF 2006: Concept Note - Support to Development and Implementation of National Code of Planted Forest in Lao PDR.
- Study made on Jatropha by Dr. Phouvong who works in the Department Environment in the PMO and Dr. Chemcheng is a chemistry teacher at NUoL: the aim of this study was to produce soap and fuel in the rural areas; it was financed by the Mennonite Community Vientiane in 1980.
- Other studies from Thai sources. Thai universities have worked on Jatropha as a source for bio-diesel and ethanol from sugarcane and cassava.

PART 3 Current Energy Status of Lao PDR

3.1 *Energy Resources in Lao PDR*

Most of the population depends primarily on biomass (fuel wood) for its domestic energy needs and on petroleum products (100%) imports for its commercial and transportation energy requirements.

According to the Department of Electricity (MEM/DoE) statistics, it was estimated that in 2005 wood fuel use was about 0.75 m^3 per capita and per year, approximately 2.4 million tones per year. Fuel wood (wood fuel and charcoal) is mainly used for cooking and heating and its use in rural areas and accounts to 69% of the average energy use (ADB, 2006[4]).

In 2002, the total primary energy supply amounted to 1,811 Ktoe. It was estimated that fuel wood represented 56% of the total energy consumption, petroleum 17%, electricity and charcoal both 12%, coal[5] 3% and city gas 0.08% (ADB, 2006).

Considering the energy consumption by sectors, the residential sector is the biggest energy consumer accounting to 51% of the total energy consumption. It is followed by the transportation sector that represented 26%, then the industry with 20%, while the agriculture and commercial sectors are very low energy consuming with 2% and 1% respectively.

Although the use of natural gas remains marginal, imports of LPG gas increase by 25% every recent year for household consumption only.

Further, geophysical investigations are carried out for natural gas and fuel sources, but without any findings of liquid or gaseous fossil fuels till now.

Available **renewable energy resources** in Lao PDR generally include solar power (for water heating and solar photo-voltaic for electricity generation), hydropower (including pico village, micro, mini, small, medium and large), wind power and biomass.

3.2 *Review of Fossil Fuels Use and Consumption*

Facts and figures of fossil fuels imports in Lao PDR:

- Most imported fuel is used in transportation. Unlike other nations, only a small proportion of fuel is used for electricity that relies more on renewable energies such as hydropower and solar power.
- Fuel oil is mostly imported from Thailand and also Vietnam, both countries receiving the majority of their oil from the refinery in Singapore[6].

[4]ADB (2006). Draft Final Report on the Promotion of the Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA), Lao PDR, Country and Policy Report, May 2006, Vientiane.
[5] Lao PDR does have some coal reserves.

- Since 2000, oil importation of Lao PDR is increased by 5% annually.
- The fuel oil imports have grown from 180,000 tons in the year 2000 to 260,000 tons in year 2004, as vehicles include motorbikes have increased from 51,000 in the year 2000 to 557,000 in the year 2004 (MEM, SNC, 2006[7]).
- The import of fossil fuel was of 450 million liters in 2006 and of 485 million in 2007.
- In the future, it is estimated that the use of fuel oil will increase by 10% annually.
- The fuel use estimate for 2010 is 561 million liters and will increase to 716 million liters by 2015, assuming diesel use is 55%, gasoline use is 40% and other fuels account for 5%. In 2020, estimations for imports give a figure of 914 million liters.

Energy Consumption in the Transport Sector:

According to a survey produced by the Department of Alternative Energy Development and Efficiency (DEDE) of Thailand[8], the energy consumed in 2004 in Lao PDR amounted to 317.7 Ktoe, decreasing by 7.1% from the year 2003: gasoline, 162.3 Ktoe and diesel, 155.4 Ktoe.

The provinces with the highest energy consumption in transport sector were Vientiane Capital with total energy consumption of 110.0 Ktoe: gasoline, 28.3 Ktoe and diesel, 81.8 Ktoe, followed by Savannakhet and Champasak, 37.3 and 30.8 Ktoe respectively. Vehicles with the highest gasoline consumption included motorcycles, 133.7 Ktoe, accounting for 82.3% of gasoline consumption of all types of vehicles. And those with the highest diesel consumption included buses, pick-up trucks, and trucks, 56.7, 41.2 and 36.9 Ktoe respectively.

Petroleum Product Consumption by Economic Sector:

According to the same DEDE survey, there are three types of petroleum products used, which were gasoline, fuel oil, and diesel. In 2004, the total consumption amount of gasoline in transport sector was 162.3 Ktoe; fuel oil in industrial sector, 1.56 Ktoe; and diesel in transport sector, agricultural, and industrial sector, 155.4, 33.6 and 8.8 Ktoe respectively. The province with the highest petroleum product consumption was Vientiane Capital, 117.02 Ktoe and that with the lowest petroleum product consumption rate was Sekong, 0.86 Ktoe. The rate in each of other provinces was at 16.25 Ktoe on average.

[6] Interviews with Mr. Phougom, Head of Renewable Energy Division / Lao State fuel Company, and Mr. Lamphoune Phimphavong, Director of Shell Laos, 2007.
[7] Ministry of Energy and Mines, National Statistic Center (10/2006).
[8] Department of Alternative Energy Development and Efficiency of Thailand: http://www.dede-acmecs.com/ENGLISH/Lao2/sum-lao2-eng.html

3.3 *Potential Bio-fuel Crops Production in Lao PDR*

Biodiesel from soy or palm oil and ethanol from corn, sugarcane and cassava are major players in biofuel energy. In principle biofuels do not increase the amount of carbon dioxide in the air, because as the plants grow they trap the CO_2 that is released when biofuels are burned. Projections for potential energy supply can be made from basic productions that are available from agricultural statistics. Data on potential biofuels has been extracted for soy bean, sugarcane, maize and peanut statistics as reported in the Table 1 below.

Table 1: Production of Crops (Possible Biofuels) in Lao PDR for Year 2006

Province	Total Land Area (sqkm)	Soy Bean		Sugarcane		Maize		Peanut	
		Area (ha)	Production (t)	Area (ha)	Production (t)	Area (ha)	Production (t)	Area (ha)	Production (t)
Vientiane Capital	3,920	405	580	1,750	60,750	1,475	6,250	50	85
Phongsali	16,270	210	275	875	47,000	4,335	13,145	400	615
Luangnamtha	9,325	140	165	1,035	60,000	1,875	7,155	120	160
Oudomxay	15,370	730	945	175	5,200	20,935	84,900	530	770
Bokeo	6,196	590	820			10,415	46,100	645	1,010
Luangprabang	16,875	2,365	2,710			12,475	37,160	1,795	2,370
Houaphanh	16,500	1,750	2,270			6,530	30,790	305	460
Xayabouri	16,389	90	100	145	4,050	29,550	131,440	2,085	3,295
Xiengkouang	15,880	200	300	90	780	9,715	38,820	715	1,200
Vientiane	15,927	775	1,395	90	1,950	4,635	17,070	885	1,450
Borikhamxay	14,863	160	245	800	14,000	1,740	6,290	745	1,200
Khammouane	16,315			40	600	1,590	4,790	90	140
Savannakhet	21,774	15	20	555	13,800	3,640	11,900	1,380	2,020
Saravane	10,691	270	310	200	4,640	2,150	5,700	5,675	8,260
Sekong	7,665	40	55	120	2,200	690	2,210	195	315
Champasak	15,415	1,180	1,760	90	2,050	1,600	5,045	2,770	4,250
Attapeu	10,320					465	1,185		
Total		**8,920**	**11,950**	**5,965**	**217,020**	**113,815**	**449,950**	**18,385**	**27,600**

Source: Agriculture Statistics Centre, MAF, Vientiane Capital, 2006

Note: Data from Xaysomboon SR were combined into Vientiane Province and Xiengkouang Province.

The production figured for 2006 stand at around 12,000 tons for soy bean, 217,000 tons for sugarcane, 450,000 tons for maize and 27,600 tons for peanut. However, a detailed study will be needed to understand the actual possibilities and costs of the transformation processes into biofuel.

Moreover, a significant palm oil industry is reported to be developing in Savannakhet Province, and a study needs to be made to examine its energy potential. Information is not readily available for coconut plantations and industry (ADB, 2006[9]).

[9] ADB (2006). Draft Final Report on the Promotion of the Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA), Lao PDR, Country and Policy Report, May 2006, Vientiane.

Further, a woody scrub with big oily seeds could be the ideal source for biofuel. In that sense, *Jatropha curcas L.* (jatropha) has been identified by the international scientific community as the most promising biofuel crop with high capability for biodiesel production. The Jatropha oil plant is abundant in the country. Lao people have traditionally planted Jatropha (Lao: Mak Niaow) for various uses but mostly as living fence. This situation creates huge opportunities at investigating the potential of exploiting Jatropha plant variety as a valuable biofuel crop for Lao PDR. Accordingly, this growing interest has lead several companies to already plan to invest on planting Jatropha. In 2007, KOLAO Farm and Bio-Energy Co., Ltd had notably announced an investment of 30 million US dollars to producing 400 million liters per year mainly for domestic use with the possibility to export surplus if any. Although this initial plan remains under reconsideration and may be reduced. Nevertheless, the KOLAO factory that is located in Phone Hong, 70 km out of Vientiane city, has already started to be cleared.

Other private companies but also associations and research institutes have recently been established with the intention to support the promotion and development of biofuels, especially biodiesel.

Estimations of seed yields from Jatropha plantations

Major advantages to planting Jatropha are oil production and erosion control. Jatropha is able to grow on marginal lands, where it can contribute to the economic development of rural areas without replacing food crop production. However it remains difficult to estimate the amount of expected seed yields since scientific knowledge on this topic is so far very limited.

The review of literature suggests that seeds yields range between 0.5 and 12 tons per hectare per year, depending on soil conditions, temperature and rainfall amounts[10].

The worst conditions for growing Jatropha are poor soils with low content of nutrients, cold temperatures and low rainfalls. If there are no possibilities to improve these conditions with e.g. irrigation and fertilization, the seed yield will approximately reach the bottom of the seed yield range with around 1-3 tons per hectare per year[11].

Where better conditions are found with good soil fertility and hot temperatures, yields of mature stands have been observed to produce annually around 7-8 tons seeds per hectare that are able to produce about 2 tons of biodiesel[12].

These figures indicate that Jatropha seed yields can be expected to reach about 3-4 tons per hectare on average per year and that those can generate an annual production of biodiesel of about 1 ton per hectare.

Although the very wide range of potential Jatropha seeds yields may create an unsure climate for those investors who want to establishing projections and business scenarios

[10] Plant Research International B.V, 2007. Claims and Facts on Jatropha curcas L., Global Jatropha curcas evaluation, breeding and propagation programme, Wageningen, The Netherlands.
[11] Dr. G. Francis and Prof. Dr. K. Becker, 2007. Bio-diesel from Jatropha plantations on degraded land, University of Hohenheim, Germany.
[12] Plant Research International B.V, 2007. Claims and Facts on Jatropha curcas L., Global Jatropha curcas evaluation, breeding and propagation programme, Wageningen, The Netherlands.

for Jatropha plantations. It is reasonable to say that the average estimation as mentioned above can constitute a good enough benchmark reference for further calculation needs, but it has to be said that there are no references of older Jatropha plantations (> 4 years) in Laos and it is therefore quite unsure.

Another important limitation of scientific knowledge about Jatropha comes from the fact that this plant has not been domesticated yet in nurseries and plantation systems. Genetic selection, manipulation, and improvement of the seed material have not been performed yet to obtain the best properties to produce biofuel and biodiesel. These agronomic research works are essential to improve the performance of the Jatropha plant species that will bear more fruits, be dryer and pest resistant. While such works are just beginning, it is however expected that these experimentations will be further developed in the next few years and results will be then made available for potential investors.

For this purpose the LIRE principally works to research on renewable energies of which bio-diesel developed a Research & Development Program on the Jatropha oil plant. As this initiative is the first and only existing so far in Lao PDR, it is presented in **Annex 1** as a Case Study.

PART 4 Main Actors and Key Partners Involved in the Bio-fuels Sector

Several biofuels potential entrepreneurs show a growing interest in buying up land, starting plantations and looking forward to making fuel from energy crops in Lao PDR.

The LIRE has identified some initiatives that have just started in the country that aim to contribute to the promotion and development of feedstock biodiesel fuel crops and/or ethanol production. However, most of initiatives remain at the very beginning of their development, and none implementation is substantial yet. All interviewed players advanced the same limits that come from the lack of effective knowledge about the processes, specialized engineering skills of staff, and a general lack of available technologies and crucial funding.

Active (potential) players are numerous. This section presents the list of the main actors and key stakeholders that have already shown an interest in favor of the promotion and development of biofuels in Lao PDR.

4.1 *Government Authorities*

So far, and at national level, the first concerned government body and also the most active one is the Department of Electricity (DoE) under the MEM, which is currently taking the lead of such policy development.

The Prime Minister's Office (PMO) and the STEA and associated associations are also actively involved in support to biofuels initiatives development, especially focused on the jatropha oil plant in the country. The National Agriculture and Forestry Research Institute (NAFRI) under the MAF is starting some research works on jatropha too.

However, many GoL's Authorities are to play an active role in support to the energy use efficiency and promotion and development of alternatives biofuels. Basically, almost all actors of the public sector are of concern here.

4.2 *Non-Profit Associations and Research Institutes*

There are some public institutes and associations such as the LIRE that is attached to the Lao Union of Science and Engineering Association (LUSEA), the National Science Council, the PMO, the Technology Research Institute (TRI) and the Renewable Energy for Sustainable Development Association (RESDALAO). Those are involved in research activities to investigate feasible feedstock crops notably jatropha and cassava for ethanol and biodiesel production.

Among others involved organizations, it can be mentioned the following:

- NUOL — National University of Laos, Department of Vocational and Higher Education , Dongkhamxang Agriculture Technical School (DATS)
- LPOPA - Lao Promotion Organic Product Association
- NPOL.ABC - Lao ABC
- AAHP - Association of Agriculture and Handicraft Promotion
- TPLPA - Tree Plantation and Livestock Promotion Association

4.3 *Private Sector*

The private sector has a pioneer role in bio-fuel developments. Numerous companies have shown an interest in bio-fuels production in the Lao PDR. Those companies involved in bio-fuel production that have been identified are listed below:

- KOLAO Farm and Bio-Energy Co., Ltd Vientiane Capital: www.kolao.net

  (Scope: Biofuel made from JATROPHA in large scale plantations)
- Sunlabob Renewable Energy, Ltd: Vientiane Capital www.sunlabob.com

  Sunlabob has shown interest in investing in the Jatropha plant in partnership with the Association for Organic Products in Khammouane as well as investing further in existing potential plants in Xieng Khouang.

  (Scope: BIOFUEL for decentralized plantations in rural areas)
- Lao Bio-Diesel Company, Vientiane Capital
- Lao Bio-Energy, Vientiane Capital
- Lao Tech Company, Vientiane Capital
- LSFC - Lao State Fuel Company, Vientiane Capital
- Y&P, Xayaboury
- Phetdalah Agricultural Company, Saravan (To-oy district)

(Scope: JATROPHA large scale plantations to be seed providers)

- Taisei Company Ltd., Vientiane

  (Scope: JATROPHA small scale plantation for the NAFRI)

- Mitr Lao Sugar Co. Ltd., Savannakhet

  (Scope: SUGAR CANE large scale production for export)

- Savannakhet Sugar Company Ltd., Savannakhet

  (Scope: SUGAR CANE and ETHANOL factory planned)

- Tenghui Trade Co. Ltd., Savannakhet

  (Scope: CASSAVA large scale production for export to China)

- Bio and Alternative Energy Lao Co., Ltd, Vientiane Capital

  (Scope: JATROPHA plantation)

- Southeast Agriculture Promotion Co. Ltd, Vientiane Capital.

  (Scope: CASSAVA and SOY BEAN plantation)

4.4 *International Non Governmental Organisations (INGOs)*

The INGOs that are involved in the biofuels development issue as identified so far are:

- SNV (The Netherlands Development Organization) in partnership with WWF (World Wide Fund for Nature)
- VECO (Vredeseilanden Coopibo)
- Triangle (Triangle Génération Humanitaire)
- CIDSE (International Cooperation for Development and Solidarity)

PART 5 Potential Crops to Support the Promotion and Development of Biofuels

This section intends to stimulate the exchange of knowledge and to increase awareness among keys stakeholders on this topic.

It is here briefly presented the key points, main findings and diagnostics that result from the LIRE research works and survey of the current knowledge on some feedstock crops that look suitable options to produce bio-fuel in the country conditions. However, a detailed study will be needed to understand the current use pattern, the opportunity cost for diverting crops or residues to energy use, collection and technological issues, etc.

5.1 *Energy Crops Generalities*

Energy crops are plants that are suitable to generating energy. In case of biofuels production, the main output of these plants is oil or sugar/starch that can be transformed into biodiesel or ethanol.

The two most favored options for producing biofuels are biodiesel and bio-ethanol. Both energy sources can be used as a fossil fuel substitute.

Research works produced on some energy plants are just at their beginning, making difficult to well estimate the expected yields, required labor and possible negative effects on humans and the environment and thus the full sustainability of the project development. It should be kept in mind that this incertitude may lead to project failure.

For instance, the development of large scale plantations can cause serious environmental impacts to the environment and may produce harmful by-products, such as the loss of biodiversity, the depletion of minerals in the soil and other various unforeseen impacts on the environment.

Another major concern resides in the issue of possible competition with food crop production that would make any biofuel project development unsustainable. Special attention must be paid for every biofuel feedstock crop plantation to verify that such development would not impact any food crop plantation existences or potentialities.

5.2 *Analysis of Potential Energy Crops*

5.2.1 Crops for Biodiesel Production

There are several promising oil plants available in Lao PDR, all with different specific properties. For the biodiesel production, crops with a low input and a huge oil production are the most valuable. The potential oil crops that can be found locally in Lao PDR country are namely jatropha, coconut and castor oil plant. However, exploitation of these crops for oil production is not implemented yet in the country. The most interesting crops for the production of plant oil that can be afterwards transesterificated into biodiesel are described below.

5.2.1.1 Jatropha (*Jatropha curcas L.)*

Many land areas are suitable to grow *Jatropha curcas L.* in Lao PDR. This plant can grow on nearly every type of soil and particularly on poor and degraded land, which makes this plant especially interesting for not entering into competition with food crop plantations.

Jatropha has a long time span and a plant can reach an age of 50 years old, which makes it easy to plant only one time for a long time life expectancy. The oil content of the seeds

ranges between 28% and 42%. With an estimated seed yield of 3 tons per hectare, it would be possible to produce about 0,8 ton of Jatropha oil[13].

The oil can be used in modified plant oil engines and also be transesterificated into biodiesel for the normal diesel engine[14].

Jatropha does not need much water and can survive the dry season in Lao PDR without damage. Among the disadvantages of the plant, the seeds contain the poison *Curcin* which could poison people who harvest, where a special attention should be point for children. The seed yield depends on various factors such as the quality of the seed material, climate, rainfall and soil fertility. In the worst case there is a risk of total loss of production and thus of investment[15]. The seeds should be harvested during the rainy season and being afterwards stored under appropriate conditions with good air ventilation[16]. It should be mentioned that Jatropha oil is not eatable and cannot be used for human or animal consumption. In that sense, this plant cultivation may compete with food crops production, which makes a great attention to be paid here regarding to the land use.

5.2.1.2 Castor Oil Plant (*Ricinus communis*)

Ricinus communis is a widespread plant in tropical regions. It is a fast growing, perennial shrub, which can reach a height up to 20 meters. Castor can resist the dry season and thus can be cultivated in Lao PDR without irrigation. Also an annual planting is possible and can be integrated into rotating crops cultivation systems. The plant does not have many requirements regarding the soil quality and can be therefore used on wastelands.

The fruits do not come to maturation at the same time. This makes the harvest complicated because the mature fruit bunches must be selected first and then picked by hand up to five times per year. A mechanical harvesting and processing system exists but quite costly which leads to high investment at the farm site.

The seeds of castor contain a high amount of oil (up to 60 %[17]) and a high yield of oil per hectare (0.4 to 1.8 tons / ha) can be exploited. Besides the use of biofuel, castor oil can be used for medicinal and chemical purposes. The oil has a substantially higher viscosity than other plant oils. Therefore, using it for engines could cause technical problems in the fuel injection. The seeds are very toxic (lethal dose is 0.18 g per kg body mass[18]) and

[13] Heller, Joachim. 1996. Physic nut. *Jatropha curcas L*. Promoting the conservation and use of underutilized and neglected crops. 1. Institute of Plant Genetics and Crop Plant Research, Gatersleben/ International Plant Genetic Resources Institute, Rome.

[14] Kaltschmitt Martin, Hartmann Hans. 2001. Energie aus Biomasse – Grundlagen, Techniken und Verfahren. Springer Verlag, Germany

[15] Heller, Joachim. 1996. Physic nut. *Jatropha curcas* L. Promoting the conservation and use of underutilized and neglected crops. 1. Institute of Plant Genetics and Crop Plant Research, Gatersleben/ International Plant Genetic Resources Institute, Rome.

[16] Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. 2005. Dezentrale Ölsaatenverarbeitung. Lokay, Germany.

[17] Roth – Korman, Germany 2005, Atlas of oil plants, Page 94 - 95

[18] Paper from the German newspaper LANDTECHNIK 5/2006. Volkhard Scholz: www.ltnet.lv-h.de/de/volltext/Lt20065/LT20065_264_265.pdf

therefore a possible intoxication of humans e.g. while harvesting and animals should be kept in mind[19].

5.2.1.3 Soy Bean

This annual plant is also located in the Lao PDR and currently planted on a total area of 8,920 ha with an average seed yield of 1.34 tons per ha[20]. Soy Bean can grow on up to 3,000 meters above sea level and is therefore suitable for mountainous regions like north of Lao PDR. It can have a positive effect on the soil because like many other bean plants it has the ability to fixing nitrogen. The soy bean is rich in protein and oil. It can be used as a fodder for animals and the oil for human consumption. The protein/oil moves to the protein side with cold temperatures. Therefore higher temperatures are favorable for the oil production. The beans can have a maximum oil content of approximately 20 %. The oil can be extracted with a solvent extraction or a normal expeller. For the harvest a lot of man power is necessary if no machines are available. The oil yield per ha is approximately 0.17 – 0.67 tons per ha low[21].

5.2.1.4 Palm Oil

The perennial plant can be used for efficient production up to 30 years, which means it is applicable for long term use. The high photosynthesis productivity of the plant causes yields of about 7 tons oil per ha and year. At the moment this is the most effective production of oil in tropical areas. After a time of three years, the plants can be harvested the first time. For the cultivation of oil palms, high input of labor, fertilizer and propagation material for planting is necessary, which lead to high investment costs on the side of the farmers.

Palm trees have high requirements to environment concerning humidity, temperature and a certain content of salt in the air, which can only be found at areas close to the sea. Hence, in most areas of Laos a production of palm oil is not possible and the attempt brings the risk of disinvestments.

5.2.2 Crops for Ethanol Production

Crops for the ethanol production as a substitute for the gasoline consist in saccharose (sugar) or starch. Many sugar and starch crops can be found locally in Lao PDR such as sugar cane, cassava or maize. According to the MAF, there are huge productions of

[19] Roth L., Kormann K., 2005.Atlas of oil plants and vegetable oils. Druckhaus Harms, Groß Oesingen, Germany
[20] Lao Ministry of Agriculture and Forestry, 2007
[21] Franke Gunther, 1989. Nutzpflanzen der Tropen und Subtropen, S. Hirzel Verlag, Leipzig, Germany.

sugar cane (around 6,000 ha) and of maize (around 115,000 ha) in Lao PDR[22]. The most interesting sugar and starch crops for the production of ethanol are described below.

The production of fuel ethanol is only possible in large scale factories because a simple distillation is not enough to remove the water completely.

5.2.2.1 Sugar Cane

Sugar cane is one of the plants with the highest photosynthetic transforming power[23]. It can produce up to 110 tons per ha per year. In the Lao PDR sugar cane covers an area of 6,000 ha that produce an average yield of 36 tons per ha[24]. Sugar cane is a plant with a high energetic output.

The main output of this plant is saccharose and biomass. The saccharose can be transformed into ethanol. Approximately 15 kg of sugarcane are necessary for producing 1 liter of ethanol[25]. For the production of bio-ethanol as a substitute for gasoline, large scale facilities are necessary. Sugar cane is highly demanding of nutrients. Permanent fertilization is also required. The plant prefers sunny and warm climate conditions; it is not resistant to cold temperatures and is sensitive to pests. In Asia, up to 60% of the harvest can be lost because of diseases. The optimum rainfall conditions lies between 1,000 and 1,200 mm. The harvest required a lot of hand work. The work is dangerous, especially if the cane is not burned (thus getting rid of leaves). Burning enables the workers to see snakes and other perils, and the absence of leaves means less cuts from leaves on hands and arms. A cleaner cane field also generally decreases the risk for accidental cuts from the machete[26].

5.2.2.2 Cassava

Cassava is a woody shrub, which is widely spread in Lao PDR. Farmers know about the plant and it would be easy to develop this plant in existing structures.

Cassava can be considered as a large source of food because of its content in calcium (50 mg/100g), phosphorus (40 mg/100g) and vitamin C (25 mg/100g).

It is also used for traditional medicine to treat diarrhoea, malaria, headache and pain. Moreover it could be used for other starch-based products besides the production of

[22] Ministry of Agriculture and Forestry.
[23] www.en.wikipedia.org/wiki/Sugarcane. 18/12/2007.
[24] GoL Ministry of Agriculture and Forestry, 2007.
[25] Franke Gunther, 1989. Nutzpflanzen der Tropen und Subtropen, S. Hirzel Verlag, Leipzig, Germany.
[26] Bilister Groena, 2006, Review of potential for social- and environmental labeling of ethanol production from sugar cane
http://www.gronabilister.se/file.php?REF=39461a19e9eddfb385ea76b26521ea48&art=376&FILE_ID=20060511084611.pdf

ethanol for energy. The ethanol production with cassava is profitable and positive in its energy balance[27] due to the high efficiency of the photosynthesis in the C4 plant[28].

The potential of the plant resides both in the root that can be used for food and energy and in the high amount of biomass in the wood produced over the soil. This biomass could be used for energy production e.g. via biomass gasification.

The disadvantages of the Cassava are associated to the toxicity of the plant, which creates a threat for humans and animals.

The plant usually requires at least 8 months growing. Although it can takes 18 or more months in dry season or periods of cold temperatures which happens in Lao PDR. Cassava still remains a possible crop for perennial planting and can also be integrated into a rotation system with other plants.

The yield of roots can reach up to 90 tons per ha, with a worldwide average of about 10 tons per ha. The harvest of the roots needs a high input of labour. The storage of the big roots requires large space and additional efforts. Therefore the investments for the cultivation and processing systems are significant[29].

5.2.2.3 Corn

Possible species or corn, which can grow in Laos are winter wheat and barley. That species can grow in the dry season and is therefore a possibility for temporary unused land. Since the maturation time is relatively short (90 – 100 days), the gap of fallow between the regular cultivation period could be filled. Average yields of 1,5 to 2 tons per ha and year could be expected.

Besides the production of ethanol, corn could be used for food production in Laos (e.g. bread).

However the short vegetation time of corn means high efforts for cultivation. A high input of labor and cost of investment for machines is necessary for a production of corn. At the moment it's not clear, whether mechanical harvesting could be realized in Laos, because machines are not already in use and investments would be high. Since corn is not a perennial plant, high efforts for cultivation and harvest have to be taken every year / time of plantation.

[27] Energy balance and GHG-abatement cost of cassava utilization for fuel ethanol in Thailand http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2W-4NRMDC3-1&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=3083c393ebe8e28a57fc0f00339f390b

[28] Franke Gunther, 1989. Nutzpflanzen der Tropen und Subtropen, S. Hirzel Verlag, Leipzig, Germany.

[29] Stephen K. O'Hair, 1995, Cassava,http://www.hort.purdue.edu/newcrop/Crops/CropFactSheets/cassava.html

PART 6 Reducing Fossil Fuel consumption

Main suggestions for reducing fossil fuel consumption in daily traffic:

1. Do not drive faster than 90 Km/H
2. Use public transportation
3. Power off the engine when you are stopping the car
4. Share a car for the same direction
5. Avoid rush hour
6. Use telephone or fax to avoid traffic jam
7. Plan your trip before go
8. Maintain full tire pressure and keep air filter clean
9. Do not overload / exceed the car
10. Regularly check your engine

PART 7 Suggestion Policy Goals and Strategies for Supporting Biofuels Promotion and Development

In this section it is proposed a preliminary political framework that will assure that biofuels development strategies will maximize benefits that are sustainable for the country without negatively impacts its population and its environment while contributing to reduce the importation of foreign fossil fuels.

Essential goals and strategic objectives to achieve are suggested in the two following sub-sections. These are non exhaustive and consist in initial ideas to stimulate an open discussion between the workshop's participants.

Rationale: Fuel imports are a major component in the country's current account deficit. In response government policy is to promote energy self-efficiency in order to reduce the vulnerability of the country to external forces. In order to achieve this, the use of imported fuel for transportation but also electricity generation should be gradually substituted by domestic production of renewable energy sources – based fuels.

For this purpose, it now becomes crucial to establish an adequate policy framework that focuses on the promotion of both fossil fuels use efficiency and use and development of biofuels in the country. In order to develop feasible operational strategies that are viable in the long-term, the full system to develop should be beneficial and sustainable.

7.1 *Issue, Goal and Principles*

7.1.1 Main Issue

The major issue to planting energy crops is the substitution to fossil fuel. In Lao PDR, fossil fuels are 100% imported from abroad.

Producing biofuel with such crops locally would be very positive for the national economy. Energy crop planting will allow generating several opportunities like jobs creation in the agriculture sector. This will contribute to alleviate poverty in the country in line with the Sustainable Development UN Millennium Goals.

Furthermore the potentials are huge and real for Lao PDR as energy crops can be planted on degraded or under-used land areas that can be found in the country.

7.1.2 Main Goal

It is to reduce the dependency of the national economy to the importations of fossil fuels.

This implies to:

- → Achieve a better and more efficient use of fossil fuels at national level, and
- → Develop the production of bio-fuels and promote their use.

7.1.3 General Principles

The development of such policy must respect some general principles that are proposed as follow:

Principle 1:

- Reduce Lao PDR's dependency towards its importations of fossil fuels in order to reduce high economic costs and expenditure for the nation, sustain national economy growth through possible new exportation developments of biofuel to neighboring countries like China; to increase the national Gross domestic product and improve the Import-Export Balance and maintain inflation.

Principle 2:

- Develop biofuels as a new economic sector that creates new revenues and new jobs for local population especially in rural areas; to contribute to poverty reduction.

Principle 3:

- Promote biofuels production and appropriate technologies that are suitable for identified land areas to not compromise the development of other valuable uses of lands for food production in particular but also for non-timber forest products collection that are of importance for local population. Also areas with cultural or religious sites should be avoided for such production development; towards sustainable land management.

Principle 4:

- Promote biofuel production and use that respect and do not damage the socio-economic livelihoods, cultural and natural assets; to preserve the cultural and natural environments of Lao people especially in plantations areas.

Principle 5:

- Favor and support local producers' organizations and investors that act at a village scale level where possible in order to maximize the potential benefits for Lao people.

Principle 6:

- Assure legal and financial adequate conditions for both potential investors and farmers that would be employed or be contracted parties.

Principle 7:

- Promote new technology for production of Biodiesel and Bio-ethanol.

Principle 8:

- Promote the research of new technology for Biofuel.

7.2 *Strategies and Targets*

7.2.1 Proposed Strategies

The MEM has proposed several governmental policies, which are to form the base to implementing an efficient national policy on the promotion of fuels efficiency consumption and use of alternative biofuels and development in Lao PDR.

Those are the following:

1) **Promotion fuel saving and efficient consumption, starting from all governmental organizations;**

2) **Promotion of oil plants planting for bio oil extraction to produce biodiesel and bioethanol production to meet initially low speed engines and then high speed engines afterwards;**

3) **Promotion and spreading of fuel saving, biofuel use and production from primitive technology to modern one to whole country;**

4) **Promotion of foreign public investment and attracting import of appropriate to Lao society and reality technologies by providing incentive measures.**

5) **Promotion of private sector for researching, promoting, development and investment of Biofuel**

7.2.2 Proposed Targets

Such policy developments should meet some clear targets. The two following are currently proposed:

1. Reduce the (fossil) fuels use by 5% each year starting from 2008 forward
2. Reach a 5% share of biofuels use in the total oil fuels consumption by 2015

→ *The establishment of these targets should be further discussed by the experts in order to reach realistic figures that could be actually met.*

PART 8 Proposed Objectives and Recommendations for Implementation

This section intends to provide inputs to the policy framework development for supporting local and national authorities and general public on wise use of bio fuels.

Some strategies, recommendations for action are proposed to implement rightly such policy. It is to provide some concrete feedings and to stimulate further discussions during the stakeholders' workshop.

8.1 *Proposed Objectives*

It is to develop, promote and support:

- research on bio-fuels to avoid starting blind without knowledge
- investment in appropriate technologies for communities
- Investment in new technologies for the commercial stage
- job creation, direct and indirect through other income generating activities
- local market and exports support by low biofuel prices
- reforestation and use of degraded lands
- environmentally clean production processes
- respect of the human and natural environments while sustain of the economic growth

Eight objectives are suggested:

1)	Create overall and unity goal in fuel saving and biofuel production
2)	Reduce oil import gradually
3)	Promote fuel saving and efficient use
4)	Encourage the promotion of biofuel production and use
5)	Create confidence and clarity for oil fuel investor and users
6)	Reduce environmental impact and global warming effect
7)	Promotion of new technology for development of Biofuel
8)	Stop or reduce the export of biofuel crops

8.2 *Proposed Recommendations for Action*

Some activities should be developed to match the above mentioned objectives. Some are suggested below:

- Further surveys, data collection and analysis. Compilation of the results of previous studies and ongoing investigations. Analysis of existing information (books, websites, maps and atlas) and preparation of field survey;
- Assess the requirements for additional investigations in consultation with relevant parties;
- Conduct a Social and environmental impact assessment (SEIA) study for any large-scale plantation project, as a prerequisite before land concession agreement;
- Design proper contracts and agreements between producers' organizations and farmers, franchise system etc. at the example of the Sunlabob's Contract;
- Develop research in the field of biofuels that should be institutionalized within the NUOL, NAFRI - in socio-economic and engineering units, and later NAFES for concrete implementation through extension services support;
- Promote projects related to support the bio-fuels promotion and development within the INGOs and donors;
- Ministry of Energy and Mines is the main authority responsible for Energy in Laos and should be the main coordination for all authorities in the country working with Biofuels. It shall coordinate all bio-fuels projects promotion and development, be in charge of gathering information from involved actors, public and private, of monitoring and reporting on bio-fuels activities in the country, and of controlling their full conformity with this policy. As issues and concerns are larger than energy alone (agriculture and forestry, land and natural resources management, industry and trade, education and so on);
- Promote more publications for the Biofuel activities in the country.

8.3 *Workshop Outcomes and Suggested Future Prospects for the Biofuel Policy Implementation in the Lao PDR*

A workshop was conducted to gathering some interested main actors involved in the biofuel sector. It was held in the morning of January 31st 2008 at the Conference Room of the Department of Electricity, Ministry of Energy and Mines, Vientiane Capital, Lao PDR.

The participants to the workshop were representatives of various public and private institutions engaged in the biofuels sector. The list of all the participants to the Workshop is presented in **Annex 3.**

Based on the support document presented at the Workshop that was very welcomed by Mr. Bouathep Malaykham, Chief of Division and congratulated, the participants have suggested some improvements and made some recommendations that are summarized below:

1. A separate independent organization should be created that represents policies and strategies on biofuels and that will be responsible for the research on feasible feedstock crops, on bio-fuel taxation and on marketing. The LIRE institute was encouraged to endorse this role.
2. The Lao State Fuel Company will produce and provide the calculation of the land area that would be required for planting feedstock crops for biofuel production in order to reach the preliminary estimation of 5% biofuel consumption in the total annual fuel consumption for Lao PDR.
3. Statistical information of imports and utilization of tractors and diesel water pumps should be collected for further planning on bio-fuel production. It is further reported that 270.000 tractors have been utilized in the Lao PDR.
4. A governmental policy on bio-fuel taxation should be clearly identified or taxation for any bio-fuel movement should be avoided in order to stimulate farmers and attract relevant sectors into substantial and sustainable practice.
5. Feasible feedstock crops plantations and notably the Jatropha projects should be developed in land areas that are specifically allocated for and where rice and other food crops cultivation cannot take place. The non-competition criteria of biofuels crops with food crop plantations must be respected at any time in order to assure the sustainability of every biofuels development project.
6. Projects using new technologies with friendly environment to produce biofuels should be supported by the industry.
7. The authors of this report and the workshop's organizers under a joint collaboration between NEDO, representative office Bangkok, LIRE, and the Department of Electricity wish to express their sincere thanks to all the participants for having shared their experiences and having provided useful insights in support to the policy making on biofuels for the Lao PDR.

Figure 1: Participators of the Workshop

PART 9 Main References

ADB (2006). Draft Final Report on the Promotion of the Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA), Lao PDR, Country and Policy Report, May 2006, Vientiane.

MAF (2006). Support to Development and Implementation of National Code of Planted Forest in Lao PDR, Concept Note.

National Science Council (2007). The Environmental Impacts of Trade Liberalization on the Bio-diesel Sector of the Lao PDR, by Paychith Sengmany, June 2007. Paper presented at the National Workshop on Achieving Sustainable Development in the GMS: A Rapid Trade and Environmental Assessment of the Lao People's Democratic Republic, hosted by the Committee for Planning and Investment on 21 June, 2007.

RESDALAO (2005a). Final Report on Energy Status in Lao PDR, November 2005, Vientiane.

RESDALAO (2005b). Interim Report on Relevant Laws & Government Guidelines Concerning Renewable Energy, November 2005, Vientiane.

PART 10 Annexes

Annex 1: Study Case: the Lao Institute Renewable Energy's Jatropha Program

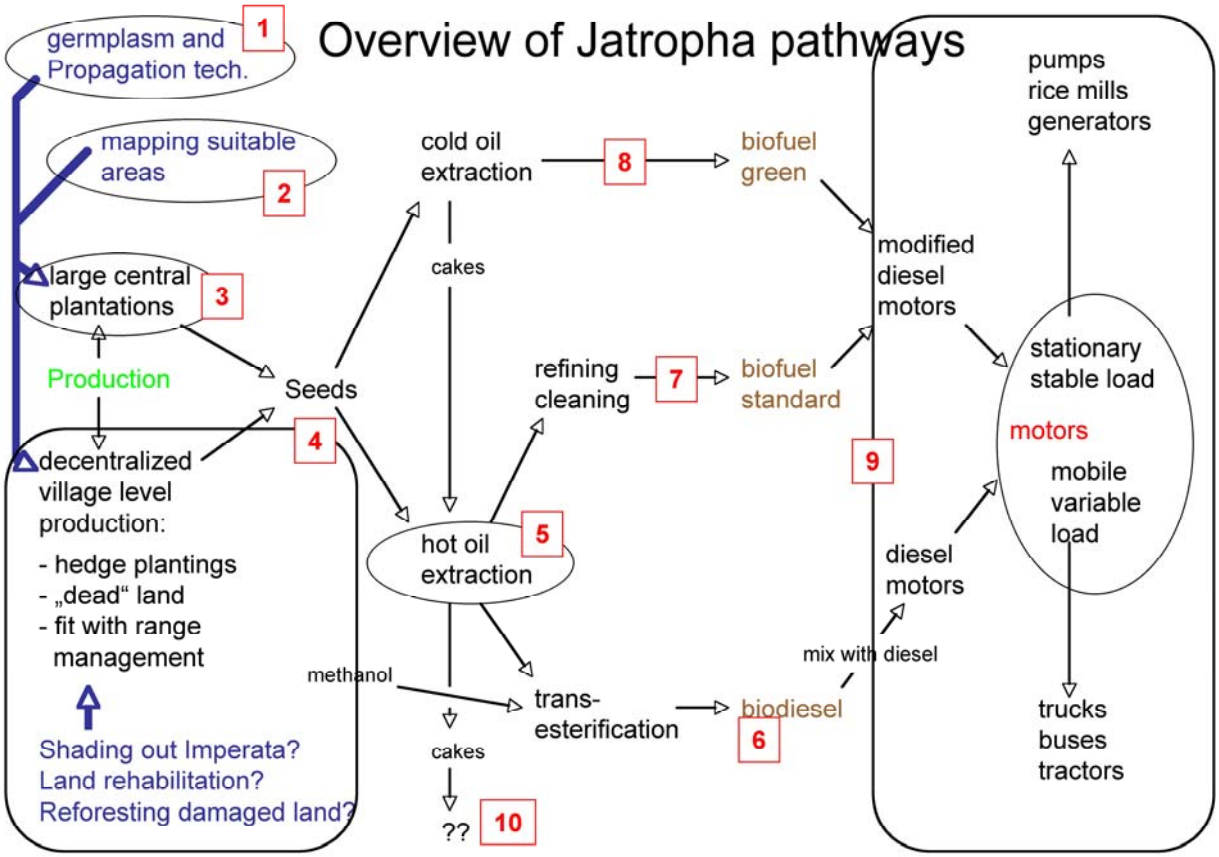
Annex 2: Biofuels Crops' SWOT Analysis

Annex 3: List of Participants to the Workshop Held on 31st January 2008, Vientiane

10.1 *Annex 1: Study Case: the LIRE's Jatropha Program*

The Lao Institute for Renewable Energy (LIRE) has initiated a research program on the Jatropha biofuel plant in order to gaining a better understanding of the potential of this biofuel plant, technological options and possible solutions for implementation in Lao PDR. The initial analysis of the material pathways has resulted in an overview of all the processes and mechanisms.

From this overview, 10 projects for Research & Development have been identified, which is presented below. For each of the 10 projects a sketch is added with the aims, activities, expected results, institutional settings and budget line items.



1. Germplasm and propagation techniques for various purposes

Which varieties grow best under what conditions? What are the efficient propagation techniques suitable on the spot?

2. Mapping suitable areas for planting and logistics for various operational approaches

Which are the ecological, social and economic criteria for mapping suitability of land types and locations for growing Jatropha? Produce maps accordingly

3. Operating large plantations (similar to tea estates)

What are the most efficient ways to operate large scale plantations?

4. Decentralized village level production

How to fit Jatropha production into the village farming systems: hedges, "waste" land, degraded land, erosion control, interactions in grazing/fencing, etc.?

5. Hot oil extraction

Explore and demonstrate viability of hot extraction in Lao PDR

6. Transesterification and producing biodiesel for normal diesel motors

Explore and demonstrate viability of producing biodiesel in Lao PDR

7. Refinement and producing standard biofuel for modified diesel motors

Explore and demonstrate production of standard biofuel for Lao conditions

8. Cold oil extraction and producing green biofuel for modified diesel motors

Explore and demonstrate cold pressed oil for use as biofuel in modified motors

9. Motor technology for various applications

Which Jatropha fuelled motors for which applications in Lao PDR?

10. Profitable use of press cakes

How can press cakes be most profitably used to offset the costs of processing the fuel?

LIRE has started working on two major projects: a study of the processing of different Jatropha seeds and a monitoring program with different Jatropha genotypes to compare different Jatropha native plants.

These studies have reached important conclusions. Jatropha can be processed to produce:

(i) Fuel that can reach the DIN standard of vegetable oil that can be used in modified diesel engines; and

(ii) Biodiesel that can be used in standard diesel engines.

Considering the agricultural aspects, LIRE found out that there are several native plants with high performance of seed yield. These identified plants could be reproduced in nurseries and been further monitored for gathering more information about the seed performance. It would then be possible to lean more about the genetic properties of the selected plant which is a key factor to develop successful new plantations. If the source seed material is of bad quality, the expected output (seed yield) of the plantation will be under its natural potential. A good example is the production of wheat in Europe. Nowadays, the wheat yield is six-times higher than in 1950! This was not a result of genetic manipulation, but the result of selecting the most performing plants and by creating a huge seed bank.

The full paper is available for presentation to interested parties, government, development agencies and industry. For more details, please contact LIRE at contact@lao-ire.org or visit the website: www.lao-ire.org

10.2 *Annex 2: Biofuels Crops' SWOT Analysis*

Strengths	Weaknesses	Opportunities	Threats
Castor			
annual and perennial planting	toxic to human and animals	use for medicinal and chemical industry	Toxification of human and animals
growth on poor soils	high viscosity	machines for harvesting available	complicated harvesting
high oil content	hydroscopic oil		
high yield	maturation of seeds not at the same time		
can resist dry period			
Soy Bean			
annual plant	not perennial plant	suitable for crop rotation	high efforts because of annual planting
suitable to grow up to 3000m altitude	high temperatures necessary	suitable for mountainous regions	high investment for oil extraction
use for food and fodder production	low oil content	fertilization of soil with nitrogen	high efforts for cultivation measures (e.g. cutting)
improve soil quality	much handwork without machines necessary		
nitrogen fixation	low amount of oil yield per ha		
Palm Oil			
high yield (7 tons of oil / ha and year; up to 10 tons possible)	no yield until 3 years after plantation	long term plantation possible (until 30 years)	not applicable to most areas in Laos
high photosynthesis productivity	high investment cost (planting material, fertilizer, labor)	good feedstock for vegetable or biodiesel plants	risk of disinvestment
	high requirements to environment (humidity, closeness to sea)		
	low experience with oil palms in Lao		

Strengths	Weaknesses	Opportunities	Threats
Cassava			
large source for human food and other starch-based products	toxins in root	also usable for biomass gasification	Toxification of human and animals
high biomass production	susceptible to pests (up to 50% yield losses)	efficient for ethanol production	storage room necessary
high photosynthetic efficiency	high input of work	production of ethanol	
medical uses	big roots		
short time as well long time planting (6 months and 3 years)			
Sugar Cane			
Eatable	negative effects on soil	use also for biomass gasification	degraded land / erosion
high biomass production	not resistant to cold temperatures	multi use (sugar, alcohol, fertilizer, bio plastic, fuel, ...)	high investment costs
crop rotation	susceptible to water accumulation	efficient for ethanol production	risky field work
high photosynthesis productivity	high soil requirements	production of ethanol	
	necessity of many hour of sun		
	high input of water and fertilizer		
	high yield losses (up to 65%)		
	not suitable for cold / and misty area		
Corn			
can grow in dry season	not accepted from local farmers	applicable for unused land in dry season	high efforts because of annual planting
short maturation time (90 to 100 days)	high effort for cultivation	use for ethanol and food production (e.g. bread)	high efforts to get machines for planting and harvesting
	machines necessary for planting (at the moment not available in Laos)		
	no perennial plant		
Jatropha			
can improve the soil quality	low research results	job creation in the agriculture sector	health risk of poisoning
production of Biomass and energy	unsure market	strength the economic	uneconomic
high photosynthesis productivity	high invest	replacement of fossil fuel	
erosion control	processing costs	Intercropping	
		use of degraded land	

10.3 *Annex 3: List of Participants to the Workshop Held on 31st January 2008, Vientiane*

No	Full name	Position	Organization
1	Ms Manisay Oudom	Officer	KOLAO Farm Company
2	Mr Bounsy Dethavong	Officer	Dept of Energy Promotion and Development , MEM
3	Ms Latsany Phakfisok	Interpreter	EDC , Company
4	Ms VilaychithSenmangthong	Interpreter	EDC , Company
5	Mr Vongkham Sensathith	Deputy Chief of Division	Technology Research Institute , STEA
6	Mr Jakob Rietzler	Managing Director	Lao Institute for Renewable Energy
7	Mr Simon Henschel	Head of Administration	Lao Institute for Renewable Energy
8	Mr Khamsing Sihathep	President	Lao Organic Production Promotion Association
9	Mr Sounthon Khetphan	Deputy Chief	Forest Research Center , Ministry of Agriculture and Forestry
10	Mr Vandy Phetpaserth	Deputy Chief of Division	Dept of Plantation , Ministry of Agriculture and Forestry
11	Mr Soukthavone Vongsay	Officer	Dept of Domestic Trade , Ministry of Industry and Commence
12	Mr Oudomsine Khamsisopha	Officer	Dept of Electricity , Ministry of Energy and Mines
13	Mr Lithanoulok latsapho	Officer	Dept of Electricity , Ministry of Energy and Mines
14	Mr Boualom	Officer	Dept of Electricity , Ministry of Energy and Mines
15	Mr Bounmark Inthavong	Deputy Chief of Division	Dept of Transportation , Ministry of Public Civil and Transportation
16	Ms Monemany Sisakmeaung	Officer	Dept of science and Technology
17	Mr Soukvilay Vilavong	Agriculture Adviser	Lao Institute for Renewable Energy
18	Mr Phoukhong Keolakhone	Chief of Renewable Energy Project	Lao Fuel State Company , Lao Fuel Association
19	Mr Souchay Youvanisavong	Deputy Chief of Division	Dept of Planning , Rural Development , Ministry of Agriculture and Forestry
20	Mr Phouvong Phommabouth	Deputy Director	Dept of Production Promotion and Commerce, Ministry of Industry and Commerce
21	Mr Phousay	Officer	Dept of Electricity , Ministry of Energy and Mines
22	Mr Bouathep Malaykham	Chief of Division	Dept of Electricity , Ministry of Energy and Mines