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OFF-GRID OPPORTUNITIES AND CHALLENGES IN VIETNAM

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in partnership with

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1 Introduction to the assignment

This assignment is focusing on the identification of the off-grid regions and communes in Viet Nam, to prepare for the follow-up work that will be done as part of the Vietnam Clean Energy Program, funded by the USAID, and with Winrock International as the main implementer.

The main focus of the Vietnam Clean Energy Program, Sub-IR 2.3 is to increase public and private investment in and piloting of renewable energy technologies. This is split into 3 focus areas:

- Result 2.3.1 Developers have economically viable renewable energy projects
- Result 2.3.2 Policy framework for renewable energy facilitates private sector investments
- Result 2.3.3 Off-grid poor communities gain access to renewable energy

This assignment is the initial step towards result 2.3.3. on off-grid poor communities.

Off-grid is defined by the project partners to areas (households, communes) that are not connected to the national grid, which are located mostly in the rural, mountainous area or island. Communities that have decentralized diesel (or other sources) electricity generation are in this report still considered to be off-grid. The off-grid areas are generally small and dispersed communities which consisting of low-income households, unattractive (due to among other reasons high installation costs – see more about this in Chapter 5) to private-sector energy providers or even government electrification programs.

The Viet Nam Master Power Plan VII (2011) indicates that still 818,947 households are not connected to the national grid, and 759,986 households do not have any access to electricity. These number of households scattered in 189 communes, account for 2.07% of the whole country's communes with 165 communes in the North, 11 communes in the Central and 12 communes in the South. These numbers vary depending on the source (Chapter 2). In off-grid areas, to meet the lighting and other basic energy needs, many households continue to depend on expensive fossil fuel based sources, such as kerosene, which are energy inefficient, unsustainable and polluting.

Viet Nam has diverse natural resources that can be used for Renewable Energy (RE) generation such as wind, solar, hydropower, biomass and even geothermal energy (see more in Chapter 3). Small and Micro Hydropower has the governments preference (MOIT, 2011) followed by PV solar solutions. Currently there are more than 1,000 wind power installations; more than 7,000 solar PV systems and 120,000 pico and micro hydropower plants installed in off-grid areas in Viet Nam. As documented, most of these power projects were funded by the Government or international organizations with the different supporting mechanism. However, only few are currently operating at full capacities

Based on the findings of the initial desk assessment of available literature two sites will be selected for survey and detailed analysis representing the geographic areas of the off-grid communities where potentially pilot energy investments would have the best prospects for replication to benefit the largest under-served populations in the country which are either un-electrified or are receiving poor quality or high cost energy.

2 Identification of Off Grid Communities

This chapter will give some general information on the off-grid communities in Viet Nam, its energy use as well as other general information and background on electricity prices.

2.1 Community information

There is not an official list publicly available that indicates the off-grid areas and communities in Viet Nam. To obtain such information multiple meetings with local authorities (different departments in ministries as well as several government institutes), agencies, organizations and companies have been established. Different reports provide different indications of the number and the locations of the off-grid communities.

The Master Power Plan (MOIT, 2011) indicates the following; by September 2009 the national power grid covered all 63 provinces and its cities and 536/547 districts (98%). Of those, 11 rural districts had not connected to power grid yet but electricity was distributed via local diesel power and local small hydro power plants. On a community level 8,931/9,120 communes have access to electricity (97.93%) - in which 8,890 communes (97.5%) connected to power grid, 41 communes (0.5%) accessed electricity by local power production. Currently, there are 189 communes left of the whole countries living without electricity including the 41 communes with off-grid solutions. Division over the country is:

- 97% of 5,523 communes in the North
- 99.3% of 1,557 communes in the Centre
- 99.4% of 2,048 communes of the South

On household level the numbers are slightly lower, 94,7% of all rural households, or 96% of all households in Viet Nam are connected to the national grid according the Master Power Plan (there are 14,671,836 rural rural households or 20,758,415 total households in 2009 in Viet Nam). An additional 58,961 households access electricity from local decentralized power generation. Division over the country is:

- 94.5% of 7,444,127 households in the North
- 94.7% of 2,214,058 households in the Centre
- 94.2% of 5,013,651 households in the South

The Master Power Plan indicates that 818,947 households were not connected to the national grid in 2009, and 759,986 households do not have any access to electricity provided by the Government/EVN.

Figures of EVN's individual companies (5 large power companies in total, with underneath several smaller subsidiaries), also of 2009, indicate similar figures 784,470 households with no connection and 56,010 households with decentralized electricity supply (this was 862,050 and 52,315 in 2008). The 2012 figures of EVN show that this has reduced to 549,131 households country wide, and an additional 30,925 households that are sourced with decentralized units.

The World Bank (2011) report on The Viet Nam Rural Electrification Experience, indicates that little over 600,000 households does not have access to electricity (3,7% of all households in Viet Nam). The most recent survey, which was done by the Committee of Ethnic Minorities Affairs (CEMA) in 2012 has shown little over 73,000 households (in 79 communes) without access to electricity.

Multiple governmental institutes, organizations and companies in Viet Nam like GIZ, ADB, WB, VinaForest, Tan Viet Solar, Golden Bridge etc. as well as local agencies as Department of Network Planning under Institute of Energy, Department of Electricity Grid under General Directorate of Energy (MOIT), Rural Electricity Network and Business Department of EVN, the Institute of Energy were met to increase understanding of the current electricity situation in Viet Nam, as well as opportunities and challenges in the field of rural electrification and electrification rates, as well as trends and strategy for electrification for next 10 years. Only the database as developed by Committee of Ethnic Minorities Affairs (CEMA) was shared and public. All other databases were indicated to be sensitive and/or non-public.

Based on the Governmental figures in the Power Plan and the other sources we have to conclude that it is unlikely that this database is a full list of un-electrified communities in Viet Nam. Unfortunately the CEMA list is the only information available in the public domain and therefore it was decided by SNV -in cooperation with the Winrock team- to move forward with this list for the GiS mapping and the selection of the communes for further investigation. The list is modified by SNV based on (more recent) literature on existing electricity projects in Viet Nam.

In this list, information on village (hamlet), households, populations, primary economic activity, climate condition, natural resources, income, poverty rate, official ranked status, energy access has been identified. The detail information of this list has been found separately from this report in Annex 1 and 2.

2.2 General assumptions on energy use and electricity prices

Electricity consumption in Viet Nam is growing from a very low base. In 1995, total power sales of 11.2 TWh amounted to only 156 kWh per capita per year. Even after growth in electricity use to 74.9 TWh about seven times the 1995 level by 2009, total per capita electricity consumption amounted to only 865 kWh per year (MOIT, 2011).

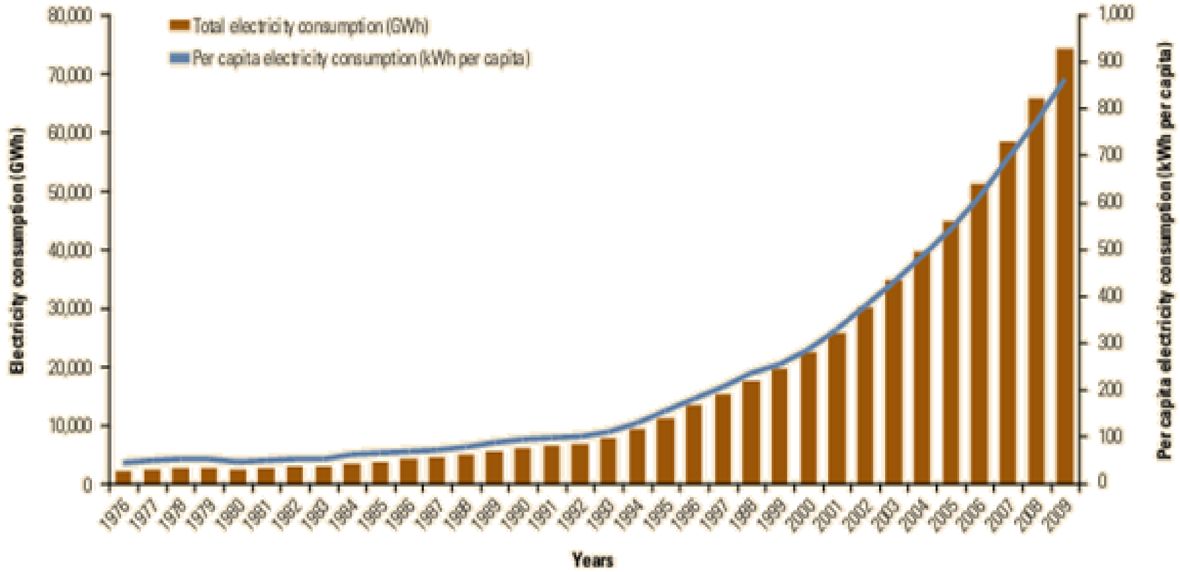


Figure 1 Per capita and total electric consumption in Viet Nam. Source: World Bank, 2011

According to the statistic data of Viet Nam on current energy consumption for household scale in different areas, the average energy demand for rural household is estimated at 30 - 70 kWh per household per month. Nevertheless there is a distinction of usage between the different rural areas as shown in Table 1 below. Electricity needs for off-grid households is really small, very often not more than a lamp and some other small appliances. It was estimated at an average of 17.8kWh/month per household by Ky, 2003 for off-grid households. It is common knowledge, and many researches and experts interviews indicate that after off-grid communities get access to electricity, usage levels will rise to the average levels in Viet Nam. The World Bank report (2011) shows that it takes in Viet Nam on average 5-6 years to get stable. Nevertheless investments and the designed power projects need to take this growth into account. The expected energy demand for rural households that are on-grid is shown in Table 1.

Table 1 The foreseen energy demand for rural household in Viet Nam (WB, 2011)(MOIT, 2011)

Unit: kWh/hh/year

No	Area	2010	2015	2020
1	Town	1000 – 1200	2500 – 3000	3000 – 4000
2	Rural Plain area	800 – 1000	1500 – 2500	2200 – 3000
3	Rural midland area	500 – 700	800 – 1200	1500 – 2000
4	Rural mountainous area	350 - 500	650 - 900	1000 - 1500

Electricity prices were increased with 5% in August 2013 (following the decision of the Ministry of Industry and Trade). The electricity price was increased with VND71.85 per kWh to VND 1,508.85 per kWh on average, these prices are charged by The Electricity of Viet Nam Group (EVN) (Phuong, 2013). More specifically the price range will be from VND993 per kWh (US$0.05) to VND 2,420 per kWh ($0.11) for local households[1]. In case of poor and low-income households there are special policies in place (see also Chapter 4), and therefore the first 50 kWh used by this group of people will be for the lowest price of VND993 per kWh mentioned in the range. Poor households will enjoy a subsidy of 30.000 VND/month ($1,42) per household for their electricity bills (see Decision No. 268/QD-TTg dated 23/02/2011 on providing electricity sale price). "Poor households" in Viet Nam is defined by having less than 400.000 VND income per month (20USD) (Decision 09/2011/QD-TTg).

With an average price and an assumed consumption of 550 kWh per year in the (extremer) rural areas the average cost per household on energy is VND825,000. For the poorest households, which are most often also the households that are still offs-grid an assumed electricity use per year is 400 kWh, which would cost them VND575,000 per year.

2.3 Off-grid Areas Electricity prices

A new regulation[2] came in place in 2013 in rural areas, highlands, and island that are not connected to the national grid (off grid areas), the retail electricity prices for domestic consumption are approved by the provincial People's Committees, and shall not exceed the following ceiling price and floor price (yearly adjusted):

a) The floor price: 2,263 VND/kWh ($0.11);
b) The ceiling price: 3,772 VND/kWh ($0.18);

In case of decentralized electricity production, the owner or investor will calculate the break-even price, the difference between this price and the set prices as indicated above will be met by state budget, and needs to be approved by the local government. Therefore the owner or investor needs to ask approval for this from the DOIT. Some examples in this report have lower prices as the projects were developed before this new regulation came in place.

[1] Circular No 19/2013/TT-BCT, Provisions on electricity selling price and implementation guidance, dated 31/07/2013, MOIT

[2] Electricity Law 2012 and the Circular No. 19/2013/TT-BCT dated 31/07/2013

Without the government subsidies on operation/electricity prices and support in investments for both capital it is unlikely that decentralized (off-grid) power production can be successful. Incentives for (commercial) companies are limited, as the affordability of the households is not in line with the costs of production (See Box 1 for an example). Often off-grid decentralized power generation is through the use of diesel, an expensive source of energy as well besides RE.

Box 1 Example of decentralized power production, prices vs. costs

The example of Ly Son Island (ADB, 2008)

A central diesel power system with a total capacity of 3MW has been installed with a 22 kV power distribution system to serve 3000 consumers. The system was owned and operated by EVN (ADB, 2008). The electricity price was subsidized at a fixed price of 750 VND/kWh ($0.04) to the households, while the production cost is informed to be around 5300 VND/kWh ($0.26). The financial gap was mainly covered by EVN (informed to be VND 9 billion in 2007 ($450,000)) and partly compensated by the Government. Therefore the power plant was in operation only few hours per day (17:00 to 23 PM) and supplied electricity to only half of the consumers in shifts every other day. The incentives to increase power productions are low, as every kWh produced will costs the state money.

Several consumers on the island also invested in their own individual power generators (1-30 kW units) to be able to access electricity for 24 hours (self-served). The individual production was found to be inefficient, at estimated cost of around 10 000 VND/kWh (0.5 USD/kWh). Such investments are of course not available for the poorest people.

Furthermore in the off-grid area, besides the energy provided by EVN or the commune (if any) people have a large demand (for household use, transport is not included in this) for kerosene, LPG and car batteries (WorldBank 2011). In the off-grid areas, the consumption of kerosene and LPG and car battery for lighting purposes were accounted for approximately 18% of total energy consumption for household's use, which is estimated about 75.000 VND /year ($3.75) (2008).

In another survey report in 2003 for Giap Trung, a poor commune in Northern Province of Ha Giang (Ky, 2003), 72% of households have access to pico hydro (through –sometimes shared-ownership) but kerosene is still widely used in the commune as a main sources of energy for lighting. 97% of households reported using kerosene for lighting with a monthly average consumption of 1.5 liter per household, cost about 7,500 VND ($0.5) per month (2003) based on the fuel cost VND 5,000 ($0.25) per liter. The dry cell battery is also used for torches and powering radio and cassette player in the. As average use of 4.4 pairs per household per month adds 9,600 VND ($0.48) to the monthly energy budget.

2.4 Mapping out the off-grid communities

The USA based National Renewable Energy Laboratory (NREL) has developed Geospatial toolkits for a large amount of developing countries including Viet Nam (NREL,2012)(funded by USAID). These maps were developed in cooperation with the Government and show a wide variety of RE resources in Viet Nam, as well as the off-grid communities. The list of off-grid communities used for the NREL map is not fully complete as a total over slightly over 16,6 million households is reflected in the map, of which 78% has access to electricity (almost 13 million) while there are more than 20,7 million households in total in Viet Nam. The Geospatial Toolkit is extremely useful for RE project development and planning for Vietnam. With additional support directly from NREL, SNV was able to extract the data, and use the developed maps for further analysis of the RE potentials in Vietnam for this study (see also Figure 5 and Figure 7).

The GiS map is designed based on the number of households in each district that does not have access to electricity. This choice was made as a certain density of people creates a more favorable situation for RE solutions, and also to make the map's additional to the work already done by NREL.

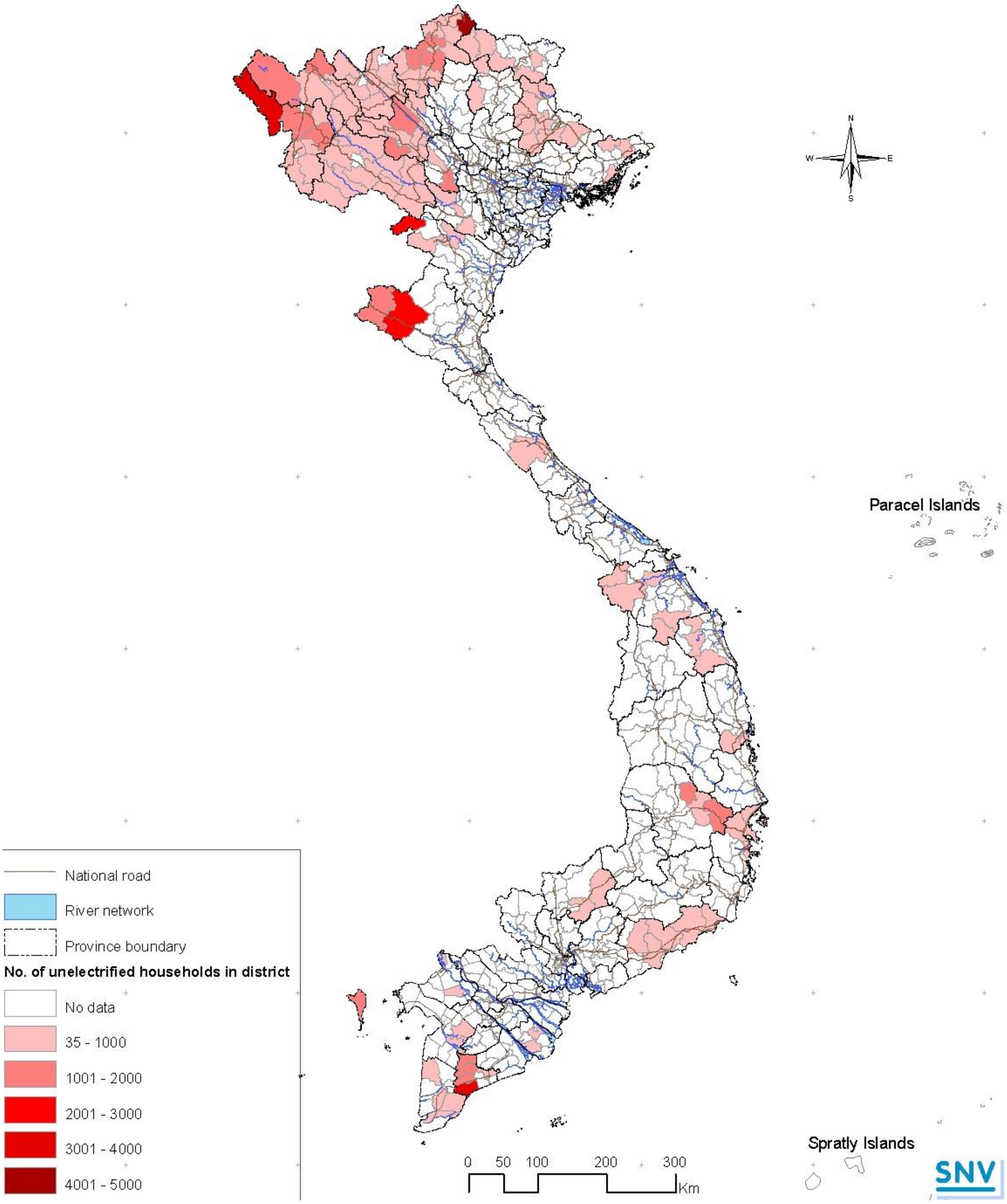


Figure 2 GiS Map of the number of households that don't have access to the National Grid (Source: CEMA data)

Additional maps, and the original size map can be found in Annex 5.

3 RE opportunities for the off-grid communities

Being an agricultural country, having monsoon tropical climate, a 3,200km long coast receiving winds from the ocean, and a vast sea area, Viet Nam has diverse natural resources that are potential energy sources. The research and development on making use of these natural sources has been high on the priority list of Viet Nam for decades. Although the outcomes –actual implementation- of the R&D results throughout the country remain limited, the results have shown the importance of the use of such renewable resources, especially in the remote areas that have no access to the national grid.

In this chapter the following resources will be studied on a general basis, based on available literature and researches.

- Wind power;
- Solar PV (does not cover solar water heaters, SWH);
- Geothermal Power
- Hydro power (mini, micro or pico system);
- Biomass to electricity

In many cases the report will touch upon the hybrid power solutions, but this will not be widely covered as the assignment is focused on RE only.

3.1 General assessment of wind energy

3.1.1 Wind potential

Viet Nam has a good potential for wind energy in general. There are about 150 meteorological stations that provide the main wind data. Typically, annual wind speeds that are recorded at these stations (at 10m) are (VUSTA, 2007):

- land: in the range of 2 to 3 m/s
- coastal: areas around 3 to 5 m/s
- islands, ranging from 5 to 8 m/s.

Wind potentials are calculated through two steps, first the theoretical potential which determines the maximum wind energy output in a certain region or area - determined by using a reference wind turbine, wind speed distribution data and the available sites in that region. Followed by the technical potential which assesses in which areas it is actually really possible to have a wind turbine constructed, at what heights and what the real wind levels are.

Wind speeds are not constant, to estimate the power output of a given commercial turbine; suppliers provide power curves to calculate its potentials. An example of a power curve of two different wind turbines are shown below in Figure 3 and Figure 4.

The small wind turbines with a capacity lower than 1000W normally have larger range of working wind speed at 3-30 m/s (survival wind speed up to 60m/s). Whereas, the higher capacity wind turbines (>1kW) work at the range of 4-25m/s (survival wind speed at 50m/s).

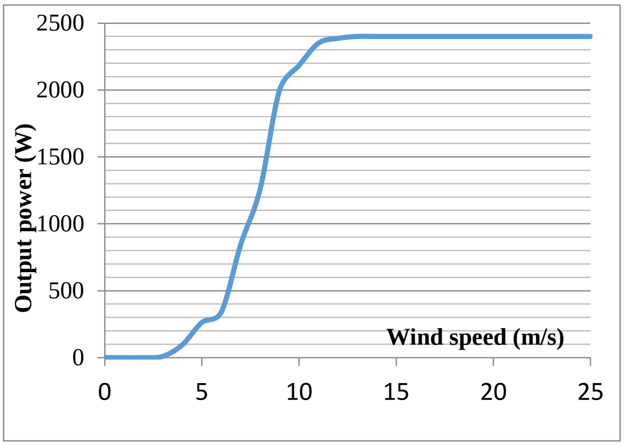


Figure 3 Power Curve of HY-2kW Wind Turbine[3] in Viet Nam

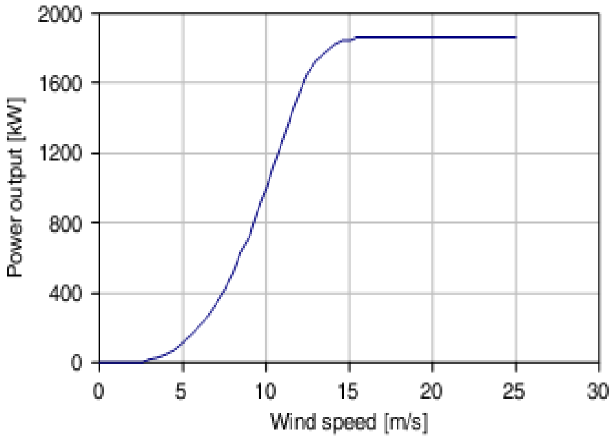


Figure 4 Power Curve of V66-1650kW Wind Turbine (Nguyen, 2006)

The wind power potential has been studied over the years by different parties in Viet Nam, the insights have changed over the years. An indication of the different insights is:

- A study in 2001, shows a potential of 8,878 MW for Viet Nam (8-9m/s)
  According to the World Bank's Wind Resource Atlas (WB, 2001) prepared for the 4 Southeast Asian countries of Viet Nam, Cambodia, Laos and Thailand, indicates that at the altitude of 65 m (above the ground level) Viet Nam has the greatest wind resources of all regional countries with the theoretical wind energy capacity reaching 513,360 MW. Of which, the good potential areas having wind speed at 7-8m/s account for 102,716 MW; very good potential at wind speed at 8-9m/s is 8,748 MW; and the excellent potential with 452MW falls in areas having wind speed >9m/s. The potential areas of large resources in Viet Nam are the coast, the Central Highland and the South.
- A study conducted in 2007, showed a potential of 1,785 MW for Viet Nam
  The research on wind resources and identified potential areas for wind power development conducted by EVN has found numbers that are smaller, the technical capacity is estimated at 1,785 MW. In which, the Central Coast is considered as having the largest wind resources of 880 MW, concentrating in Quang Binh and Binh Dinh provinces, followed by the south Central Coast with 855 MW, mainly in Ninh Thuan and Binh Thuan provinces.
- A study conducted in 2010, showed a potential of 2,400 MW in Viet Nam
  In 2010, the MOIT and WB together conducted a survey at 3 sites for observative data to be included in Viet Nam's wind resource atlas at the altitude of 80m. Results show that the wind power potential at the altitude of 80 m is 2,400 MW and that the annual average wind speed is 7 m/s.

Since 2012, a joint research has been conducted by the MOIT and the GIZ Wind Energy (Table 2). The project has measured wind speed at 10 sites in the Central Highland and Central Coastal provinces at altitudes of 80m, 60m and 40m. The project is designed to produce wind data representative of Viet Nam's areas that have wind resources for the development of wind power in the future. After project completion, the project's reports

[3] Turbine provided by Viet Tan Group, a wind turbine supplier, see more about this further in this paragraph.

on its procedure and standards for the installation of wind measuring poles will serve as helpful reference for wind power developers.

Table 2 Viet Nam's wind resources at the elevation of 80 m above the ground (2012, GiZ)

Average wind speed	<4m/s	4-5m/s	5-6m/s	6-7m/s	7-8m/s	8-9m/s	>9m/s
Area (km^2)	99,916	70,868	40,473	2,435	220	20	1
Area percentage (%)	45.7	33.8	19.3	1.2	0.1	0.01	<0.01
Potentiality (MW)	956,161	708,678	404,732	24,351	2,202	200	10

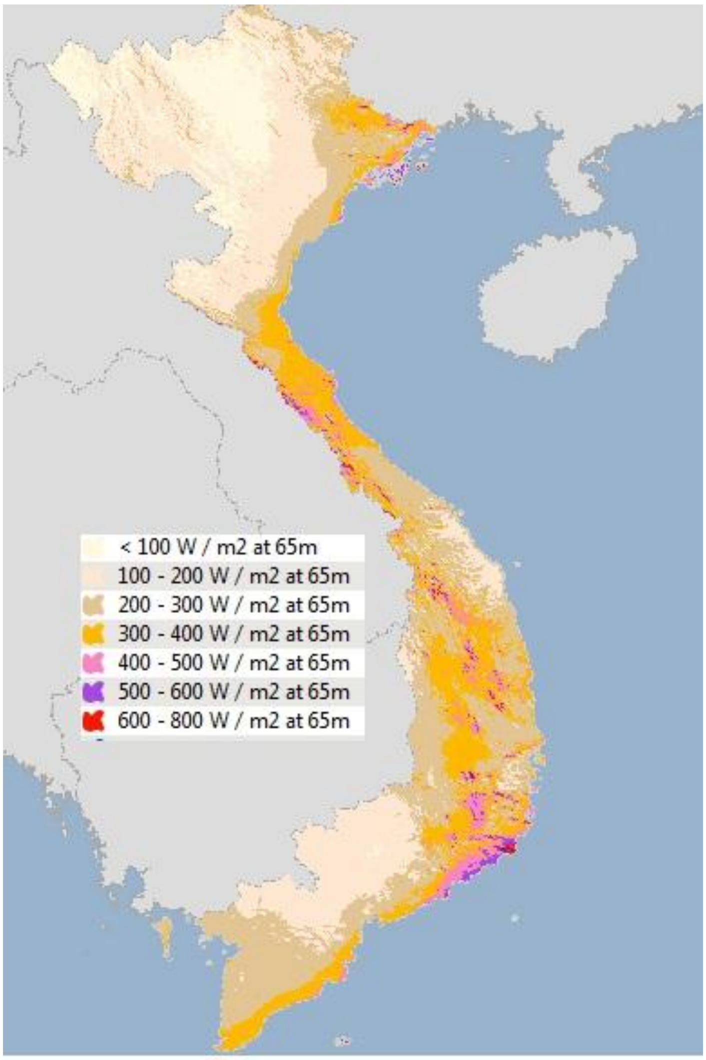


Figure 5 Wind Resources in Viet Nam (NREL, 2012)

3.1.2 Current wind use

The wind has been used for energy purposes for many years already in Viet Nam, initially for water pumping, later also to generate power in the remote areas. Since 1990s, stand-alone wind turbines with a capacity of 50 to 500 W were manufactures and sold by Institute of Energy (model IE1700).

Many national and foreign supported projects on especially the production and implementation of nationally made small scale wind power equipment as well as the introduction of foreign technologies to Viet Nam have been implemented (IE, 2012).

Beside standalone wind solutions there are also hybrid solutions available where project developers combine (often) diesel generators with wind turbines. The range of capacities of such turbines is between 30 kW and 2000 kW (2MW) which is selected based on the assessment of energy demand-side and wind power potential of the locations.

Table 3 Off-grid / stand-alone Viet Nam Wind Projects (IE, 2012) (Thong, 2009)

Application	Capacity	Quantity of wind turbine	Operation start	Areas of installation
Household wind turbine	100 – 500W	>1000*	Since 1999	Central coastal areas
Off-grid wind power plants	1-50 kW	about 11	Since 2009 - 2012	Offshore islands
Wind-diesel hybrid	30kW	1	1999	Hai Thinh, Hai Hau, Nam Dinh Province
Wind-diesel hybrid	30 kW wind + 10 kW diesel	1	2002	Thinh Long, Nam Dinh
Wind-solar hybrid	2 MW	1	2000	Dac Ha, Kon Tum Province
Bach Long Vi wind-diesel **	800 kW	1	2004	Bach Long Vi island
PV Power Corporation Wind-diesel hybrid	9MW (6MW wind + 3MW diesel)	3	2012	Phu Quy

* not all in operation any more ** not in operation any more, see below.

There were many technical issues during operation of these projects. Several projects have stopped due to the lack of skilled personal, maintenance and spare part. The hybrid wind-diesel system in Back Long Vy island stopped working since 2006 due to technical issue. It appears that household scale wind turbines (100 - 500W installations) operate better because of regular maintenance as the households feel responsible, this is an additional stimulant towards these solutions for off-grid areas.

It can be concluded that wind power application in Viet Nam is still limited; most of the projects are small scale, low quality and un-sustainable.

3.1.3 Off-grid solutions and investments

When it comes to (smaller scale) wind solutions there are already a few providers in Viet Nam. Several International wind turbine manufacturers including GE, Vestas, Gamesa, Nordex, Fuhrlaender, IMPSA, Avantis and Sany have shown interest in Viet Nam's wind power market. However, they are all interest in large scale wind power project development.

Chinese wind turbine manufacturers have recently shown special interest in Viet Nam's wind power market. Sany Group (1,5 and 2,0 MW installations) and Shanghai Electric (1,25 – 2 and 3,6 MW turbines) have sequentially opened their representative offices in Viet Nam to study the market. Chinese manufacturers offer very competitive price wind turbines, and they guarantee power output that is equivalent to or better than those of western suppliers. With the current tariff policy issued by Viet Namese Government, Chinese wind turbines have the potential to dominate Viet Nam's wind power market.

Table 4 Viet Nam's Wind Power manufacturers and/or implementers

Organisation	Capacities	Track record

The Research Centre for Thermal Equipment and Renewable Energy (RECTERE) HCMC University of Technology	200 - 300W for household wind turbine.	Manufactured and installed more than 900 wind turbines in Viet Nam.
Institute of Energy MOIT	150 W units (developed and installed one 3.2 kW unit)	Manufactured and installed so far 30 units for households in remote mountainous areas,
The Renewable Energy Centre, Hanoi University of Technology (HUT) the RE&EE JSC established since 2011, its original precursor is RE Centre of HUT)	150 W - 500 W.	Installed 25 units of 150 W and 5 units of 500 W.
Viet Tan Joint Stock Company	1 - 15 kW	Developed wind power projects for island: Hon Me, Phu Quoc and Con Dao
Viet Linh Manufacturing and Trading electricity limited company	500 W	Viet Linh has more than 20 years of experience on design, manufacture power equipment. Wind turbine with 500W capacity is one of their main product which has been installed in Hue as hybrid solar-wind power for a riverside resort.

The off-grid potentials are estimated to be significant (Phong, 2008). On the islands it is estimated at 800-1400 kWh/sqm/year, for the coastal areas in the Central Region at 500-1000 kWh/sqm/year and in the highlands and other regions at less than 500 kWh/sqm/year.

The Master Power Plan 7 (MOIT, 2011) indicates a focus on the off-grid islands and coastal areas that have suitable wind for turbines with a capacity of 150-300W. In the below table the Government has summarized the districts and communes with the highest expected potential for wind power.

Table 5 Government focus of decentralized wind power solutions (MOIT, 2011)

No	Commune	District	Province	Number of households	Estimated capacity (kW)
1	-	Phu Quoc	Kien Giang		5,000
2	-	Bach Long Vi	Hai Phong		800
3	Big island	Ly Son	Quang Ngai		1,500
4	Quan Lan	Van Don	Quang Ninh		1,600
5	-	Co To	Quang Ninh		1,600
6	-	Phu Quy	Binh Thuan		7,000
7	-	Con Dao	Ba Ria – Vung Tau		1,600
Total				**18,232**	**19,100**

The wind power technology has production cost at the range at 10-11 US cents/kWh. The electricity production from wind energy has become more costly over the last few years due to the rapid increase in material costs for wind turbine manufacture. Furthermore there is an imbalance between wind turbine demand and supply.

The initial investment cost for wind solutions is relative high, for larger scale turbines the investment costs fall in the range of 1,800 – 2,000 USD per kW (GiZ/MOIT, 2011). The Institute of Energy (2012) indicated that the hybrid wind-diesel power system mostly used on commune levels- requires investments around 2,400 USD/kW, in which, equipment and installation cost is account for 1560 USD/kW and 840USD/kW, respectively, the O&M cost is about 72 USD/kW. For smaller scale (home solutions) the investment cost is about 250-300

USD for a typical small size wind turbine (150W), exclusive of installation and auxiliary costs. This investment cost is still too high for rural households (Nguyen, 2006).

Box 2 An example of a hybrid solution on Phu Quy Island, Wind Power combines with Diesel Power

The example of Phu Quy Island (EVN PECC3, 2010)

Phu Quy is an isolated district island, located in Binh Thuan province, about 120km from southeast of Phan Thiet city. There are 3,293 household with about 27,000 people living in this island. The main economic activities are fishing and agriculture. The island has potential wind energy for electricity generation with an average wind speed at 60m high is > 9.2 m/s.

Previously, power for the island was generated solely by the diesel plant.

- Total capacity 3MW - 6 diesel generator units, capacity 500kW each
- Operating time: 16 hours per day (from 7:30 am to 11:30 pm),
- Production cost: 24 cents/kWh.

The production and daily activities were interrupted because of non-continuous power supply; therefore, over 30 individual diesel generators with a total capacity of an additional 1,000kW of electricity. Very expensive, and not available for all residents.

To solve the problem, a hybrid system (Wind-Diesel) was installed for better service. The project was funded by the Petro Viet Nam Power Corporation (PV Power ER) and started construction in 2010 and was finalized in Sept 2012.

Total Capacity:

- The existing diesel generators 3MW is remained, expected to cover 20% of power load demand for island.
- Additionally 6 MW of wind power was installed (3 units @ 2MW), expected to cover 80% of power load demand for island.
- The power plant will provide annual output of 25.39 GWh

Total Investment:

- estimated at $ 17.000.000 USD (VND335 billion):
- investment in the wind power component was 2,833 USD per KW
- Project lifetime 25 years

Monitoring and evaluation in 2013 have shown the following results (Thanh Nien Online, 2013):

- The poor households are paying 1,863 VND/kWh for domestic use (for the first 50 kWh/month)
- Business users paying at the price of 2,329- 3,105 VND/Kwh;
- The production cost reaches a high value of 6,647 VND/Kwh (excl. VAT).

Due to the high electricity prices, local people have cut down the demand from total consumption of 8GWh in 2011 to 7.2 GWh in 2012 (is estimated), and it is expected to be lower in 2013. Therefore the full capacity of the turbine is not utilized.

The electricity price applied for island currently is not stipulated by EVN and Government; it has been issued by Electricity Regulation Authority and Binh Thuan People committee. An incentive for tariff to encourage local household having more demand is necessary to recover full load operation and maintenance for power plant.

Electricity generated by wind is the only renewable electricity that has an approved feed-in-tariff higher than the normal tariffs. More on this can be found in the policy chapter.

3.2 General assessment of Solar Power

3.2.1 Solar potential

Viet Nam lies from 23° to 8° North latitude and has good constant solar radius. The areas with the highest potential for solar energy are the Central and the South of Viet Nam, where the sun shines almost throughout the whole year with an average total solar radiation of 5kW/h/m2. The solar intensity in the North varies between 2.4 to 5.6 kWh/m2/day. The potential of solar energy per region is shown in Table 6.

Table 6 Data on radiation intensity in Viet Nam (VUSTA, 2007)

Region	Provinces	When	Average radiation	Hours of	Radiation	Application

			intensity (Wh/m^2/day)	sunshine/yr	Kcal/cm^2/yr	possibility & Comments
North-East	Cao Bang, Bac Kan, Lang Son, Tuyen Quang, Thai Nguyen, Vinh Phuc, Bac Giang, Bac Ninh, Quang Ninh	May – October	3,600	1500 – 1700	100 – 125	Low In some mountainous areas the total average radiation intensity is lower due to fog and clouds.
North-West	Lai Chau, Son La, Lao Cai, Ha Giang, Yen Bai, Phu Tho, Hoa Binh	March - May	3,500 (Max 5,831)	1750 - 1900	125 – 150	Low Under 1500m
		August - May	3,600			Medium Above 1500m
Red River Delta	Hanoi, Hai Phong, Ha Tay, Hai Duong, Hung Yen, Ha Nam, Nam Dinh, Thai Binh, Ninh Binh	May-October	3,900 – 4100			Good
Northern Central	Thanh Hoa to Hue	April - October	4,200	1700 – 2000	140 – 160	Good increase of radiation intensity when going south
Central Highlands	Gia Lai, Kontum, Dac Lak, Dang Nong, Lam Dong	July-September	4,500	2000 – 2600	150 - 175	Very good
Southern Central	Da Nang, Quang Nam, Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa	March - October	4,500 – 6,500	2000 – 2600	150 - 175	Very good
South of Viet Nam		Whole year	4,500	2200 – 2500	130 - 150	Very good
Total Range			3,500 – 6,500	1500 - 2600	100 - 175	Good

The figure below (Figure 6) gives a good overview of how radiations per day vary in the different regions per day, during the year.

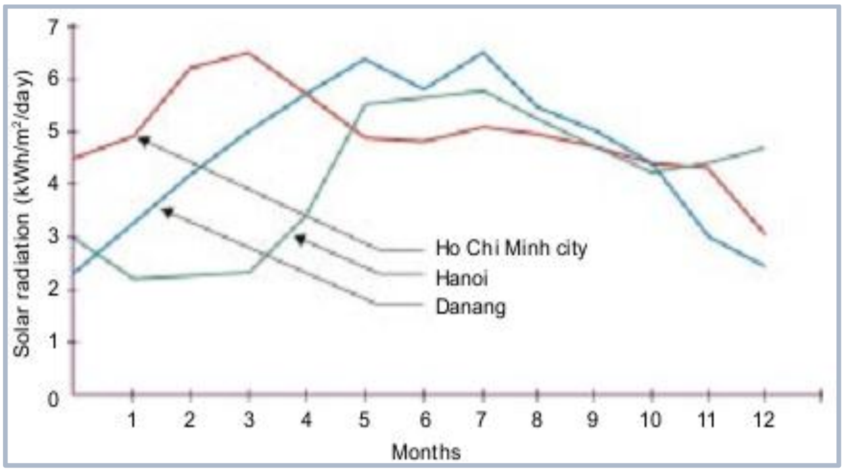


Figure 6 Example of solar radiation in the North, Middle and South of Viet Nam (Dung, 2009)

Solar PV testing is standardized worldwide and all solar panel capacities are tested with the same conditions of an insolation of exactly 1000 Watt per m^2 (a measurement of solar radiation received on a certain surface) and at 25 ^{o}C. Therefore a 200 Watt-peak system will generate 200Watt with these exact conditions. As shown in Table 6 and Figure 7 the insolation varies per region, the average insolation nevertheless in most areas is about 4 - 5 kWh/m^2/day. This means on a clear day 4 - 5 kWh of electricity will be generated. However, this describes an ideal situation, not including losses from temperature, shading of the module or incorrect installation. During the darkest month of the year, the energy losses can amount to 50 %, which implies a system efficiency of 50%, at which, 2 kWh of electricity will be generated per day instead of 4kWh. It is safe to design the system based on the average daily insolation in the month with the lowest insolation.

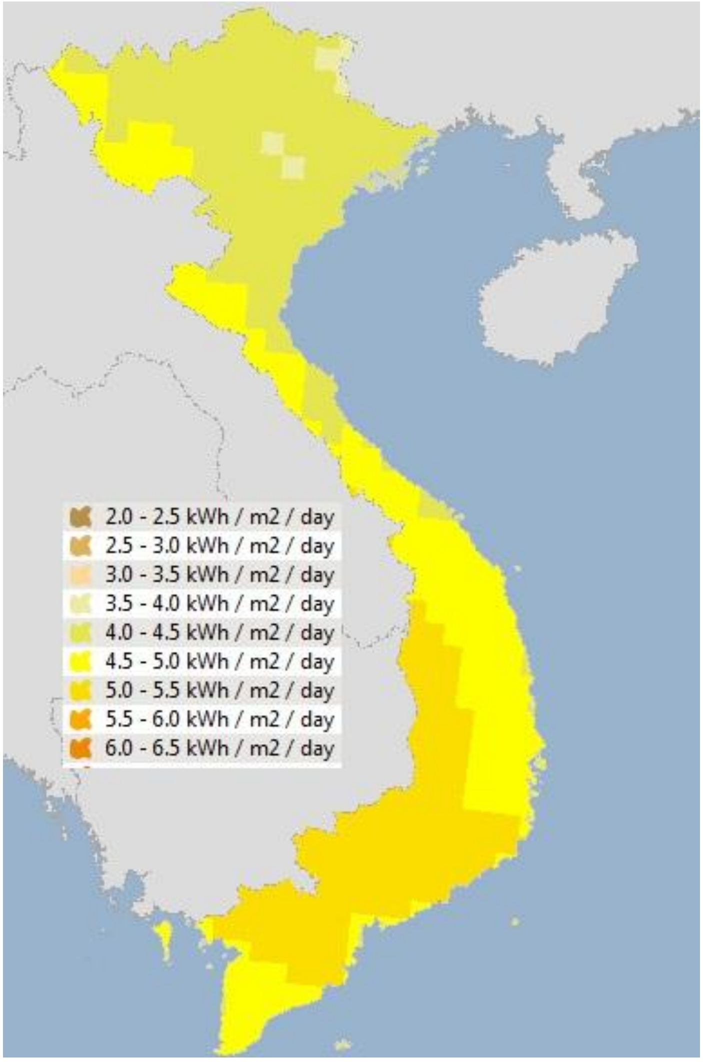


Figure 7 Solar Resources in Viet Nam (NREL, 2012)

Solar water heaters are already widely available and used in Viet Nam, a large directory of SWH retailers and producers is available. These transactions are fully commercial and no donor interactions are involved in this market. The Government did have a promotional tool under the National Target Program on Energy Saving and Energy Efficiency for SWH in the past. Therefore this section focuses only on Solar Electricity.

3.2.2 Current Solar Power use

So far, more than 6,000 small solar power stations with total capacity of 750kW have been installed in the mountains and islands, half of which is used for telecommunication, 30% is used for public power for the community centers, schools, clinics and the rest is for household use. Most of these installations are found in the southern provinces of Viet Nam because of the high solar radiation. There are two kind of PV system that are being used for off-grid areas in Viet Nam, the stand-alone solar PV system and stand-alone hybrid system of solar PV with other energy resource such as wind, hydropower and diesel.

Table 7 Development of solar energy application in Viet Nam (Dung, 2009)

Year	Solar energy application	Number	Average Installed capacity (Wp)	Total capacity (KWp)
1989-2008	Solar home system	4000	22-100	314,010
1989-2008	Public systems	152	100-300	30,394
1989-2008	Medical centre	24	150-300	3,450
1990-2008	Telecommunication systems	2000	500-3,000	1,000,000
1996-2000	Radio telephone	2	75-100	0.175
1995-2008	Forest guard station	90	100-1,000	32,000
1989-2008	Cultural & battery charging centre	80	300-3,200	52,000
1990-2008	Navigation beacon	1300	50-150	45,000
1995-2008	Satellite receiver	50	500-4,000	100,000
2000-2003	Solar boat	2	250-640	0.89
2002-2006	Solar power plant	2	100-154	254,000
2005-2008	Solar villa/house roof	7	1,000-4,000	11,200

There are hybrid systems implemented as well.

- Hybrid system of: PV(28kW) & diesel (20kW) for Bai Huong village, Cu Lao Cham island, Quang Nam
- Hybrid system of: PV (100kW) & minihydro (24kW) at Mang Yang, Gia Lai Province (Central Highlands)
- Furthermore Golden Bridge Co Ltd has developed feasibility studies for several island applications including Wind-Solar Hybrid installation (searching for the necessary funds at the moment).

3.2.3 Off-grid solutions and investments

As already indicated in the above paragraphs there is a large potential for (off-grid) solar electrification, with average solar radiation of 3 - 4.5 kWh/m2/day in winter and around 4.5 - 6.5 kWh/m2/day in summer, and with 1,800 to 2,700 hours of sunshine per year. The theoretical energy potential for Viet Nam is 43,9 billion TOE/year (Phong, 2008). Solar energy in the Southern and Central regions can be used on average 300 days per year. Whereas, in the Northeast and Northwest region, the insolation is a bit lower during winter time, however, still having high potential and can be used around 250 - 280 days per year. In off-grid areas solar PV off-grid system is considered to be one of the most feasible options to bring electricity to local people.

In Viet Nam most solar panels are imported as well as the batteries. The invertor, controller and other side equipment can be manufactured locally. There are only two producers of solar panels in Viet Nam, and a third one is planning to start soon.

1) SolarLab - Institute of Physics in Ho Chi Minh City under the Vietnamese Academy of Science and Technology (VAST), is one of the producers, who designed the first prototype that was in line with international standards, in Viet Nam in 2000. Their focus is on hybrid systems, solar combined with hydro (in mountainous areas), diesel or the national grid. This is Solarlab's Hybrid Technology of Renewable Energy sources (Madicub). Solarlab was also able to export to some of the neighboring countries. A follow-up product; the Madicub Intelligent Energy Power, is an integrated solar-local grid managing system suitable for expanding PV power. This model is being further developed for rural electrification, as a "mini solar power plant". Madicub is available

from 1 kVA to 10 kVA basic for a solar array of a variable power range between 500 Wp and 10 kWp.

2) SolarBK also successfully developed their own PV equipment production. Both the panels and the inverters are made in Viet Nam. They also still provide imported models. The capacities delivered can vary for the solar solutions from 200 – 250 Wp per unit (can be placed in parallel).

Planned or ongoing projects from international investors are:

3) A solar panels production factory invested by Indochina Energy located at Chu Lai Economic zone, Quang Nam province has been newly constructed. The ground breaking ceremony was on 14 May, 2011. The factory requested the government for an extension on the completion time (which was expected in 2012), current status is unknown. The investment capital of 390 million USD and was for a total capacity of 120 MW/yr.
4) First Solar (a US based company) postponed recently its plants to kick off a project on making thin-film technology solar panels in Ho Chi Minh City, with an investment of 300 million USD. Their solar panels with the size of 60X120 cm are capable of producing 80-85 watts per hour and have a guarantee period of 25 years.
5) Another solar panel production factory recently ground broken in January 2013 at Phong Dien industrial zone, Phong Dien district, Hue province. The project investors are Worldtech Transfer Investment and Global Sphere, total investment for the first phase is expected at 300 million USD. Expected completion is July 2015.

Some larger retailers in the solar market in Viet Nam are:

1. **Tan Viet Joint stock company** established in 1997, a leading company in providing equipment and service for RE development in Viet Nam. Tan Viet has implemented quite a number of solar power projects for extremely poor communes in Ca Mau, Quang Binh, Bac Lieu and subcontracted for NAPS SYSTEMS on implementing solar power solution for 300 poor communes in the mountainous areas within the framework of Program 135 funded by Finnish government.

2. **Selco Vietnam Co., Ltd** is a subsidiary of SELCO-Inc based in U.S.A. Specially in the design, assembly and installation solar home system (SHS), officially put into operation in Viet Nam at the end of 1997. Selco Viet Nam has installed solar energy up to 100 stations for 30 National Parks, Natural conservation zones etc nationwide. They installed solar energy capacity up to 1000Wp for more than 50 army border stations and islands; Supplied more than 150kWp solar photovoltaic to the telecom companies and rural post offices; Installed over 500 kit of solar signaling for waterway, airway each kit was around 50Wp.

3. **SolarV** is the registered Trademark of Vu Phong Co., Ltd has worked in Viet Nam since 2009 on Design, Supply and Install Solar Power System for gridded or off-grid purposes.

4. **Viet Linh Manufacturing and Trading Electric – Eelectronic Limited Company** was established in 1986 from a small production workshop in HCM City with the AST brand name. AST has a distribution network throughout the country.

Currently, about 80% of PV equipment items such as solar panel, inverter up to 10 kVA and charger controller with 10-12 channels have been manufactured in Viet Nam. Most of them still follow analog technology, and the production is limited.

The Viet Nam Master Power Plan 7 (MOIT, 2011) also indicates a focus on solar solutions for off-grid areas, with a focus on systems with capacities between 120-150Wp. Solar power requires a significant initial investment. A price / investment cost estimation is provided based on the separate components of such a system (Thong, 2011).

Table 8 Price indications for solar solutions in Viet Nam

Key Component	Price	Unit
PV System	8,000 – 9,000	USD / kWp
PV Module	4 – 5	USD / Wp
Battery	65 – 75	USD / kWh
Charge controller (SolarV - source)	30 – 200	USD (depend on the size)
Inverter (SolarV)	100 - 1000	USD (depend on the size)

Based on the electricity standard demands, some models of mini SHS have been developed as a set for easy installation by Viet Linh. The table below indicates a range of prices for the different systems they provide as an example.

Table 9 Example Mini Solar systems provided by Viet Linh Company in Viet Nam

Mini-Solar Systems	Daily power demand (Wh)	Daily power supply (Wh)	Solar panel	Battery	Solar charger	DC-AC Inverter	Total investment
160Wp	~ 500	450 – 750	2 x 80Wp 6,004,800	3,231,750	583,800	3,669,600	**13,500,000 (650 USD)**
360Wp	~ 1120	1000 – 1500	2 x 180 Wp 13,510,800	6,255,000	834,000	3,669,600	**24,269,400 (1200 USD)**
480Wp	~ 1720	1800 – 2200	6 x 80 Wp 18,014,400	8,340,000	1,563,750	5,045,700	**32,964,000 (1600 USD)**
1080Wp	~ 3,564	3000 – 5000	6 x 180 Wp 40,532,400	11,467,500	1,563,750	7,714,500	**61,278,000 (3000 USD)**

Based on existing projects in Viet Nam it is known that on average an off-grid household will install 2 panels with around 160 – 360 Wp in total. Therefore assuming an installed capacity of 360 Wp, the total investment would be 650 – 1,200 USD for one rural household.

Box 3 A hybrid system for Solar and diesel generator for Bai Huong village, Cu Lao Cham island

The hybrid power system of solar and diesel for Bai Huong village example

The village Bai Huong is located in a narrow stretch of the south-west coast side of Cu Lao Cham island, that belongs Tan Hiep commune in Cu Lao Cham island, Quang Nam province. Bai Huong village has 95 households, their main occupation is fishing with an annual average income about 300,000 VND/month.

Current power supply is through diesel generators:

- Total capacity: 29KW (12KW-15KVA and 17KW-20KVA generators) were too old
- The operation cost: 8,000 VND/kWh
- The electricity price: 4,000 VND/kWh

Like in "Box 2 An example of a hybrid solution on Phu Quy Island, Wind Power combines with Diesel Power" also here many households invested in their own personal generators (2-3 kW) for their business like tea shop, karaoke or otherwise. Partly also because the existing (out of date) diesel generator was not able to supply electricity for the whole village causing a shortage of electricity and extremely high electricity prices.

To solve the problem, a hybrid solar-diesel has been designed based on the total electricity demand in 2008 and the expectations of the average electricity demand for the period of 2008-2028 for Bai Huong village. The annual consumption in 2008 was about 27,804 kWh distributed of which 19,152 kWh for domestic use (69%); 2,892 kWh for public and service use (10%) and 5,760 kWh for productive use (21%). The expectation on annual demand for 2028 is 36,500 kWh/yr.

The hybrid solar-diesel power system that was installed since 2009:

- Solar PV system capacity: 28kW
- Back up diesel generator capacity: 20 kW (5 + 15)
- Number of household : 100
- Total investment cost: 412,098 USD
- Investors: SIDA – Sweden (80%) & Quang Nam province budget (20%)
- Cost per installed capacity: 8,585 USD/kW
- Cost per connected household: 3,924 USD/hh
- Annual operation cost: 5,067.3 USD/yr
- Capacity output: 27,804 kWh/year

The equipment that was installed:

- 165 solar panels using Sharp – Japan products with capacity 175Wp/module (total capacity 28,8 KW)
- 5 controllers SM600 and 7 inverters SI5048 using SMA – German products
- 145 battery 12V-100Ah using Voltatech - Korea

The electricity price of the system:

- For domestic, public and service users: 2,500 VND/kWh (0.156$)
- For productive: 3,000 VND/kWh (0.19$)
- Average process: 2,600 VND/kWh (0.163$)

The hybrid of PV and diesel power system has been put in operation since 2011 but currently it is working under installed capacity and therefore inefficiently. The electricity is supplied a few hours per day only. 50 batteries are in place but not operational due to a lack of spare parts for replacement and repair. (Source)

3.3 General assessment for Geothermal Energy

Geothermal heat includes the direct use of heat from the earth, like for example geothermal baths and swimming facilities, but it can also be directly used for heat pumps or electricity generations. Direct use of geothermal heating is site specific and may not be an option for any remote communities.

Geothermal energy has been on the radar of the government for many years. Several institutes have studied the potentials of the country or specific regions since early ‘80s (with international and high level national support). This has not yet resulted in any geothermal projects for electricity production. Furthermore in the Masterplan (MOIT, 2011) it is only briefly mentioned as an offgrid solution and has no priority.

According to recent interviews with VAST (in public newspapers) there are more than 300 natural geothermal sources recorded identigied in Viet Nam in six geothermal regions of which the Northwest is the most potential area. Even though publications show that there is some interest in (commercial) development of geothermal electricity generation, no real movement has been identified in the Vietnamese market and no local organisations – other than research institutes and/or universities have show commercial interest in the development of geothermal projects.

One of the leading geothermal power technology companies worldwide is ORMAT Technologies, has a long history in Viet Nam, some of their local activities included:

- R&D in Viet Nam in the ‘90s and planned a geothermal power plant project of 20 MW in the country. At that time the lack of supporting policies for project development of power purchase stopped developments and they withdrew.
- Ormat applied for a license for five geothermal power, with a total capacity of 150-200MW plants in 2008. It is unknown why these plans were not implemented.
- Regional news reported early 2012 that Ormat might be supplying the technology for two newly developed geothermal power projects in Quang Ngai province (designed capacity of each 18.7 MW). No recent news on these developments.

Geothermal electricity systems require large upfront investments, these include large site selection costs as the identification and analysis of the geothermal resource is a lengthy process (RETD, 2012)(Kyoto Energy). Geothermal Electricity could be a solution for Remote Areas in Viet Nam, but developments in the local markets, policies in place and the knowledge levels seem not yet ready. MOIT has contracted, funded by EEP Mekong, Kyoto Energy to develop the strategy and roadmap that can feed into the National Power Plan and national strategy. This research started in July and will end by the end of 2013. Existing data (which is all outdated, from the ‘90s) will be used to better estimate the potentials (initially estimated at 400MW only for Viet Nam, while some reports like (Phong, 2008) indicate as low as 200MW) and policies will be analysed locally, as well as internationally (the US is furthest developed, and has good views on how policies can support the further development of this sector. This report will not focus on Geothermal Energy, it is advised to continue the discussion after the work done by Kyoto Energy and its partners, in cooperation with MOIT.

3.4 General Assessment for Hydropower

3.4.1 Hydropower potential

Viet Nam has a great potential of hydro power with 2360 rivers and streams of $\geq$ 10km long. In general the hydropower opportunities can be divided in several different sizes. Please note that as far as known there is no official definition set by the Vietnamese Government on the right terminology to be used. The below sizes are based on common understanding in the market.

Table 10 Scaling Hydropower

Name	Size	Example usage
Pico Hydro	< 5kW	two fluorescent light bulbs & a TV / radio in about 50 off-grid households
Micro Hydro	<100kW	One household (assuming demand growth) or a small community/hamlet.
Mini Hydro	<1000 kW (1MW)	Mini off-grid aim to supply electricity for a group of households, hamlet or village.
Small Hydro	<10MW	Grid connected or mini off-grid supply electricity to village or commune.
Hydropower	>10MW	Grid connected

Small and larger hydropower (sometimes mini) are based on the larger basin's in Viet Nam, and are all located around the 9 basin in Viet Nam that cover areas of ≥ 10,000 km^2 and are rich of water resources.

- The Red river system in the North , including the Da and Lo - Gam - Chay rivers.
- The Mekong river delta in the South being among the largest rivers in the world.
- In the central, there are the Ma river and the Ca river of the northern part,
- The Vu Gia - Thu Bon river of the central part
- The Se San river and the Srepok river of the Central Highlands,
- The Ba river of the Coastal Area
- The Dong Nai river of the southern part.

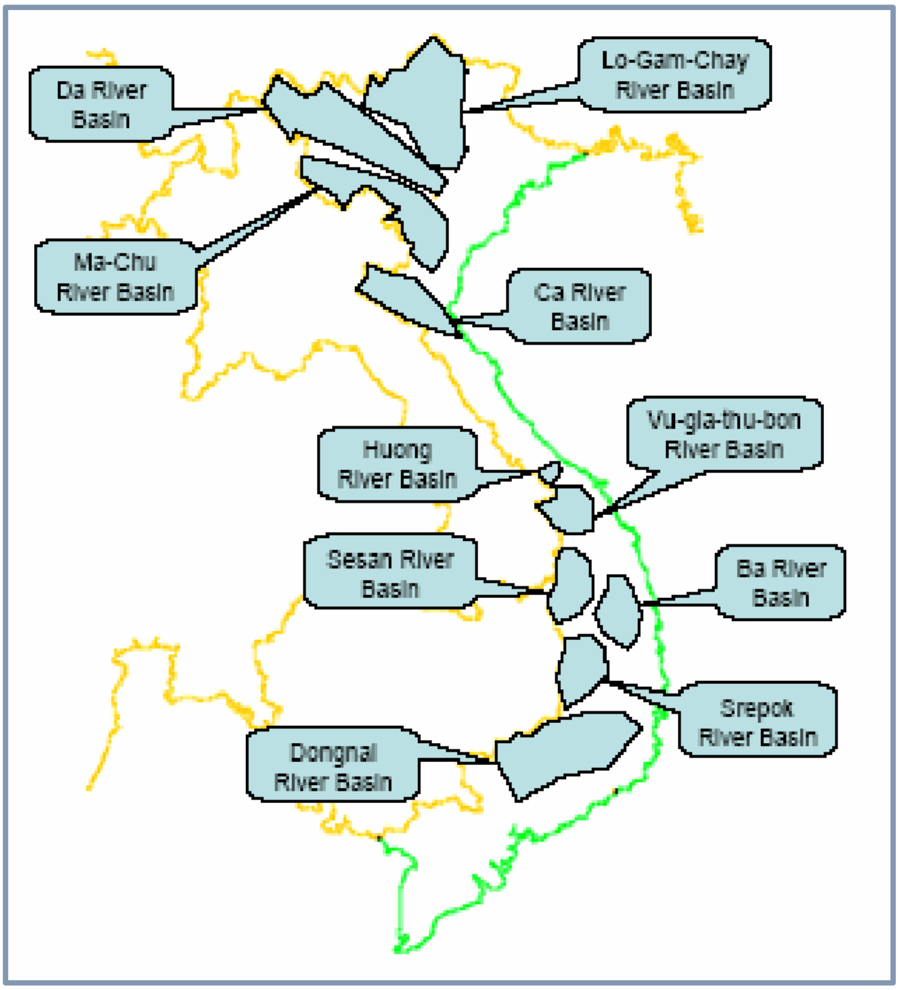


Figure 8 Locations of the main river basins in Viet Nam

Viet Nam's gross theoretical potential of hydropower is 34,674 MW equal to 300 TWh/year, and its economically feasible potential is 18,6-20 GW or 82-100 TWh/year (see also Table 11). Viet Nam's technical/economical hydro power potential is estimated to 80 to 100 TWh/year, representing about 17,700 MW. Of the total potential 51 TWh/year are in the North, 19 TWh/year in the Central regions and 10 TWh/year in the South. The hydropower potential is mainly concentrated on three rivers: 6,250 MW on the Da river in the north. 1,500 MW on the Sesan river in central Viet Nam, and 2,500 MW on the Dong Nai river in the south. In addition to the above the potential for small- and medium-size hydropower stations is estimated at 1,600 to 2,000 MW. These numbers include the total potential for all sizes.

Table 11 The Viet Nam hydropower potentials (PECC1, date unknown)

River basins	Areas, km^2	Number of dams	Total capacity, MW	Power amount (GWh)
Da River	17,200	8	6,800	27,700
Lo-Gam_chay	52,500	11	1,600	6,000
Ma-Chu	28,400	7	760	2,700
Ca	27,200	3	470	1,800
H-ong	2,800	2	234	990
Vu Gia – Thu Bon	10,500	8	1,502	4,500
Se San	11,450	8	2,000	9,100
Srepok	12,200	5	730	3,300
Ba	13,800	6	550	2,400
Dong Nai	17,600	17	3,000	12,000
Micro hydropower			1,000 – 3,000	4,000 – 12,000
Total			**19,000 – 21,000**	**80,000 – 84,000**

3.4.2 Current use of hydropower

The pico, micro and mini hydropower has been the most effective technology applied popularly in Viet Nam for off-grid areas. The potential stream energy is mainly in the North and Central parts of Viet Nam, particularly in Lao Cai, Son La, Thai Nguyen, Nghe An, Thanh Hoa etc.

Water resources in Viet Nam are very unevenly distributed geographically. Viet Nam has an annual river flow estimation of about 830 billion cubic meter. The average run-off per sq. km is 2,66 million cm, about 10 -90 liter/s.km^2. The amount of power that can be obtained from a river or steam depends much on the flow rate of river or stream and the height of water falls (head). The required water flow rate and head for small hydropower plants operating at 50% efficiency is summarized in Table 12.

Table 12 Required water flow and head for small hydropower plants (NREAS)

Capacity output (kW)	**Head** (the height of water falls), m				
	3.05	**6.1**	**15.25**	**30.5**	**61.0**
			Water flow rate required (m^3/s)		
0.5	0.034	0.017	0.007	0.003	0.0017
1	0.068	0.034	0.014	0.007	0.0034
2	0.133	0.068	0.025	0.014	0.0068
5	0.334	0.167	0.068	0.034	0.0170
10	0.668	0.334	0.133	0.068	0.0340

According to the Institute of Energy (Phong, 2008), so far, about 120,000 pico and micro hydropower household plants have been installed with capacities ranging from 0.2 to 5kW with a total capacity approximately 30 – 60 MW, giving annually electricity generation output of 8 – 20 million kWh, about 50% plants located in the North of Viet Nam. About 60 MW aggregate capacity of grid-connected mini-hydropower is being exploited in 48 sites through out of Viet Nam with capacity sizes ranging from 100 to 7500 kW. The installation of these systems were either directly financed by the government or through international aid (Ulfsby, 2004).

Viet Nam has a large number of large scale hydropower plants, often foreign investments or Government owned. This has also resulted in 223 hydropower projects registered with the UNFCCC; created an average annual 15,574,462 tCO_2 credit (IGES, 2013). At the same time Viet Nam's Government is becoming more aware of the natural hazards of larger scale hydro, which resulted in the cancellation of a large amount of already planned hydro systems (VietnamNet, 2013).

3.4.3 Off-grid solutions and investment

The Master Power Plan (MOIT, 2011) indicates a list of off-grid priority areas for hydro power for which feasibility studies have already been developed, see table below.

Table 13 Planned off-grid solutions by the Government of Viet Nam (MOIT, 2011)

No	Name of project	Construction Location	Capacity (MW)	Total investment (billion VND)			Number of households access to electricity
				Total	Loan	Counterpart	
1	Thac Bay	Dien Bien	4.5	55.94	40.28	15.66	80
2	Suoi Lum 3	Son La	7.5	222.22	160.00	62.22	130
3	So Vin	Son La	2.1	62.22	44.80	17.42	60
4	Nam Sai	Lao Cai	7.5	224.71	161.79	62.92	456
5	Nam Nghe	Lai Chau	2.8	121.08	87.18	33.90	265
6	A Roang	T.T. Hue	7.2	177.78	128.00	49.78	379
7	Dak Pring	Quang Nam	7.5	200.00	144.00	56.00	425
8	Cha Van	Quang Nam	5.6	133.33	96.00	37.33	357
9	Song Bung 3	Quang Nam	7.5	266.67	192.00	74.67	450
	Total		**52.2**	**1,464.00**	**1,054.00**	**410.00**	**2,602**

Based on these calculations the average investment for small hydro is estimated at 28 billion VND per MW (or 1,3 Million USD/MW).

Other studies also show the importance of smaller scale hydropower to electrify the off-grid areas. Hydro power stations with capacities between 0,5 and 10 MW play an important role especially in the midland and mountainous areas. The potential for small, mini hydroelectric power is estimated to 7 - 10% of the total economic hydropower potential in Viet Nam, which are mostly situated in the North and Central Viet Nam. The small hydropower potential (<10 MW per site) in the country is estimated to be around 800-1400 MW. This consists of the following:

1. 400 – 600 MW for grid connected mini-hydro;
2. 300 – 600 MW for decentralized, independent mini-grids and;
3. 90 – 150 MW for decentralized, independent pico-hydro systems.

Local institutions and companies have already shown their capability to manufacture a large number of systems of various types, Francis, Kaplan, Pelton and Cross flow in the capacity range from 5 to 1500 kW. However, the investors have shown some reluctance to purchase Vietnamese equipment; they have more favours in purchasing Chinese (or other foreign) equipment.

The Hydro Power Centre (HPC) is the most active organisation in providing consultancy for grid connecting mini hydro plants. The centre has a manufacturing capacity for around 30 mini hydro plants of 20 to 400 kW annually (2004).

The investment cost for small and mini hydropower electricity is very much depending on the adopted technology, location of installation and hydropower plant scale. Therefore the investment range is really large between 950 to 2700 USD/kW (Ky, 2003). See for an example investment the box below.

Box 4 Cao Bien pico-hydropower plant, a sustainable solution for Off-grid electrification

The Cao Bien micro-hydropower plant example

Cao Bien is the poorest hamlet without electricity connection in Phu Thuong commune, Vo Nhai district, Thai Nguyen. There are 30 households with about 150 people with Dao as the main ethnic minority in this hamlet. The main income source is from agriculture activities and the hamlet is mainly self-sufficient .

The Cao Bien micro-hydro was designed based on the actual electricity demand and the possibility of increased demand in the future.

- Capacity: 18kW
- Annual capacity output: 57,600 kWh./yr
- Investment capital sources are ETC – Netherlands and Vo Nha district budget
- Construction took place in 2006
- Number of beneficiary: 30 households, 1 school, 1 culture building and 1 mechanical workshop.
- Investment cost: 35,000 USD
- Operation cost: 400 VND/kWh

A management model had been set up for Cao Bien micro hydropower, which aimed to provide a full package service for local people. An operation and management team with 2 technicians has been well trained. The local people contributed initial amount of 200,000 VND to "operation and maintenance fund" and paying annual small amounts as an using fee to maintain operation and maintenance activities. This model has worked successfully and very appropriated to apply for off-grid rural and mountainous areas.

3.5 General assessment for biomass

Biomass is an important source of energy in Viet Nam and one that the country is well endowed in. It is estimated that approximately 90% of domestic energy consumption in rural areas is derived from biomass such as fuel wood, agricultural residues (e.g. rice straw and husks) and charcoal. Moreover, biomass fuel is also an important source of energy for small industries located mainly in rural areas.

Viet Nam has a large variety of agricultural residues and woody biomass, as well as waste materials from the processing sector. The most important sectors in Viet Nam are grouped below (SNV, 2012).

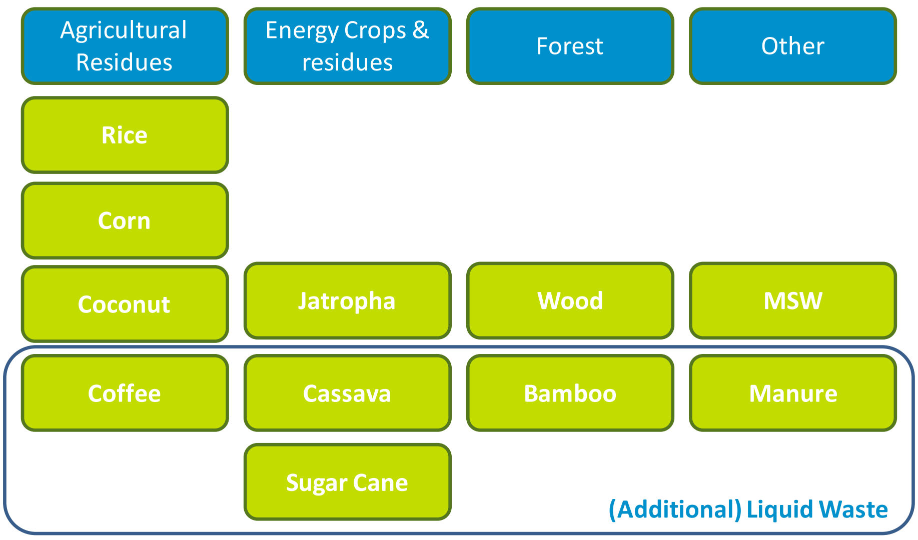


Figure 9 Selected residues for further research

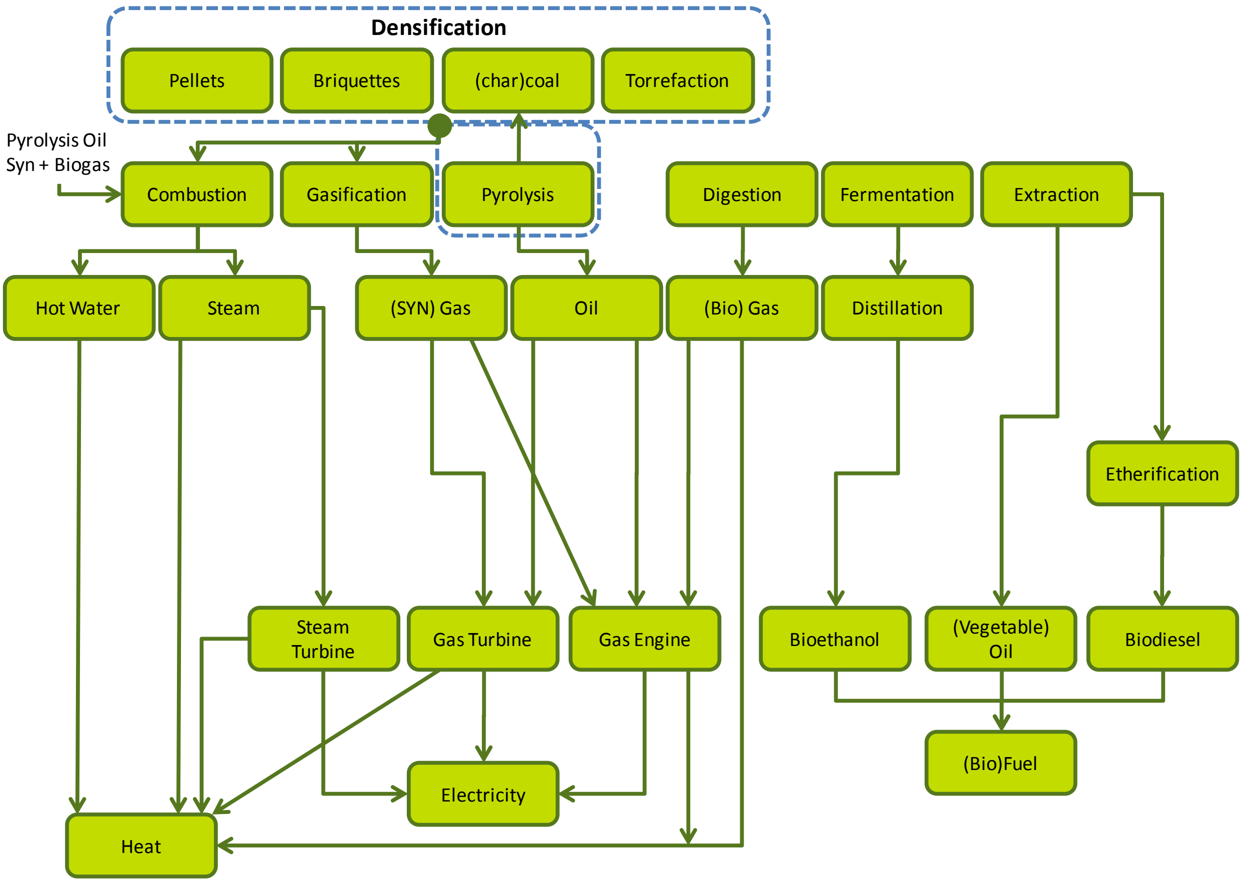
Table 14 Biomass Availability in Viet Nam per crop

	#Ha	Yield/Ha	Location	% of resource is residue or waste	Current practices	Theoretical Availability (ton)	Practical Availability
Bamboo	800,000 plus 600,000 mixed forest	10 - 13 t/ha	Northwest and east (33%). Mostly: Lam Dong (6.2% bamboo plantations and 16% mixed forest). Tuyen Quang, Son La, Bac Can, Yen Bai (7% BP and 43% MF)	50 - 70%	1) floor manufacturing: Combustion for primary energy 2) charcoal 3) used for paper and pulp production (50 - 80%) 4) domestic fuel	Around 7 million ton/year	unknown
Cassava	560,400	17 t/ha	Central, North East, Mekong	Stem is 30% of the cassava harvest The peel: 3% The cassava root: 40% (moisture 50%) Waste water: 31%	1) Agricultural waste after harvesting: cassava stem and agro-industries' residues - fertilizer and as seedling for next harvest (not collected) 2) Waste of tapioca starch processing can be used for raw fodder and/or fodder processing 3) Waste water for biogas production	3 million tons of cassava stem	unknown
Coconut	130,000	13 t/ha	84% in Mekong Delta (Ben Tre 30%)	30% weight is husk, plus leaves and bark it is 6.5 tons/ha of fuel wood	100% shell: activated carbon or domestic fuel or industrial thermal. 96% husks: processed into coir	975 tons only husk + 1.6 million tons fuel wood + 1 million tons pith	80,000 ton of fine pith
Coffee	500,000 (7% Arabica, 93% Robusta)	1.8 t/ha	Robusta in the Central Highlands Arabica in the North	15% of the dried cherry weight	Combusted, fertilizer, dumped	135,000 tons	unknown
Corn Cobb	1,125,000 ha	4.0 t/ha	50% Northeast and 10% in south east	20-50%	animal feed, cooking, fertilizer production, export (mainly)	1,066,500 tons	unknown
Corn Stob				200%	animal feed, cooking	9 million tons	unknown

Manure	-	±30.000 million heads, manure 2kg/head	Nation wide	n.a.	biogas, dumped, fertilizer	almost 1 million ton	almost 1 million ton
Rice husk	7,500,000 ha	5.32 t/ha	20% in Red river delta and 50% in Mekong river delta	20%	Cooking (15%), brick kiln (40-45%), power plant, briquette (10%), left over (20-25%)	8 million ton	2 million ton
Rice straw				85% (on average)	mushroom, cooking, burning in field, fertilizer, animal feed, bonsai, fruit bed (58%), burning (42%)	23 million ton	17 million ton
Sugar Cane	266,000 ha	51.7 t/ha	Mekong River Delta, North Middle and Coastal Plain, and East South	Top: 30%, Leaves: 10%, Bagasse: 9%, Fructose: 1.8%, Others: 1.2%	50-60% bagasse: combustion in Furnace; bagasse: fertilization	Top: 4,110,150t; Leaves: 1,370,050t; Fructose: 246,609t; Others: 164,406t	Leaves: 2.1 mill t; Molasses: 0.4 - 0.8 mill t; Bagasse: 2.4 - 5mil t
Wood residues	13 million (*)	residues: 5 million tons/year (**)	Central Highlands, Central North and Northeast (40%), Southeast (20%)	40% Logging, Saw-milling (38% solid, 12% sawdust)	wood chip export, particle boards, burning in kilns, domestic cooking	11 million ton residues. 4million m3 wood production	unknown

(*) 13 million ha in total, 10 ha natural forest and 3 ha planted forest
(**) 2 mil. tons from logged timber, 2.5 mil. tons from sawmills, 500,000tons from scattered trees

Different biomass sources can be converted into several energy carriers (like oil, gas, pellets, or charcoal) or can be converted into energy directly (through combustion). The different conversion routes are shown below, where in this report interest goes to electricity generation.



In the table below these conversion routes are linked to the different relevant sources of biomass. Other organic material is potentially available like energy crops, jatropha or organic solid waste, but they will not be further considered here. Furthermore several conversion routes that are not applicable for the focus on off-grid situations (too complex, or in early stages of development) have also been removed. The figure above and table below are for indicative reasons; to indicate what options has been explored to come to the conclusions in the next chapter on opportunities.

Table 15 Conversion Technologies linked to the biomass sources

	Pellets	Briquettes	Charcoal	Combustion	(An)aerobic (co-) digestion
Bamboo			X	X	
Cassava					
Coconut (Coil and Pith)	X	X	X	X	
Coffee Pith	X	X		X	
Corn (Cobb and Stob)		X		X	?
Manure					X
Manure (poultry)				X	X
Rice Straw				X	X*
Rice Husk				X	X
Sugar Cane Bagasse				X	
Wood	X	X	X	X	

Note: Energy efficient fermentation particularly of straw and leaves could make a substantial contribution to power supply.

Currently an in-depth study is executed by the Institute of Energy on the usage of Bagasse, and a follow-up study by SNV will be done on woody biomass availability, both under the framework of the Vietnam Clean Energy Program. Therefore more in-depth information will be given in later stages and reports.

Biomass for electricity generation is minimally applied in Viet Nam, due to a lack of support systems, the business plans are not bankable, pay back times and IRR's are not sufficient to be able to obtain the financial support necessary. The only biomass source that is used for electricity generation on both a small and large scale is biogas. Nevertheless for this report it was requested by Winrock not to include biogas potentials and solutions for Viet Nam, only solid and liquid biomass solutions.

There are nevertheless examples of large scale power projects in Viet Nam fed with biomass. Like for example the six 10MW rice husk-fired power plants in the provinces of Tien Giang, An Giang, Kien Giang, and Dong Thap (TPO, 2010). Each 10MW rice husk power plant consumes 85,000 tons of rice husks per year.

Another example is from the sugar cane sector. It is estimated that about two million tons of bagasse are used annually by sugar plants for burning in steam boilers to produce at least 4 million tons of steam and 560 million kWh of power (Cuong, 2011), (Tho, 2011). Most of this is used onsite for processing and at present, only 3 power plants are selling their surplus electricity to the national power grid. The highest feed-in tariff received by these plants is 4US cents/kWh. All three plants are located in Tay Ninh province and the biggest power plant is 24MW capacity. There are 38 sugar factories that are producing heat and power from bagasse.

For off-grid communities biomass is often linked to heat production and not electricity production. Solutions like cookstoves, biomass (wood, rice husks, etc) replacing coal or other sources in the processing industry (like brick making for example), gasifiers – in Cambodia used for electricity generation due to the high electricity prices, but not in Viet Nam (and not off-grid). Biomass for electricity production plays worldwide almost no role. This is also reflected in the Master Power Plan, where biomass is only briefly mentioned when talking about biogas only. Nevertheless for heat production the potentials are large, both from biomass availability perspective as well as technology wise.

4 Policy framework

RE is considered to play a significant role in providing electricity services to rural and poor people in Viet Nam. Policy frameworks having great influence on the development and implementation of the off-grid rural electrification program, Vietnamese Government has built a clear policy framework with a set of principles, long-term goals, and national commitments to the program as below:

In the Master Power Plan the strategy to develop and create rural power supply's is indicated. Government will stimulate EVN to develop the national power grid to supply power to 100% households by 2020. The aims are (MOIT, 2011):

- To further develop the national power system to supply efficiently and with highly quality sufficient electricity to meet the power demand for production and residential purpose in rural areas. In case areas cannot meet conditions to access to national power grid, the Government provides investment and support policies for development of local power resource to ensure that by 2020 the ratio of electricity available households is 100%.
- Government provides support policies to help developing socio-economic situations, including developing power supply system for provinces and poor households in remote areas, especially if it concerns ethnic minorities, in order to strengthen ethnic's solidarity, maintain defense security, ensure the living and production of people, and improve physical and mental living.
- To have a Government program to development investment and power supply to every hamlets and minority ethnics of Tay Nguyen.
- Upgrade rural power grid to increase supply capability and electricity quality; reduce power loss in power lines.

The rural electrification (REII) project is expected to fund such developments. The objective of the REII, which became effective in 2005, is to improve access to good, affordable electricity services to rural communities in an efficient and sustainable manner. Financed with a US$200 million IDA credit and US$5.25 million GEF grant, would be achieved through:

- A major upgrading and expansion of rural power networks in about 1,200 communes.
- Conversion of the existing ad hoc local electricity management systems to LDUs as legal entities recognized under Vietnamese law, to improve management of power distribution in rural areas, ensure financial sustainability, and enable future mobilization of private funds.
- Capacity building assistance for the LDUs, provincial authorities, participating regional PCs, and national authorities involved in the planning and regulation of rural electrification.

Additional financing for the Second Rural Electrification Project (US$200 million IDA credit, approved in May 2009). Which increased the outcome to 1,500 communes (1,5 million households) instead of 1,200 as indicated above.

Table 16 Viet Nam Policies that stimulate off-grid electrification

Legal document	Time approval	Main contents related to rural electrification
Electricity Law No. 28/2004/QH11, by the National Assembly	3/11/2004	Title: **Electricity law – 2004** **Related contents:** **Chapter VIII: Electricity in services of rural and mountainous areas, Islands.** **Article 60:** Policies on development of rural, mountainous, island electricity to attract al resources and encourage organization, individual to invest in building electricity infrastructure, to accelerate the process of rural electrification. **Article 61:** Investment in development of rural electrification. The state shall adopt policies to provide support in investment capitals, interest rates, capital loans and tax preferences for building, renovating, upgrading off-grid electrification for rural, mountainous area, islands.
Decision No.110/2007/QĐ-TTg by Prime Minister	18/07/2007	Title: **Approval of the Master Plan for National Power Development in period 2006-2015 with view to 2025.** Related content: **Article 1:** to approve the Master plan for National Power Development for the period 2006 - 2015 with the vision to 2025. Continue to implement program on rural electrification which have approved by Prime Minister set target to provide electricity to 95% and 100% of the communes in 2010 and 2015, respectively.
Decision No. 1855/Qd-TTg, by Prime Minister	27/12/2007	Title: **Approving Viet Nam's National energy development strategy up to 2020 with 2050 vision.** Related content: **Article 1:** To approve Viet Nam's national energy development strategy op to 2020, with 2050 vision • To complete the program on rural and mountainous energy: By 2010, 95% of rural households will be supplied with electricity and by 2020, almost all rural households will be supplied with electricity**.** • To integrate the use of new and renewable energies into the energy conservation program and other national target programs such as those on rural electrification, afforestation, hunger eradication and poverty alleviation, clean water, integrated fish pond-livestock pen-home garden model, etc. • To increase investment from the state budget for energy projects in rural and mountainous areas and islands so as to contribute to economic development and hunger eradication and poverty alleviation in these areas.
Circular No.	28/10/2008	Title: **Circular on implementing state support policies for investment, development of electricity**

<table>
<tr><td>97/2008/TT-BTC, by Ministry of Finance</td><td></td><td>in rural, mountainous and island areas.
Related contents:
Article 1: Scope of regulation
This Circular guides the implementation of Article 61 of the Electricity Law - 2004 on the State's support policies for electricity development investment in areas in which electricity investment and activities would bring no economic benefits; and for building off-grid for rural or mountainous areas or islands.
The project owners can borrow a portion of investment capital, and enjoy preferential conditions, terms, loan interest rates, payback period and risk treatment.
Article 2: Subjects of application
Project owners who are enterprises, organizations investing all type of power development projects for rural areas.</td></tr>
<tr><td>Decision 1208/QD-TTg, by Prime Minister</td><td>21/07/2011</td><td>Title: Approval of the National Master plan for Power Development Plan period 2011-2030 (Master Plan VII):
Related contents:
Article 1: Approve the National Master Plan for power development for the period of 2011 – 2020 with the vision to 2030. (3) The national master plan for power development. (d) The power supply to rural and mountainous areas and islands:
The development perspective of electrification in rural, mountainous areas and islands:
Promote rural electrification in order to help accelerate industrialization and modernization of agriculture and rural areas.
Using the sources of new and RE to supply electricity to the remote, border and island areas. Develop favorable mechanisms for management and investment to maintain and develop power sources in the regions.
Master plan for electricity supply in rural areas:
The period of 2011 to 2015: Invest for expansion of the national grid to supply electricity for 500 thousand households in rural areas. Provide electricity from RE sources to about 377 thousand rural households.
The period of 2016 – 2020: Invest in new power supply from the national grid to 200 thousand rural households. Supply electricity from RE sources to about 231 thousand rural households.</td></tr>
<tr><td>Decision No.</td><td>19/12/2011</td><td>Title: Decision on the electricity subsidy for poor people.</td></tr>
</table>

2409/QD-TTG, by Prime Minister		**Related contents:** **Article 1:** Providing an expense of 930 billion VND in 2011 to support poor households on payment for electricity bills. **Article 2:** Targeted additional supports taken from social security expenditure of central budget for local budgets in 2012 to support electricity bills for poor households under national poverty line at 30.000 VND/household/month.
	20/11/2012	Title: **Amending and supplementing a number of articles of the Electricity Law.** **Related contents:** **Article 1:** To amend and supplement a number of article of the electricity law as below: • 2. Supplement to the item 1a. Priority is given to develop the rural electrification for rural, mountainous areas, islands; particularly for areas having extremely difficulty in economic-social condition. • 4. Enhance the new and RE exploitation and use; preferences policies toward development and investment projects on utilizing new and RE. **Article 8a**. Power development plan contents • 1d. National power development plan includes the detail program on power source development, grid development, connection of the national grid to regional countries, rural electrification, new and RE development and other related contents. • 2d. Assessment of local capable power supply status; particularly for the areas having extremely difficulty in economic-social condition. **Article 62.** The power tariff for rural, mountainous areas and islands. • 2. The power tariff for rural, mountainous areas, islands where having no access to the national grid is stipulated as below: - With regard retail electricity prices for domestic consumption, People Committee will approved the appropriate prices built by local power Unit based on the electricity subsidy approved by Prime Minister.
Decision No. 8217/QD-BCT	28/12/2012	Title: **Approval of Renewable Energy Development Plan for Delta, midland area up to 2020 and 2030 vision.** **Related contents:** **Article 1.4.** Renewable energy development plan for Delta, midland area. 1.1. Development plan for period 2013 - 2020: • Development of RE serving rural electrification in remote area, far from national grid areas.

		Targeted to provide electricity for 22,899 household based on potential RE available at local areas with capacity of 7801 kWp. • Development of off-grid areas: Targeted to self-provide electricity for medium cattle farms. Develop and apply about 2,421,000 m^3 biogas digesters for electricity generation. 1.2. Development plan for period 2020 – 2030 • Development of off-grid electrification: electricity self-provide for medium cattle farms; develop and apply about 436,000 m^3 biogas digesters for electricity generation. • RE exploitation program for heat and bio-fuel production: develop and apply 1,158 million m^2 solar water heating; 7.98 million m^3 biogas digesters; 627 thousand biomass improved cook stoves; 543 thousand biomass grassfires; 198 million litter of bio-fuel of ethanol.
National target program	Under reviewing	**National target program on off-grid electrification for rural, mountainous areas and Islands period 2013 – 2020.** **Related contents:** The program mainly focuses on the electricity demands and investment activities to build off-grids electrification for hamlets, villages where having no access to the national grid.

Table 17 Other supporting policies in place

Legal document	Time approval	Main contents related to rural electrification
Law No.52/2005/QH11 endorsed by the National Assembly 11	29/11/2005	Title: **Environmental Law – 2005** **Related contents:** **Article 6:** Environmental protection actions which encourage development, use of clean energy, RE, GHG emission reduction, reduction of ozone layer destruction. **Article 33:** Development of clean energy, RE and environmental friendly products. Organizations or individuals who invest in the development and utilization of clean and RE for producing environmentally friendly products, will enjoy tax incentives, investment capital support and land use for the construction of production facilities.
Investment Law No.59/2005/QH11 endorsed by the National Assembly and Decree	29/11/2005 22/09/2006	Title: **Investment law 2005** **And Detailing and guiding the implementation of a number of articles of the Investment law**. **Related contents:** **Chapter IV.** Domains and Geographical areas entitled preferences, investment preferences and support.

No.108/2006/ND-CP , by Government		Decree stipulated for special investment in the construction of establishments using solar energy, wind energy, biogas, geothermic and tidal energy. • Incentives for tax rates, corporate tax, equipment imported tax and income tax from technology transfer. • Terms of land use and land rent exemption. • Loss transfer. • Fast depreciation
Decision No.130/2007/QD-TTg by Prime Minister	02/08/2007	Title: **Decision on several financial mechanism and policies applied to Investment Project on Clean Development Mechanism**. **Related content:** **Article 3.** Potential fields to be invested and carried out CDM project (b) Harvest an apply RE source CDM projects and their products will be granted the following incentives: • Tax exemption: for goods imported as fixed assets, materials, and supplies or semi-finished products which cannot yet be domestically produced and are imported for production activities; preferential enterprises income tax rates. • Land use fee: entitlement to land use levies or rent exemption or reduction under current legal provisions. • Price subsidy: products might be subsidized by the Viet Nam Environmental Protection Fund.
Decision No. 177/2007/QD-TTg, by the Prime Minister.	20/11/2007	Title: **Approving the scheme on development of bio-energy up to 2015, vision to 2025.** **Related contents:** **General objective:** To develop biofuel, a new and RE, for use as an alternative to partially replace conventional fossil fuels, contributing to assuring energy security and environmental protection. **Specific objectives for each period:** • 2015: production of ethanol and vegetable oil will reach 250 thousand tons, accounting for 1% of whole country's gasoline, oil demand; • 2025: production of ethanol and vegetable oil reaches 1.8 million tons, accounting for 5% of whole country's gasoline, oil demand.
Joint Circular No. 58/2008/TTLT-BTC-BTN&MT	04/7/2008	Title: **Guiding on implementation of some articles of Decision No.130/2007/QD-TTg.** **Related contents:** Stipulating on price subsidy for products of CDM projects, including: • Electricity produced from wind energy, solar energy, geothermal energy and tidal energy.

		• Electricity produced from covered methane gas (solid wastes, coal mines) (Subsidy/kWh = cost/kWh + reasonable profit/kWh – selling price/kWh –CDM selling price)
Decision No. 18/QD-BCT, by Ministry of Finance.	18/8/2008	Title: **Promulgation of avoided cost based tariff schedule and standard power purchase agreement**. **Related contents:** • Regulation on conditions, procedures for development, amendment and cancellation of electricity generation tariff applied for RE small power plants connected to the national power grid. Standard power purchase agreement. • Applicable for organizations, individuals purchasing electricity from RE small power plants.
Decree No. 04/2009/ND-CP, by the Government	14/01/2009	Title: **Decree on incentives and support on Environmental protection activities.** **Related contents:** Renewable energy projects might receive the following incentives: • Regulation on incentives, support on land, capital; • Preferential corporate tax. • Exemption from import tax on machines, equipment, facilities and materials imported for production activities. • Exemption from environmental protection fees. • Be allowed to depreciate fixed assets 1.5 times faster than the normal depreciation levels under current regulations. *For example: Solid waste treatment project gets 50% investment capital from the Government.*
Decree No. 87/2010/ND-CP, by the Government	13/08/2010	Title: **Detailing a number of articles of the Law on Import Duty and export duty.** **Related contents:** **Appendix 1:** List of sectors eligible for import duty incentives includes (3) the Investment in the building of power source projects operated by solar energy, wind energy, biogas, geothermal energy and tide. **Article 12. Duty exemption** Import tax exemption is applied to goods imported as fixed assets of RE projects.
Decision No. 37/2011/QD-TTg, by Prime Minister	29/06/2011	Title: **Decision on the Mechanism supporting the development of wind power project in Viet Nam.** **Related contents:** **Article 4.** Make, approve and announce of planning of wind power development: People's Committee of centrally-affiliated cities and provinces make plan of wind power development at provincial level,

		submit the Minister of Industry and Trade for approving. **Article 12.** Preferential of capital, tax and charge: Priority given to investment capital, tax, fees, land use.
Decision No. 50/2011/QD-TTg, by Prime Minister	05/09/2011	Title: **Stipulating functions, tasks, powers and organizational structure of the General Department of Energy directly under the Ministry of Industry and Trade.** **Related contents:** **Article 2:** Duties and power of General Department of Energy. (8) New energy and RE: • Develop and submit to the Minister of Industry and Trade for approval of master plans for provincial development of RE; mechanisms and policies to encourage development of new energy, RE, national target programs on new energy, RE; • Manage and supervise the implementation of national target programs and projects in developing new energy, renewable energy.
Circular No. 06/2013/TT-BCT, by Ministry of Industry and Trade	08/03/2013	Title: **Regulation on the Content, Process and Procedures for Preparation, Validation and Approval of Wind Power Development Planning.** **Related contents:** **Article 7.** Provincial wind power development planning. Wind power development planning of provinces and cities of first category (hereinafter referred to as provincial wind power development plan) is a Planning Project designed to identify the overall theoretical and technical wind power potential and distribution of wind potential across an individual province. **Article 9.** Process, procedure for preparation and appraisal of provincial wind power development planning. The provincial Department of Industry and Trade shall develop a Planning Project including project outline, cost estimation and submit to the provincial People's Committee for approval; **Article 10.** Appraisal, approval and publication of provincial wind power development planning. The General Directorate of Energy shall appraise the Planning Project.

Decision (under reviewing)	In place 2013	Title: **Decision on supporting development mechanism for the biomass based power projects in Viet Nam.** **Related contents:** **Article 15.** Preferences and support towards off-grid biomass based powers projects**.** • Off-grid biomass power projects will enjoy the preferences and supports on investment capital, loans, tax and land use, • The off-grid investors propose the electricity prices and determine the total support for the different in avoided cost tariff of biomass power project and the actual price before submit to Ministry of Industry and Trade for appraisal. Then after, report to the Prime Minister for consideration and approval. The fund support for the difference in avoided cost tariff of approved project and the actual price will be covered by Environmental Protection Fund.

4.1 International Cooperation for off-grid projects in Viet Nam

There is a number of donor projects that have supported the Vietnamese Government in their aim to reach 100% electrification by 2020. The below list gives an indication of the (kind of) projects, but the total list is longer.

Program	Donors	Time	Description and Achievement
Joint UNDP/ World Bank Energy Sector Management Assistance Program (ESMAP)	UNDP World Bank (WB)	Since 2001	The objective of the RE action plan was to provide cost-effective and reliable electricity to help rural people to improve their standard of living and increase their income. The Renewable electricity was to supply isolated household and communities that cannot be reached economically by the grid and argument grid supply in remote areas. The program was focused on potential markets segment for RE and given priority to provide energy service in poor isolated communities and villages.
Vietnam Sweden Rural Energy Program (VSRE)	SIDA	2004	SIDA and MOIT launched the VSRE in order to support the acceleration of electrification in the country's rural and mountainous areas through the use of off-grid RE systems, especially small and medium scale hydropower, solar PV and biogas technology. VSRE conducted numerous assessments of the capacity and RE potential of rural areas across Viet Nam to identify the most promising areas for development of indigenous RE sources and built capacity to support of RE policies. VSRE also developed the new technology standard for rural electrification which were formally adopted in 2006 as national standard to replace the localized standard.
The Solar Energy project in Vietnam.	Finish Government - NAPS system Oy – Finland	2005	The Finnish government has funded EUR5.3 million for a project on solar energy application in rural areas and localities inhabited by ethnic minority people in Viet Nam. The government of Viet Nam will contribute EUR1 million in reciprocal capital for the project worth over EUR6 million in the first phase. At the initial, the project helped on applying solar energy in 17 mountainous communes and localities inhabited by ethnic minority people in Ky Son, Que Phong and Quy Chau districts in the central province of Nghe An. An additional 283 communes in Nghe An province were also in the plan for solar energy development.

Renewable Energy Development and Network Expansion and Rehabilitation for Remote Communes Sector Project.	ADB	2009	The Asian Development Bank (ADB) is extending a US$151 million loan to help Viet Nam expand and improve electricity services in poor and remote communities. This project aim to build on the inroad made by VSRE to deploy hydropower in rural areas which will develop 5-10 mini hydropower plants to serve communes in mountainous areas in the north and center of the country. It will also provide financial support to the Government's ongoing rural electrification program, which is seeking to expand power coverage throughout the country, particularly in provinces with large ethnic minority communities.
	World Bank	1994 - today	WorldBank has supported Viet Nam's developments in Rural Electrification for 2 decades. A range of projects, with EVN and in some cases together with IDA. • Power Sector Rehabilitation and Expansion Project • Power Development Project • Rural Energy Project • Second Rural Energy Project • Rural Distribution Project
Sustainable business model to deliver clean energy in rural Viet Nam.	Co-funding World vision Australia and REEEP	2013-2014	With total budget of 293,090 EUR co-funded by REEEP and World Vision Australia. Project is to create a business model to deliver clean electricity to off-grid villages in Viet Nam, to test and refine the model in two communities to ensure its viability for a wider roll-out. The project expected to provide 100 MWh of renewably sourced electricity per year to two remote villages. Project will construct the actual plants and mini-grids in the test communities, give training to local people on installation, use and maintenance of technology. Besides, project also plan to develop local community awareness and school education.

5 Barriers for electrification of off-grid areas

Off-grid electrification projects in Viet Nam have been having a challenging time, many projects including (but not limited to) The World Bank supported Remote Area Rural Electrification (RARE), and the Muong Te scheme (combines new off-grid electrification with rehabilitation of existing hydro schemes)(World Bank, 2011) the low-cost village-level electrification by JICA, the Vietnam Sweden Renewable Energy Project (VSRE) have all suffered many delays and difficulties (IE, 2009). This chapter will explain such challenges and barriers for the application of RE solutions in remote Viet Nam.

5.1 Affordability and financial barriers

It is widely known, that the main financial barrier for RE projects is the higher initial costs compared to more traditional forms of energy like kerosene or diesel generators. Feasibility studies have shown nevertheless that on the longer term RE solutions are cost competitive, when looking at the total life cycle (IOREC, 2012). In Viet Nam this barrier has been lowered or reduced by the involvement of donors and/or the government. So far, most of the off-grid RE power projects in Viet Nam were and are funded by the Government or international organizations with different supporting mechanisms. Off-grid areas are, as indicated previously, mostly remote rural areas, mountainous area or islands with a relatively high percentage of poor people. The local people have low to extremely low incomes, they are not able and/or willing to pay for electricity at high prices.

The difficulty of defining credible revenue models in the context of Viet Nam also limits the opportunities to access (low cost) financing, either to support the initial investments, but also in prior stages of feasibility study. More on financial models available in Viet Nam will be presented in the final report.

Furthermore the high involvement of Government funds, donor funds and/or EVN investments compete directly with potential private sector investments. Investments might not be encouraged, and –as mentioned- local stakeholders will (rather) wait for public funding with lower costs than take any investment risks themselves. When the aim is to stimulate private sector investment in the RE sector, it needs to be considered how public funds can further stimulate private sector investments instead of limit / discourage. This can be part of future policy development. This could also mean a close public-private cooperation, through cost sharing or leveraging investments, or more ESCO's like arrangements (Energy service companies - pay for service).

The affordability question was grouped in two sections;

5.1.1 Investment costs

The small scale household level. In the mountainous off-grid areas, if there is access to electricity, it is often self-sufficient by local household / entrepreneurs with pico hydropower plants (own investments), SHS's (or diesel generators). However, only few households live close enough to the stream to be able access it for the use of pico hydro. For households further away from the stream, the installation costs for pico hydro solutions are too high. For the poorest households it is not feasible to invest in either pico hydro, or SHS for their energy needs.

The medium and larger scale level. Investments for capital intensive RE solutions need to come from the local governments and/or EVN. Local governments get budget's allocated yearly that they need to allocate themselves in line with the government priorities and the local priorities. As EVN has indicated that they will extend the grid (100% by 2020), the willingness to allocate funds to invest in (renewable) energy is very limited. At the same time, RE solutions require larger investments than conventional solutions, so it will not be the highest priority in these often poor areas. Other more basic needs that *RE* have larger priorities. So the ability to invest is also low.

This also means that whatever investment is done on the short term, it should be in RE solutions that continue to be viable after the village or household gains access to the National Grid, through – for example- the sales of (surplus) electricity to the grid. Such viable business cases need to be developed.

5.1.2 Operational costs

This meanly is related to medium and large scale solutions, operation also requires a logistical system to collect fees (for medium and larger scale solutions), and a system that maintains the installation. Local governments and/or EVN also need to allocation budget and organize this system. Furthermore as explained in paragraph 2.3. as well as in the case studies in the Box's, there is a gap between what that households can pay (based on government calculations) and what the real costs of production are. In case of diesel generation each kW produced costs EVN money, which lower the incentive of initial investment and running it continuously.

5.2 Location and logistics

Especially in the mountainous areas available infrastructure is limited, roads and means of transport are not in place, and at the same time community (or household) density is low. Transportation of the systems to the location is therefore an additional high cost and physical barrier for implementation. Installation in the mountainous areas can take more than a day of transporting with motorbikes and/or horses or horse carriages as more modern transport technologies cannot reach the sites. This is not applicable for off-grid island locations.

Box 5 Example of bottleneck in location

Example of difficulties in location selection (GiZ 2012).

A good example is the wind power project of REVN in Binh Thuan. It was a 2 months effort to transport 5 wind turbines (nominal power 7,5MW in total) from Phu My Seaport to the project location in Binh Thuan on the 300 km stretch of road – and this wasn't even remote or extremely rural area. Additionally the company had to hire a crane from Singapore, as no cranes were available at that time in Viet Nam to erect the turbines.

5.3 Technology

5.3.1 Hydropower specific barriers

Unfortunately even for this well established market there are still a few barriers.

Cheap, out of date and low quality technology imported from China is still dominating in the off-grids areas in Viet Nam. There is limited spare part availability in the remote mountainous areas for replacement and repairs. Lack of knowledge on repair (less a problem in Viet Nam) and/or spare parts can stop a whole system from working.

Natural hazards heavily influence the lifetime of the smaller installations. It was reported to us by several smaller scale projects that the regular flooding washes away or damages the small pico and micro hydro systems as there is no flow control build in, turbines get swept away without protection (which is often lacking).

There are also safety issues linked to the installation of pico and micro hydro, often household purchase the technology individually and *install systems without any technical support* from experts, leading to low quality installments, breakages and short lifetimes. Furthermore the un-insulated electric wires used can cause electrical shocks for the installers / operators in case not properly installed.

5.3.2 Wind power specific barriers

The wind energy market in Viet Nam is rapidly changing. Due to the introduction of the first feed in tariff in Viet Nam -for wind-, a lot of attention has been given to the development of this market, also influencing the off-grid sector. Especially the unit size of the turbines available in Viet Nam has increased throughout the last years, from imported low capacity turbines from China and the EU (<250kW) to the now larger capacity units of 1-2 MW. The reliability of the wind data in Vietnam is questioned, even though it is widely available, especially for the rural and remote areas for the wind potentials (GiZ, 2012).

The relatively new FIT is 1,614 VND (7,8 USD cents/kWh) in Viet Nam, compared to –for example- 18 USD cents/kWh in Thailand and 23 USD cents/kWh in the Philippines. These FIT already give a good indication of the real production prices. When we extrapolate this to off-grid production we know, also from earlier chapters that the initial investment is relatively high, and therefore production costs are high.

Furthermore, some of the provinces with good wind potentials are also rich in minerals, this could potentially create a conflict in land sourcing (wind parks vs. mines), like for example in Binh Tuan and Ninh Thuan.

5.3.3 Solar specific barriers

As indicated before the solar market has developed quickly over the last few years and most projects are donor driven in Viet Nam (PV for electricity production not for hot water). Local producers are in the market but have difficulties competing in quality with imported panels and side equipment from Europe and China The equipment failure rate is high, and therefore the trust in local equipment is low.

Systems lifetimes are at risk due to the limited knowledge levels when it comes to selection and operation of the systems. This often results in compromises on the quality of the charge controllers (for example) which than impacts the overall lifetime of the system and / or its costs.

There are no standard reported for Solar technologies; performance standards, equipment certification and codes of practice for quality control need to be developed and accepted, this is an essential part of creating sustainable solutions.

5.3.4 Biomass specific barriers

Barriers in the biomass sector stem from the scattered locations of the residues throughout the country. Especially rice is a good example of this scatteredness, as it is not always processed in a central, large scale, location, normally the residues are spread over a large area especially in the remote areas. The same is nevertheless true for other residues like corn residues for example. As a result a RE system needs to be developed where residues can be efficiently be collected and transported to - at a central power station or processing location.

This also makes contracting of the biomass sourcing difficult. Transport from inland or remote areas to the commune or hamlet center for decentralized production might be a financial barrier for the farmers, and potentially even a logistical barrier (due to the bad roads). The benefit might not out weight the additional costs, and there is no logistical system in place for these transports. Biomass is mainly air and water, which is transported, so densification could be a solution for this (pelletizing and/or briquetting). After densification the biomass can be used for either heat production (for industrial use, brick making etc.) or for (co-)generation. The latter does require significant investments. Biomass electricity production gets more interesting at scale, nevertheless heat production can be interesting at any scale.

5.4 Policy Barriers

Major barrier for renewables to establish off-grid (and on-grid) RE business in Viet Nam is a lack of favoring policies, a reliable legal framework and the substantial subsidization to encourage developing RE power projects at off-grid areas. There is a lack of strong and comprehensive policy for investment, management and operation RE project both in off-grid remote areas as well –as often reported- for on-grid projects. There was a lack of a focal point in Viet Nam, but this was put into place in 2011 with the introduction of the General Directorate of Energy which is the managing body for energy development in Viet Nam.

Not directly relevant for off-grid solutions, but a good indicator that shows the lack of supporting policies is the absence of feed-in tariffs (only in place for Wind Power). A feed-in tariff is usually referred to a regulatory guaranteed price per kWh that an electricity utility has to pay to a private, independent producer of electricity fed into the grid, this can be financed with state budget or other with other funds. The independent producer could be a household, a community or an investor. This can be of interest – as indicated RE solutions that are introduced in off-grid areas should be designed in a way that they can be connected to the grid if/when the grid is extended to the rural areas so that the investment doesn't become a waste after the grid is extended but it can continue to contribute to pay back the investment. This is when FIT do play an important role for off-grid projects.

With a policy of 100% electricity access by 2020, the Government of Viet Nam has set itself a very ambitious and almost impossible goal. The last mile, in other words, the last households to be connected will be expensive solutions for the Government and/or EVN. If this goal of 100% by 2020 is not supported by sufficient budget's to reach this – which is the case at the moment. It will be difficult to reach the remote areas not yet connected. Also this policy gives local governments an excuse to not invest their state budget's allocated, as expectations are in place that either EVN or National State budget will cover in the nearby future the grid extension.

Incentives for RE project development are not only in the form of subsidies or FIT, the government can also further develop its tax policies (current tax exemption has shown not to be sufficient), create access to green loans, develop favorable loan mechanisms (grace periods, longer timelines, favorable interest rates, etc), mobilize capital (through ODA and/or bilateral foreign loans).

5.5 Local Capacities

Almost every survey done on rural electrification, specifically in Viet Nam (IE, 2009)(GiZ, 2012)(WorldBank, 2011) or more general (IOREC, 2012) indicates that there is a large need for proper training and knowledge transfer. This refers to knowledge on many levels:

- At present the R&D efforts and RE developments in Viet Nam take place very scattered over the country. Viet Nam has a large number of research institutes and universities developing RE solutions, there is limited to no coordination between the organisations which results in overlapping results instead of further development of the total market. There is no coordinating body for learning institutes (on all levels universities, colleges and vocational schools) that supports knowledge exchange between them. The human resource availability in clean tech solutions is only developing at the moment, resulting in a relatively young and inexperienced group of RE experts, and a limited number of senior RE experts with sufficient experience. This is an obstacle for the development of the sector.
- Enterprises interested in developing energy projects often have limited skills in the development of bankable business plans to attract sufficient financing for the projects (either through loans and/or grants). Support is given by organisations like the Nexus Group, or CIF PFAN, but his is not for all available.
- Local enterprises sometimes also have limited information or access to information about what technologies are available abroad and this leads to low quality import for example, or not available spare parts.
- Provincial, or other local governments have limited knowledge on the wide variety of the opportunities of RE technologies. Solar, wind, biomass, hybrid solutions are not known or understood by the local governments and can therefore not be stimulated. Nor will it receive more priority for the local government budget allocation.

In the field, the capacity necessary also relates to operation and maintenance. Depending on the technology used maintenance will play an important role. It has been acknowledge by local enterprises in Viet Nam, that this is the main barrier for RE solutions after installation. The operation and maintenance can be seen as a challenge and an opportunity at the same time. Operation and maintenance will create new jobs in the rural areas, (the same can be said about fee collection). The challenge is however the availability of capable and trained maintenance technicians. Given the geographic isolation of off-grid areas and the comparatively small opportunity of replication of the RE systems in the area (low density of communities), it is challenging for project developers to create capacity building and training programs in a cost-effective manner that are sustainable (sources: own experience writer in previous projects, interviews with local entrepreneurs)(IOREC, 2012). Local government may not have the resources to finance such expertise, or to coordinate or set-up such systems.

The local RE entrepreneurs interviewed also indicated that often spare parts are not available in the Viet Nam mountainous areas, and knowledge levels are not up to the levels needed for the technical support. It is often seen therefore on project sites, that after (ODA) projects leave the sites, 3 to 5 years later the installations are not operational anymore.

From a logistical point of view it is therefore more interesting to look at off-grid areas that do have a diesel system in place and which can be replaced. Nevertheless this is also an additional barrier; for local governments this could potentially mean double investments (if they invested themselves in the diesel generation) or it will not be a priority to invest the scare financial resources in a RE project as they already have access to electricity (in case EVN invested);

even when relatively fuel savings benefits can be demonstrated through the feasibility study.

Furthermore, it has been reported by several project developers that the equipment implemented in the rural and remote areas is regularly used for other purposes (like the batteries or other parts) and not returned, especially when there is no clear ownership of the installation or if it is community based.

6 In-depth case studies

6.1 Selection of communities

As indicated in the introduction of this report, Viet Nam already has a grid connection outreach to 97,6% of the country. With such high electrification numbers it is easy to understand that the grid has not expanded *only* to the inaccessible areas and/or the areas where connections are economically not interesting. These off-grid areas are mainly mountainous communes and islands. It is the responsibility of the Provinces to establish local generation solutions in these communes in the form of diesel, small hydro power, solar power, or other solutions.

These off-grid areas are often the poorest areas in Viet Nam, as also shown in paragraph 2.1. These provinces have limited resources to divide among their projects and focus areas in their area. Therefore investments in (often more expensive) RE solutions, instead of the standard diesel connection or no electricity access, is not the highest priority.

Furthermore interviews with RE technology suppliers, especially the RE entrepreneurs, have indicated that the mountainous areas that are off grid are often difficult to reach. No good roads lead up to these areas, and it is challenging to transport (expensive) equipment to these areas. From a business perspective these areas seem to be less interesting, also because the communities are small, and the density of the communities is small. So there is also limited opportunities to sell several systems in the same areas.

Furthermore as indicated in the barriers Chapter 4.1, there is the challenge of operation and maintenance in the remote mountainous areas. With a future focus of this program to increase public and private investment in and piloting of RE technologies, it might be challenging to work with commercial enterprises in these areas.

EVN supports and finances grid extension, which is something that needs to be financed by the provinces in case they ‘extend’ the grid on their own with diesel or RE solutions. This includes both the initial investment costs as well as the operation, maintenance and fee collection costs. Therefore provincial offices prefer to trust on the grid extension by EVN, instead of making long term high investments themselves in local solutions for off-grid areas. EVN has indicated to the provinces that the grid will be extended to them in the next 8 years, the government has committed to 100% access to electricity for households (on-grid and off-grid) by 2020. This is an additional reason that there is limited interest from the local provinces to invest themselves in electrification solutions, they prefer to wait for EVN to make the investment.

6.2 Site selection criteria

To be to select the first two sites which will be studied in more depth, a list of selection criteria was developed (Table 18).

Table 18 Main selection criteria

No	Criteria
1.	Site is off-grid - in other words the site is not connected to the National Grid.

2.	The site must hold potential for RE Solutions (wind, solar, biomas and/or hydro), making it possible to supply electricity from RE as the main source.
3.	Sites must have either no or unreliable, unaffordable or unsustainable electricity supply. In other words – no RE Solutions are in place yet for (decentralized) electricity supply.
4.	The economic development of the site is assumed to improve from access to reliable and affordable energy supply4.
5.	Local Government is interested in RE solutions and willing to look into the different options available for this site. Local Government or other local stakeholders are willing to invest in RE solutions for electricity purposes.
6.	Scale-ability or replicability of the potential solutions that can be offered to the location. The selected commune/region needs to represent the general characteristics of off-grid areas.
7.	Outreach / number of households that could be reached, including –if available- an indication of the density of the households.

A second list is developed with preferential criteria, which will also weight when making the decision of the site (Table 19).

Table 19 Preferential Selection Criteria

No	Criteria	Justification
1	Distance to National Grid must be Substantial and/or grid connection is costly	These locations will be more open to own investment in RE solutions.
2	No plan to connect to the National Grid in the nearby future (next ten years)	These locations will be more open to own investment in RE solutions.
3	Currently an electricity generation system in place (diesel fed for example), that can be replaced by (or join/combined with) a RE Solution.	Based on interviews with experts, locations where diesel is already provided have the necessary logistical systems in place.
4	Preferably there is a nearby commune that does have access to a decentralized electricity solution	To be able to also analyse the success and/or failure of this solution.

6.3 Site Screening process

A quick scan of the CEMA/SNV un-electrified communes list indicates that quite a number of communes match with the selection criteria as indicated above. In cooperation with the Winrock team it was decided that the two sites to be selected will be one Island location, and one mountainous area. This way a few on both quite different rural settings can be developed for the follow-up phases of the Vietnam Clean Energy Program.

Based on a general analysis of the long list, a short list was developed of 3 high potential islands and 3 mainland, mountainous areas with a high potential. The three islands shortlisted are Con Co (Quang Tri), Cu Lao Cham (Quang Nam) and Ly Son (Quang Ngai) and the three mountainous areas shortlisted are Cao Phong (Hoa Binh), Vi Xuyen (Ha Giang) and Tuong Duong (Nghe An). General information of each location have been collected and analyzed. The most suitable island and mountainous area for off-grid field surveys will be selected from the comparison of these observed locations.

[4] For example farming activities as water pumping, processing or agro-business or services activities

6.3.1 Shortlisted Island locations

In the table below indicates the results of the analysis of the different shortlisted areas.

Table 20 Shortlisted Island Location selection (part 1)

No	Criteria	Justification		
	Name of candidate	Con Co	Cu Lao Cham (or Cham Islands)	Ly Son
	General Information	• a surface of 2 km^2 • tropical climate with monsoons • The average temperature is from 20-250C. • Annual rainfall is from 2000-2700mm/y • Averaged humidity is 70-80%. • Con Co has an official marine reserve since 2010, which is 4,532ha http://conco.quangtri.gov.vn/	• part of the Cu Lao Cham Marine Park, a world Biosphere Reserve recognized by UNESCO • sand beaches, forested hills and the sea • 1,549 hectares (ha) of natural forest and 6,716 ha of water surface http://culaochammpa.com.vn/	• A surface of 10km2 • 70% of the main island is volcano terrain • Annual rainfall is 2,260 mm per year. • Average humidity is 85% http://lyson.gov.vn/
1.	Site is off-grid	Yes	Yes	Yes
2.	RE Potential -see also table below-	Solar power Wind energy	Solar power Wind power	Solar power Wind power
3.	no RE Solutions are in place yet	No	Not in the selected commune	Not in the selected commune
4.	The economic development of the site is assumed to improve from access to reliable and affordable energy supply.	Its main economic activities is (local) tourism and aquaculture	Its main economic activity is fishery, but tourism is rising and will play a major role in the nearby future.	Its main economic activities is aquaculture, garlic production, coastal sand mining. And a growing tourism industry. 60% of the households live of the sea, 30% of households live by agriculture (mainly onion, garlic,

				corn) and 10% of households have other professions.
5.	Local Government support	Quang Tri has published a request for donors/project developers for RE solutions for the island. Decision 1936/QD-UBND dated on 16 Oct, 2012	Local authorities expressed interest for general support from local authorities in online news sources, and with supporting feasibility studies or other projects in the past.	Local authorities expressed interest for general support from local authorities in online news sources, and with supporting feasibility studies or other projects in the past. Also their local government requested in-depth study of the potential of the use of wind energy compared to help improve the efficiency of resource use climate for economic and social development.
6.	Scale-ability or replicability of the potential solutions that can be offered to the location. The selected commune/region needs to represent the general characteristics of off-grid areas.	No potential for scale up within the district as Con Co is a small island with no other surrounding islands with inhabitants	Cu Lao Cham district exists of 8 small islands. Furthermore the main island has 3 big communes and several small ones	Ly Son island has two main islands and several small ones. There are three communes on the two main islands.
7.	Population density	500 households	900 households	4,745 households

Table 21 Shortlisted Island Location selection (part 2)

Preferential criteria				
	Name of candidate	Con Co	Cu Lao Cham (or Cham Islands)	Ly Son
1	Distance to National Grid	28km from the mainland	18km from the mainland	30km from the mainland.
2	No plan to connect to the National Grid in the nearby future (next ten years)	No plan, or plan unknown	No plan, or plan unknown	EVN is planning to expand the grid to this island by September 2014 (source)

3	Currently an electricity generation system in place	The District People Committee invested in a centralized diesel based power station (132KVA / 112.2kW / 0.4kV) comprising of two units of 66kVA each to meet electricity demand on the island.	There are three diesel generators on the island located in Bai Lang islet with total capacity of 585kVA and Bai Huong with capacity of 75kVA. Many of households in the island have access to electricity provided by diesel generators, with central electricity supply a lot of costs and unsustainable energy use can be avoided.	There is an existing diesel generator of 2,5MW to meet the electricity demand of the islander.
4	Site had developed a pilot RE project.	No RE solutions present	In 2009 VSRE piloted a hybrid system of solar and diesel in Bai Huong islet with capacity of 28kW, voltage 220V to provide the electricity for about 90 households	Hydrothermal waters on Lý Sơn provide heat for the local power plant.

Table 22 Renewable Resources Potential at the shortlisted sights (Islands)

Island	Solar (VUSTA, 2007)	Wind (ADB, 2008) (ADB, 2008)	Biomass (NREL, 2012)	Hydro
Con Co	Good Solar intensity : 4.5 – 6.5 kWh/m^2/day with 2000 – 2600 sunshine hour/yr	Good 3.9 m/s @ 12m H 6.0m/s @ 70m H	Very low Biomass from all crop residual: 100,000 – 500,000 tons/yr Biogas: 0 – 0.5 tons Methane/yr	Very low
Cu Lao Cham[5]	Good Solar intensity: 4.42 kWh/m^2/day with 2182 sunshine hour/y	1.3 m/s @ 10m H (1978 – 1998) measured annually at Da Nang station No wind power data available for Cu lao Cham at the moment.	Biomass, and biogas are not available	Water source is not available for hydropower
Ly Son	Good Solar intensity: 4.5 – 6.5 kWh/m^2/day with 2000 – 2600 sunshine hour/yr (average sunshine is 2430 hours per year)	Good Wind is available at annual average 4.3 m/s@12m height	Very low Biomass from all crop residual: 100,000 – 500,000 tons/yr Biogas: 0 – 0.5 tons Methane/yr	Very low

All three islands have very favorable conditions to focus the first pilot study on, that is why they were shortlisted initially. Therefore decision factors are marginal. The above screening process indicates that the most appropriate island for field survey is Cu Lao Cham, because of the following reasons:

- During the survey lessons learned from the implementation of the PV hybrid system in Bai Huong village of Cu Lao Cham will studied, and analyzed and can potentially be scaled up on other parts of the islands or other islands.
- The electricity demand for other three villages (Bai Lang, Bai Ong, Thon Cam) in Cu Lao Cham island increasing, and so is the tourism sector for this island group. The village for the in-depth study will be chosen in cooperation with the local representatives.
- High potential RE source of wind and solar in the island, and even a relatively (for an island) large forest area.
- The island is easily accessible, when being an example project for further scale up.

[5] Feasibility Study of Bai Huong Hybrid System of Solar Photovoltaic and Diesel Generators

6.3.2 Cu Lao Cham island basic information

Cu Lao Cham Island belongs to Tan Hiep commune, Hoi An town. It is located 18km from Hoi An town. It consists of 4 villages (Bai Cam, Bai Lang, Bai Huong and other small islands). The population of the island is about 3,000 persons living in 900 households. There are no ethnic minorities on the island. The main economic activity is fishing and the main part of the total catch is landed and consumed on the island as fresh fish. Most households have access to electricity provided by diesel generators, but the production cost are relatively high, at about 8,000 VND/kWh and the electricity price that local people have to pay is 4,000 VND/kWh (2008). There is not a clear plan to connect the island with the electricity grid due to high investment cost. The island holds a good potential of wind and solar energy sources.

In 2009 VSRE installed a hybrid system of solar PV and diesel generator to meet the increasing demand of electricity on Bai Huong islet. However, this project somehow has not satisfied the demand of local islanders, and the electricity has not yet available at 24h/24h for use.

After the field visits this information in this report will be updated and extended.

6.3.3 Shortlisted Mountainous areas

The mountainous areas are known as very rich of water sources and having high potential for hydropower. The most suitable technology for electricity generation and widely applied to these areas is pico, micro and mini hydropower. Besides, biomass from forest is also a valuable source to generate electricity but biomass generator seem not appear in these area as documented so far. The solar potential also can be considered as a good solution for off-grid electrification.

In parallel, there is a cultivated forest managed by Vinaforest, covering over 100,000 ha spread over eight Northern provinces with activities focused on sustainable hardwood forest plantation establishment, forest management, harvesting, and the trading of logs, chips, and biomass. Vinaforest is interested in being a RE project developer which focus on electricity generation from woody biomass, woodchips or wood pellets to utilize the large amount of residues from wood processing.

The mountainous areas having low electrification rate will be given high priority for selection process. Vi Xuyen (Ha Giang) and Tuong Duong (Nghe An) indicate from the un-electrified list that having highest percentage of un-electrified households and carrying lot of RE sources. Whereas, Cao Phong (Hoa Binh) showing the less un-electrified households number but having high potential and reliable source for development of a RE project. The districts selected are indicative, in cooperation and in discussion with the provincial representatives it could potentially be decided that the focus will be on other districts within the selected province, as SNV wants to approach to province in a flexible matter.

The suggested three districts have been shortlisted for in-depth analysis based on given criteria:

- Cao Phong district, Hoa Binh province;
- Vi Xuyen, Ha Giang province;
- Bao Lac district, Cao Bang province.

Justification of selection has been given in the table below.

Table 23 Shortlisted Mountainous off-grid Location selection (part 1)

No	Criteria	Justification		
	Name of candidate	Cao Phong district, Hoa Binh	Vi Xuyen district, Ha Giang	Tuong Duong district, Nghe An
	General Information	http://www.hoabinh.gov.vn/	http://www.hagiang.gov.vn/	http://nghean.gov.vn/wps/portal/huyentuongduong/
1.	Site is off-grid	Yes	Yes	Yes
2.	RE Potential -see also table below-	Good potential for solar and biomass. Wind data unreliable	Hydro potential Wind data unreliable	Hydro potential, Solar potential Wind data unreliable
3.	No RE Solutions are in place yet	Not in place for un-electrified communes	Not in place yet for un-electrified communes	Not in place yet for un-electrified communes
4.	The economic development of the site is assumed to improve from access to reliable and affordable energy supply.	Its main economic activities is agriculture (cultivation and animal husbandry) and forestry.	Its main economic activities is agriculture.	Its main economic activities is agriculture.
5.	Local Government support	District and provincial levels are willing to support for electrification program especially for off-grid areas. In the Province Economic development plan for 2010 – 2015, the access to electricity has been targeted to increase from 95% households in 2012 to 97% of the households in 2015.	Ha Giang province had put lot of effort on rural electrification program since 2001 to supply electricity for remote communities. In the adjustment Province development plan to 2020, Giang had planned to build up new 220kV and 110 kV transmission lines with several stations to supply electricity to remote area. And 96% of hamlets, 85% of households expected to access electricity by end of 2020.	In the development plan period of 2011 - 2015, Nghe An province has plan to install new transmission lines of 22kV and 35 kV and stations to connect national grid to remote areas. The plan expected to cover electricity to 98% of households by end of 2015, of which 90% of household using electricity from grid.
6.	Scale-ability or replicability of the potential solutions that can be offered to the location. The selected commune/region needs	Cao Phong district has 122 households have no access to centrally provided electricity. Furthermore this forest area is an	Vi Xuyen, Ha Giang still has a large amount of households without access to electricity, about 1,352 households in total	Tuong Duong, is one of most three poorest district of Nghe An with very low income. There are 2389 household at district level

	to represent the general characteristics of off-grid areas.	example area for other forest provinces in Viet Nam.	(almost 7000 people). Ha Giang is the province with the lowest % of electrification in Viet Nam.	are living without electricity.
7.	Population density	There are three main ethnic groups of Muong (72.38%); Dao 2.77% and Kinh (24.69%). The population density distributed unequally with an average of 158 people/km^2.	There are about 15 minority ethnic groups living in this districts (Tay, Dao, Kinh, Nung) and unequally distribution	Mainly Thai people (72%); Mong (4%); Tay (0.7%); O Du 0.8%); Kho Mu (11%) and Kinh (10%).The average density is 27 people/km^2

Table 24 Shortlisted Mountainous off-grid Location selection (part 2)

Preferential criteria				
1	Distance to National Grid must be substantial	In all three provinces and districts there are still lot of un-served communes because of the long distance to the national grid and limited infrastructures where roads and means of transport are not in place.		
2	No plan to connect to the National Grid in the nearby future (next ten years)	There is existing grid in district level, but it doesn't reach all households. It is unknown if and when this potentially would be extended.	According to province development plant to 2020, only 4% of hamlets will not yet have access to electricity by 2020.	A 110kV grid will be installed for Tuong Duong and Ky Son to be completed in 4/2014. This grid will cross several communes of Thach Giam, Xa Luong, Luu Kien, and Hoa Binh town. However many other communes are out of the district power development plan (Luan Mai, Tam Hop, Huu Khuong, Yen Hoa, Yen Na, Luong Minh, Luu Kien).
3	Currently an electricity generation system in place	No for un-electrified communes	No for un-electrified communes	No for un-electrified communes
4	Site had developed a pilot RE project at Mung hamlet, Xuan Phong commune.	Institute of Energy Science (IES) installed a hybrid system of PV solar and diesel generator for 41 households, a cultural house and a heath station.	No	4 hydropower plants are in operation/under construction period, located in Ban Ve 320MW, Khe Bo (100 MW), Yen Thang and Xong Con (10MW).

Table 25 Renewable Resources Potential at the shortlisted sights (Remote Area)

Location	Solar (VUSTA, 2007)	Wind (WB, 2001)(NREL, 2012)	Biomass (NREL, 2012)	Hydro
Cao Phong district, Hoa Binh province **(Northwest)**	Medium 3.6 kWh/m^2/day with sunshine hours 1750 – 1900 hr/yr.	Extremely low wind speed <3m/s @ 80m Wind resource: 100 – 200 W/m2 @ 65m No reliable available data for assessment	Good Biomass from all crop residual: 900,000 – 125,000 tons/yr Biogas: 2700 – 5500 tons methane/yr High potential for biomass energy from 6,000 ha of cultivated forest (2002)	Good potential Hoa Binh has four major river systems: Da River, Ma river, Thuong Tien and Song and and many other small streams
Vi Xuyen district, Ha Giang province **(Northwest)**	Low 3.5 kWh/$m^{2/}$day with sunshine hours 1750 – 1900 hr/yr.	Extremely low wind speed <3m/s @ 80m Wind resource: 100 – 300 W/m2 @ 65m No reliable available data for assessment	Extremely low Biomass from all crop residual: 100,000 – 500,000 tons/yr Biogas: 1150 – 2700 tons methane/yr	Good potential high density of rivers and streams. 3 major river systems: Lo River, Chay river, Gam river and smaller rivers like Nho Que, Mien river, Bac river and Chung
Tuong Duong district, Nghe An province (Northern Central)	Good 4.2 kWh/$m^{2/}$day with sunshine hours 1700 – 2000 hr/yr	Extremely low wind speed <3m/s @ 80m Wind resource: 100 – 300 W/m2 @ 65m No reliable available data for assessment	Low Biomass from all crop residual: 100,000 – 500,000 tons/yr Biogas: 5000 – 211,000 tons methane/yr	Good potential high dense river and stream network and sloping terrain. The estimated hydro potential capacity is up to 1,200MW in province.

For above three districts, Cao Phong was selected for the in-depth survey because of the:

- The widely available potential for RE solutions in for hydro, biomass, solar power and potentially even wind if there is more in-depth study on this.
- The (nearby) site was piloted with a hybrid system of solar PV (8kWp) and diesel generator (11.5kVA) which creates a good opportunity to learn more about the success or failure in developing an off-grid project for this area, and can potentially result in a scale up.
- VinaForest has cultivated 12,000ha of forest in Cao Phong district and Da Bac district, Hoa Binh province and have expressed their interest and willingness to invest in a biomass based power plant utilizing wood chips and residues from wood manufacturing.
- The first successful electrification model will be a good example for scaling up in future for other off-grid areas where having high potential source for biomass.

6.3.4 Cao Phong district, Hoa Bing general information

As indicated above, the selected district is a suggestion and will be finalized after the consultation of the provincial Government.

Cao Phong is a mountainous district of Hoa Binh province in the northwest region of Viet Nam. It about 50km from Hoa Binh town. Its primary economic activity is agriculture and forestry. The main ethnic groups living in the district are Muong and Dao. There are still 122 households that have no access to electricity and no plan yet to be connected to the national grid son. In 2011 Institute of Energy and Science (IES) installed a hybrid system of about 8kWp of solar PV and 11.5kVA diesel generator to provide the electricity for 41households, a cultural house and a commune clinic in a nearby district.

The site would be located in forest plantation project area where VinaForest company having plan for develop biomass- based power plant.

After the field visits this information in this draft report would be updated and extended.

6.4 Survey design and methodology

The main aim of the surveys as formulated in the ToR is "to survey for possible demonstration sites" and therefore it is indicated that the survey will at least contain demographic data, socio-economic data, current energy usage by sample of households, energy needs of the community, ability and willingness to pay for electricity, resource assessment, preliminary superficial assessment of RE technology options and costs, analysis of investment in terms of CBA and ROI.

Furthermore, the survey seeks an understanding on the developing trends within RE solution application for electrification of remote mountainous areas and islands, people attitudes and driving factor for change. The survey also targets to assess the potential of RE sources available in the selected areas.

6.4.1 Key survey questions

The following topics will be key to be answered with the survey:

1. What is the current situation of the electricity usage in remote areas and islands?
    - Number of households, demand, supply, fuel costs, tariffs etc.

2. What is the affordability of RE resources from an investment point of view, as well as the household point of view?

3. What is the RE potential for the selected site?

4. What are the lessons learned from existing implemented RE solutions in neighboring communes/districts and how can they be applied at the selected site?

6.4.2 Data collection methods

Methods used for the study include desk study, semi-structured interviews using questionnaires, and case studies.

Desk study is to review study reports related to clean and RE, off-grid electrification in Viet Nam and abroad, energy (the electricity) consumption and practices, and the potentials of RE solutions in Viet Nam.

Semi-Structured interviews is a tool to collect primary information on energy, leaving room to go in-depth into selected questions if necessary. As the survey is only a quick scan as little time is allocated data will not represent a proper sample size, and more emphasizes will be on qualitative data. In-person interview using questionnaires will be used to ensure reliability and validity. More information is given in paragraph 6.4.3.

Case study is employed as a qualitative study method to reflect upon representative RE pilot projects. This will include information such as operation situation of existing power system, applied business/financing model, willingness to pay for the electricity of local resident, happiness of local resident with this system, etc. In other words it will focus on the change process, lessons learned and replicability.

6.4.3 Questionnaires – for semi structured interviews

Several questionnaires are designed to gather the required data, (Annex 3 and 4). The questionnaires are split in three levels:

1. Household level - which is aimed to acquire data on consumption and use of the electricity by each household, their willingness to pay for the electricity. This also includes (small) enterprises.
2. Community or village level to collect information on site as social-economic conditions, population, infrastructure (electricity and road access, school, heal care station, etc), general potential of RE sources
3. Local Government level – to collect socio economic and geographic information, biomass potentials, and other RE potentials.

Interviews with Provincial governments will be open interviews based on checklists. Furthermore an open interview will be executed in the nearby commune (if applicable) that already has access to a RE pilot technology. The interview structure for this still needs to be developed. A tentative meeting schedule for the two field visits is indicated below.

Table 26 Tentative meeting schedule

Date	Timing	Meeting	Content
Day 1		To province	Traveling
Day 2	Morning	Visit PPC and DOIT	• Introduce VCEP program and purpose of the field visit • Difficulties in supplying the electricity for the site. • Information on the current e-situation. • Obtain approval for the site visit to do the small survey. • Social-economic development master plan of the site • Information on demand and supply • Look at the Provincial plan of the grid extension • Collect information on locally available RE sources potential and power master plan at provincial level
	Afternoon	Visit local Power Company	• Look for the plan to expansion of the grid if any or other plans related to supply the electricity by RE sources in the future. • Collect information on locally available RE sources potential and power master plan at provincial level

			• The electricity tariffs • Technical feasibility and affordability of RE solutions in the region/site.
Day 3	Morning	Travel to site	
	Afternoon	DPC	• Social-economic conditions (including population, demographics, average household size, housing density, primary economic activities) • Natural resources and climate conditions on the island • Energy needs of islander and costs they have to pay to have enough energy for use or production (electricity tariff, oil/gasoline prices)
		Start interviews if possible	Electricity demand & ability and willingness to pay for the electricity
Day 4	Morning	Interviews with enterprises	
	Afternoon	Interview with households	
Day 5 –if applicable-	Morning	Travel to site with an RE pilot	Traveling
	Afternoon	Interview relevant parties like DPPC	Energy situation, growth of demand, success factors and/or failures, lessons learned, replicability.
Day 6		Back to Hanoi	Traveling

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ANNEX 1 – List of off-grid communities in Vietnam

Province Level

List of un-electrified communities Source: Data collected by Committee of Ethnic Minorities Affairs (CEMA) in Sept 2012 updated by SNV RE team in Aug 2013
Last update 21-08-13

	Name of Province/district/commune/village	Number of households	Number of inhabitants	Poverty Rate (GSO 2011)	Average income (1000 VND/person/month) (GSO	Climatic conditions**	Natural enevironment***			
							Water	Wind	Solar	Biomass (forest and rice crop residue)
	TOTAL	*74,941*	*355,304*							
	PROVINCES IN NORTH	41,066	209,728							
I	LAO CAI PRORVINCE	1,587	8,551	36.6%	819	-Average temperature is from 15-29 degree. -Annual rainfall is from 1400-2000mm.	There are two big rivers flowing the provinces (Hong & Chay) and thousands of small steams and rivers with a length greater than 10km), to be very good hydro potential for small hydro development.	The wind power potential in Lao Cai is quite low. It keeps less than 100W/m2 at 65m. However, somepoints bodering with Lai Chau province shows a quite good potential of wind at 300-400W/m2 at 65m.	The map show Lao Cai average potential for solar energy development with solar radiation intensity from 4-4.5kWh/m2/day.	Forest resources: 307573ha of which 249434ha of natural forest and 58139 ha of cultivated forest area.
II	YÊN BÁI PROVINCE	3,099	18,577	25.2%	884	-Average temperature is 22-25 degree. -Annual rainfall is from 1500-2200mm. -Average moisture is about 86%.	Water resources: there are two big rivers flowing the provinces (Hong & Chay) and about 200 small rivers and streams. It is very good for small hydro development.	Yen Bai doest not have good potential for wind energy development, except for somepoints bodering with Son La province. It shows 300-400W/m2 at 65m.	The map show Yen Bai average potential for solar energy development with solar radiation intensity from 4-4.5kWh/m2/day.	Forest resources: 406230.9ha of which 231,563.7ha of natural forest and 174,667.1ha of cultivated forest area.
III	ĐIỆN BIÊN PROVINCE	8,167	46,664	46.4%	611	-Average temperature is 21-23 degree. -Annual rainfall is from 1,700-2,500mm. -Average moisture is about 83-85%.		Dien Bien does not have good potential of wind energy sources.	Dien Bien has good potential for solar energy development with radiation intensity from 4.5-5kWh/m2/day.	Forest resources: 348,049ha.
IV	PROVINCE LAI CHÂU	4,157	24,209	46.8%	567	-Average temperature in 2011 is 23.6degree. -Annual rainfall in 2011 is 2017.7mm. -Average moisture in 2011 is about 82.3%.	Lai Chau is located upstream of Da river with large rainfall and some big rivers as Nam Na, Nam Ma & Nam Mu flowing across this province create good potential for hydro develoment.	Lai Chau shows a good potential of wind energy at boder with Lao Cai province.	Lai Chau has low potential for solar energy development with radiation intensity from 4.0-4.5kWh/m2/day.	Forest resources: 283,667ha of natural forest area.
V	PROVINCE SƠN LA	3,674	19,636	34.8%	802	-Average temperature in 2011 is 20.6degree. -Annual rainfall in 2011 is 1093.4mm. -Average moisture in 2011 is about 81.2%.	Water resources: There are two big rivers (Da & Ma rivers) flowing aross the province, 35 large streams and hundreds of small streams create a significant potential for hydro power development.	Son La shows somepoints bodering with Laos and Yen Bai province potential for wind energy development.	Son La has good potential for solar energy development with radiation intensity from 4.5-5kWh/m2/day.	Forest resources: 572,859ha of forest
VI	PROVINCE HOÀ BÌNH	453	1,519	27.7%	829	-Average temperature is 23degree. -Annual rainfall is about 1,800mm. -Average humidity is about 85%.	Water resources: Hoa Binh has four major river systems: Da River, Ma river, Thuong Tien and Song and and many other small streams giving it a major advantage to develop hydro power projects.	Hoa Binh does not have good potential for wind energy development.	The potential for solar energy application is low.	Forest resources: Hoa Binh has over 200 thousand hectares of forest with rich flora, including many valuable timber species such as ironwood, tau, slug, for-credit study, lat hoa
VII	PROVINCE PHÚ THỌ	2,336		17.0%	1,126	-Average temperature is 23degree. -Annual rainfall is about 1,600-1,800mm. -Average humidity is about 85-87%.	Water resources: Phu Tho has three major river systems: Da River, Hong river, and Lo river.	No potential for wind energy development.	It keeps low potential for solar energy development withh radiation intensity from 3.5-4.5kwh/m2/day.	Forest resources: Phu Tho has potential for development of forestry industry. It also has very good potential of biomass energy source from rice husk (1.8-6.8million tones/year)
VIII	PROVINCE HÀ GIANG	11,979	64,768	45.5%	610	-Average temperature is about 21.6-23.9degree. -Annual rainfall is about 2,300-2,400mm. -Average humidity is about 85%. -Number of annual sunshine hours is about 1,427hours.	Ha Giang has three major river systems: Lo River, Chay river, Gam river and smaller rivers such as Nho Que, Mien, Bac, Chung creating a considerable advantage to develop hydro power projects.	Ha Giang shows some potentials for wind energy development at 300-400W/m2.	It keeps average potential for solar energy development.	Forest resources: Ha Giang has about 345,860ha of natural forest.
IX	PROVINCE CAO BẰNG	1,520	7,003	35.5%	749	-Average temperature is about 23-30degree.	Cao Bang has four major river systems: Bang Giang River, Quay Son river, Gam river and Bac Vong river and small streams system creating a considerable advantage to develop hydro power	Cao Bang shows some potentials for wind energy development at 300-400W/m2 and especially some points having better potential at 400-500W/m2.	It keeps average potential for solar energy development.	Cao Bang has about 10,000ha of forest.
X	PROVINCE BẮC KẠN	459	2,556	28.6%	776	-Average temperature is about 20-22degree. -Annual average rainfall is about 1,400-1,600mm. -Annual average humidity is about 84%. -Average sunshine hours in province is from 1,400-1,600.	Bac Kan has five major river systems: Lo River, Ky Cung river, Gam river, Bang river and Cau river and small streams system creating a considerable advantage to develop hydro power projects.	Bac Can map shows some potentials for wind energy development at 300-400W/m2.	It keeps average potential for solar energy development.	Forest resources: Bac Kan has a total forest area of 420,990.5ha in which 224,151.4ha of natural forest, and 39,352.5ha of cultivated forest area and others.
XI	PROVINCE LẠNG SƠN	2,648	12,205	25.0%	930	-Average temperature is about 17-22degree. -Annual average rainfall is about 1,200-1,600mm. -Annual average humidity is about 80-85%.	Water resources: Lang Son has five major river systems: Thuong River, Ky Cung river, Luc Nam river, Tien Yen-Ba Che river and Na Lang river and dense streams network.	Lang Son keeps a good potential of wind energy. Somepoints at boder with China show greater than 800W/m2. On average is 300-400W/m2.	It has low potential for solar energy development with radiation intensity from 3.5-4.5kwh/m2/day.	Forest resources: Lang Son has a total forest area of 172,635.01ha including natural forest and cultivated forest areas.
XII	PROVINCE QUẢNG NINH	987	4,040	6.5%	1,787	-Average temperature in 2011 is 22.6degree. -Annual rainfall in 2011 is 1823.8mm. -Average moisture in 2011 is about 82.1%.		Quang Ninh shows a good potential of wind energy. Somepoints at boder with China show greater than 800W/m2. On average is 300-400W/m2. Islands in this province also have a good potential to install wind turbines.	The potential for solar development is ranked as average with radiation intensity from 4-4.5kwh/m2/day.	Forest resources: Quang Ninh has about 243,833.5ha of forest in which 80% is area of natural forest.
XIII	PROVINCE THANH HOÁ	3,013	15,169	22.6%	840	-Average temperature is about 23-24degree. -Annual rainfall is about 1,600-2,300mm. -Average moisture is about 85-87%. -Annual sunshine hours are about 1,600-18,00.	Thanh Hoa has four main river systems: Hoat, Ma, Bang and Yen river with a total length of 810km and catchment area of 39,756km square which creates a significant potential for hydro power development.	Thanh Hoa has an average potential of wind energ for electricity supply. As mapped it shows wind energy density is from 300-400W/m2.	The potential for solar development in Thanh Hoa is classified as average with radiation intensity from 4-4.5kwh/m2/day.	Forest resources: Thanh Hoa has about 484,246ha of forest with reserve of about 16.64 mill meter cubic wood. Besides, Thanh Hoa shows very good potential of biomass energy source from rice husk (1.8-6.8million tones/year)
XIV	PROVINCE NGHỆ AN	4,142	16,643	22.5%	920	-Average temperature in 2011 is 23.3degree. -Annual rainfall in 2011 is 2558.6mm. -Average moisture in 2011 is about 83%.	Nghe An has a dense river and stream network and sloping terrain which facilitaes hydro power development. The estimated hydro potential capacity is up to 1,200MW in province.	Nghe An has wind energy density quite good (300-400W/m2 along with the seacoastal) and somepoints bodering with Laos has wind energy density is upto 500-600W/m2.	Nghe An has good potential for solar energy development with solar radiation intensity reaching to 5kwh/m2/day.	Forest resources: Nghe An has a total forest area of 885,339ha in which 732,741ha of natural forest and 152,867ha of cultivated forest area. Nghe An also has quite good potential of biomass energy source from rice crop residues.
XV	PROVINCE QUẢNG BÌNH	57	257	23.0%	950	-Average temperature is about 24-25degree. -Annual average rainfall is from 2,000-2,300mm.	Quang Binh has a large system of rivers and streams with the density of 0,8 - 1,1km/km2. 5 main rivers are named Ron, Gianh, Ly Hoa, Dinh and Nhat Le. There are3 160 natural and artificial lakes with expected capacity of 243.3 million m3.	Quang Binh has a good potential of wind energy source. The wind energy density shows 300-400W/m2 and some places bodering Laos keep at 500-600W/m2 and even greater than 800W/m2.	Good potential for solar energy development.	Forest resources: Quang Binh has 486,688 ha of forest including 447,837ha of natural forest and 38,851ha of planted forest.

XVI	**PROVINCE QUANG TRI**	150	500	**21.7%**	**951**	-Average temperature is about 24-25degree. -Annual average rainfall is from 2,200-2,500mm. -Average relative humidity is about 85%. -Average sunshine hour is quite good, about 5-6hours per day.	Quang Tri has three main river systems discharging into sea: Ben Hai river, Thach Han river and O Lau river.	Quang Tri has good potential of wind energy, especially in areas bodering with Laos. The wind energy density is from 300-800W/m2.	Very good potential for solar energy development with radiation intensity to be able to reach 6kwh/m2/day at some sites bodering with Laos.	Forest resources: Quang Tri has 219,638.85ha of forest including 101,631.02ha of productive forest; 62,664.45ha of protective forest and 55,343.38ha of special forest. The potential of utilizing rice residues are moderate.
XVII	**PROVINCE QUẢNG NAM**	**1,066**	**4,291**	**21.7%**	**935**	-Average temperature is about 25.4degree. -Annual average rainfall is from 2,000-2,500mm. -Average relative humidity is about 84%.	Quang Nam has a dense river and stream network with total length of 900km including 9 major rivers such as Thu Bon and thus makes it high potential for hydro power development.	Quang Nam has potential for wind energy development, espcially in western districts of province.	Quang Nam give a good opportunity for solar development with radiation intensity from 5-6kwh/m2/day.	Forest resources: Quang Nam has 425,921ha of forest including 388,803ha of natural forest and 37,118ha of planted forest. Quang Nam also has a quite good potential of biomass energy sources.
XVIII	**PROVINCE QUẢNG NGÃI**	**1,060**	**4,536**	**20.8%**	**909**	-Average temperature is about 25.8degree. -Annual average rainfall is from 2,200-2,500mm. -Average relative humidity is about 85%. -Accumulative sun radation amount is from 130-150kcal/cm2/year.	Quang Ngai has four main rivers including Tra Bong, Tra Khuc, Ve and Tra Cau with catchment areas are respectively 697km2, 3,240km2, 1,260km2 and 442km2. Thus, it has good potential for development of hydro power projects.	The potential for wind energy development in Quang Ngai is not significant.	Quang Ngai also has a good potential for solar development with radiation intensity from 5-6kwh/m2/day.	Moderate potential for utilization of rice crop residues.
XIX	**PROVINCE BÌNH ĐỊNH**	**794**	**3,912**	**15.2%**	**1,150**	-Average temperature is about 20.1-26.1degree. -Annual average rainfall is 1,751mm. -Average relative humidity is about 79-92%.	Binh Dinh has four major rivers Lai Giang, Kon, La Tinh and Ha Thanh. The estimated hydro potential capacity is about 182.4 Million KW.	Binh Dinh show good potential for wind energy development.	Binh Dinh keeps a quite good potential for solar energy development with radiation intensity from 4-5kwh/m2/day.	Binh Dinh has huge potential for utilizing rice husk.
XX	**PROVINCE KHÁNH HOÀ**	**820**	**3,653**	**8.8%**	**1,258**	-Average temperature in 2011 is 26.7degree. -Annual rainfall in 2011 is 1327.6mm. -Average moisture in 2011 is about 77.6%.		The map show Khanh Hoa quite potential for wind energy development. Somepoints has wind energy density is up to 800W/m2.	Khanh Hoa has solar radiation intensity from 4.5-5kwh/m2/day, making it a good potential for solar applications.	Moderate potential for utilization of rice crop residues.
XXI	**PROVINCE ĐĂK LĂK**	**1,814**	**8,476**	**19.6%**	**1.067.7**	-Annual average rainfall is 1,600-1,800mm.	Dak Lak has big potential for hydro development with estimated capacity of 2,636 million Kw, especially small hydro power projects to electrify some remote areas in province.	The map show Dak Lak quite potential for wind energy development with average wind energy density is 300-400W/m2 and up to 800W/2 at somesites.	Dak Lak has a really good opportunity for solar application with radiation intensity from 5-5.5kwh/m2/day.	Dak Lak has quite good potential for utilization of rice crop residues.
XXII	**PROVINCE BÌNH PHƯỚC**	**1,640**	**6,401**	**9.1%**	**1,526**	-Annual average temperature is about 25.8-26.2 degree. -Annual average rainfall is from 2,045-2325mm. -Total sunshine hours in year is quite abundant, about 2,400-2,500. The sunshine time on average is 6.2-6.6hours per day. -Annual average humidity is about 80.8-81.4%.	Binh Phuoc has a dense river and spring system with density of 0.7-0.8km/km2, including Sai Gon river, Song Be river, Dong Nai river, Mang and other small ones.	Binh Phuoc does not have wind energy potential.	Binh Phuoc has a really good opportunity for solar application with radiation intensity from 5-5.5kwh/m2/day.	Forest resources: Binh Phuoc has a total forest area of 165,701ha.
XXIII	**PROVINCE BÌNH THUẬN**	**1,407**	**6,268**	**9.3%**	**1,560**			Binh Thuan has a very goood potential of wind enegy with density on average of 400-500W/m2 and 500-600W/m2 along the sea coast.	Binh Thuan has a really good opportunity for solar application with radiation intensity from 5-5.5kwh/m2/day.	Binh Thuan has potential for utilization of rice husks. As pointed out in NREL map annual rice crop residues are from 550,000-900,000 tones/year.
XXIV	**PROVINCE BA RIA-VUNG TAU**	**1,000**		**4.8%**	**1,695**	-Average temperature in 2011 is 27.5 degree. -Annual rainfall in 2011 is 1382.9mm. -Average moisture in 2011 is about 79.1%. -Sunshine hours in year is quite signfinicant, about 2,400 hours/year.		Vung Tau also shows potential for development of wind energy turbines along the sea coast.	Vung Tau has a quite good potential for solar development with radiation intensity from 4.5-5.5kwh/m2/day.	It has low potential for utilization of rice residues due to insignificant amount (from 80,000-285,000 tones/year)
XXVI	**PROVINCE AN GIANG**	**459**	**2,192**	**8.5%**	**1,319**	-Annual average temperature is about 28 degree. -Average relative humidity is about 80%. -Average daily sunshine hours are from 7-10hours.		No potential for wind enegy development.	It has a really good potential for solar energy development.	An Giang also has huge potential of rice husk amount. As mapped out it is about 1.8-6.8million tones/year.
XXVII	**PROVINCE TRÀ VINH**	**529**	**2,155**	**21.1%**	**1,089**	-Annual average temperature is about 26-27 degree. -Average relative humidity is about 80-85%. -Annual average rainfall is from 1,400-1,600mm.		Tra Vinh has good potential for wind energy development with energy density from 300-500W/m2.	Really potential for solar energy development.	Forest resources: Area of forests and forest land is 24,000 ha and agri- cultural land is about 186,170 ha with annual rice crop residues from 1.8-6.8million tones/year..
XXVIII	**PROVINCE KIÊN GIANG**	**6,634**	**27,748**	**8.1%**	**1,316**			The wind energy potential in Kien Giang is not really clear. Only some sites has average wind potential with energy density from 300-400W/m2.	Quite potential for solar energy development with radiation intensity from 4.5-5.5kwh/m2/day.	Kien Giang also has huge potential of rice husk amount. As mapped out it is about 1.8-6.8million tones/year.
XXIX	**PROVINCE BẠC LIÊU**	**7,745**	**36,921**	**12.9%**	**1,273**	-Average temperature is about 28.5 degree.		Bac Lieu has good potential for wind energy development along the sea coast.	Quite potential for solar energy development with radiation intensity from 4.5-5.5kwh/m2/day.	Amount of rice crop residues in Bac Lieu is 550,000-900,000 tones/year.
XXX	**PROVINCE CÀ MAU**	**1,545**	**6,454**	**10.9%**	**1,251**	-Average temperature in 2011 is 27.5 degree. -Annual rainfall in 2011 is 2445.9mm. -Average moisture in 2011 is about 79.5%.		Ca Mau has good potential for wind energy development along the sea coast.	Quite potential for solar energy development with radiation intensity from 4.5-5.5kwh/m2/day.	Forest resources: Ca Mau has 97,187ha of forest including 9,986ha of protective forest, 11,530ha of special forest and 75,670ha of productive forest. Agricultural land area for cultivating rice is about 248,200ha with annually rice husk amount from 285,000-

ANNEX 2 – List of off-grid communities in Vietnam

Village Level

List of un-electrified communities — Source: Data collected by Committee of Ethnic Minorities Affairs (CEMA) in Sept 2012 updated by SNV RE team in Aug 2013

Last update — 21-08-13

	Name of Province/district/commune/village	Ethnic group	Number of households	Number of inhabitants	Poverty Rate (GSO 2011)	Average income (1000 VND/person/month) (GSO	Climatic conditions**	Natural eneivronment***			
								Water	Wind	Solar	Biomass (forest and rice crop residue)
	TOTAL		*74,941*	*355,304*							
	PROVINCES IN NORTH		**41,066**	**209,728**							
I	**LAO CAI PRORVINCE**		**1,587**	**8,551**	**36.6%**	**819**	-Average temperature is from 15-29 degree. -Annual rainfall is from 1400-2000mm.	There are two big rivers flowing the provinces (Hong & Chay) and thousands of small steams and rivers with a length greater than 10km), to be very good hydro potential for small hydro development.	The wind power potential in Lao Cai is quite low. It keeps less than 100W/m2 at 65m. However, somepoints bodering with Lai Chau province shows a quite good potential of wind at 300-400W/m2 at 65m.	The map show Lao Cai average potential for solar energy development with solar radiation intensity from 4-4.5kWh/m2/day.	Forest resources: 307573ha of which 249434ha of natural forest and 58139 ha of cultivated forest area.
	Văn Bàn District		**220**	**1,150**							
	Nậm Xây Commune		**57**	**285**							
	Phìn Hồ village	H'Mông	57	285							
	Dần Thàng commune		**58**	**290**							
	Nậm Cần village	Dao	58	290							
	Làng Giàng commune		**54**	**320**							
	Ít Lộc 1 village	Dao	54	320							
	Nậm Tha commune		**51**	**255**							
	Khe Nà village	Dao	51	255							
	Mường Khương district		**331**	**2,082**							
	Cao Sơn commune		**143**	**825**							
	Sảng Lùng Chéng village	H'Mông	73	428							
	Sả Lùng Chéng village	H'Mông	70	397							
	Dìn Chin commune		**120**	**849**							
	Lồ Sử Thàng village	Nùng	69	616							
	Cốc Cáng village	Nùng	51	233							
	La Pan Tẩn commune		**68**	**408**							
	Sà San village	H'Mông	68	408							
	Bảo Thắng district		**271**	**1,511**							
	Gia Phú commune		**187**	**1,092**							
	Nậm Trà village	Dao	125	743							
	Nậm Phảng village	Dao	62	349							
	Phong Hải town		**84**	**419**							
	Ải Nam 1 village	Mông, Nùng	84	419							
	Bảo Yên district		**71**	**424**							
	Xuân Hòa commune		**71**	**424**							
	Mo 2 village	H'Mông	71	424							
	Bắc Hà district		**118**	**472**							
	Nậm Lúc commune		**68**	**332**							
	Nậm Lầy village	Dao	68	332							
	Tả Củ Tỷ commune		**50**	**140**							
	Sông Lẫm commune	Nùng	50	140							
	Bát Xát district		**315**	**1,779**							
	Cốc Mỳ commune		**85**	**479**							
	Tả Liềng village	H'Mông	85	479							
	Dần Thàng commune		**67**	**435**							
	Ngải Thầu village	H'Mông	67	435							
	Y Tý commune		**51**	**312**							
	Hồng Ngài village	Hà Nhì	51	312							
	Trịnh Tường commune		**112**	**553**							
	Lao Chải vilage	Hà Nhì	53	208							
	Sín Chải village	H'Mông	59	345							
	Sa Pa district		**261**	**1,133**							
	Ban Phùng commune		**53**	**156**							
	Ban Toòng village	Dao	53	156							
	Nậm Sài village		**74**	**441**							
	Nậm Ngấn village	Dao	74	441							
	Thanh Kim commune		**57**	**228**							
	Lếch Mông village	H'Mông	57	228							
	Trung Chải commune		**77**	**308**							
	Mống Sến II village	Mông, Dao	77	308							
II	**YÊN BÁI PROVINCE**		**3,099**	**18,577**	**25.2%**	**884**	-Average temperature is 22-25 degree. -Annual rainfall is from 1500-2200mm. -Average moisture is about 86%.	Water resources: there are two big rivers flowing the provinces (Hong & Chay) and about 200 small rivers and streams. It is very good for small hydro development.	Yen Bai doest not have good potential for wind energy development, except for somepoints bodering with Son La province. It shows 300-400W/m2 at 65m.	The map show Yen Bai average potential for solar energy development with solar radiation intensity from 4-4.5kWh/m2/day.	Forest resources: 406230.9ha of which 231,563.7ha of natural forest and 174,667.1ha of cultivated forest area.
	Văn Yên district		**1,131**	**6,325**							
	Mỏ Vàng commune		**78**	**415**							
	Khe Lóng 3 village	H'Mông	78	415							
	Đại Sơn commune		**51**	**214**							
	Làng Bang Hạ village	Dao	51	214							
	Xuân Tầm commune		**68**	**338**							
	Khe Đóm 1 village	Dao	68	338							
	Phong Dụ Thượng commune		**199**	**1,239**							
	7 Khe Mạng village	Dao	101	647							
	Village 8 village	Tày	98	592							
	Châu Quế Thượng commune		**74**	**410**							
	8 Ao ếch village	H'Mông	74	410							
	Lang Thíp commune		**673**	**3,366**							
	Làng Khoang village	Dao	70	370							
	Liên Sơn village	H'Mông	124	621							

	Đam I village	Dao	61	269							
	Đam II village	Dao	91	472							
	Bùn Dạo village	Dao	66	338							
	Thíp Dạo village	Dao	104	562							
	Tiến Đạt village	Dao	90	425							
	Bo village	Dao	67	309							
	Lâm Giang commune		**62**	**343**							
	Village 17 village	Dao	62	343							
	Văn Chấn district		**261**	**1,552**							
	Cát Thịnh commune		**61**	**387**							
	Làng Ca village	H'Mông	61	387							
	An Lương commune		**55**	**363**							
	Sài Lương 4 village	H'Mông	55	363							
	Suối Quyền commune		**77**	**420**							
	Vàng Ngần village	Dao	77	420							
	Sùng Đô commune		**68**	**382**							
	Giàng Pằng village	H'Mông	68	382							
	Trấn Yên district		**140**	**770**							
	Hồng Ca commune		**140**	**770**							
	Khe Tiến village	H'Mông	56	326							
	Khe Ron village	H'Mông	84	444							
	Lục Yên district		**70**	**400**							
	Tô Mậu commune		**70**	**400**							
	Nà Hoá village	Dao, Tày	70	400							
	Trạm Tấu district		**1,350**	**8,519**							
	Xà Hồ commune		**235**	**1,418**							
	Kháo Dê village	H'Mông	55	342							
	Sáng Pao village	H'Mông	127	743							
	Suối Giao village	H'Mông	53	333							
	Ban Mù commune		**372**	**3,085**							
	Mù Cao village	H'Mông	59	445							
	Tà Ghênh village	H'Mông	120	922							
	Pang Dê village	H'Mông	87	979							
	Giàng La Pán village	H'Mông	106	739							
	Phình Hồ commune		**57**	**394**							
	Suối Xuân village	H'Mông	57	394							
	Làng Nhì commune		**61**	**359**							
	Háng Đay village	H'Mông	61	359							
	Pá Hu commune		**288**	**1,606**							
	Háng Gàng village	H'Mông	62	391							
	Pá Hu village	H'Mông	105	565							
	Tà Tầu village	H'Mông	64	350							
	Cang Dông village	H'Mông	57	300							
	Túc Đán commune		**337**	**2,016**							
	Pá Khoan village	H'Mông	81	481							
	Làng Linh village	H'Mông	52	295							
	Tổng Ngoài village	H'Mông	76	471							
	Háng Tầu village	H'Mông	128	769							
	Mù Cang Chải district		**147**	**1,011**							
	Chế Tạo commune		**58**	**337**							
	Ban Háng Tầy village	H'Mông	58	337							
	Nậm Có commune		**89**	**674**							
	Ban Lùng Cúng village	H'Mông	89	674							
III	**ĐIỆN BIÊN PROVINCE**		**8,167**	**46,664**	**46.4%**	**611**	-Average temperature is 21-23 degree. -Annual rainfall is from 1,700-2,500mm. -Average moisture is about 83-85%.		Dien Bien does not have good potential of wind energy sources.	Dien Bien has good potential for solar energy development with radiation intensity from 4.5-5kWh/m2/day.	Forest resources: 348,049ha.
	Điện Biên district		**624**	**3 424**							
	Thanh Nưa commune		**133**	**777**							
	Ban Nậm Ty A village	H'Mông	75	449							
	Ban Pá Sáng hamlet	H'Mông	58	328							
	Núa Ngam commune		**220**	**1 081**							
	Ban Hẹ 2 hamlet	Thái	60	285							
	Ban Hẹ 1 hamlet	Thái	97	429							
	Ban Na Côm hamlet	H'Mông	63	367							
	Mường Nhà commune		**146**	**954**							
	Ban Sen Tống hamlet	H'Mông	146	954							
	Mường Lói commune		**125**	**612**							
	BanTin Tốc hamlet	Khơ Mú	64	342							
	Ban Noong É hamlet	H'Mông	61	270							
	Điện Biên Đông district		**591**	**2 063**							
	Xa Dung commune		**74**	**367**							
	Ban Thâm Mỹ A hamlet	H'Mông	74	367							
	Phình Giàng commune		**127**	**328**							
	Ban Phi Sua A hamlet	H'Mông	50	141							
	Ban Phả Khẩu hamlet	H'Mông	77	187							
	Háng Lìa commune		**57**	**256**							
	Ban Huổi Va B hamlet	H'Mông	57	256							
	Tìa Dình commune		**102**	**290**							
	Ban Chua Ta A hamlet	H'Mông	51	136							
	Ban Na Hay A + B hamlet	Thái	51	154							
	Keo Lôm commune		**53**	**198**							
	Ban Huổi Xa 2 hamlet	Thái	53	198							
	Pu Nhi commune		**112**	**411**							
	Ban Háng Giống hamlet	H'Mông	52	178							

	Ban Pu Nhi A hamlet	H'Mông	60	233							
	Phì Nhừ commune		**66**	**213**							
	Ban Na Nghịu hamlet	Thái	66	213							
	Tủa Chùa district		**524**	**3 181**							
	Sín Chải commune		**183**	**1 110**							
	Ban Cáng Chua 1 hamlet	H'Mông	69	416							
	Ban Séo Mí Chải hamlet	H'Mông	64	388							
	Ban Trung Gầu Bua hamlet	H'Mông	50	306							
	Mường Báng commune		**83**	**493**							
	Từ Ngài 1 village	H'Mông	83	493							
	Sa Nhè commune		**110**	**681**							
	Sông A village	H'Mông	110	681							
	Tủa Thàng commune		**148**	**897**							
	Phi Giàng 1 village	H'Mông	91	554							
	Phi Giàng 2 village	H'Mông	57	343							
	Tuần Giáo district		**1 321**	**6 517**							
	Tỏa Tình commune		**111**	**528**							
	Háng Tầu hamlet	H'Mông	60	275							
	Chê Á hamlet	H'Mông	51	253							
	Pú Nhung (Nhi) commune		**172**	**888**							
	Trung Dình hamlet	H'Mông	86	430							
	Chua Lú hamlet	H'Mông	86	458							
	Mùn Chung commune		**356**	**1 751**							
	Ban Ta Lếch village	Khơ Mú	90	414							
	Ban Bó Lếch village	Khơ Mú	85	375							
	Ban Phiêng Pẻn village	Thái	129	649							
	Ban Co Muông village	H'Mông	52	313							
	Mường Mùn commune		**257**	**760**							
	Ban Pu Xi 2 hamlet	H'Mông	52	161							
	Ban Huổi Khạ hamlet	H'Mông	74	206							
	Ban Ta Pao hamlet	Thái	70	174							
	Ban Hua Mùn hamlet	H'Mông	61	219							
	Phình Sáng commune		**373**	**2 248**							
	Ban Hang Á hamlet	H'Mông	84	482							
	Mỹ Làng A hamlet	H'Mông	68	385							
	Mỹ Làng B hamlet	H'Mông	88	546							
	Háng Chua hamlet	H'Mông	70	447							
	Phảng Củ hamlet	H'Mông	63	388							
	Tênh Phông commune		**52**	**342**							
	Xá Tự hamlet	H'Mông	52	342							
	Mường Ẳng district		**284**	**1 444**							
	Nặm Lịch commune		**57**	**404**							
	Thẩm Phẩng hamlet	H'Mông	57	404							
	Ngối Cáy commune		**103**	**380**							
	Chan III hamlet	H'Mông	50	200							
	Nặm Cứm hamlet	H'Mông	53	180							
	Mường Đăng commune		**67**	**339**							
	Hamlet Chan II	H'Mông	67	339							
	Búng Lao commune		**57**	**321**							
	Huổi Cắm hamlet	Khơ mú	57	321							
	Mường Chà district		**1 752**	**10 975**							
	Huổi Lèng commune		**54**	**368**							
	Nậm Chua hamlet	H'Mông	54	368							
	Mường Mươn commune		**139**	**956**							
	Huổi Meo hamlet	H'Mông	75	506							
	Pú Múa hamlet	H'Mông	64	450							
	Na Sang commune		**138**	**930**							
	Huổi Hạ hamlet	H'Mông	66	450							
	Nậm Bó hamlet	H'Mông	72	480							
	Ma Thì Hồ commune		**302**	**1 853**							
	Ma Thì Hồ II hamlet	H'Mông	57	346							
	Nậm Chim hamlet	H'Mông	51	333							
	Huổi Mý hamlet	H'Mông	72	411							
	Huổi Quang II hamlet	H'Mông	66	393							
	Huổi Quang I hamlet	H'Mông	56	370							
	Mường Tùng commune		**55**	**378**							
	Nậm Piền hamlet	H'Mông	55	378							
	Sá Tổng commune		**62**	**332**							
	Xà Phìn I hamlet	H'Mông	62	332							
	Pa Ham commune		**294**	**1 743**							
	Lùng Thàng hamlet	H'Mông	96	625							
	Huổi Bon hamlet	H'Mông	111	736							
	Mường Anh I hamlet	Thái	87	382							
	Chà Tở commune		**92**	**571**							
	Hô Củng hamlet	H'Mông	92	571							
	Chà Nưa commune		**63**	**355**							
	Nậm Đích hamlet	H'Mông	63	355							
	Phìn Hồ commune		**175**	**1 030**							
	Đề Pua hamlet	Hoa	76	376							
	Phìn Hồ hamlet	Mông	99	654							
	Hừa Ngài commune		**378**	**2 459**							
	San Súi hamlet	H'Mông	113	628							
	Hát Tre hamlet	H'Mông	109	743							
	Huổi Mý I hamlet	H'Mông	80	565							

	Huổi Mý II hamlet	H'Mông	76	523							
	Mường Nhé district		**3 071**	**19 060**							
	Chung Chải commune		**65**	**402**							
	Nậm Vì hamlet	H'Mông	65	402							
	Leng Su Sìn commune		**341**	**2 243**							
	Phứ Ma hamlet	Ha nhì	58	274							
	Cà Là Pá hamlet	H'Mông	283	1 969							
	Nậm Vì commune		**77**	**503**							
	Vang Hồ hamlet	H'Mông	77	503							
	Commune Mường Toong		**327**	**1 959**							
	Hamlet Nậm Mỳ II	H'Mông	80	497							
	Hamlet Nậm Xả	H'Mông	85	491							
	Hamlet Huổi Lếch	H'Mông	50	312							
	Hamlet Nậm Pan I	H'Mông	112	659							
	Commune Nậm Kè		**286**	**1 716**							
	Hamlet Chuyên Gia I	H'Mông	74	440							
	Hamlet Chuyên Gia II	H'Mông	58	398							
	Hamlet Huổi Thanh I	H'Mông	57	310							
	Hamlet Huổi Khon	H'Mông	97	568							
	Commune Pá Mỳ		**121**	**641**							
	Hamlet Huổi Lích II	Dao	65	345							
	Hamlet Huổi Lụ II	Dao	56	296							
	Commune Na Cô Sa		**290**	**1 988**							
	Hamlet Pắc A	H'Mông	80	471							
	Hamlet Na Cô Sa III	H'Mông	98	708							
	Hamlet Na Cô Sa II	H'Mông	62	425							
	Hamlet Na Cô Sa I		50	384							
	Commune Pa Tần		**179**	**1 080**							
	Hamlet Huổi Sâu	Dao	69	395							
	Hamlet Lả Chà	Cống	53	297							
	Hamlet Huổi Tang	H'Mông	57	388							
	Commune Chà Cang		**250**	**1 534**							
	Hamlet Mốc IV	H'Mông	64	324							
	Hamlet Nậm Tin IV	H'Mông	50	264							
	Hamlet Hồ Hài	H'Mông	66	385							
	Hamlet Nậm Hài	H'Mông	70	561							
	Commune Nà Khoa		**454**	**2 831**							
	Hamlet Nậm Chua I	H'Mông	76	459							
	Hamlet Nậm Chua III	H'Mông	63	378							
	Hamlet Nậm Nhừ I	H'Mông	77	526							
	Hamlet Nậm Nhừ III	H'Mông	102	610							
	Hamlet Nậm Chẩn	H'Mông	74	480							
	Hamlet Huổi Lụ II	H'Mông	62	378							
	Commune Nà Hỳ		**182**	**1 033**							
	Hamlet Nậm Chua IV	H'Mông	57	358							
	Hamlet Huổi Sang	H'Mông	67	379							
	Hamletg Sam Lang	H'Mông	58	296							
	Commune Nà Bủng		**499**	**3 130**							
	Hamlet Trên Nương	H'Mông	110	682							
	Hamlet Ham Soong I	H'Mông	63	390							
	Hamlet Nộc Cốc II	H'Mông	56	305							
	Hamlet Pá Kha	H'Mông	104	665							
	Hamlet Huổi Dạo	H'Mông	75	519							
	Hamlet Huổi Khương	H'Mông	91	569							
IV	**PROVINCE LAI CHÂU**		**4,157**	**24,209**	**46.8%**	567	-Average temperature in 2011 is 23.6degree. -Annual rainfall in 2011 is 2017.7mm. -Average moisture in 2011 is about 82.3%.	Lai Chau is located upstream of Da river with large rainfall and some big rivers as Nam Na, Nam Ma & Nam Mu flowing across this province create good potential for hydro develoment.	Lai Chau shows a good potential of wind energy at boder with Lao Cai province.	Lai Chau has low potential for solar energy development with radiation intensity from 4.0-4.5kWh/m2/day.	Forest resources: 283,667ha of natural forest area.
	District Mường Tè		**1 182**	**6 870**							
	Commune Pa Ủ		**53**	**268**							
	Hamlet Pha Bu	La Hủ	53	268							
	Commune Mù Cả		**85**	**446**							
	Hamlet Gò Cứ	Hà Nhì	85	446							
	Commune Nậm Khao		**55**	**284**							
	Hamlet Nậm Phìn	La Hủ	55	284							
	Commune Tà Tổng		**228**	**1 616**							
	Hamlet Nậm Dính	H'Mông	89	622							
	Hamlet Nậm Ngà	H'Mông	84	578							
	Hamlet U Na	H'Mông	55	416							
	Commune Mường Mô		**232**	**1 397**							
	Hamlet Tắc Ngá	Cống	68	418							
	Hamlet Nậm Chà	Dao	103	597							
	Hamlet Huổi Dạo	H'Mông	61	382							
	Commune Nậm Manh		**149**	**1 047**							
	Hamlet Huổi Chát	H'Mông	72	518							
	Hamlet Nậm Nàn	H'Mông	77	529							
	Commune Vàng San		**52**	**347**							
	Hamlet Nậm Xuổng	Mảng	52	347							
	Commune Bum Tở		**277**	**1 214**							
	Hamlet Nậm Cấu	La Hủ	110	454							
	Hamlet Huổi Han	La Hủ	79	354							
	Hamlet Nậm Xả	La Hủ	88	406							
	Commune Nậm Hàng		**51**	**251**							

	Hamlet Huổi Van I	Mảng	51	251							
	District Than Uyên		**458**	**2 807**							
	Commune Mường Khoa		**50**	**312**							
	Hamlet Hô So	H'mông	50	312							
	Commune Nậm Sỏ		**308**	**1 905**							
	Ít Luông	Thái	92	554							
	Nà Ui	Thái	92	598							
	Ngam Ca	H'mông	71	447							
	Ui Dạo	Dao	53	306							
	Commune Tà Mít		**100**	**590**							
	Hamlet Nậm Khăn	Thái	100	590							
	Phong Thổ district		**1 388**	**7 829**							
	Commune Hoang Thèn		**53**	**279**							
	Hamlet Tả Lèng	H'Mông	53	279							
	Commune Huổi Luông		**385**	**2 196**							
	Hamlet Nậm Le 1	Hà Nhì	70	409							
	Hamlet U Ra	Dao	60	334							
	Hamlet Làng Vây 1	Hà Nhì	86	499							
	Hamlet Ngài Trồ	H'Mông	94	537							
	Hamlet Nhiều Sáng	Dao	75	417							
	Commune Nậm Xe		**389**	**2 019**							
	Hamlet Van Hồ 1	H'Mông	70	380							
	Hamlet Hoàng Liên Sơn 1	H'Mông	63	304							
	Hamlet Hoàng Liên Sơn 2	Dao	57	317							
	Hamlet Nậm Xe	Giáy	69	376							
	Hamlet Po Trà	Dao	130	642							
	Commune Dào San		**184**	**1 122**							
	Hamlet San Cha	H'Mông	57	350							
	Hamlet Ma Can	H'Mông	67	424							
	Hamlet Dền Sang	H'Mông	60	348							
	Commune Sin Suoi Hồ		**74**	**447**							
	Hamlet Chảng Phàng	H'Mông	74	447							
	Commune Sì Lở Lầu		**108**	**710**							
	Hamlet Lản Nhì Thàng	Dao	108	710							
	Commune Ban Lang		**142**	**781**							
	Hamlet Sàng Giang	Dao	78	401							
	Hamlet Nậm Lùng	Dao	64	380							
	Commune Pa Vây Sử		**53**	**275**							
	Hamlet Sín Chải	H'Mông	53	275							
	District Tam Đường		**381**	**2 253**							
	Commune Khun Há		**83**	**603**							
	Hamlet Ma Sao Phìn Thấp	H'Mông	83	603							
	Commune Tả Lèng		**112**	**646**							
	Hamlet Phìn Ngan Sin Chải	H'Mông	62	361							
	Hamlet Phìn Ngan Lao Chải	H'Mông	50	285							
	Commune Hồ Thầu		**63**	**293**							
	Hamlet Sì Thâu Chải	Dao	63	293							
	Commune Giang Ma		**51**	**276**							
	Hamlet Ngài Trù	H"Mông	51	276							
	Commune Ban Giang		**72**	**435**							
	Hamlet Suối Thầu	H'Mông	72	435							
	District Sìn Hồ		**748**	**4 450**							
	Commune Tủa Sin Chải		**244**	**1 697**							
	Phìn Én	H'Mông	94	629							
	Thành Chử	H'Mông	76	618							
	Háng Lìa	H'Mông	74	450							
	Commune Nậm Ban		**113**	**605**							
	Nậm Vạc I	H'Mông	62	442							
	Hua Pảng	Mảng	51	163							
	Commune Căn Co		**86**	**443**							
	Nậm Kinh	Dao	86	443							
	Commune Nậm Hăn		**123**	**616**							
	Hua Pha	Dao	58	221							
	Nậm Lốt	Dao	65	395							
	Commune Nậm Cha		**65**	**314**							
	Seo Phìn	Dao	65	314							
	Commune Pa Tần		**53**	**320**							
	Nậm Tần Mông I	H'Mông	53	320							
	Commune Pu Sam Cáp		**64**	**455**							
	Hamlet Nậm Béo	H'Mông	64	455							
V	**PROVINCE SƠN LA**		**3,674**	**19,636**	**34.8%**	**802**	-Average temperature in 2011 is 20.6degree. -Annual rainfall in 2011 is 1093.4mm. -Average moisture in 2011 is about 81.2%.	Water resources: There are two big rivers (Da & Ma rivers) flowing aross the province, 35 large streams and hundreds of small streams create a significant potential for hydro power development.	Son La shows somepoints bodering with Laos and Yen Bai province potential for wind energy development.	Son La has good potential for solar energy development with radiation intensity from 4.5-5kWh/m2/day.	Forest resources: 572,859ha of forest
	District Quỳnh Nhai		**963**	**4 892**							
	Commune Cà Nàng		**84**	**387**							
	Hamlet Ít Pháy	Dao	84	387							
	Commune Pác Ma - P Khinh		**181**	**862**							
	Hamlet Tậu	Thái	106	505							
	Hamlet Khứm	Thái	75	357							
	Commune Mường Giôn		**183**	**1 031**							
	Hamlet Cha Có	Thái	55	254							
	Hamlet Huổi Ngà	H'Mông	74	438							

	Hamlet Kéo Ka	H'Mông	54	339							
	Commune Chiềng Khay		**172**	**1 035**							
	Hamlet Khâu Pùm	H'Mông	61	355							
	Hamlet Nặm Ngựa	Thái	55	250							
	Hamlet Nặm Tấu	Thái	56	430							
	Commune M.Giàng		**63**	**331**							
	Hamlet Phiêng Ban	H'Mông	63	331							
	Commune Chiềng Khoang		**228**	**1 022**							
	Hamlet Lỷ	Thái	128	545							
	Hamlet Sản	Thái	100	477							
	Commune Nặm Ét		**52**	**224**							
	Hamlet Bó Ún	Thái	52	224							
	District Sốp Cộp		**403**	**1 862**							
	Commune Mường Lạn		**208**	**934**							
	Hamlet Huổi Lè	Khơ mú	64	251							
	Hamlet Pú Hao	H'Mông	83	377							
	Hamlet Noong Phụ	H'Mông	61	306							
	Commune Nậm Lạnh		**56**	**281**							
	Hamlet Hua Lạnh	H'Mông	56	281							
	Commune Mường Lèo		**139**	**647**							
	Hamlet Huổi Luông	H'Mông	72	321							
	Hamlet Nậm Pừn	Khơ mú	67	326							
	District Mai Sơn		**445**	**2 480**							
	Commune Chiềng Nơi		**56**	**316**							
	Hamlet Nà Phẳng	Khơ mú	56	316							
	Commune Phiêng Pằn		**389**	**2 164**							
	Hamlet Nà Hiên	Sinh mun	104	569							
	Hamlet Vít	Sinh mun	92	550							
	Hamlet Ta Lúc	Sinh mun	77	416							
	Hamlet Nà Nhụng	Sinh mun	116	629							
	District Yên Châu		**55**	**270**							
	Commune Chiềng Tương		**55**	**270**							
	Hamlet Pá Khôm	H'Mông	55	270							
	District Thuận Châu		**633**	**3 720**							
	Bó Mười		**133**	**520**							
	Hamlet Nà Viềng	Thái	133	520							
	Tông Lạnh		**119**	**659**							
	Hamlet Dẹ B	Thái	65	354							
	Hamlet Dẹ A	Thái	54	305							
	Co Mạ		**119**	**789**							
	Hamlet Po Mậu	H'Mông	51	337							
	Hamlet Noong Vai	H'Mông	68	452							
	Pá Lông		**63**	**380**							
	Hamlet Tinh Lá	H'Mông	63	380							
	Phổng Lập		**57**	**285**							
	Lọng Dốm	Thái	57	285							
	Mường Bám		**142**	**1 087**							
	Hamlet Phèn	Thái	92	587							
	Hamlet Hát Pang	Thái	50	500							
	District Sông Mã		**286**	**1 523**							
	Mường Cai (Sai)		**52**	**361**							
	Hamlet Háng Lìa	H'Mông	52	361							
	Đứa Mòn		**76**	**401**							
	Hamlet Huổi Lếch I	H'Mông	76	401							
	Nậm Ty		**108**	**517**							
	Hamlet Mòn	Thái	54	254							
	Hamlet Phiêng Phù	H'Mông	54	263							
	Nà Nghịu		**50**	**244**							
	Hamlet Nà Lươi	Thái	50	244							
	District Mường La		**141**	**877**							
	Chiềng lao		**141**	**877**							
	Hamlet Phiêng Phả	HMông	62	386							
	Hamlet Đàn Én	HMông	79	491							
	District Bắc Yên		**206**	**1 252**							
	Hua Nhàn		**206**	**1 252**							
	Hamlet Pa Khốm	H'Mông	74	470							
	Hamlet Suối Sát	H'Mông	80	457							
	Hamlet Khúm Khia	H'Mông	52	325							
	District Mộc Châu		**141**	**826**							
	Chiềng Khừa		**141**	**826**							
	Hamlet Căng Ty.	H'Mông	76	417							
	Hamlet Ông Lý	H'Mông	65	409							
	District Phù Yên		**401**	**1 934**							
	Huy Tường		**78**	**387**							
	Suối Pai	Dao	78	387							
	Mường Cơi		**86**	**411**							
	Suối Cốc	Dao	86	411							
	Mường Bang		**167**	**817**							
	Hamlet Dinh	Dao+Mông	79	*389*							
	Hamlet Lao	Dao	88	428							
	Kim Bon		**70**	**319**							
	Suối Lẹt	H'Mông	70	*319*							

VI	**PROVINCE HOÀ BÌNH**		**453**	**1,519**	**27.7%**	**829**	-Average temperature is 23degree. -Annual rainfall is about 1,800mm. -Average humidity is about 85%.	Water resources: Hoa Binh has four major river systems: Da River, Ma river, Thuong Tien and Song and and many other small streams giving it a major advantage to develop hydro power projects.	Hoa Binh does not have good potential for wind energy development.	The potential for solar energy application is low.	Forest resources: Hoa Binh has over 200 thousand hectares of forest with rich flora, including many valuable timber species such as ironwood, tau, slug, for-credit study, lat hoa
	District Cao Phong		**163**								
	Commune Dong Phong		**91**								
	Hamlet Chang Trong		52								
	Hamlet Chang Ngoai		20								
	Hamlet Quang		19								
	Commune Xuan Phong		**41**								
	Hamlet Mung	Mường	41								
	Commune Yen Thuong		**31**								
	Hamlet Khang	Muong	10								
	Hamlet Um A	Muong	15								
	Hamlet Um B	Muong	6								
	District Đà Bắc		**52**	**198**							
	Commune Trung Thành		**52**	**198**							
	Hamlet Sổ	Tày	52	198							
	District Lạc Sơn		**238**	**1 321**							
	Commune Văn Nghĩa		**72**	**460**							
	Hamlet Pheo	Mường	72	460							
	Commune Quý Hoà		**166**	**861**							
	Hamlet Thung 1	Mường	79	404							
	Hamlet Thung 2	Mường	87	457							
	Da Bac district		**52**								
	Trung Thanh commune										
	Xom So hamlet	Tay	52								
	Lac Son district		**238**								
	Van Nghia commune										
	Xom Pheo hamlet	Muong	72								
	Quy Hoa commune										
	Xom Thung 1	Muong	79								
	Xom Thung 2	Muong	87								
VII	**PROVINCE PHÚ THỌ**		**2,336**		**17.0%**	**1,126**	-Average temperature is 23degree. -Annual rainfall is about 1,600-1,800mm. -Average humidity is about 85-87%.	Water resources: Phu Tho has three major river systems: Da River, Hong river, and Lo river.	No potential for wind energy development.	It keeps low potential for solar energy development with radiation intensity from 3.5-4.5kwh/m2/day.	Forest resources: Phu Tho has potential for development of forestry industry. It also has very good potential of biomass energy source from rice husk (1.8-6.8million tones/year)
	District Thanh Sơn		**1 653**								
	Commune Thu Ngạc		**250**								
	Mang Thượng		57								
	Cọ Sơn 1		105								
	Cọ Sơn 2		88								
	Commune Thạch Kiệt		**201**								
	Minh Nga		121								
	Dụt dàn		80								
	Commune Thu Cúc		**451**								
	Đồng Tô		122								
	Kliên Trung		137								
	Mỹ Á		66								
	Ngả Hai		126								
	Commune Lai Đồng		**50**								
	Kết		50								
	Commune Đồng Sơn		**50**								
	Mới		50								
	Commune Xuân Đài		**153**								
	Thang		102								
	Đìa		51								
	Commune Kim Thượng		**342**								
	Nhàng		158								
	Hạ Bằng		81								
	Xoan		50								
	Tân Hồi		53								
	Commune Mỹ Thuận		**156**								
	Cú		156								
	District Yên Lập		**683**								
	Commune Trung Sơn		**544**								
	Dích		126								
	Ngọt		70								
	Đặng		179								
	Đồng Măng		113								
	Bằng		56								
	Commune Mỹ Lương		**139**								
	Tân Tiến		50								
	Quyết Tiến		89								
VIII	**PROVINCE HÀ GIANG**		**11,979**	**64,768**	**45.5%**	**610**	-Average temperature is about 21.6-23.9degree. -Annual rainfall is about 2,300-2,400mm. -Average humidity is about 85%. -Number of annual sunshine hours is about 1,427hours.	Ha Giang has three major river systems: Lo River, Chay river, Gam river and smaller rivers such as Nho Que, Mien, Bac, Chung creating a considerable advantage to develop hydro power projects.	Ha Giang shows some potentials for wind energy development at 300-400W/m2.	It keeps average potential for solar energy development.	Forest resources: Ha Giang has about 345,860ha of natural forest.
	District Mèo Vạc		**4 788**	**26 538**							

	Commune Xín Cái		**56**	**295**							
	Hamlet Tìa Kính	H'Mông	56	295							
	Commune Pải Lủng		**113**	**525**							
	Hamlet Séo Sả Lủng	H'Mông	55	269							
	Mua Lài Lủng	H'Mông	58	256							
	Commune Niêm Sơn		**347**	**1 875**							
	Hamlet Chỏm Siêu	Dao	60	351							
	Hamlet Nậm Chuầy	H'Mông	81	433							
	Hamlet Cá Thể Hamlet Tồng	H'Mông	52	242							
	Hamlet Nà Giáo	H'Mông	60	278							
	Hamlet Khuổi Luông	H'Mông	94	571							
	Commune Tả Lủng		**61**	**325**							
	Hamlet Phố Mỳ	H'Mông	44	200							
		Dao	17	125							
	Commune Cán Chu Phìn		**570**	**3 236**							
	Hamlet Làn Chải	H'Mông	78	464							
	Hamlet Lũng Thà	H'Mông	61	343							
	Hamlet Đề Chia	H'Mông	66	403							
	Hamlet Tìa Chí Đùa	H'Mông	59	355							
	Hamlet Mèo Qua	H'Mông	102	608							
	Hamlet Sán Sì Lủng	H'Mông	100	545							
	Hamlet Há Ía	H'Mông	104	518							
	Commune Pả Vi		**163**	**857**							
	Hamlet Há Súng	H'Mông	89	482							
	Hamlet Kho Tấu	H'Mông	74	375							
	Commune Sủng Trà		**380**	**1 932**							
	Hamlet Sủng Pờ A	H'Mông	64	326							
	Hamlet Sủng Pờ B	H'Mông	65	319							
	Hamlet Tả Chà Lảng	H'Mông	103	566							
	Hamlet Sảng Sò	H'Mông	72	316							
	Hamlet Lò Lở Phìn	H'Mông	76	405							
	Commune Tát Ngà		**63**	**347**							
	Hamlet Tát Ngà	Giáy	63	347							
	Commune Sủng Máng		**70**	**439**							
	Hamlet Sủng Ú	Dao	70	439							
	Commune Khâu Vai		**958**	**5 556**							
	Hamlet Phiêng Bung	H'Mông	75	400							
	Hamlet Trù Lủng Dưới	H'Mông	83	485							
	Hamlet Ha Cá	H'Mông	87	470							
	Hamlet Trù Lủng Trên	H'Mông	103	597							
	Hamlet Xín Thầu	H'Mông	70	433							
	Hamlet Sán Séo Tỷ	H'Mông	76	399							
	Hamlet Pó Ngần	Mông + Dao	112	650							
	Hamlet Ha Dế	H'Mông	75	480							
	Hamlet Khâu Vai	H'Mông	60	340							
	Hamlet Lũng Lầu	H'Mông	89	556							
	Hamlet Pắc Cạm	Mông + Dao	128	746							
	Commune Giàng Chu Phìn		**170**	**973**							
	Hamlet Dì Chủa Phàng	H'Mông	70	444							
	Hamlet Tìa Cua si	H'Mông	100	529							
	Commune Lũng Pù		**137**	**827**							
	Phấu Hía	H'Mông	85	528							
	Há Tỏ Sò	H'Mông	52	299							
	Commune Sơn Vĩ		**426**	**2 307**							
	Dìn Phàn Sán	H'Mông	56	253							
	Xéo Hồ	H'Mông	87	417							
	Mé Lầu	H'Mông	79	444							
	Lẻo Chá Phìn A	H'Mông	55	317							
	Lẻo Chá Phìn B	H'Mông	78	484							
	Tù Lủng	H'Mông	71	392							
	Commune Niêm Tòng		**628**	**3 479**							
	Hamlet Nà Pinh	H'Mông	62	384							
		Giáy	17	114							
	Hamlet Po Qua	H'Mông	90	479							
		H'Mông	75	449							
		Giáy	15	72							
	Hamlet Nà Cuổng I	Dao	7	26							
	Hamlet Nà Cuổng II	H'Mông	135	734							
	Hamlet Nà Pù	H'Mông	120	650							
		H'Mông	95	531							
		Tày	8	27							
	Hamlet Phiêng Tòng	Giáy	4	13							
	Commune Lũng Chinh		**328**	**1 725**							
	Hamlet Sèo Lủng Sán	H'Mông	71	360							
	Hamlet Sủng Khể	Dao	71	366							
	Tìa Sính	H'Mông	125	664							
	Sủng Tà	H'Mông	61	335							
	Commune Thượng Phùng		**184**	**1 024**							
	Hamlet Lủng Chư	H'Mông	102	557							
	Hamlet Thín Ngài	ông + Giá	82	467							
	Commune Nậm Ban		**134**	**816**							
	Hamlet Nà Tằm	ông + Giá	81	432							
	Hamlet Nà Nông	ông + Giá	53	384							
	District Đồng Văn		**254**	**1 245**							

	Tả Phìn		**76**	**398**							
	Khúa Lủng	H'Mông	76	398							
	Sảng Tủng		**55**	**244**							
	Village Chừ Lủng	H'Mông	55	244							
	Phố Cáo		**123**	**603**							
	Village Tráng Phóng B	H'Mông	71	334							
	Village Lủng Sính	H'Mông	52	269							
	District Yên Minh		**885**	**4 973**							
	Sủng Trang		**51**	**234**							
	Village Sủng Chớ	Mông	51	234							
	Ngam La		**57**	**296**							
	Village Sủng Hoà	H'Mông	57	296							
	Commune Mậu Long		**563**	**3 204**							
	Village Lũng Màng	H'Mông	92	528							
	Village Mùa Lệnh	H'Mông	56	335							
	Village Lầu Khắm	Dao	63	389							
	Village Hamlet Khoang	Giáy	69	375							
	Village Hạt Trả	Giáy	58	342							
	Village Nà Mòn	Giáy	61	353							
	Village Khau Nhang	Tày	74	393							
	Village Nà Luông	H'Mông	90	489							
	Lao Và Chải		**214**	**1 239**							
	Village Sủng Là	H'Mông	68	386							
	Village Lao Xì Lủng	H'Mông	86	521							
	Village Xì Phài	H'Mông	60	332							
	District Quản Bạ		**885**	**4 377**							
	Commune Tùng Vài		**199**	**1 024**							
	Sì Lò Phìn T. Vài	H'Mông	94	461							
	Lùng Chu Phìn T.Vài	H'Mông	105	563							
	Commune Quyết Tiến		**239**	**1 231**							
	Village Bình Dương	Dao + Mông	65	345							
	Village Lùng Mười	Dao + Mông	100	511							
	Village Khâu Bủng	Mông + Dao	74	375							
	Commune Quản Bạ		**263**	**1 304**							
	Village Khung Nhung	H'Mông	57	272							
	Village Lùng Khuý	H'Mông	89	407							
	Village Pản Hò	H'Mông	117	625							
	Commune Tả Ván		**184**	**818**							
	Village Pao Mã Pìn	H'Mông	55	244							
	Village Hoà Xì Pan	H'Mông	59	246							
	Chúng Trải	H'Mông	70	328							
	District Bắc Mê		**455**	**2 629**							
	Commune: Giáp Trung	H'Mông	**56**	**389**							
	Village: Lùng Cao	H'Mông	56	389							
	Commune: Yên Định		**50**	**328**							
			50	**328**							
		Dao	37	243							
	Village: Khuổi Trông	H'Mông	13	85							
	Commune: Yên Phong		**52**	**250**							
	Village: Thanh Tâm	Dao	52	250							
	Commune: Phú Nam		**57**	**357**							
	Village: Ban Nưa		**57**	**357**							
		Tày	38	249							
		Dao	19	108							
	Thị Trấn: Yên Phú		**104**	**488**							
	Village: Giáp Yên	Dao	104	488							
	Commune: Đường Âm		**136**	**817**							
	Village: Nà Nôm	Nùng	55	329							
	Village: Đoàn Kết	Dao	81	488							
	District Vị Xuyên		**1 312**	**6 895**							
	Commune Phương Tiến		**65**	**344**							
	Village Mào Phìn	Dao	65	344							
	Commune Thượng Sơn		**316**	**1 623**							
	Village Lùng Vùi	Dao	158	754							
	Village Hamlet Khoét	Dao	158	869							
	Commune Xín Chải		**63**	**315**							
	Village Nậm Lầu	Dao	63	315							
	Commune Thanh Thuỷ		**52**	**239**							
	Village Nậm Ngặt	Dao	52	239							
	Commune Thuận Hoà		**403**	**2 129**							
	Village Lũng Khoẻ A	Dao	57	265							
	Village Minh Tiến	H'Mông	80	416							
	Village Lũng Pù	H'Mông	87	514							
	Village Khâu Mèng	H'Mông	127	694							
	Village Minh Phong	H'Mông	52	240							
	Commune Minh Tân		**142**	**705**							
	Village Thượng Lâm	H'Mông	78	376							
	Village Hoàng Ly Pả	H'Mông	64	329							
	Commune Cao Bồ		**68**	**400**							
	Village Khuổi Luông	Dao	68	400							
	Commune Bạch Ngọc		**137**	**821**							
	Village Khuổi Dò	H'Mông	51	325							
	Village Ngọc Sơn	H'Mông	86	496							
	Commune Ngọc Minh		**66**	**319**							

Village Tân Bình	Dao	66	319
Commune Lung Chang			
Village Nam Thua	Dao	40	
Thành Phố Hà Giang		**64**	**312**
Commune Phương Thiện		**64**	**312**
Village Cao Bành	Dao	64	312
District Bắc Quang		**176**	**792**
Commune Tân Thành		**51**	**145**
Village Phìn Hồ	Dao	28	64
	H'Mông	18	71
	Tày	1	2
	Nùng	4	8
Commune Tân Lập		**69**	**339**
Village Khá Thượng	Dao	69	339
Commune Đồng Tiến		**56**	**308**
Village Pù Đồn	H'Mông	54	301
	Dao	2	7
District Quang Bình		**449**	**2 265**
Commune Xuân Minh		**56**	**291**
Lang Cang	Dao	56	291
Commune Nà Khương		**55**	**315**
Làng Ái	H'Mông	55	315
Commune Tiên Nguyên		**70**	**298**
Village Tây Sơn	Dao	70	298
Commune Yên Hà		**66**	**330**
Village Trung Thanh	Dao	66	330
Commune Tân Nam		**66**	**388**
Village Năm Qua	Dao	66	388
Commune Ban Rịa		**63**	**258**
Village Minh Tiến	Dao	63	258
Commune Yên Thành		**73**	**385**
Village Thượng Bình	Pà Thẻn,	73	385
District Hoàng Su Phì		**1 798**	**9 441**
Commune Túng Sán		**247**	**1 215**
Village 5 Túng Quá Lìn	H'Mông	58	287
	Clao	10	48
Village 8 Thượng hạ	Nùng	31	141
	Dao	47	223
	Dao	16	101
Village 6 Chúng Phùng	H'Mông	35	173
	H'Mông	50	242
Commune Nàng Đôn		**151**	**1 322**
Village Cốc Rế	Nùng	63	569
Village Thỉnh Rầy	Nùng	88	753
Commune Hồ Thầu		**50**	**158**
Village Quang Vinh	Dao	50	158
Commune Nam Sơn		**279**	**1 457**
Village 7 - Lùng Thàng	Dao	50	325
	Nùng	13	90
Village 4 - Nậm Ai	Dao	52	246
Village 8 - Tả Phìn	Nùng	70	340
Village 5 - Nậm Ai	Dao	94	456
Commune Nậm Khoà		**125**	**689**
Village Sơn Thành Thượng	Dao	55	260
Village Sơn Thành Hạ	Dao	70	429
Commune Đản Ván		**121**	**428**
Village Cao Thượng (Khu Tù Sủ)	Nùng	65	218
Village Lủng Khum (Khu ao thần)	Nùng	56	210
Commune Nậm Ty		**91**	**473**
Village Hồ Piên	Dao	51	251
	H'Mông	40	222
Commune Sán Xả Hồ		**182**	**909**
Village Cóc Cọc	Tày	57	280
Village Trà Thượng	Nùng	62	299
Village Thượng	Nùng	63	330
Commune Ban Nhùng		**201**	**1 101**
Village Thiêng Rầy	Nùng	45	229
	Tày	11	59
Village Nhìu Sang	Nùng	60	402
Village Ma Lù Súng	Nùng	85	411
Commune Thàng Tín		**104**	**532**
Village: Cóc Rặc + Ngài Thầu	Mông	32	168
	Nùng	72	364
Commune Pố Lồ		**127**	**570**
Village Ngàm Bồng	Nùng	52	246
	Tày	16	74
Village Nàng Ha	Nùng	59	250
Commune Ban Péo		**120**	**587**
Village Kết Thành	Dao	66	323
Village Nậm Dịch	Mông	54	264
District Xín Mần		**913**	**5 301**
Commune Nàn Xỉn		**63**	**350**

	Village đông lợi	La Chí	63	350							
	Commune Pà Vẩy Sủ		**61**	**366**							
	Village Sì Kha Lá	H'Mông	61	366							
	Commune Nàn Ma		**76**	**456**							
	Village Nàn Lý	H'Mông	76	456							
	Commune Ban Ngò		**175**	**1 050**							
	Village Nậm Phàng	Dao, Tày	100	600							
	Village Xín Chải	Mông	75	450							
	Commune Chế Là		**180**	**947**							
	Village Xỉn Khâu	H'Mông	64	384							
	Village Lùng Pô	Nùng	58	348							
	Village Gì Thàng	H'Mông	58	215							
	Commune Nấm Dẩn		**141**	**830**							
	Village Nấm Lu	Nùng	65	390							
	Village Ngam Lâm	Nùng	76	440							
	Commune Ngán Chiên		**161**	**966**							
	Village Ma Lỳ Sán	Nùng	86	516							
	Village Cốc Chíu	Nùng	75	450							
	Commune Nà Chì		**56**	**336**							
	Village Nậm Ánh	Tày	56	336							
IX	**PROVINCE CAO BẰNG**		**1,520**	**7,003**	**35.5%**	**749**	-Average temperature is about 23-30degree.	Cao Bang has four major river systems: Bang Giang River, Quay Son river, Gam river and Bac Vong river and small streams system creating a considerable advantage to develop hydro power	Cao Bang shows some potentials for wind energy development at 300-400W/m2 and especially some points having better potential at 400-500W/m2.	It keeps average potential for solar energy development.	Cao Bang has about 10,000ha of forest.
	District Quảng Yên (Uyen)		**273**	**1 155**							
	Commune Phi Hải		**193**	**815**							
	Hamlet Cáp Tao	H'Mông	50	245							
	Hamlet Khuổi Xàm	Nùng	57	220							
	Hamlet Hamlet Hoa, Hamlet Cốc Phia, Hamlet Đông Ke	Tày	86	350							
	Commune Hoàng Hải		**80**	**340**							
	Hamlet Lũng Thốc, Hamlet Lũng Nhùng, Hamlet Lũng Kít, Hamlet Lũng Khà	Tày, Nùng	80	340							
	District Thạch An		**162**	**606**							
	Commune Đức Thong		**50**	**265**							
	Hamlet Cầu Lặn, Hamlet Khuổi Phin	Dao	50	265							
	Commune Canh Tân		**60**	**125**							
	Hamlet Khuổi Hoỏng	Dao	60	125							
	Commune Thái Cường		**52**	**216**							
	Hamlet Phiêng Un	Nùng	52	216							
	District Bảo Lâm		**321**	**1 788**							
	Commune Mông Ân		**110**	**682**							
	Phiêng Mẹng	H'Mông	110	682							
	Commune Nam Quang		**60**	**344**							
	Pác Ròm	H'Mông	60	344							
	Commune Lý Bôn		**71**	**362**							
	Nà Mỹ	Tày, Nùng,	71	362							
	Commune Thạch Lâm		**80**	**400**							
	Khau Noong	H'Mông	80	400							
	District Nguyên Bình		**400**	**1 434**							
	Commune Ca Thành		**58**	**375**							
	Hamlet Nặm Kim	Mông, Dao	58	375							
	Commune Phan Thanh		**101**	**625**							
	Hamlet Pác Chắn + Cốc Cai	H'Mông,	51	333							
	Hamlet Lũng Chủ	Dao	50	292							
	Commune Mai Long		**241**	**434**							
	Hamlet Khuổi Hẩu	H'Mông	56	434							
	Hamlet Cốc Mòn	Dao	185								
	District Bảo Lạc		**364**	**2 020**							
	Commune Sơn Lập		**154**	**909**							
	Hamlet Phia Pàn	H'Mông	57	335							
	Hamlet Khuổi Tâu	H'Mông	97	574							
	Commune Cô Ba		**92**	**522**							
	Hamlet Lũng Vầy		92	522							
	Commune Thượng Hà		**118**	**589**							
	Hamlet Hamlet Chang	Nùng	55	273							
	Hamlet Lũng Nà	Dao	63	316							
X	**PROVINCE BẮC KẠN**		**459**	**2,556**	**28.6%**	**776**	-Average temperature is about 20-22degree. -Annual average rainfall is about 1,400-1,600mm. -Annual average humidity is about 84%. -Average sunshine hours in province is from 1,400-1,600.	Bac Kan has five major river systems: Lo River, Ky Cung river, Gam river, Bang river and Cau river and small streams system creating a considerable advantage to develop hydro power projects.	Bac Can map shows some potentials for wind energy development at 300-400W/m2.	It keeps average potential for solar energy development.	Forest resources: Bac Kan has a total forest area of 420,990.5ha in which 224,151.4ha of natural forest, and 39,352.5ha of cultivated forest area and others.
	District Pác Nặm		**122**	**666**							
	Commune Bằng Thành		**122**	**666**							
	Khuổi Mạn	H'Mông	70	409							
	Khau Bang	Dao	52	257							
	District Chợ Đồn		**337**	**1 890**							
	Commune Xuân Lạc		**231**	**1 337**							
	Village Cốc Slông	H'Mông	54	338							
	Village Nà Hamlet	H'Mông	57	321							

	Village Tà Han	H'Mông	64	375							
	Village Pù Lùng 2	H'Mông	56	303							
	Commune Bình Trung		**106**	**553**							
	Village Khuổi Đẩy	H'Mông	54	252							
	Village Vằng Dọọc	H'Mông	52	301							
XI	**PROVINCE LẠNG SƠN**		**2,648**	**12,205**	**25.0%**	**930**	-Average temperature is about 17-22degree. -Annual average rainfall is about 1,200-1,600mm. -Annual average humidity is about 80-85%.	Water resources: Lang Son has five major river systems: Thuong River, Ky Cung river, Luc Nam river, Tien Yen-Ba Che river and Na Lang river and dense streams network.	Lang Son keeps a good potential of wind energy. Somepoints at boder with China show greater than 800W/m2. On average is 300-400W/m2.	It has low potential for solar energy development with radiation intensity from 3.5-4.5kwh/m2/day.	Forest resources: Lang Son has a total forest area of 172,635.01ha including natural forest and cultivated forest areas.
	District Văn Quan		**712**	**3 393**							
	Commune Tú Xuyên		**178**	**853**							
	Village Bó Càng	Tày, Nùng	110	504							
	Village Hamlet Mù	Tày, Nùng	68	349							
	Commune Lương Năng		**338**	**1 669**							
	Village Pá Hà	Tày, Nùng	99	456							
	Village Hamlet Kình	Tày, Nùng	108	525							
	Village Nà Lượt	Tày, Nùng	54	275							
	Village Hamlet Chầu	Tày, Nùng	77	413							
	Commune Song Giang		**57**	**258**							
	Village Hamlet Thâm	Tày, Nùng	57	258							
	Commune Trấn Ninh		**139**	**613**							
	Village Khun Thẩm	Tày, Nùng	52	230							
	Village Phiêng Lầy	Tày, Nùng	87	383							
	District Bắc Sơn		**730**	**3 386**							
	Commune Vũ Lễ		**167**	**514**							
	Village Lân Kẽm	Dao	59	193							
	Village Kha Hạ	Dao	108	321							
	Commune Tân Tri		**271**	**1 412**							
	Village Suối Tát	Dao	73	358							
	Village Suối Tín	Dao	64	353							
	Village Bình An	Dao	58	299							
	Village Thâm Xỉ	Dao	76	402							
	Commune Long Đống		**55**	**237**							
	Village Tân Rã	Dao	55	237							
	Commune Nhất Hòa		**131**	**642**							
	Village Làng Khà	Dao	54	286							
	Village An Ủy	Tày	77	356							
	Commune Trấn Yên		**106**	**581**							
	Village Lân Cà I	Dao	52	305							
	Village Noóc Mò	Dao	54	276							
	District Hữu Lũng		**190**	**908**							
	Commune Hòa Sơn		**65**	**317**							
	Village Hồ Mười	Tày	65	317							
	Commune Yên Sơn		**51**	**230**							
	Village Lân Thuồng	Nùng	51	230							
	Commune Hữu Liên		**74**	**361**							
	Village Lân Châu	Dao	74	361							
	District Lộc Bình		**360**	**1 517**							
	Commune Tĩnh Bắc		**120**	**512**							
	Village Hamlet Hu	Tày	62	228							
	Village Hamlet Quyêng	Tày	58	284							
	Commune Sàn Viên		**58**	**212**							
	Village Tà Lạn	Tày	58	212							
	Commune Lợi Bác		**130**	**564**							
	Village Phai Vài	Tày	65	286							
	Village Nà Mu	Tày	65	278							
	Commune Đông Quan		**52**	**229**							
	Village Sông Sài	Tày	52	229							
	District Tràng Định		**407**	**1 821**							
	Commune Chi Lăng		**40**	**167**							
	Village Nà Pàng		40	167							
	Commune Đề Thám		**188**	**786**							
	Village Ban Quyền		64	275							
	Village Nà Căm		67	280							
	Village Lũng Khẩu		57	231							
	Commune Hùng Sơn		**60**	**273**							
	Village Ban Pioòng		60	273							
	Commune Tân Tiến		**119**	**595**							
	Village Khuổi Biấp		54	270							
	Village Khuổi Cù		65	325							
	District Chi Lăng		**84**	**388**							
	Commune Hữu Kiên		**84**	**388**							
	Village Nà Lìa	Tày	84	388							
	District Bình Gia		**165**	**792**							
	Commune Hoa Thám		**165**	**792**							
	Đội Cấn I		55	270							
	Hamlet Pìn		60	284							
	Vĩnh Quang		50	238							

XII	**PROVINCE QUẢNG NINH**		**987**	**4,040**	**6.5%**	**1,787**	-Average temperature in 2011 is 22.6degree. -Annual rainfall in 2011 is 1823.8mm. -Average moisture in 2011 is about 82.1%.		Quang Ninh shows a good potential of wind energy. Somepoints at boder with China show greater than 800W/m2. On average is 300-400W/m2. Islands in this province also have a good potential to install wind turbines.	The potential for solar development is ranked as average with radiation intensity from 4-4.5kwh/m2/day.	Forest resources: Quang Ninh has about 243,833.5ha of forest in which 80% is area of natural forest.
	District Cô Tô		**250**	**850**							
	Commune Thanh Lân		**210**	**690**							
	Village 1	Kinh	60	210							
	Village 3	Kinh	150	480							
	Đảo trần	Kinh	40	160							
	District Vân Đồn		**561**	**2 353**							
	Commune Đài Xuyên		**70**	**283**							
	Hamlet Đài Van	Dao	70	283							
	Commune Ban Sen		**57**	**224**							
	Village Điền Xá	Kinh	57	224							
	Commune Thắng Lợi		**365**	**1 586**							
	Village 1	Kinh	76	187							
	Village 2	Kinh	75	292							
	Village 3	Kinh	59	342							
	Village 4	Kinh	68	461							
	Village 5	Kinh	87	304							
	Commune Quan Lạn		**69**	**260**							
	Village Tân Lập	Kinh	69	260							
	District Bình Liêu		**62**	**434**							
	Commune Hoành Mô		**62**	**434**							
	Village Lòng Vài	Sán chỉ	62	434							
	District Hải Hà		**114**	**403**							
	Commune Cái Chiên		**114**	**403**							
	Village Đầu Rồng	Kinh	58	204							
	Village Cái Chiên	Tày	56	199							
	CENTRAL PROVINCES (5 PROVINCES, 17 Districts, 78 Communes, 221 Villages, Hamlets)		**9,488**	**41,396**							
XIII	**PROVINCE THANH HOÁ**		**3,013**	**15,169**	**22.6%**	**840**	-Average temperature is about 23-24degree. -Annual rainfall is about 1,600-2,300mm. -Average moisture is about 85-87%. -Annual sunshine hours are about 1,600-18,00.	Thanh Hoa has four main river systems: Hoat, Ma, Bang and Yen river with a total length of 810km and catchment area of 39,756km square which creates a significant potential for hydro power development.	Thanh Hoa has an average potential of wind energ for electricity supply. As mapped it shows wind energy density is from 300-400W/m2.	The potential for solar development in Thanh Hoa is classified as average with radiation intensity from 4-4.5kwh/m2/day.	Forest resources: Thanh Hoa has about 484,246ha of forest with reserve of about 16.64 mill meter cubic wood. Besides, Thanh Hoa shows very good potential of biomass energy source from rice husk (1.8-6.8million tones/year)
	District Mường Lát		**2,115**	**11,049**							
	Commune Quang Chiểu		**195**	**951**							
	Hamlet Hạm	Thái	76	361							
	Hamlet Pù Đứa	H'Mông	54	329							
	Hamlet Cúm	Thái	65	261							
	Commune Tén Tằn		**134**	**640**							
	Hamlet Đoàn Kết	Khơ mú	134	640							
	Commune Tam Chung		**196**	**984**							
	Hamlet Cân	Thái	79	341							
	Hamlet Tân Hương	Thái	56	267							
	Hamlet Suối Loóng	H'Mông	61	376							
	Commune Pù Nhi		**549**	**2,842**							
	Hamlet Pha Đén	H'Mông	71	353							
	Hamlet Hua Pù	H'Mông	54	247							
	Hamlet Pù Ngùa	H'Mông	155	833							
	Hamlet Cá Tớp	H'Mông	71	368							
	Hamlet CÁ Nọi	H'Mông	85	445							
	Hamlet Cơm	H'Mông	113	596							
	Commune Trung Lý		**422**	**2,268**							
	Hamlet Tà Cóm	H'Mông	77	491							
	Hamlet Cánh Cộng	H'Mông	56	282							
	Hamlet Cá Giáng	H'Mông	88	432							
	Hamlet Cò Cài	H'Mông	99	434							
	Hamlet Pa Búa	H'Mông	102	629							
	Commune Mường Lý	H'Mông	**619**	**3,364**							
	Hamlet Tài Chánh	H'Mông	61	247							
	Hamlet Nàng I	H'Mông	60	252							
	Hamlet Muống I	H'Mông	81	424							
	Hamlet Xì Lồ	H'Mông	50	284							
	Hamlet Trung Tiến I	H'Mông	65	300							
	Hamlet Ún	H'Mông	102	666							
	Hamlet Sài Khao	H'Mông	72	521							
	Hamlet Trung Thắng	H'Mông	75	459							
	Hamlet Chiềng Nưa	H'Mông	53	211							
	District Quan Sơn		**818**	**3,805**							
	Commune Na Mèo		**193**	**822**							
	Hamlet Son	Thái	63	288							
	Hamlet Xá Ná	Thái	66	277							
	Hamlet Bo	Thái	64	257							
	Commune Sơn Thủy		**80**	**467**							
	Hamlet Mùa Xuân	H'Mông	80	467							
	Commune Mường Mìn	**Thái**	**109**	**516**							

	Hamlet Yên	Thái	109	516							
	Commune Sơn Điện	**Thái**	**126**	**585**							
	Hamlet Sủa	Mường	65	305							
	Hamlet Na Phường	Mường	61	280							
	Commune Tam Thanh		**91**	**431**							
	Hamlet Pa	Thái	91	431							
	Commune Trung Thượng		**219**	**984**							
	Hamlet Bàng	Thái	92	415							
	Hamlet Khạn	Thái	61	293							
	Hamlet Mảy	Thái	66	276							
	District Bá Thước		**80**	**315**							
	Commune Lũng Cao		**80**	**315**							
	Village Thành Công	Thái	80	315							
XIV	**PROVINCE NGHỆ AN**		**4,142**	**16,643**	**22.5%**	**920**	-Average temperature in 2011 is 23.3degree. -Annual rainfall in 2011 is 2558.6mm. -Average moisture in 2011 is about 83%.	Nghe An has a dense river and stream network and sloping terrain which facilitaes hydro power development. The estimated hydro potential capacity is up to 1,200MW in province.	Nghe An has wind energy density quite good (300-400W/m2 along with the seacoastal) and somepoints bodering with Laos has wind energy density is upto 500-600W/m2.	Nghe An has good potential for solar energy development with solar radiation intensity reaching to 5kwh/m2/day.	Forest resources: Nghe An has a total forest area of 885,339ha in which 732,741ha of natural forest and 152,867ha of cultivated forest area. Nghe An also has quite good potential of biomass energy source from rice crop residues.
	District Kỳ Sơn		**1,753**	**6,028**							
	Commune Hữu Lập		**94**	**355**							
	Hamlet Nọng Ó	Thái	94	355							
	Commune Hữu Kiệm		**66**	**235**							
	Hamlet Định Sơn	Khơ Mú	66	235							
	Commune Nậm Cắn		**185**	**297**							
	Hamlet Huồi Pốc	Mông	185	297							
	Commune Đoọc Mạy		**115**	**390**							
	Hamlet Noọng Hán	H'Mông	115	390							
	Commune Na Loi		**74**	**356**							
	Hamlet Piêng Lau	Thái	74	356							
	Commune Keng Đu		**264**	**1 068**							
	Hamlet Quyết Thắng	Khơ Mú	68	308							
	Hamlet Huồi Lê	Khơ Mú	129	470							
	Hamlet Huồi Xui	Khơ Mú	67	290							
	Commune Bắc Lý		**142**	**530**							
	Hamlet Buộc	Thái	92	340							
	Hamlet Nhọt Kho	H'Mông	50	190							
	Commune Mỹ Lý		**196**	**681**							
	Hamlet Piêng Vai	H'Mông	60	245							
	Hamlet Hoà Lý	Thái	136	436							
	Commune Bảo Nam		**102**	**519**							
	Hamlet Phia Khoáng	Khơ Mú	50	195							
	Hamlet Khe Nạp	Khơ Mú	52	324							
	Commune Bảo Thắng		**160**	**314**							
	Hamlet Ca Da	Khơ Mú	97	164							
	Hamlet Tát Xao Va	Khơ Mú	63	150							
	Commune Na Ngoi		**59**	**121**							
	Hamlet Pù Qoặc 2	H'Mông	59	121							
	Commune Nận Càn		**126**	**533**							
	Hamlet Nậm Khiêm	H'Mông	126	533							
	Commune Mường Típ		**80**	**365**							
	Hamlet Tà Đo	H'Mông	80	365							
	Commune Mường Lống		**90**	**264**							
	Hamlet Xám Xúm	H'Mông	90	264							
	District Tuong Dương		**2,389**	**10,615**							
	Commune Lượng Minh		**545**	**2 610**							
	Hamlet Chăm Puông	Khơ Mú	167	793							
	Hamlet Minh Tiến	Khơ Mú	107	497							
	Hamlet Minh Thành	Thái	70	289							
	Hamlet Cà Moong	Khơ Mú	131	614							
	Hamlet Xốp Cháo	Khơ Mú	70	417							
	Commune Hữu Khuông		**500**	**2 146**							
	Hamlet Xàn	Thái	176	747							
	Hamlet Con Phen	Khơ Mú	55	279							
	Hamlet Pủng Bón	Thái	70	269							
	Hamlet Tùng Hốc	Khơ Mú	72	300							
	Hamlet Hồi Cọ	Khơ Mú	74	291							
	Hamlet Hồi Pủng	Khơ Mú	53	260							
	Commune Nhôm Mai		**259**	**1 170**							
	Hamlet Nhôm Mai	Thái	161	704							
	Hamlet Na Hỷ	Thái	98	466							
	Commune Mai Sơn		**211**	**945**							
	Hamlet Hồi Xá	Thái	88	420							
	Hamlet Hồi Tố 1	Thái	67	280							
	Hamlet Chà Lò 2	Khơ Mú	56	245							
	Commune Yên Hoà		**139**	**717**							
	Hamlet Xốp Kha	Thái	74	369							
	Hamlet Yên Hương	Thái	65	348							
	Commune Yên Tĩnh		**459**	**1 562**							
	Hamlet Na Cáng	Thái	79	334							
	Hamlet Pà Khốm	Thái	180	241							
	Hamlet Hồi Pai	Thái	66	346							

	Hamlet Chà Lúm		134	641							
	Commune Nga My		**276**	**1 465**							
	Hamlet Na Kho	Thái	74	366							
	Hamlet Xốp Kho	Thái	90	420							
	Hamlet Na Ngân	Thái	112	679							
XV	**PROVINCE QUẢNG BÌNH**		**57**	**257**	**23.0%**	**950**	-Average temperature is about 24-25degree. -Annual average rainfall is from 2,000-2,300mm.	Quang Binh has a large system of rivers and streams with the density of 0,8 - 1,1km/km2. 5 main rivers are named Ron, Gianh, Ly Hoa, Dinh and Nhat Le. There are3 160 natural and artificial lakes with expected capacity of 243.3 million m3.	Quang Binh has a good potential of wind energy source. The wind energy density shows 300-400W/m2 and some places bodering Laos keep at 500-600W/m2 and even greater than 800W/m2.	Good potential for solar energy development.	Forest resources: Quang Binh has 486,688 ha of forest including 447,837ha of natural forest and 38,851ha of planted forest.
	District Bố Trạch		**57**	**257**							
	Commune Tân Trạch		**57**	**257**							
	Hamlet 39	A Rem	57	257							
XVI	**PROVINCE QUANG TRI**		150	500	**21.7%**	**951**	-Average temperature is about 24-25degree. -Annual average rainfall is from 2,200-2,500mm. -Average relative humidity is about 85%. -Average sunshine hour is quite good, about 5-6hours per day.	Quang Tri has three main river systems discharging into sea: Ben Hai river, Thach Han river and O Lau river.	Quang Tri has good potential of wind energy, especially in areas bodering with Laos. The wind energy density is from 300-800W/m2.	Very good potential for solar energy development with radiation intensity to be able to reach 6kwh/m2/day at some sites bodering with Laos.	Forest resources: Quang Tri has 219,638.85ha of forest including 101,631.02ha of productive forest; 62,664.45ha of protective forest and 55,343.38ha of special forest. The potential of utilizing rice residues are moderate.
	District Con co	Kinh	150	500							
XVII	**PROVINCE QUẢNG NAM**		**1,066**	**4,291**	**21.7%**	**935**	-Average temperature is about 25.4degree. -Annual average rainfall is from 2,000-2,500mm. -Average relative humidity is about 84%.	Quang Nam has a dense river and stream network with total length of 900km including 9 major rivers such as Thu Bon and thus makes it high potential for hydro power development.	Quang Nam has potential for wind energy development, espcially in western districts of province.	Quang Nam give a good opportunity for solar development with radiation intensity from 5-6kwh/m2/day.	Forest resources: Quang Nam has 425,921ha of forest including 388,803ha of natural forest and 37,118ha of planted forest. Quang Nam also has a quite good potential of biomass energy sources.
	Hoi An city										
	Cu Lao Cham island (Bai Cam, Bai Lang, Bai Huong and other small islands)	No	900	3,000							
	District Tây Giang		**159**	**694**							
	Commune Ch'ơm		**159**	**694**							
	Village Tà Lu I	Cơtu	65	320							
	Village C'Nốc	Cơtu	94	374							
	District Nam Giang		**289**	**1 465**							
	Commune Chơ Chun		**142**	**750**							
	Village Côn Dốt	Cơtu	70	361							
	Village B Lăng	Cơtu	72	389							
	Commune La Ê		**147**	**715**							
	Village Pà Oi	Cơtu	88	389							
	Village Pa Lan	Cơtu	59	326							
	District Bắc Trà My		**326**	**978**							
	Commune Trà Bùi		**101**	**303**							
	Village 8, Commune Trà Bui	Kdoong	101	303							
	Commune Trà Giác		**140**	**420**							
	Village 3A, Commune Trà Giác	Kdoong	60	180							
	Village 3B, Commune Trà Giác	Kdoong	80	240							
	Commune Trà Núi		**85**	**255**							
	Village 4, Commune Trà Nú	Cor	85	255							
	District Đại Lộc		**225**	**866**							
	Commune Đại Sơn		**225**	**866**							
	Đồng Chàm	Kinh	85	326							
	Village Đầu Gò	Kinh	66	233							
	Village Thác Cạn	Kinh	74	307							
	District Nam Trà My		**67**	**288**							
	Commune Trà Nam		**67**	**288**							
	Nóc Long Riu, Village 5	Xê Đăng	67	288							
XVIII	**PROVINCE QUẢNG NGÃI**		**1,060**	**4,536**	**20.8%**	**909**	-Average temperature is about 25.8degree. -Annual average rainfall is from 2,200-2,500mm. -Average relative humidity is about 85%. -Accumulative sun radiation amount is from 130-150kcal/cm2/year.	Quang Ngai has four main rivers including Tra Bong, Tra Khuc, Ve and Tra Cau with catchment areas are respectively 697km2, 3,240km2, 1,260km2 and 442km2. Thus, it has good potential for development of hydro power projects.	The potential for wind energy development in Quang Ngai is not significant.	Quang Ngai also has a good potential for solar development with radiation intensity from 5-6kwh/m2/day.	Moderate potential for utilization of rice crop residues.
	District Ba Tơ		**546**	**2 730**							
	Commune Ba Xa		**59**	**295**							
	Village Nước Lăng, Commune Ba Xa	H'Re	59	295							
	Commune Ba Thành		**50**	**250**							
	Village Huy Ba I (Gọi Ôn), Commune Ba Thành	H'Re	50	250							
	Commune Ba Giang		**127**	**635**							
	Village Gò Khôn, Commune Ba Giang	H'Re	127	635							
	Commune Ba Tiêu		**68**	**340**							
	Village KRầy, Commune Ba Tiêu	H'Re	68	340							
	Commune Ba Nam		**53**	**265**							
	Village Làng Vờ, Commune Ba Nam	H'Re	53	265							

	Commune Ba Tô		**75**	**375**							
	Làng Danh - Village Làng Mạ	H'Re	75	375							
	Commune Ba Trang		**114**	**570**							
	Bùi Hui – Con Dóc	H'Re	50	250							
	Làng Leo-Con Dóc	H'Re	64	320							
	District Sơn Hà		**219**	**998**							
	Commune Sơn Thuỷ		**53**	**215**							
	Hamlet Giá Gối, Village Tà Cơm, Commune Sơn Thủy	Hre	53	215							
	Commune Sơn Kỳ		**103**	**512**							
	Hamlet Mồ Ních, Village Làng Riềng, Commune Sơn Kỳ	Hre	53	215							
	Hamlet Bấc, Village Làng Rê, Commune Sơn Kỳ	Hre	50	297							
	Commune Sơn Ba		**63**	**271**							
	Hamlet Cạp La, Village Làng Bung, Commune Sơn Ba	Hre	63	271							
	District Tra Bong		**295**	**808**							
	Commune Trà Sơn		**75**	**192**							
	Village Tây, Commune Trà Sơn	Cor	75	192							
	Commune Trà Bùi		**80**	**198**							
	Village Tang, Commune Trà Bùi	Cor	80	198							
	Commune Trà Thuỷ		**140**	**418**							
	Village 1+ Village 4, Commune Trà Thủy	Cor	140	418							
	District island Ly Son (An Binh, An Vinh & An Hai communes)		4,746	20,344							
	SOURTH PROVINCES (10 PROVINCES, 40 Districts, 135 Communes, 217 Village, Hamlet)		**24,387**	**104,180**							
XIX	**PROVINCE BÌNH ĐỊNH**		**794**	**3,912**	**15.2%**	**1,150**	-Average temperature is about 20.1-26.1degree. -Annual average rainfall is 1,751mm. -Average relative humidity is about 79-92%.	Binh Dinh has four major rivers Lai Giang, Kon, La Tinh and Ha Thanh. The estimated hydro potential capacity is about 182.4 Million KW.	Binh Dinh show good potential for wind energy development.	Binh Dinh keeps a quite good potential for solar energy development with radiation intensity from 4-5kwh/m2/day.	Binh Dinh has huge potential for utilizing rice husk.
	Quy Nhon city										
	Nhon Chau island commune (Cu Lao Xanh)		**484**	**2,623**							
	District Vân Canh		**310**	**1 289**							
	Commune Canh Liên		**310**	**1 289**							
	Village Canh Tiến	Bana, Chăm	102	392							
	Village Cà Bông	Bana, Chăm	70	295							
	Village Chồm	Bana, Chăm	75	312							
	Village Cát	Bana, Chăm	63	290							
XX	**PROVINCE KHÁNH HOÀ**		**820**	**3,653**	**8.8%**	**1,258**	-Average temperature in 2011 is 26.7degree. -Annual rainfall in 2011 is 1327.6mm. -Average moisture in 2011 is about 77.6%.		The map show Khanh Hoa quite potential for wind energy development. Somepoints has wind energy density is up to 800W/m2.	Khanh Hoa has solar radiation intensity from 4.5-5kwh/m2/day, making it a good potential for solar applications.	Moderate potential for utilization of rice crop residues.
	City Nha Trang		**438**	**1 950**							
	Vĩnh Nguyên Ward		**438**	**1 950**							
	Island Bích Đầm	Kinh	194	922							
	Island Đầm Bấy	Kinh	69	220							
	Island Vũng Ngán	Kinh	117	547							
	Island Hòn Một	Kinh	58	261							
	District Vạn Ninh		**327**	**1 423**							
	Commune Vạn Thanh		**327**	**1 423**							
	Village Ninh Đảo	Kinh	160	722							
	Village Ninh Tân	Kinh	94	401							
	Village Điệp Sơn	Kinh	73	300							
	Town Ninh Hoà		**55**	**280**							
	Commune Ninh Tây		**55**	**280**							
	Hồ Suối Sim - Buôn Lác	Ê đê	55	280							
XXI	**PROVINCE ĐĂK LĂK**		**1,814**	**8,476**	**19.6%**	**1.067.7**	-Annual average rainfall is 1,600-1,800mm.	Dak Lak has big potential for hydro development with estimated capacity of 2,636 million Kw, especially small hydro power projects to electrify some remote areas in province.	The map show Dak Lak quite potential for wind energy development with average wind energy density is 300-400W/m2 and up to 800W/2 at somesites.	Dak Lak has a really good opportunity for solar application with radiation intensity from 5-5.5kwh/m2/day.	Dak Lak has quite good potential for utilization of rice crop residues.
	District Ea Kar		**428**	**2 140**							
	Commune Cư Elang		**298**	**1 490**							
	Village 3	Nùng	63	315							
	Village 6B	Nùng	55	275							
	Village 6D	Nùng	180	900							
	Commune Ea Sar		**130**	**650**							
	Village Thanh Sơn	Mường	58	290							

	Village Thanh Bình		72	360							
	District M'Drắk		**1 386**	**6 336**							
	Commune Cư Prao		**67**	**168**							
	Village 1	Kinh	67	168							
	District Krông Năng		**1 319**	**6 168**							
	Commune Dliê Ya		**55**	**270**							
	Village Tân Hiệp	Ê đê	55	270							
	Commune Phú Lộc		**462**	**1 848**							
	Village Lộc Bằng	Kinh	88	352							
	Village Lộc Thái	Kinh	134	536							
	Village Lộc Xuân	Kinh	98	392							
	Village Lộc An	Kinh	142	568							
	Commune Ea Hồ		**97**	**480**							
	Village Trường Hà	Tày	97	480							
	Commune Ea Tam		**424**	**2 121**							
	Village Tam Đa	Tày	124	611							
	Village Tam Điền	Tày	114	574							
	Village Tam Phương	Tày	186	936							
	Town Krông Năng		**125**	**675**							
	Village Bình Minh	Kinh	125	675							
	Commune Ea Dăh		**102**	**527**							
	Village Xuân Nguyên	Mường	50	255							
	Village Xuân Thái	Thái	52	272							
	Commune Phú Xuân		**54**	**247**							
	Village Xuân Thái 5	Kinh	54	247							
XXII	**PROVINCE BÌNH PHƯỚC**		**1,640**	**6,401**	**9.1%**	**1,526**	-Annual average temperature is about 25.8-26.2 degree. -Annual average rainfall is from 2,045-2325mm. -Total sunshine hours in year is quite abundant, about 2,400-2,500. The sunshine time on average is 6.2-6.6hours per day. -Annual average humidity is about 80.8-81.4%.	Binh Phuoc has a dense river and spring system with density of 0.7-0.8km/km2, including Sai Gon river, Song Be river, Dong Nai river, Mang and other small ones.	Binh Phuoc does not have wind energy potential.	Binh Phuoc has a really good opportunity for solar application with radiation intensity from 5-5.5kwh/m2/day.	Forest resources: Binh Phuoc has a total forest area of 165,701ha.
	District Hớn Quản		**138**	**529**							
	Commune Phước An		**138**	**529**							
	Áp Tranh I	S'tiêng	82	330							
	Áp Tranh II	S'tiêng	56	199							
	District Bù Gia Mập		**292**	**1 199**							
	Commune Bù Gia Mập		**107**	**349**							
	Village Đăk Á		107	349							
	Commune Phú Nghĩa		**75**	**300**							
	Village Tân Lập	S'tiêng	75	300							
	Commune Phước Minh		**50**	**250**							
	Village Bình Giai	S'tiêng	50	250							
	Commune ĐaKia		**60**	**300**							
	Village Đăk-Khâu	S'tiêng	60	300							
	District Đồng Phú		**900**	**3 521**							
	Commune Đồng Tâm		**53**	**221**							
	Áp III		53	221							
	Commune Tân Hưng		**326**	**1 135**							
	Áp Pa Pếch		160	541							
	Áp Suối Nhung		166	594							
	Commune Tân Lợi		**403**	**1 692**							
	Áp Thạch Màng		403	1 692							
	Commune Tân Hoà		**118**	**473**							
	Áp Đồng Tân		118	473							
	District Bù Đăng		**310**	**1 152**							
	Commune Đăng Hà		**125**	**422**							
	Village 1	Tày, Nùng	63	126							
	Village 5	Sán Chay	62	296							
	Commune Bình Minh		**185**	**730**							
	Village 5	S'tiêng, Tày,	120	450							
	Village 6	Hoa	65	280							
XXIII	**PROVINCE BÌNH THUẬN**		**1,407**	**6,268**	**9.3%**	**1,560**			Binh Thuan has a very goood potential of wind enegy with density on average of 400-500W/m2 and 500-600W/m2 along the sea coast.	Binh Thuan has a really good opportunity for solar application with radiation intensity from 5-5.5kwh/m2/day.	Binh Thuan has potential for utilization of rice husks. As pointed out in NREL map annual rice crop residues are from 550,000-900,000 tones/year.
	District Tuy Phong		**67**	**390**							
	Commune Phước Thể		**67**	**390**							
	Cửa Sút, Village 1		67	390							
	District Bắc Bình		**685**	**3 654**							
	Commune Sông Bình		**293**	**1 412**							
	Village Sông Bằng	Tày	96	472							
	Village Đá Trắng	Tày-Hoa	197	940							
	Commune Phan Thanh		**174**	**954**							
	Khu vực Ngã Hai	Chăm	174	954							
	Commune Phan Hoà		**218**	**1 288**							
	Tầm Ru-Tà Bo	Chăm	114	673							
	Đất Động	Chăm	104	615							
	District Hàm Thuận Bắc		**312**	**974**							
	Commune Đa Mi		**312**	**974**							
	Village Đa Tro		312	974							
	District Tánh Linh		**231**	**933**							
	Commune Gia Huynh		**231**	**933**							

	Khu 300 và Ngã 3 Năm Chục	Châuro	231	933							
	District Hàm Thuận Nam		**112**	**317**							
	Village Lò To	Kinh	112	317							
XXIV	**PROVINCE BA RIA-VUNG TAU**		**1,000**		**4.8%**	**1,695**	-Average temperature in 2011 is 27.5 degree. -Annual rainfall in 2011 is 1382.9mm. -Average moisture in 2011 is about 79.1%. -Sunshine hours in year is quite signfinicant, about 2,400 hours/year.		Vung Tau also shows potential for development of wind energy turbines along the sea coast.	Vung Tau has a quite good potential for solar development with radiation intensity from 4.5-5.5kwh/m2/day.	It has low potential for utilization of rice residues due to insignificant amount (from 80,000-285,000 tones/year)
	District island Con Dao	Kinh	1,000	4,528							
XXVI	**PROVINCE AN GIANG**		**459**	**2,192**	**8.5%**	**1,319**	-Annual average temperature is about 28 degree. -Average relative humidity is about 80%. -Average daily sunshine hours are from 7-10hours.		No potential for wind enegy development.	It has a really good potential for solar energy development.	An Giang also has huge potential of rice husk amount. As mapped out it is about 1.8-6.8million tones/year.
	District An Phú		**50**	**203**							
	Commune Vĩnh Hội Đông		**50**	**203**							
	Ấp Vĩnh An, Commune Vĩnh Hội Đô	Kinh	50	203							
	District Châu Thành		**409**	**1 989**							
	Commune Vĩnh Hội		**318**	**1 561**							
	Ấp Vĩnh Hoà, Commune Vĩnh Hội	Kinh	318	1 561							
	Commune Vĩnh Nhuận		**91**	**428**							
	Ấp Vĩnh Hiệp, Commune Vĩnh Nhuận	Kinh	91	428							
XXVII	**PROVINCE TRÀ VINH**		**529**	**2,155**	**21.1%**	**1,089**	-Annual average temperature is about 26-27 degree. -Average relative humidity is about 80-85%. -Annual average rainfall is from 1,400-1,600mm.		Tra Vinh has good potential for wind energy development with energy density from 300-500W/m2.	Really potential for solar energy development.	Forest resources: Area of forests and forest land is 24,000 ha and agri- cultural land is about 186,170 ha with annual rice crop residues from 1.8-6.8million tones/year..
	District Trà Cú		**330**	**1 304**							
	Commune Đôn Xuân		**194**	**744**							
	Cụm dân cư ấp Bàu Sấu	Kinh	64	247							
	Cụm dân cư ấp Cây Cồng	Khmer	55	205							
	Cụm dân cư ấp Lộ Sỏi A	Khmer	75	292							
	Commune Đôn Châu		**136**	**560**							
	Cụm dân cư ấp La Bang Kinh	Kinh	136	560							
	District Châu Thành		**199**	**851**							
	Commune Long Hoà		**94**	**326**							
	Cụm dân cư ấp Cồn Phụng	Kinh	94	326							
	Commune Lương Hoà		**53**	**265**							
	Cụm dân cư ấp Ba Se A	Kinh,	53	265							
	Commune Hưng Mỹ		**52**	**260**							
	Cụm dân cư ấp Ngãi Lợi	Kinh,	52	260							
XXVIII	**PROVINCE KIÊN GIANG**		**6,634**	**27,748**	**8.1%**	**1,316**			The wind energy potential in Kien Giang is not really clear. Only some sites has average wind potential with energy density from 300-400W/m2.	Quite potential for solar energy development with radiation intensity from 4.5-5.5kwh/m2/day.	Kien Giang also has huge potential of rice husk amount. As mapped out it is about 1.8-6.8million tones/year.
	District Phú Quốc		**1 208**	**4 637**							
	Commune island Gành Dầu		**162**	**618**							
	Ấp Rạch Vẹm, Commune Gành Dầu	Kinh, Hoa,	162	618							
	Commune island Thổ Châu		**421**	**1 407**							
	Tổ 3 ấp bãi Ngự	Kinh, Khmer	69	210							
	Tổ 4 ấp bãi Ngự	Kinh, Khmer	62	204							
	Tổ 5 ấp bãi Ngự	Kinh, Khmer	69	238							
	Tổ 6 ấp bãi Ngự	Kinh, Khmer	77	243							
	Tổ 7 ấp bãi Ngự	Kinh, Khmer	74	281							
	Tổ 8 ấp bãi Ngự	Kinh, Khmer	70	231							
	Commune island Bãi Thơm		**270**	**1 083**							
	Ấp Bãi Chướng, Commune Bãi Thơm	Kinh, Hoa,	270	1 083							
	Commune Hòn Thơm		**355**	**1 529**							
	Ấp Bãi Nam	Kinh, Hoa,	257	1 099							
	Ấp Hòn Roi, Commune Hòn Thơm	Kinh, Hoa,	98	430							
	District Gò Quao		**35**	**166**							
	Commune Thủy Liễu		**35**	**166**							
	Ấp Thạnh Hoà I	Kinh, Khmer	35	166							
	District Giồng Riềng		**65**	**312**							
	Commune Hoà Thuận		**65**	**312**							
	Ấp Xẻo Lùng, Commune Hòa Thuận	Kinh, Khmer	65	312							
	District Kiên Hải		**4 939**	**20 975**							
	Commune island Lại Sơn		**1 882**	**7 615**							
	Ấp Bãi Nhà A	Kinh, Hoa,	753	2 967							
	Ấp Bãi Nhà B	Kinh, Hoa,	312	1 419							
	Ấp Thiên Tuế	Kinh, Hoa,	584	2 230							
	Ấp Bãi Bấc	Kinh, Hoa,	233	999							
	Commune island An Sơn		**1 136**	**5 189**							
	Ấp An Cư	Kinh, Hoa,	414	1 847							
	Ấp Bãi Ngự	Kinh, Hoa,	437	1 911							
	Ấp bãi Bấc	Kinh, Hoa,	285	1 431							
	Commune island Nam Du		**874**	**3 795**							
	Ấp Hòn Mấu	Kinh, Khmer,	123	640							

	Ấp An Phú		540	2 154							
	Ấp An Bình		211	1 001							
	Commune island Hòn Tre		**1 047**	**4 376**							
	Ấp I	Kinh, Hoa,	596	2 450							
	Ấp II	Kinh, Hoa,	365	1 545							
	Ấp III	Kinh, Hoa,	86	381							
	Town Hà Tiên		**387**	**1 658**							
	Commune Tiên Hải		**387**	**1 658**							
	Ấp Hòn Tre Lớn Commune Tiên Hải	Kinh	270	1 170							
	Hòn Đước Commune Tiên Hải	Kinh	64	267							
	Hòn Giang Commune Tiên Hải	Kinh	38	163							
	Hòn Ụ Commune Tiên Hải	Kinh	15	58							
XXIX	**PROVINCE BẠC LIÊU**		**7,745**	**36,921**	**12.9%**	**1,273**	-Average temperature is about 28.5 degree.		Bac Lieu has good potential for wind energy development along the sea coast.	Quite potential for solar energy development with radiation intensity from 4.5-5.5kwh/m2/day.	Amount of rice crop residues in Bac Lieu is 550,000-900,000 tones/year.
	District Hồng Dân		**1 219**	**4 943**							
	Ninh Thạnh Lợi A		80	310							
	Ninh Thạnh Lợi		364	1 297							
	Vĩnh Lộc A		271	1 145							
	Vĩnh Lộc		119	445							
	Ninh Hoà		64	314							
	Lộc Ninh		112	486							
	Ninh Quới A		71	350							
	Ninh Quới		66	299							
	TT Ngan Dừa		72	297							
	District Vĩnh Lợi		**84**	**345**							
	Châu Hưng A	Kinh	84	345							
	District Đông Hải		**3 809**	**19 984**							
	Long Điền Đông A		848	3 392							
	Long Điền		1 004	4 106							
	An Trạch A		642	3 210							
	Long Điền Tây		409	1 636							
	Định Thành A		298	1 192							
	An Phúc		476	1 904							
	Long Điền Đông		666	2 664							
	An Trạch		470	1 880							
	District Phước Long		**1 585**	**6 373**							
	Vĩnh Phú Tây	Kinh	393	1 513							
	Vĩnh Thanh	Kinh	46	188							
	Vĩnh Phú Đông	Kinh	152	608							
	Hưng Phú	Kinh	190	845							
	Phước Long	Kinh	122	540							
	Phong Thạnh Tây A	Kinh	335	1 271							
	Phong Thạnh Tây B	Kinh	194	826							
	TT Phước Long	Kinh	153	582							
	District Giá Rai		**1 048**	**5 276**							
	Phong Thạnh Đông	Kinh	261	807							
	Phong Thạnh	Kinh	112	458							
	Phong Thạnh A	Kinh	152	680							
	Phong Thạnh Tây	Kinh	396	2 841							
	Phong Thạnh Đông A	Kinh	127	490							
XXX	**PROVINCE CÀ MAU**		**1,545**	**6,454**	**10.9%**	**1,251**	-Average temperature in 2011 is 27.5 degree. -Annual rainfall in 2011 is 2445.9mm. -Average moisture in 2011 is about 79.5%.		Ca Mau has good potential for wind energy development along the sea coast.	Quite potential for solar energy development with radiation intensity from 4.5-5.5kwh/m2/day.	Forest resources: Ca Mau has 97,187ha of forest including 9,986ha of protective forest, 11,530ha of special forest and 75,670ha of productive forest. Agricultural land area for cultivating rice is about 248,200ha with annually rice husk amount from 285,000-

ANNEX 3 – Site analysis Questionnaire

Site Analysis

No	Questions	Answer
I	**Respondent information**	
1	Name of respondent	
2	Sex & age	☐ Male ☐ Female Age:…………
3	Organization	
4	Position in community	
II	**General infrastructure information**	
1	How far is it to the district/ commune/village centre from your site?	From district centre : ....km From commune centre : .... km From village centre : ....km
2	What is total population in your commune/village?	……………………………persons
3	How many households are in your commune/village?	……………………………households
4	How many schools are there in your commune/village?	……………………………schools
5	How many clinic stations are there in your commune/village?	……………………………stations
6	Is there any road leading directly to your site?	☐ Yes ☐ No
7	How far is it to the closest road from your site?	…………………………..…..km
8	What is the name of this road?	……………………………
9	What transport mean(s) can access to this road?	
10	What the reason (s) that the transport mean(s) cannot come by the road?	
III	**Existing power system information**	
1	Is there any existing power system in your site?	☐ Yes ☐ No If yes, please go to 2-10 If no, please go to 11
2	If yes, what is it?	☐ Mini hydro power ☐ Wind power ☐ Solar energy ☐ Diesel power ☐ Wind & diesel ☐ Solar & diesel ☐ Others, specify…………………………………
3	What is its capacity?	……………kW
4	Who are investor and operator?	
5	How much time does it operate a day?	
6	How is the electricity quality?	
7	Is it enough for use daily?	☐ Yes ☐ No
8	Do you have to pay money for it?	☐ Yes ☐ No
9	If yes, what is the electricity tariff?	………….VND/kwh
10	Have you been satisfactory with it yet?	☐ Yes ☐ No

		If no, please tell us why……………………………………
11	If there is no electricity on your site what kind of energy do you use to meet your energy demand (i.e lighting, watching TV…)?	
12	What is the energy price you have to pay?	……………VND/lit (kg)
IV	**Renewable energy potentials**	
1	Is there any river, stream very close to your site?	☐ Yes ☐ No
2	How far is it from your site to the closest point of the river/stream?	
3	How much time within one year and when the water in the river / stream is abundant?	…………………………….months/year
4	Is there any renewable energy unit like mini hydro-, wind-, solar or other renewable power generation unit existing in your area?	☐ Yes ☐ No ☐ Mini hydro power ☐ Wind power ☐ Solar energy ☐ Biomass power ☐ Biogas power ☐ Others, specify…………………………………
5	What is its capacity?	…………….kW
6	How many woody, food and agro-processing units are there in your commune/village?	…………………………....units
7	What is its capacity?	……………………………ton (m^3)/day
8	Is there any wood processing in the site?	☐ Yes ☐ No If yes, what is the capacity?..................(tone/day) and what is woody wastes collection situation?...
9	Are there any rice millings in your site?	☐ Yes ☐ No If yes, what is the capacity?..................(tone/day) what is rice husk collection situation?...
10	Is there any aquatic processing unit in your site?	☐ Yes ☐ No If yes, what is the capacity?..................(tone/day) what is waste collection situation?...
11	Are there any waste dumping yard in your site?	☐ Yes ☐ No If yes, what is the capacity?..................(tone/day) and what is the employed technology for waste treatment?..

Date:…………………………..

Interviewer (Sign, name)

Respondent (Sign, name)

Biomass Resource Availability in Community

No	Checklist	Unit	Value	Remark
I	**Information on biomass availability in the commune/village**			
1	Total land area of the commune/village	Km^2		
2	Productive natural forest			
	Type			These data may be available in commune/village documents or in the District (Commune) Agriculture & Rural Development Office
	Area	ha		
	Standing stock	m^3/ha		
	The distance from the centre of the commune/village to the forest?	Km		
	Estimated area accessible fraction	%		
3	Productive Plantation forest			
	Area	ha		These data may be available in commune/village documents or in the DARD
	Standing stock	m^3/ha		
	The distance from commune/village centre to plantation	km		
4	Industrial trees			
	4.1. Coffee	Ha		Indicate land areas on which these trees are growing
	4.2. Rubber	Ha		
	4.3. Tea	Ha		
	4.4. Scattered trees	ha		These trees are planted by local people in uncultivated land. The data may be measured by land area or by the number of trees.
		Trees		
5	Is there wood waste from wood processing at site?			
	Total number of wood processing units in the commune/village.			
	Capacity of the biggest unit.	M^3/day		
	How many wood processing units with processing capacity in the range of 2 - $10m^3$ of wood/day	Unit		

	How many wood processing units with processing capacity more than 10 m^3 of wood/day	Unit		
	How many wood processing clusters located within an area of 1 -2 ha with a total processing capacity of more than 10 m^3 of wood/day	Cluster		
6	Agro-residues			
	6.1 Rice			
	Cultivation area	Ha		The total land area in commune/village for rice cultivation
	Sown area	ha		If rice is cultivated on the same land for 2 or 3 seasons in one year, the sown land is then 2 or 3 times higher than cultivated area
	Yield of paddy	t/ha/y		
	Number of crop seasons in one year			
	Proportion of rice residues for cooking and other purposes	%		Would be estimated by Respondent
	Total number of rice milling units in the communes/village	Unit		
	Maximum/average milling capacities	t/day/unit		
	Average operating time of rice milling units in one year	Days/y		
	For what rice husk produced from milling units is used?			
	The selling price at milling units	VND/kg		
	6.2.Corn			
	Cultivation area	Ha		
	Sown area	ha		If corn is cultivated on the same land for 2 or 3 seasons in one year, the sown land is then 2 or 3 times higher than cultivated area
	Yield of corn	t/ha/y		
	Number of crop seasons in one year			
	Duration of harvesting time in one year	Days/y		
	The fraction of maize stalk collected to home?	%		

	Are there any maize processing units existing in your commune/village which has corn cob as a residue from processing and concentrated at site?			
	If there are such processing units with concentrated corn cob, please indicate how many they are and list the names of the biggest processing units and their capacities in the following: . 1) …………………………………….. 2) …………………………………….. 3) ……………………………………	Unit		
		T corn grain/day		
	Average operating time of maize processing units	Hour/year		
	6.3. Peanut			
	Cultivation area	Ha		
	Sown area	ha		If it is cultivated on the same land for 2 or 3 seasons in one year, the sown land is then 2 or 3 times higher than cultivated area
	Yield of groundnut	t/ha/y		
	Number of crop seasons in one year			
	Duration of harvesting time in one year	Days/y		
	The fraction of peanut stalk collected to home?	%		
	Are there any peanut processing units existing in your commune/village which has shell as a residue from processing and concentrated at site?			
	If there are such processing units with concentrated nutshell exist, please indicate how many they are and list the names of the biggest processing units and their capacity.	Unit		
	6.4. Sugar cane			
	Cultivation area	Ha		
	Sown area	ha		If it is cultivated on the same land for 2 or 3 seasons in one year, the sown land is then 2 or 3 times higher than cultivated

				area
	Yield of sugar cane	t/ha/y		
	Number of crop seasons in one year			
	Do small scale sugar production units exist in your commune/villages?			
	If sugar production units do exist, please indicate how many they are and list the names of the biggest processing units and their capacity	Unit		
	If yes, please tell us what is their capacity?	Tone of cane/day		
	Average operating time of sugar production units in one year	Days/year		
	6.5. Acacia			
	Cultivation area	Ha		
	Yield of acacia	t/ha/y		
	Number of crop seasons in one year			
	Do small scale acacia processing units exist in your commune/villages?			
	If acacia processing units do exist, please indicate how many they are and list the names of the biggest processing units and their capacity	Unit		
	If yes, please tell us what is their capacity?	Tone of acacia/day		
	6.6. Coffee			
	Cultivation area	Ha		
	Yield of coffee	t/ha/y		
	Number of crop seasons in one year			
	Harvesting duration in one year	Days/y		
	Do coffee processing units which has coffee husk as a residue from processing and concentrated at site exist in your commune/village?			
	If such processing units with concentrated coffee husk do exist, please indicate how many they are and list the names of the biggest processing units and	Unit		

	their capacity.			
	If yes, please tell us what is their capacity?	Tone of coffee/day		
	6.7. Others (please specify)			
	Cultivation area	Ha		
	Yield of this agro-product	t/ha/y		
	Number of crop seasons in one year			
	Harvesting duration in one year	Days/y		
	Number of processing units for this agro-product			
	List some of the biggest units existing in the commune/village and their capacity.	Unit		
	Operation duration of these processing units in one year	Days/year		
II	**Information on availability of manure in commune/village**			
1	Pig			
	Total number of pigs in the commune/village	heads		
	Average live weight	Kg/head		
	Local pig raising habit (raising in a pigsty or in the garden)			
	The number of households raising more than 10 pigs at the same time	HH		
	The number of household clusters living within an area of 1 hectare and are raising totally 50 – 100 pigs.	HH		
2	Cattle (cow or buffalo)			
	Total number of cattle in the commune/village	head		
	Average live weight	Kg/head		
	Local cattle raising habit (raising in a stable or in the forest)			
	The number of households raising more than 5 cattle at the same time	HH		
	The number of household clusters living within 1 hectare and raising totally 25 – 50 cattle?	HH		
III	**Information on availability of residential residues in commune/village**			
	Is there any landfill point in the			

	commune/village?			
	If yes, how much the waste is collected annually?	t/y		This data may be provided by the people doing sanitation works of the commune/village
	What is the fraction of residual residues in the commune/village are collected and brought to the common landfill point?	%		
IV	**Information on commercialisation of biomass/biogas fuel**			
1	Firewood			
	Retail price of the market	VND/t (m^3)		All these data may be indicated by a range of values.
	Retail price of the end user	VND/t (m^3)		
	Wood transportation cost in the commune/village	VND/t (m^3)		
2	Rice husk			
	Retail price of the market	VND/t (m^3)		All these data may be indicated by a range of values.
	Retail price of the end user	VND/t (m^3)		
	Wood transportation cost in the commune/village	VND/t (m^3)		
	How is rice husk currently used in at site?			
	Maximum quantity which could be supplied to end-users for one point of time	Tone/time		
3	Sawdust (or woodchip)			
	Retail price of the market	VND/t (m^3)		All these data may be indicated by a range of values.
	Retail price of the end user	VND/t (m^3)		
	Wood transportation cost in the commune/village	VND/t (m^3)		
	How is sawdust currently used in at site?			
	Maximum quantity which could be supplied to end-users for one point of time	Tone/time		
4	Others (please identify)			
	Retail price of the market	VND/t (m^3)		All these data may be indicated by a range of values.
	Retail price of the end user	VND/t (m^3)		
	Wood transportation cost in the commune/village	VND/t (m^3)		
	Maximum quantity which could be supplied to end-users for one point of time	Tone/time		

Date:…………………………..

Interviewer (Sign, name)

Respondent (Sign, name)

ANNEX 4 – Energy use household Questionnaire

Checklist questions for households

<table>
<tr><th>No</th><th>Questions</th><th>Answer</th></tr>
<tr><td>I</td><td>Respondent information</td><td></td></tr>
<tr><td>1</td><td>Name of respondent</td><td></td></tr>
<tr><td>2</td><td>Sex and age</td><td>☐ Male
☐ Female
Age……………..</td></tr>
<tr><td>3</td><td>Address</td><td></td></tr>
<tr><td>4</td><td>Your position in commune/village</td><td></td></tr>
<tr><td>5</td><td>Your professional</td><td></td></tr>
<tr><td>II</td><td>Household information</td><td></td></tr>
<tr><td>1</td><td>How many people are there in your household?</td><td></td></tr>
<tr><td>2</td><td>Do you use electricity now?</td><td>☐ Yes
☐ No
If yes, please go to 3-7
If no, please go to 8-9</td></tr>
<tr><td>3</td><td>What kind of electricity do you use?</td><td>☐ From pico/or mini hydro power
☐ From solar modules
☐ From wind turbines
☐ From gasoline or diesel engine
☐ From other sources, please specify…………</td></tr>
<tr><td>4</td><td>Is the electricity from above source stable and enough for use?</td><td>☐ Yes
☐ No</td></tr>
<tr><td>5</td><td>For what the electricity is used in your household?</td><td>☐ Lighting
☐ TV& radio running
☐ Electric fan
☐ Pumping
☐ Cooking
☐ Rice milling
☐ Processing of other crops (specify name…………………….…………)
☐ Wood processing
☐ Ice making
☐ Others, identify…………………………………</td></tr>
<tr><td>6</td><td>How is the required capacity for your electric appliances?</td><td>Electric appliances of households
<table>
<tr><td rowspan="2">Appliances</td><td rowspan="2">Required electric capacity (W)</td><td colspan="2">Estimated duration of use</td></tr>
<tr><td>Hours/day</td><td>Days/year</td></tr>
<tr><td>1.</td><td></td><td></td><td></td></tr>
<tr><td>2.</td><td></td><td></td><td></td></tr>
<tr><td>3.</td><td></td><td></td><td></td></tr>
<tr><td>4.</td><td></td><td></td><td></td></tr>
<tr><td>5.</td><td></td><td></td><td></td></tr>
<tr><td>6.</td><td></td><td></td><td></td></tr>
<tr><td>7.</td><td></td><td></td><td></td></tr>
<tr><td>8.</td><td></td><td></td><td></td></tr>
<tr><td>9.</td><td></td><td></td><td></td></tr>
<tr><td>10.</td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>7</td><td>How much money do you have to pay</td><td>…………………………(VND/month)</td></tr>
</table>

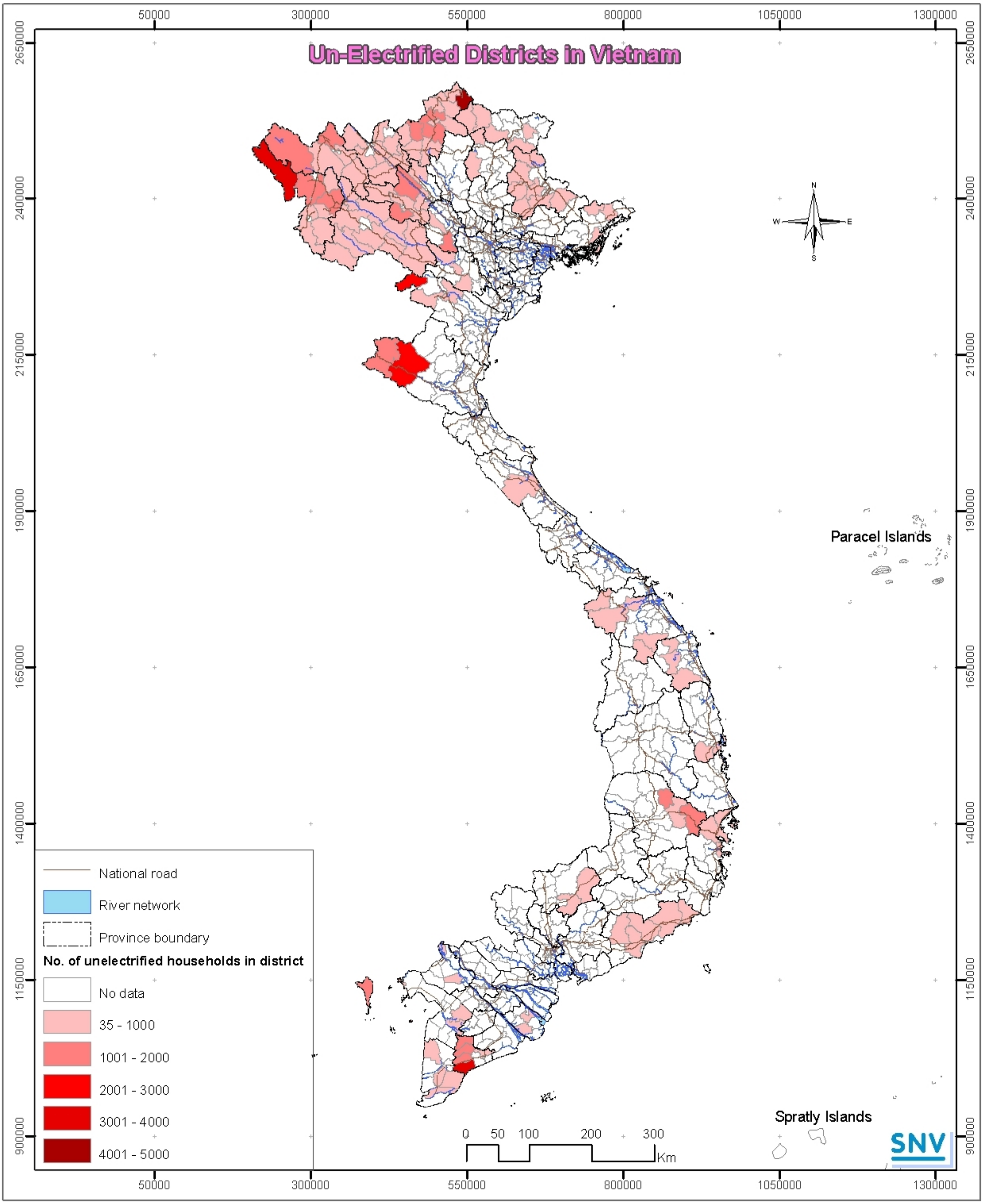
<table>
<tr><td></td><td>for the electricity now?</td><td></td></tr>
<tr><td>8</td><td>If you have no access to the electricity what kind of energy are you using now?</td><td></td></tr>
<tr><td>9</td><td>What is the energy price?</td><td>……………………VND/litter (kg)</td></tr>
<tr><td>10</td><td>Are you willing to use electricity from new bio power plant?</td><td>☐ Yes
☐ No
If yes, please go to the next question (11-13)
If no, please give us your reason…………………………………………….</td></tr>
<tr><td>11</td><td>What purpose do you want to use the bio electricity for?</td><td>☐ Lighting
☐ TV& radio running
☐ Electric fan
☐ Pumping
☐ Cooking
☐ Rice milling
☐ Processing of other crops (specify name……………………….………….)
☐ Wood processing
☐ Ice making
☐ Others, identify………………………………….</td></tr>
<tr><td>12</td><td>How much are you able to pay for <u>bio electricity</u> in one month?</td><td>………………………(VND/month)</td></tr>
<tr><td>13</td><td>Could you please tell us what your ability to pay for bio electricity used for different purpose?</td><td>Ability of households to pay for electricity
<table>
<tr><th>Use of electricity</th><th>Number of electric appliances used</th><th>Duration of use (hour/day) or (ton/day) with productive activity</th><th>Your ability to pay for electricity (VND/month)</th></tr>
<tr><td>1. Lighting</td><td></td><td></td><td></td></tr>
<tr><td>2.TV/radio</td><td></td><td></td><td></td></tr>
<tr><td>3.Electric fan</td><td></td><td></td><td></td></tr>
<tr><td>4.Air conditioner</td><td></td><td></td><td></td></tr>
<tr><td>5.Refrigerator (ice-box)</td><td></td><td></td><td></td></tr>
<tr><td>6.Elecric cooker</td><td></td><td></td><td></td></tr>
<tr><td>7.Water pumping</td><td></td><td></td><td></td></tr>
<tr><td>8.Rice milling</td><td></td><td></td><td></td></tr>
<tr><td>9. Ice making</td><td></td><td></td><td></td></tr>
<tr><td>10. Others, specify</td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>14</td><td>Do you expect to have the gird electricity?</td><td>☐ Yes
☐ No
If yes, please tell us why…………………………………………………………..</td></tr>
</table>

Date:…………………………..

Interviewer (Sign, name)

Respondent (Sign, name)

ANNEX 5 – GiS Maps


Un-Electrified Districts in Vietnam
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2400000
2150000
1900000
1650000
1400000
1150000
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N
W
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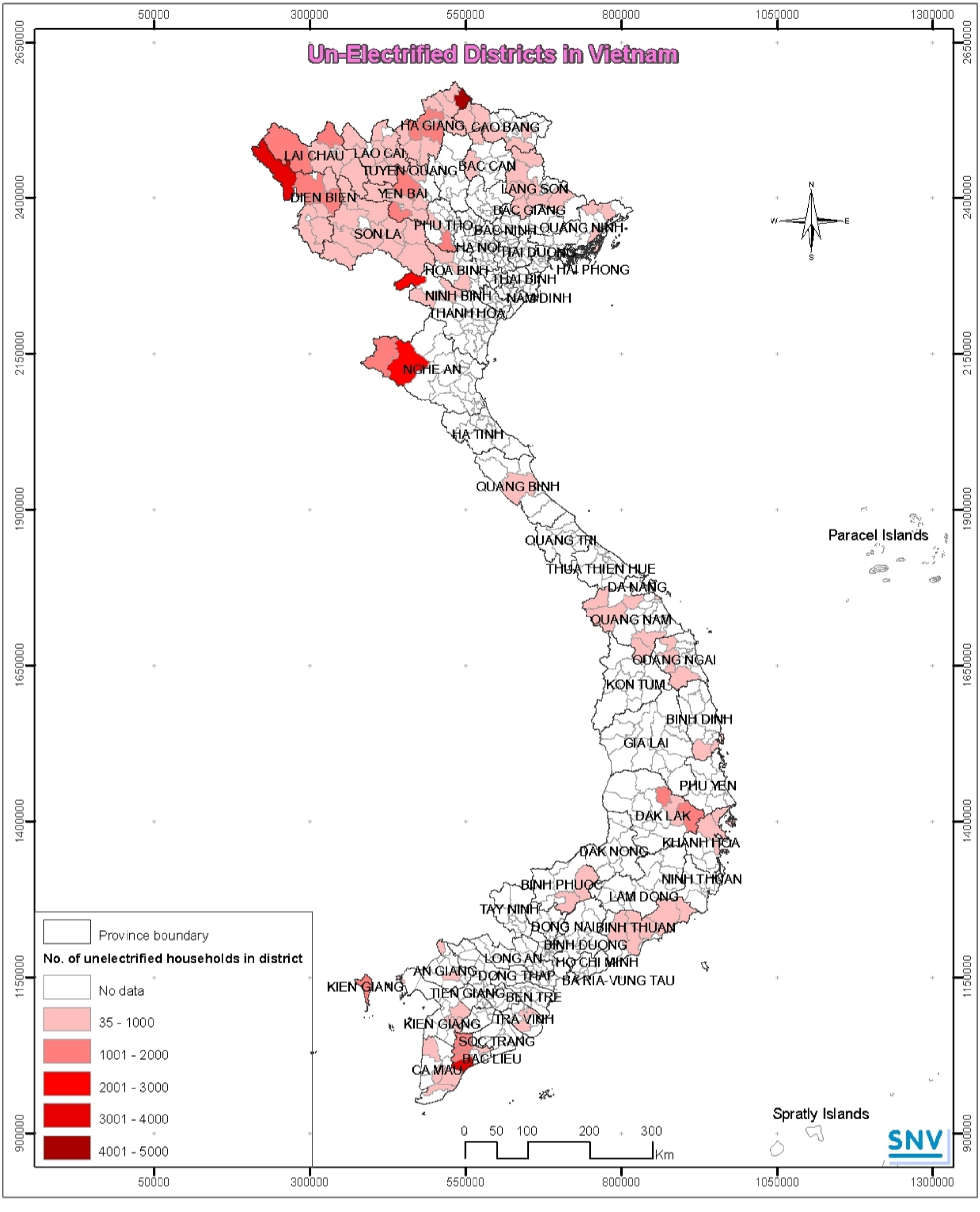
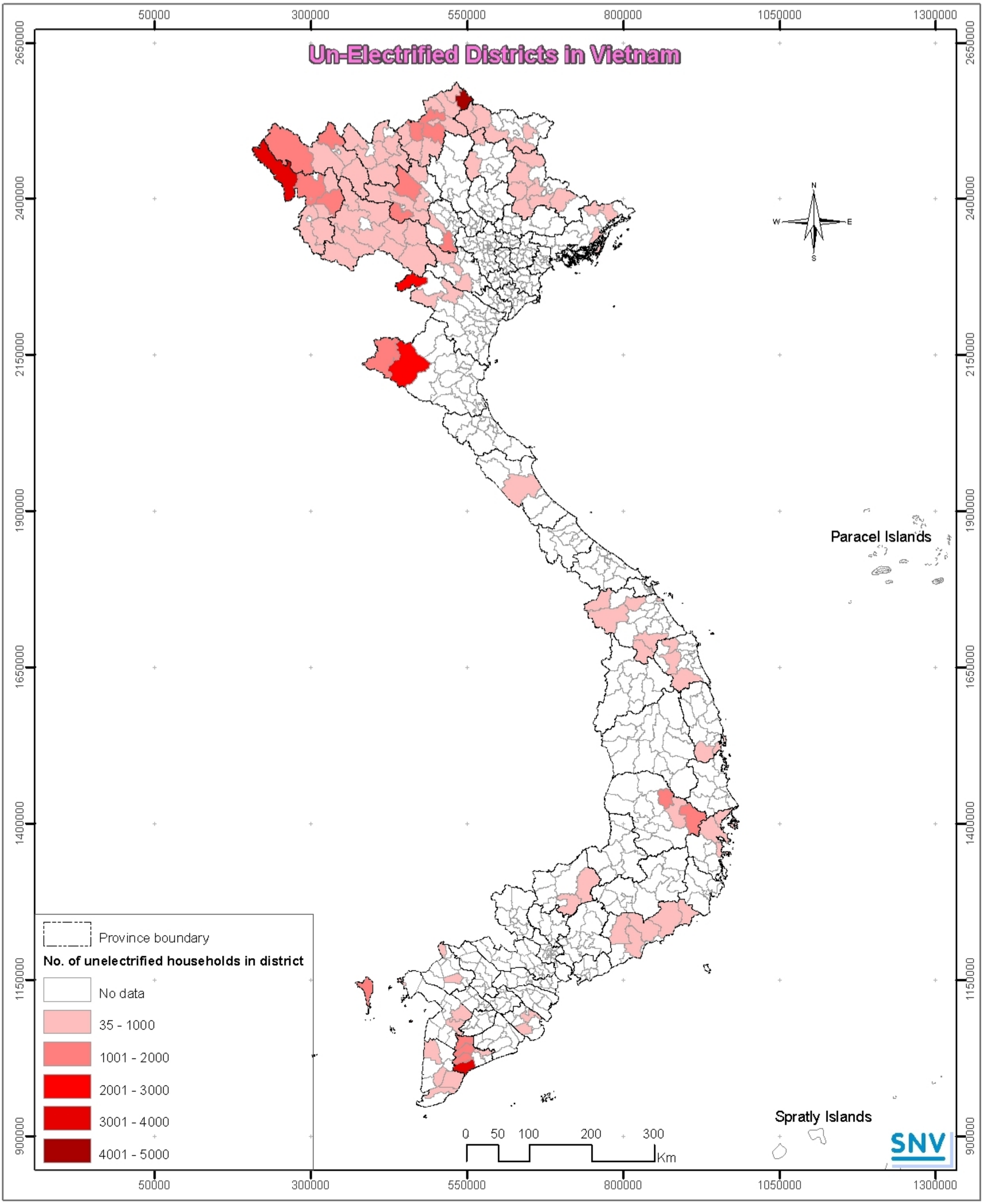
S
Paracel Islands
Spratly Islands
National road
River network
Province boundary
No. of unelectrified households in district
No data
35 - 1000
1001 - 2000
2001 - 3000
3001 - 4000
4001 - 5000
0
50
100
200
300
Km
SNV

Un-Electrified Districts in Vietnam




Un-Electrified Districts in Vietnam
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E
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Paracel Islands
Spratly Islands
Province boundary
No. of unelectrified households in district
No data
35 - 1000
1001 - 2000
2001 - 3000
3001 - 4000
4001 - 5000
0
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100
200
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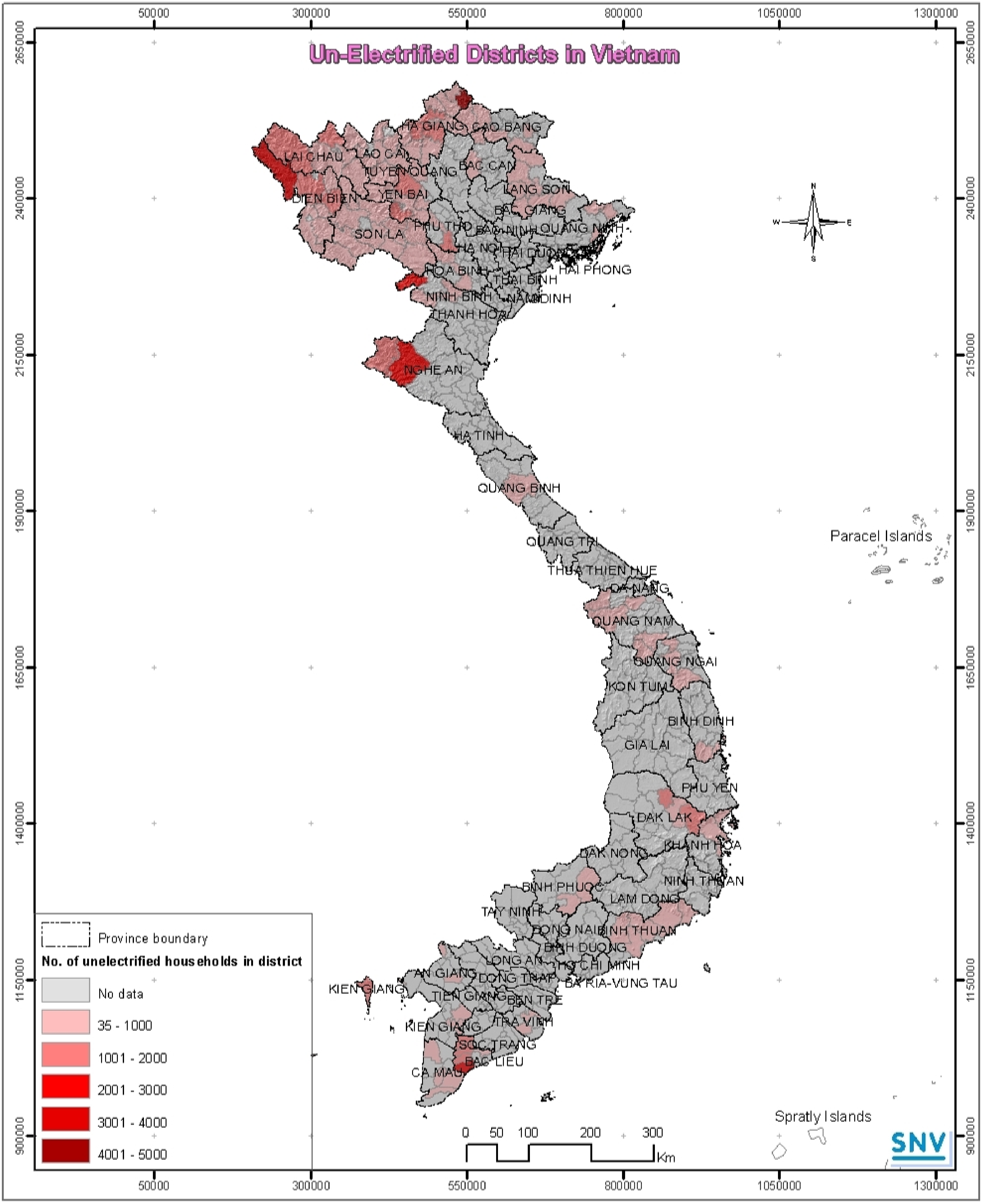
Km
SNV


Un-Electrified Districts in Vietnam
HA GIANG
CAO BANG
LAI CHAU
LAO CAI
TUYEN QUANG
BAC CAN
YEN BAI
DIEN BIEN
LANG SON
BAC GIANG
PHU THO
BAC NINH
QUANG NINH
SON LA
HA NOI
HAI DUONG
HAI PHONG
HOA BINH
THAI BINH
NINH BINH
NAM DINH
THANH HOA
NGHE AN
HA TINH
QUANG BINH
QUANG TRI
THUA THIEN HUE
DA NANG
QUANG NAM
QUANG NGAI
KON TUM
BINH DINH
GIA LAI
PHU YEN
DAK LAK
KHANH HOA
DAK NONG
BINH PHUOC
NINH THUAN
TAY NINH
LAM DONG
DONG NAI
BINH THUAN
BINH DUONG
LONG AN
AN GIANG
DONG THAP
HO CHI MINH
KIEN GIANG
BA RIA-VUNG TAU
TIEN GIANG
BEN TRE
TRA VINH
SOC TRANG
BAC LIEU
CA MAU
Paracel Islands
Spratly Islands
Province boundary
No. of unelectrified households in district
No data
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1001 - 2000
2001 - 3000
3001 - 4000
4001 - 5000
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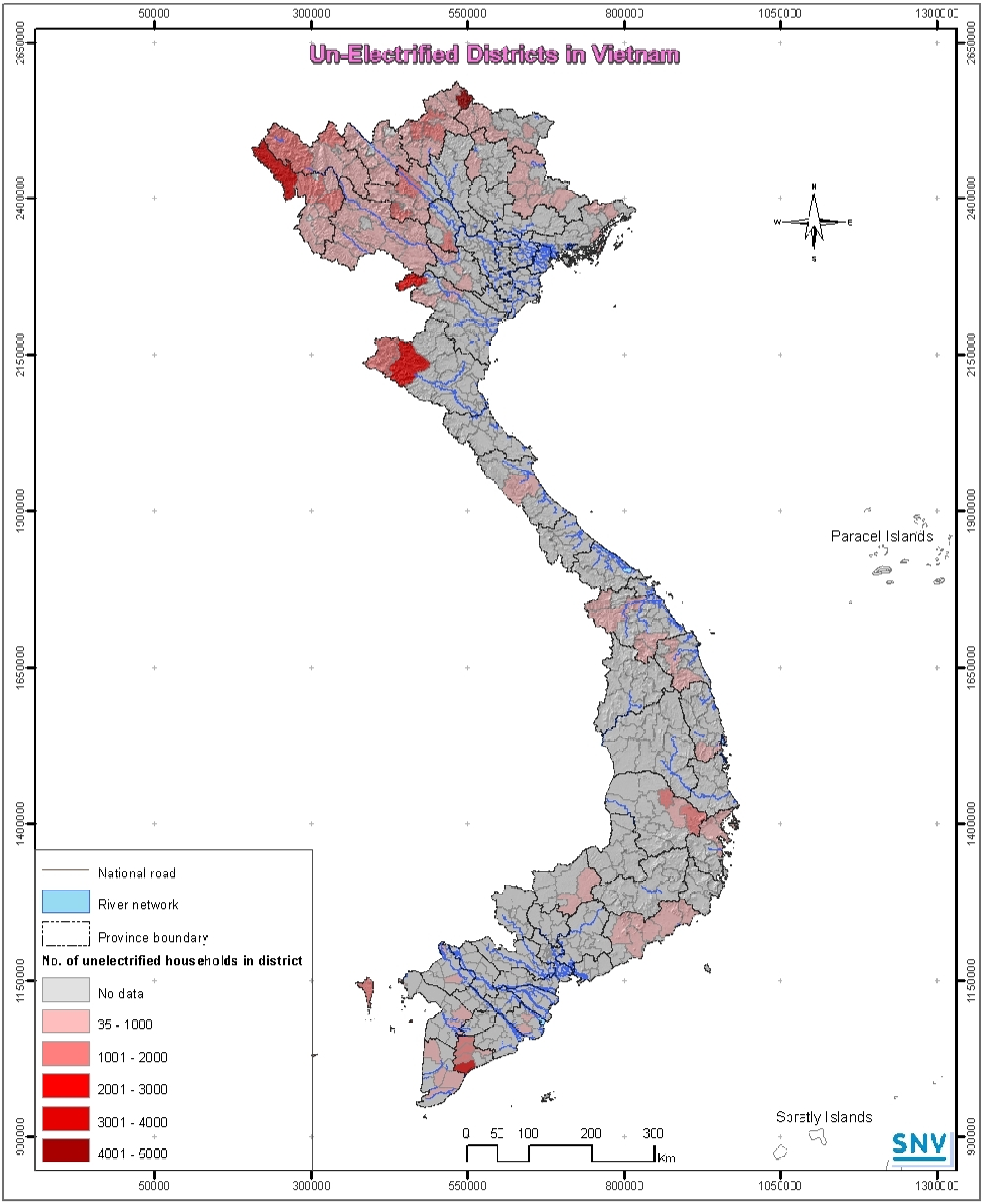
Km
SNV



Un-Electrified Districts in Vietnam
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Paracel Islands
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National road
River network
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No. of unelectrified households in district
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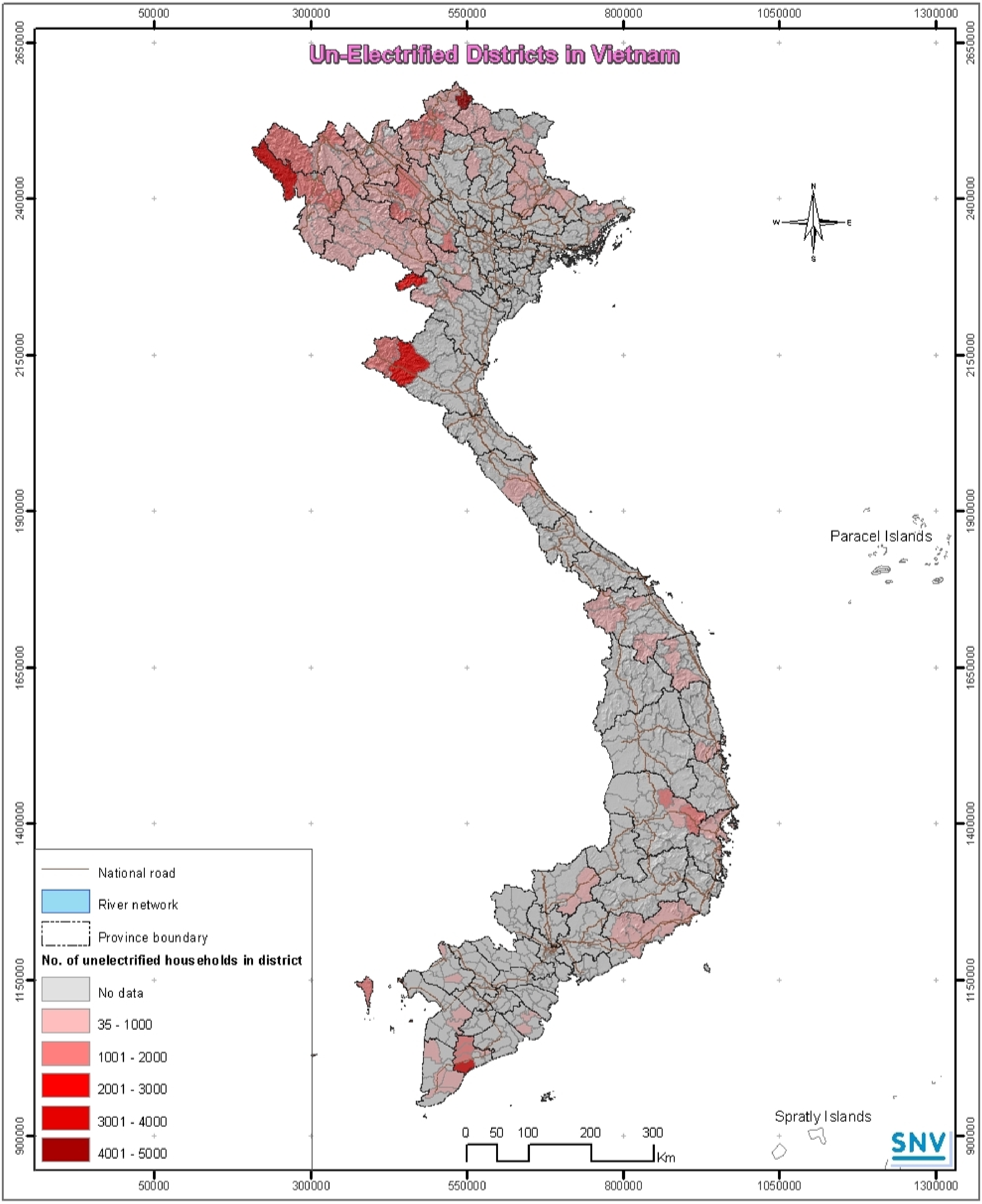
Un-Electrified Districts in Vietnam
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No. of unelectrified households in district
No data
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1001 - 2000
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4001 - 5000
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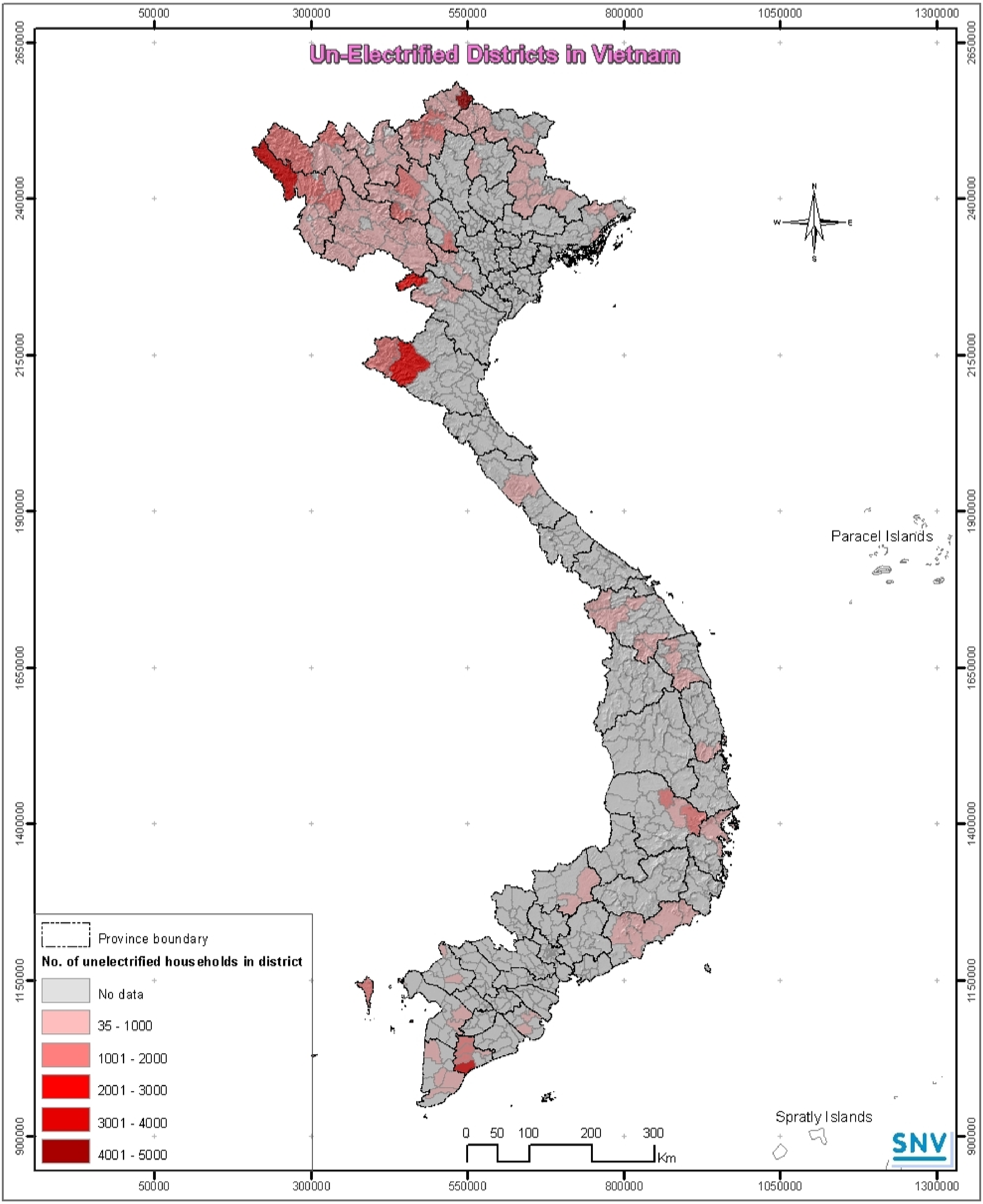
Km
SNV


Un-Electrified Districts in Vietnam
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1650000
1400000
1150000
900000
Paracel Islands
Spratly Islands
Province boundary
No. of unelectrified households in district
No data
35 - 1000
1001 - 2000
2001 - 3000
3001 - 4000
4001 - 5000
0
50
100
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300
Km
N
S
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W
SNV