Mission Report
Energy Scoping Myanmar

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Part I: SCOPING MISSION REPORT

1 Background of the Scoping

The EU Energy Initiative - Partnership Dialogue Facility (EUEI PDF) is an instrument developed and funded by a number of EU member states and the European Commission in the context of the EU Energy Initiative (EUEI). The overall objective of the EUEI PDF is to support partner countries and regions across Africa, Southeast Asia, Latin America and the Pacific in developing policies and strategies for the promotion of access to energy.

Since early 2011, Myanmar has shown noticeable signs of potentially moving away from the authoritarian rule. The government has committed itself to reforms and some significant steps have been taken already. Furthermore, several European countries have recently sent high-level delegations to Myanmar, pledging their support to the political, social and economic development of the country. These changes are opening up new prospects for development cooperation between Europe and Myanmar – potentially also in the energy sector.

Several countries and international organizations have started preliminary scoping activities. The United Nations Development Programme UNDP has undertaken an energy sector scoping which is scheduled for completion by May 2012. EUEI PDF has had discussions with the energy unit of the UNDP Regional Centre. Both parties agreed that an initial scoping would be timely and that synergies should be used to the fullest in order to allow for successful future donor coordination for a general scoping of the energy sector in Myanmar. Given the low access rate to modern energy services and the high dependency on biomass for cooking energy EUEI PDF and UNDP deemed it useful to provide additional expertise to the general scoping in order to undertake more in-depth analysis on energy access issues in general and biomass energy issues in particular.

The objective of the scoping mission therefore is to establish a sound information basis for future (donor) activities in Myanmar from an energy sector policy perspective, to identify possible areas of intervention, and to contribute to successful donor coordination. Recommendations for potential future support of EU member states to Myanmar's energy sector shall be provided and possible, early stage activity options for the EUEI PDF in Myanmar be identified.

The present document reports on the Scoping Mission in Myanmar, undertaken by EUEI PDF in cooperation with UNDP in the period from 22.04.-03.05.2012. The scoping consisted of the following core steps:

- Preparatory analysis of documents & identification of stakeholders
- Meetings[1] with representatives of parliament, ministries, NGOs, private sector & international organisations
- Field visit

The assessments and findings drawn from the extensive literature analysis, the more than 20 meetings, and the field visit are presented as consolidated tables on "fact & figures" and "SWOT-analysis" complemented by short texts. Recommendations for potential future development interventions are provided in the form of separate "Option Papers".

[1] The mission schedule as well as the contact details of stakeholders met are provided in Chapter 6.

Although a high degree of care has been exerted in collecting, analysing and presenting information and deriving recommendations in this report, it should be noted that this is based on very few insights only. In Myanmar's past, energy access issues had not been subject to intense assessments and external reviews. Thus, quantitative data found in the few available documents often appears inconsistent or shows large variance. Even though this data was plausibility checked during the scoping mission to the extent possible, there remains a significant level of uncertainty. The report should therefore rather be considered as a base for further assessment and dialogue than for ultimate decision making.

2 Country Overview

The Republic of the Union of Myanmar (Myanmar) has a population of about 60 million. Population figures are rough estimates, the last partial census was taken in 1983. Myanmar which is geographically the largest country in mainland Southeast Asia has a population density of 75/km², one of the lowest in Southeast Asia.

Graph 1: Map of Myanmar

Source: EIU 2012

As of February 2011, the country constituted of 14 states and regions, 67 districts, 330 townships, 64 sub-townships, 377 towns, 2,914 wards, 14,220 village tracts and 68,290 villages.

Myanmar shares borders with Bangladesh, India, China, Laos and Thailand and has 1,930 kilometres of coastline along the Bay of Bengal and Andaman Sea. Three mountain ranges run north-to-south from the Himalayas and divide Myanmar's three river systems, which are the Irrawaddy, Salween (Thanlwin), and the Sittaung rivers. Fertile plains exist in the valleys between the mountain chains. The majority of Burma's population lives in the Irrawaddy valley, which is situated between the Rakhine Yoma and the Shan Plateau. Myanmar lies in the monsoon region of Asia, with its coastal regions receiving over 5,000 mm of rain annually.

Annual rainfall in the delta region is approximately 2,500 mm, while average annual rainfall in the Dry Zone is less than 1,000 mm. Northern regions of the country are the coolest, with average temperatures of 21 °C. Coastal and delta regions have an average maximum temperature of 32 °C.[2]

Table 1: Facts & Figures - Country Background

Facts & Figures - General	
Population	Total : 60,62 mln (ADB, 2011) Yangon: 5 mln Mandalay: 1.4 mln Rural: 66 % (2010 estimate)
Land area	676,563 km²
Ethnic groups (official estimates yr. 2005)	Burmese (68%), Shan (9%), Kayin /Karen (7%), Rakhine (4.2%), Mon (2.6%), Chin (2.0%), Kachin (1.4%), Karenni/Kayinni (0.4%) , others incl. Chinese & Indians (5.7%)
HDI	Rank 147 (out of 187 countries; value = 0.483; HDR 2011)
Corruption perception	Rank 180 (out of 182 countries; CPI 2011)
GDP/capita	855 US$ (current prices; IMF 2012 estimate) 1,394 US$ (power purchase parity; IMF 2012 estimate)
Econ. growth projection	4.9% p.a. (2012-13) ; 6.5% p.a. (2014-16)

Source: as stated in table; others: Munzinger 2011, EIU 2012.[3]

Agriculture, with rice as the major product, is a backbone of the economy by employing the majority of the country's workforce. Myanmar, although nowadays classified as a least developed country, has a wealth in natural resources such as e.g. timber, hydropower, natural gas, precious gems and minerals. For figures available on Myanmar's energy resources see Table 2.

Some sources estimate the country's income from natural gas exports (so far mainly to Thailand, with new pipelines in the future also to China) at around US$ 1.5 bln per year. The Economist Intelligence Unit, EIU (2012), forecasts that "export revenue will be underpinned by relatively strong regional demand for natural gas and gems, which are Myanmar's largest export categories, in 2012. Revenue from sales of natural gas is expected to rise sharply in 2013, when new fields come on stream in that year."Economic growth effects of natural gas sales revenues, however, seem not yet to have trickled down and benefitted a significant share of the population. Their energy supply is based to more than 70% on traditional biomass and 74-87% of the population are considered to be without access to electricity.

[2] Extracted from http://en.wikipedia.org/wiki/Burma; for further country information see also e.g. https://www.cia.gov/library/publications/the-world-factbook/geos/bm.html.

[3] Note on GDP/capita: figures found vary widely. In parts, this is attributable to different population figures and to different exchange rates for the conversion of Kyats to US$. For IMF data on purchasing power parity see http://www.imf.org/external/pubs/ft/weo/2012/01/weodata/index.aspx.

Table 2: Facts & Figures - Non-Biomass based Energy Resources

Facts & Figures – Energy resources	
Hydropower potential (estimations)	Large hydro = 40,000 MW Small hydro (here: ≤ 10 MW) = 10-15 TWh/year Actual exploitation: max. 6%
Natural gas (reserves / production)	Reserves: 12,190 bln. cu ft Production: 1.2 bln. cu ft per day
Coal / lignite	Reserves: 711,000,000 tons Production: 1,117,240 tons (yr. 2007)
Petroleum	Reserves: 216 mln. barrels (yr. 2006 ; on- & off-shore) Production: 19,700 barrel/day (yr. 2009-10) Import: 17,300 barrel/day (yr. 2009-10)
Average solar irradiation	4.5-5.5 kWh/m²/day
Wind energy potential	estimated at 365 TWh/year at coastal & mountain areas (source & methodology of estimation unclear)
Geothermal potential	93 sites identified; 43 investigated

Source: NREL, GEF, UNEP 2005; Thein Tun 2011; Arter 2006; MOGE 2011; MES 2010.

3 Energy Access Policy & Institutional Framework

3.1 Overview & Observations

Highly fragmented responsibilities for rural energy issues

At central government level, there are eight ministries in charge of energy issues (see Table 3). In particular for rural energy issues which concern approx. 2/3 of Myanmar's population, the responsibilities seem highly fragmented with none of the ministries being clearly noticeable in the lead, at present.

Table 3: Facts & Figures - Energy Governance

Facts & Figures – Energy governance	
Major (domestic) political players in energy sector	➢ Min. of Energy – Oil & gas ➢ Min. of Mining – Coal ➢ Min. of Electric Power No (1) – Hydropower (>10 MW) ➢ Min. of Agriculture & Irrigation – Hydropower (<10 MW) ➢ Min. of Electric Power No (2) – Gas power plants, T&D ➢ Min. of Science & Technology – Renewable energies ➢ Min. of Environmental Conservation & Forestry – Biomass ➢ Min. of Industry – Rural electrification ➢ Inter-ministerial Rural Energy Development Supporting Committee ➢ Township Rural Electrification Committees

Source: Scoping mission.

Poverty recognized as an issue of politics

In Myanmar's recent past, "poverty" was a taboo and officially not existent. In the new era, however, it has become a subject of governmental politics with eight development priorities for poverty reduction addressed by eight committees at ministerial level.

Inter-ministerial committee for rural energy access

As one of eight committees on poverty reduction, in 06/2011, the inter-ministerial *Rural Energy Development Supporting Committee* was put in place. The Committee has seven members from various ministries and is chaired by the Minister of Industry. The Committee is supposed to address issues of rural energy access including rural electrification by renewables and diesel-gensets. The Ministry of Industry informed that the Committee is in charge of drafting a rural electrification master plan for isolated power provision.

Rural energy access policy has yet to come

A comprehensive policy approach towards rural energy access, including a dedicated allocation of financial resources, has yet to come. One of the corner stones of a future rural electricity policy already communicated to the mission team is the prioritization of stand-alone and isolated mini-grid solutions[4]. In particular mini-grid solutions are recognised as full-fledged alternative to an extension of the national grid towards rural areas since the latter is considered too slow and too costly.

Limited capacities for addressing rural energy access issues

Knowledge about major characteristic of various rural energy supply options seems limited and data for planning and decision making often either unavailable or inconsistent. The government at national and sub-national levels seems to be in need of specific know-how for rural energy planning.

Multi-level approaches of technical cooperation welcomed – also for policy advisory

The Ministry of Electric Power No. (2) - MoEP2 informed that a rural electrification law, which shall be finalised within 2012, is currently in the process of legal drafting. The mission team was welcomed to make examples and experiences and from other countries available as input for this process.

However, MoEP2 deems examples from abroad, which they have assessed so far, as not suitable or sufficiently transferrable to Myanmar. Therefore, MoEP2 expressed their hope to get support in systematically testing rural electrification approaches as a sound basis for subsequent policy making.

Governmental institutions are occupied with internal transformation process

The Ministry of Environmental Conservation and Forestry - MoECaF indicated that at present, the ministries concerned with biomass energy are strongly occupied with internal transformation processes. Considering the dimension of fundamental changes that Myanmar is currently imposing oneself, this holds probably true for all governmental institutions concerned with energy issues.

Government can also rely on additional actors

Although the Government of Myanmar has been handling a large number of energy sector related functions directly by itself (e.g. operating factories for hydro turbines and PV panels), it can also rely on additional actors. In Myanmar, private sector participation in power generation is permitted for

[4] For details on mini-grids see Chapter 4.2.2.

domestic and foreign investors, whereby foreign investments did not improve domestic power supply, in the past. Township rural electrification committees have been organizing the implementation of rural distribution grids in the vicinity of high-voltage transmission lines. Countless informal self-help electricity supply activities can be found at village level and private sector enterprises sell PV and other energy equipment to remote villages (for details on electricity access see Chapter 4). Also concerning access to biomass energy there is a large number of domestic and international NGOs as well as private sector actors (for details on biomass energy access see Chapter 5) active in Myanmar.

3.2 Conclusions & Recommendations on Energy Access Policy

Leapfrogging as the way forward

Although there are no blueprints that could easily be applied in the case of Myanmar's transition, the donor community should be ambitious to promote a leapfrogging development by providing the best of international good practices in advisory and cooperation approaches. Tangible and far reaching improvements of the devastating energy access situation are required quickly for stabilising the country's development path.

Plenty of conceptual manoeuvring space for rural energy access

With a rural energy access policy not yet in place, there seems to be plenty of conceptual manoeuvring space. All government representatives met by the scoping mission seem to be aware that there are no blueprints available for solving Myanmar's energy issues. Consequently, they also communicated their interest and openness to put to test different concepts in order to find out what works (in terms of e.g. technologies, promotion mechanisms, and degree of participatory planning) in the context of Myanmar and what should eventually be included in a respective energy policy.

Development cooperation needs to adjust modes of delivery to internal transformation

Myanmar's government representatives concerned with energy seem to be well aware of the huge dimension that their task ahead is having. Thus, international support on improving energy access is highly welcomed. Being also aware of the resources that their internal transformation will absorb, two different ways of delivering international support were suggested to the mission team.

One suggestion was to not yet work with ministries on policies and strategies. Instead, international partners are hoped to directly take care of improving energy access at the field level of target areas. This should happen preferably together with local NGOs rather than working through the government structures. The government structures not being concerned with international partners could meanwhile focus on the reorganisation of their processes while in parallel things would already improve in the field. The other suggestion comprised of not only working at field level but to also conduct capacity development within the governmental structure including support to the government's policy and strategy development.

Harnessing NGOs' experiences for policy support activities

In Myanmar, NGO's have been playing a crucial role in rural energy issues vis-à-vis the government. Compared to many other countries in the region, their role was mainly on service delivery, less on advocacy. However, they are deemed to have a better insight in rural energy issues than some of the

governmental organisations which are just about to start addressing rural energy. The familiarity of NGOs with energy and socio-economic issues in remote areas of Myanmar should therefore be valued and harnessed in policy support processes.

Before concluding with the introduction of two options for potential development cooperation measures, Table 4 provides a condensed overview on the various aspects considered relevant for policy and institutional framework related cooperation.

Table 4: SWOT Analyses - Energy Policies & Institutional Framework

Strengths	Opportunities
▪ Ministries state their willingness to improve processes and performance ▪ Energy poverty recognised as an issue ▪ Transition process has started ▪ Inter-ministerial committee in charge of rural energy development ▪ System allows decentralised energy supply initiatives (i.e. Committee at Inle Lake)	▪ Good practice for transformation processes available – late mover advantage ▪ *Strong international interest to support energy sector transformation process (?)* ▪ *Private sector investment interest and private sector's imminent energy needs might push for improvements in the regulatory framework (?)*
Weaknesses	**Threats**
▪ Data for planning & decision making partly unavailable or inconsistent ▪ Governmental institutions seem highly occupied with internal transformation process ▪ Fragmented responsibilities – uncoordinated actions ▪ Weak capacities for policy and strategy formulation ▪ Weak enforcement and implementation capacities (resources and manpower) ▪ Driver to push coordinated action within rural energy committee is not yet recognisable – low capacity and power of the committee to fulfil its tasks ▪ Dedicated allocation of financial resources missing ▪ No dedicated regulation/policy yet in place for rural energy	▪ Internal transformation process might cause a vacuum which gets adversely exploited by vested interests (e.g. exploitation of natural resources) ▪ Little or non-coordinated donor policy advice might lead to conflicting policies

Source: scoping mission.

Enhancing the understanding of policy concepts for energy access

With the transformation process being in full swing, capacities for a more inclusive and needs oriented policy development are required in Myanmar. The scoping mission team therefore has outlined an option for potential development cooperation measures that aim at enhancing the understanding of rural energy issues and policy concepts within the Rural Energy Development Supporting Committee. Thereby, the Committee respectively its member organisations shall be enabled to initiate a process of developing, monitoring and updating energy access policies and strategies. The respective **Option Paper "Technical & Policy Advisory of Rural Energy Development Committee"** is provided as a separate document in Part II.

Fragmentation of responsibilities for energy issues calls for good coordination

In one of the ministries visited, institutional reform, i.e. the consolidation of major energy related activities within one governmental body, was named as a vision to improve coordination in the future. However, since such a far reaching re-organisation clearly belongs to the sovereign processes

of any government, the donor community could provide respective advisory only based on a very explicit request from the Government of Myanmar.

On the subordinate level of rural energy planning, however, support on coordination has already been welcomed in various meetings during the scoping mission. The scoping mission team therefore has outlined an option for potential development cooperation measures with defined objectives and recommended activities. The respective **Option Paper "Support in Rural Energy Planning & Coordination"** is provided as a separate document in Part II.

Obviously, coordination should also take place between the donors active in promoting energy issues in Myanmar. Since responsibilities among potential partners in Myanmar's government are fragmented, functioning and transparent donor coordination appears even more important in Myanmar than in most other developing countries. For example, donors' policy advice should be coordinated in order to not end-up with a set of conflicting policies. Also donors' regional, sectoral or sub-sectoral focus of activities should be coordinated in order to maximize effectiveness and avoid undesired increase of geographic imparity in energy poverty.

4 Electricity

4.1 Electricity Sector Overview

Hydropower is the largest source of electricity in Myanmar

In terms of installed capacity and produced electricity, hydropower is the major source for electricity in Myanmar, followed by gas, coal, and diesel stations (for details see Table 5). Various data sources suggest that only 6% (at maximum) of the hydropower potential has been exploited to date.[5] The further exploitation of this potential by rigorous implementation of mega-scale dams has triggered widespread controversy; most prominently in the case of the Myitsone dam. In 09/2011, the Chinese-led US$ 3.6 billion project was eventually suspended by President Thein Sein in a move to "respect the people's will".

The central electricity grid is weak

The central electricity transmission and distribution (T&D) grid is weak with privately operated gen-sets being a common sight in urban Myanmar for coping with scheduled and un-scheduled black-outs that occur particularly outside the rainy season. Technical and non-technical losses are reported to stand at a very high 25.1%. The country's very low household electrification ratio of 13-26% indicates that grid-extension has mainly been an industry supply and export oriented process so far.[6]

[5] For a comprehensive overview on large-scale hydropower in Myanmar, see e.g. Kattelus 2009.
[6] For further details on T&D-related issues, see Table 5 respectively Thein Tun 2011 and MoEP2 2012.

Private sector participation in power generation is permitted

Private sector participation is permitted in electricity generation in the form of independent power production (IPP) for local investors and as built-operate-transfer (BOT) or joint ventures (JV) for foreign investors.[7]

Foreign investments did not aim at improving domestic power supply

According to Thein Tun (2011), foreign investors are said to be interested more in power export or in directly supplying business operations held by their country fellowmen than in producing for Myanmar's domestic electricity needs. As of 10/2010 four power generation projects were approved with a foreign investment volume of US$ 11.3 billion, equalling 35.49% of all official foreign investments and bringing the power sector at rank two behind the oil and gas sector.[8]

Emerging paradigm shift: future energy resources to supply domestic demand

A high rank representative of the Ministry of Energy explained that Myanmar's natural gas production, from the two major fields that went on stream in 1988 & 2000, is sold to large extent to Thailand, with 30-years contracts being signed when the domestic demand was low and the need for foreign currency high. In light of increased domestic demand, it was emphasized that new sources – "as long as not yet promised to China or Thailand" – will only be used to cover domestic needs.[9]

Improving electricity access in Myanmar is for the most part an issue of rural electrification

Up to over 50 mln inhabitants have no access to reliable and affordable electricity. Given that 2/3 of Myanmar's estimated 60 mln. people live in rural areas, it would take unbearably long until a majority of the population could be supplied via conventional grid-extension. Being characterized by a challenging topography and one of the lowest population densities in S-E Asia, conventional grid-extension is not considered a financially viable solution for most rural areas of Myanmar in the foreseeable future.

For rural energy access, responsibilities are highly fragmented and resources are not allocated

Already when looking at conventional i.e. grid-based electricity access issues only, the responsibilities are fragmented by having e.g. two Ministries of Electric Power, as shown by Graph 2 and Graph 3.
When looking at rural electrification even more ministries come into the picture. The government has therefore formed the inter-ministerial Rural Energy Development Supporting Committee which is chaired by the Minister of Industry. The Committee is supposed to address issues of rural energy access as one of the government's eight development priorities for poverty reduction. So far, a dedicated allocation of financial resources for rural energy issues is missing.

[7] See MoEP2 2012. Differing from the usual utilization of the term IPP, during several meetings in Myanmar, „IPP" was also used for captive power production and (informal) diesel-genset based power supply of family & friends at village level.
[8] See also International Rivers 2012.
[9] For background information on Myanmar's oil & gas sector, see also Kolas and Tonnesson 2006.

Table 5: Facts & Figures - Electricity

Facts & Figures - Electric power

Installed generation capacities (yr. 2010-11)

	Grid (MW)	Isolated (MW)	Total (MW)	Share
Hydro	2,526	33	2,559	74 %
Gas	715	./.	715	21 %
Coal	120	./.	120	3 %
Diesel	./.	63	63	2 %
Bio-mass	./.	4	4	< 1 %
Total	3,361	100	**3,461**	100 %

Power mix (yr. 2010-11)

	Grid (GWh)	Isolated (GWh)	Total (GWh)	Share
Hydro	6,145	44	6,189	72 %
Gas / Steam	2,012	./.	2,012	23 %
Coal	391	./.	391	5 %
Diesel	./.	33	33	< 1 %
Total	8,548	77	**8,625**	100 %

Transmission lines (yr. 2012)

Voltage (kV)	No. of existing lines	km of existing lines	No. of lines under construction	km of lines under construction
230	42	3,251	3	207
132	39	2,383	1	17
66	137	3,614	9	537
Total	**218**	**9,248**	**13**	**761**

Transmission expansion planning

Long term: 131 lines totalling 14,834 km
Short term: 35 lines totalling 3,842 km (until yr. 2016)

Distribution lines (yr. 2012)

Voltage (kV)	km of existing lines	Existing capacity (MVA)
33	7,115	3,866
11	12,785	3,806
6.6	1,391	1,465
Total	**21,291**	**9,137**

T&D losses

25.1% (MoEP 2010-11 –figures)

Electrification ratio

26 % (MoEP 2011-figures)
13 % (IEA 2009 figures, IEA-WEO 2011)

Electricity consumption/capita

144 kWh/yr (calculation based on MoEP 2011-figures)

Electricity tariffs (national grid)

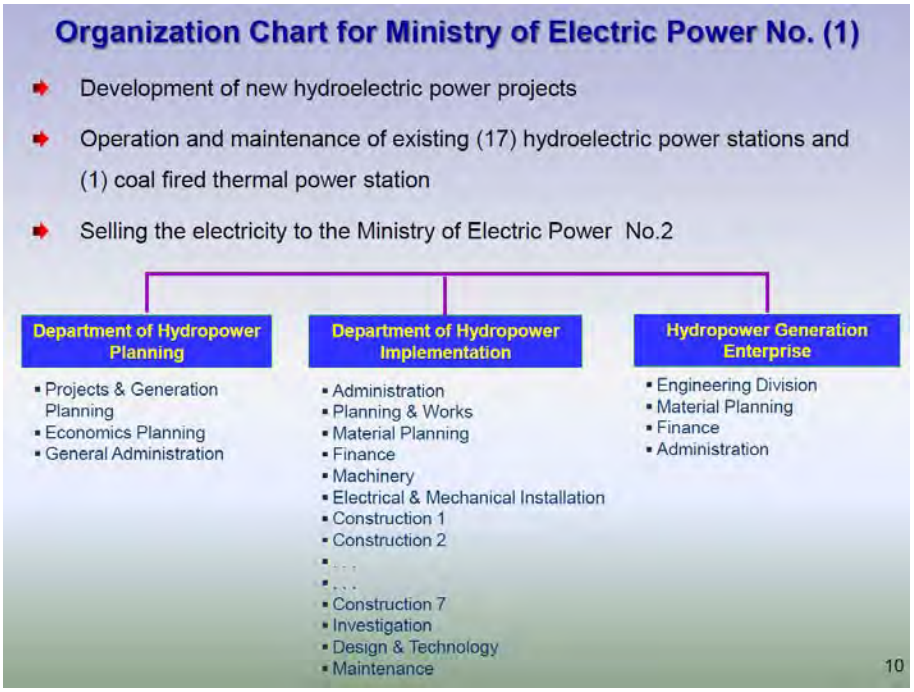
	2006 per kWh	2012 per kWh
Domestic	25 Kyats	35 Kyats
Industry & Commercial	50 Kyats	75 Kyats
Foreigner	8 US$-cents	12 US$-cents

Examples of rural hh-expenditure for electricity & candles

- 6,000 Kyats /month (~ 6 EUR) for 2 candles @ 5 hrs/night plus 1,000 Kyats/month (~ 1 EUR) for torch-batteries
- alternatively: 1,000 Kyats/month per 1 CFL powered by pico hydro

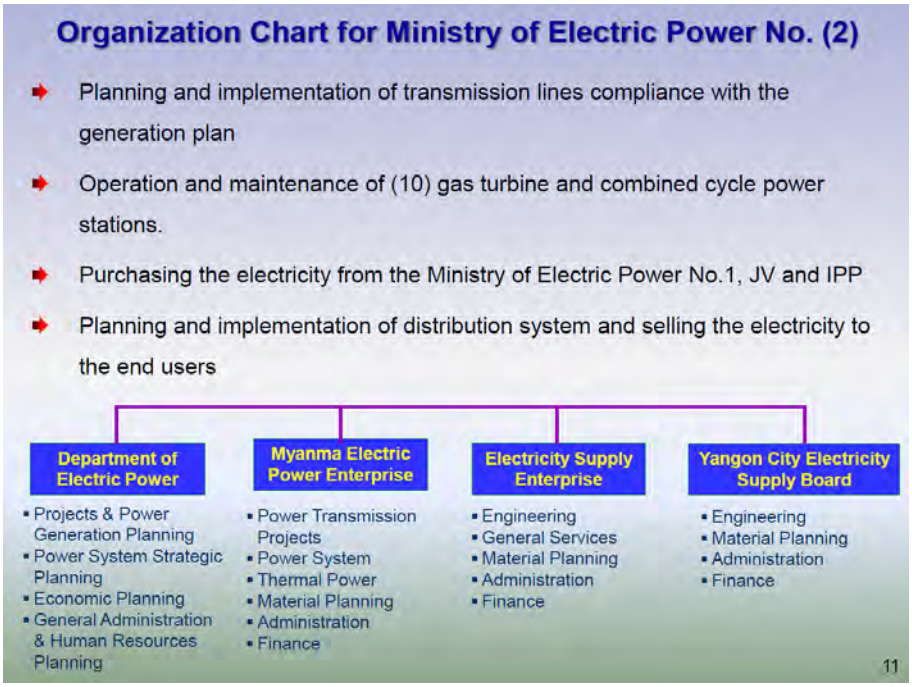
Source: MoEP2 2012; IEA 2011; scoping mission.

Graph 2: Tasks & Structure - Ministry of Electric Power No. (1)



Source: MoEP2 2012.

Graph 3: Tasks & Structure - Ministry of Electric Power No. (2)



Source: MoEP2 2012.

4.2 Rural Electricity Access

4.2.1 Electricity Situation in the Field

During the scoping mission, for administrative reasons, staying at rural areas was limited to a 2-days visit of the Inle Lake's surroundings. Thus, apart from this snap shot visit, the information provided in the following is mainly based on insights shared by people regularly travelling to Myanmar's rural areas.

There is mostly no access to the grid

With an overall electrification ratio of 13-26%, the vast majority of the country's 66% rural population has no access to the central grid or a reliable and affordable isolated mini-grid. As the mission team could exemplarily observe in two villages visited in the surroundings of the Inle Lake, even where high voltage transmission lines pass overhead, villages have no connection.

Provisional energy sources require disproportionate spending

The use of provisional energy sources such as small gensets, disposable batteries, diesel lanterns or candles consumes a disproportional high share of people's income and harms the environment. Solely for lighting by candles and electric torches, households assessed in the surroundings of the Inle Lake spend up to 7 €/month.

> For the Irrawaddy Delta, MercyCorps (2011) reports: "The average household income is around US$80/month but for around 40% of the population who work as casual labourers, the average monthly income is only around US$40. [...] Average weekly cost of household fuel consumption for lighting is US$2.02 for diesel, US$2.17 for grid electricity, US$1.79 for candles, $1.53 for small batteries and US$1.10 for large batteries."

In the absence of kerosene, not even most basic needs for lighting are sufficiently met

Unlike in other countries that show a high level of energy poverty, in Myanmar kerosene is not available as substitute for electric lighting since its subsidized supply was reduced by the government in the 1970s and completely ceased in the 1980s. The remaining expensive and low-quality alternatives do not even sufficiently meet the most basic energy needs, i.e. the needs for proper light.[10]

Insufficient energy supply limits economic activities in rural areas

Insufficient energy supply also limits the local economic development and the expansion of social infrastructure. A sharp increase of state-set fuel prices in January 2012, e.g. for petrol by 34%, affects productive, income-generating use of energy in rural areas.[11]

[10] MercyCorps (2011) states: „Households can afford an average of 3.8 hours of light per night although they would like 5 hours on average. If they had extra hours of light ..., adults would prefer to do income generation activities, household chores, and social activities while children would prefer to do school-related homework."

[11] See EIU 2012. At the time of the scoping mission diesel was priced at 4,500 Kyats/gallon (0.99 EUR/litre).

Examples of self-organized alternative approaches are in place

Probably one of the most wide-spread alternative approaches is driven by small entrepreneurs and craftsmen who own a gen-set for their core business and in addition operate it during evening hours to supply not only their own household but also some family & friends in the surroundings. Since gen-sets operated at part-load are fuel-inefficient and fuel prices have increased dramatically, this might be an approach with very limited up-scaling potential.

Another approach observed by the mission team in the field was a pico hydropower based village electricity supply, implemented by a wealthy farmer. During the night he supplies 14 households for lighting. Those who want to operate TV-sets bring car-batteries to the farmer's house for charging during day-time. Three years ago, the initial investment in the low-tech Chinese pico hydro system was about 300 EUR (including fittings and wiring) whilst the yearly revenue is at least 170 EUR.
A third approach observed was a 50 W_p solar home system (SHS) bought privately at around 220 EUR and which was in far better condition than the probably more expensive one provided to the neighbouring household for free by a donor initiative.

Despite widespread poverty, major preconditions for market based approaches are in place

Already the small selection of self-organized alternatives for electricity supply reported here, indicate that the two major preconditions for market based approaches are in place: there is energy-related entrepreneurial spirit at village level and there are rural inhabitants who are used to pay for energy service. Compared to subsidy dependent programs, this allows for better up-scaling of electricity access.

4.2.2 Rural Electricity Access Options

Within the scoping, a number of rural electricity supply options have been assessed by taking into account typical energy needs, geographic and socio-economic conditions, as well as option-specific characteristics e.g. in terms of technological complexity, reliability and degree of maturity or suitable dissemination approaches. The assessments are presented mainly as consolidated overviews in the form of SWOT analysis. The sequence of the options is from addressing most basic energy needs for lighting up to a fully fledged electricity connection to the national grid. Since the scoping did not permit for deeper assessments, only a selection of typical cases can be presented here. In reality there are more differentiated energy needs and a wider range of options to address them.

Household-level PV solar energy (PicoPV & SHS) for places with no significant potential for productive energy use, i.e. where lighting and ICT accounts by far for most of the electricity demand

In recent years, good quality PicoPV-systems have become a least-cost option for lighting due to mass-production of PV panels as well as technological progress in LEDs and batteries. PicoPV systems are over-the-counter consumer products which do not require engineering know-how for installation or O&M. Therefore, electric lighting with PicoPV has lower transaction costs than other grid or off-grid alternatives.[12] Whilst some PicoPV-systems also allow for radio and mobile phone charging (i.e.

[12] For more details on PicoPV refer to e.g. https://energypedia.info/index.php/Portal:Solar.

information & communications technology - ICT), the powering of TV-sets requires slightly larger solar home systems (SHS). With highly energy efficient flat screen LCD-TFT TV-sets (<20W) available, SHS are nowadays increasingly designed with smaller and more reliable battery systems. Not requiring a mini-grid network that connects the houses, thus also not requiring a village-scale electricity utility for management, operation & maintenance is one of the fundamental advantages of individual, household-level PV systems. For further characteristics as analysed in the context of Myanmar, see Table 6.

Whilst the Yellow Pages lists about a dozen PV-related companies in Myanmar, the mission team had the opportunity to visit two private companies, Sun Power and Proximity Designs; who are selling PV solutions to rural customers. Their PicoPV LED lighting products are offered at prices between 9,000 Kyats to 65,000 Kyats (approx. 9-65 EUR), indicating that there is already a market for PV in rural areas which can be supported and strengthened for an improved electricity access.

Graph 4: Impressions on Rural Household Lighting in Myanmar

Low-quality & expensive lighting by candles and dry-cell batteries

Badly protected battery of a makeshift SHS - provided for free and without user training

Roof mounted SHS-sized PV panel of approx. 50W_p	Customer information in a PV-shop in Yangon: different CFL & LED suitable for PV	Sun Power's locally manufactured 6W & 12W PicoPV LED lighting systems
		
Proximity Designs' imported PicoPV LED lanterns	Cheap, low quality LED lamps	

Pictures: scoping mission team.

Table 6: SWOT Analysis - Household-level PV (PicoPV & SHS)

Strengths	Opportunities
▪ People are used to pay for energy – market approach in principle possible ▪ High solar irradiation throughout Myanmar => wide geographical outreach & inclusion of ethnic minorities possible ▪ Technology relatively easy to install & maintain ▪ Pilots available for learning ▪ Government (e.g. Min. of Industry) keen on PV ▪ Domestic assembly & Myanmar-wide dealer network in place / upgradable ▪ High environmental relevance => substitution of disposable batteries ▪ High possible savings at household-level => substitution of candles and batteries ▪ Existing NGO structure with some initial experience in PV to build upon	▪ Expected increase of microfinance might facilitate purchase of energy equipment ▪ Large window of opportunity to foster (international) cooperation between private, public and civil society sectors ▪ Year of "Sustainable Energy for All" => high international attention & opportunities to support the issue ▪ Globally emerging companies & markets for BoP-customer oriented Pico PV solutions ▪ Due to market opening: more/better product choice for different user-needs
Weaknesses	**Threats**
▪ Little cash availability in most rural households ▪ W/o awareness campaigning and quality assurance: durability & performance of systems not recognizable at purchase for customers ▪ Training for PV professionals not yet in place ▪ Insufficient user training & information => premature end of PV-systems' life-time ▪ C-grade quality & low performance of some existing systems in the field => potentially compromising technology's reputation ▪ No coordinated action – no systematic exchange of experience among involved actors	▪ Market opening w/o accompanying measures => inflow of more bad quality systems ▪ Market distortion by unsuitable subsidy-schemes might prevent the sustainable growth of a private sector driven mass-market ▪ Uncoordinated donor activities might increase geographic imparity in energy-poverty

Source: scoping mission.

PV mini-grids for densely populated places with potential for small productive energy use

Photovoltaic (PV) solar energy powered mini-grids allow within limits to operate small electric appliances for productive purposes (e.g. soldering device or small woodworking machines) that are beyond the possibilities of an individual SHS. Given Myanmar's low electricity consumption (144 kWh/capita/year) PV mini-grids are recognized as fully fledged alternatives to extending the central grid. In order to have electric light (and other energy services) at night time, PV mini-grids store energy in form of a battery bank. Since storing energy in a PV mini-grid is a task of a village-scale electricity utility which manages, operates & maintains the system, taking care for the sensitive battery storage can be done in a more professional way than compared to individual PV systems. A further advantage compared to individual systems is the possibility to flexibly allocate the electricity to different users according to their power needs (e.g. temporarily prioritizing the supply of a rural health station by reducing the full-fledged supply of a wealthy household). On the downside, there is higher investment costs (inter alia for the wiring between the houses) compared to individual PV systems. This additional investment, however, is considered 'future-proof' since a PV mini-grid can relatively easy be interconnected with the central grid, should grid-extension eventually take place in Myanmar's rural areas. For further characteristics as analysed in the context of Myanmar, see Table 7.

Table 7: SWOT Analysis - PV for Mini-Grids

Strengths	Opportunities
▪ People are used to pay for energy – market approach in principle possible ▪ High solar irradiation throughout Myanmar ▪ Technology relatively easy to install and maintain ▪ Government (Ministry of Industry) keen on PV dissemination ▪ High environmental relevance → substitution of dry-cell batteries and inefficient operation of diesel gen-sets ▪ Grid-like electrification: mini-grids in Myanmar recognised as full fledged alternative to grid-extension (allowing for small scale productive use for cottage industries, individual TV sets possible) ▪ Modular extendable if needed, i.e. upon emergence of new SMEs or positive migration ▪ Future proof: inter-connectable should national grid arrive	▪ Decreasing prices for PV panels – increase in fossil fuel prices ▪ Large window of opportunity to foster cooperation between private, public and civil society sector. ▪ Increase in professionalism (likely) of PV system integrators due to commercial energy demand (diesel substitution) ▪ Learning about PV in a safe environment for future scaling up also for grid-interconnection ▪ 'Sustainable energy for all initiative' – high international attention
Weaknesses	**Threats**
▪ High investment costs compared to individual systems ▪ Insufficient cash available in most rural households for significantly contributing to initial investment ▪ Requires management and operation structure ▪ Only very limited experience with PV mini-grids within Myanmar ▪ Training for PV professionals not yet in place ▪ No coordinated action and systematic exchange of experience among involved actors (NGOs, government, business) ▪ Scaling-up without strong governmental (donor) support is difficult	▪ Uncoordinated (geographical) donor activities might increase geographic imparity in energy poverty ▪ System implementation without social engineering and after-sales / post-installation services might lead to lost investments ▪ Users might expect similar tariff levels as in national grid which would not be cost-covering for PV mini-grids , thus leading to neglecting O&M

Source: scoping mission.

The Ministry of Industry (MoI) informed that they see PV mini-grids as main priority for rural electrification at present. MoI also operates a PV thin-film factory and hopes for the future to provide domestically produced PV panels for PV mini-grids.
So far there seems to be very limited experience at governmental, NGO, and private sector levels with PV mini-grids in Myanmar. Capacity development on technological, socio-economical, and managerial aspects of PV powered mini-grids is required.

MHP village electrification for densely populated places with potential for substantial productive use

Micro & mini hydropower (MHP) typically do not need sensitive energy storage and allow for relatively low electricity production costs (when comparing e.g. with PV). However, the required engineering input and financial investment is substantial. Low electricity costs in most cases are only achievable when utilizing the installed power generation capacity to a high degree. In other words, the energy shall not only be used during night time after farmers return home from field work but also throughout the day. In order to absorb and even more important also to pay for the energy, productive daytime use is required. For further characteristics as analysed in the context of Myanmar, see Table 8.
The smallest category of hydropower, the so-called pico hydro systems have the advantage of not requiring engineering skills for the design of the power station (as is the case for MHP), thus being sold over the counter of agro and hardware shops in Myanmar. However, there are serious issues regarding electric safety of people operating pico hydro systems. For technical reasons, these cannot be solved without massively increasing the price of pico hydro.

The mission team had the opportunity to meet with U Khun Kyaw, a seasoned MHP equipment manufacturer and project developer who, since 1983, has implemented in total some 300-400 sites with more than 100 MHP sites in the >10kW size category. According to him, the majority of sites which are operated by villagers whom he trained are still functioning. The MoI informed that they have an own hydropower factory which manufactures turbines of 75-2,000 kW. Thein Tun (2011) lists 32 “small and medium hydropower plants outside grid system” of sizes from 12 kW to 2 x 2,000 kW with a combined capacity of approx. 33 MW.
According to U Khun Kyaw, the quality of know-how for MHP site surveying and engineering among the younger generation of engineers in Myanmar needs to be improved – an assessment that was also communicated by the Myanmar Engineering Society (MES).

Graph 5: Pico Hydro & MHP based Self-help Approaches

Surprisingly functioning: low-cost pico hydro system integrated in a drop-structure of the irrigation

Pico hydro powered business: battery charging to run TV and DVD

Different sizes of Chinese-made pico hydro systems for high head applications in a nearby agro-shop in Taunggyi...

... and for low head applications from 0.5-5 kW

A life for MHP: U Khun Kyaw (middle) sharing insights based on his 30 years of MHP develpment in sizes of 5-150 kW

One of the many photo documentaries U Khun Kyaw has of the MHP schemes

Pictures: scoping mission team.

Table 8: SWOT Analysis - Micro/Mini Hydropower Village Electrification

Strengths	Opportunities
▪ People are used to pay for energy – market approach principally possible ▪ High environmental relevance => substitution of dry-cell batteries and inefficient operation of diesel gen-sets ▪ Least cost option in cases where load factor is high ▪ High relevance for agricultural sector (main backbone of country) i.e. energy use in agro-processing ▪ Government recognises mini grids as full-fledged alternative to grid extension ▪ High local content in construction and O&M possible ▪ Future-proof: easily connectable should national grid arrive ▪ Hydro power in principle known: examples available for learning	▪ MHP knowledge available within ASEAN – peer learning possible (e.g. via ASEAN Hydropower Training & Competence Centre "HYCOM" in Indonesia) ▪ Proximity to China allows for import of low cost equipment ▪ 'Sustainable energy for all initiative' – high international attention
Weaknesses	**Threats**
▪ High investment costs compared to individual systems ▪ Insufficient cash available in most rural households for significantly contributing to initial investment ▪ Requires management and operation structure ▪ High investment costs compared to individual systems ▪ Distinct dry season in some areas ▪ Specific hydro power engineering know-how not widely spread ▪ Trainings for hydro power professionals not available ▪ No coordinated action and systematic exchange of experience among involved actors (NGOs, government, business) ▪ Scaling-up without strong governmental (donor) support is difficult	▪ Improper implementation risks loss of reputation ▪ Uncoordinated donor activities might increase geographic imparity in energy-poverty ▪ System implementation without social engineering and post-installation services might lead to lost investments ▪ Users might expect similar tariff levels as in national grid which would not be cost-covering for PV mini-grids, thus leading to neglecting O&M ▪ Donors expect fast implementation which might compromise on quality of required PFS/FS ▪ Significant change of water flow due to climate change possible

Source: scoping mission.

Community based low-cost distribution of bulk power where the national grid is nearby and the population density as well as the power demand is high

In rural locations close to the national grid, it is supposed economically viable to connect respective villages as long as the distribution grid can be kept compact and the power demand is sufficiently high to generate required revenues. A promising example of such an approach has been implemented by the Inle Township Rural Electrification Committee. The Committee is providing guidance to communities in the setting-up of the distribution system – financially, technically[13], and managerially. Moreover, the Committee is facilitating them in buying bulk power from the national grid and selling it to the households via their own distribution network. Per each connected village, there is only one meter (right behind the respective 66/11 kV sub-station) that is read by the national utility which charges the village collectively, i.e. has nothing to do with collecting money from individual households.

Although for this kind of distribution grids low-cost concepts are followed (e.g. by using wooden instead of concrete or metal poles), significant upfront investments are still required. Particular in places with good income generating end-use potential, setting-up of a pre-financing structure (e.g. a revolving fund) might therefore speed-up the application of this approach.

Graph 6: Self-organized Distribution of Power purchased in Bulk

A meeting with the Inle Township Rural Electrification Committee

`Bridging the last mile:´ the distribution system organized by the Committee

[13] For advise and supervision of electro-technical and safety related issues, the Committee has contracted a private company which employs government-certified engineers and technicians.

Challenging terrain for the Committee – not only politically

`Save The Nature:´ by substitutionof diesel and disposable dry-cell batteries

Snapshot of distribution system in Yangon

Well maintained installation of the Committee's distribution system

Pictures: scoping mission team.

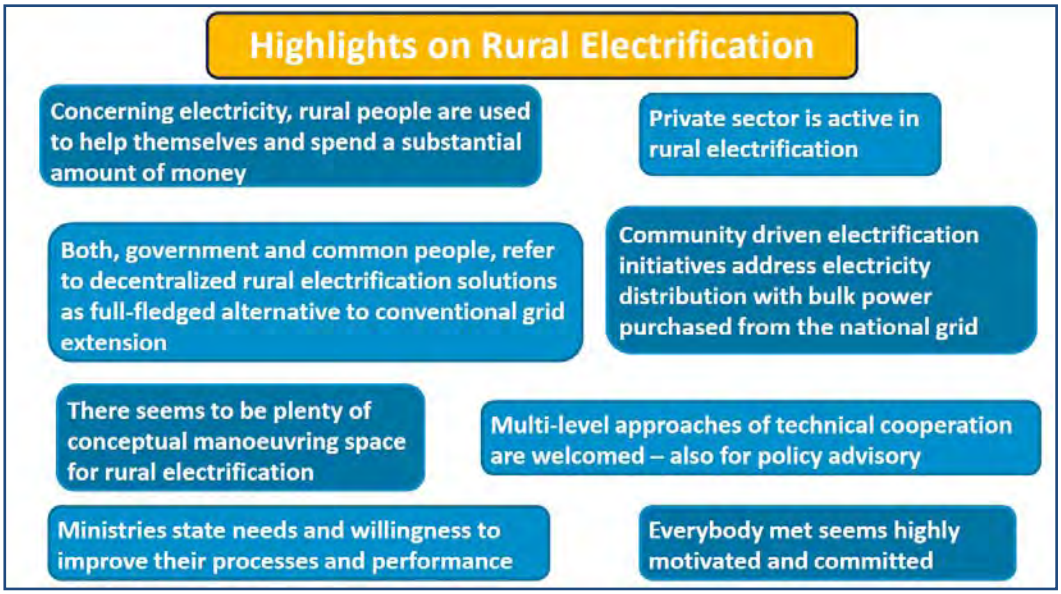
4.2.3 Conclusions & Recommendations on Rural Electricity Access

Since about 2/3 of Myanmar's population is living in rural areas, it is predominantly the *rural* part of electrification that is key to make development positively experienced by up to 52 million people who are considered being without access to date.

So far, not even the most basic needs for lighting are sufficiently met. Provisional energy sources require disproportionate high spending of households and insufficient energy supply limits economic activities in rural areas. Yet, self-organized informal electricity supply approaches provide evidence of a dynamic entrepreneurial spirit when it comes to rural electricity provision. Moreover, people have

a high willingness to pay for electricity services. Thus, despite widespread poverty, major preconditions for market based approaches are in place.

Graph 7: Highlights - Rural Electrification



Source: scoping mission.

People offering electricity products and services under most difficult rural conditions to people who are used to adequately pay for these is a precious asset which must not get spoiled by any pressure for showing quick results on donors' and government's side.
Programs for speeding-up rural electrification need to be designed and implemented with care in order to not jeopardise the reputation of decentralised, mainly renewable energy based approaches. These decentralised approaches are essential for tackling the Herculean rural electrification task in Myanmar if one does not want to wait unbearably long for conventional grid-extension having covered the whole country.

Capacities need to be developed in order to get things right before getting them multiplied. As the overview on selected rural electrification options in the previous Chapter showed, specific know-how is required. For consideration of a respective development intervention, the scoping mission team has outlined a concept for piloting a number of different village mini-grid approaches. They shall enable systematic learning of what works in Myanmar (in terms of e.g. technologies, business and ownership models, degree of participatory planning) under which conditions and thereby provide concerned stakeholders in the government, the NGOs and the private sector with proven and applicable knowledge for scaling-up mini-grid electrification throughout Myanmar. Thereby, particular attention will be given to transferring respective knowledge for the energy access planning to sub-national government and public administration levels as they are geographically closest to future mini-grid locations. This outline is provided as separate **Option Paper "Piloting Village Mini Grid Approaches"** in Part II.

For rapidly addressing the undeserving rural lighting situation, the **Option Paper "Market Development for HH-level PV Systems"** proposes to improve the access to modern energy services for lighting, information & communication through a market-oriented promotion of good quality household-level PV systems that are easy to install, operate and maintain and allow for lower energy-specific household expenditures. Also this Option Paper is provided separately; see Part II.

4.3 Notes on Urban, Commercial & Industrial Electricity Supply

Urban and industrial electricity supply is mainly an issue of the central grid which has not been assessed in similar details as the above presented rural electrification. Nevertheless, in the following a few of the scoping mission team's open questions and snap-shot observations are provided. They facilitate to outline a potential future scoping process that would specifically focus on grid related issues.

Implications of (too) low electricity tariffs?

Although electricity prices were increased in late 2011 by 40% (for domestic customers) and 50% (for industrial & commercial as well as for foreign customers) their absolute levels deem still low in international comparison. Households pay 35 Kyats/kWh (approx. 3.5 €cents) whilst industrial & commercial customers are charged at 75 Kyats/kWh (approx. 7.5 €cents).[14]

Low electricity tariffs, however, do not necessarily mean to also enjoy a low-priced electricity supply: Private households which apply for an electricity connection are facing long waiting times and an initial connection fee of 500,000 Kyats (approx. 500 €) which in many cases is prohibitively high. Those electricity customers who eventually got connected to the central grid are suffering from frequent scheduled and un-scheduled power cuts as well as low power quality. When resorting to diesel gen-sets as back-up their actual cost easily exceed 37 €cents/kWh.[15]

Grid densification in urban & semi-urban areas being (not yet) an option?

Considering the prevailing power shortage in the central grid and the priority of Myanmar's government to provide electricity to industrial production centres first, it does not necessarily seem a promising option to connect households to the grid in large numbers. This is particularly the case when assuming that with the lifting of economic sanctions an increase of industrial production (e.g. garment industry) might even worsen the current power supply crisis.

On the other hand, political pressure for solving the urban people's electricity supply situation is high with open protests being already taken to Myanmar's streets.

A forward-looking advisory process should therefore start immediately and provide a positive signal to the public in order to bridge the time until the required volume of electricity in the grid will be available. Technical advisory would assess options to lower the initial connection fees. Policy advisory

[14] Though cost figures for electricity supply were not accessible during the scoping, at least the tariff for residential customers appears to be politically fixed below costs. Under such conditions, every kWh supplied increases the power sector's financial losses, i.e. making it a financially rational choice not to connect additional houses.

[15] Conservative calculation solely based on fuel expenses, i.e. not taking into account the hardware and maintenance costs of a diesel genset. Calculation basis: 4,500 Kyats/gallon (0.99 EUR/litre) diesel fuel; 0.37 l/kWh specific consumption (at typical part load operations).

would explore how to create (potential) customers' acceptance for cost-covering electricity tariffs in exchange for an acceptable electricity supply.
The expected increase in the credibility of Myanmar's political decision making and in the people's economic welfare is hoped to create sufficient manoeuvring space for eventually establishing sustainable levels of electricity tariffs.

For a consolidated overview of grid densification aspects in the context of Myanmar, see Table 9.

Table 9: SWOT Analysis - Grid Densification for Household Electrification

Strengths	Opportunities
▪ Technology relatively easy to install & maintain ▪ Engineering capacities available ▪ In general, provides full and unlimited electricity services ▪ Economies of scale and scope by adding additional customers ▪ Future proof investments especially in urban and semi-urban areas	▪ Government is planning to increase the electricity generation (not for export) – possibility to supply higher share of domestic demand ▪ Political & administrative decentralisation process and increase in civil society participation might strengthen the ground for systematic grid densification ▪ Currently planned grid extension allows to harness more energy resources
Weaknesses	**Threats**
▪ At present, not enough power capacity on the grid – frequent brown & blackouts ▪ High initial connection fee for households ▪ Long waiting times for initial connections, i.e. manpower might not readily be available ▪ Oversized investment compared to households' small electricity consumption	▪ Predicted increase in industrial consumption might increase electricity shortage for households and lead to more frequent shedding of residential power load

Source: scoping mission.

Large-scale grid-interconnected PV solar energy as an option?

With 4.5-5.5 kWh/m^2/day the average solar irradiation in Myanmar is between 1.6-1.9 times higher than in Germany – the country with currently most grid-interconnected PV installed worldwide. Grid-connected PV becomes financially particularly interesting where expensive fossil fuels can be substituted during day time, i.e. in particular in diesel power stations. Since there is no diesel based power in Myanmar's national grid, large-scale PV might only be employed at a limited extend in some of the isolated grids where in total 63 MW diesel power generation capacity is installed.
Nevertheless, as a relatively simple and modular technology PV would in principal also qualify as fast-track option for increasing and diversifying the generation capacity in Myanmar's national grid. However, compared to conventional coal or gas fired power plants, the initial investment cost of PV is far higher and its payback period far longer. Whilst an economic life-cycle cost analysis might still characterise PV as superior option, it is rather the financial engineering (e.g. the higher risk premium charged for a higher and longer-term investment) that makes investments in large-scale PV challenging. In an investment climate as difficult as in Myanmar at present, it is conventional power plants that offer quick-win investments opportunities instead.[16]

[16] In line with this, the mission team learned from JICA that a Korean company is preparing to invest in a large-scale gas fired power station, at present.

Table 10: SWOT Analysis - Large scale Grid-Interconnected PV

Strengths	Opportunities
▪ High solar irradiation throughout the country ▪ PV in principle known ▪ Short gestation periods ▪ Modular, scalable fast-track option for adding generation capacity to the grid ▪ Diversification of energy mix (mitigation of draughts)	▪ Decrease in prices for PV panels – increase in fossil fuel prices ▪ Knowledge & experience in large-scale PV available within ASEAN - peer learning possible ▪ With Myanmar's transition process: large window of opportunity to foster cooperation between private, public and civil society sector
Weaknesses	**Threats**
▪ High RE-specific upfront investment costs ▪ PV-specific long-term lock-up of capital, i.e. high investment risk exposure ▪ No experience yet with grid-connected PV within Myanmar ▪ Training for PV professionals not yet in place	▪ Imminent need for additional power generation might be tackled with quick fix solutions (e.g. gas fired power plants) that jeopardise potential business cases for grid-interconnected PV

Source: scoping mission.

PV solar energy for captive power or back-up supply in industry and tourism?

For captive power supply of tourism or industrial operations far away from any central or isolated grid, the case looks relatively clear: since the fuel price hikes in 01/2012 for diesel fuel (4,500 Kyats/gallon, i.e. 0.99 EUR/litre at the time of the scoping) renewable energies like MHP or PV often pose the least-cost options. Due to high solar irradiation throughout Myanmar and its technological simplicity, PV is supposed to be an attractive solution for a large number of cases – especially where battery storage capacities can be kept small by covering peak loads with the still existing diesel-gensets.

For PV-powered back-up of grid-connected commercial, tourism and industrial operations, the picture looks different. Whether investing in back-up generation is financially attractive depends on how fast grid power supply improves, respectively, on whether the installed back-up PV system can be sufficiently exploited by also selling excess power to the grid. In this context it is potentially worthwhile having a closer look at concepts like net-metering in the near future.

Interconnecting private back-up diesel power stations to the national grid?

A potential fast track approach to improve grid power would be to remunerate private owners of larger diesel gen-sets for feeding the power that they can generate in excess into the national grid. Under the header "emergency power" there is a whole global industry specialised in rapidly providing large capacities of diesel power plants on a rental basis to countries or industries in need.[17] By resorting to Myanmar's commercial, industrial and tourism sectors which have already heavily invested in power generation equipment, the government could get an emergency power supply organised faster and cheaper than via any of the global rental companies.

[17] See e.g. http://www.aggreko.com/. Whilst typically this is expensive and environmentally polluting it is often the last option to avoid civil unrest and to "stay in power" thereby gaining time for the implementation of sustainable solutions.

Graph 8: Large-scale Diesel Back-up Power Supply in Hotel Industry

Satellite image of a hotel complex in Yangon showing the hotel's huge diesel back-up power station (see upper right corner).

Picture: Google Earth.

Technical advisory on high voltage transmission grid issues?

As Thein Tun (2011) and MoEP2 (2012) describe, not only the distribution grid but also the transmission system of Myanmar is in dire need for improvements. An almost self-evident conclusion would therefore be to explore with the Government of Myanmar, in particular with the Ministry of Electric Power No. (2) that is in charge of T&D, what related kind of assistance is required.

However, the upgrading of transmission systems is typically addressed by financial cooperation agencies. They do not only provide related technical and political advisory but also the required funds for the investments as a packaged solution.

Given the huge tasks in electrification and political transformation that Myanmar's government is facing, the mission team assumes that providing additional technical and/or policy advisory that would be independent from financial support of transmission issues could easily overstress the government's capacities at this point in time.

5 Biomass Energy

5.1 Biomass Energy Governance

At national level,[18] the biomass energy sector has links to several ministries. The Ministry of Environmental Conservation and Forestry (MoECaF) is in charge of the wood fuel sector. Biogas and biomass gasification are technologies promoted by the Ministry of Science and Technology. The Ministry of Agriculture & Irrigation is in charge of the use of agro-waste for fuel (direct combustion) as well as biofuels. The fragmentation of responsibilities in the energy sector in general and in the biomass energy sub-sector in particular creates a large demand for coordination towards a coherent management of the biomass energy sector. MoECaF indicated that at present, the ministries concerned are strongly occupied with the internal transformation process. Therefore, it might be premature to engage in biomass energy related policy advisory and strategy development at this point in time.

Table 11: Facts & Figures - Biomass Energy

Facts & Figures – Bio-energy	
Share of biomass & waste in primary energy (yr. 2009)	70%
Share of wood in primary energy consumption	62%
Share of biomass for hh's cooking & heating	88%
Share of agro waste (pigeon pea stems) in rural households' primary energy consumption	26.2%
Forest area coverage	56% (1990) – 52% (2000) – 50% (2005)

Sources: OECD/IEA 2011; Sovacool 2012; GMS 2009; FAO 2009.

5.2 Wood Fuel Situation

Wood is the main source of biomass energy

Biomass energy contributes more than 60% of the total energy consumption and is used by more than 70% of the population. Wood is the largest source of biomass energy. In wood deficit areas, agro-waste such as rice husks and pigeon pea stems are already used to substitute wood fuel. Biogas, bio-ethanol, straight vegetable oil, bio-diesel or producer gas from biomass gasification have not (yet) played a significant role in the energy sector.

Wood energy is the dominant fuel for cooking and space heating

In rural areas, firewood is used by 93% of households.[19] For most parts of the rural areas of Myanmar, the access to wood fuel is not (yet) commercialized. Only in some areas of specific wood

[18] Sub-national level governance structures would be subject to future assessment since time did not permit to include them in the initial scoping-mission activities.
[19] See GMS 2009.

scarcity, firewood has become a commodity. Not surprisingly, charcoal is a commercial product and much more used in urban areas.

Wood energy is also used in cottage industries and large agro-industries in rural areas

The processing of agricultural products in rural areas often requires process heat e.g. for frying, drying, roasting, cooking, boiling, steaming etc. Small scale cottage industries as well as larger agro-industries use wood energy to generate this heat. Specified data on the quantities of wood consumed in this sector have not been found yet.

Use of forest resources appears not to be sustainable

Statistics on "area under forest", "volume of wood standing in forest" and "species available" suggest that there is a long decline in the quantity and quality of the forest resources. Many factors have been discussed as driving forces for this development. The use of wood fuels for cooking is one of them. The abolition of kerosene provisions as cooking fuel to households in the 1980s has been mentioned as one key factor which enhanced the use of wood fuel for cooking. However, this might be overemphasizing the role of cooking energy in comparison to other factors such as industrial uses of forest products (e.g. teak extraction and paper production) or the expansion of farming areas due to population growth. While most of the biomass energy interventions have been justified with the battle against deforestation, it might be unrealistic to expect these interventions to stop deforestation completely unless other contributing factors are addressed simultaneously.

Regional differences in the availability of wood fuel

It is reported that the central Dry Zone and the coastal mangrove areas have been of a particular concern in respect to forest degradation and deforestation. MercyCorps (2011) reports that here even rural firewood access has been commercialised, suggesting that access to forests for individual firewood collection has deteriorated considerably in the past decades.

Community forestry – "so close and yet so far"

Myanmar appears to have plenty of trained foresters, with some being trained even abroad (e.g. in Germany). There also seems to be good knowledge on the technical side of plantations etc. In recent years, efforts were made to involve communities in the planting and management of forest areas based on the "community forestry approach". All required laws and regulations for community forestry seem to be in place. However, the application of this bottom-up forestry approach is apparently jeopardised by imposing top-down targets to the forest officers. They, in consequence, seem to undermine the empowerment part of the concept in order to fulfil their delivery targets. While the concept of community forestry has shown good results in other countries in the region (e.g. Nepal), there is an apparent need for more capacity development and exposure activities to allow for a more successful application of the community forestry concept also in Myanmar.

5.3 Improved Cook Stoves (ICS)

After 15 years of ICS promotion, the penetration of ICS still seems to be small.

There is a surprisingly large number of NGOs which have been involved in some kind of ICS intervention. This appears to be an asset for future work on ICS. Local organisations like EcoDev,

EGG, FREDA, MERN or REAM were commonly recruited by international organisations such as FAO, UNDP or MercyCorps for their interventions focussing on the central Dry Zone and the coastal areas of the mangrove forest. This engagement has been particularly intensified as part of the interventions addressing the negative impacts of the Cyclone Nargis which in 2008 devastated Myanmar's southern areas, in particular the Irrawaddy Delta.

These efforts have been great in terms of reaching many people at a particular point in time. They rendered benefits to the targeted households as long as the distributed stoves stayed intact. However, interviews at NGO and village level indicated that these efforts did not really contribute to a long term improvement of the cooking energy situation of the households (see below).

Graph 9: Impressions on the Improved Cook Stove (ICS) Situation

Pottery process of making an A1 improved cook stove (ICS)

Kiln for firing the clay stoves

Demonstration of a newly produced A1 stove

Typical kitchen situation (near Inle Lake)

Discussion with stove users duringthe mission

Commercially priced alternatives to the A1 stove at a rural market in Nyaungshwe

Pictures: scoping mission team.

The promoted ICS seem to have quality problems

The A1 stove model was introduced in the mid-1990s through the Forest Research Institute. It is a kiln fired clay stove. The design has not much changed since its introduction. Both literature as well as feedback from NGOs and communities suggests that despite the kiln firing of the stove, the durability of the stove often remains rather limited. This has spoiled the reputation of the product in some areas. Beyond the A1 stove, there are a number of other stove designs. Most of them are also clay or mud based – some of them with metal parts as cladding or grid. Modern firewood stove concepts like the rocket stove principles (developed by the Aprovecho Institute) have not yet reached Myanmar. Stoves designs have been focussed on very low-cost solutions which offer rather small advantages over the 3-stone fire.

The dominant ICS promotion concepts did not focus on sustainable markets

Most ICS interventions have been part of either environment or food security/livelihood oriented programs. The basic assumption was that the target group is too poor to afford an ICS. The other line of argument was that it would take just too long to reach many people if it is left to market forces whilst in the meantime the forest would be gone. In any case, the development goals of these interventions were not targeting the establishment of sustainable ICS markets. Stoves were bought by projects from producers and distributed to households in “model villages”. There was often no provision for user training, quality control of the stove, spare part supply system, warranty for early breakages, etc. There was no structure build up to allow the replacement of damaged ICS even if the household was prepared to pay for it. The distribution concept did not promote the idea that stoves are a useful commodity with a value which can be bought like any other tool in the household.

Little exchange and learning on ICS between stakeholders

These experiences have been made by many of the stakeholders. However, a broad based discussion about the modes of delivery in the ICS sector has not yet taken place. There are still NGOs insisting

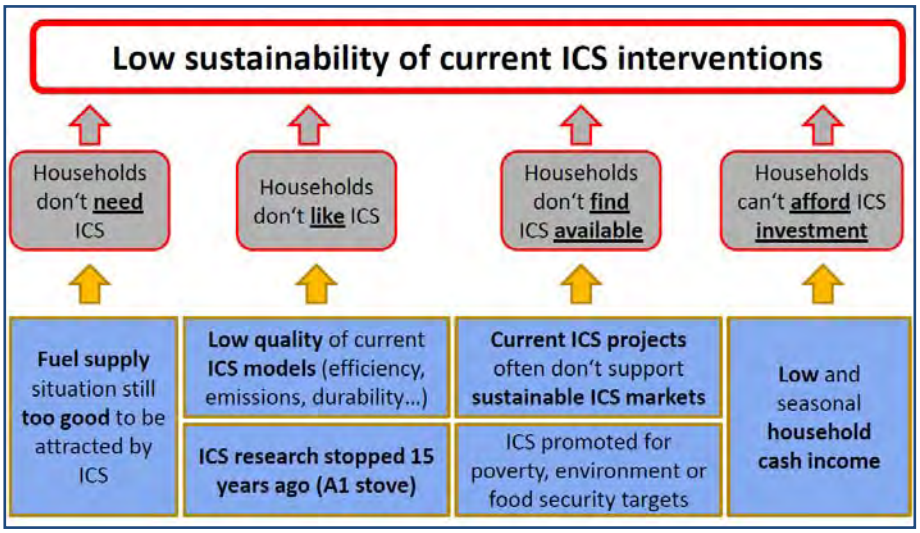
that free distributions should continue or at least the stoves should be strongly subsidized. A critical exchange between the practitioners of the various NGOs, the private sector as well as the research scene and donors has not (yet) taken place.

Issues to be addressed for sustainable improvements of the ICS sector

Stove distributions are a valuable activity in emergency situations. In the response to the Cyclone Nargis, it was beneficial to bring quick assistance to the areas hit by the disaster.

However, the promotion of ICS in Myanmar is often justified with the battle against deforestation. In this case, short term ICS distributions are not the right instrument as they do not sustainable contribute to the desired developments. The potential reasons for ICS penetration still standing at a low level (in relation to the numerous promotion efforts) in Myanmar are summarized in Graph 10.

Graph 10: Potential Reasons for low ICS Penetration in Myanmar



Source: scoping mission.

Market based approaches with new ICS models can succeed in rural areas

MercyCorps and partners conducted an energy poverty survey in 2011 which has clearly elaborated the above mentioned problems of the ICS work in Myanmar. They concluded to adjust the product and the promotion approach to fit the local market conditions.

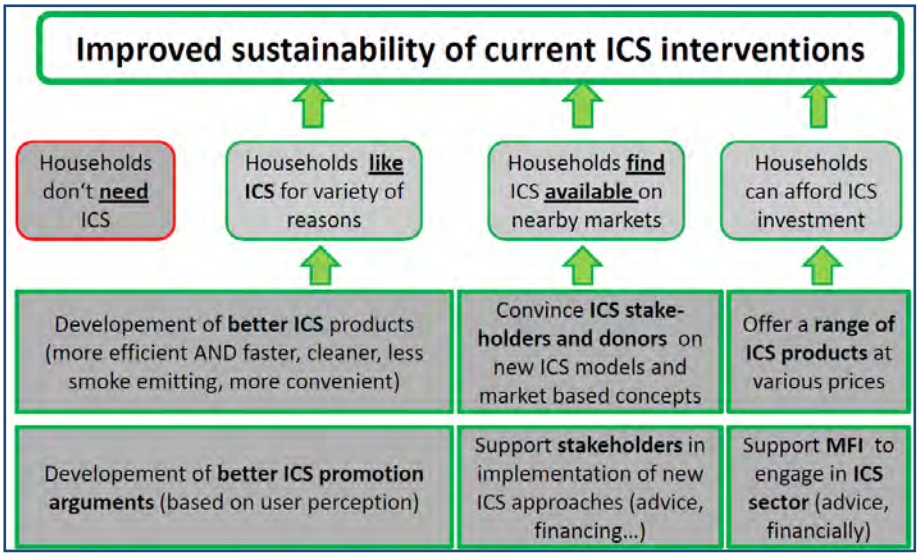
Addressing irrigation in the agricultural sector, the social enterprise Proximity Designs has managed[20] to sell treadle pumps at prices starting at approx. 15 EUR to small farm households. This might indicate that the households have sufficient economic power to also buy an unsubsidised ICS from the market.

Specific interventions proposed to improve the sustainability of the ICS market

[20] Proximity Designs inter alia promotes their products by offering loans that allow customers to cope with their limited cash availability.

Whilst Chapter 5.5 covers both the biomass energy supply and demand side, Graph 11 illustrates in particular the required interventions for sustainable ICS promotion which is expected to eventually reduce the demand for biomass.

Graph 11: Required Interventions for Sustainable ICS Promotion



Source: scoping mission.

The promotion of ICS should be focussed primarily on the perception of the user-households and not on the overall development goal or "reducing deforestation". Hence, new promotion arguments are required which are addressing the preferences of the target groups. ICS should be improved in respect to these preferences. Both interventions may improve the acceptance and interest of the target groups in the ICS usage.

A continuous supply of ICS to the rural population of Myanmar free of charge is obviously not possible. As the stoves have a limited life span, even full distribution coverage of all rural households would only result in a temporary change in wood fuel usage as there is no structure to promote the replacement of the ICS. Market based approaches are therefore key if sustainable usage of ICS shall be achieved. This change in the mode of delivery can only work if all major stakeholders in the country agree to it. A parallel application of free handouts of ICS and market based approaches will not work.

To address the differences in power to purchase and power to invest, a variety of ICS products of different costs and different quality should be offered to the customers. Micro-finance opportunities can be applied to reduce the investment barriers for ICS.

Solid biomass waste is used as complementary cooking fuel in some areas

Pigeon peas (2.3 tons/year) and rice husks (0.3 tons/year) were reported as important supplementary fuels particularly in wood deficit areas like the central Dry Zone. About a third of the households visited during the field trip were growing pigeon peas and all of them used the stems for fuel. This concept, which has been a large success in other countries, might be another option to be pursuit in the years to come for building up sustainable biomass energy supply/demand systems in rural areas.

5.4 Other Forms of Biomass Energy

Early biogas trials have not (yet) resulted in large scale application

During the 1980s and 1990s a number of smaller and larger biogas plants have been installed (approx. 1,000 in total). Unfortunately, reports on these installations – though written recently – give no reference on the success of these installations. During the discussions with FAO, the mission team learnt that nowadays still `pilot installations´ are implemented that face basic technical problems. However, the mission team did not hear or see any evidence that biogas has become a largely used technology. The mission team was informed that the Dutch development NGO SNV has assessed the biogas potential for household and large scale installations.

Gasification of biomass has a potential for agro-industry

During discussions with the Myanmar Engineering Society the mission team was informed about Myanmar's own gasifier technology which won the ASEAN Energy Award 2006.[21] Due to technical challenges, its main field of application is seen in conjunction with the agro-industry, where technically skilled operators are typically easier to employ than at village level.

Bio-ethanol is produced to a limited extend by the private sector

Possible feedstocks for bio-ethanol are molasses from processing sugarcane (highest potential), cassava and maize. So far, it seems that only the sugar industry has started to produce bio-ethanol. Generally, it has to be taken into consideration that the use of feedstock with food properties for fuel production is problematic as long as food security is still an issue in the country.

The "Jatropha-story" has a small chapter in Myanmar

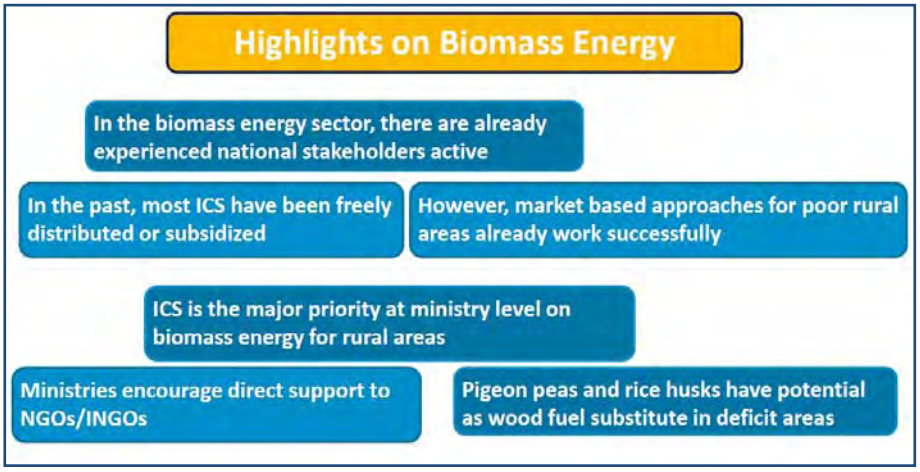
According to literature, plans for planting 3 million hectares of Jatropha have been initiated. These plans have been partially implemented. There are no reports with regards to the processing of Jatropha into biodiesel available. Though there have been ideas mentioned to use Jatropha oil for off-grid power generation, this topic was not raised as a priority amongst the stakeholders met.

[21] For information on a gasifier installation in Myanmar supported by the European Commission via IEE-REEPRO, see: http://www.reepro.info/fileadmin/files/REEPRO/International_projects/Biomass_Rural_Electrification_with_rice_husk_gasifier_in_Myanmar.pdf .

5.5 Conclusions & Recommendations on Biomass Energy

The wood fuel sector with interventions on the supply side (e.g. community forestry, food and fuel crops) and demand side (e.g. ICS promotion) is the part of biomass energy sector which has the most direct impact on the quality of life of the majority of mainly rural, but also urban population. There is already an infrastructure of partners from government, NGOs, and the private sector which have experiences in implementing respective activities.

Graph 12: Highlights - Biomass Energy



Source: scoping mission.

While this is an encouraging finding, it would be dangerous to assume that the immediate allocation of large funding for implementation would result in long lasting improvement of the situation in rural Myanmar. Observations of the outcome and impact of the previous activities in the sector suggest – though not quantitatively evaluated – that there is an urgent need to invest into capacity development and networking amongst the service providers of the wood fuel sector before financing further implementation. As the consolidated overview in Table 12 indicates, this applies for both the promotion of community forestry as well as for the ICS.

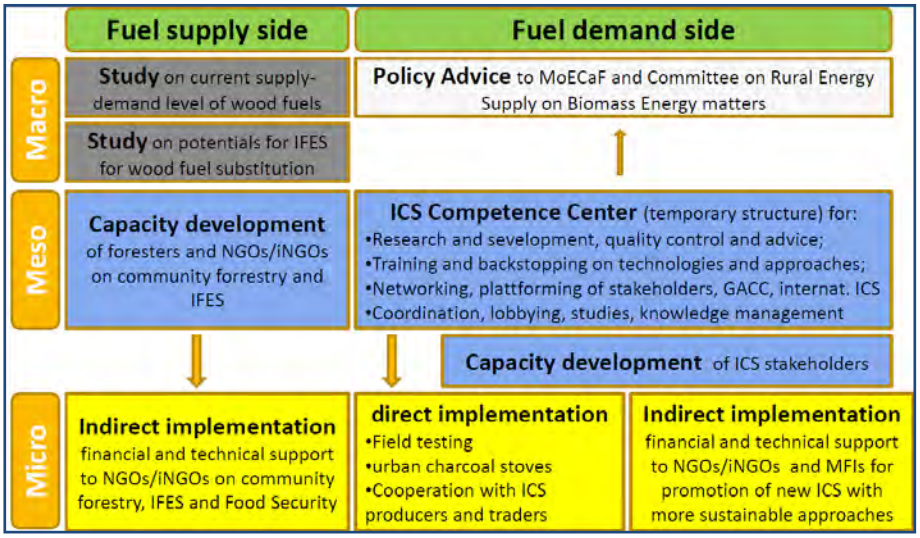
Table 12: SWOT-Analysis - Biomass Energy for Domestic Cooking

Strengths	Weaknesses
MoECaF supports direct international support to NGOs /iNGOs **Fuel supply side:** -App. 50% of the area is forest (though declining and degrading). In most rural areas, wood fuel can still be collected, whereas in urban areas and some rural areas, wood fuel is a commodity; -Regulations for "community forestry" are available; many internationally trained foresters are available; -In some areas, solid agro-waste is used as supplementary fuel (p/peas, maize cobs, rice husks); **Fuel demand side:** -Long history of ICS promotion in Myanmar (knowledge, actors, structures for ICS available). Many NGOs and iNGOs are engaged in promotion of ICS -In some areas, commercial supply-demand systems for ICS have emerged. Paying for stoves (< 3,000 K) is acceptable in these areas. Good business case for efficient charcoal stove in urban areas available.	Very little capacity at ministry level to deal with biomass energy (no policy, no strategy, no plan, no budget, no infrastructure) **Fuel supply side:** -Current level of wood fuel consumption not sustainable? Lack of reliable data (agriculture and forest industry have to be considered) -Forestry services have little understanding of "community forestry" -Potential for "food and fuel" synergies have not yet been extensively utilized; **Fuel demand side:** -There is no systematic coordination and exchange between ICS implementers. No research and quality control on ICS is done. As a result, stoves are facing quality problems, and modern designs have not yet reached Myanmar. -The purchase power in many rural area is low. Many stakeholders believe that ICS promotion requires subsidy/free handouts. Many short term ICS interventions dishing out free stoves without supply system for spare parts and replacement stoves, no user training on use and maintenance. This has given the Clay-ICS (A1) a bad reputation in some areas of the country.
Opportunities	**Threats**
Fuel supply side: - "Good practices "on community forestry available in the region; - Concepts and good practice on integrated food and energy farming systems (FAO: IFES) are available; **Fuel demand side:** - New design principles for efficient ICS internationally available; - Many concepts for sustainable promotion of ICS for "poor people" internationally available; - Some organizations consider carbon financing for ICS as opportunity - Easy /cheap access to parts and modern ICS from China and India - Gasifier household cook stoves is a new technology to provide convenient cooking with agricultural waste (e.g. rice husks)	-**Fuel supply side:** - Other forest based Industries might be stronger (teak, paper…); - International organisations tend to think/operate within sectors (not open for integrated approaches); **Fuel demand side:** - New donors/programs may promote "one stove solutions" rather than provide training on design principles; - High volume short term programs may focus on "fast distribution success" rather than long term sustainability; - Many example show that carbon financing can undermine sustainability of ICS promotion; - IGA aspect of stove promotion might be undermined by imports

Source: scoping mission.

Injecting new funds for scaling-up of community forestry or ICS activities in various areas without investing into capacity development might result in a perpetuation of unsustainable outcomes with little impact for the target groups concerned. Therefore, approaches need to be reviewed, products need to be improved, and a joint understanding of good practice should be developed so that there are little contradictions between development efforts of various interventions in the years to come. Graph 13 shows the core building blocks of respective capacity development interventions.

Graph 13: Structure of Recommended Development Interventions on Biomass Energy



Source: scoping mission.

With a focus on capacity building, the scoping mission team has outlined two options for potential development cooperation measures. The **Option Paper "Preparatory Assessment of Woodfuel Supply & Demand Side"** and the **Option Paper "Biomass Cooking Energy Programme for Rural Areas"** are provided in Part II.

6 Scoping Mission Schedule & Contact Details

Date	Meeting with	Persons met[22]
22-4-2012	**European Union**	Andreas List – Head of Office
23-4-2012	**UNDP**	Akbar Usmani – Senior Deputy Resident Representative Joseph D'Cruz – Regional Advisor Environment U Min Htut Yin – Assistant Resident Representative Thet Win Htun – Socio Economist
	Renewable Energy Association Myanmar (REAM)	U Aung Myint – General Secretary Prof. Saw Win – Central Committee Member U Hla Myint – Central Executive Committee
	EcoDev	Kyan Dyne Aung – Program Officer
	Mangrove Environmental Rehabilitation Network (MERN)	Prof. Dr. Kyaw Tint – Chairman ECCDI Shwe Shwe Sein Latt – Director Phan Tee Eain Aung Thant Zin – Fund Manager MERN Daw May Aye Shwe – General Secretary ECLOF U Maung Maung Soe Tint – Chairman BADA
24-4-2012	**Mercy Corps**	Paolo Cerati – Country Director
	Ever Green Group (EGG)	Zaw Zaw Han – Chairman Prof. Aung Kyin – Honorary Advisor
	FAO	Bui Thi Lan – FAO Representative Dr. Aung Swe – Assistant FAO Representative
25-4-2012	**Ministry of Environmental Conservation and Forestry** (MOECAF)	Sann Lwin – Director General of Planning and Statistics Dept Win Hlaing – Director of Global Environmental Facility Focal Point, (MOECAF)
	Ministry of Electric Power No. (2) – Department of Electric Power	U Khin Maung Win – Deputy Director General
	Ministry of Energy – Energy Planning Department	Htin Aung – Director General

[22] Note: in order to allow for an easy follow-up, only those persons are listed here which provided their name card to the mission team. For further contact details please contact info@euei-pdf.org.

	Ministry of Industry – Directorate of Heavy Industrial Planning	Than Htaik – Director General Head of 'Rural Energy Development Committee
	Members of Parliament	Thein Lwin – MP, Secretary of The Natural Resource and Environmental Conservation Committee Prof. Than New - MP
26-4-2012	**Sunpower**	Nay Win Tun – Sales Manager Win Min Zaw – R&D Manager
	FREDA	U Ohn – Vice Chairman
	Myanmar Engineering Society (MES)	U Tin Maung Win – Managing Director United Win Engineering Col. Thoung Win – Central Executive Committee MES Prof. Dr. Sein Myint – Vice President ASEAN Academy of Engineering and Technology Dr. Yin Yin Tun – Professor Mechanical Engineering, Yangon Technical University U Shein Kyi – Uni Tech Technical Enterprise
27-4-2012	**Field Visit Shan State** Lawenyeint Village Thantaung Village	- A1 improved cook stove production - Pico hydropower plant
28-4-2012	UNDP Township Office	
	Magyisin Village	Village with no electricity connection
	Township Rural Electrification Committee	U Win Myint – Minister for Inntha Affairs, Shan State
	MHP project developer & manufacturer (in Nyaungshwe)	U Khun Kyaw
1-5-2012	Debriefing with **UNDP** Myanmar	
	JICA	Matuoka Hajime – Representative
2-5-2012	Debriefing with **EU**	Andreas List
	Proximity Designs – Social Enterprise	Debbie Aung Din Taylor – Director James Taylor – Director Valentino Soe Myint – Project Manager
3-5-2012	Debriefing with **UNDP** Bangkok	Joseph D'Cruz Thiyagarajan Velumail – Regional Technical Advisor on Energy

Part II: OPTION PAPERS

Option Paper:
Technical & Policy Advisory of Rural Energy Development Committee

1. Issue at Stake

Development needs adequate energy supply. More than 70% of Myanmar's population rely on biomass for cooking & heating whilst the country's forest coverage is shrinking. With an electrification ratio of 13-26%, up to 52 million inhabitants have no access to reliable and affordable electricity.[23]

Whilst in the past rural people did not expect much in terms of public infrastructure services, the situation has changed fundamentally since new forms of political participation are on the rise. To cater for the 2/3 of Myanmar's population that live in rural areas the government has formed the inter-ministerial *Rural Energy Development Supporting Committee*.

The Committee is chaired by the Minister of Industry and is supposed to address issues of rural energy access as one of the government's eight development priorities for poverty reduction. The Committee is in charge of drafting a rural electrification master plan for isolated power provision. The mission team was requested by the Ministry of Industry to consider technical assistance that increases the understanding of suitable technology solutions and that helps to overcome budget constraints in rural energy development.

2. Challenges

- Knowledge about major characteristic of various rural energy supply options seems limited and data for planning and decision making seems to some extent either unavailable or inconsistent
- Responsibilities for rural energy issues are highly fragmented, actions are not coordinated and a dedicated allocation of financial resources for rural energy issues is missing
- A rural energy policy is not yet in place and policy development beyond acting on orders had been a relatively unpractised process in Myanmar's recent history

3. Objective

Enhancing the understanding of rural energy issues and policy concepts within the *Rural Energy Development Supporting Committee* and committee member organisations in order to enable a continuous process of developing, monitoring and updating energy access policies and strategies.

4. Potential Scope of Intervention

- Carrying out a joint assessment together with representatives of the *Rural Energy Development Supporting Committee* to further deepen the understanding of rural energy developing needs

[23] In Myanmar's past, energy access issues had not been subject to intense assessments and external reviews. Thus, quantitative data often appears inconsistent or shows large variance and should be considered rather as best guess than as proven facts.

- Conducting a multi-stakeholder workshop to discuss the assessment's findings and agree upon Myanmar-specific rural energy policy development priorities
- Initiating dialogue, networking and exposure activities in order to foster the exchange of knowledge on previously identified and prioritized rural energy policy issues
- Carrying out a study to support the Committee in policy and/or strategy development on up to two previously prioritized issues[24]

5. Urgency & Time Requirement of Intervention

Considering the fundamental character of the issue for the rural energy access, the political pressure for progress on the Committee, and the explicit request to EUEI-PDF for support, the **urgency** is rated as **high-very high**. Time wise, the support can be delivered as a **short term intervention** package that tackles up to two issues in detail whilst for remaining issues priorities and recommendations would be provided for follow-up.

6. Potential Partners

The major addressee of the intervention would be the inter-ministerial Rural Energy Development Supporting Committee, respectively the core representatives from the Committee's member ministries, primarily from the Ministry of Industry which is chairing the Committee. To which extent and what occasions also representatives from NGOs and business associations shall be involved would need to be clarified with the Committee.

[24] Since the issues shall be jointly identified and prioritized during the advisory process, the following examples are mentioned for illustrative purposes only: familiarisation with methods for needs assessment & investment planning; introduction of methods & related tools for rural electrification planning; consultative process for the integration of energy access into national and/or regional development plans.

Option Paper:
Support in Rural Energy Planning & Coordination

1. Issue at Stake

Development needs adequate energy supply. More than 70% of Myanmar's population rely on biomass for cooking & heating whilst the country's forest coverage is declining in quality and quantity. With an electrification ratio of 13-26%, up to 52 million inhabitants have no access to reliable and affordable electricity.[25]

Whilst in the past rural people did not expect much in terms of public infrastructure services, the situation has changed fundamentally since new forms of political participation are on the rise. To cater for the 2/3 of Myanmar's population that live in rural areas, the government at national and sub-national levels is now in dire need of specific know-how for rural energy planning. The Ministry of Industry as well as the Ministry of Electric Power No. (2) expressed their hope for receiving international support on this issue.

Since for the foreseeable future the government will likely be unable to cope with the energy issue in the rural areas on its own, it can be assumed that numerous development organizations, NGOs and private sector companies will themselves tackle the issue of rural energy. The multiplication of actors, however, requires effective sharing of information, communication and coordination. To avoid setting-up of unsustainable parallel coordination structures, the capacities of respective governmental bodies should be developed in order to take care of the issue from the outset.

2. Challenges

- Knowledge about major characteristic of various rural energy supply options seems limited and data for planning and decision making seems unavailable or inconsistent
- Responsibilities for rural energy issues are highly fragmented, actions are not coordinated and a dedicated allocation of financial resources for rural energy issues is missing
- Governmental institutions are currently occupied with the internal transformation process
- The transformation might lead to a vacuum which gets adversely exploited by vested interests

3. Objective

Enabling respective governmental bodies at national and sub-national levels to increasingly assume crucial functions of public administration on rural energy planning and coordination in order to promote a coherent and cost-efficient increase of modern energy access in rural parts of Myanmar.

4. Potential Scope of Intervention

- Transferring know-how to concerned public servants and their technical service providers for decision making on suitable rural energy supply options

[25] In Myanmar's past, energy access issues had not been subject to intense assessments and external reviews. Thus, quantitative data often appears inconsistent or shows large variance and should be considered rather as best guess than as proven facts.

- Exposure visits to exemplary implementations
- Workshops with know-how providers from within the region (peer-learning)

- Introducing software-based rural energy resource assessment and planning tools
- Introducing software (e.g. GIS and/or wiki) that can be used for coordination and communication of energy issues and subsequently be scaled-up to a wider infrastructure coordination platform that facilitates inter-sectoral development
- Providing accompanying training courses for respective public servants and their technical service providers
- Handholding throughout initial application of acquired know-how in planning or assessing and implementing of respective investment projects
- Documentation and communication of lessons learned and recommendations derived for a potential mainstreaming of the approach throughout Myanmar

5. Urgency & Time Requirement of Intervention

With the transformation process being in full swing, the respective capacities of concerned governmental bodies should be developed rather soon in order to avoid the emergence of vacuum situations and/or parallel structures. Particularly when combined with the exemplary implementation of investment projects, this would be a visible signal that the government (vis-à-vis the donor community) is increasingly assuming its functions and taking care of the people. Based on this political rationale the **urgency** is rated as **high**.

Whilst exposure activities and the provision of software-tools and accompanying trainings can be done in a relatively short period of time, the **subsequent training on the job is considered crucial** for the success of the intervention. Especially when considering also a later up-scaling beyond 1-2 pilot regions, the support should be planned **at least** as **medium term intervention.**

6. Potential Partners & Intermediaries

During the energy sector scoping mission, the following actors have been identified. Since rural energy planning and coordination formed only a part of the assessment, this list cannot be complete but instead might serve as starting point for a more detailed assessment.

- Governmental bodies: Rural Energy Development Supporting Committee, Ministry of Industry, Ministry of Electric Power No. (2), Central Statistical Organisation
- Associations & NGOs: In the past, associations and NGOs in many cases assumed functions which in other countries would rather be performed by the government. Including the capacities of e.g. the Renewable Energy Association Myanmar or the Myanmar Engineering Society, also as potential service providers to the government, might therefore be advisable for this intervention
- Private sector companies engaged in the planning, engineering and implementation of various RE-technologies

Option Paper:
Piloting Village Mini-Grid Approaches for Systematic Learning

1. Issue at Stake

With an electrification ratio of 13-26%, up to 52 million inhabitants have no access to reliable and affordable electricity in Myanmar.[26] The use of provisional energy sources such as small gensets, disposable batteries, diesel lanterns or candles consumes a disproportional high share of people's income and harms the environment. Insufficient energy supply also limits the local economic development and the expansion of social infrastructure.

Given that approx. 2/3 of Myanmar's people live in rural areas, it would take unbearably long until a majority of the population could be supplied with electricity by conventional grid-extension in a cost-efficient manner. Governmental representatives (in particular the Ministry of Industry)met during the scoping mission therefore recognise village mini-grids as full-fledged alternative and expressed their hope for support in pilot installations.

In locations with good potential for high load factors, mini-grids are often the least-cost option. This is the case where in remote areas energy is required beyond for lighting also for income generating productive purposes e.g. for cottage industries and/or agro-processing. With the agricultural sector being a major backbone of Myanmar's economy, the relevance for mini-grid solutions is considered high.

2. Challenges

- Compared to individual energy systems at household level, mini-grids require coordinated actions, e.g. regarding the raising of funds for the upfront investments or for the setting-up and running of a management and O&M structure. Scaling-up the number of mini-grids is therefore considered difficult unless supported by knowledgably government and/or donor organisations
- Since the few existing mini-grids are based on self-help initiatives (pico & micro hydro mostly in remote areas or diesel gen-sets for the informal supply of family & friends) there seems to be no systematic know-how or institutionalized experience available on mini-grids in Myanmar at government, NGO and private sector levels
- Given Myanmar's high degree of diversity (e.g. physical conditions & landscapes, cultures & religions, livelihoods) there is likely no "one size fits all" approach to village mini grids. Particularly not when aiming at sustainable solutions, i.e. going beyond the increasingly unaffordable diesel gen-sets by introducing hybrid solutions or completely RE-based systems

3. Objective

Piloting a number of different village mini-grid approaches that allow for systematic learning of what works in Myanmar (in terms of e.g. technologies, business and ownership models, degree of participatory planning) under which conditions and thereby provide concerned stakeholders in the

[26] In Myanmar's past, energy access issues had not been subject to intense assessments and external reviews. Thus, quantitative data often appears inconsistent or shows large variance and should be considered rather as best guess than as proven facts.

government, the NGOs and the private sector with proven and applicable knowledge for scaling-up mini-grid electrification throughout Myanmar. Thereby, particular attention will be given to transferring respective knowledge for the energy access planning to sub-national government and public administration levels as they are geographically closest to future mini-grid locations.

4. Potential Scope of Intervention

- Assessing and documenting experiences with existing village mini grids in Myanmar
- Providing international good practices that allow for leapfrog development in Myanmar
- Conducting a needs assessment on promising mini grid approaches likely required in the future
- Deriving a set of crucial characteristics of mini-grids that need to be systematically field tested
- Developing a monitoring & evaluation system that provides stakeholders with required data
- Choosing / initiating a number of exemplary investment projects suitable for systematic learning
- Document and communicate lessons learned and recommendations derived
- Assure mainstreaming of findings by initially accompanying follow-up investment projects

5. Urgency & Time Requirement of Intervention

Although the number of diesel engines and diesel gen-sets in rural Myanmar indicate the need for productive power, the immediate political pressure of tackling this advanced level of electrification is considered lower than for the substitution of candles and batteries for lighting which concerns almost all rural population. On the other hand, several initiatives have started at policy level (e.g. drafting of rural electrification law and rural electrification master plan) which would benefit from systematically addressing the topic rather sooner than later. Based on the scoping mission's preliminary information, the **urgency** is therefore rated as **medium-high**.

Piloting mini grid approaches is considered as a **medium term intervention** since the learning from exemplary implementation and the mainstreaming of findings requires a minimum of time during which the mini-grids are systematically monitored.

6. Potential Partners & Intermediaries

During the energy sector scoping mission, the following actors have been identified. Since mini-grid approaches formed only a part of the assessment, this list cannot be complete but instead might serve as starting point for a more detailed assessment.

- Governmental bodies: Rural Energy Development Supporting Committee, Ministry of Industry, Ministry of Science & Technology, Ministry of Electric Power No. (2), Min. of Agriculture & Irrigation
- Associations & NGOs: Renewable Energy Association Myanmar, Myanmar Engineering Society, NGOs active in community development and livelihood support
- Private sector companies engaged in the planning, engineering and implementation of various RE-technologies

Option Paper:
Sustainable Market Development for Household-level PV Systems

1. Issue at Stake

With an electrification ratio of 13-26%, up to 52 million inhabitants have no access to reliable and affordable electricity in Myanmar.[27] The use of provisional energy sources such as small gensets, disposable batteries, diesel lanterns or candles consumes a disproportional high share of people's income and harms the environment. Solely for lighting by candles and electric torches, rural households spend up to 7 €/month.

Given that approx. 2/3 of Myanmar's people live in rural areas, it would take unbearably long until a majority of the population could be supplied with electricity by conventional grid-extension in a cost-efficient manner. This holds particularly true for the politically important but geographically difficult to access border areas.

In recent years, due to mass-production of PV panels and technological progress in LEDs and batteries, good quality PicoPV-systems have become a least-cost option for lighting. Whilst some PicoPV-systems also allow for mobile phone charging and radio, powering TV-sets requires larger solar home systems (SHS). Although SHS had severe technical problems in the past, high energy efficient TV-sets (<20W) increasingly allow for smaller and more reliable SHS nowadays.

2. Challenges

- Although rural inhabitants of Myanmar are used to regularly pay small amounts for energy, their power for cash purchases is limited. Without suitable pre-financing schemes, the majority can only afford low quality PV products which compromise the technology's reputation
- A typical customer cannot recognize the durability & performance of PV systems at purchase
- The current market's opening might boost an inflow of more bad quality PV products
- Donors' quest for quick results might undermine a sustainable market growth– particularly when handing out subsidized PV systems to the poorest households and thereby spurring the misconception of "a poor solution for poor people"

3. Objective

Improving the access to modern energy services for lighting, information & communication through a market-oriented promotion of good quality household-level PV systems that are easy to install, operate and maintain and allow for lower energy-specific household expenditures.

4. Potential Scope of Intervention

[27] In Myanmar's past, energy access issues had not been subject to intense assessments and external reviews. Thus, quantitative data often appears inconsistent or shows large variance and should be considered rather as best guess than as proven facts.

Supporting a sustainable market development requires a set of interventions as exemplary listed[28]:

- Consumer awareness and education campaign
  - Providing potential users with objective information on proven and reliable products in order to become knowledgeable customers
  - Providing required know-how to correctly install, operate and maintain the systems at home
- Manufacturer & distributor support
  - Offering standardized product testing and performance verification in order to design and/or source suitable products
  - Offering tailored business development service packages, addressing e.g. quality control, financial management, business planning, marketing, distribution strategy, after-sales service
- Financier support
  - Supporting local financial institutions in addressing finance-related bottlenecks along the PV value chain (e.g. long-term growth capital, trade-finance and short-term working capital) by facilitating access to risk mitigation instruments and refunding
  - Helping (micro-)financiers to understand the particularities of PV lending to Base-of-Pyramid (BoP) customers
- Government support & policy advisory
  - Providing access to international good practices for the creation of conducive framework conditions
  - Supporting the analysis of potential policy actions concerning the consequences of e.g. taxes, duties and subsidies on PV market growth
  - Support the government in defining and assuming its role for PV market development vis-à-vis the private sector (e.g. regarding R&D, trainings for PV professionals)
  - Supporting the government in mainstreaming successfully tested PV market support approaches throughout Myanmar

5. Urgency & Time Requirement of Intervention

The **urgency** of the intervention is considered **very high** for the following reasons:

- Imminent need: the disproportional high share of income for candles and batteries indicates the need that rural people in Myanmar attribute to what is often underrated as `just lighting´
- Political rationale: promoting household level PV systems has a high geographic outreach and thereby also allows for the inclusion of ethnic minorities (=> ethnic peace dividend)
- Timing of market opening: Myanmar and its markets are opening now which defines a unique window of opportunity for limiting a mass inflow of unsustainable products and promoting the dissemination of good quality PV solutions from the outset
- Users' attitude: rural inhabitants of Myanmar are still used to pay for lighting and electricity which is probably the most precious asset for any market-based approach. With the increasing number of donors coming to Myanmar, this attitude might easily get spoiled unless the issue is visibly been taken care of in the right approach from the outset

The **time requirement** for addressing PV market development support can be differentiated in a short and a medium term track:

[28] For more details, refer to e.g. https://energypedia.info/index.php/Portal:Solar, http://www.lightingafrica.org/ or http://sfa-pv.org/.

- **Short-term intervention**: sensitising key actors in government, business associations and NGOs for international good practices (e.g. by studies, workshops, exposure visits)
- **Medium-term intervention**: comprehensive support for sustainable market development as outlined above

Although the short-term intervention is considered too limited to sufficiently address the issue, it would allow at least to signal that the sector is taken care of and thereby to gain time for the preparation of a suitable medium term intervention.

6. Potential Partners & Intermediaries

During the energy sector scoping mission, the subsequently listed actors have been identified. Since PV formed only a part of the assessment, this list cannot be complete but instead might serve as starting point for a more detailed assessment.

- Governmental bodies: Rural Energy Development Supporting Committee, Ministry of Industry, Ministry of Science & Technology, Ministry of Electric Power No. (2)
- Associations & NGOs: Renewable Energy Association Myanmar, Myanmar Engineering Society
- Financial sector: so far the mission team learned only about one MFI named PACT; however, it is expected that many more will become active in Myanmar soon
- Private sector representatives: the mission team has met with Sun Power and Proximity Designs; the current Yellow Pages of Myanmar list about a dozen PV-related companies in Myanmar

Option Paper:
Preparatory Assessment of
Woodfuel Demand & Supply Side

1. Issue at Stake

Development needs adequate energy supply. More than 70% of Myanmar's population rely on biomass for cooking & heating whilst the country's forest coverage is rapidly declining in quality and quantity for a variety of reasons. A dramatic increase of walking distances and time requirements for woodfuel collection has been reported in recent years e.g. for the Dry Zone region.

On the biomass supply side, plenty of trained foresters have been engaged in tree planting activities. As of late, also the regulations required for community forestry approaches seem to be in place. However, while the concept of community forest has shown good results in other countries in the region (e.g. Nepal), there is an apparent need for more capacity development and exposure activities to allow for a more successful application of the community forest concept also in Myanmar.

On the biomass demand side, the issue of improved cook stoves (ICS) has been addressed for more than 15 years by a large number of NGOs; yet ICS penetration still seems to be small. Stove designs have been focussed on low-cost solutions which offer rather small advantages over the traditional 3-stone fire. Unless introducing up-to-date international stove design and promotion know-how, the expected inflow of further funding would probably result in a perpetuation of past shortcomings and thereby spoil the reputation of ICS.

2. Challenges

- The promoted ICS seem to have quality problems and modern firewood stove concepts like the rocket stove principles have not yet reached Myanmar
- The dominant promotion concepts do not focus on a sustainable ICS market development
- Community forestry as a bottom-up concept seems to be challenged by top-down targets, forcing foresters to jeopardise the concept's empowerment part to fulfil their delivery targets

3. Objective

Establishing a preparatory, action-oriented overview on woodfuel demand & supply side issues that allow for state-of-the-art design of comprehensive development interventions on biomass energy in rural areas.

4. Potential Scope of Intervention

- Conducting a stakeholder mapping and establishing an overview concerning ongoing and future activities of development agents
- Elaboration of a status report on previous efforts, current situation and lessons learnt
- Identification of low hanging fruits and early actions (areas of intervention, target groups etc)

- Identification of potential partners for implementation and of suitable infrastructure to support early actions

5. Urgency & Time Requirement of Intervention

Considering the fundamental character of the issue for the rural energy and environmental situation plus the imminent need of development organisation to draft their future country programs the **urgency** of this preparatory work is rated as **very high**. Time wise, the activity is considered as a **short term intervention** that would outline the way forward for a comprehensive series of longer-termed follow-up interventions.

6. Potential Partners

Besides the Ministry of Forestry and Environmental Conservation as potential partner, the main providers of information for the envisaged assessment consist probably of local NGOs like EcoDev, EGG, FREDA, MERN and REAM and international organisation such as FAO, MercyCorps and UNDP.

Option Paper:
Biomass Cooking Energy Programme for Rural Areas

1. Issue at Stake

Development needs adequate energy supply. More than 70% of Myanmar's population rely on biomass for cooking & heating. In the past decades, the country's forest coverage is rapidly declining in quality and quantity for a variety of reasons. As a result, a dramatic increase of walking distances and time requirements for woodfuel collection has been reported in recent years e.g. for the Dry Zone region.[29]

In order to counteract this trend, a number of interventions both on the supply and the demand side of biomass energy have been applied in the past years. However, stakeholders report that the impact of these activities has been rather limited so far.

On the biomass supply side, plenty of trained foresters have been engaged in tree planting activities. As of late, all regulations required for community forestry approaches seem to be in place. However, while the concept of community forest has shown good results in other countries in the region (e.g. Nepal), there is an apparent need for more capacity development and exposure activities to allow for a more successful application of the community forest concept also in Myanmar.

On the biomass demand side, the issue of improved cook stoves (ICS) has been addressed for more than 15 years by a large number of NGOs; yet ICS penetration even in the most fuel wood deficit areas still seems to be small. Stove designs have been focussed on low-cost solutions which offer rather small advantages over the traditional 3-stone fire. Unless introducing up-to-date international stove design and promotion know-how, the expected inflow of further funding will probably result in a perpetuation of past shortcomings and thereby spoil the reputation of ICS.

However, there are also a number of encouraging facts to be reported. For example, in some areas where firewood is very scarce, pigeon peas and rice husk are used as supplementary fuels. Besides subsidized ICS promoted by NGOs there also exists a commercial and scalable market segment for improved biomass cook stoves. A social enterprise has even managed to sell treadle pumps at prices starting at approx. 15 EUR to small farm households who had commonly been considered as too poor to afford ICS at cost-covering prices.

Within a biomass energy program for rural areas, these promising approaches shall be fostered and complemented by internationally proven concepts.

2. Challenges

- The promoted ICS seem to have quality problems and modern firewood stove concepts like the rocket stove principles have not yet reached Myanmar
- The dominant promotion concepts do not focus on a sustainable ICS market development
- There is little (institutionalised) exchange and learning between biomass energy stakeholders

[29] In Myanmar's past, energy access issues had not been subject to intense assessments and external reviews. Thus, quantitative data often appears inconsistent or shows large variance and should be considered rather as best guess than as proven facts.

- Community forestry as a bottom-up concept seems to be challenged by top-down targets, forcing foresters to jeopardise the concept's community empowerment part
- Balancing biomass energy's supply and demand side would not necessarily stop the decline of forests since its reasons depend also on non-energy related factors such as the timber industry

3. Objective

Introducing, adapting and establishing international good practices on sustainable rural biomass energy utilization for cooking with high up-scaling potential to eventually outreach to the majority of Myanmar's population whose main source of energy is biomass.

4. Potential Scope of Intervention – Short Term (3-6 months)

Based on the results of a preparatory assessment of woodfuel issues (to be conducted either as separate intervention[30] or as first activity of this program), the following set of actions would form a consistent intervention that is expected to deliver visible progress within a short period of time:

- Capacity development actions on community forestry (training, regional exposure tour…)
- "Pigeon pea as fuel": assess current practice, document and publish success story for future replication at larger scale in Myanmar
- Formation of national practitioner's network on ICS
- Stove camp on stove design principles and stove testing with regional & international experts
- Establishing a national stove testing facility
- Assessing priorities of target groups on stove design by testing and ranking a variety of local, regional & international firewood and charcoal cook stoves through women groups

5. Potential Scope of Intervention – Medium-Long Term

The proposed medium-long term intervention would build upon the results of the a.m. short term intervention and assure their thematic consolidation and geographic outreach:

- Technical and financial support to public administration and NGOs on community forestry
- Promotion of pigeon peas as "food & fuel crop" in areas with firewood scarcity
- Development of new ICS designs based on international experiences and the feedback from women groups and stove producers for different target groups;
- Improvement of local ICS production systems for a more sustainable stove production
- Support to bridging the gap between suppliers of rural energy products and their customers
- Support to quality control and quality awareness on rural energy products and services
- Support to microfinance institutions on lending for household energy solutions in rural areas

6. Urgency of Intervention

Considering the high relevance of the issue for the rural energy situation and the forest degradation, the proposed intervention is rated with **rather high urgency**, i.e. it should start soon after completion of the preparatory assessment. Showing good quality progress at an early stage is not only important politically towards the stakeholders in Myanmar but also to other donor initiatives who might be looking for promising approaches to be replicated.

[30] See separate Option Paper: „Preparatory Assessment of Woodfuel Demand & Supply Side".

7. Potential Partners

From the energy sector scoping mission, it is known that the Ministry of Forestry and Environmental Conservation as well as local NGOs like EcoDev, EGG, FREDA, MERN, REAM and international organisation such as FAO, MercyCorps and UNDP have been addressing ICS issues.

The envisaged *Preparatory Assessment of Woodfuel Demand & Supply Side* would provide further insights on potential partners for this biomass cooking energy programme.

Abbreviations

ASEAN	Association of South East Asian Nations	LED	Light Emitting Diode
bln	billion	MERN	Mangrove & Environmental Rehabilitation Network
BOT	Built Operate Transfer	MES	Myanmar Engineering Society
CFL	Compact Fluorescent Light	MFI	Micro Finance Institution
CPI	Corruption Perception Index	MHP	Micro & Mini Hydropower
cu ft	cubic feet	mln	million
EcoDev	Economically Progressive Ecosystem Development	MoECaF	Ministry of Environmental Conservation and Forestry
EGG	Ever Green Group	MoEP1	Ministry of Electric Power No. (1)
EIU	Economist Intelligence Unit	MoEP2	Ministry of Electric Power No. (2)
EU	European Union	MOGE	Myanma Oil & Gas Enterprise
EUEI	EU Energy Initiative	MoI	Ministry of Industry
FAO	Food and Agriculture Organization of the United Nations	MW	Megawatt
FREDA	Forest Resource Environment Development & Conservation Association	NGO	Non Governmental Organisation
GACC	Global Alliance for Clean Cook stoves	NREL	National Renewable Energy Laboratory
GDP	Gross Domestic Product	O&M	Operations and Maintenance
GEF	Global Environment Facility	p.a.	per annum
GMS	Greater Mekong Sub-region	PDF	Partnership Dialogue Facility
GWh	Gigawatt-hour	PV	Photovoltaic
HDI	Human Development Index	REAM	Renewable Energy Association Myanmar
HDR	Human Development Report	S-E Asia	South East Asia
HYCOM	Hydropower Competence & Training Centre	SHS	Solar Home System
ICS	Improved Cook Stove	SWOT	Strengths , Weaknesses, Opportunities &Threats
ICT	Information & Communications Technology	TFT	Thin Film Transistor
IEA	International Energy Agency	T&D	Transmission and Distribution
IEE-REEPRO	Intelligent Energy Europe - Promotion of the Efficient Use of Renewable Energies in Developing Countries	TWh	Terawatt-hour
IFES	Integrated Food-Energy Systems	UNDP	United Nations Development Programme
IMF	International Monetary Fund	UNEP	United Nations Environment Programme
iNGO	international Non Governmental Organisation	W	Watt
IPP	Independent Power Production	WEO	World Energy Outlook
JICA	Japan International Cooperation Agency	W_p	Watt peak
JV	Joint Venture		
K	Kyats		
kV	Kilovolt		
kW	Kilowatt		
kWh	Kilowatt-hour		
LCD	Liquid Crystal Display		

List of Graphs & Tables

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