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Indicative requirements and recommendations to substitute 10% of fossil fuel with biofuels by 2020

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LIRE

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Biofuel Assessment Study in Lao PDR:

**Indicative requirements and
recommendations to substitute 10% of
fossil fuel with biofuels by 2020**

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1 Introduction

Following completion of the baseline assessment and comparative impact analysis of biofuel in the Lao PDR, a draft interim report was prepared and presented for submission to the Department of Electricity. A workshop was held by DoE and facilitated by LIRE to present the status and key interim findings of the study to representatives of the main government bodies and other stakeholders involved in the study. The preceding part of this document represents a condensed version of the interim report, following minor modifications according to the recommendations of the workshop participants. The workshop was also an opportunity to review the emerging limitations of the study and to formulate a more focused Terms of Reference for the final phase of the assignment. Participants were invited to provide comments and suggestions in written form, and additionally a closed consultation meeting was held at DoE shortly after the workshop.

The primary objective of the second and final part of this assignment is to present indicative requirements, and organizational and programmatic recommendations to substitute 10-12% of fossil fuel with biofuels by 2020, with a preference for biodiesel in the short term. As such this report focuses on the measures necessary to meet 10% diesel consumption with Jatropha based biodiesel by 2020. The risks associated to these activities will also be considered and where required, mitigation strategies proposed. In addition, the potential internal and external markets shall be reviewed, with particular reference to the main NGPES aims. Critical figures shall include the number of litres biodiesel required per year, and related land requirements and investment costs. Three of the six market chains shortlisted in the previous phase of work were selected by DoE for further study in this latter phase, namely

- Jatropha farmer associations, small-scale
- Jatropha 2+3 contract farming, large scale
- Large scale bioethanol production

Large-scale bioethanol production has greater capacity to meet the 10% target, but may not achieve the environmental, social and development goals desired. Small-scale production will contribute more to these goals but may be incapable of producing large volumes of biofuel.

Regarding Chain 2, the DoE advised the study team that the Lao State Fuel Company (LSF) has been chosen to be solely responsible for processing and distributing biodiesel produced from contract farming (depending on independent private sector activities, LSF may purchase seeds, unrefined oil, or pure biodiesel, and consequently 'processing' may only entail blending and quality assurance). The long term strategy of LSF is expected to be discussed bi-laterally with DoE in the near future.

1.1 A clarification of Purpose

This study needs to make clear the objectives the biofuel policy aims to achieve. Are policies aiming to stimulate production for domestic consumption or production for export? Developing an export market will require different policies to developing an internal market; each will have different impacts on the nation's social, environmental and economic goals.

Throughout this document, programmatic and organisational recommendations have been taken from the text and explicitly stated to facilitate rapid reader comprehension, the first of these are given below. Each recommendation is summarised in the Road Map and elaborated upon in Annexes 3 and 4.

- **Programmatic Recommendation:** The policy target sector needs to be clearly defined.
- **Organisational Recommendation:** Clearly define goals, prioritise energy security, rural development, environmental protection or the development of an export market.
- **Background:** If biofuels are going to be produced for national consumption, policy needs to reflect the governments intention to support transport, to assist rural development or to improve environmental protection. Although these are cross-cutting issues each project would need to be oriented to tackle one issue.
- **Programmatic Recommendation:** Develop understanding of the viability of producing for export markets
- **Organisational Recommendation:** Undertake market analysis of EU and Asian markets (especially Japan and India who could be the potential buyers).

- **Background:** This needs to be done if GoL intends to develop biofuels for export. The US market is currently inaccessible due to focus on bioethanol and strong competition between US and Brazilian companies. The EU strategy for biofuel is still evolving but they may become a net biofuel importer, there will be strong production competition from France, Germany and Spain.

2 The purpose of meeting the 10% target

This chapter will assess the objectives the GoL aims to achieve by developing a biofuel policy. It investigates the stated goal of achieving 10% biodiesel substitution of fossil fuel diesel by 2020. The physical requirements of meeting the target are discussed and a prediction of the likelihood of meeting targets made.

It is hoped that biofuels can contribute to the National Growth Poverty Eradication Strategy (NGPES), improving energy security, rural development, and environmental protection. However this chapter explains that a single biofuel strategy is unlikely to meet all of these goals. Reaching 10% biodiesel substitution may improve energy security, but will require large-scale monoculture plantations which may not aid rural development or environmental protection. So meeting all aims may require parallel market chain development.

2.1 Physical requirement of targets

Calculating the physical requirements of meeting the target is relatively straightforward although many assumptions need to be made where real data is lacking. Assuming the production parameters set out in Table 1, 64 million litres of biodiesel will need to be available for domestic consumption in 2020 to meet the 10% target. In order to achieve this, 303 million litres of Jatropha oil will need to be produced. The volume of raw oil required is significantly larger than the biodiesel consumed due to the large volume of biodiesel export predicted. When export of raw Jatropha oil is also accounted for, almost a million tonnes of Jatropha seed will be required to meet the 10% target. Given the predicted plantation maturity and expected yields, 655,714 ha of agricultural land will be required for Jatropha cultivation in 2020. This prediction is summarized in Table 2 and the impact on land use shown in Figure 2.

Table 1: Biofuel production parameter assumptions

National target for proportion of diesel consumption provided by Jatropha, 2020	10%
Consumption and Export Variables	
Predicted total fossil fuel consumption, 2010 (litres)	592,490,000
Predicted annual increase in fuel consumption	5%
Proportion of fuel consumption that is diesel	55%
Proportion of crude oil exported	10%
Proportion of crude oil used for biodiesel	95%
Proportion of biodiesel that is exported	70%
Agricultural Land-use Variables	
Annual increase in cultivated area	5%
Annual increase in rice area	1%
Jatropha Variables	
Seed yield at maturity (t/ha)	2
Seed oil content	35%
Oil extraction ratio	90%
Density of oil (kg/l)	0.92
Conversion factor, oil to biodiesel	94%

Table 2: Jatropha production required to meet 10% target in 2020

Year	2015	2020	2025
Target (% total diesel consumption)	5%	10%	15%
Predicted total diesel fuel consumption (litres)	457,048,831	641,034,629	899,084,229
Domestic biodiesel consumption required (litres)	24,929,936	64,103,463	130,775,888
Biodiesel required, accounting for export (litres)	83,099,787	213,678,210	435,919,626
Jatropha oil for biodiesel required (litres)	88,404,029	227,317,244	463,744,283
Total domestic biodiesel and Jatropha oil consumption (litres)	93,056,873	239,281,310	488,151,877
Jatropha oil exported (litres)	10,339,653	26,586,812	54,239,097
Total oil to be produced (litres)	103,396,525	265,868,122	542,390,974
Tones of seed required (tonnes)	301,984	776,504	1,584,126
% of national plantation that is mature	50%	75%	100%
Required Jatropha Area (ha)	301,984	517,669	792,063

Figure 1 shows the impact that meeting the 10% target will have on land use in Lao PDR. 15% of agricultural land will have to be given over to Jatropha cultivation. It is important to consider the opportunity cost of this shift in land use; which agricultural products will not be grown, which markets, which trade opportunities and which tax revenues will be forgone due to Jatropha expansion.

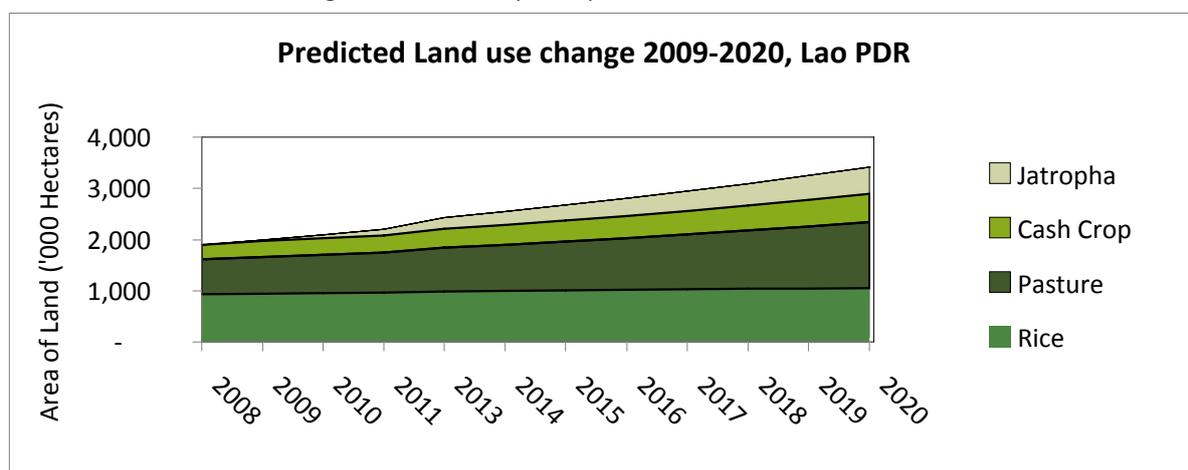


Figure 1: Predicted impact on land use

2.1.1 The impact of limiting export

Table 1 shows that this calculation assumes that 90% of raw Jatropha oil will remain in Laos, that 95% of this remaining crude oil will be used to make biodiesel and that 70% of the biodiesel produced will be exported. GoL should note that the 10% target could be met with a much smaller impact on land use if the export of raw oil and biodiesel is restricted, although this may not be an attractive option in economic terms. Figure 2 shows the impact on land use with no crude oil or biodiesel export, with all domestic crude oil used to produce biodiesel. In this scenario 132,782 hectares of land are required for Jatropha production, 4% of agricultural land.

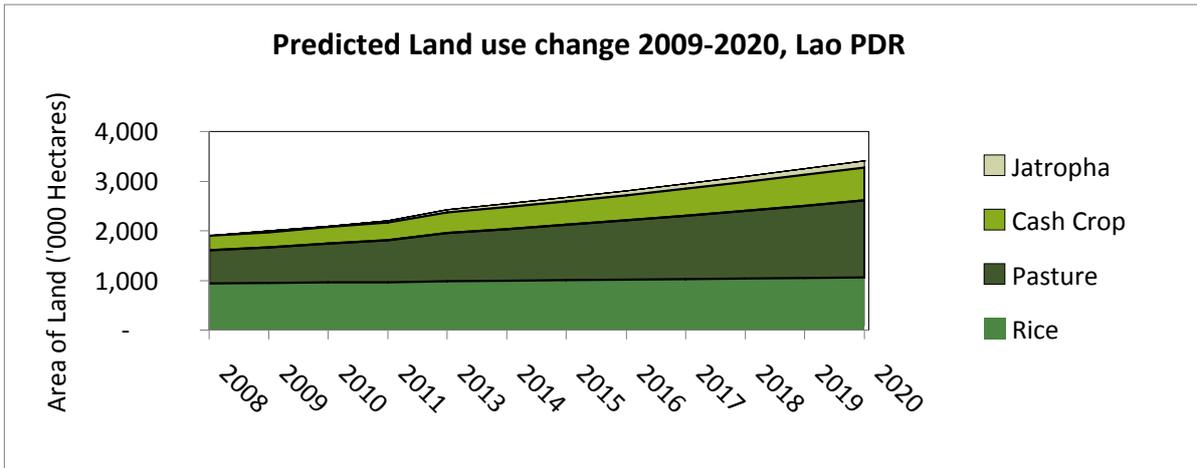


Figure 2: Impact of Jatropha on land use with export restrictions

2.2 Expected Jatropha Production

Although GoL would like to meet a target of 10% biodiesel consumption in 2020, assessment of the current scenario suggests the target is unlikely to be met. Consultation with Jatropha growers indicates that the area under cultivation in 2020 will be approximately 334,750 hectares. However in the current legislative environment this study believes that only half of this target will be met. As such the cultivation of 167,375 hectares of Jatropha in 2020 is seen to be most likely; this area could provide sufficient feedstock to meet 3.2% of diesel consumption in 2020. Given the assumptions set out in Table 1, this area of Jatropha is approximately 350,000 hectares short of meeting the 10% diesel substitution target.

Again it should be emphasized that the 10% target could be met using the predicted 167,375 hectares, but this would require the restriction of the export of biodiesel. Alternatively the 10% target could be met by improving the legislative environment for the Jatropha growers, helping them to achieve their cultivation expansion goals. Figure 3 shows the predicted scenario for fossil and bio fuel consumption.

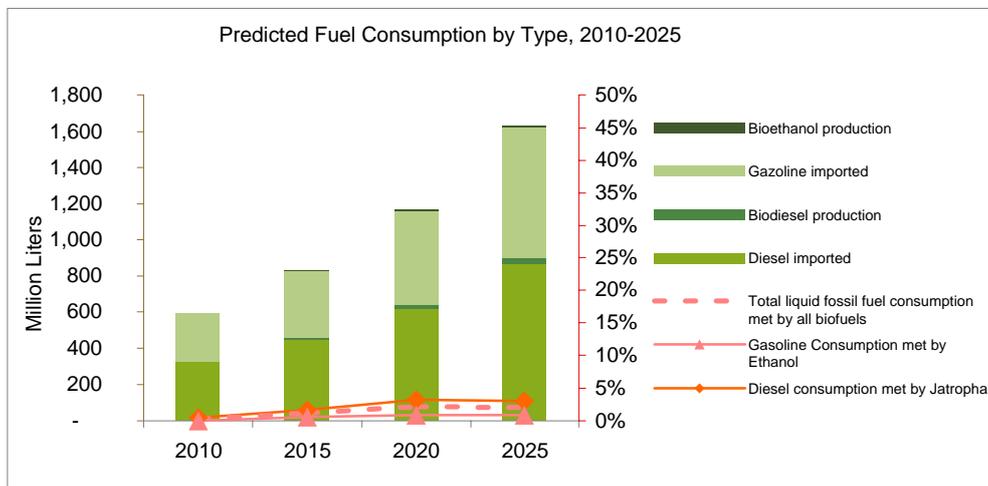


Figure 3: Predicted fuel consumption by type between 2010 and 2025

Two alternative methods of meeting the 10% target without dramatically increasing predicted Jatropha production or restricting export are now described.

Biodiesel could be imported from countries with established biofuel industry such as Thailand. Although this policy would not immediately achieve the stated goals of the biofuel targets, namely ensuring energy security, rural development and protection of biodiversity in Lao PDR, it would serve to kick start the biofuel industry in Lao PDR, begin to create demand for biofuel, increase public awareness and build investor confidence. As such a biofuel industry would develop and the stated goals achieved in the future.

A second approach would be to improve fuel use efficiency. Figure 3 shows the significant increase in fossil fuel consumption predicted over the next decade. If this growth can be slowed by improving fuel use efficiency then less biodiesel will be required to meet the 10% target.

It should be noted that these predictions have been made using the basic data that has been available to this study. An additional in-depth analysis and follow up study will be required to provide accurate advice regarding future scenarios.

2.3 Resource potential for small-scale biofuel

In order to estimate the resource potential for small-scale production and utilisation of biodiesel, it is necessary to further evaluate local energy demand. Nationwide diesel consumption per capita in 2007 was 56.7 litres¹. For rural households relying on diesel/kerosene for lighting, typical annual consumption is up to 40 litres². The biofuel produced from 1 ha of *Jatropha*³ is thus approximately equivalent to the diesel demand of 10 households. Therefore *Jatropha* biodiesel could be interesting for small-scale production, in areas that meet the necessary criteria for land and labour availability. The economic viability of small-scale biofuel has not yet been tested under real conditions in the Lao PDR.

2.4 Assessment of the merits of increasing biofuel production

Considerable debate still exists as to the commercial viability, environmental cost and poverty alleviation benefits that biofuels offer. GoL should not assume all to be positive. Indeed there is a mounting body of evidence that suggests that biodiesel targets set in developed countries, particularly the 2009 European Union Renewable Energy Directive (which mandates member-states' road transport fuel to comprise a minimum of 10% renewable content by 2020), have been politically driven rather than being based on strong scientific evidence. As such GoL should be wary following Europe and committing to targets that could have negative environmental, social and economic impacts. As such the relevance of achieving 10% biodiesel substitution may not serve the stated goals. Some of the key issues are now discussed.

2.4.1 Commercial viability and financial benefit

It should be noted that biofuels are not currently commercially viable in any county in the world without significant support from the state. Industry in countries like Brazil and the United States can produce of biodiesel feedstock very efficiently, but still require state support. National markets also tend to require government support in the form of trade protection policies. Research suggests that no biodiesel pathway and product combination can provide a low-risk and profitable investment without some kind of government fiscal support (Kojima et al. 2007).

A further consideration is that some studies suggest diverting more than 10 % of a given crop to a biodiesel market could link the price movement of that commodity to the world petroleum market (Kojima & Johnson 2006). As a result, large-scale production of biofuel would not protect consumers against high petroleum prices for long, because feedstock prices would rise and reduce the price gap between petroleum and biofuel. In this scenario the domestic production of *Jatropha* would not insulate Lao PDR from high global crude oil prices.

2.4.2 Environmental Costs

There is concern about the environmental cost of widespread biodiesel plantation development in Lao PDR as other countries in Southeast Asia have experienced a rapid increase in the burning and clearing of rain forests to plant oil palm and soybeans.

Furthermore, increased biodiesel production based on current technologies will be limited by environmental factors such as the amount of unutilized land that can economically be brought into production and potential water shortages that may constrain expansion.

Feedstock production and biodiesel processing may also carry environmental costs such water and air pollution, soil depletion, habitat loss, and potentially very large GHG emissions associated with the conversion of forests and grasslands to cropland. With this in mind, it should be noted that biodiesel subsidies in a

¹ Based on diesel consumption records of MEM, and updated national census 2007

² Assuming 3.5 hours burn time per day, LIRE research, unpublished

³ 2 tones per hectare, producing 500 litres of finished B100 biodiesel

number of countries in the past have exceeded the value of the environmental gains from fuel substitution (Kojima & Johnson 2006).

2.4.3 Poverty Alleviation

The net effect of increased production of biofuels on a large scale will be higher food prices, which will benefit food producers but harm consumers. So in Lao PDR, whilst some large landowners will benefit, evidence suggests that poor farming households in rural areas are often net buyers of food so will be worse off. Although small benefit will be gained from marginal fuel price reduction, the welfare of urban workers and net buyers of food will decline.

2.5 Mitigation of External Factors

Interventions may be necessary to decrease the external pressures associated with the bio fuel sector like fuel and food demand.

In the context of national development, it is important to observe that the variables for bio-fuel production employed in the model used in this study are dominated by two external parameters: the projected food and energy demands of the country. Indeed, since the development of bio-fuel is being supported with the primary intention of improving the wealth of the Lao PDR, it should be noted that growth implies increasing food and energy demand (Rajagopal 2008). Thus, given limited resources, especially land and labour, the development of bio-fuel must be undertaken within the wider context of efforts to improve the productivity and efficiency of the Lao economy. From an agricultural perspective, this entails increasing crop yields and improved management of food inventories. In terms of national energy demand, additional initiatives are required to improve energy efficiency, and reduce the demand for fossil fuels. Such initiatives should include the wider adoption of alternative (and locally available) energy sources.

Producing bio-fuels or bio-fuel feedstock in the Lao PDR for sale in the external market for will not directly contribute to the goals set by the GoL. However, there are opportunities to utilise the capacity of neighbouring economies during a transitional period, and as a means to stimulate infrastructure development in the country.

It will be important to establish trade arrangements for importation of finished bio-fuels, and introduction of blended biodiesel in urban areas at a cost to harmonise with liquid fuel costs in rural areas. Bio-fuels should be introduced to the public transport sector before the private sector, especially intercity buses which have no alternative energy source to liquid fuel. In addition it would be helpful to promote the use of electric transport in urban areas to reduce fuel consumption.

3 Expected outcomes of biofuel strategies

With an understanding of the constraints and limitations set out in Chapter One, this chapter will now assess how different strategies can contribute to achieving the stated goals. It first makes estimates of the probable financial costs and benefits of establishing a bio fuel industry, before going on to examine how the three potential strategies (listed below) can be facilitated and what they can achieve.

1. Small-Scale Jatropha production through farmer associations
2. Large scale Jatropha production using the 2+3 contract farming model
3. Large scale bioethanol production

3.1 Government support required to increase biofuel production

A domestic biofuel market is unlikely to appear without government leadership, due to the interdependencies inherent to the development of each component in the supply chain. Therefore, the role of the GoL is to enable and incentivise foreign and domestic actors to engage with local production and utilisation of biofuel, subject to local viability, whilst monitoring and mitigating negative impacts as they emerge. The government policy is to utilise the following policy tools to varying degrees to guide the development of the biofuel sector. Selection of an appropriate policy for Lao PDR will depend on the availability of budget, resources and information, but also transaction costs and political economy considerations (Rajagopal & Zilberman 2008).

Whilst putting direct costs to specific biofuel policies is very challenging, a qualitative assessment of the socio-economic and environmental costs associated with reaching the 10% target can be made based existing academic research and on the experiences of other countries.

When examining the direct costs to the state, support policies to encourage Jatropha production can be considered in two general categories:

- Policies that aim to replace consumption of petroleum fuels by mandating biodiesel use and by reducing fuel taxes for biofuels.
- Policies that aim to stimulate biodiesel production domestically by using producer subsidies, import tariffs to protect local producers and direct government support for all biofuels to local production, and research to develop new or improved technologies.

Some policies reduce trade directly; others do not reduce trade directly but may have indirect distorting effects on trade.

- **Programmatic Recommendation:** Make accurate estimate of financial costs of establishing biofuel industry
- **Organisational Recommendation:** Coordinate all government departments to gather data required to undertake full economic analysis of bio fuel industry development. Requirement is shown in Figure 4 and Annex 1.
- **Background:** Making an estimate of the cost of reaching a 10% diesel offset is challenging given the limited availability of cost data. Figure 4 sets out the information that needs to be gathered in order to make an accurate prediction of the costs associated with establishing a biodiesel industry in Lao PDR.

Figure 4 illustrates the need to understand the opportunity cost of creating a biodiesel industry. The concept of opportunity costs highlights that some opportunities must be forgone to allow others to occur. Further detailed assessment needs to be made of what must be given up (the next best alternative) as a result of the decision to promote biofuels. What agricultural, industrial or trade opportunities must be forgone to make way for biofuels. Opportunity costs, rather than the prices paid should be used to ensure that the costs of subsidized inputs and alternative uses of resources are properly reflected (Kojima & Johnson 2006).

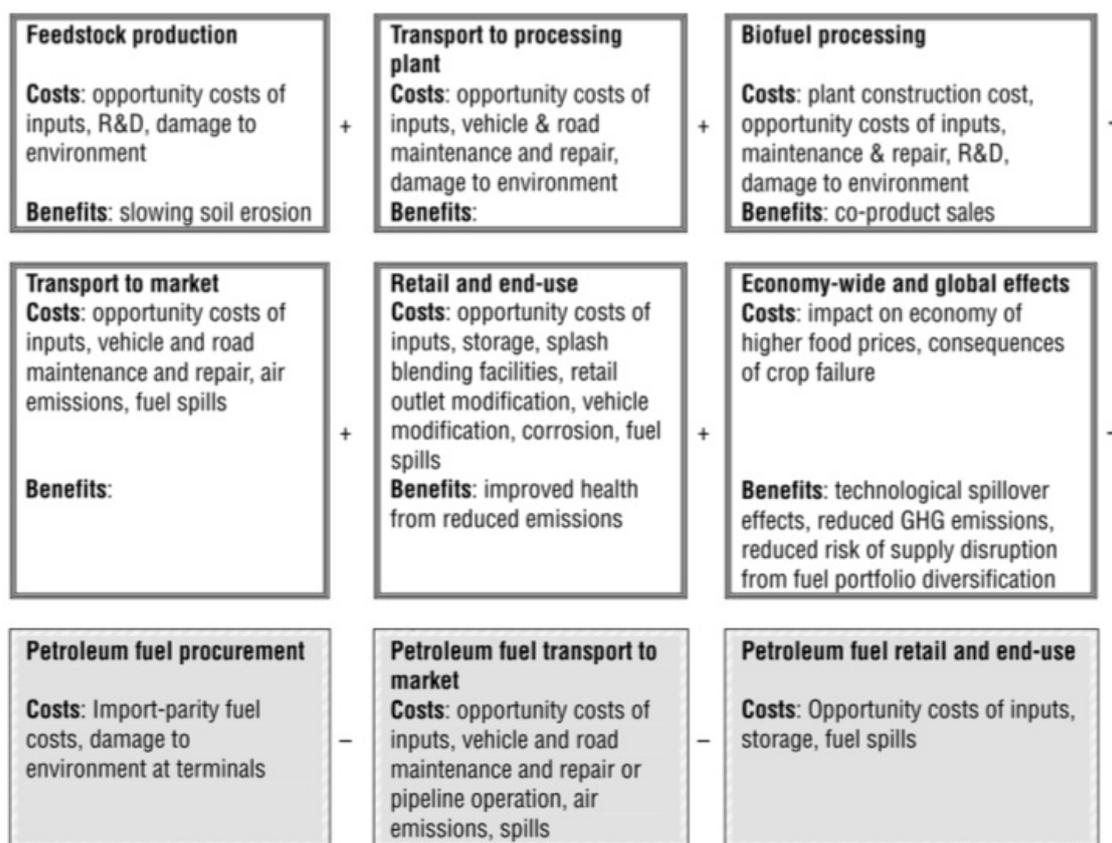


Figure 4: Required Economic analysis of biodiesel production and marketing for a country importing transportation fuel, (Kojima & Johnson 2006)

Achieving this data is well beyond the scope of this study given limited access to government information regarding costs and subsidies. Key unknown variables include GoL payment for diesel imports and the extent to which this import is subsidized. It is unclear where the money to subsidize fuel imports comes from and unknown if this money could be diverted to support biodiesel production.

Undertaking valid economic analysis is further limited by the confidentiality maintained by private agribusiness companies regarding their current business plan and future biodiesel production strategies. For example, it is unknown if the businesses are obliged to export a given quantity of the fuel that they or what their predicted production costs are.

Annex 1 shows a tool that can be used to undertake the required economic analysis of biodiesel production and marketing for Lao PDR. The tool requires access to information that has not been available to this study; it will be of use to GoL departments with access to the specific data requirements.

The costs of the institutional components of the 'Lao Biofuel Programme' can be minimized by fully utilizing existing capacities of government organizations and including biofuel components into the annual budget and activity plans of all relevant offices. In parallel to assigning new responsibilities in this manner, the government should evaluate the ability of offices to fulfil these roles, and where necessary, employ technical assistance to build capacity. The government may also consider enabling civil society, including community-based organisations, non-profit associations and mass organizations, to channel information to the public.

Capacity-building activities and further studies represent a major part of the costs over the short term, followed by infrastructure development that increases through the mid-term. The costs associated with recommended biofuel and feedstock imports over the short term may to some extent be covered by reduced imports of fossil fuels, but cannot be determined without a full external market analysis.

Providing certain external conditions are met, foreign investment and funds are likely to contribute significantly to the development of biofuel in the Lao PDR. The experience of FDI to date for contract farming however demonstrates the need for the government to ensure national and international interests are met. Providing attractive returns of investment can be offered by a domestic biofuel market rather than export,

several of the existing biofuel companies have expressed an interest to adapt their business strategies⁴. In terms of development funds, until at least 2012 there are good prospects for financing projects that focus on energy access, climate change, biodiversity, green employment, rural development, bio-energy, and energy efficiency.

There are several activities that are however unlikely to achieve adequate foreign finance, and thus would require government support (including development loans). The infrastructure for national level blending, quality analysis⁵ and standards certification, and distribution shall require substantial government investment, unless these activities are assigned to a foreign enterprise. Essential in-country R&D shall also require government funding, although this need may be relaxed by fostering stronger technology transfer and research partnerships.

3.2 Financial Benefits

The import of fossil fuel represents a considerable expense to the Government of Laos. In 2009 it is estimated that 1,955 billion kip (231 million USD) will be spent on diesel alone (assuming a cost of 6,000 kip per litres, consumption of 325,869,500 litres diesel, currency conversion 8455 Kip - USD). This represents 6% GDP in 2008. As such reducing the expense, or internalizing the expense, so money is channelled to domestic biofuel industry rather than foreign petroleum traders would be positive for GoL.

If the 10% biodiesel target is met, in the year 2020 approximately 61 million USD will remain in Laos, invested in the biofuel industry rather than being spent on fossil fuel imports. This is predicted to be equivalent to approximately 1% GDP in 2020. The calculation assumes the variables set out in Table 3.

Table 3: Assumption required estimating economic benefit of biofuel industry.

Bio-fuel target	10%
Predicted annual increase in fuel consumption	5%
Proportion of fuel consumption that is diesel	55%
Cost of Diesel	6,000Kip/l
Currency Conversion: 1 usd =	8,455Kip
Inflation	5%
Predicted GDP growth	5%

A small saving would be made as subsidy would not be paid on the 10% biodiesel. At present GoL spends approximately 48 Billion Kip per year subsidising diesel import. 10% of this value could be spent elsewhere if fuel were domestically produced. Assuming the values set out in Table 4, this amounts to 570,000 USD in the year 2020.

However, 10% will only be reached by 2020 so although savings will be increasing, they will be quasi null in the first years. As such the government will have to secure investment from another budget line to reach the target and so must recognise the importance of private investors for developing the market. So developing biofuels does not represent the financial benefit that the government might expect, benefits lie in indirect savings, energy security and a transition to other energy resources. GoL needs to find mechanisms to attract private investor and developers such as subsidies and permits to cultivate land.

Table 4: Assumptions required to estimate fuel subsidy of Bio-fuel industry.

Government fuel subsidy	4billion kip / month
Government fuel subsidy	48billion kip /yr
Annual fuel use	325,869,500Litres / yr
Subsidy	0.000000147billion kip / l
Subsidy	147kip / l
Pump price	10000kip / l
Level of Subsidy	1.47%
If 10% target met, subsidy saving	4,800,000,000Kip / yr
With 10%, subsidy saving	567,711USD/ yr

⁴ According to stakeholder analysis in Biofuel Assessment and Policy Recommendations, Part 1, LIRE 2009.

⁵ Laboratory equipment required would cost ~\$100,000 each for biodiesel and bioethanol, based on a preliminary cost analysis of the Thai market in 2009, LIRE.

So developing a biofuel industry does not represent the financial benefit that the government might expect, benefits lie in indirect savings, energy security and a transition to other energy resources. GoL needs to find mechanisms to attract private investor and developers such as subsidies and permits to cultivate land.

- **Recommendation:** GoL needs to find mechanisms to attract private investor and developers such as subsidies and permits to cultivate land.
- **Background:** Developing bio fuels does not represent the financial benefit that the government might expect; benefits lie in indirect savings, energy security and a transition to other energy resources.

4 Analysis of proposed market chains

Figure 5 shows the market chains that have been selected to offer most potential for developing biofuel in Lao PDR. This section will discuss the benefits and limitations of establishing the distinct chains.

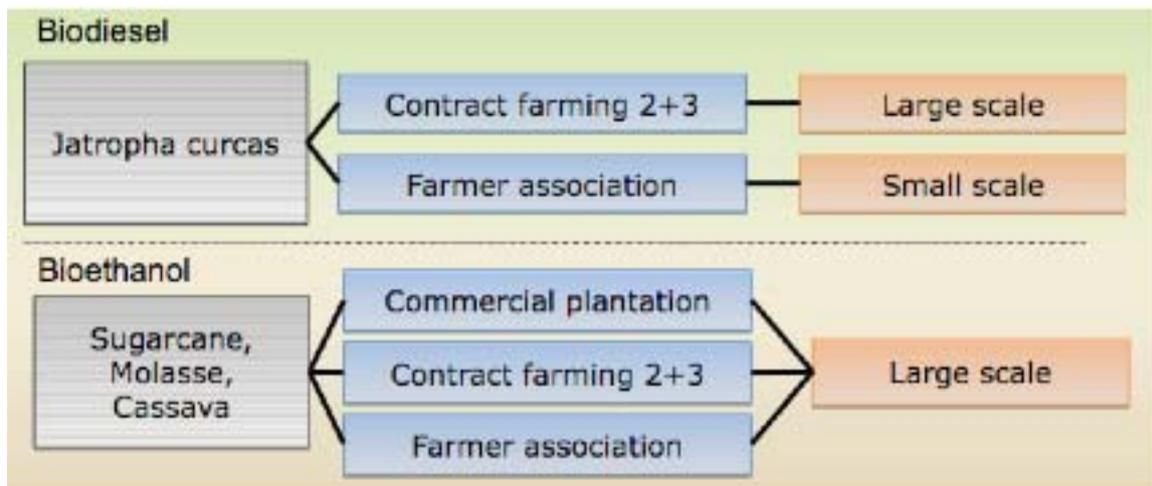


Figure 5: Illustration of potential market chains

4.1 Small Scale Jatropha Production

According to the SWOT analysis in chapter 6.2, Jatropha cultivation and biodiesel production at the community scale offers potential to assist rural development, local energy security and improve environmental protection and biodiversity. Moreover, impacts from global market drivers on biofuel are limited at this scale, reducing external threats for producers and consumers. On one hand, impact on national energy security is limited over a short time frame. On the other hand, this market chain represents a suitable opportunity to build capacity, particularly for market mechanisms and technology. Despite strong opportunities, this market chain is not yet initiated in Lao PDR so several interventions will be needed to overcome constraints and to enable market initiation and development.

4.1.1 Costs and benefits

Cultivation:

Jatropha cultivated as a cash crop yields approximately 2 tons/ha. For the farmer the direct earnings from selling Jatropha seeds can vary due to yield and price fluctuation. However given the expected seed yield and an assumed farm gate price of 750 LAK/kg, the average earning achieved from Jatropha cultivation is approximately 177 US\$/ha. This figure must be carefully compared with other cash-crop options in terms of benefit and agricultural input. Operating cost is divided between labour input (100 man days per hectare) and in the case of poor soil fertility, additional manure.

Farmer associations:

The creation and operation of an association requires economic input and resources which have to be initially provided by local stakeholders such as the public, donor, or entrepreneur. Given the fact that organized farmers are able to work more efficiently and with better economic orientation, this model offers opportunities for long-term sustainability but requires resources at the beginning. Operating cost is mainly shared between labour, housing, communication and processing equipment.

Small scale production:

Small-scale processing of biofuels is technically feasible in Lao PDR. A seed yield of 2 tons/ha can be translated into 400 litres of biofuel per hectare (crude oil or biodiesel) if an oil content of 35% and an extraction ratio of 65% is achieved. Operating cost for crude oil production is mainly shared between feedstock costs (70 - 90%) and pressing costs (10 - 30%) including hardware costs, wages, maintenance and insurance.

4.1.2 Constraints**Cultivation:**

Lack of feedstock is a major constraint to market initiation. The economic viability of *Jatropha* strongly depends on future R&D results from abroad. The currently used wild plant material bears the risk of dramatic economic losses due to the appearance of low seed yields, pests and diseases, unfavourable harvest time and other features which cannot be excluded until domesticated, explored and advanced seed material is available. Furthermore farmers have limited access to basic cultivation information which presents a risk for yield and return on investment. Another constraint represents the demanded initial investment for perennial *Jatropha* cultivation which is a burden for many farmers.

Farmer associations:

Despite initiatives reported in coffee and tea cultivation, there are few farmer associations or cooperatives in Laos. Farmer's initiatives to gather production and set up farmer associations are unlikely to happen without intervention. Farmers are lacking access to market information. Proper management skills will be a major constraint to sustain the development of such an organization. The lack of legal framework is another limitation to the development of farmer associations that should not be overlooked.

Biofuel processing:

Crude *Jatropha* oil (CJO) production at a community scale may face constraints due to: lack of feedstock, high initial investment for utilities, lack of skilled technicians, and proper quality assurance of produced oil, lack of market for produced crude oil or lacking local biofuel utilization.

Biodiesel production at district or community level may face similar constraints as stated for the crude oil production. Another constraint which has to be overcome is the accessibility of local feedstock suppliers and the requirement for methanol. Furthermore, the utilization and maintenance of a transesterification unit has to be done by trained technicians. The blending mandate, production standards and legal framework all need to be put in place to enable and secure local distribution.

Distribution and utilization of produced bio fuel:

At a community scale, the utilization of CJO in modified diesel engines is limited by technical skills and modification technology. Furthermore, the direct use of CJO in engines is limited by the availability of plant oil compatible engines on the local market and the cost of investment. At a district level, distribution legal framework and standards are the main constraints to market development. Incentive practices (e.g. price) and warranty are essential to attract final consumers.

4.2 Large scale *Jatropha* cultivation

Large scale cultivation by 2+3 contract farming is currently the most favoured market chain in terms of existing investment efforts. According to the SWOT analysis and stakeholder consultation, several internal constraints and threats for farmers, private companies, and government bodies need to be overcome to sustain development of this market chain. Moreover, in the integrated market context, the domestic biofuel market will be directly impacted by international economic drivers. International biofuel demand is likely to grow in the coming years; however market opportunities have to be investigated.

4.2.1 Costs and Benefit

As mentioned before, there is insufficient economic data to conduct an accurate analysis of the market chain. But general statement can be mentioned:

- Companies need to make a large investment to initiate feedstock production by providing incentives, training on cultivation and breeding practices. Further studies are needed to assess this cost.
- Because of dispersed production, transportation costs are expected to be high

- Building a processing unit is a big investment and a minimum seed supply is needed to run the process and reach affordable processing cost.
- Farmer gross income is low when compared to other cash crops like maize.

The following forecast aimed to give an approximation of feedstock cost, processing cost and final cost of biodiesel made from Jatropha.

The first model (Model A) is based on a farm gate price of 750 kip per kilogram of Jatropha (2009 average farm gate price collected during the stakeholder consultation). Farm gate price of the second model (Model B) has been fixed at 1260 kip/kg by assessing that farmer gross income must reach 300 USD per ha to be attractive and sustainable for farmer (Average yield used: 2 t/ha).

Each model is based on:

- 5% annual inflation of farm gate price
- Conversion factor based on 35% oil content, 90% of oil extracted, oil density of 0.92 and oil-biodiesel conversion ratio of 0.94.
- Processing and energy cost and company margin may accounted for 25% of the final cost

Table 5: Predicted cost of manufacturing one litre of biodiesel

	A) Based on farm gate price (2009)		B) Based on min. gross income (2009)	
	2009	2020	2009	2020
Farm gate priced USD/kg	\$0.09	\$0.20	\$0.15	\$0.26
Farmer gross income USD/ha	\$175	\$408	\$300	\$513
Feedstock cost USD/litre	\$0.32	\$0.75	\$0.55	\$0.94
Processing + energy cost + company margin USD/litre	\$0.08	\$0.19	\$0.14	\$0.24
Final cost USD/litre	\$0.40	\$0.94	\$0.69	\$1.18

So Jatropha production appears favourable only when a minimum biodiesel cost is enforced. But biofuel price is likely to increase due to inflation related to high expected national economic growth. Economic feasibility is questioned and further economic study need to be done to assess viability at middle and long term of biodiesel from Jatropha.

4.2.2 Constraints

Cultivation:

Biofuel companies are finding it increasingly difficult to identify land to contract farm. Process to get land concessions for contract farming is complex and not standardized. Clear roles and responsibilities are lacking to enable a good climate of business and to secure farmer, private company and environmental interests.

As Jatropha is time consuming to cultivate, many farms are limited by human resources. Moreover, income generated from this cultivation is low. If farmers hire external labour the economic viability of Jatropha cultivation is weakened. This constraint may be responsible for the lack of farmer interest in Jatropha and the low management of existing plantations that has been reported by private companies. Poor farmer knowledge of cultivation practices and breeding techniques endanger the sustainability of production and represent a serious threat to both farmers and private companies. Access to quality seed material is a similar concern.

Contract farming:

Lack of legal framework for contract farming is the main threat for both farmers and private companies. Roles and responsibilities are not defined and usually contracts are done under informal agreement. In this legal context, investment and interest of both parts are not secure. The sustainability of such agreements is uncertain. Contract issues and frameworks are often poorly understood by farmers who lack the information required to make effective decisions. This situation could be improved by improving farmer education and increasing access to relevant expertise.

Processing:

Most private companies plan to build their own processing unit but insufficient feedstock constrains the initiation of any development. Companies like Kolao are struggling to find suitable land concessions to set up

processing factories. Land needs to meet several criteria such as large area, communication access, and electricity supply. High investment cost may be the main constraint for smaller companies. Availability and Lao market price of methanol is another concerned that should not be overlooked.

Distribution and end-use:

The following items are required to ensure initiation and development of the biofuel domestic market:

- Blending mandate
- Fuel standard
- Distribution mandate and supply blending (B2, B5, B10, B20, B100)
- Trade agreement between biofuel maker, distributor and government
- Price regulation and retail price
- Coordination agency
- Identification of final consumer (public transport, individual/enterprise vehicles, good transportation)
- Vehicles must be guaranteed by their producers to secure the final consumer.

The export market is limited by:

- Lack of export tax mechanism for biofuel
- Standard- Country bilateral or multilateral trade agreement on biofuel
- Surplus of biofuel in neighbouring countries

4.3 Large Scale Bioethanol production

Cassava and sugarcane are the preferred energy crops for bioethanol production. Molasses, a by-product from the sugar industry is another suitable feedstock for this market chain. Both energy crops are already cultivated in Lao PDR but to a volume and operational model which is insufficient to supply a bioethanol processing facility. However, from an agronomic perspective, both the sugar and starch crops can be cultivated in a highly mechanized advanced manner which is necessary to produce significant amount of feedstock for the factory.

4.3.1 Costs and Benefits

Table 6: Approximate costs of bioethanol production

	Sugarcane		Cassava	
	2009	2020	2009	2020
Farm gate priced USD/kg	\$0.03	\$0.04	\$0.06	\$0.10
Farmer gross income USD/ha	\$1,000	\$1,710	\$1,272	\$2,176
Feedstock cost USD/litre	\$0.37	\$0.64	\$0.43	\$0.73
Processing + energy cost + company margin USD/litre	\$0.09	\$0.16	\$0.11	\$0.18
Final cost USD/litre	\$0.47	\$0.80	\$0.54	\$0.92

As stated earlier in the report, bioethanol factories needs a certain level of mass flow to become economically viable and therefore require a significant amount of resources such as feedstock, technical know-how and investment. As seen on other large scale industries and investments in Lao PDR like mining, hydropower or cement, it is possible to establish a new industry branch on mid and long term perspective.

Nevertheless it is unknown if large scale bioethanol can contribute to rural development, national energy security and the protection of biodiversity due to a lack of experience and legal frameworks. Moreover, impacts from global market drivers on biofuel can be on a high level at this scale and represent increasing external threats for producers and consumers. This market chain lacks experience and knowledge and has to build capacity, particularly for market mechanisms, logistics and technology. Several interventions will be needed to overcome constraints and to enable market initiation and development.

4.3.2 Constraints

Financial services:

There is a need for laws and regulations for loan collection and collateral enforcement, in order to improve the financial sector. At present there are difficulties for investors to gather access to loans and time consuming

approval procedures, the absence of a stock exchange and high interest rates are crucial for the Lao financial and bank sector and hamper investment activities. Enforcement of prudent guidelines is ineffective and standards for credit worthiness are low.

Investment security:

There is weak regulatory and administrative framework and time consuming, opaque bureaucratic processes. Although the government is highly interested in attracting foreign investment nearly no regulatory improvements were achieved during the last two business years in Lao PDR in terms of an enabling environment for doing business. There is no practice of efficient bankruptcy and laws on closing a business, but the “freedom to fail” is seen as an encouraging variable for entrepreneurs. The investor protection rights stagnate on a very low level, import/ export costs stagnate on a high level, also in comparison to other regional countries. The ranking for credit accessibility, especially legal rights and their enforcement are seen as weak. In order to offer favourable conditions for investment related to bioethanol development which requires significant amount of resources, several constraints has to overcome. Current practice in other large scale investment such as hydropower, mining or paper processing are that the Lao government offers natural resources (minerals, land, biomass, water) and receives a share of the joint venture. Rules and legal framework is limited as well as the enforcement of each party’s obligations. Clear structures about responsibilities (central, provincial or district authorities) and concerning government bodies is needed to provide a better investment climate. Furthermore unclear plans on tax regulation harm investment climate for investors.

Logistics:

Since bioethanol processing factories requires significant amounts of feedstock, an appropriate infrastructure, especially the road condition for transportation is constraints for market development in terms of supplying the factory but also for disseminating the product to the market (blending facilities, domestic market or for export). Especially in Northern provinces with its mountainous geographic features, infrastructure has to be improved.

Cultivation:

Land clusters especially in larger size and favourable conditions are difficult to find (plane area, fertile soil, connected to roads). Other constraints include labour shortage, pests and diseases, unsuitable land and lacking extension service, unattractive for farmers due to low income.

Biofuel processing:

There is a lack of feedstock, high initial investment for utilities, lack of skilled technicians, proper quality assurance of produced bio ethanol, lack of market (domestic and export orientated)

5 Steps to Elaborate Biofuel Policy

This Chapter provides a background for and presentation of detailed recommendations based on main report findings. It sets out an indicative program of required Government support sufficient to meet a target of 10% biodiesel displacement of fossil fuel diesel imports by 2020. The section draws on experience from elsewhere in the region to identify the types of Government intervention needed to have the desired result over a ten-year period beginning in 2010.

These tools could all help to achieve the desired economic and environmental goals, but vary in cost effectiveness and distributional efficiency. Selection of an appropriate policy for Lao PDR will depend on the availability of budget, resources and information, but also transaction costs and political economy considerations (Rajagopal & Zilberman 2008). An estimate of the likely effects attributable to each major market intervention is now made and complementary interventions identified.

5.1 Policy options and outcomes

Interest in Biofuels across the world has allowed some countries to develop considerable production capacity. The production and processing of various feed-stocks has been encouraged using a number of explicit policies and indirect trade mechanisms. The experience of the leading Asian and global biofuel producers is listed in Annex 2. The Annex shows the opportunities to engage with external markets, but also potential threats. For example Thailand has large bioethanol surplus which would limit the profitability of a Lao bioethanol production business. However, Thailand also has a shortage of biodiesel which may provide an opportunity for export.

5.1.1 Excise tax credit

At present fuel tax reductions are the most commonly used biodiesel support measures internationally. However, this fiscal instrument is dependent on the level of excise taxes levied on petroleum fuels. As such Lao PDR is not in a position to use this mechanism as the government subsidizes the import of petroleum fuels so has no tax levy to remove. Indeed, a review of the existing academic literature regarding international biodiesel production suggests that large tax reductions are always required to allow biofuels to compete with petroleum fuels (Kojima et al. 2007). This factor will make it difficult to launch a commercially viable biodiesel market in Lao PDR.

5.1.2 Direct Control

Market regulation through direct control can be achieved by setting biofuel targets and blending mandates. This mechanism is used in India, China and Thailand where mandatory blending ranges from 5-10%. In Brazil, bioethanol blending varies from 20-25% depending on availability of supply. In contrast to a system of tax credits, market regulation through direct control drives up the price of fuel. Although for the government this policy is revenue neutral, consumer surplus (benefit to the consumer) is reduced and producer surplus (benefit to the producer) is increased (Gardner 2003).

5.1.3 Agricultural Policies

Agricultural feed-stocks account for more than half the cost of biofuel production. As such, agricultural and trade policies that influence the supply, demand and price of agricultural commodities have a strong influence on production economics. Numerous policy mechanisms are available to the government to regulate price and availability of feedstock, notably price supports, land use regulation and regulation of trade.

5.1.4 Trade Policies

Trade restrictions on the movement of feedstock and biofuel are imposed by most biofuel producing countries. Import tariffs and quotas can protect domestic producers and restrict benefit to trade partners. Taxing exports can have a similar impact, reducing the volume of goods leaving the country.

5.1.5 Research and Development

It has been argued that the most appropriate government support given to biofuels is to fund research and development (R&D) for activities that, because of their public good characteristics, are more likely to be undertaken if centrally financed (Rajagopal & Zilberman 2008).

5.2 Potential Policy Outcomes

Table 7: Impact of biofuel policies on economic and environmental indicators

Policy Instrument	Reduction of oil use	GHG Reduction	Farm Income	Bio-fuel Producers	Consumer Benefit (Food)	Consumer Benefit (Energy)	Government Budget
Energy and Fuel							
Bio-fuel tax credit	+	?	+	+	-	?	-
bio-fuel mandate	+	?	+	+	-	-	?
Carbon/ Gasoline Tax	+	+	?	?	?	-	+
Efficiency standard	+	+	?	?	?	+	?
Vehicle Subsidy	?	?	?	?	?	?	-
Agricultural and Trade Policies							
Price Support	+	?	+	?	+	+	-
Area control	?	?	+	-	-	-	-
Import tariff	+	?	+	+	-	-	+
Export Subsidy	?	?	+	+	-	-	-
Export quota	+	?	-	+	+	+	?

+ = Positive Impact
 - = Negative Impact
 ? = Uncertain Impact

Adapted from (Rajagopal & Zilberman 2008)

Table 7 sets out the impact of various biofuel policies on economic and environmental indicators. The following points are of more detailed consideration:

- All the policies in Table 3 have the ability to increase biofuel supply whilst reducing demand for liquid fossil fuels, but the scale of impact may be marginal
- GHG reductions associated with increased biofuel supply are uncertain, dependent on crop, production intensity (particularly chemical inputs) and the nature of land use change. All these factors will vary with location and time.
- Policies that encourage biofuel production will increase farm income, benefiting larger landowners over smallholder.
- Food processing industries may suffer higher input prices.
- Livestock production may suffer if they make use of feed-stocks directly, they may benefit if they can make use of biofuel by-products
- A mandatory biofuel blend will increase the fuel price for consumers. Price support for biofuel crops and export quotas will lower the cost of energy so benefit consumers.
- For the Lao people, taxes and tariffs are superior to tax credits, price support and trade subsidies. The former generate public money whilst the latter spend it.
-

These statements must be taken in isolation, they do not account for the potential interacting effects of different policies. The interaction of multiple policies is complex to the extent that predicting the outcomes of interaction is beyond the scope of any existing research.

See Annex 6 for an outline of the development of appropriate biofuel policy options in Europe.

5.3 Developing GoL Capacity to Promote and Development Biofuel Programs

When combined, the various experiences of stakeholders in the current uncontrolled biofuel market, and the main limitations encountered by the present study team, give some clear indications of the general constraints to biofuel development. This study has highlighted the sharp discordance between the current preference for export shown by the private sector, and the targets of the GoL to establish a domestic biofuel market. To reconcile activities to the preferred direction, the GoL will therefore need to facilitate the development of the market chains described in this report. In summary the following recommendations will aid the development of bio fuel capacity:

1. Improve information sharing between departments
2. Provide sources of revenue to government department
3. Develop technical capacity within the government
4. Develop options for governance of biofuel programs and associated land
5. Improve education and public awareness of biofuels
6. Increase funding to research and development, or develop network of researchers abroad

These points will now be elaborated upon.

5.3.1 Access to Information

- **Programmatic Recommendation:** Improve access to information and cross ministry communication.
- **Organisational Recommendations:**
 - Charge a single organization with directing the biofuel sector and enabled by other offices of other ministries to evaluate factors that may not fall within its usual scope of expertise
 - Develop access to village-level data on resource supply
- **Background:** There is insufficient access to information necessary to assess, plan and track the emerging bio fuel sector

Most apparent to the present study is the challenge presented by the lack of access to information necessary to assess, plan and track the emerging biofuel sector. The primary reasons for this are assumed to be first, that biofuels require a cross-ministry engagement: the supply chain is reliant upon an agricultural product; the main potential consumers are the transport and rural energy sectors; and current development is largely driven by foreign investment. This implies that even if biofuel development is directed from a single office, the responsibility for information collection must be shared. Moreover, the organization charged with directing the biofuel sector must be enabled by the offices of other ministries to evaluate factors that may not fall within its usual scope of expertise.

A second but equally limiting constraint is that some necessary information is not currently collected, or presented in a format that is useable for decision-makers at the national level. Having access to village-level data on resource supply and demand would be an asset for national government, and the current policy of data aggregation serves to mitigate the extent to which national policy can deliver on local needs.

5.3.2 Technical capacity

- **Programmatic Recommendation:** Develop technical expertise required to implement and facilitate the above market interventions
- **Organisational Recommendations:**
 - Provide technical training and support to government bodies from third parties
 - Contract technical experts on a short term basis
- **Background:** Enhanced capacity will be essential for the repositioning of targets to follow emerging needs over the following ten years and beyond.

Government bodies shall require access to specific technical expertise in order to implement and facilitate the above market interventions, and also to monitor and evaluate activities in the sector. The latter will also be essential for the repositioning of targets to follow emerging needs over the following ten years and beyond. Some market interventions shall require direct action by government bodies, and since the current technical capacity for biofuels in government is generally observed to be quite low, as such these bodies shall require

technical training and support from third parties. For other interventions and evaluation activities, the GoL will likely contract technical experts on a short term basis. Even so, it would be advantageous for the responsible government office to have sufficient technical capacity to maintain a global perspective of interventions, and to effectively respond to the recommendations of short term studies.

5.4 Measures to support small scale Jatropha production

5.4.1 Develop legal frameworks

- **Programmatic Recommendation:** Develop legal frameworks
- **Background:** Setting up a legal framework for farmer associations is a priority to enable organization development.

Frame works must include:

- License number register to the chamber of commerce
- Right, duties and obligation of farmer and buyer
- Right to get financial account and access to cash flow management
- Right to contract loans
- Blending mandate and distribution
- License
- Right, duties and obligation of the blender and distributor
- Standard and authorized testing method
- Warranty on vehicles from distributors

5.4.2 Build Local Capacity

- **Programmatic Recommendation:** Build local Jatropha cultivation capacity
- **Organisation Recommendations:**
 - Provide training in cultivation techniques and research exchange with other countries
 - Support extension services specialized on cultivation techniques, weed management, pest management, pruning and harvesting
 - Develop decision making and basic economic tools for assisting farmers decision process
 - Provide training at community level on processing techniques
- **Background:** Jatropha cultivation is not optimized and faced by low and uncertain seed yields

As previously stated, Jatropha cultivation is not optimized and faced by low and uncertain seed yields. To overcome this important threat, training in cultivation techniques and research exchange with other countries has to be undertaken. Extension services specialized on cultivation techniques, weed management, pest management, pruning and harvesting are demanded in order to offer sufficient assistance to Jatropha growers. Furthermore, decision making- and basic economic tools for assisting farmer's decision process are needed in order to support farmers decision making process. Promotion of Jatropha should highlight conservative cultivation practices such as intercropping, fencing and cultivation on marginal land until more experience is gained. At community level, training has to be delivered on process techniques (oil extraction, transesterification and blending), and utilization of produced biofuel (blending, quality assurance, distribution network, engine modification). As a summary, direct beneficiaries of capacity building means should be all actors involved in this market chain including private companies, public sector, Universities, PAFO and DAFO staff.

5.4.3 Provide access to financing, soft credit and loans

- **Programmatic Recommendation:** Provide access to financing, soft credit and loans
- **Organisation Recommendations:**
 - Soft loans with long payback terms should be encouraged by government bank and international credit organization such as ADB
 - Special promotion must be undertaken for rural electrification and agriculture mechanization projects
- **Background:** Investment may be the one of the main bottleneck for smallholders

Investment may be the one of the main bottleneck for smallholders. Soft loans with long payback terms should be encouraged by government bank and credit organization (e.g. Garmin Bank, APB). Incentive credit must be given in priority to farmer association and biofuel manufactures. In order to secure loans and farmers, a business model need to be assessed and strengthened by advisers. Special promotion must be undertaken for rural electrification and agriculture mechanization projects.

5.4.4 Fund research and development

- **Programmatic Recommendation:** Fund research and development
- **Organisation Recommendations:**
 - Coordinate existing research in a more productive way by appointing an appropriate biofuel stakeholder to channel efforts jointly
 - Make research publicly available
 - Fund research through taxation of vehicles and bio fuel company profit
- **Background:** Research on cultivation practices, processing and biofuel utilization is essential to sustain and improve production of Jatropha based biofuel.

Research on cultivation practices, processing and biofuel utilization is essential to sustain and improve production of Jatropha based biofuel. There are currently several R&D efforts undertaken in Lao PDR carried out by private companies, public institutes, national companies and INGO's. However most of the research conducted is not coordinated and as a result efforts are unnecessarily replicated and information not public available. There is a clear need to coordinate these efforts in a more productive way by appointing an appropriate biofuel stakeholder to channel efforts more jointly.

5.4.5 Provide incentives to farmers

- **Programmatic Recommendation:** Provide incentives to farmers
- **Organisation Recommendations:**
 - Provide quality seed materials for free
 - Make additional land concessions
 - Arrange tax incentives
 - Supply transesterification units and methanol manufacturing plants
- **Background:** Government incentives are required to initiate the market.

Quality seed materials may be provide for free to encourage farmer Jatropha cultivation and secure production. Additional land concessions especially on marginal land can also be a good means of promoting Jatropha cultivation. Tax incentives provide a powerful means to encourage farmers, biofuel makers and final consumers to invest and use biodiesel. Processing facilities such as transesterification units and methanol manufacturing plants could be supplied initially by government to initiate the market.

5.4.6 Establish pilot projects

- **Programmatic Recommendation:** Establish pilot projects
- **Organisation Recommendations:**
 - Identify suitable locations
 - Undertake spatial analysis
 - Make funds available
- **Background:** Pilot projects are required to assess economic feasibility of Jatropha based biofuel production in Lao PDR to help identify bottlenecks before large-scale promotion commences.

Pilot projects are required to assess economic feasibility of Jatropha based biofuel production in Lao PDR. This will help identify bottlenecks within this market chain before large-scale promotion commences. Promising pilot projects are undertaken already, however it is important that the evaluation of these pilots are undertaken by neutral organizations.

5.5 Measures to support large scale *Jatropha* production

5.5.1 Develop Legal frameworks

- **Programmatic Recommendation:** Develop Legal frameworks
- **Organisation Recommendations:**
 - Clearly define and publish roles, responsibilities, rules and regulation of farmer and buyers
 - Provide support for farmers in case of appeal against private company.
 - Fix a national minimum farm gate price in agreement with private companies
 - Make strict classification of land
- **Background:** A legal framework must be set up for contracts to secure investment from private company and guarantee farmers' rights

Land allocation mechanisms need a clear procedure. Before any land allocation happens, a strict classification of land must be done based on agro-ecosystem potential and threats. Food production area, biodiversity area, cash crop and agro-forestry area must be clearly identified to avoid impact on food security, environment and cash crop production. NTFP is one of the main sources of income of farmer and is a non negligible source of food for locals. These areas must not be overlooked especially in upland area with high sensitivity to food insecurity. Based on this classification, potential area for *Jatropha* cultivation must be identified and consultation with farmers must be conducted to know the net area that can be cultivated. A legal frame work must be set up for contracts to secure investment from private company and guarantee farmers' rights. Roles, responsibilities, rules and regulation of farmer and buyer must be clearly defined and publicized. Any contract set between farmer and private company must be done with a legal representative that clearly explains the content of the contract and warranty rights and duties of the two parts.

Considering level of education and knowledge of the law, farmers should be supported in case of appeal against private company. In order to warranty welfare of farmer and sustainability of the production, a national minimum farm gate price should be fixed in agreement with private companies, Government representative (e.g. Ad hoc comity of biofuel) and farmer representative (e.g. Lao Women Union). This minimum farm gate price should be revised periodically to follow national economic growth and inflation. Income generation from *Jatropha* is low, farmer should be allowed to cultivate cash crop intercropped with *Jatropha* to improve and diversify their income.

5.5.2 Build local capacity

- **Programmatic Recommendation:** Build local cultivation capacity
- **Organisation Recommendations:**
 - Provide training in cultivation techniques
 - Provide information concerning yield, labour input, crop calendar, farm gate price and age of full productivity
 - Highlight conservative practices such as inter-cropping, fencing and cultivation on marginal land
- **Background:** There is low knowledge of *Jatropha* cultivation in Lao PDR

As previously stated in the prior market chain, *Jatropha* cultivation suffers insufficient experience on cultivation and lacking understanding of the plant itself. To overcome this weakness, training in cultivation techniques is usually undertaken by private companies. Information concerning yield, labour input, crop calendar, farm gate price and age of full productivity must be made accessible to farmers so that they can assess *Jatropha* cultivation feasibility. Promotion should highlight conservative practices such as inter-cropping, fence, cultivation on marginal land.

5.5.3 Improve access to financing, soft credit and loans

- **Programmatic Recommendation:** Improve access to financing, soft credit and loans
- **Organisation Recommendations:**
 - Encourage soft loans for farmers with long payback terms from by government bank and credit organizations
 - Assess and strengthen a business model for *Jatropha* production

- Provide special promotion for innovative projects
- **Background:** Investment is one of the main bottlenecks for smallholders.

Soft loans for farmers with long payback terms should be encouraged by government bank and credit organization (e.g. Garmin Bank, APB). Loan terms must avoid any mortgage and secure farmer against project's collapse and contracting company bankruptcy that may drive farmer into poverty. Special promotion must be undertaken for innovative projects.

5.5.4 Fund Research and development

- **Programmatic Recommendation:** Fund research and development
- **Organisation Recommendations:**
 - Coordinate existing research in a more productive way by appointing an appropriate biofuel stakeholder to channel efforts jointly
 - Make research publically available
 - Fund research through taxation of vehicles and biofuel company profit
- **Background:** Research on cultivation practices, processing and biofuel utilization is essential to sustain and improve production of Jatropha based biofuel.

Research on cultivation practices, processing and biofuel utilization is essential to sustain and improve production of Jatropha based biofuel. There are currently several R&D efforts undertaken in Lao PDR carried out by private companies, public institutes, national companies and INGO's. However most of the research conducted is not coordinated and as a result efforts are replicated and information not public available. There is a clear need to coordinate these efforts in a more productive way by appointing an appropriate biofuel stakeholder to channel efforts more jointly. Research funding may be undertaken by taxation on vehicles, bio fuel company gross income and investment.

5.5.5 Provide Incentives to kick start industry

- **Programmatic Recommendation:** Provide incentive to farmers, producers and consumers.
- **Organisation Recommendations:**
 - Allocate marginal land to farmers for Jatropha cultivation
 - Provide financial compensation during first year of cultivation
 - Devise taxation mechanisms and price regulation to support investment in production and promote the domestic market
 - Import of Jatropha seed from neighbouring countries to initiate production
 - Set retail price of biodiesel slightly lower than fossil fuel diesel
 - Use biodiesel in government vehicles
- **Background:** Production and consumption of biodiesel needs to be encouraged.

Land allocation to farmer willing to cultivate Jatropha is a powerful mean to boost seed production. Allocation program should only target marginal land. Selection mechanism should focus on farmer with sufficient labour force to undertake additional cultivation. Initial financial compensation during first year of cultivation should be fixed following the same process of farm gate price. Level of compensation must be carefully decided and must not encourage a shift of food crop. Taxation mechanisms and price regulation should support investment in production and promote the domestic market rather than export market.

Lack of feedstock is currently the main constraint for biofuel makers, so import of Jatropha seed from neighbouring countries like Thailand could be a powerful means to initiate production. As seed market is likely to be locked, bilateral agreement should be sought.

Several incentives for final consumer must be designed to promote large scale biofuel utilization. Government has the biggest vehicles fleet in the country and should be the first biofuel consumer. A retail price slightly lower than conventional diesel is a sine qua none condition for large utilization by privates. Retail price must be regulated by government through agreement with biofuel maker and distributor. Although production cost seems to be lower than fossil fuel cost at the moment, subsidies should be foresee to guarantee incentive retail price in case of fossil fuel price decrease (unlikely at medium term) or increase of seed price (likely at medium term).

5.6 Measures to support large scale ethanol production

5.6.1 Develop finance mechanism

- **Programmatic Recommendation:** Develop finance mechanism
- **Organisation Recommendations:**
 - Develop local capacity in finance and economics in the country
 - Improve and involve national banks (e.g. commercial or agriculture banks) in financing process
 - Develop legal framework for foreign investment

5.6.2 Improve investment laws

- **Programmatic Recommendation:** Improve investment laws
- **Organisation Recommendations:**
 - Legislation to facilitate foreign investment
 - Facilitate investment and overcome services barriers by strengthening local capacity
 - Introduce and strengthen electronic commerce
 - Develop legal framework for foreign investment
- **Programmatic Recommendation:** Increase international integration
- **Organisation Recommendations:**
 - Promotion of WTO membership
 - Ensure transparency and consistency in the legal and regulatory of foreign direct investment law
- **Programmatic Recommendation:** Strengthen investment procedure
- **Organisation Recommendations:**
 - Implementation and enforcement of the anti-corruption decree
 - Ensure transparency and consistency in the legal and regulatory of foreign direct investment law

5.6.3 Improve infrastructure at potential or identified bioethanol site

- **Programmatic Recommendation:** Improve infrastructure at potential or identified bio ethanol site
- **Organisation Recommendations:**
 - Enable proper communication between concerning authorities
 - Evaluate and develop regulations for infrastructure development with investor
 - Improve and standardize the process of customs when exporting to other countries: Transit should be simplified

5.6.4 Identify suitable large scale plantation site for cassava and sugar cane

- **Programmatic Recommendation:** Identify suitable large scale plantation site for cassava and sugar cane
- **Organisation Recommendation:** Create database on suitable areas for sugar and starch crop production including climate data (NLMA, MAF), grade of slope, available size and other relevant data

5.6.5 Increase productivity of sugar cane and cassava production

- **Programmatic Recommendation:** Increase productivity of sugar cane and cassava production
- **Organisation Recommendations:**
 - Capacity building within DAFO in order to provide suitable extension service at cultivation sites
 - Knowledge exchange with neighbouring countries on cultivation issues
 - Legislation to facilitate contract farming

- Identification of suitable land by NLMA

5.6.6 Engage in technology transfer from neighbouring countries

- **Programmatic Recommendation:** Engage in technology transfer from neighbouring countries
- **Organisation Recommendations:**
 - Build technical capacity within suited local institutions and
 - Technology dissemination initiatives
 - Undertake partnership with international universities

5.6.7 Public communication campaign about the use of biofuel

- **Programmatic Recommendation:** Public communication campaign about the use of bio fuel
- **Organisation Recommendations:**
 - Need to increase information sharing between government ministries
 - Awareness creation about domestic utilization of bio ethanol
 - Institutionalization of the ad hoc committee as a bio fuel committee

5.6.8 Mandate blended fuel for public transport, or urban users by 2015

- **Programmatic Recommendation:** Mandate blended fuel for public transport, or urban users by 2015
- **Organisation Recommendations:**
 - Analysis of potential for compulsory use of specific blends
 - Forecast demand for transport fuel

5.7 Organizational Requirements

This section presents broad organisational requirements that will be needed to assist biofuel development within Lao PDR.

1. GoL needs to clarify the priority objectives for developing a biofuel industry. Should policy focus on energy security or rural development?
2. Access to information needs to be improved for accurate decisions to be made. This can be facilitated by:
 - 2.1. Cross-ministry engagement and improved information collection
 - 2.2. Defining clear responsibility for specific information for each office
 - 2.3. Institutionalisation of Ad Hoc Committee
 - 2.4. Publication of information resources for all stakeholders
3. Work needs to be undertaken to improve technical capacity. Institution should be developed with the technical expertise in biofuels in order to advise, plan and track biofuel sector
4. Effort needs to be made to integrate the various policies that are relevant to the development of the biofuel sector. This policies include:
 - 4.1. Agriculture (land)
 - 4.2. Economic
 - 4.3. Energy (and energy efficiency)
5. Careful consideration must be given to finding the revenue with which to finance the essential and expensive interventions necessary to fund bio fuel development. These could include:
 - 5.1. Increase price of petroleum fuels in urban areas (note: also promotes energy efficiency)
 - 5.2. Tax revenue from biofuel exports – requires market analysis of neighbouring nations, and from ‘polluters’: e.g. vehicle imports

6. This report assesses options for development of biofuel over the next 10 years, but thought must be given to long term biofuel development. This should involve support for research and development of feedstock diversification and bio fuel applications

5.8 Programmatic requirements: Energy Security and the 10% target

1. Achieving this target will require significant infrastructure development and private investment incentives. Measures that will facilitate this are:
 - 1.1. Import biodiesel for interim – need market analysis
 - 1.2. Export taxes on biofuel: lower tax for biodiesel than raw feedstock
 - 1.3. Mandatory use of blended biodiesel for public sector vehicles
 - 1.4. Licensing and regulations for biofuel purchase and distribution – role of LSF?
 - 1.5. Facilitate bi-lateral trade agreements
 - 1.6. Support university curriculum development and training centres
2. Biofuel crops should be cultivated only for the domestic market. If biofuels are exported then it will be very difficult to achieve the 10% target. In addition there will be a need for:
 - 2.1. Legislation for contract farming
 - 2.2. Detailed resource and market mapping study
 - 2.3. Extension services for small holder farmers
 - 2.4. Regulations to fix farm gate price for biofuel crops
 - 2.5. R&D into yield optimisation
 - 2.6. Soft loans for small holder farmers
3. Support will need to be provided to the domestic market in the form of:
 - 3.1. Price guarantees to domestic biofuel producers based on diesel import price
 - 3.2. Further cost analysis of biofuel production development should be undertaken
 - 3.3. A level of mandatory sale of blended fuel in urban areas should be set

5.9 Programmatic requirements: Rural Development

1. As with achieving the 10% target effort will need to be made to develop infrastructure and provide investment incentives. This could be done through:
 - 1.1. Shift from a volumetric target of 10% biodiesel substitution, to a target of 10% rural small holders making use of biofuel technology by 2020.
 - 1.2. Support for pilot projects for small scale biofuel
 - 1.3. Financial incentives for biofuel producers
 - 1.4. Soft loans for processing equipment
2. Farmers should be encouraged to produce biofuel crops for the domestic market by providing:
 - 2.1. Legislation for farming associations
 - 2.2. Detailed resource and market mapping study
 - 2.3. Extension services for small holder farmers
 - 2.4. Targeted promotion of Jatropha on marginal land
 - 2.5. R&D into yield optimisation
 - 2.6. Soft loans for small holder farmers
3. The domestic market for biofuels needs to be developed. Measure that can assist that include:
 - 3.1. A study of detailed rural energy needs
 - 3.2. R&D into biofuel applications such as cooking, heating, transport and electricity
 - 3.3. Subsidies need to be provided to incentivise local use of biofuel crops, perhaps funded by fossil fuel revenue
 - 3.4. Biofuel for rural electrification should be encouraged
 - 3.5. Regulations for biofuel production and distribution should be developed for local markets
 - 3.6. District level capacity building should begin to support market regulation and law enforcement

5.10 **Road Map and Action Plan** (To be read in conjunction with Annex 3 and Annex 4)

Programmatic Recommendation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1 Provide leadership for biofuel development															
1.1 Clearly defined policy targeted sector															
1.2 Set up a Biofuel National Agency (BNA) with mandate to direct biofuel sector															
1.3 Link BNA to local level activities															
1.4 Improve access to information and cross ministry communication															
1.5 Develop expertise, implement and facilitate interventions															
1.6 Develop understanding of the viability of producing for export markets															
1.7 Analyze and monitor the domestic market															
1.8 Make accurate estimate of financial costs of developing bio fuel															
1.9 Find the revenue to finance interventions necessary to fund biofuel															
2 Create enabling environment for biofuel development															
2.1 Design legal framework for biofuel development															
2.2 Improve investment laws															
2.3 Increase international integration															
2.4 Strengthen investment procedure															
2.5 Develop finance mechanism															
3 Ensure domestic market development															
3.1 Initiate biofuel production															
3.2 Initiate biofuel distribution															
3.3 Initiate biofuel consumption															
3.4 Provide incentives for domestic biofuel production															
3.5 Initiate small scale production															
3.6 Provide access to financing, soft credit and loans for small-scale production															
4 Promote biofuel development															
4.1 Identify suitable site for Jatropha, cassava and sugar cane plantation															
4.2 Provide incentives to farmers															
4.3 Improve access to financing, soft credit and loans															
4.4 Provide incentive to producer															
4.5 Encourage final consumer to use biofuel															
5 Ensure the sustainability of biofuel development															
5.1 Fund research and development															
5.2 Engage in technology transfer from neighboring countries															
5.3 Build extension service															
5.4 Build local capacity															
5.5 Enhance farmer rights, rural Development and poverty alleviation															

6 Conclusions

- There is to integrated policy all the policies associated with biofuel development. There are difficulties developing a biofuel policy without clear land allocation policy, economic policy, and renewable energy policy.
- At present biofuel development in Lao PDR is focusing on production for the export market. Significant policy intervention will be required to ensure that this industry contributes to the improving energy security, rural development, and environmental protection.
- This study has made an estimate of the market potential associated with biofuels; however accuracy has been limited by insufficient data.
- Reducing growth in petroleum fuel use by improving fuel use efficiency would make the 10% biodiesel substitution target easier to meet.
- Similarly, limiting export of biofuel would reduce the scale of biofuel production required to meet the 10% target.
- Energy security targets favour large scale production with low exports in the short term
- Rural development targets favour small scale production. The government should consider a new target of 10% small holders making use of bio fuel technology by 2020. This will contribute to the NGPES more concretely than the 10% biodiesel substitution target.

7 Reference

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8 Annex

8.1 Annex 1: Tool to undertake the required Economic analysis of bio-diesel production and marketing for Lao PDR

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Costs associated with developing biofuel industry

Feedstock Production

Costs: OC of inputs (TBC), OC of R+D (TBC), OC of environmental damage (TBC)

Benefits: Slowing soil erosion (TBC)

Net Cost: =SUM(D5:D7)-D8

Transport to processing plant

Costs: OC of inputs (TBC), OC of vehicle and road repair (TBC), OC of environmental damage (TBC)

Benefits: None (TBC)

Net Cost: =SUM(D12:D14)-D15

Biofuel Processing

Costs: Plant construction cost (TBC), OC of inputs (TBC), OC of maintenance and repair (TBC), OC of R+D (TBC), OC of environmental damage (TBC)

Benefits: Co-product sales (TBC)

Net Cost: =SUM(D19:D23)-D24

Transport to market

Costs: OC of inputs (TBC), OC of vehicle and road repair (TBC), OC of air pollution and fuel spills (TBC)

Benefits: None (TBC)

Net Cost: =SUM(D28:D30)-D31

Retail and end use

Costs: OC of inputs (TBC), OC of storage (TBC), OC of splash blending facilities (TBC), OC of retail outlet modification (TBC), OC of vehicle modification (TBC), OC of corrosion (TBC), OC of fuel spills (TBC)

Benefits: Improved health from reduced emissions (TBC)

Net Cost: =SUM(D35:D41)-D42

Economy-wide and global effects

Costs: Higher food prices (TBC), Consequence of crop failure (TBC)

Benefits: Tech spill over (TBC), Reduced GHG emissions (TBC), Fuel supply diversification (TBC)

Net Cost: =SUM(D46:D49)-D50

Total Net Cost: =D51+D43+D32+D25+D16+D9

Minus the Baseline alternative:

Petroleum fuel procurement

Costs: Import-parity fuel costs (TBC), Damage to environment at terminals (TBC)

Net Cost: =SUM(D59:D60)

Petrol transport to market

Cost: OC of inputs (TBC), OC of vehicle and road repair (TBC), OC of environmental damage (TBC)

Net Cost: =SUM(D64:D66)

Petrol retail and end use

Costs: OC of inputs (TBC), OC of storage (TBC), OC of fuel spills (TBC)

Net Cost: =SUM(D70:D72)

Total Net cost: =D73+D67+D61

Grand Net Cost developing Biofuel industry: =D53-D75

TBC= To Be Confirmed, OC=Opportunity Cost
Based on: Economic analysis of biofuel production and marketing for a country importing transportation fuel
 Kojima, M. & Johnson, T., 2006. Biofuels for transport in developing countries: socioeconomic considerations. Energy for Sustainable Development, 10(2), 59-66.

Annex 2: Summary of current capacity, targets and biofuel policy in relevant countries.

Biofuel	Current capacity	Future targets - quantity and year	Main feedstock	Biofuel policies (explicit)	Main trade policy for bio fuels
Thailand	330 million litres of ethanol (2006) Important Ethanol surplus. 2009 = 12.3 million litres/day	By 2022 : Ethanol 9 million litre/day Biodiesel	Cassava, sugarcane molasses	Price subsidy, capital subsidies Compulsory use of B2 and B5 in 2012	Import tariff of 2.5 baht per litre and ad valorem tariff of 5% on biodiesel
Indonesia	340 million litres of biodiesel (2006)	10% ethanol and 10% biodiesel effective April 2006	Oil palm	Mandatory blending, capital subsidies	Lower export tax for processed oils compared to crude palm oil
Malaysia	340 million litres of biodiesel (2006)	5% biodiesel from April 2007	Oil palm	Mandatory blending, capital subsidies	Lower export tax for processed oils compared to crude palm oil
China	1.2 billion litres of ethanol (2006)	na	Maize, cassava, sugarcane	Subsidies and tax breaks but only for non-grain feedstock	Import tariff of 30% on ethanol
US	18.4 billion litres of ethanol (2006), 284 million litres biodiesel (2005)	28 billion litres of ethanol by 2012 and 1 billion litres of cellulosic ethanol by 2013	Maize	Excise tax credit, mandatory blending, capital grants, vehicle subsidies	Import tariff of \$0.1427 per litre ethanol plus ad valorem tariff with some exemption for Caribbean countries
Brazil	17.5 billion litres (2006)	25% blending of ethanol (has been in effect for long time), 2.4 billion litres of biodiesel by 2013	Sugarcane, soybean	Mandatory blending, capital subsidies, vehicle subsidies	20% ad valorem import tariff on ethanol (waived in case of domestic shortage)
EU	3.6 billion litres of biodiesel (2005), 1.6 billion litres of ethanol (2006)	5.75 % of transportation fuel on energy basis by 2010	Rapeseed, sunflower, wheat, sugar beet and barley	Excise tax credit (beginning to be phased out), carbon tax credit, mandatory blending, capital grants and funding for R&D	Ad valorem duty of 6.5% on biodiesel and import tariff of \$0.26 per litre on ethanol (latter is waived for some categories countries)

Source: Adapted from Rajagopal & Zilberman 2008

Annex 3: Programmatic and Organisational Recommendations

1 Provide leadership for biofuel development	
Programmatic Recommendation	Organizational Recommendation
1.1 Clearly defined policy targeted sector	<p>Prioritizes energy security, rural development, environmental protection, or developing export market.</p> <p>Steering committee meeting to review recommendations. All member to provide a summary of past and ongoing promotion activities, including costs and staff, offices, and resources used.</p>
1.2 Set up a Biofuel National Agency (BNA) with mandate to direct biofuel sector	<p>Institutionalize Ad hoc committee on bio-fuel</p> <p>Establish a schedule of regular steering meetings, twice per year. (<i>Agenda: 1) each member reports on action carried out in period, review of data and status of activities 2) review and discuss progress 3) formulated action plan for next period including recommendations for changes to targets if necessary</i>)</p> <p>Ad hoc committee on bio-fuel, MEM and concerned ministry should agree which ministry leads BNA, responsibilities and duties</p>
1.3 Link BNA to local level activities	<p>Define province and district implementation Provisionally assign responsibilities to PAFO+PDEM, DAFO+DDEM offices. Provide strategy document to all offices</p> <p>District level capacity building should begin to support market regulation and law enforcement. (<i>Prior to this action: Spatial study of biofuel viability; Develop extension materials</i>)</p> <p>Enable communication between the appropriate authorities</p>
1.4 Improve access to information and cross ministry communication	<p>Identify information needed by BNA and its source. (<i>elaborate as a simple list of information and related ministries in 10-page document</i>)</p> <p>Mobilize province and district authorities to collect village-level data</p> <p>Design a network linking BNA with concerned ministry and define clear responsibilities for specific information for each office. The process should be done in collaboration with the relevant ministry</p> <p>BNA to adopt a single measure and single value for each relevant piece of information required by BNA. (<i>example: agreement on single estimate of forecasted diesel demand, land availability, etc</i>)</p> <p>Enable BNA to evaluate factors that may not fall within its usual scope of expertise</p> <p>BNA to review internal capacity to provide public information resources</p> <p>Publish all relevant information resources and make available to all stakeholders</p> <p>Publicize small-scale pilot projects operated by private and public sector organizations</p> <p>Build awareness of domestic utilization of biofuel. (<i>after technical capacity and viable model is available in the country</i>)</p>
1.5 Develop technical expertise required to pilot biofuel development, implement and facilitate the required market intervention	<p>Provide technical training and support to government bodies from third parties</p> <p>Contract technical experts on short term basis to present technical reviews of sector progress</p> <p>Policy review in collaboration with ongoing RE strategy team</p> <p>Integrate the various policies that are relevant to the development of the bio fuel sector. This policies include: Agriculture, Economic and Energy</p>
1.6 Develop understanding of the viability of producing for export markets	<p>Undertake market analysis of EU and Asian markets (<i>especially Japan and India who could be the potential buyers</i>)</p> <p>conduct bilateral discussions with neighboring nations to establish trade agreements in return for technology dissemination (<i>strong requirement to limit export commitments</i>)</p>
1.7 Analyze and monitor the domestic market	<p>Undertake detailed resource and market mapping study</p> <p>Inform ALL province and district authorities, and publicize the areas designated as high potential for small and large scale biofuel development</p> <p>Biofuel Market monitoring with market indicator</p> <p>Analysis of potential for compulsory use of specific blends</p> <p>Develop forecast demand for transport fuel</p> <p>Conduct a study of detailed rural energy needs, identify energy needs most dependent upon petroleum fuels</p>
1.8 Make accurate estimate of financial costs of establishing bio fuel industry	<p>Undertake full economic analysis of biofuel industry development</p> <p>detailed cost analysis of centralized blending, quality testing and standard certification</p> <p>Undertake further cost analysis of bio fuel production development, including consultation of private sector to determine economic conditions for supply to domestic market</p>
1.9 Find the revenue with which to finance the essential and expensive interventions necessary to fund bio fuel development	<p>Increase price of petroleum fuels in urban areas (note: also promotes energy efficiency)</p> <p>raise public awareness to use revenue from fossil fuel price rises to develop domestic biofuel (<i>bill board, TV, ...</i>)</p> <p>Tax revenue from bio fuel exports</p> <p>Analysis of tax revenue from 'polluters' - major fossil fuel consumers and related imports (e.g. vehicle imports)</p> <p>Redirect tax revenue from sectors contributing to fossil fuel demand (<i>after Analysis of tax revenue from 'polluters'</i>)</p>

2 Create enabling environment for biofuel development	
Programmatic Recommendation	Organizational Recommendation
2.1 Design legal framework for biofuel development	Develop licensing and regulations for bio fuel purchase and distribution. Define the role of LSF Set mandatory sale of blended fuel in urban areas Develop regulations for bio fuel production and distribution for local markets Develop Legislation for contract farming Clearly define and publish roles, responsibilities, rules and regulation of farmer and buyers for contract farming Develop legislation for farming associations Clearly define and publish roles, responsibilities, rules and regulation of farmer and buyers for farmer organization Make strict classification of land Legislation to facilitate contract farming
2.2 Improve investment laws	Legislation to facilitate foreign investment Facilitate investment and overcome services barriers by strengthening local capacity Introduce and strengthen electronic commerce Develop legal framework for foreign investment
2.3 Increase international integration	Promotion of WTO membership Ensure transparency and consistency in the legal and regulatory of foreign direct investment law Facilitate bi-lateral trade agreements
2.4 Strengthen investment procedure	Implementation and enforcement of the anti-corruption decree Ensure transparency and consistency in the legal and regulatory of foreign direct investment law Evaluate and develop regulations for infrastructure development with investor
2.5 Develop finance mechanism	Develop local capacity in finance and economics Improve and involve national banks (e.g. commercial or agriculture banks) in financing process Improve and standardize the process of customs when exporting to other countries: Transit should be simplified
3 Ensure domestic market development	
Programmatic Recommendation	Organizational Recommendation
3.1 Initiate biofuel production	Import of Jatropha seed from neighboring countries to initiate production cost analysis of centralized bioethanol blending QA, and certification review of possible infrastructures for (centralized blending), quality assurance, standard certification, and distribution invite expressions of interest for bioethanol development for domestic market Incentivise feedstock diversification by limiting Jatropha biodiesel production to 10% of diesel demand
3.2 Initiate biofuel distribution	Import bio-diesel for interim (Note: This measure requires further market analysis before implementation) develop infrastructure for blending, quality assurance, standard certification, and distribution
3.3 Initiate biofuel consumption	Mandate use of blended biodiesel for public sector vehicles Bio fuel for rural electrification should be encouraged Mandate blended fuel for public transport, or urban users by 2015
3.4 Incentives domestic biofuel production	Levy export taxes on bio fuel: lower tax for bio-diesel than raw feedstock or raw oil Develop price guarantees for domestic bio fuel producers based on diesel import price
3.5 Initiate small scale production	Establish pilot projects by identifying suitable location, undertaking spatial analyses and making funds available Make soft loans available for small holder farmers Provide support for pilot projects for small scale biofuel use Provide financial incentives for biofuel producers Make soft loans for processing equipment available Shift from a volumetric target of 10% biodiesel substitution, to a target of 10% rural small holders making use of bio fuel technology by 2020.
3.6 Provide access to financing, soft credit and loans for small-scale production	Soft loans with long payback terms should be encouraged by government bank and credit organization such as Garmin Bank and APB Special promotion must be undertaken for rural electrification and agriculture mechanization projects. Supply trans-esterification units and methanol manufacturing plants

4 Promote biofuel development	
Programmatic Recommendation	Organizational Recommendation
4.1 Identify suitable site for Jatropha, cassava and sugar cane plantation	Create database on suitable areas for Jatropha and sugar and starch crop production including climate data (NLMA, MAF), grade of slope, available size and other relevant data spatial analysis of land clusters available for bioethanol feedstock crops
4.2 Provide incentives to farmers	Provide quality seed materials for free Make additional land concessions Arrange tax incentives Allocate marginal land to farmers for Jatropha cultivation Provide financial compensation during first year of cultivation
4.3 Improve access to financing, soft credit and loans	Encourage soft loans for farmers with long payback terms from by government bank and credit organizations Assess and strengthen a business model for Jatropha production Provide special promotion for innovative projects
4.4 Provide incentive to producer	Devise taxation mechanisms and price regulation to support investment in production and promote the domestic market
4.5 Encourage final consumer to use biofuel	A public awareness campaign needs to be facilitated regarding appropriate bio fuel production and utilisation Set retail price of biodiesel slightly lower than fossil fuel diesel
5 Ensure the sustainability of biofuel development	
Programmatic Recommendation	Organizational Recommendation
5.1 Fund research and development	Coordinate existing research in a more productive way by appointing an appropriate biofuel stakeholder to channel efforts jointly Fund R&D into yield optimization Fund R&D into bio fuel applications such as cooking, heating, transport and electricity Make research publicly available Fund research through taxation of vehicles and bio fuel company profit Fund R&D into biofuel feedstock diversification
5.2 Engage in technology transfer from neighboring countries	Build technical capacity within suited local institutions Technology dissemination initiatives Undertake partnership with international universities Support university curriculum development and training centers
5.3 Build extension service	Develop extension services specialized on cultivation techniques, weed management, pest management, pruning and harvesting Knowledge exchange with neighboring countries on cultivation issues Provide training in cultivation techniques and research exchange with other countries
5.4 Build local capacity	Capacity building within DAFO in order to provide suitable extension service at cultivation sites Provide extension services for small holder farmers Promote the use of Jatropha on marginal land Developed decision making and basic economic tools for assisting farmers decision process Provide training in cultivation techniques Provide information concerning yield, labor input, crop calendar, farm gate price Highlight conservative practices such as inter-cropping, fencing and cultivation on marginal land Provide training at community level regarding processing techniques
5.5 Assist Rural Development, improve farmer rights and contribute to poverty alleviation	Provide support for farmers in case of appeal against private company. Provide regulation to fix farm gate price for bio fuel crops

Annex 4: Institutional targets to be met over the next 15 years

	Target 2010	Target 2015	Target 2020	Target 2025
1 Provide leadership for biofuel development 1.1 Clearly defined policy targeted sector 1.2 Set up a Biofuel National Agency (BNA) with mandate to direct biofuel sector Link BNA to local level activities 1.3 1.4 Improve access to information and cross ministry communication 1.5 Develop expertise, implement and facilitate interventions 1.6 Develop understanding of the viability of producing for export markets 1.7 Analyze and monitor the domestic market 1.8 Make accurate estimate of financial costs of developing bio fuel 1.9 Find the revenue to finance interventions necessary to fund bio fuel	Policy and agenda NBA Registration Identify data needed Technical training Market analysis Market mapping study Gather economic data Setup tax tariff to export	Operational province and district implementations Operational Cross ministry network Concerned government bodies trained Operational monitoring system Operational monitoring system Accurate financial cost Operational funding system		
2 Create enabling environment for biofuel development 2.1 Design legal framework for biofuel development 2.2 Improve investment laws 2.3 Increase international integration 2.4 Strengthen investment procedure 2.5 Develop finance mechanism	Contract farming law	Legal framework completed Investment law improved Operational bilateral trade agreement Decrease corruption Local capacity developed; Loan procedure setup	Transparency in investment procedure	WTO membership
3 Ensure domestic market development 3.1 Initiate biofuel production 3.2 Initiate biofuel distribution 3.3 Initiate biofuel consumption 3.4 Provide incentives for domestic biofuel production 3.5 Initiate small scale production 3.6 Provide access to financing, soft credit and loans for small-scale production		3% biodiesel offset Operational blending and distribution infrastructure for BD Blended BD mandated 50 % of the production use for domestic market 5 % of rural smalholder making use of Biofuel tech Improve loans access and conditions for farmers	10% BD, 5% BE offset Operational blending and distribution infrastructure for BE Blended BE mandated 10 % of rural smalholder making use of Biofuel tech Improve loans access and conditions for farmers	15% BD, 10% BE offset Improve loans access and conditions for farmers
4 Promote biofuel development 4.1 Identify suitable site for Jatropha, cassava and sugar cane plantation 4.2 Provide incentives to farmers 4.3 Improve access to financing, soft credit and loans 4.4 Provide incentive to producer 4.5 Encourage final consumer to use biofuel	Suitable area for Jatropha mapped	Suitable area for cassava / sugarcane mapped Viability of Jatropha cultivation improved Loans access and conditions improved Number of producers increased Set retail price	Number of smallholders cultivating Jatropha increased Number of producers increased 50% of diesel vehicles use BD	50% of vehicles use BF
Ensure the sustainability of biofuel development 5.1 Fund research and development 5.2 Engage in technology transfer from neighboring countries 5.3 Build extension service 5.4 Build local capacity 5.5 Enhance farmer rights, rural Development and poverty alleviation	Operational funding mechanisms Technology transfer initiated	Research coordinated Operational University curriculum in BF and partnership Operational extension service 50% smallholder trained Operational farm gate price mechanisms of regulation	Jatropha yield and BF applications improved 100% smallholder trained Operational farmer law organization	Biodiesel feedstock diversified

Annex 5: Volumetric targets to be met over the next 15 years

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Biodiesel offset target	0%	0%	0%	1%	1.5%	2%	3%	5%	7%	9%	10%	11%	12%	13%	14%	15%
Target of biodiesel offset produced from Jatropha	0%	0%	0%	1%	1.5%	2%	3%	5%	7%	9%	10%	10%	10%	10%	10%	10%
Volume Biodiesel required (Million liters)	0	0	0	4	6	8	13	23	34	45	53	56	59	61	65	68
Seed needed (Thousand tones)	0	0	0	14	22	31	48	84	124	167	195	205	215	226	237	249
Area required (Thousand hectares)	0	0	0	7	11	15	24	42	62	84	97	102	107	113	118	124
Target of biodiesel offset produced from alternative feedstock	0	0	0	0%	0%	0%	0%	0%	0%	0%	0%	1%	2%	3%	4%	5%
Volume Biodiesel required (Million liters)	0	0	0	0	0	0	0	0	0	0	0	56	117	184	258	339
Bioethanol offset target	0%	0%	0%	0%	0%	0%	0-5%	0-5%	0-5%	0-5%	5%	6%	7%	8%	9%	10%
Volume Biodiesel required (Million liters)	0	0	0	0	0	0	NA	NA	NA	NA	22	27	34	40	48	55
Indicator from BE production based only on cassava																
Cassava needed for 100% production(Thousand tones)	0	0	0	0	0	0	NA	NA	NA	NA	121	152	186	223	264	308
Area required (Thousand hectares)	0	0	0	0	0	0	NA	NA	NA	NA	6	7	9	11	13	15
Indicator from BE production based only on sugarcane																
Seed needed (Thousand tones)	0	0	0	0	0	0	NA	NA	NA	NA	310	391	479	575	679	792
Area required (Thousand hectares)	0	0	0	0	0	0	NA	NA	NA	NA	8	10	13	15	18	21
Combined biofuel offset target	0%	0%	0%	1%	1%	1%	2%	3%	4%	5%	8%	9%	10%	11%	12%	13%

It is very important to note that these figures assume no biofuel is exported from Lao PDR. If export of fuel or feedstock occurs the amount of fuel required will be significantly higher.

Annex 6: Biofuel Policy in the EU

The European institutions have been encouraging the development of renewable energy and particularly of biofuels for some time. The first proposal for a Directive allowed Member States, but did not oblige them, to reduce fuel duties on pure biofuels or biofuels blended into other fuels used for heating or transport purposes. In October 2003 the EU Directive on the Taxation of Energy was passed. It allows Member States to reduce fuel duties in proportion to the percentage of biofuels incorporated in the fuel, without the need for authorization from the EU's Council of Ministers.

The EU Directive on the Promotion of the Use of biofuels or other Renewable Fuels for Transport was passed in May 2003. The Directive sets indicative targets for the Member States, who have to reach a minimum share of biofuel use in the total petrol and diesel use for transport of 2% in 2005, of 5.75% in 2010 and of 10% in 2020. The percentages have to be calculated on the basis of energy content, whose conversion factors are also specified in Annex 1. The 2005 target was not met, and according to a study of the European Environmental Bureau it is unlikely that at EU level the target for 2010 will be met either. To allow the Member States to comply with the EU targets, the EU itself mandated them to build up the necessary legislation and it allowed for fuel duty concessions for the promotion of biofuel use.

Beside the biofuel directive two further support measures are relevant at EU level for the development of biofuels production: A tariff for bioethanol imports and a tax on biodiesel imports. Moreover within the Common Agricultural Policy the EU provides a specific area payment for crops used for energy generation with the Energy Crop Aid. 45 Euro/ha is paid for feedstock used for biofuels production and for those used for the Combined Heat and Power generation (CHP).

The European Commission aims to achieve 20% renewable energy by 2020. The mix of the sectors' share in reaching the overall target is left to the Member States' discretion, however by 2020 each Member State has to achieve a binding 10% minimum target for biofuel in transport. Without specific requirements biofuels would not be developed, as they are still more expensive to produce than other forms of renewable energy.

Support measures for biofuels

Given the high production cost of biofuels compared to fossil fuels and the need to modify infrastructure, transport and delivery systems it is unlikely that renewable fuels will prosper without public support from national governments.

A study from the OECD (2008) shows a classification of different examined and/or applied policy measures required to foster the development and use of renewable biofuel industries in OECD member countries. The study distinguishes measures affecting the production of biomass, measures affecting the conversion of agricultural feedstock into biomass for renewable fuels, measures affecting the distribution of biofuels and support measures for renewable fuels consumption.

The conversion of agricultural feedstock into biomass for biofuels

Some measures aim to reduce infrastructure costs. Governments can finance investment costs and give capital grants. Alternative approaches include a system for guaranteed loans underwritten by the state or capital grants exclusively allocated by the government to the firms owning a license. The direct reduction of production costs guarantees an amount of money to the upstream producer usually proportional to the amount of biomass produced. Another way is to guarantee a price that the biofuel distributor has to pay to producers of biofuel. The price can be fixed for a multi-year period or regularly adjusted. This guaranteed minimum price is also known in some cases as a "feed-in-tariff". In addition, quantitative requirements such as quota obligation schemes can be used to set the amount of fuel that must be produced from agricultural feedstocks or biomass.

Reduction of distribution costs

Measures can be used to affect the distribution of biofuels such as a fuel duty credit to biofuels blenders. Biofuels blenders pay fuel duty on the fuel supplied, then can claim tax credit for part of the biofuels supplied. A direct subsidy in the form of State Aid can also guarantee the distribution costs of biofuel. Government can require infrastructure quotas focused on distribution, i.e. to oblige petrol stations to sell a certain amount of biofuels.

Support measures for renewable fuel consumption can be a reduction of biofuels price compared to the price of the fossil fuels. To obtain this a fuel duty exemption for biodiesel and bioethanol is commonly used. Quantitative requirements can be set again here, a quota obligation scheme to set the minimum consumption of renewable fuels. It can be a minimum share target or a blending percentage under which biofuel users may

be required to consume a certain amount of renewable fuel with their total fuel purchases. In case of non-compliance to the set targets a penalty can be set.

Mix of policy instruments used

The targets of the biofuels directive the Member States used regulatory instruments, i.e. the stick, in the form of support measures affecting the distribution of biofuels; or economic instruments, i.e. the carrot, in the form of support measures to promote the consumption of renewable fuels. Regulatory instruments require distributors to supply minimum percentages of biofuels to the consumers. Its aim is to control and to raise demands of biofuels through quotas.

One type of economic instrument reduces biofuels prices compared to the price of fossil fuels through a fuel duty exemption or reduction. It is an economic instrument classified under the "in-cash" form, with a part or the total of the fuel duty being tax-exempted. In this way the cost of taking actions deemed valuable by the government is reduced, favouring these actions, but neither prescribing nor prohibiting them.

Evidence suggests the larger and the more continuous the fuel duty exemption is, the higher the biofuels share in the total fuels sold per year. However, this is not the case in the countries where a non-continuous fuel tax exemption has been in force. If the system of fuel duty incentives does not guarantee a long-term perspective to the companies aiming to produce biofuels, it is harder for them to make the investment needed to start biofuel production.

The high level of fuel duty on diesel and gasoline in the EU facilitates the use of duty reduction to support alternative fuels and technologies (Di Lucia & Nilsson, 2007). Germany and Italy begun with a total exemption from fuel duty for a determined product or a predetermined quantity, while the UK and Finland provided a duty reduction for a determined product. In the case of Finland the quota obligation system is implemented but no fuel duty reduction used. In practice, a regulatory instrument (the biofuels obligation) is added to the economic instrument, (fuel duty exemption). In doing so governments require infrastructure quotas focused on distribution. They oblige petrol stations to sell a minimum percentage of biofuels.

Finland, the UK and Italy have begun a quota obligation system to ensure that the EU biofuels target will be reached in 2010. It was hoped that the regulatory obligation would have a more direct effect than the market instrument. In fact, the level of duty reduction together with the uncertainty the measure has offered in each of the three countries has proved to be insufficient to reach the level of capacity and infrastructure requirements to meet the biofuel directive's targets. Higher level of fuel duty incentives would be too expensive, potentially causing unsustainable costs for public finances.

Moreover the European Commission had also indicated that higher levels of fiscal incentives could give rise to overcompensation risks as was the case in Germany, where overcompensation occurred. A quality obligation is predicted for Germany in 2009 specifying sustainability standards.