

Overview of energy development in Lao PDR

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Outline

- Introduction
- Energy sector Institutional framework
- Status of energy development
- Potential renewable energy from Agriculture sector
- Strategy development plan 2011-2025 and Vision 2030
- Summary and recommendation
- References

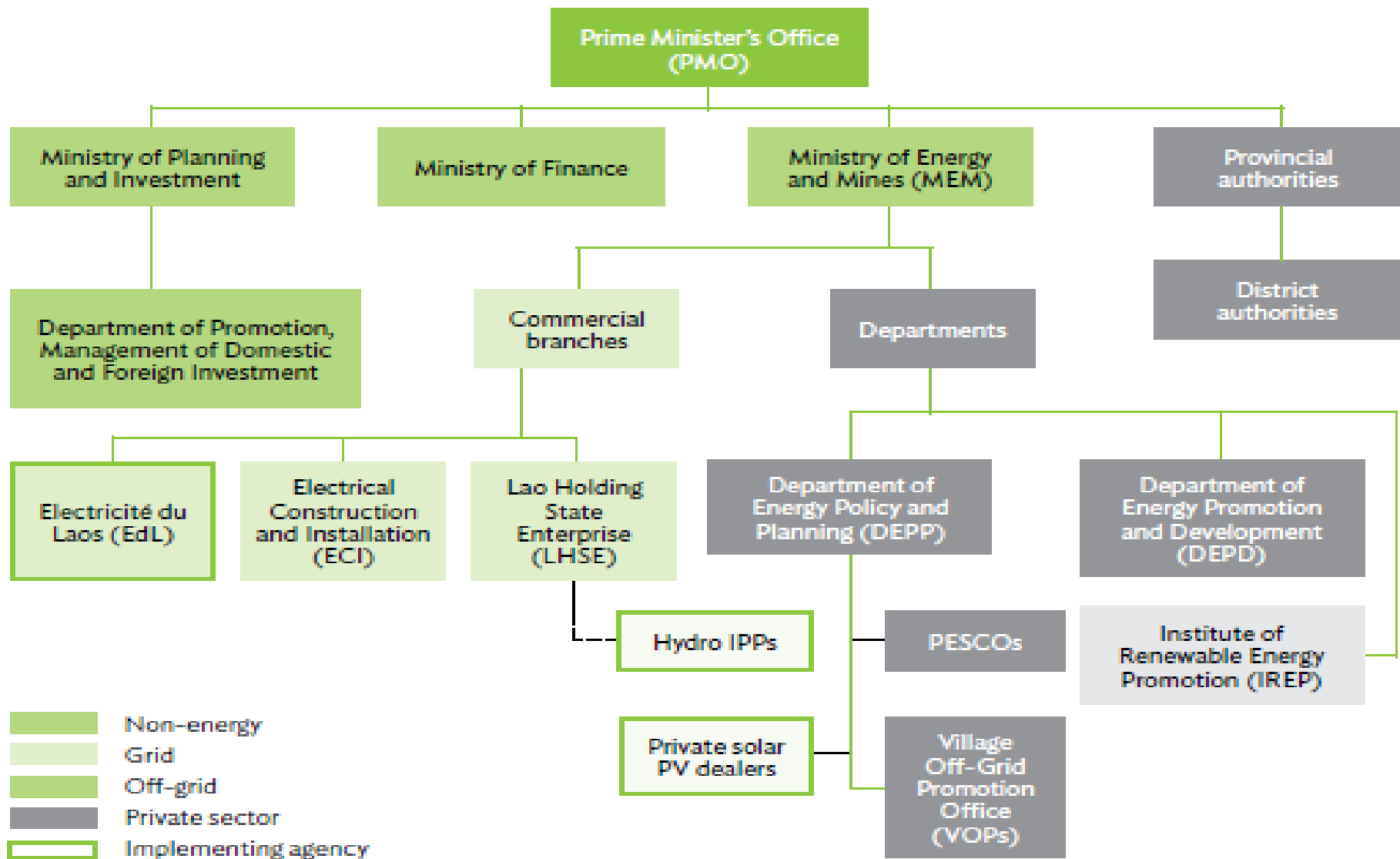


Introduction

- Terrain:
 - Land locked
 - > 70% mountainous
 - Area of 236,800 km²; more than 90% located in Mekong river basin.
- Population:
 - 6.5 million (2015)
 - >1.2 million HHs
 - 73% in rural areas
- Economic:
 - GDP 1,875 US\$/Capita (2015)
 - Ser. 38%, Ind. 32% , & Agri. 23% & (2014)
- Energy Resources:
 - Hydropower (18,000 MW potential, excluding Mekong river)
 - Solar and biomass



Figure 5.1: Energy Sector Institutional Framework: Lao PDR



IPP = independent power producer, Lao PDR = Lao People's Democratic Republic, PESCO = Provincial Electricity Supply Company, PV = photovoltaic.

Source: Modified from World Bank (2012).

Box 5.2: Role of Line Ministries in Promoting Renewable Energy: Lao PDR

Ministry of Agriculture and Forestry, in collaboration with the Ministry of Natural Resources and Environment and provincial governments, carries out participatory land use planning and local land use zoning related to biomass crop production. Its provincial, district, and village cluster representatives promote biofuel development and provide extension services in cooperation with the Ministry of Energy and Mines (MEM).

Ministry of Natural Resources and Environment does research into the use of water resources and collaborates with the MEM in addressing concerns about the environmental and social impact of renewable energy development.

Ministry of Science and Technology conducts research into, and pilot-tests, renewable energy applications developed by other countries.

Ministry of Industry and Commerce facilitates the import of equipment and seeds related to the development of renewable energy, and supports the construction of gas stations for the distribution of biofuels.

Ministry of Public Works and Transportation promotes the use of alternative fuels in vehicles, public transportation systems, and freight and air transport.

Ministry of Finance determines appropriate tax and duty policies for renewable energy projects and helps raise funds for renewable energy development.

Central Bank of Lao PDR provides credit and low-interest loans for renewable energy projects.

Ministry of Planning and Investment formulates investment policies and incentives to attract and facilitate domestic and foreign investment in renewable energy projects.

Ministry of Culture and Tourism helps the public to understand better the government's energy efficiency and renewable energy development policies.

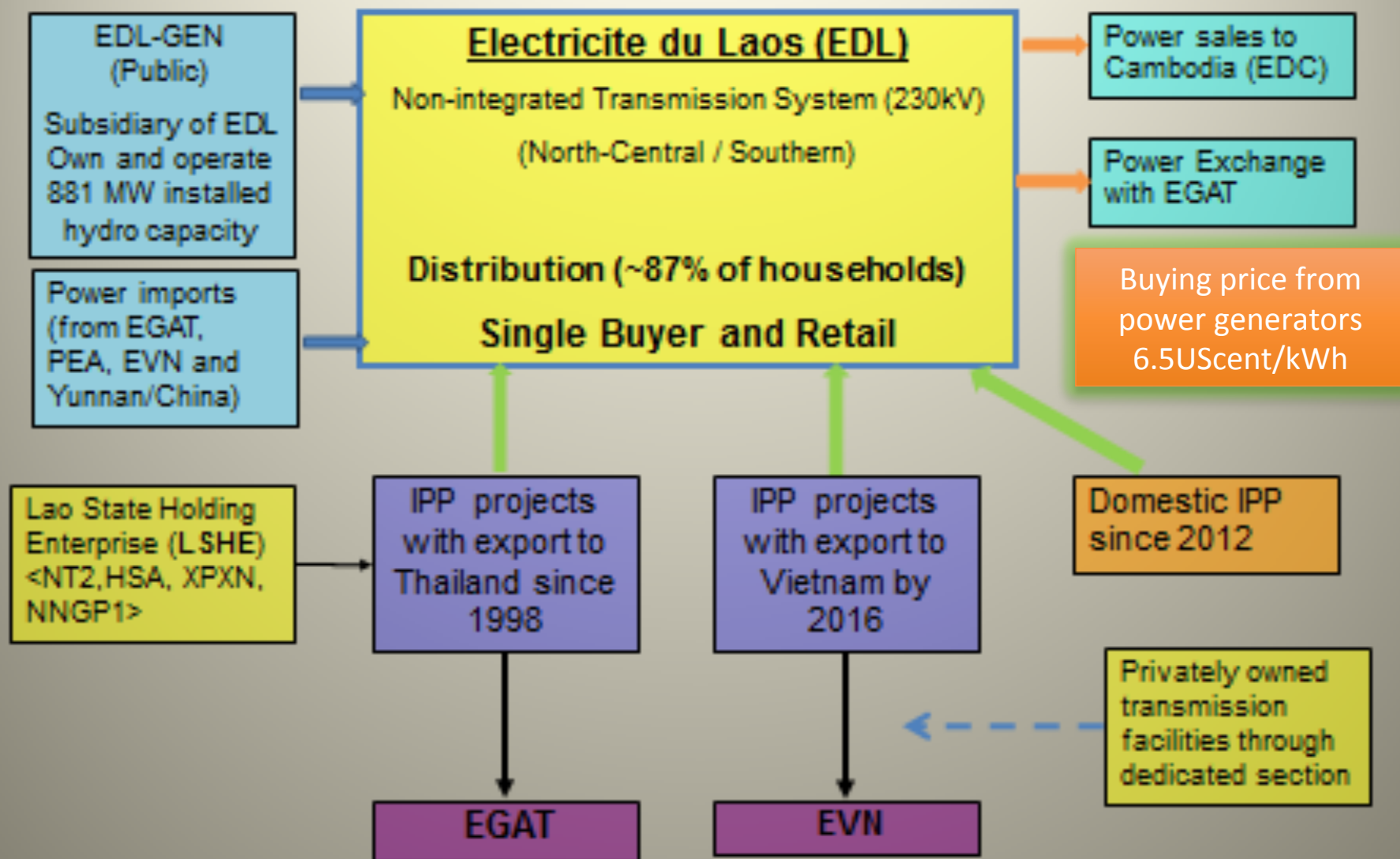
Ministry of Education and Sport encourages the development of the renewable energy curriculum and its integration into tertiary education.

Other sectors and provincial governments support the roles and responsibilities of these agencies.

Lao PDR = Lao People's Democratic Republic.

Source: IREP (2011).

Current Structure of Lao PDR Power Sector



Status of Energy

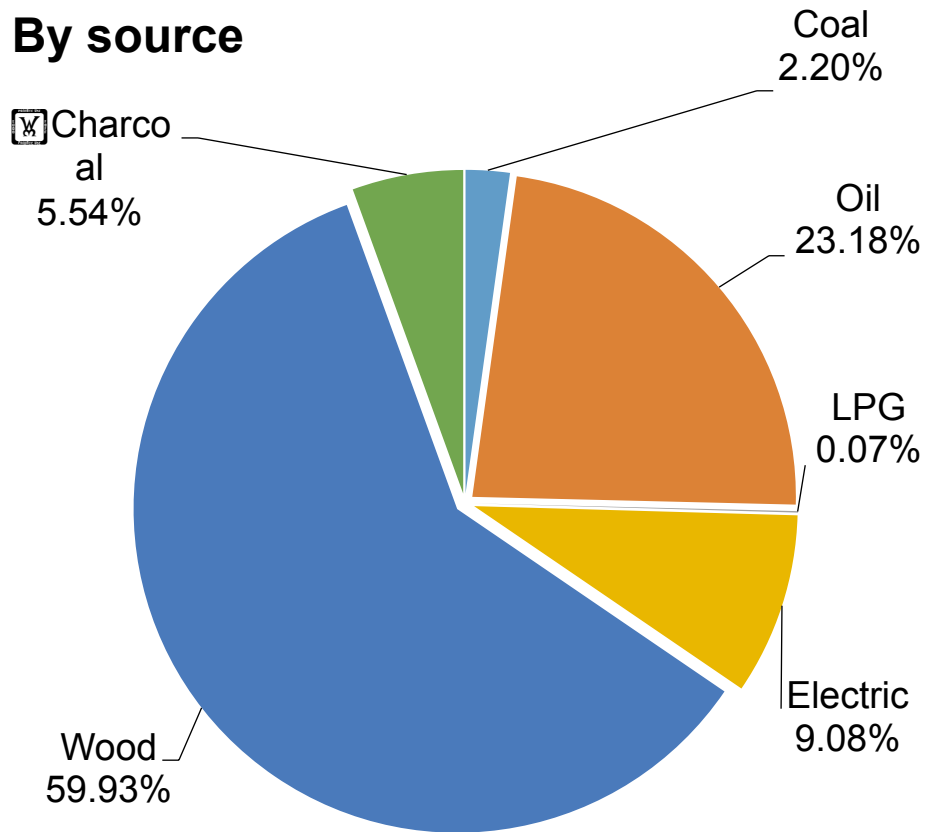
- Electrification ratio reached 80% or 1,060,413 households in 2012, increased from 19% in 1996;
- Per Capita Electricity Consumption of 470 kWh/a but has been growing at an average rate of more than 10% in the last 15 years;
- Electricity export ~ 15% of total country's export revenues; Power sector's contribution to GDP is projected to increase to ~16% in 2020;
- Installed capacity is 3,200 MW in 2012 and will be 12,500 MW in 2020, substantially all hydro and about 85% is planned for export;

Existing and Planned Projects (as March 2015)

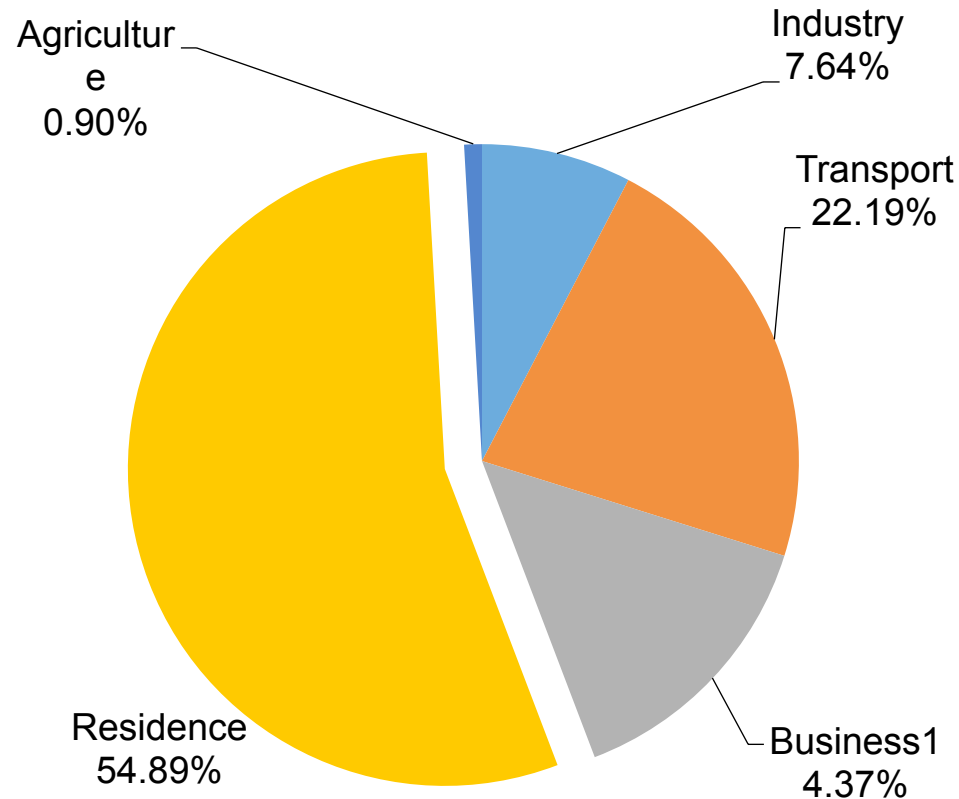
1. **27** hydro Projects in operation: **3,294MW** with energy output 15,887GWh
2. 2 Biomass power plants: **35MW** with 163GWh
3. **44** hydro + **1** thermal projects under construction: **6,185MW** with energy output 32,866GWh
4. **24** hydro projects under final preparation / negotiation and F/S: **1,642MW** with energy output 7,305GWh
5. Hydro potential in Laos is about 26,000 MW

Energy Consumption (2013): 2,556 KTOE

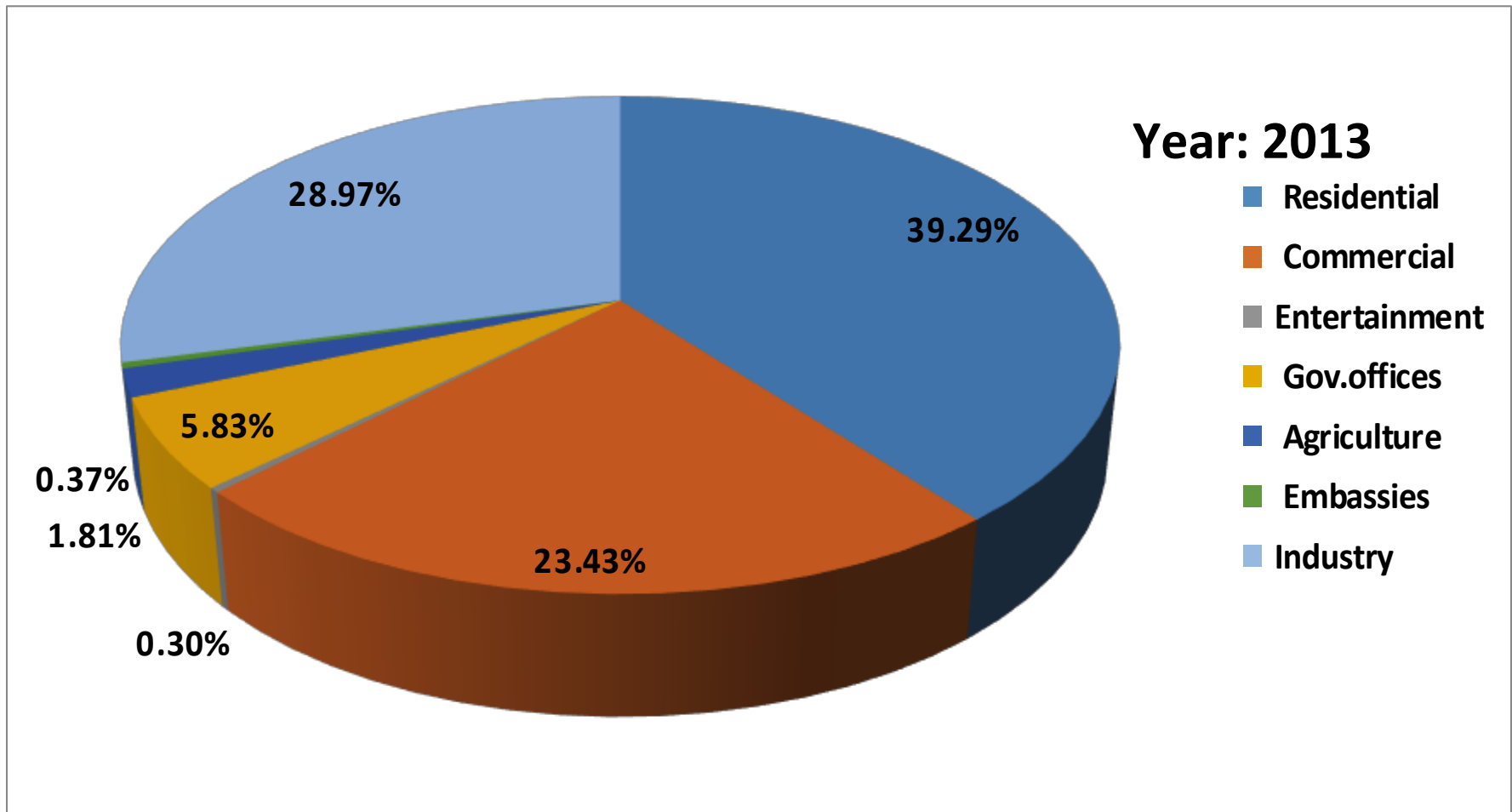
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By sector

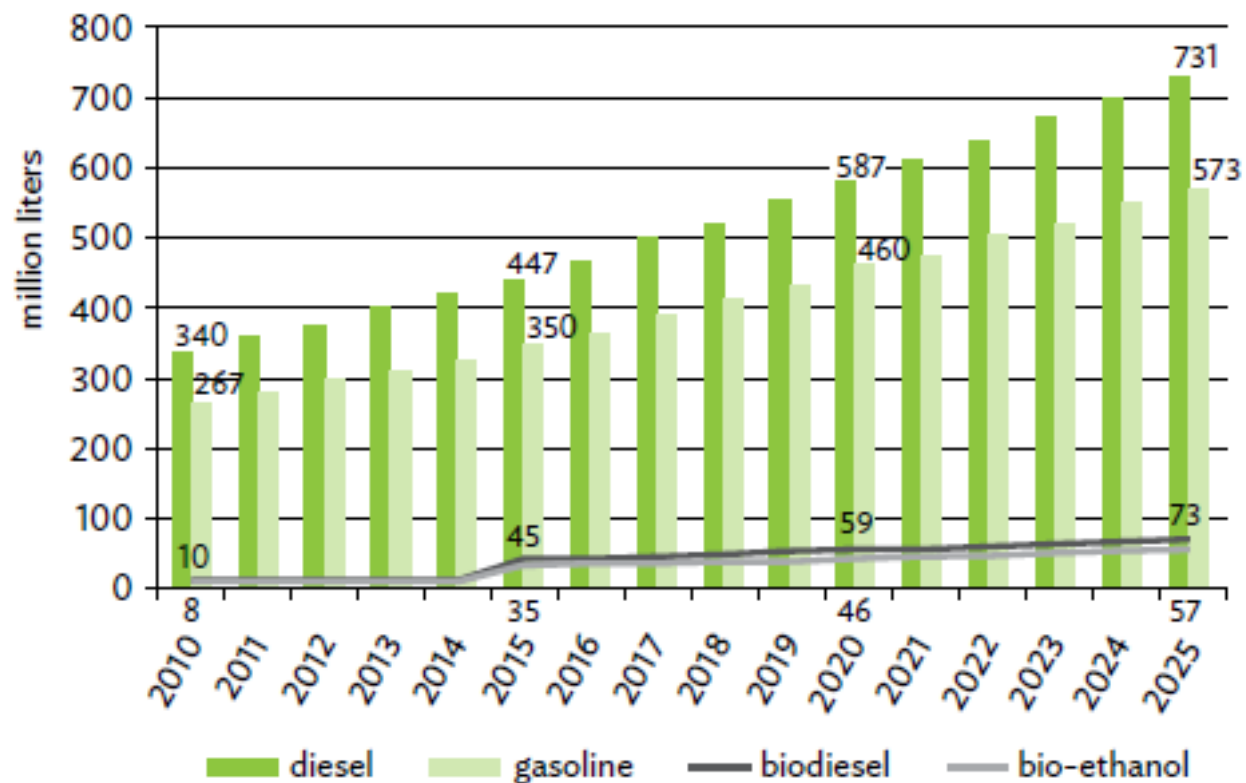


Power consumption by categories



During 2012, the residential sector accounted the biggest share in the total electricity consumption which was 39.2% (1,160 GWh), followed by commercial sector: 28.97% (800 GWh), Industry sector: 23.43% (681 GWh), Government's offices: 5.83% (173 GWh)...

Figure 5.3: Transportation and Biofuel Demand Projections: Lao PDR



Source: NSDTA (2011).

DEVELOPMENT TREND

- Energy demand increase at 3.6% a year (1.8 MTOE in 2005 → 3.9 MTOE in 2025)
- Traditional Biomass Consumption (Fuel Wood, Charcoal) declines from 77.8% in 2005 and 38.5% in 2025
- Energy demand in industrial sector increase at 8% a year, from percent share 6.1% in 2005 and 17% in 2025
- Transportation sector grows at 6.8%. Fuel demand increase 5% a year which reach 1,174 million liters in 2025 (45% gasoline).

GOL POLICY APPROACHES

- **PRIORITY TO ALTERNATIVE/RE ENERGY DEVELOPMENT FOR: SOCIAL ASPIRATIONS AND MICRO/ MACRO ECONOMIC DEVELOPMENT;**
- **MAINTAIN AND EXPAND AN AFFORDABLE, RELIABLE AND SUSTAINABLE ENERGY SUPPLY; AND**
- **PROMOTE ENERGY FOR EXPORT TO GENERATE REVENUE TO MEET DEVELOPMENT OBJECTIVES**

OBJECTIVES OF RE STRATEGY

1. ADEQUATE ENERGY SUPPLY:

- Promote cultivation of fuel crops
- Production of bio-fuel as main energy (reduce imported fossil fuels)

2. BENEFITS FOR NATIONAL ECONOMY:

- Improve production;
- Increase income generation;
- Develop the renewable energy industry; and
- Create more employment opportunities .

OBJECTIVES (CONTD)

3. POVERTY ERADICATION

- ensure social equality and enhance the equality of all ethnic groups
- decrease the disparity between those rural and urban people, and
- promote gender equality, especially for women in rural areas

4. ENVIRONMENTAL PROTECTION:

- protect the environment
- reduce green house effects by replacing non-renewable energy with renewable and alternative sources.

Renewable Energy Development Plan 2010-2025

Short-Term: 2010-2015

- Develop legal documents (laws, regulations and guidelines);
- Study development models;
- Market assessment and energy source studies
- Integrated rural energy planning;
- Develop model projects, capacity building and raising awareness on renewable energy technology;
- Financing and marketing at both national and local levels.

Renewable Energy Development Plan 2010-2025 (CONTD)

Mid-Term: 2016-2020

- Formulate a **clear framework** for a midterm program (through focus on increased competition)
- Support the **full development** of renewable energy: biodiesel and bio-ethanol production from crops, production of biomass, biogas for household use and industrial purposes at community level;
- **Increased competition** and reduced dependency

Renewable Energy Development Plan 2010-2025 (CONTD)

Long Term: 2021-2025

- Promote new, economically viable, renewable energy technologies and encourage full competition based on equality;

Renewable Energy Development Plan



Financial Incentive for Investors

Renewable Energy Strategy Development (2011-2025)

Develop and Modify Legal documents (laws, regulations and guidelines)



Target: increase RE use to 30 % (of national demand) by 2025 (bio-fuel production to account 10 %)

Solar+ Wind		SHP	Bio-Energy			Biofuels (ML)	
106 MW			Biomass	Biogas	Waste	Ethanol	150
Solar	33 MW	400 MW	58 MW	51 MW	36 MW	Biodiesel	300
Wind	73 MW		113 ktoe	178 ktoe	-		

Table 5.1: Renewable Energy Targets: Lao PDR

Renewable Energy Types	Potential	Existing	2015		2020		2025	
	MW	MW	MW	ktoe	MW	ktoe	MW	ktoe
Electricity			140		243		728	416
Small hydropower	2,000	12	80	51	134	85	400	256
Solar	511	1	22	14	36		33	21
Wind	>40		6	4	12	23	73	47
Biomass	938		13	8	24	8	58	37
Biogas	313		10	6	19	16	51	33
Solid waste	216		9	6	17	12	36	23
Geothermal	59					11		
Biofuel	ML	ML	ML		ML		ML	
Ethanol	600		10	7	106	178	150	279
Biodiesel	1,200	0.01	15	13	205	239	300	383
Thermal Energy	ktoe	ktoe						
Biomass	227			23		29		113
Biogas	444			22		44		178
Solar	218			17		22		109
Total								
Energy demand (ktoe)				2,504		4,064		4,930
Renewable energy contribution				172		668		1,479
Proportion				7%		20%		30%

ktoe = kilotons of oil equivalent, Lao PDR = Lao People's Democratic Republic, ML = million liter, MW = megawatt. Source: IREP (2011).

BENEFITS

Economic

- reduction of fossil fuel imports;
- promotion of private sector investments;
- creation of employment opportunities in related industries
- generation of added income through carbon financing
- reduction of public investments
- increased economic growth from development of the industrial biofuels sector.

BENEFITS (CONTD)

Social

- additional job opportunities in rural areas resulting in less migration into cities;
- improvement in living standards.

Environment

- reduced emissions of environmental pollutants
- reduce emission of green house gases.

IMPLEMENTATION MEASURES

1. INSTITUTIONAL ARRANGEMENT

- Ministry of Energy and Mines (MEM)
- Ministries Concerns;
- Local Authorities

2. Driving Measures To Kick-start Short Term Implementation

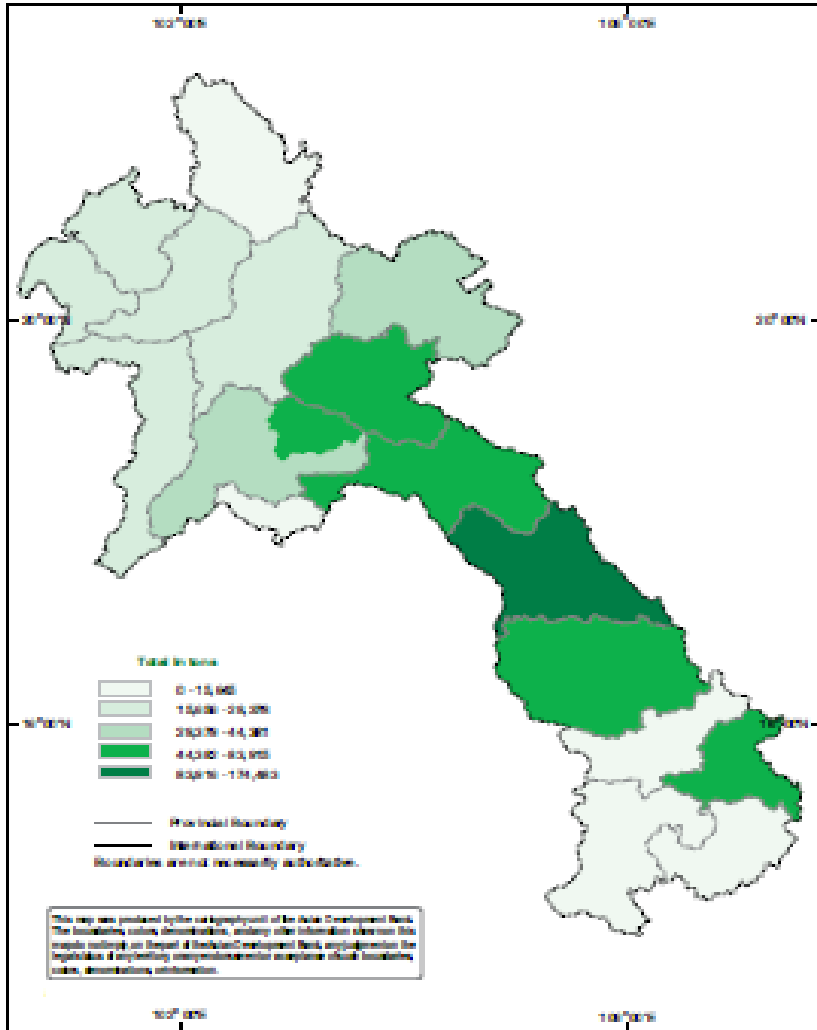
- Identify promotion policies (Establish appropriate incentive policies)
- Promotion on research and studies
- Human resource capacity building, awareness raising and public relations

IMPLEMENTATION MEASURES (CONDT)

3. Important Factors For Successful Implementation

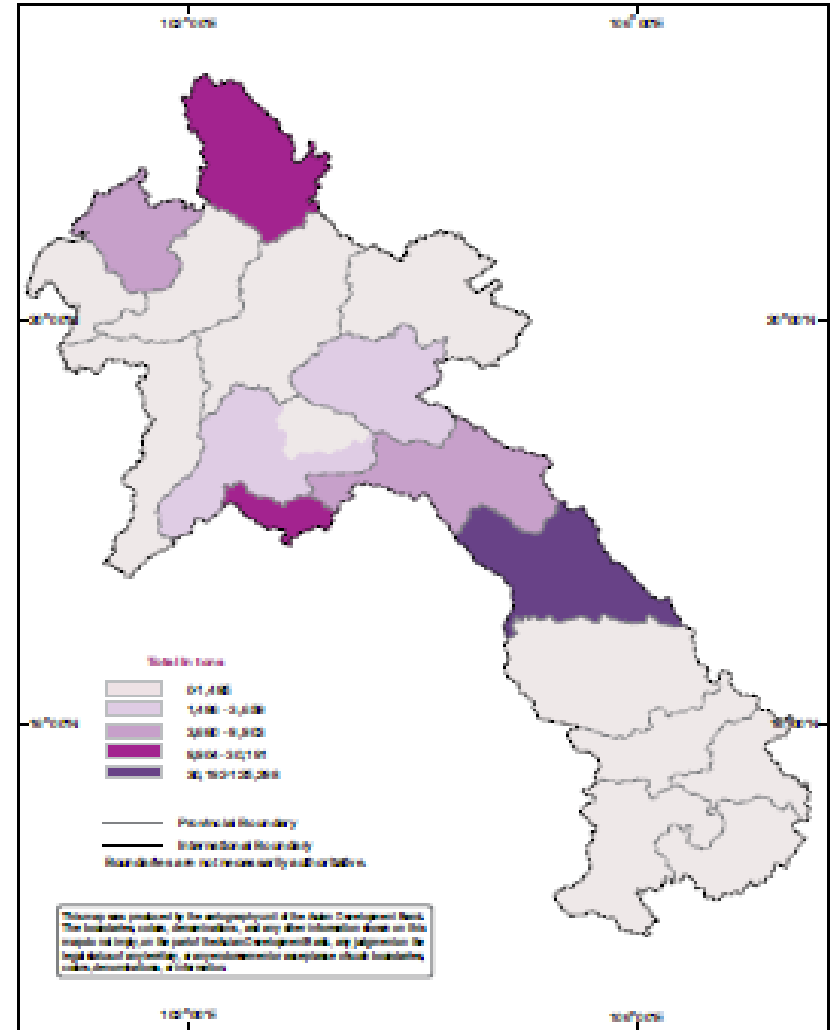
- Define renewable energy into national agenda (integrated into socio-economic development plan of the government...);
- Financial Appropriate Policy (Feed in Tariff, Risk Warranty, Loans, Taxes...)

Rice Husk Production, 2010



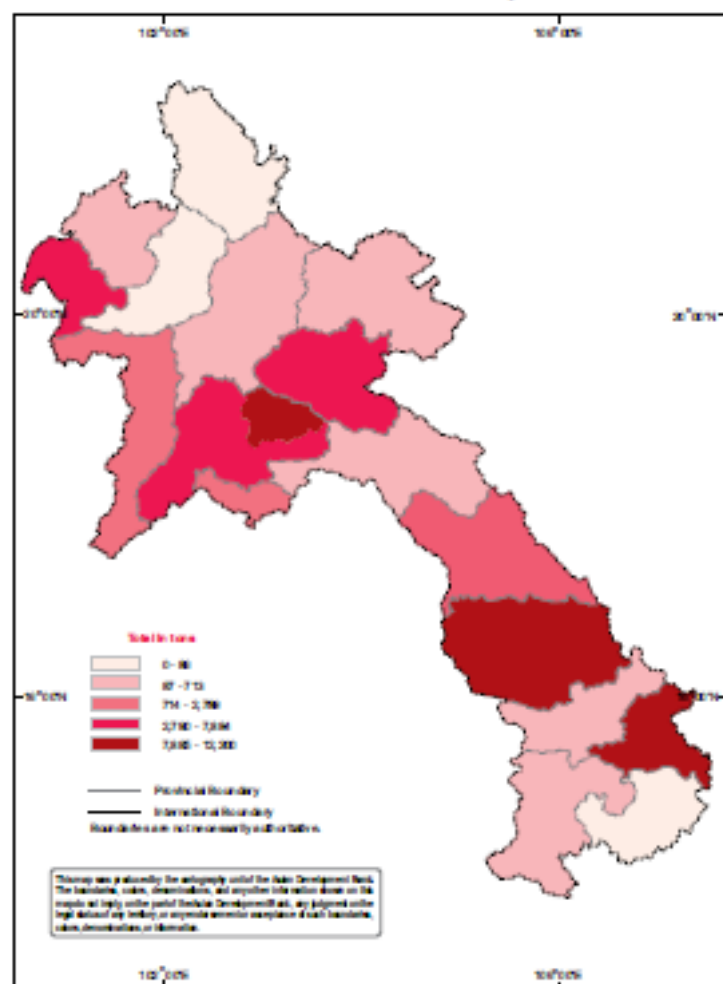
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Sugar Cane Bagasse Production, 2010



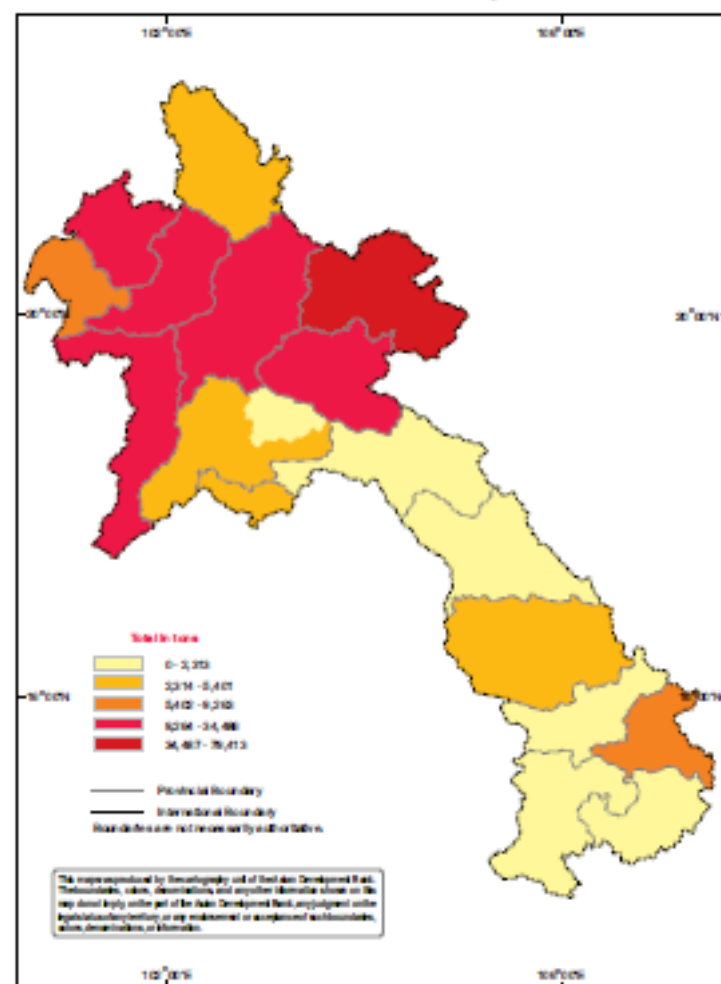
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Cassava Stalk Production, 2010



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Maize Cob Production, 2010



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Table 5.4: Theoretical Biomass Energy Potential of Agricultural Residues: Lao PDR

Biomass Residue	Total Yearly Biomass Production (10³ tons)	Total Theoretical Energy Potential (10⁶ GJ)	Total Theoretical Energy Potential (GWh)
Rice husks	767	9.86	2,740
Rice straw	1,013	6.12	1,700
Maize or corn cobs	255	3.66	1,017
Cassava stalks	64	0.44	123
Sugarcane tops and trash	247	1.66	462
Sugarcane bagasse	205	1.32	366

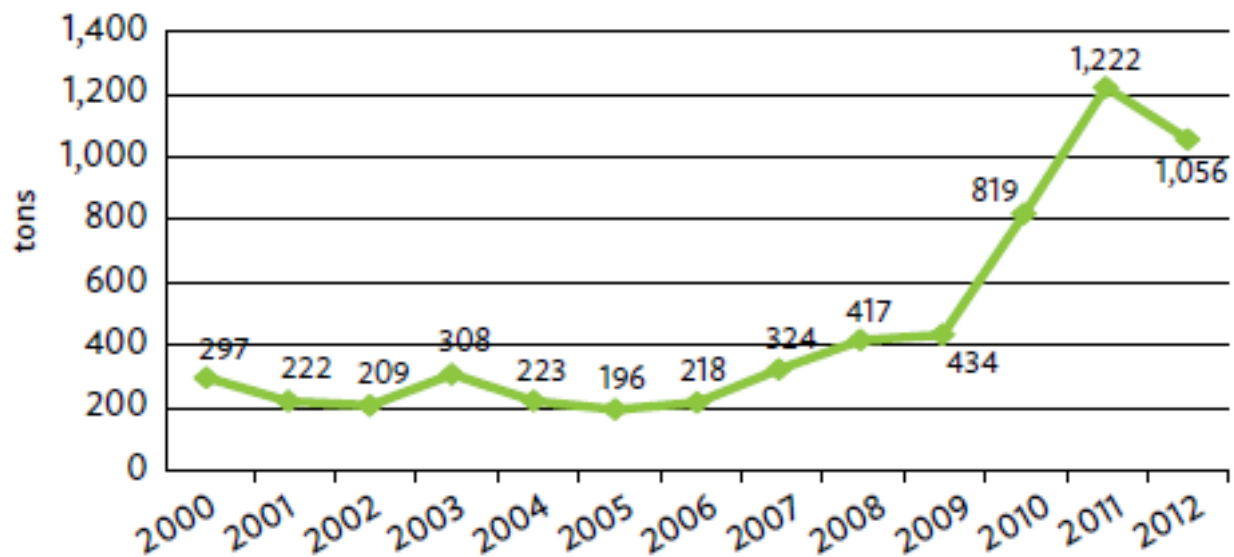
GJ = gigajoule, GWh = gigawatt-hour, Lao PDR = Lao People's Democratic Republic.

Source: MAF (2010); Author's calculations.

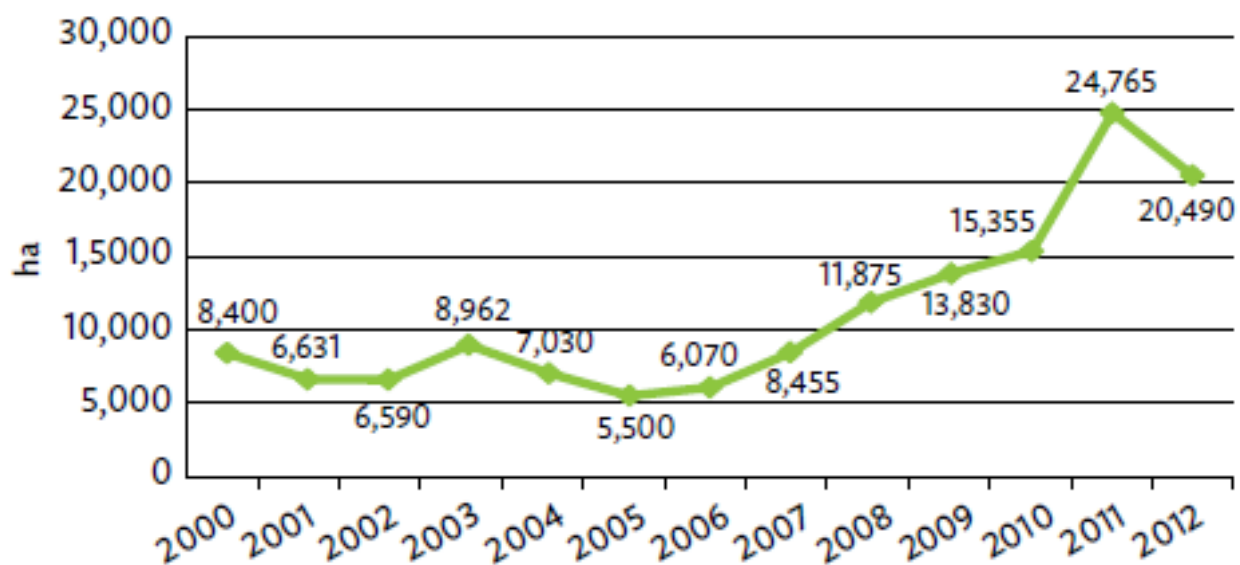
Table 5.5: Projected Land Requirements for Jatropha and Biodiesel Production: Lao PDR

Item	2015	2020	2025
Projected diesel demand (million liters)	447.00	587.00	731.00
10% biodiesel requirement (million liters)	44.66	58.65	73.09
Conversion factor: crude oil to biodiesel	0.94	0.94	0.94
Required Jatropha crude oil (million liters)	47.52	62.40	77.76
Kg/liter density of crude oil	0.92	0.92	0.92
Required Jatropha crude oil (thousand tons)	43.71	57.40	71.54
Extraction ratio (technology)	0.90	0.90	0.90
Jatropha seed oil content	0.35	0.35	0.35
Jatropha seed requirement (thousand tons)	138.77	182.23	227.10
Average Jatropha seed yield (tons per hectare)	2.00	2.00	2.00
Land requirement (thousand hectares)	69.00	91.00	114.00

Sugarcane Production



Area Planted to Sugarcane



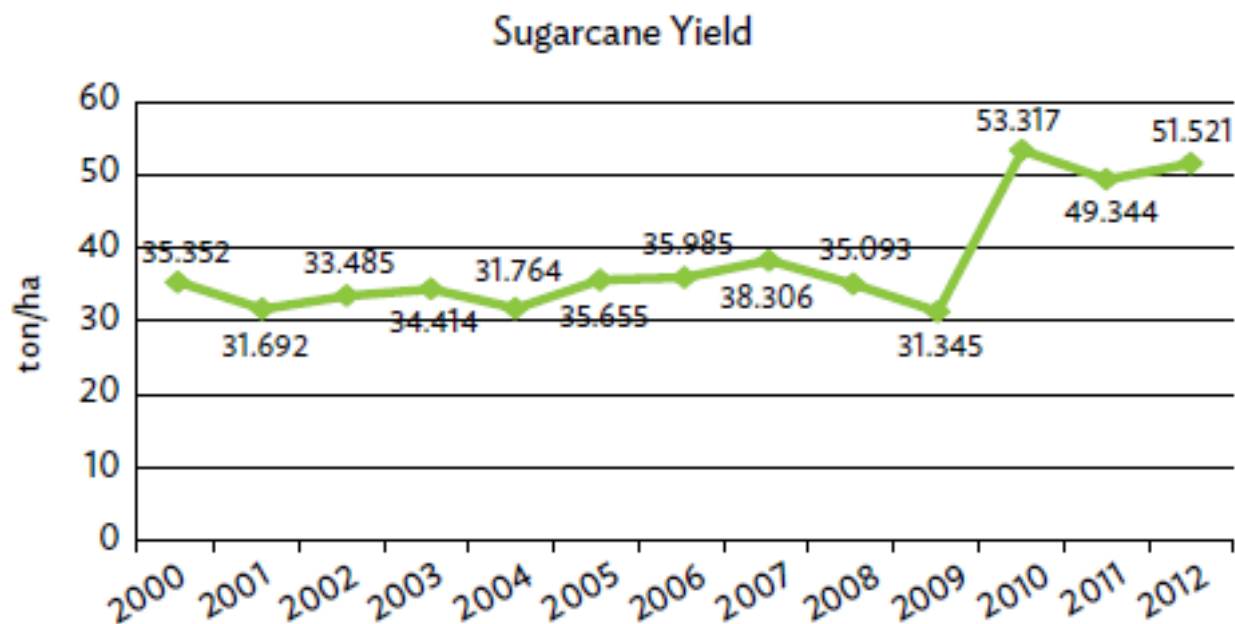


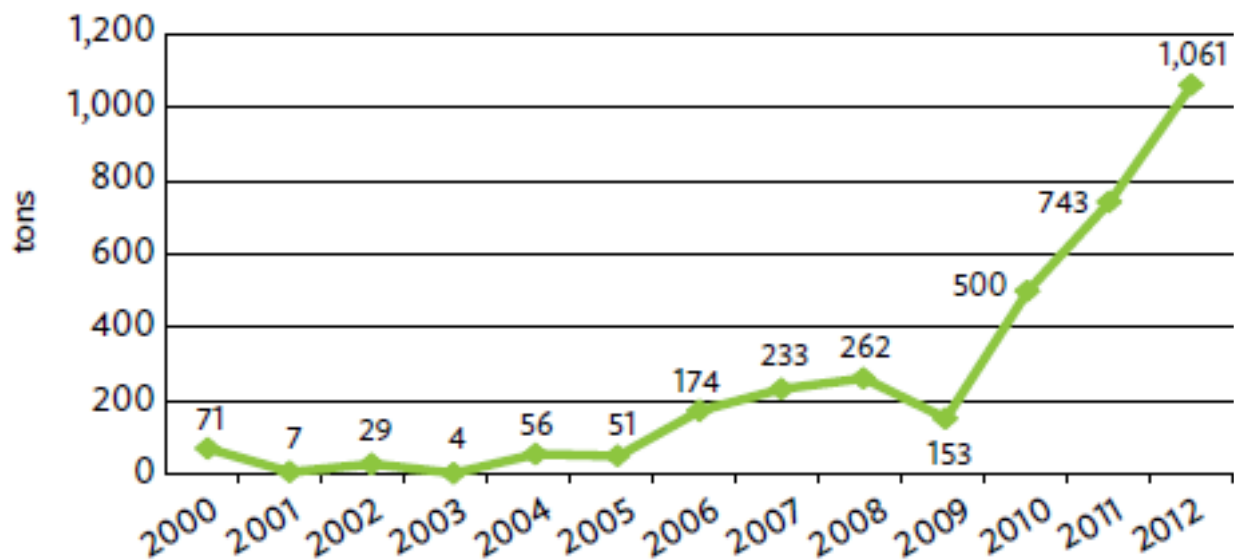
Table 5.6: Sugarcane and Bio-Ethanol Target Requirements: Lao PDR

Item	2015	2020	2025
Gasoline demand (million liters)	350.42	460.16	573.45
10% bio-ethanol requirement (million liters)	35.04	46.02	57.34
Conversion factor (kg sugarcane/liters ethanol)	15.00	15.00	15.00
Million kg of sugarcane	525.64	690.25	860.17
Average sugarcane yield (tons per hectare)	50.00	50.00	50.00
Land requirement (hectares)	10,513.00	13,805.00	17,203.00

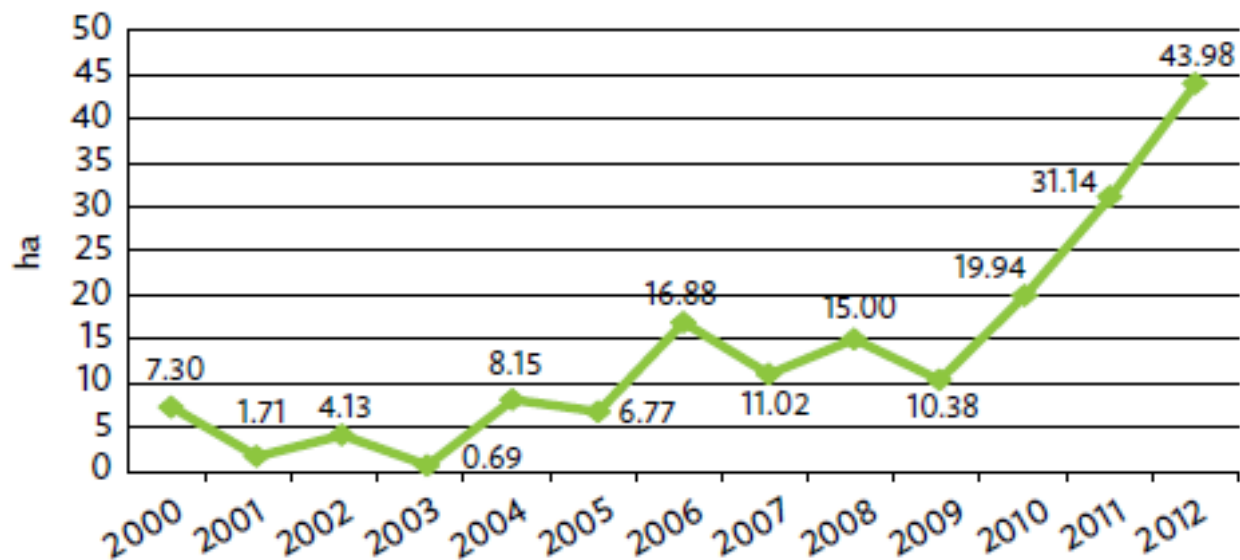
kg = kilogram, Lao PDR = Lao People's Democratic Republic.

Source: Authors' calculations.

Cassava (Starchy Roots) Production



Area Planted to Cassava



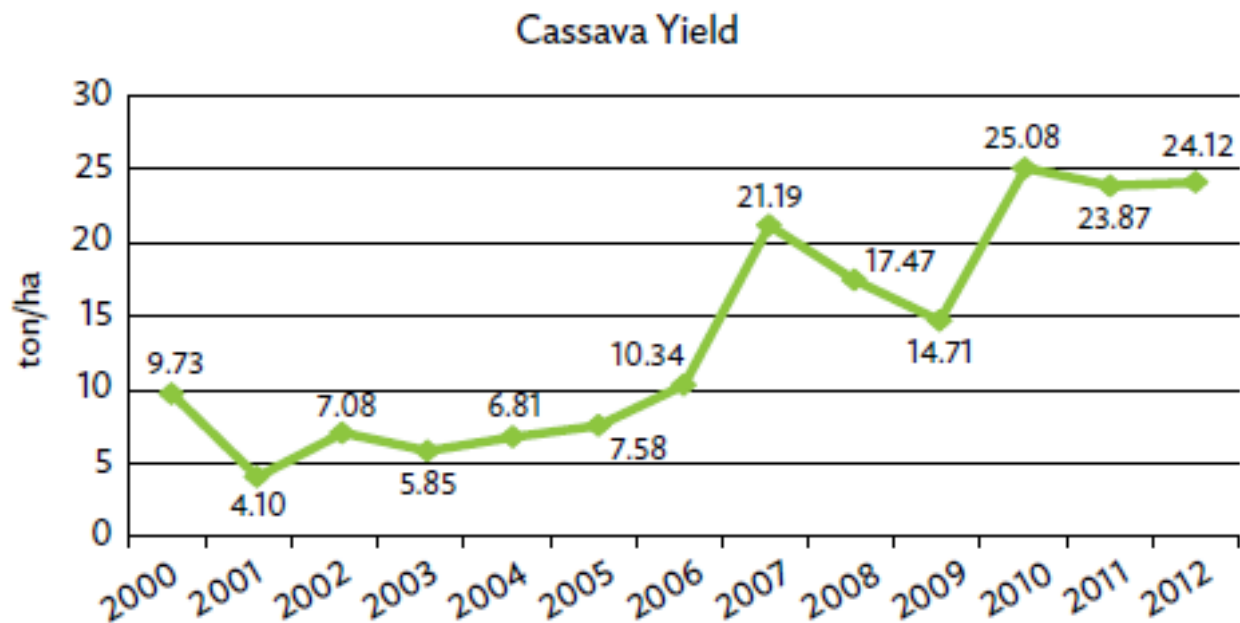


Table 5.7: Projected Land Requirements for Cassava and Bio-Ethanol Production: Lao PDR

Item	2015	2020	2025
Gasoline demand (million liters)	350.42	460.16	573.45
10% bio-ethanol requirement (million liters)	35.04	46.02	57.34
Conversion factor (liters ethanol/tons cassava)	180.00	180.00	180.00
Million tons of cassava	0.19	0.26	0.32
Average cassava yield (tons per hectare)	21.00	21.00	21.00
Land requirement (hectares)	9,270.00	12,174.00	15,171.00

Lao PDR = Lao People's Democratic Republic.

Source: Authors' calculations.

Figure 5.6: Livestock and Poultry Production: Lao PDR

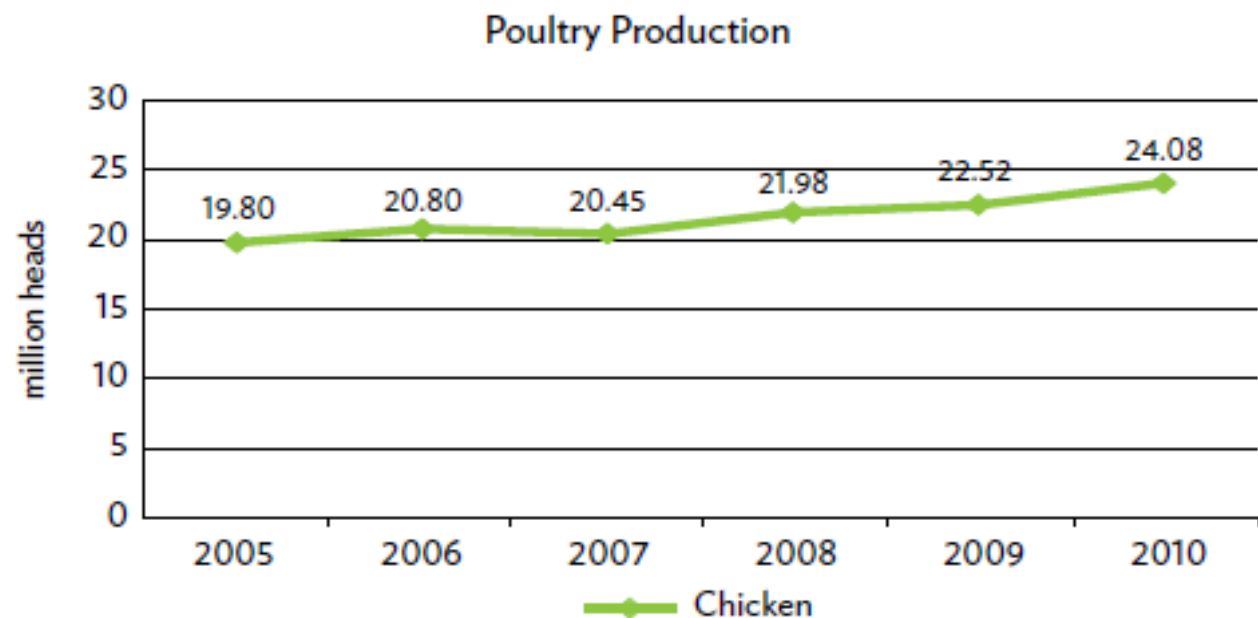
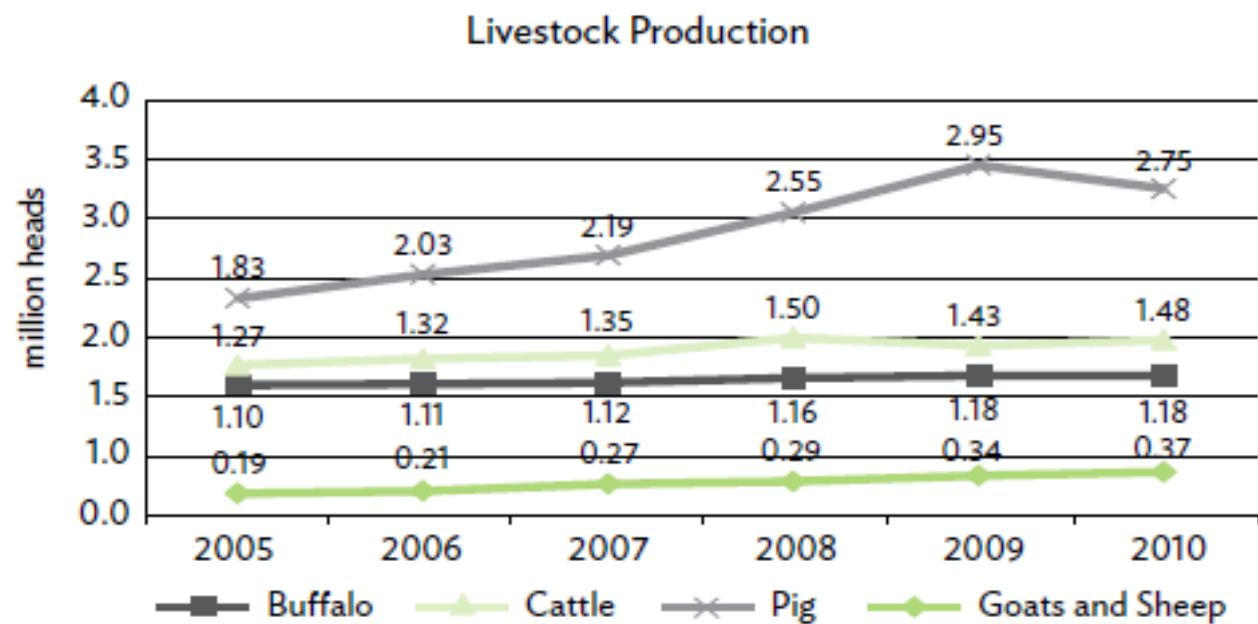


Table 5.8: Theoretical Biogas Energy Potential: Lao PDR

Livestock	2010 Production (million heads)	Daily Manure Production Factor (kg/animal)	Substrate Quantity (kg/day)	Dry Matter Factor (%)	Total Dry Matter Available (kg/day)	Mean Biogas Yield Factor (m ³ /kg dry matter)	Daily Biogas Production (m ³ /day)
Buffalo	1.183	8.00	9,464,000	16	1,514,240	0.250	378,560
Cattle	1.475	8.00	11,800,000	16	1,888,000	0.250	472,000
Pigs	2.752	2.00	5,504,000	17	935,680	4.200	3,929,856
Chicken	24.078	0.08	1,926,240	25	481,560	0.575	276,897
Total							5,057,313

kg = kilogram, Lao PDR = Lao People's Democratic Republic, m³ = cubic meter.

Source: Authors' calculations.

Table 5.9: Biodigester Volumes and Daily Feed Rates: Lao PDR

Item	Digester Volume (m ³)			
	4	6	8	10
Daily dung ^a requirement (kg)	20–40	40–60	60–80	> 80
Daily gas production (m ³)	0.8–1.6	1.6–2.4	2.4–3.2	> 3.2

kg = kilogram, Lao PDR = Lao People's Democratic Republic, m³ = cubic meter.

^a Based on a hydraulic retention time of 40 days, type of manure.

Source: Author's calculations.

Table 5.10: Technical Biogas Energy Potential: Lao PDR

Livestock	Total No. of Households	Ave. No. of Animals per Household	Daily Manure Production Factor (kg/animal)	Substrate Quantity (kg/day)	Dry Matter Factor (%)
Buffalo	123,728	6.8	8	6,839,603	16
Cows	156,152	6.8	8	8,494,669	16
Pigs	66,725	8.5	2	1,134,325	17
Total				16,484,597	

Livestock	Net Dry Matter Available (kg/day)	Mean Biogas Yield Factor (m ³ /kg dry matter)	Daily Biogas Production (m ³ /day)	Energy Content per Day (kWh/m ³)
Buffalo	1,094,337	0.25	273,584	1,641,505
Cows	1,359,147	0.25	339,787	2,038,721
Pigs	192,835	4.20	809,908	4,859,448
Total	2,646,319		1,423,279	8,539,674

kg = kilogram, kWh = kilowatt-hour, Lao PDR = Lao People's Democratic Republic, m³ = cubic meter.

Note: Number of households based on 1998/99 census; total number includes only those with three or more livestock heads for buffalo and cattle, and above 10 heads for pigs.

Source: Authors' calculations.

ROAD MAP

Road Map for implementing up to 2025

- Promotion and Development of Biodiesel- B10
- Promotion and Development of Bio-ethanol - E10
- Promotion and Development of Small Hydropower-
 - Introduce simplified procedures for small hydropower below 15 MW.
 - Provide financial incentives to small hydropower investors
- Upscale grid connected solar PV program.
- Upscale medium and large scale biogas systems.
- Develop biomass-based IPPs.
- Develop Wind IPPs- Target development of 50 MW by 2025.

Vision 2030 of the Power Sector

1. Developing all potential renewable resources available based on competitiveness, sustainability and efficiency;
2. Promoting the power interconnection with the region by harmonizing and strengthening the national power grid;
3. Ensuring the reliable supply to all sectors in line with the industrialization and modernization policy.

SUMMARY AND RECOMMENDATIONS

- Renewable Energy Development should focus on simple appropriate technology and utilize existing potential in country: Hydropower, Solar, Biomass, Wind Power;
- Create appropriate promotion policy and incentives for attracting investments;
- Provide investment risk warranty through a Renewable Energy Fund;

SUMMARY AND RECOMMENDATIONS (CONTD)

- Encourage people to participate in the development, production, use and management;
- Establish standard prices of renewable energy, which correspond to economic and technological conditions;
- Support research and development of renewable energy through the allocation of a budget and cooperation with stakeholders or donors;
- Collaborate with stakeholders to amend laws/regulations that facilitate the investment in renewable energy.

References

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