Rural electrification, path dependence and energy alternatives for sustainable development in Vietnam

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Abstract

For two decades Vietnam has experienced substantial socio-economic development, being one of the fastest growing economies in Southeast Asia. In parallel the country made considerable efforts to electrify rural areas. Rural electrification is considered a major element of poverty reduction, sustainable livelihoods and rural development. Based on a methodology mix of data analysis and expert interviews this paper draws parallels between the successful rural electrification programmes and the major challenges arising from the chosen path. Involvement of major international donors and strong political commitment by the Vietnamese government initiated rural electrification through a grid extension scheme, starting a development, which boosted the household electrification rates from 2,5% in 1975 to 96.3% in 2009. Impact studies show that poverty in rural areas was reduced significantly and rural livelihoods were strengthened. In this respect the Vietnamese rural electrification programmes proved to be very successful, if not to be a showcase in rural electrification. Choosing grid extension for rural electrification was economically and technically feasible, but has left the country with certain substantial challenges for the power sector. The national power grid has to cover most of the national electricity needs now. New rural consumers, high rates of transmission losses, rapid economic development and increasing industrial needs for electricity put a strain on the available energy generation potentials. Large investments in grid extension limit the range of economically feasible decentralized alternatives for electricity generation and distribution. Governmental plans face this challenge with an extension of centralized fossil fuel utilization despite an enormous potential for renewable energy in Vietnam. Scenarios show that the Southeast Asian country will become a net energy importer. The domestic potentials of fossil energy carriers is not sufficient to cover the energy needs of the future. This would be contradictory to a sustainable socio-economic development based on sustainable energy supply. This path would be highly inefficient for sustainable development and is likely to eventually lead to an energy lock-in, leaving Vietnam being dependant on fossil fuels imported from other countries. Nevertheless, there are chances of escaping path dependence and an energy lock-in. This involves a multiplicity of elements in a comprehensive and all-embracing approach considering power demand and supply in conjunction with environmental sustainability. A market oriented power sector should

gradually abandon subsidies and consider externalities of energy carriers to create electricity tariffs reflecting realistic generation costs. This would boost cost-competitiveness of renewable energy technologies. However, dedicated support schemes for renewable energy projects in an integrated legal and institutional framework would be necessary. Support schemes for the rural poor need to secure the affordability of electricity and thus their livelihoods so that they are not sacrificed for market orientated tariffs. Furthermore Vietnam's abundance of small and medium renewable energy potentials provides major possibilities for decentralized electricity generation. A pragmatic change from largely centralized power generation towards the utilization of scattered power potentials provides major opportunities for the country to meet its future power needs without relying on fossil fuels.

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ADB	– Asian Development Bank
ASEAN	– Association of Southeast Asian Nations
CDM	– Clean Development Mechanism
DEG	– Decentralized Electricity Generation
DPC	– District Peoples Committee
EAP	– East Asia and Pacific Region
ERAV	– Electricity Regulatory Authority of Vietnam
EVN	– Electricity of Vietnam
GDP	– Gross Domestic Product
GIZ	– Deutsche Gesellschaft für Internationale Zusammenarbeit
GSO	– General Statistics Office of Vietnam
GWh	– Gigawatt hour
HDI	– Human Development Index
IDA	– International Development Association
IE	– Institute of Energy Vietnam
IoS	– Institute of Sociology
IMF	– International Monetary Fund
KfW	– Kreditanstalt für Wiederaufbau
ktoe	– Kilotons of Oil Equivalent
kV	– Kilovolt
kW	– Kilowatt
kWh	– Kilowatt hour
LDU	– Local Distribution Unit
LV	– Low-Voltage
MOIT	– Ministry of Industry and Trade
MV	– Medium-Voltage
MW	– Megawatt
NPT	– National Power Transmission Corporation
PC	– Power Company
PPC	– Provincial People Committee
PV	– Photovoltaic
RCEE	– Research Center for Energy and Environment

R&D	– Research and Development
RE	– Renewable Energy
REP	– Rural Energy Project (REP)
RE2	– Second Rural Energy Project
SHS	– Solar Home Systems
SHP	– Small Hydro Power
SNV	– Netherlands Development Organisation
SIDA	– Swedish International Development Agency
TWh	– Terawatt hour
VBARD	– Vietnam Bank for Agriculture and Rural Development
VND	– Vietnamese Dong
VNEEP	–Viet Nam National Energy Efficiency Program
VWU	– Vietnam Women's Union

1 Introduction

1.1 Motivation and objectives

Vietnam has made an astonishing development in the last decade. The country has shown extraordinary economic growth for the past years, attracting large foreign investments. From the debris of war and the tumble of strict socialism, the country is on the way to become an industrialized nation. Outclassing many other countries in Southeast Asia, the industrial sector superseded agriculture as the most important economic sector with no perspective of the development coming to a halt. The substantial development is reflected by Vietnam's efforts to electrify and develop the country and in particular the rural areas. The process and the success are well recognized among experts. Within little more than a decade most areas of the country got access to electricity, leaving only a fraction of the population in very remote regions without connection to the power grid. The rural development and the advancing industrialization of the country has changed the energy and electricity consumption patterns of Vietnam.

This paper aims to analyse whether the basis in terms of energy and electricity supply for Vietnam's socio-economic development is sustainable and thus lasting in the long run. A special focus is on the recent rural electrification programmes as they influence the further development of the power sector. The guiding questions are about what has been done, how it has been done and what the consequences are.

The basis is set by a description of the relation between access to electricity, rural and overall socio-economic development in the scope of sustainability. The analysis deals with the aspects, which are causal for the expeditious progress in rural electrification and elaborates the challenges that accrue from this in terms of future electricity supply and consumption patterns on the background of the overall situation and prospects of the Vietnamese energy sector. Special attention is given to the current energy mix, the future energy strategy as well as the legal and institutional framework. This paper draws a link between the rural electrification and the overall energy situation in Vietnam, asking whether any specific consequences from the development in rural electrification arise for the Vietnamese power sector. In this respect the thesis utilizes the concept of path dependence to illustrate the consequences of rural electrification in Vietnam.

Finally, options for overcoming specific challenges und thus altering the path will be pointed out in order to create favourable conditions for sustainable energy security. The aspect of sustainability plays a vital role. Sustainable rural and overall development by means of electrification needs a sustainable basis. The analysis puts a special focus on the role of renewable energy technologies as for they are a crucial element of sustainable development and energy security.

For the research I undertook a three and a half months study period in the Vietnamese capital of Hanoi embedded in the "wind energy" project of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), which is working on the promotion of renewable energy in Vietnam.

1.2 Structure and composition

After describing the research fundamentals and methods, general interdependencies between energy or electricity and sustainable socio-economic development are outlined. To provide a basis for the research parameter, the paper first introduces the reader to the scope and the interdependencies of energy and development in general and rural electrification and rural development in particular. Accordingly, the current state of knowledge of how access to energy or electricity has an impact on poverty, income and quality of life in general and in the specific case of rural communities is described. In this respect special attention is given to the clarification of the aspect of sustainability. Before proceeding to the developments of rural electrification in Vietnam, the energy background of the country is reconsidered in the context of the rich and troublesome socio-economic history of the country. Taken into account is the energy supply and demand as well as the institutional organization of the energy and electricity sector, energy mix and the future prospects and plans in energy policy. This is necessary in order to understand the rural electrification process Vietnam has followed in the past decades. Details of how Vietnam electrified its rural regions and which impacts it had on rural people and society are given thereafter.

The findings form the basis for a range of expert interviews, which are aimed to provide information about the crucial factors in the success of rural electrification in Vietnam and the resulting challenges for the power sector. The information gathered through the interviews adds a subjective contribution to the hard facts that can be found in the concluding reports and data. The outcome of these interviews is then put into context with the data and findings from literature and data research, leading towards the concept of path dependence. Specific path dependence for the Vietnamese energy sector is shown and the potential inefficiencies are discussed. The possibilities of altering the path are agued thereafter with special reference to the grid extension and decentralized electricity generation from renewable energy sources. Eventually, the possibilities for further research are discussed to encourage others to further follow and analyse the challenges, risks, chances and necessities for the Vietnamese energy sector.

2 Methodological approach

To investigate the crucial factors of success and challenges of rural electrification on the background of the whole power sector in Vietnam, a combination of methods is applied to make use of a multitude of sources for information. A combined use of data, literature and results from expert interviews offers a broad basis for relevant information.

2.1 Literature and data analysis

Rural electrification is a classic topic in the scope of socio-economic development and has been widely discussed for decades. Thanks to enormous developments in rural electrification across the globe in recent years, an abundance of project reports and evaluations of rural electrification projects from various countries are in existence. They cover technical aspects as well as institutional matters and welfare impacts. This proved to be a good basis for assessing the situation and the circumstances of the Vietnamese rural electrification. In the specific case of Vietnam, major electrification projects have been finalized and evaluated or an evaluation of subprojects or projects in mid-term has been done. Thanks to this, the amount of literature to be found regarding rural electrification in Vietnam is quite abundant giving a rather comprehensive overview regarding the situation before and after electrification. In general literature on sustainable energy was widely available, however data was more limited regarding Vietnam. This literature covers resource potentials as well as socio-economic implications and climate related issues.

Appropriate tools for search and metasearch were the *Web of Knowledge* and *Google scholar*. These tools acted as gateways to comprehensive journal articles, reports and books. Journal articles on the energy-development nexus, rural electrification, sustainable energy and other related topics such as reports of contributors or stakeholders in rural electrification process in Vietnam comprised the major source of information. However, a substantial proportion of this literature was only detected during my study period in Hanoi and often provided by colleagues and people engaged in energy and electrification related projects. Furthermore the pace of Vietnam's development soon outdated some Vietnam-specific articles or reports, which posed a challenge to always have access to the most recent publications. Consequently the review of literature could have not been so comprehensive without the stay in Vietnam. The duration of about three and a half months was favourable as some reports and other literature were sometimes difficult to obtain.

Appropriate datasets in the scope of electricity, energy and socio-economic aspects in Vietnam were indispensible for this thesis. In order to clarify the energy situation in Vietnam and identify causalities, data and the correlation of several datasets was important. For analysing the situation in regards of rural electrification in Vietnam, data was collected about electrification rates, electricity consumption and generation, energy mix as well as socio-economic data like development of the Gross Domestic Product (GDP), the Human Development Index and population growth and distribution. The availability of data was generally good and the World Bank databank as well as the United Nations databank *UNdata* proved to be the most comprehensive sources for data of this kind. Considering the broad acceptance and use of World Bank and UN data, the datasets can be considered reliable in the scope of this thesis. Furthermore, data from the General Statistics Office of Vietnam (GSO) was also taken into account for some macro-economic figures. Some information contained in this thesis was derived from data and estimates from Electricity of Vietnam (EVN) found in the literature, as for access to primary EVN data was restricted. This is mainly the case for data on rural electrification and general electrification rates. For some early years reliable data is missing, forcing even EVN to estimate figures. In particular data about household and commune electrification rates have thus to be treated with care, because sometimes data simply referred to as "electrification rate" is not specified further as household or commune rates. Secondary data was used from a number of articles and reports, especially regarding the Power Development Master Plan as for data about power planning was not directly accessible. The collected data was used to clarify conditions and causalities, sometimes shown in graphs giving informative overviews.

2.2 Expert interviews

2.2.1 The benefit of expert interviews

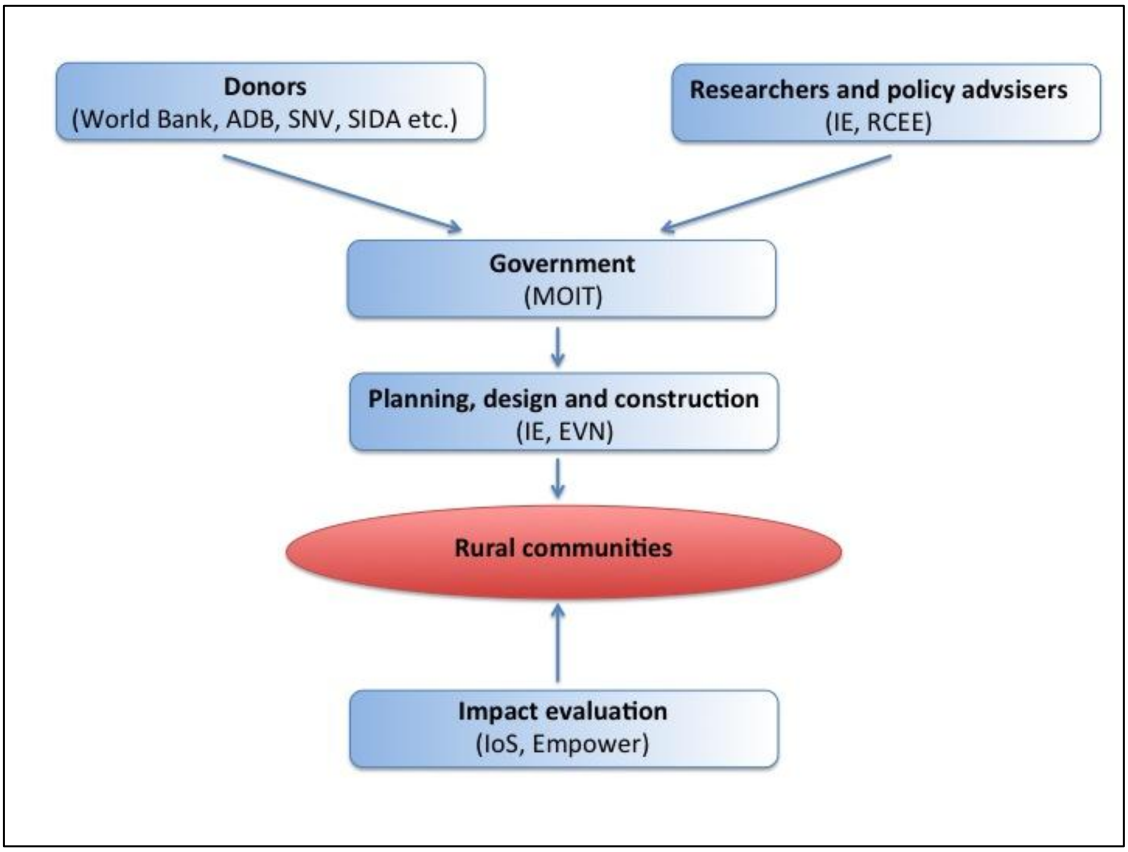
During the stay in Hanoi, several expert interviews were conducted with people involved in the scope of rural electrification, the energy sector and energy development in Vietnam. Even though expert interviews are somewhat considered a soft asset of data, the benefit of interviews as a research method is valuable. Interviews with experts provide a chance to make tacit knowledge explicit, ergo to provide information unavailable in the existing literature or in other explicit sources. Hence, interviews create new additional knowledge and add a subjective view to the topic (FLICK, 2009: 155). This seems plausible given the fact that until now there has been little differentiated information regarding the critical factors and contributors of the Vietnamese success in rural electrification and the resulting challenges for the Vietnamese power sector. This method provides the chance of aspects to pop up that often submerge under piles of charts, numbers and data, when analysing so called hard facts. Interviews are even capable of verifying data and can help to interpret data in a certain context. Eventually, the results from expert interviews in combination with a comprehensive set of data, reports and further literature make for a well-rounded research. However, there are limits to this method as it is subject to interpretations (FLICK, 2009; 160). Thus care needs to be taken, when applying outcomes of interviews, putting them into context and crosschecking them with data and literature. The specific added value of expert interviews in the scope of rural electrification is to analyse whether perceptions of the success and the challenges of rural electrification and the power sector differ or whether there is a common understanding on certain topics. Naturally, when it comes to the future challenges, experts with different backgrounds might focus on different aspects and have beliefs, opinions or perceptions of importance of certain aspects. This provides a comprehensive picture of the range of challenges. Consequently, the aim of the interviews in conjunction with data and findings in literature is to draw a comprehensive picture of which aspects were crucial for the success of rural electrification in Vietnam and which challenges the development poses to the Vietnamese power sector.

2.2.2 The expert group

The first challenge of the interviewer is to identify an expert. Regarding experts, the question needs to be answered, who actually is an expert in this context. A general definition is somewhat inappropriate and hardly possible, because the term expert is very blurry and often based on soft facts. It does not depend on a certain graduation or title, but rather on the experience and background of a person relevant for the scope of the topic. Thus, one can denote those persons as experts, who are particularly competent on a certain topic (FLICK, 2009: 165-166). The status of an expert, being a source of information in an interview is naturally granted by the researcher, considering people that are able to give valuable input from their very specific background, which might not be accessible by everyone. They are involved in the context of actions related to the field of study in various roles (NAGEL AND MEUSER, 2005: 73; ULLRICH, 2006: 102). In the context of this paper this was done by identifying persons, who are or were involved in or are familiar with rural electrification projects or the power sector in Vietnam, regardless of the role they fulfil to gain a multitude of views.

The search for interview partners started in Germany with an analysis of literature. Some authors of relevant articles that are based in Hanoi were targeted as interview partners. At least two experts were eventually identified from literature analysis (experts 2 and 8; see Appendix B). After arrival in Hanoi a detailed insight into the political, professional and personal network in the field of energy within the country was possible. Access to key documents, such as reports and guidelines was another important aspect of extensive research. The final identification of the stakeholders in rural electrification was conducted through a process model (see Figure 2.1): The central government and provincial authorities define policies and targets, which correspond to the conditions of the donors and are advised by researchers and specialists. These targets and policies are to be converted into power development planning, which eventually results in the design and construction of the power network. Rural communities get access to electricity as an affected party and often maintain the low voltage lines (LV lines) leading to the communities and households from the last transformation station. Finally, an impact evaluation analyses the consequences of access to electrification within rural communities. Representative organizations for each function or role in the model were identified, resulting in a list of potential organizations that could be of interest (see Table 2.1). Interview partners within these organizations were identified by recommendations or project responsibilities derived from available organization charts. Local communities could not be targeted as interview partners due to various reasons: Mostly there were either no established contacts within local communities or authority approval was required to visit and interview community members, which could not be obtained. These constraints thus made interviews in an appropriate frame impossible. The targeted organizations were approached via email, telephone or introduction through colleagues in the GIZ "wind energy" project.

Figure 2.1: Stakeholders in rural electrification in Vietnam.



Source: Own graphic.

Interview agreements could not be reached with some institutions for various reasons. For instance, introduction and authorization to visit the provincial or district people committees was needed for a visit. This is due to the complicated political and administrative procedures in Vietnam. As for this thesis was not part of a bigger project of the major donors or development agencies in the country, an authorization could not be attained and even other ways of seeking contact proved to be unsuccessful. The Swedish International Development Agency (SIDA), a major player in the field of rural electrification in Vietnam, had finalized its projects in rural electrification and the staff involved had since taken assignments in other countries. Contact with experts from the national electricity provider Electricity of Vietnam (EVN) could not be established due to missing feedback on emails, phone calls and other approaches. The Vietnamese Ministry of Industry and Trade (MOIT) responded with a short written statement mostly referring to a World Bank report on rural electrification and giving only very few answers. Nevertheless, these responses were taken into account, thus the MOIT respondent is listed as one of the experts. The constraints in terms of time, availability or changed responsibilities eventually reduced the group of actually interviewed experts to ten, originating from eight organizations (see Table 2.1).

Table 2.1: List of organizations targeted for interviews.

Organization	Category	Contact established and agreement for interview
Ministry of Industry and Trade (MOIT)	Government	YES (limited)
Provincial peoples committee	Government	NO
Institute of Energy (IE)	Planning, design and construction	YES
Research Centre for Energy and Environment (RCEE)	Planning, design and construction	YES
Electricity of Vietnam (EVN)	Planning, design and construction	NO
PECC 1-4 (Power Engineering Consulting Companies)	Planning, design and construction	YES
World Bank	Donor	YES
Asian Development Bank (ADB)	Donor	YES
Swedish International Development Agency (SIDA)	Donor	NO
Netherlands Development Organisation (SNV)	Donor	YES
Kreditanstalt für Wiederaufbau (KfW)	Donor	YES
Institute of Sociology (IoS)/Empower	Impact evaluation	YES

Source: Own table.

Most of the interviews were conducted in a personal meeting. However, certain constraints lead to some interviews being either held via Skype (interview partner in New Zealand) or submitted as written questionnaires due to tight schedules or hearing impairment. All personal interviews as well as the Skype interviews were recorded, which ensured that no information got lost due to missing notes and made the transcription and analysis of the responses less difficult. The duration of an interview lasted between 40 and 75 minutes.

All identified persons are involved in rural electrification and power sector development. Four experts are or were involved in planning, design and construction, which mainly consisted of long-term power planning and project implementation following government policies and targets. Their work is mostly funded by the government and sometimes by private investors in energy infrastructure. International donors are well-represented with representatives of the biggest donor organisations World Bank and

Asian Development Bank as well as the German Kreditanstalt für Wiederaufbau (KfW) and the Netherlands Development Cooperation (SNV). However, the scope of their work varies. The World Bank's representative confirmed the leading involvement in rural electrification on a large and multi-sectoral scale. The scope of their work embraces rural electrification over a long-term with a focus on the poorer and less electrified provinces as well as network rehabilitation and management improvement. The latter resulted in a top-down management with most responsibilities in rural electrification being centralized since 2009. The KfW shares the scope of network rehabilitation with all their loans being bound to an environmental benefit. The rehabilitation of the network aims to reduce transmission losses and support energy efficiency. Loans and assistance from the Asian Development Bank (ADB) cover the development of mini-hydropower as well as grid extension in remote regions (see Appendix B: Table 1). All these interview partners work in an environment with multiple stakeholders such as the government, which plays a central role, EVN and its regional branches, the donors, and the population, which highlights with multilateral nature of rural electrification. Expert 8, who is working for SNV now was formally involved in impact evaluation as was expert 9, who is an expert from a New Zealand company cooperating with the Institute of Sociology in one of the most comprehensive studies about impacts of rural electrification that has been done to date.

This selection of experts, who have actually been interviewed, can be considered a rich source of information and give comprehensive insight into rural electrification in Vietnam. However, there are limits to the overall balance of experts as representatives of the government, the national electricity provider EVN, the consumers and local people were not available for an interview and the Ministry of Industry and Trade offered only short statements. This needs to be taken into account, when evaluating the outcome of the interviews and the results of the study.

2.2.3 Interview design and processing

Regarding the interview design and processing there is no general consensus on how an expert interview should be conducted, since no clear definition of an expert interview can be found in the existing literature. This is not surprising, considering that interviews have different aims depending on the research. Nevertheless, an interview guideline is important in order to focus the discussion and to not deviate from the topic (NAGEL AND

MEUSER, 2005: 78). The aim of this study is to gather knowledge about the crucial factors for success of the Vietnamese rural electrification and its implications on challenges in future energy policy. A semi-structured interview was considered most appropriate with questions of relatively broad scope followed by more detailed questions in order not to handicap the interviewees in their range of possible responses, but still retain focus on the topic. This principle allows responses and aspects to come up, which might have been not considered before (HOPF, 1978: 99). The design of the interview guideline aims to approach the topic of rural electrification logically and go into more detail regarding the factors for success, crucial contributors and future implications and challenges, aiming specifically at the aspect of sustainability. The interview guideline consists of five main questions:

- In which way are or were you involved in rural electrification in Vietnam?
- What do you think are the main benefits of the rural electrification process for Vietnam?
- What were the crucial aspects of Vietnam's success in rural electrification?
- Who or which institutions were the main contributors to the successful rural electrification and why?
- What are the challenges imposed by the successful electrification of Vietnam?

Each of these questions contains several sub questions going into more detail (for the complete questionnaire see Appendix A: Interview guideline). For a comprehensive set of information and the appropriate evaluation of the responses, the interview partners were asked to describe their role in the scope of rural electrification in Vietnam to verify their allocation towards a group. On this background they were asked to include their view on who were the main beneficiaries, the crucial aspects of success and the main drivers of the rural electrification process in Vietnam. Having received responses regarding the factors of success in the past, the next part of the questionnaire was aimed at learning about the interview partner's opinion regarding the future implications of Vietnam's recent development in terms of energy and rural electrification. They were specifically asked, whether the development poses a risk or challenge to Vietnam in terms of energy security and environmental sustainability. The concluding questions asked about significance of the increasing demand for electricity due to successful rural electrification for the overall energy strategy in Vietnam and how this will be covered on the background of ending resources, climate change and environmental degradation. While conducting the interviews sometimes conversations came up besides the questions creating even more valuable input initially not targeted by the interview guideline. The course of an interview depends on, among other factors, the situation, the surroundings and people's comfort and mood (FLICK, 2009: 163, 172). Hence, the outcome of an interview needs to be evaluated considering the atmosphere, in which the interview was conducted. Most of the interview partners were Vietnamese (except two experts from the Netherlands and New Zealand) and fluent in English. Most of the interviews were conducted on the premises of the experts' organizations. Nevertheless the questionnaire was kept in the simplest possible wording. Clear terms and simple wording help to prevent misunderstandings from which the outcome of an interview could suffer (CLIFFORD ET AL., 2010: 79). An interview features the highest scientific value, when it is coded in an appropriate way (FLICK, 2009: 155). This allows filtering answers into analytic codes. For the interviews conducted the coding procedure presented by CLIFFORD ET AL. (2010: 440-452) was adapted. The demonstrative flow of the procedure is as follows:

Response → Condensation of response → Analytic generalization → Analytic code

First analytic generalizations were derived from the condensed experts' responses. These generalizations were market with a reference (e.g. E1Q5: expert one, quote 5). This mark allows tracing back the quotes to the corresponding expert in the course of the discussion in this paper. The analytic generalizations are the basis for the forming of analytic codes. These codes allow a categorization of the responses and generalizations. This is helpful, because similar statements are often framed by different wording by the different experts. The categorization merges similar statements with different wordings. It is furthermore an enabler to visualize the experts' perceptions in charts. An example of the coding procedure as it has been used in the processing of the interviews and as it can be found in the appendix is given in Table 2.2.

Table 2.2: Example of interview coding procedure.

Expert	Analytic generalizations	Analytic code
2	E2Q12: Government policies main drivers E2Q13: World Bank made progress more aggressive, because justification for funds	Government World Bank

Source: Own table, adapted from CLIFFORD ET AL., 2010: 448.

This procedure allows classification of the responses. All responses are condensed prior to applying analytic generalizations and analytic codes, which are then discussed in the scope of the topic. This way the interviewees' statements can be better put into a general analysis, covering the range of responses from all interview partners. For visualization the results of the analytic code analysis are mostly shown in a radar chart.

The results of the interview are then discussed and put into context with the aim of this thesis. They form the basis for the application of the concept of path dependence.

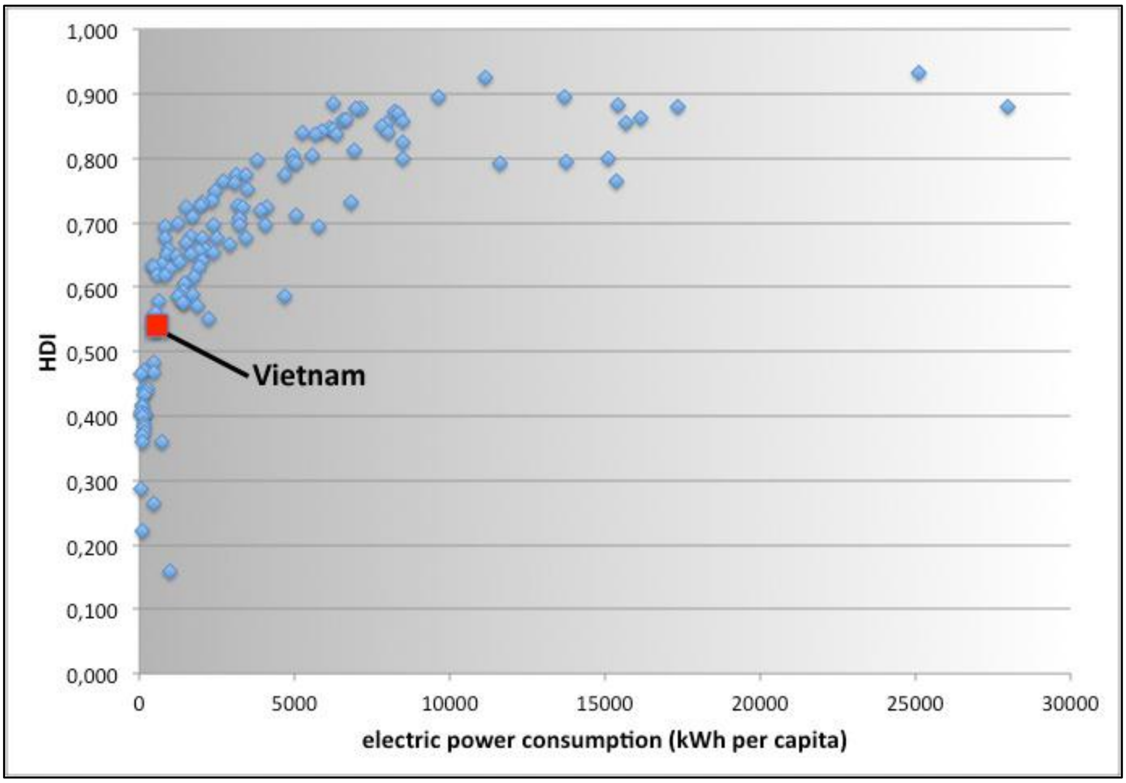
3 Energy and sustainable socio-economic development

3.1 The nexus between energy and development

Energy can be considered as the driving force and precondition for development. It is neither produced nor consumed. It is transformed. Consequently energy has a transformative character. This very basic scientific cognition can easily be applied in a broader sense. We need energy to move and to produce things. It is the enabler for change and transformation in economies and societies. Energy might even be considered the most-vital factor for socio-economic development (DAS, 2006: 1). Of course energy provision itself does not give valuable benefits. It needs to be utilized. With this conception in mind, a link between energy and development is evident. The fastest and easiest way to analyse the impact of energy supply and consumption on socio-economic development is to put it in context with the Gross Domestic Product (GDP) of a country. For a long time the GDP-energy nexus is a well-discussed phenomenon. A linkage between energy consumption and GDP is well established indeed and the existing literature on energy and economic development does indicate that both aspects are interlinked and that energy is of significant importance for broader development (JEMELKOVA AND TOMAN, 2003: 3-5). Taking into account historical developments, this is evident as BRUNE (1998: 54-56) stresses the parallelism of broad economic development and activity in regards to energy utilization. Nevertheless, GDP has only a limited expressiveness regarding the overall socio-economic situation of a nation. Not only do energy services provide an essential input to economic activity, they also contribute to social development by helping meeting human needs – factors generally not captured by GDP figures. Income generation itself cannot be considered a basic goal of socio-economic development, but rather progress in overall living conditions, namely social equality, health, education and beyond. In return, access to electricity itself, is not a basic need, but is an important element for providing these needs (GOLDEMBERG AND JOHANSON, 1995: 9-17).

Considering the weak expressiveness of the GDP in this context, the Human Development Index (HDI) seems to be more suitable to draw a general link between a country's energy use and socio-economic development. There is a very strong link between commercial and non-commercial per capita electricity consumption and the HDI for all countries (IEA, 2004: 334) (see Figure 3.1).

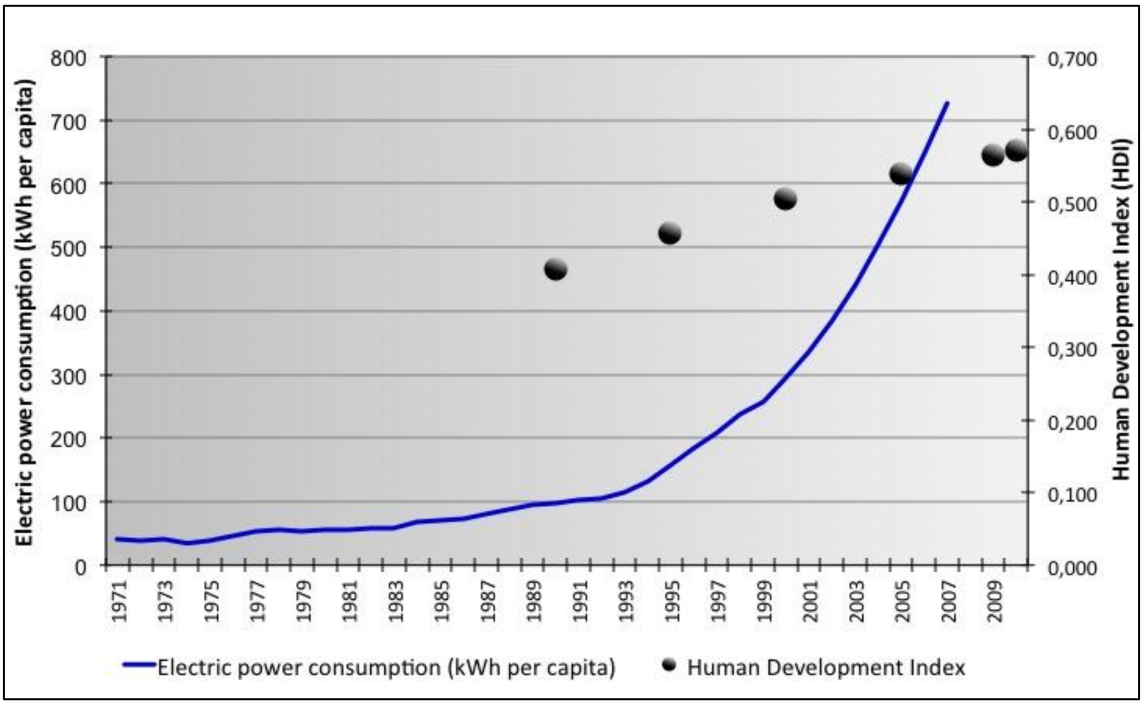
Figure 3.1: Parallelism of HDI and per capita electricity consumption across nations in 2005.



Source: Own graph, based on WORLD BANK, 2011 and UN, 2011.

By trend increased per capita electricity consumption correlates with an increased HDI. However, this correlation gradually weakens above a certain level of per capita income. Electricity consumption of more than 10.000 to 12.000 kWh per capita per year seems not to have a causal positive impact on human development. The historic development of Vietnam's Human Development Index (as of 2010: rank 113 with a HDI of 0,572) is no exception. Vietnam's per capita electricity consumption and the HDI development show parallel tendencies, indicating interdependencies (see Figure 3.2). However, again it is shown that increases in per capita electricity consumption do not necessarily result in an increased HDI. While the Vietnamese HDI shows steady growth, per capita electricity consumption boosted since 1993, decoupling from HDI development. In the long run of course healthy and educated people are more productive. Hence, long-term socio-economic development can eventually also be reflected by a country's GDP to a certain extent.

Figure 3.2: Human Development Index and electricity consumption in Vietnam.



Source: Own graph, based on WORLD BANK, 2011 and UN, 2011.

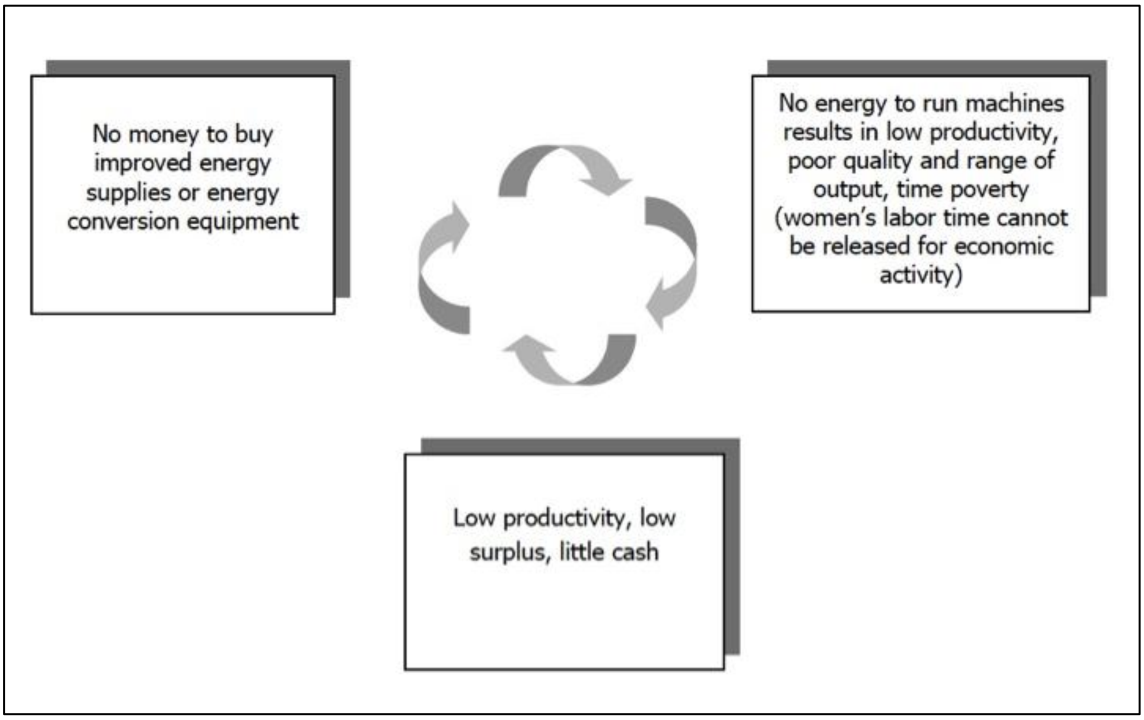
Concerning energy as an enabler for development, electricity services need to be considered an elementary part of development and thus of the Millennium Development Goals, which the United Nations set for 2015. Access to electricity supports basic improvements, as it is a means of facilitation for certain services like education, healthcare or electrically powered agricultural production (CABRAAL ET AL., 2005: 122). Each of the following development goals is thus related to the supply of electricity in a way:

- Goal 1: Eradicate extreme poverty and hunger
- Goal 2: Achieve universal primary education
- Goal 3: Promote gender equality and empower women
- Goal 4: Reduce child mortality
- Goal 5: Improve maternal health
- Goal 6: Combat HIV/AIDS, malaria & other diseases
- Goal 7: Ensure environmental sustainability
- Goal 8: Develop a global partnership for development

(UNITED NATIONS, 2010)

Without access to electricity these development goals can hardly be achieved. Interestingly in the Millennium Development Goals Report 2010 the topic of access to electricity or rural electrification as a means for poverty reduction and development is not mentioned at all. However, the link between access to electricity and poverty can be drawn even closer. The impact of energy and electricity supply on poverty is closely related to what RAMANI and HEIJNDERMANS (2003: 28) call the vicious circle of energy poverty.

Figure 3.3: Vicious circle of energy poverty.



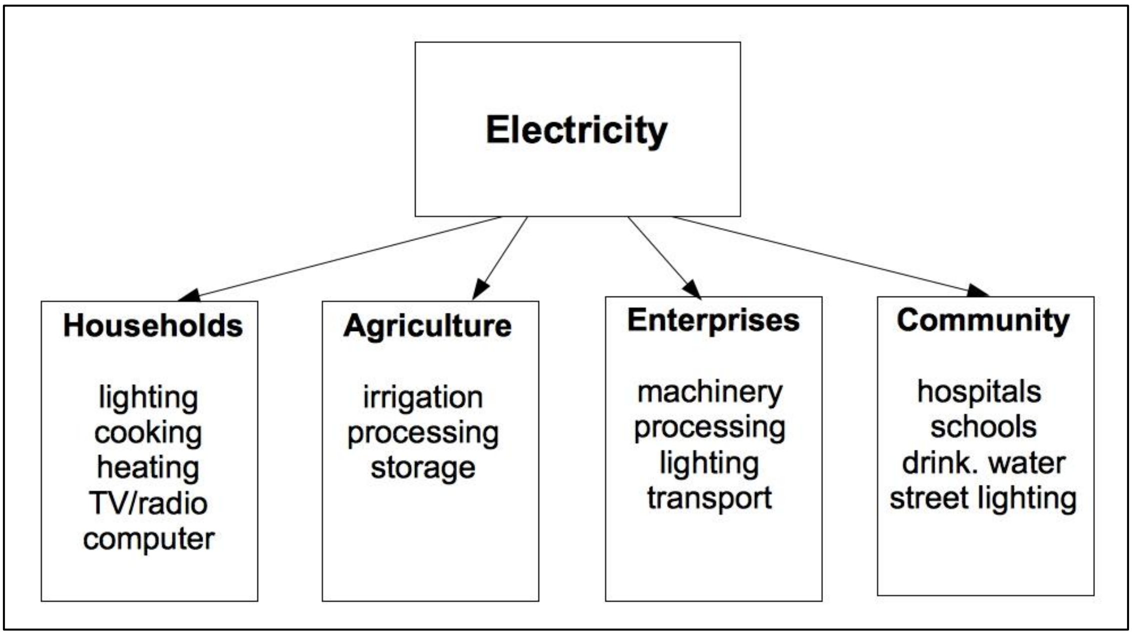
Source: RAMANI AND HEIJNDERMANS, 2003: 28.

First poor people cannot afford improved supply of energy and electricity. These improved energy services are then missing to improve productivity. Finally the low productivity results in lasting poverty due to missing improved income (see Figure 3.3). While the link between energy services and poverty is evident, rural people in developing countries are far more affected by this phenomenon than people living in urban regions.

3.2 Rural electrification and rural development

Missing or only little electrification is encountered in rural and sparsely populated areas in developing countries. For decades rural development enjoys special attention in the global development debate and electrification has since been a central factor for the same reasons energy or electricity are central to overall socio-economic development: Electricity acts as an enabler and is considered a prerequisite for improvement of living standards and facilitating productive and economic work. As stated before, provision of electricity itself does not give valuable benefits. However, access to electricity can significantly improve consumers' quality of life and without electricity there are limits to any type of growth especially in rural areas (CABRAAL ET AL., 2005: 140; ALAZRAQUE-CHERNI, 2008: 106). Rural electrification is necessary but not sufficient for improving rural livelihoods and reducing poverty. Reliable and low cost electricity services need to be part of a multi-sectoral approach and electrification projects have to be embedded in projects with other development factors (MODI, 2004: 6-7).

Figure 3.4: Areas of impact of electricity in rural areas.



Source: Own figure based on DAS, 2006: 3.

Furthermore, rural electrification needs to give rise to greater productivity, if they are to be sustainable. Productive activities create sustainable livelihoods for poor rural communities and they are needed in order to make such projects financially viable. Among the productive services can be income generation through manufacturing with machinery, lighting for business and manufacturing, technically supported agriculture as well as drinking water provision, medical services and education (KHENNAS, 2002: 10). Rural electrification can aim to tackle electricity related problems in remote regions. Despite cultural differences worldwide rural development can be based on four pillars and their link to electricity, namely households, agriculture, enterprises, and community (see Figure 3.4).

Households

Among a household's very basic needs is cooking, heating and lighting. Around 40% of the world's population – most of them living in developing countries – still rely on traditional biomass as the prime resource for cooking or heating (BMU, 2010: 57). Burning of biomass for example in the form of open fire is not only comparatively inefficient; it also puts pressure on the landscape as a carrier of the resource (BRÜCHER, 1997: 239). At least in some cases it might also foster environmental destruction and the competition of biomass for fuel or food (MEIER, 2001: 18-19). Electrified cooking facilities could replace biomass and accordingly reduce related negative impacts like fire hazards or pollution, a factor not to be underestimated as respiratory infection annually kills an estimated two million children under the age of five with some 800.000 of those deaths as a result of air pollution, partly imposed using fossil fuels for cooking and lighting (WORLD BANK, 2008A: 42; WORLD BANK 2008C: 1).

As a side effect the time spent for collecting biofuels, which will be more difficult as the resources get scarce, can be used for other productive (or unproductive) activities (MEIER, 2001: 17). In this context electrification also influences the issue of gender inequality. Women and men often do not have the same opportunities for personal development, because of their cultural gender role. In many cultures household activities like fetching water and collecting firewood is often a task of women. The time saved, when tapped water and electricity are available would allow them to pursue productive activities, which might support their ability to make an independent living (CELESKI, 2000: 19-20).

Electric lighting extends waking hours, can support social gatherings after dark and also benefit many other household activities and productive electricity use like providing illumination for small family businesses such as shops, which then can open longer hours independent of daylight. Furthermore, it can replace health-threatening devices like petroleum lamps often used in remote areas and thus reduce health hazards. These seemingly simple things can improve living conditions. Electric media devices can serve for entertainment and communications as well as being a source of information. Whether television or radio can be seen as productive (source for information) or unproductive use (entertainment) needs to be assessed individually on a differentiated basis.

Agriculture

Agriculture as a major source of rural incomes is a beneficiary of access to electricity. Electric power can support basic functions needed for farming, such as electrical irrigation pumps, which not only enhance crop productivity, but also contribute to agriculture being less vulnerable to droughts or uneven distribution of water. Electrical tooling, machinery and irrigation can impart efficiency in processing (KHANDKER ET AL., 2008: 24-25), which eases the effort for rural farmers and possibly the ability to produce and process more agricultural goods. Agricultural capacities are often crucial for developing countries. Thus, rural electrification in this context would be a contribution to food security.

Enterprises

Local economy is affected by having access to electricity in manifold ways and modern electricity services have a positive influence on local economy and small businesses. Electric light extends the working hours and potentially increases revenue. Local economy can moreover profit by electrically empowered machinery, which is likely to increase efficiency and has potential to open up new business opportunities and thus generate new forms of household income. Often simple items like electric light or a refrigerator can improve local shops' conditions. They enhance food storage capabilities, thus shopkeepers can offer a wider range of products. As in developing countries small shops are often the main source of family incomes these effects can have major influence on the well-being of families (CABRAAL ET AL., 2005: 123; WORLD BANK, 2008A: 46-47). Additionally, there is also the potential for upcoming new businesses. In the specific case of Vietnam, ZWEBE (2005: 35-36) discovered that in rural Vietnam the possibility of making ice is an economic diversification impossible without access to electricity. Even simple devices like television can spark business ideas (MCLEAN, 2010: 20), which then can be a source of income. It gives people ideas about what is going on and what is in demand (e.g. business ideas in tourism or diversification in agriculture).

Community

On a community level access to electricity can improve medical services and schooling, drinking water supply or street lighting. It allows clinics to remain open in darkness and provide better health services through the use of electrical equipment as well as the use of water treatment technologies (WORLD BANK, 2008A: 39-49). The same applies for schools being able to utilize computers and electric light or operating fans. Light at night supports social gatherings after dark and is therefore strengthening social life. Street lighting can increase security in darkness, reduce crime and therefore positively impact living conditions in the community.

Whilst all development potentials mentioned above are evident and mostly crucial for improving people's overall quality of life in rural communities, the rural rich might benefit more, because they simply can more easily afford electricity and consumption (DAVIS, 1998: 216). They are the first in line with better capabilities to improve their situation, whereas the rural poor first have to improve their basic living conditions before gaining economic benefit.

3.3 Energy and development in the scope of sustainability

Sustainability has become one of the most commonly used phrases in the frame of socio-economic and environmental challenges for society. The last decade witnessed a rapid increase of energy consumption in the course of industrial development and population growth, especially in developing countries on their path to becoming an industrialized nation. This implies that more people are competing for a limited amount of space and resources. If development is to be persistent, a sustainable type of development is inevitable. The Brundtland Commission (The World Commission on Environment and Development) described sustainable development as a "*[...] development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (UN, 1987). For the vital role of energy for development, this implies a sustainable utilization of energy, as sustainable energy is the basis for sustainable development. Hence, sustainability in terms of energy means "*[...] the provision of energy such that it meets the needs of the future without compromising the ability of future generations to meet their own needs*" (REEEP, 2004: 9). Sustainability in this respect includes the source of electricity. Currently the dominant energy resources in the world are fossil. Fossil energy resources are unsustainable in multiple ways: They have an ending character, independent from the different consumption scenarios. Furthermore fossil fuels pose environmental threats, such as environmental degradation, ground water and air pollution from exploitation and combustion impacting climate change. On the other hand, especially oil and gas are often found in unstable regions. A competition for limited resources between players, who need the resources for their well-being thus carries massive potential for conflict and further destabilization (SCHEFFRAN, 2000: 380). Hence, future generations might be subject to conflict about remaining resources and intact living environments. This emphasizes the broad impact of fossil energy supply. Renewable energy solutions can positively affect several environmental and socio-economic aspects linked to energy supply.

In the scope of poverty reduction and rural development one frequently encounters the term 'sustainable livelihoods'. Taking into account the concept of sustainable livelihoods further clarifies the key role that electricity can play in rural development and improvement in quality of life. As defined by CHAMBERS AND CONWAY (1991: 6) a sustainable livelihood comprises "*[...] the capabilities, assets (stores, resources, claims and access) and activities required for a means of living. A livelihood is sustainable, when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the long and short term.* "

This implies that livelihood systems consist of a complex combination of economic, social and physical assets. Based on these assets individuals or groups develop livelihood strategies to make a living (SCOONES, 1998: 8). Hence, whether people can make a living does not depend on certain factors alone, but on the combination of assets. Access to electricity can support certain assets like economic capital (e.g. increased income through enhanced efficiency with electric machinery), social capital (e.g. better schooling due to light and utilization of electrical devices) or even natural capital (e.g. more efficient utilization of available resources) in various ways. Electricity enables sustainability in the context of livelihoods. In the rural context farming and small-scale businesses play an important role. So if farmers can keep up agricultural production even at times of limited precipitation thanks to electrically powered irrigation pumps, they are less vulnerable to environmental stress or shock. Enhanced schooling or health services would maintain human and social capital through education and health care for instance enhancing chances for development for the generations to come.

From the perspective of sustainable development and the role of energy, renewables are a promising alternative to fossil fuels. Renewable resources such as wind, solar radiation or hydropower are widely available and do not need the conventional forms of exploitation of oil or coal. Besides construction and installation of power plants (e.g. wind parks or photovoltaic systems) or power distribution systems, renewables cause relatively little environmental damage or atmospheric pollution. Renewable energy resources like wind or solar power are recurring and as such they support security of energy supply and a reduced competition for fossil fuels in politically unstable regions (GOLDEMBERG, 2007: 808-809). The utilization of renewable energy sources supports a country's sustainability in a sense of a system being able to utilize its own assets without degrading or overexploiting them as well as maintaining and enhancing itself comparable to sustainable livelihoods. Consequently, sophisticated and widely applied renewable energy would be capable of meeting the future energy needs without interfering with the abilities and capabilities of future generations.

3.4 Path creation and path dependence

The phenomenon of path dependence is widely discussed in economic sciences as well as in broader social sciences. The concept is based on the studies of economic historians PAUL DAVID (1985) and BRIAN ARTHUR (1989, 1990) about how past actions influence technological trajectories. It describes the phenomenon of how decisions taken in the past influence and limit the range of possibilities and alternatives in the present and in the future. It is based on the simple assumption that "history matters" (HIRSCH AND GILLESPIE, 2001: 71-72; STACK AND GARTLAND, 2003: 490; SCHREYÖGG ET AL., 2003: 261-269). There is a range of alternatives for decisions in the beginning of a process, but at a certain stage of the process the decisions taken beforehand shape and limit the number of alternatives and possibilities for decisions later in the process. The selection is thus the origin of the path and the future decisions are dependent on the path taken. In other words, decisions create a path, which a process follows. The further a process follows the path, the narrower the alternatives for decisions become. A development towards a certain direction implies that the range of alternatives for decisions gets narrower the further a process proceeds into a certain direction. This is because some alternatives were only available earlier and were abandoned in favour of other options. Ergo the development of a process and the way it evolves over time resembles a path, which is shaped by the decisions that have been and will be taken during the course of the process. In the words of LIEBOWITZ AND MARGOLIS (2000: 981), path dependence means *"[...] that where we go next depends not only on where we are now, but also upon where we have been."* They furthermore classify path dependence:

- *First-degree* path dependence is minimal and is not harmful to the connected aims.
- *Second-degree* path dependence is characterised by a path that is less efficient than other paths that might have been of a more positive effect.
- *Third-degree* path dependence applies to a highly inefficient path, which leads to error. However, this error was avoidable, because other more efficient paths were among the range of selection (LIEBOWITZ AND MARGOLIS, 1998: 981). Such high path dependence leads to the dominance of a certain element, which roots in a particular historical development as a combination of political decisions and technology-market interactions (LAFFERTY AND RUUD, 2008: 18-20).

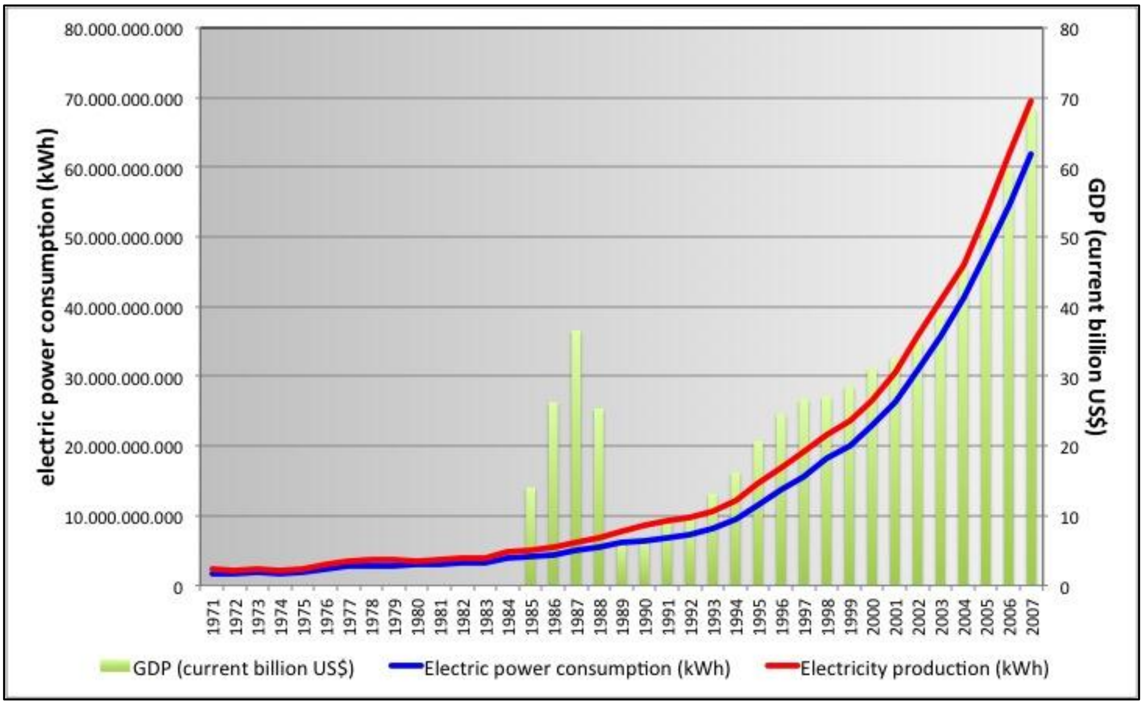
The energy sector is a demonstrative example for path dependence. Energy is an enabler for socio-economic development and as such needed for progress in society. To fulfil the aims of development, appropriate energy supply and ergo an efficient enabler is needed (DAS, 2006: 3). For instance, promotion of coal or oil as a cheap and reliable major energy resource in the long run can be considered as a third-degree path dependence, because a long lasting and sustainable energy supply is not possible as coal and oil are ending resources subject to price fluctuation and regional and political constraints. Coal and oil will become the dominant element of the path, but prove to be inefficient, as they are not capable of covering the energy needs for sustainable development in a sustainable and lasting way. This strong path dependence on the other hand is created by certain conditions and decisions that are taken in past and present. Consequently a path does not form randomly, but is rather created. With a range of decisions and tools, paths are created, sometimes willingly, sometimes unwillingly. As for development and energy are strongly interlinked path dependence of the energy sector has an impact on socio-economic development as well. This paper aims to apply the concept of path dependence to the Vietnamese energy sector on the background of recent efforts and success in rural electrification as a means for rural development. The efforts of the Vietnamese government to develop rural regions through electrification in conjunction with overall developments create a path for the power sector, shaped by decisions, projects and initiatives related to power supply and consumption. Certain questions arise from the recent developments in Vietnam: Is the Vietnamese energy sector subject to path dependence and possibly a lock-in with a dominant element? How did decisions and policies create a certain path in the power sector and for socio-economic development? There is interplay between rural electrification, rural development, performance of the energy sector and an overall sustainable development. The characteristics of the path for the power sector induce consequences for the path of development.

4 Energy background and rural electrification in Vietnam

4.1 Energy demand and economic recovery in Vietnam

To better understand Vietnam's development in terms of energy and electricity demand as well as to put it into a broader context it is worth considering Vietnam's overall development and specifically the economic development since the so called "American War" (1968-1975), known as the Vietnam war in the western world. While socialist policies were carried out in the north of Vietnam since the mid-fifties, it was only after the reunification of the country and the proclamation of the Socialist Republic of Vietnam in 1976 that all of Vietnam was under strict socialist economic policy. Since then the country was recovering from the ravages of the war, which destroyed large parts of the infrastructure, leaving behind an underdeveloped power system. While some 80% of the population lived on the countryside in the 1970s, mostly being engaged in agriculture, unfavourable economic development hit the whole country. Despite favourable agricultural potential Vietnam had to import 5,6 million tons of food from 1976 until 1980 (PHAM ET AL., 2000: 14), showing the extremely bad economic efficiency. Nevertheless Vietnam started an impressive economic development in 1986, when economic reforms under the slogan *Doi Moi* (renovation policy) were proclaimed in order to orient the country towards a more open socialist economy. With the first step of *Doi Moi* in the mid 1980s, farmers were allowed to directly invest and produce on land leased to individual households without being member of a collective. The second period, starting in 1989, focussed on economic liberalisation as a whole, the reform of state-owned enterprises and the allowance and assistance for private business. The central control of prices for products and service was largely abandoned and state enterprises were reformed to joint stock companies with private and public ownership (TRINH ET AL., 2000: 55-58). This reform eventually resulted in an evolving economic boom reflected by the GDP development, which grew nearly nine fold from 1990 to 2009, with annual growth rates of up to above 9% (see Figure 4.1). The sudden slump after a first short boom phase from 1985 until 1989 can potentially be explained with the collapse of the communist block and therefore the loss of traditional trading partners towards the 1990s.

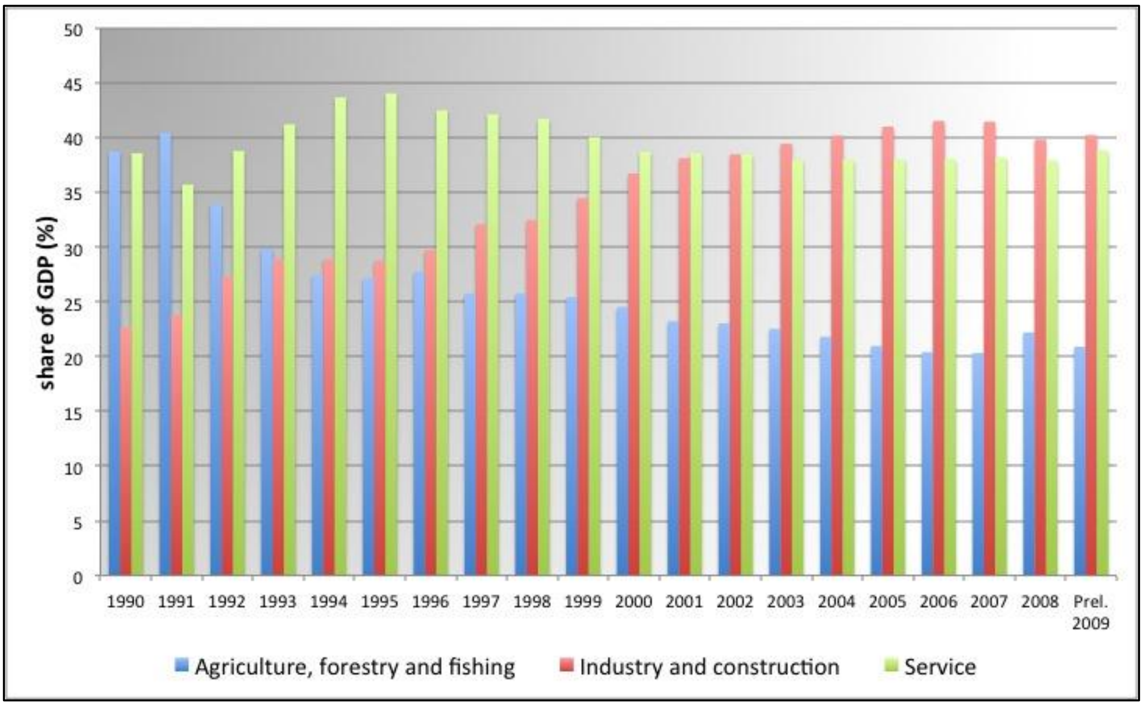
Figure 4.1: Development of GDP vs. electricity consumption and production in Vietnam.



Source: Own graph, based on WORLD BANK, 2011.

Vietnam is one of the fastest growing economies in East Asia and the Pacific (EAP) region. In parallel the Human Development Index (HDI) of Vietnam went up from 0,407 in 1990 to 0,527 in 2010 as was shown in Figure 3.2. However, this economic development comes at a price. With an annual inflation rate of 6,5% in 2009, Vietnam now finds itself on the top position in the EAP region (WORLD BANK, 2010: 5). Vietnams economic output was dominated by agriculture for many decades. Nevertheless domestic and agricultural energy use was soon surpassed by industrial energy demand as the effects of *Doi Moi* set in. The last twenty years have seen a considerable increase in the contribution of the industrial sector to the overall GDP. The GDP share of industry and construction increased from 22,67% in 1990 to 40,2% in 2009 (GSO, 2011). So most of the economic development nowadays is based on the industrial and commercial sector, even though the global economic crisis from 2007 slowed down recent industrial development (see Figure 4.2). Another aspect are rising living standards during the last decades, which saw a progressing replacement of biomass fuels with commercial fuels and electricity and a population that nearly tripled within the last 50 years (see Figure 4.6). These factors altogether resulted in an increasing demand for electricity in Vietnam that needs to be covered (NGUYEN AND MINH, 2009: 2-5).

Figure 4.2: GDP structure in Vietnam.



Source: GSO, 2011.

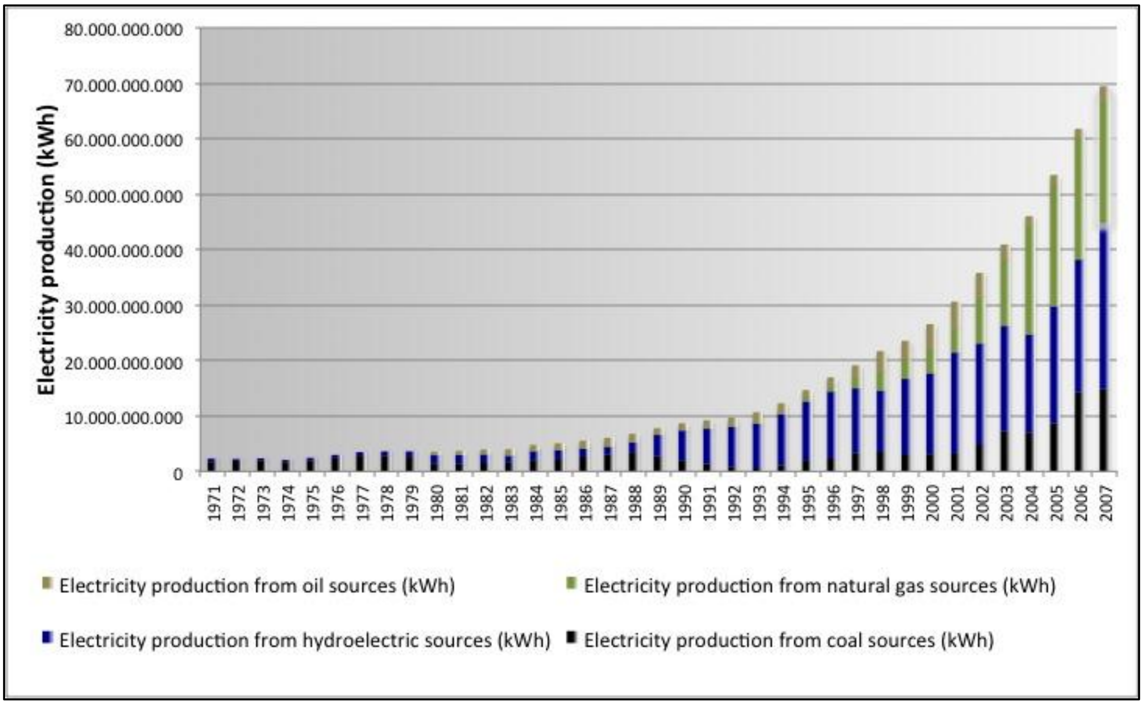
Correspondingly, the overall Vietnamese demand for electricity grew steadily (see Figure 4.1) over the years since *Doi Moi* (KHANH TOAN ET AL., 2010: 1-3). Up to 2007 electricity demand had grown at an average rate of 13 to 15% per annum. Between 1975 and 2008 the average per capita electric power consumption grew from around 40 kWh per year to over 799 kWh per year. Compared to overall developing East Asia and the Pacific (EAP), which in total has more than twice the amount, these figures are still low (developing EAP 2008: 1972 kWh/year) (WORLD BANK, 2011).

4.2 Energy supply and energy mix

When Vietnam's economy was mostly agriculture-based, biomass supplied the bulk of energy needs. With the country's economy developing, the role of biomass fuels in the energy sector lost importance, even though as of 2005 energy from biomass (non-commercial energy) consumed in Vietnam still comprised over one third of total energy demand (see Figure 4.3). Vietnam is endowed with a variety of primary energy ending resources including coal, crude oil, gas and uranium as well as abundant potential for hydropower and in places favourable solar radiation and wind potential. According to

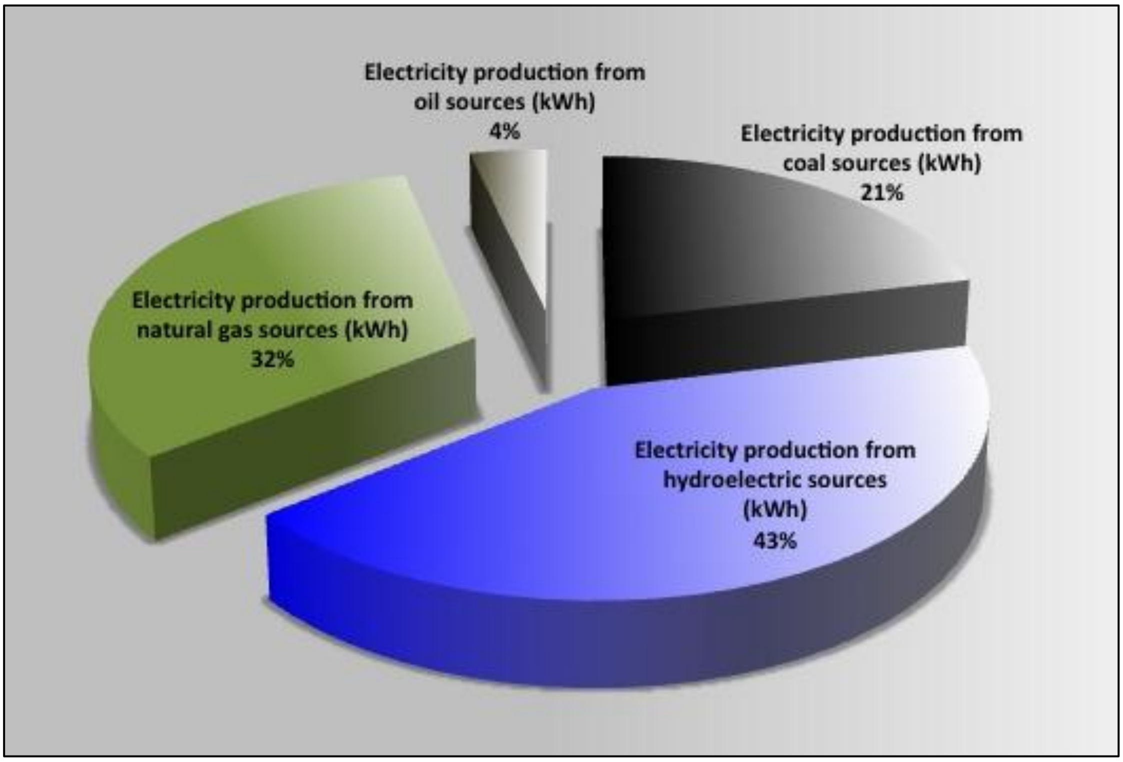
WORLD BANK'S Carbon Finance Assist (2007B: 1) Vietnam has potentially exploitable renewable energy resources amounting to 18.000 to 20.000 MW of hydropower; 6 to 10 MW of solar energy; 1680 MW of wind power; 600 to 800 MW of biomass; and 200 to 300 MW of geothermal energy. However, these potentials are always relative, since they depend on the economic and technical feasibility standards one applies. Other assumptions and preconditions might result in different figures. Nevertheless, thanks to the abundant resource availability hydropower has ever since played a significant role in electricity production and most of the commercial electricity production in Vietnam is currently still covered by hydropower, comprising of around 43% of the total power generation in 2007. Natural gas and coal sources are the second and third in line with 32% and 21% (see Figure 4.3 and Figure 4.4). In 2009, the total installed generation capacity was 18.201 MW (NGUYEN, 2010: 9). Despite the abundance of energy resources Vietnam imported 3,85 billion kWh of electricity in 2009, while exporting only 535 million kWh (CIA, 2011). The reasons for this are manifold. On the one hand, it might partly be due to changing weather conditions. During rainy season a lot of electricity from the northern hydropower plants is available and distributed to the south of Vietnam. In the dry season biogas power plants in the south produce more electricity, which is distributed.

Figure 4.3: Sources of electricity production in Vietnam (absolute).



Source: Own graph, based on WORLD BANK, 2011.

Figure 4.4: Source of electricity production in Vietnam 2007 (relative to total).



Source: Own graph, based on WORLD BANK, 2011.

Furthermore interchange of electricity capacities between the south and the north is subject to massive thermal and transmission losses. So shortages in the northern regions, especially in those close to the Chinese border are covered by electricity imported from China (560 MW in 2009) and excess electricity generated in the south is exported to neighbouring countries (NGUYEN, 2010: 9). On the other hand Vietnam is a net exporter of primary energy sources like coal or oil, which is largely due to the lack of processing facilities in the country. The country exports large amounts of crude oil for instance, because it is lacking a sufficient number of refineries in the country (KHANH TOAN ET AL., 2006: 3; KHANH TOAN ET AL., 2010: 3).

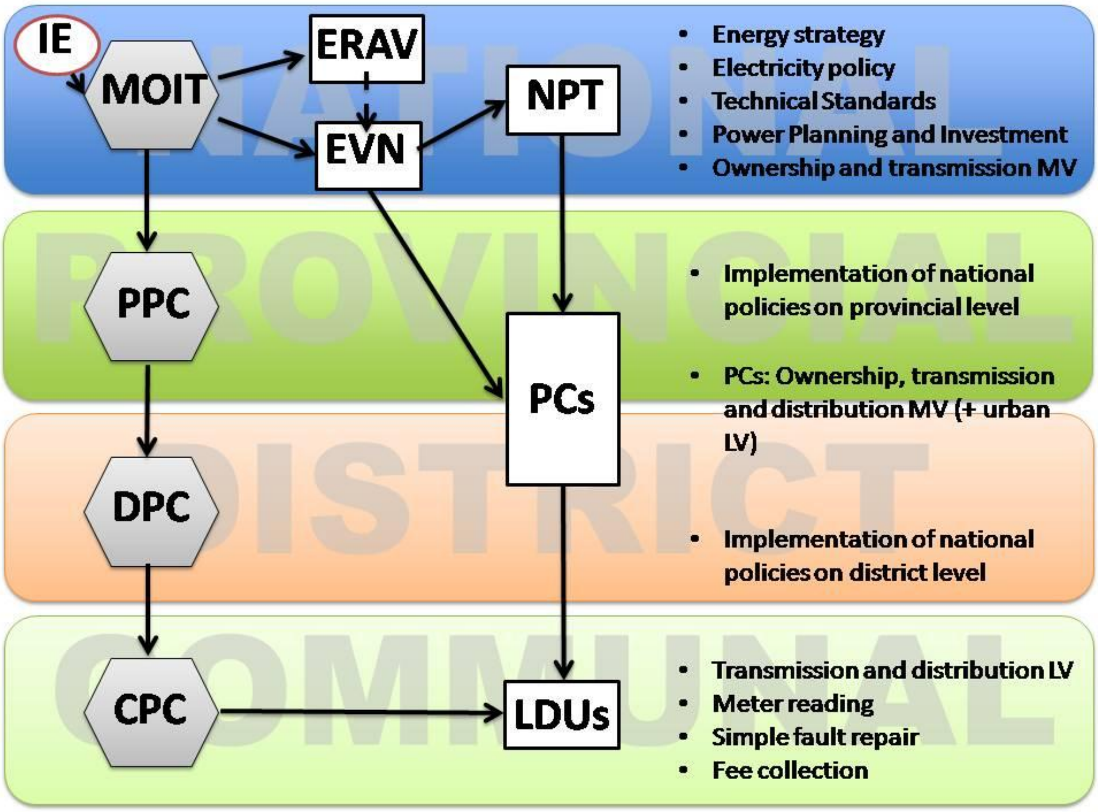
4.3 Institutional and legal framework

Talking about the development in terms of electricity it needs to be noted that Vietnam’s electricity authorities have undergone a major reform. Until the middle of the 1990s administration of electricity affairs was concentrated under the Ministry of Energy, planning under the Institute of Energy (IE) and transmission and distribution under the control of three regional power companies (PC) (north, south and centre).

This complicated formation hampered a development towards a more efficient and increased electricity generation. Major reforms in the power sector began in 1995, which main objectives were to rationalise the power sector institutions, commercialise the power companies, introduce an appropriate legal and regulatory framework and accelerate rural electrification (HAANYIKA, 2006: 2983; GENCER ET AL., 2011: 5). The Ministry of Energy was abandoned and the Ministry of Industry and Trade (MOIT) was created by merging the Ministry of Energy, Ministry of Light Industry and the Ministry of Heavy Industry. The national electricity provider Electricity of Vietnam (EVN) was established. The country has since an entity under which nearly all electricity sector activities are consolidated (KHANDKER ET AL., 2008: 3; NGUYEN, 2010: 9-11). The Ministry of Industry and Trade (MOIT) and its related body, the Institute of Energy, carry out the planning and policy making. Operative investment and management – namely electricity production, transmission and distribution – is left to EVN. This entity comprises of many member businesses dealing with research and development, installation, maintenance, production, distribution and local customer services. The regional Power Companies (PC) are subsidiaries of the electricity provider. EVN is now the major electricity provider, owning two thirds of electricity generation capacity and its actions have to be in line with the requirements of the national development strategies (NGUYEN, 2010: 9-11; GENCER ET AL., 2011: 11-15). After the Vietnamese government encouraged private investment in the power sector, non-EVN-owned electricity generation capacity grew from 7% in 2002 to 32% in 2008. Through its subsidiaries, the National Power Transmission Companies (NPT) (founded in 2008 as part of Vietnam's energy market reform strategy to manage, invest, operate and maintain the national transmission network) and the regional Power Companies (PC) own transmission and distribution systems mainly in urban areas (GENCER ET AL., 2011: 11-12).

After the reform of the energy sector and consecutive steps, the institutional framework for rural electrification comprises of several levels of jurisdiction and entities altogether forming an overall rural electricity management system (see Figure 4.5). The Provincial People Committee (PPC) is the highest local organ to implement national power policies on a provincial level. It is funded by central government funds and local tax funds. The committee is organized in several departments and within the Department of Industry the division of electricity is responsible for the development of power master plans with a planning horizon of five years and annual plans, renewable energy development as well as supervision of network and tariff setting. In Vietnam provinces consist of several districts. One level below the PPC the District People Committee (DPC) takes care of the implementation of national policies on district level (NGUYEN, 2010: 11-14).

Figure 4.5: Institutional and legal framework of the Vietnamese power sector.



abbreviations:
MOIT: Ministry of Industry and Trade; ERAV: Electricity Regulatory Authority of Vietnam; EVN: Electricity of Vietnam; NPT: National Power Transmission Corporation; PPC: Provincial Peoples Committee; DPC: District Peoples Committee; CPC: Communal People Committee; PCs: Power Companies; LDUs: Local Distribution Units

Source: Own graphic.

As part of the power sector reform from 1995, rural electrification departments were set up in the PCs to enhance the power network for irrigation and drainage in agricultural areas. Distribution as well as operation and ownership of the power lines in rural areas is now mostly in the hands of a mix of different entities including the PCs and Local Distribution Units (LDUs) that belong to the communes or are locally owned private companies. EVN and its associated PCs act as kind of a whole seller here, selling electricity to the LDUs, which take care of distribution to the end user. This way, local communities are responsible for metering and billing, repairs, network extensions and routine maintenance of the low voltage (LV) system. They are supported in maintenance and training by the Power Companies, who run the medium voltage lines (GENCER ET AL., 2011: 10; NGUYEN, 2010: 13). Currently, a takeover of the LV network from the LDUs by EVN is in progress, corresponding to a government's decision. This takeover challenges the participation of local people that own the systems through the LDUs. With this decision the government aims at providing equal access, equal quality and equal tariffs to all consumers in the country. For financing the progress in rural electrification many provinces charge an electricity tariff surcharge from their urban customers. Furthermore, in 2009 the government decided to progressively increase the average tariff to gradually meet generation cost. A special protection mechanism with subsidies aims to keep electricity being affordable for poorer households. The consumer surcharges from the increased tariff and support from private investment shall provide new funding (NGUYEN, 2010: 38-39).

Three main governmental decisions are considered crucial for the fast electrification. With the decision 22 from the Prime Minister in 1999, which outlined the allocation of responsibilities and costs of rural electrification, Vietnam had a clear allocation of responsibilities for the rural electricity development for the first time. Decree 45 from 2001 fixed that the Prime Minister would set the ceiling price for residential electricity in rural areas, while the People's Committees of Cities and Provinces would determine the prices for their areas. Furthermore it says that private investors investing in rural networks in areas with difficult conditions could borrow money from development investment funds at lower interest rates. In 2004 Vietnam's first electricity law was enacted, which enforced the mobilization of financing resources to speed up rural electrification. Under this law the Electricity Regulatory Authority of Vietnam (ERAV) was established with the aim to abandon central control and to create a power market in Vietnam with power pool rules, market procedures and licensing in the long-term (GENCER ET AL., 2011: 21-22). Renewable energy policies as part of the electricity law are since then in place, including planning, subsidies and tax deductions for capital investment in renewable energies. In order to attract private investment into renewable energy projects from within and outside Vietnam, renewable electricity generation projects shall receive tax exemption, for instance on income tax, import tax and value added tax as well as long term loans. Concrete and detailed instruments like feed-in tariffs or a price subsidy per 1 kWh of electricity produced from renewable energy still need to be developed though. However, while laws and policies related to the development of renewable energy in Vietnam are formally in effect, detailed and reliable conditions and an appropriate enforcement of the policies are still missing to date (PHUONG, 2009; KHANH TOAN ET AL., 2010: 8-9).

4.4 Extension of the power grid – electricity to the rural front doors

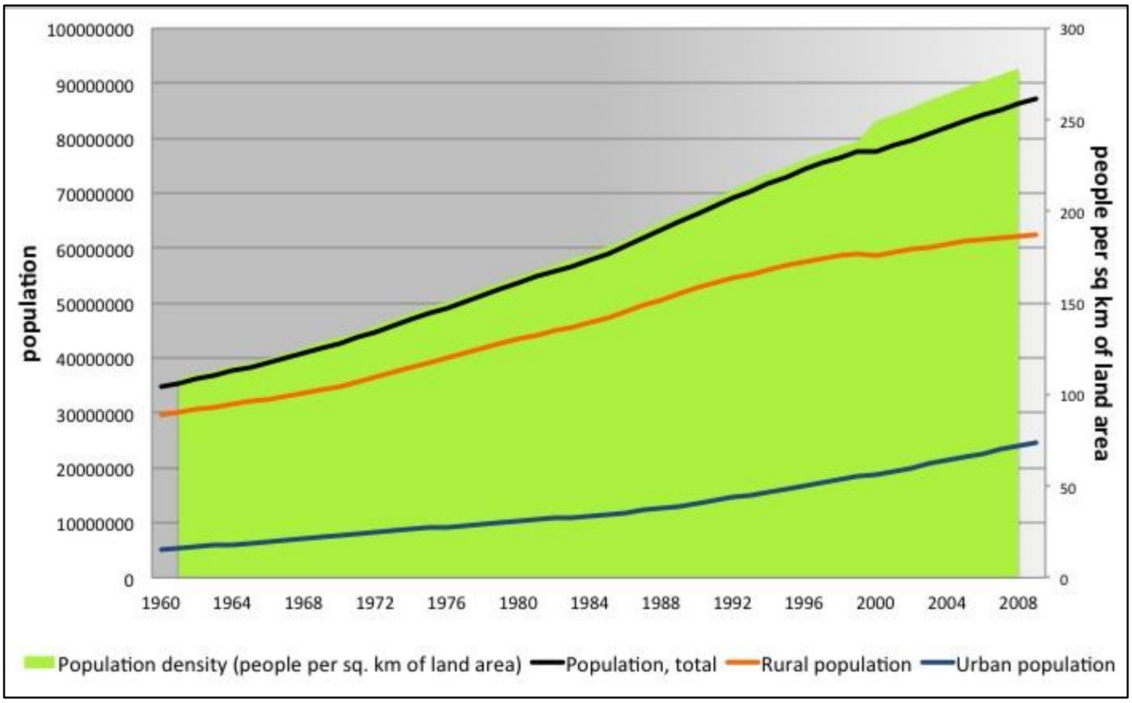
The history of rural electrification in Vietnam is closely tied to the development of the national power transmission grid. The choice for a technology option to electrify rural areas depends on various factors like the requested load, the number of connected electricity users and the technological and economic feasibility to connect to the central electricity generation plants. In most countries the largest share of electricity is generated in central power plants with large electricity loads. The electricity is then distributed via a transmission and distribution system often simply referred to as an electricity grid or a power grid. As long as a critical number of population and therefore customers request electrification, it is often economically feasible to extend the existing power grid. According to MARTINOT ET AL. (2000: 14) consumers tend to prefer being connected to the grid rather than receiving energy services from a solar home system for instance, given that all other factors are equal. It is simply the most comfortable option with electricity services being delivered into their homes.

Geographically Vietnam forms a narrow S stretching around 1650 kilometres from north to south and east to west being around 600 kilometres at the widest point. With about 90 million people living in Vietnam it is a rather densely populated country with 281 people per square kilometre of land in 2008 (for regional comparison: Laos 27/km^2, Cambodia 84/km^2, Thailand 133/km^2, P.R. China 143/km^2) (WORLD BANK, 2011). Even though the industrial development triggered a growth in urban population due to migration from the rural countryside to the industrial centres of the country, more than 70% of the Vietnamese population still live in rural areas (see Figure 4.6). This geographic setting is favourable for a relatively simple grid, which does not have to reach too far off the north-south main line.

Vietnam's electricity transmission grid consists of three regional power systems: the northern power system, including northern provinces from Ha Tinh northward, the central power system, including central provinces from Quang Binh to Khanh Hoa and four provinces in the highlands (Kon Tum, Gia Lai, Dac Lac and Dac Nong) and the southern power system, including the southern provinces and the provinces of Binh Thuan, Ninh Thuan and Lam Dong (see Figure 4.7).

However, the destructive war from 1968 to 1975 left Vietnam with a rather weak electricity network. While recovering from the war and rebuilding the country, electrification was tied to the objectives of national economic programs focusing on commercial aspects, connecting agricultural areas, industry or transport. Enhancement of agricultural output was the initial target of the Vietnamese rural electrification projects starting in the 1970s. Consequently, efforts concentrated on support for agriculture, particularly in the fertile northern parts of Vietnam with enabling water pumping for rice cultivation, rather than providing electricity to households and helping the poor (HANH, 1992: 456-460; NGUYEN, 2010: 16; GENCER ET AL., 2011: 7).

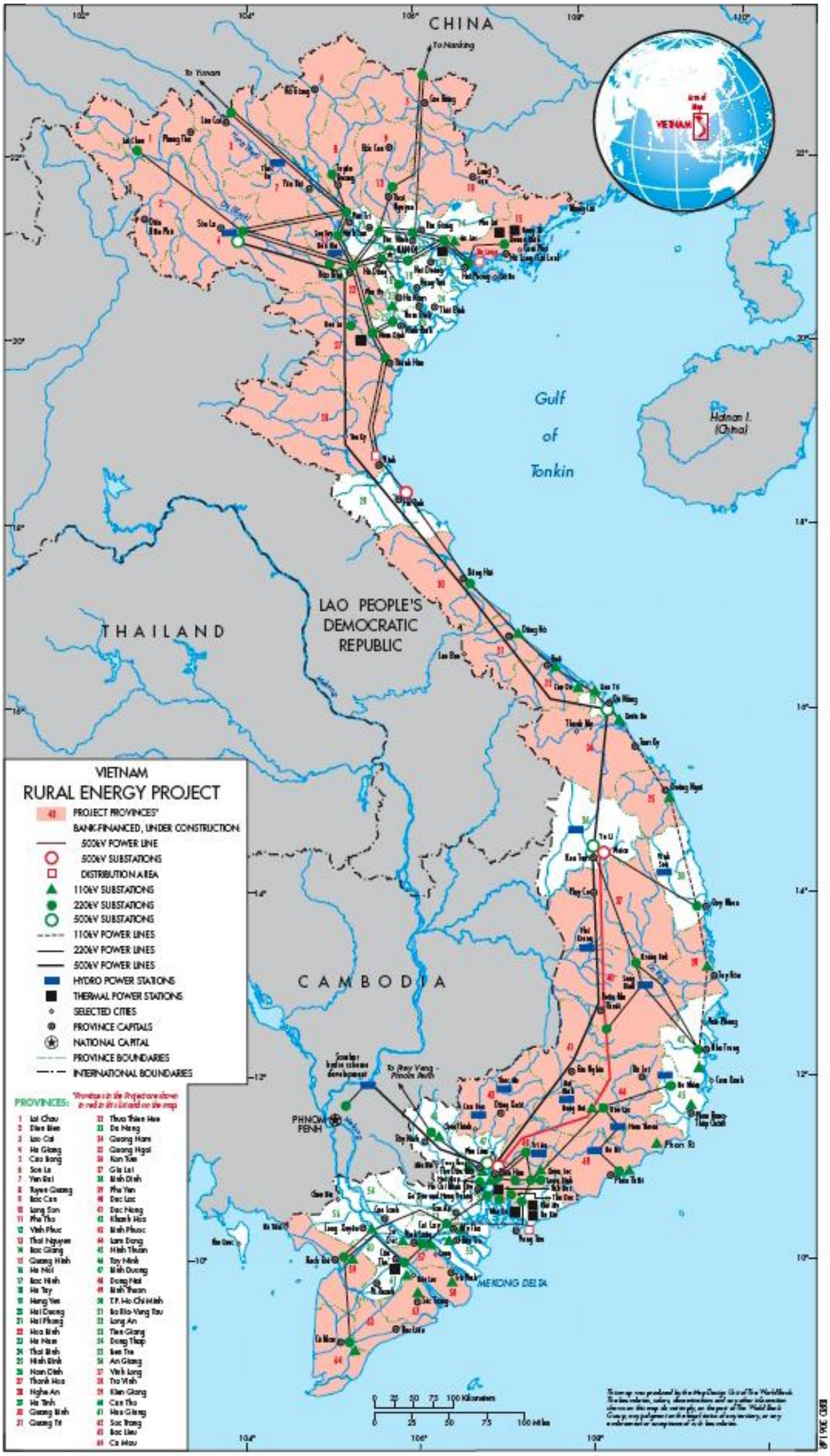
Figure 4.6: Population structure of Vietnam.



Source: Own graph, based on WORLD BANK, 2011.

This was needed for increasing agricultural production, a vital economic factor. This focus paid off indeed. After a long period of necessary food imports caused by political mismanagement, Vietnam was a rice exporter again by 1988 (PHAM ET AL, 2000: 18; GENCER ET AL., 2011: 8). However, as a side effect the share of households with access to electricity increased from 2,5% in 1975 to 9,3% in 1985 (see Figure 4.8). This was mainly the case for households being located close to the main transmission lines.

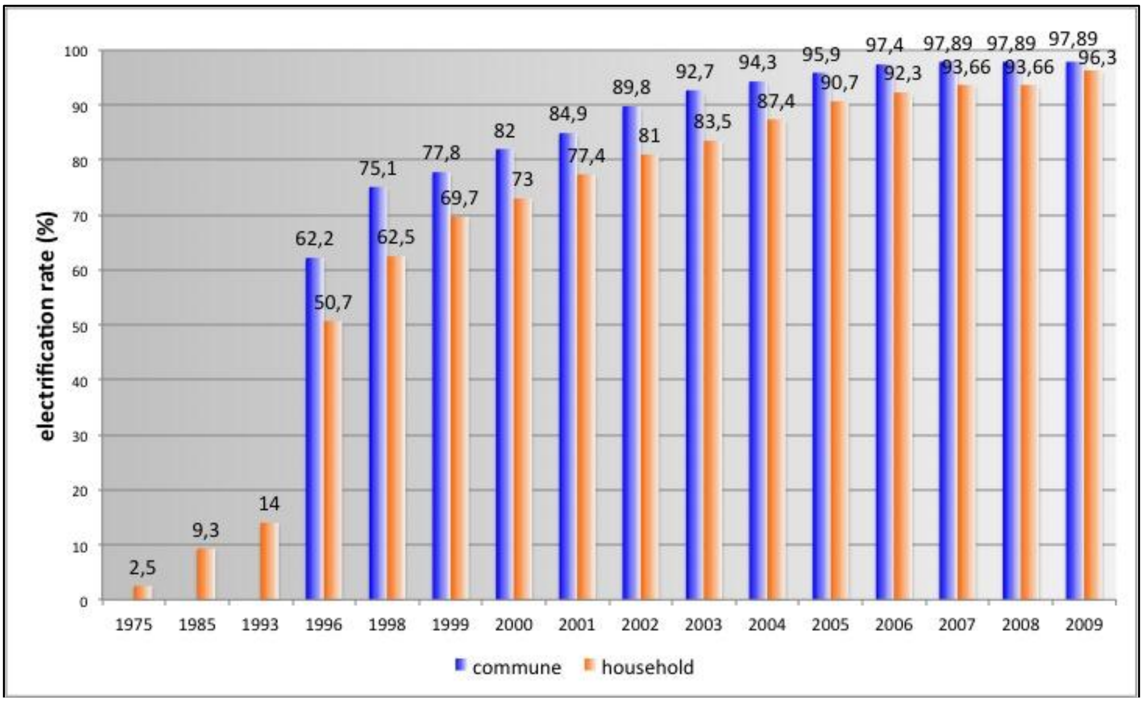
Figure 4.7: Electricity grid of Vietnam as of 2007.



Source: WORLD BANK, 2007A: 41.

Reliable data or even estimations on the extent of the network are not available for the years before the late 1980s. The earliest figures are available from 1988, when the total length of the medium voltage (MV) lines was 17.137 kilometres. In 1990 the agricultural tax exemption motivated farmers to invest the savings in connection to the grid for enhancing efficiency of their agricultural production. During this time several large hydropower plants jointly producing nearly 3000 Megawatt (MW) were set up. At times these facilities generated more electric power than could be consumed by consumers connected to the regional grids. As a consequence, in 1992 the government chose to construct a high voltage 500 kV line with a length of 1487 kilometres from the north to central and southern Vietnam to be able to distribute the surplus throughout the country. Other regional high voltage lines were gradually expanded as well. In conjunction with on-going construction of distribution lines into northern mountainous areas since the mid of the 1980s this resulted in the electrification rate for poor households increasing further from 13,9% in 1990 to 49% in 1993, again with residential access to electricity as a by-product of a commercial focus (GENCER ET AL., 2011: 8-10). In the last two decades Vietnam invested in a massive extension of the national power grid. By the end of 1994, the total length of the MV lines doubled from 17.137 kilometres in 1988 to about 33.822 kilometres (GENCER ET AL., 2011: 10). In the same year the 500 kV line from north to south was completed and in operation, which linked the regional isolated systems to one, forming the basis for the progress of Vietnamese rural electrification. The massive investment in construction left EVN with negative business results. Being a commercial business since 1995, they had to abandon projects that were too expensive. After making a lot but rather chaotic progress the country was lacking funds to further extend the power grid. Regional networks were often built without technical standards or specifications and the merging of these different systems was part of EVN's task. It was not before the late 1990s that national technical standards were introduced (GENCER ET AL., 2011: 23). Having started the institutional reforms, the government set up structured subsidies for EVN and other associates for commercially unviable rural electrification projects. Around the time of the energy sector reform, the World Bank got involved in the Vietnamese power sector in 1995 and started to provide technical, institutional and capacity building support. The household electrification rate made a considerable jump at this time, increasing from around 14% in 1994 to 62,5% in 1998, which might partly be the result of the World Bank support and the 500 kV line enabling easier access to the grid (see Figure 4.8).

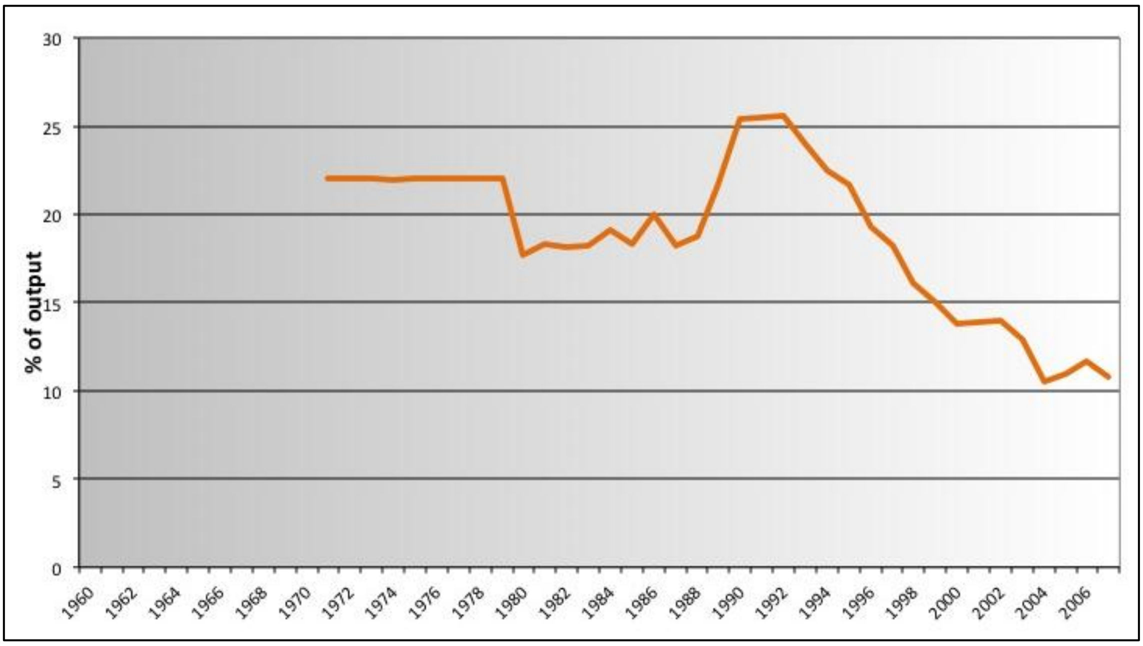
Figure 4.8: Development of the electrification rate in Vietnam.



Source: Own figure, based on GENCER ET AL., 2011: 6, 24, 29).

In the new millennium two major projects were funded by the World Bank to enhance rural electrification in Vietnam: The first was the Rural Energy Project (REP) from 2000 to 2006 with a funding of around 150 million US Dollars, which main focus was to extend the existing power grid to reach about 671 communes in 32 provinces. However, with the project being finalized in 2006 the original goals were impressively outperformed. Eventually an additional 976 rural communes and 550.000 households had access to electricity, 45% more communes and 41% more households than initially targeted (WORLD BANK, 2007A: 9-14; GENCER ET AL., 2011: 42-47). The Second Rural Energy Project (RE2) from 2004 to 2011 financed by a 200 million US Dollar credit from the World Bank's IDA fund (International Development Association) concentrated on repair and enhancement of existing network systems as well as local institutional capacity building. In May 2009, the provision of another 200 million US Dollars as additional financing for the Second Rural Energy Project was approved. The Vietnam Rural Distribution Project from 2008 to 2013 aims at improving the reliability of the power network as well as building more technical and management capacities within regional power companies (PCs). As of 2009 the high voltage power grid comprised of 3438 kilometres of 500 kV lines, 8497 kilometres of 220 kV lines and 12.145 kilometres of 110 kV lines (IE, 2010).

Figure 4.9: Transmission and distribution losses of Vietnamese electricity grid.



Source: Own graph, based on WORLD BANK, 2011.

As an effect of the massive grid extension, total electricity distribution losses increased. However, considering the increase of the overall output the share of losses decreased significantly from more than 25% in 1990 to slightly over 10% in 2007, which can be traced back to the enhanced technology used for recent grid extensions (see Figure 4.9). Having achieved a considerable grid extension, since 2005 the institutional focus is on rehabilitation of the old part of the network, with the challenge being the last mile to the consumers. Another focus is on the development of transmission inter-connections with neighbouring countries, including Laos, Cambodia, and China. The progress in rural electrification lead to the number of people with access to electricity growing from 1,2 million in 1976 to about 82 million in 2009, so 97,89% of the communes and 96,3% of all households had access to electricity (NGUYEN, 2010: 21; KHANH TOAN ET AL., 2010: 9; GENCER ET AL., 2011: 6, 24, 29). This left about one million people being still without access to electricity at all in 2009 (NGUYEN, 2010: 41; GENCER ET AL., 2011: 30).

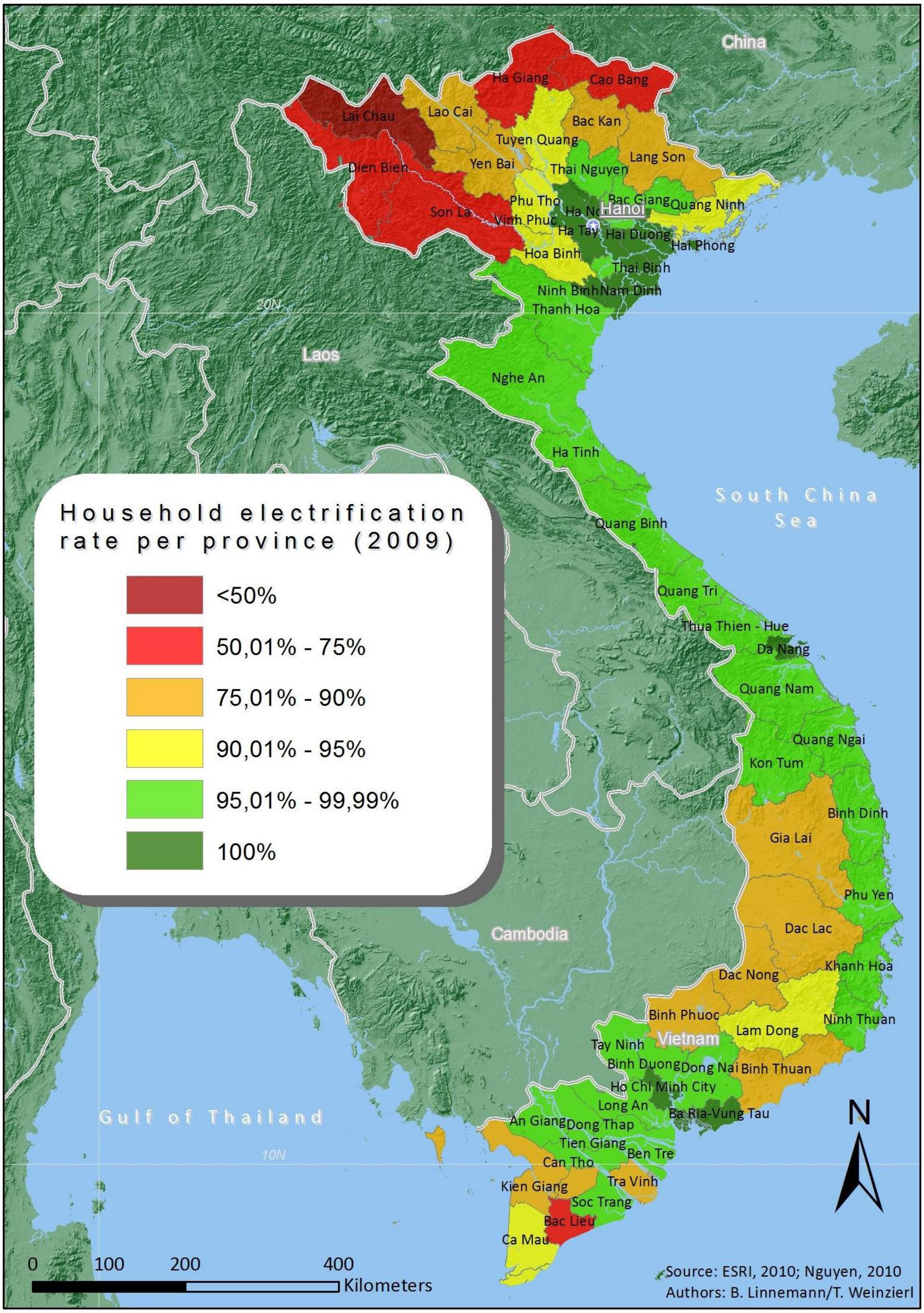
4.5 Rural electrification and its impacts on development

The history of grid extension shows the tremendous progress Vietnam has made in bringing electricity to its people – even in remote areas. As described, the rate of total households electrification jumped from 2,5% in 1975 to 96.3% in 2009. With the

ASEAN region (Association of Southeast Asian Nations*)* reaching an average total electrification rate of 71,9% and 54,9% in rural regions, Vietnam shows an outstanding performance, although it is still behind more developed countries of the ASEAN like Brunei, Malaysia, Singapore or Thailand (IEA, 2011; GENCER ET AL., 2010: 2-37). By 2020 the goal is for 100% of rural households to have access to the power grid (GENCER ET AL., 2011: 36-37). As of today the level of electrification in Vietnam is still largely dependent on the region or province. The regions with 100% household electrification comprise the main metropolitan areas of Hanoi in the north, Ho Chi Minh City in the south and Da Nang on the central coast (see Figure 4.10). Both the Red River Delta in the north and the Mekong Delta in the south were the first rural regions to be electrified and owe their high electrification rate to the political commitment to support and enhance agricultural production efficiency in these fertile areas in the 1970s and 1980s, the phase of recovery after the war (GENCER ET AL., 2011: 7). The fertility of the land is causal for the high population density, which in return decreases the cost per household connection. Most of central Vietnam is well electrified now, because most of the terrain is easily accessible and extension of the grid from the main 500 kV line stretching north to south was comparatively easy. However, rates are decreasing in the highlands north of Ho Chi Minh City, where population density is low and terrain is mountainous and sometimes rough. Electrification rates are significantly low at the northern and southern tips of the country. The northern highlands bordering China are probably the least accessible area of the country, where landscape barriers and a largely scattered population often makes grid-based electrification technically and economically unfeasible. Consequently, electrification rates here are very low compared to the rest of the country.

Positive impacts of rural access to electricity in Vietnam can be observed already. Next to other evaluations on a smaller scale, three extensive surveys were conducted by the Institute of Sociology (IoS) of the Vietnamese Academy of Social Sciences in 2002, 2005 and 2008 to evaluate the impact of rural electrification on people's quality of life. The study is considered exemplary for impact assessment among experts. For this evaluation data was gathered in seven provinces – namely Ha Giang in the northeast, Lai Chau and Hoa Binh in the northwest, Quang Binh on the north central coast, Quang Nam on the south central coast, Dac Lac in the central highlands and Soc Trang in the Mekong Delta. Representative households were selected from each commune and district to measure conditions before and after electrification.

Figure 4.10: Household electrification rates in Vietnam by province, 2009.



Source: Own map, based on Nguyen, 2010: 19.

The findings are generally in line with impacts experienced in other rural electrification projects in developing countries as they were discussed in chapter 3.2. It was found that poverty rates reduced significantly (see Table 4.1).

Table 4.1: Poverty rates in selected surveyed communes.

province	2000	2004
Chieng Hkeo	14,1%	11,9%
Chieng Trung	40%	36%
Tu Vu	32%	18%
Phuong Mao	33%	24%
Tro Quang	31%	17%
Thai Nien	28,5%	9,9%

Source: WORLD BANK, 2007A: 15.

In terms of poverty reduction generally the poorest groups benefited the most and the impacts are generally higher during the first few years after a household received electricity and incremental benefits eventually levelled off after some years of electricity use (KHANDKER ET AL., 2008: 24-25). Access to electricity was in most cases life changing and basic aspects of livelihood improved. Electric light for instance lead to less pollution from kerosene lamps, there was no need for dedicated fire hazard control inside the houses and the cost for lighting decreased. Household productivity grew because of the switch from biomass to electricity. After electrification less time was needed to collect biofuels, a task often carried out by women. So this impact does not only leave time for more productive work, but supports women's capabilities to pursue other types of work. Health and health care have significantly improved since electrification, as medical clinics now operate under better conditions for both diagnosis and treatment. This applies especially for emergencies, as operation of medical equipment becomes easier and safer with a reliable electricity supply. The positive impact on education can be traced back to two main aspects. Firstly, enhanced capabilities in schools induced by electricity and secondly, children in electrified households spend more time reading and studying. On the other hand the rate of school attendance depends on living standard. While 82% of households in the highest income group had children who attended school, only 69% of poor households did so and proportions were similar before and after electrification. In general, people appreciated the enhanced reading opportunities due to electric lighting and around 10% received guests after dark now, highlighting the social impact of electric lighting. As expected, causality was detected between electrification and increasing incomes. Farm and small business incomes increased since electrified irrigation, processing and machinery boosted efficiency. In general people benefited more in terms of increased income the higher their education and living standard prior to electrification was already and 58,2% of the high living standard group said, they had increased income. In return increasing rural incomes leads to more affordability of electricity access and availability of credits (WORLD BANK, 2007A: 32-35; MCLEAN, 2010: 13-20; GENCER ET AL., 2011: 42-56). That is in line with the finding that households that have access to electricity tend to have a higher income than those that do not. However, it was found that only 12,5% of the questioned people said that access to electricity created new jobs for them. Generally households from a developed commune were more likely to get grid connection than households from an underdeveloped commune (WORLD BANK, 2007A: 33). That might largely be due to the fact that already developed communes have more favourable conditions in terms of infrastructure and more funds for connection to the grid. On the other hand, there might still be a focus on economic development in regions with higher potential for development rather than supporting the poor and reducing poverty.

Table 4.2: Survey results for reasons of improvement in quality of life.

Reason	% of respondents
Better electricity services	25,4%
Better health	18,7%
Better roads	11,9%
Better services	11,4%
Better access to education and training	5,5%
Better access to resources	5,4%
Better water supply	4,9%

Source: WORLD BANK, 2007A: 33.

Asked for the reason of their improvements in quality of life, most of the people named better electricity services (25,4%) (see Table 4.2). However, other factors like better health services (18,7%), education (5,5%) or water supply (4,9%) are linked to electricity. So the total impact of electricity to people's improvement of quality of life is even higher. Access to electricity leads to more electric devices being installed and used in households, such as radios, fans, air conditioners, television or refrigerators (GENCER ET AL., 2011: 44-45). However, access to television among other forms of entertainment and information such as internet or radio, is considered an important source of information for remote communes to overcome their isolation and get inputs and ideas for business (MCLEAN, 2010: 14). The general improvement of standards of living also had an impact on household consumption, which increased in general and thus posing a potential for local economic and industrial growth (GENCER ET AL., 2011: 45-47).

Summarizing the studies, the Vietnamese rural electrification was not only successful in numbers, but also by having positive impacts on people's living conditions. However, long-term impacts are yet to be assessed to provide a broader picture and whether the triggered development is sustainable is yet to be seen.

4.6 The Vietnamese Power Development Master Plan

The government's social and economic growth targets for the future are estimated to require increasing electricity supply at a rate faster than GDP (1.7 times in 2007) (WORLD BANK, 2007A: 1). Under current conditions Vietnam is expected to have a prolonged electricity strain due to rural electrification, urbanization, population growth and economic development. In order to meet the challenges the rising electricity demand poses for the country, Vietnam has prepared a National Energy Development Strategy for the period up to 2030 with an outlook to 2050. One of the most urgent topics is energy security, an aspect the strategy aims to meet with the development of an enhanced energy mix. New power plants (hydropower, coal fire plants, nuclear power etc.) and modernized power networks in addition to more refineries for enhanced national capacities for processing crude oil are planned.

As part of this strategy the Vietnamese Institute of Energy developed a Power Development Master Plan for the government. Being updated on a five-year basis, currently Master Plan 6 is in place. This volume covers planning for several energy related aspects until 2030, includes energy and electricity demand forecasts based on GDP and population growth in three different scenarios and a power grid development plan, including a plan for electric power exchanges and regional interconnections

(KHANH TOAN ET AL., 2010: 7-8).[1] In Master Plan 6 Vietnam's population is expected to grow to 101,6 million in 2025 and the projected GDP growth is between 7% and 8,5% per year slightly slowing down over time depending on the case scenarios (low, base and high). The implications for electricity demand are enormous: In all three case scenarios the demand for electricity will increase rapidly in all sectors. Total electricity demand is expected to grow nearly nine fold from 2008 to 2030 just in the low case scenario. Naturally, the other scenarios feature even higher figures with total electricity needs growing eleven fold in the base case and nearly 14 fold in the high case scenario. In all cases the share of industry will further increase as economic development progresses. Even in the low case scenario the industrial electricity needs are projected to double from 2010 to 2015 with growing amounts of electricity needed for the coming decades resulting in a tenfold increase in demand until 2030. Domestic and agricultural electricity demand is expected to increase in all case scenarios, while the overall share of these categories of the total demand will decrease constantly (see Table 4.3). In conjunction with rising demands for energy other than electricity (e.g. for transport), these scenarios lead to an energy need, which challenges the country's capabilities. Currently Vietnam enjoys a surplus of primary energy resources. This surplus (17.000 KTOE in 2005) however, is expected to turn into a deficit within the next decades. Needed energy imports are projected to be at 28.000 KTOE in 2020, which will balloon to over 104.000 KTOE by 2030 (see Table 4.4). This is even assuming an increase in domestic exploitation of oil, gas, and coal. Only since 2009 does the country have an oil refinery, still being largely dependent on the import of oil products with a negative effect on the economic and society development objectives of Vietnam (KHANH TOAN ET AL., 2010: 3).

[1]As direct access to the Power Development Master Plan 6 was restricted, all data regarding this plan was taken from KHANH TOAN ET AL., 2010.

Table 4.3: Projected electricity sector demand as in Power Development Master Plan 6.

	2008		2010		2020		2030	
	GWh	%	GWh	%	GWh	%	GWh	%
Low case								
Agriculture-forestry-fishery	661	1,00	718	0,85	1.323	0,47	1.882	0,32
Industry-construction	33110	50,22	44.056	52,12	155.742	55,06	329.867	56,19
Commercial-service	3229	4,90	3.958	4,68	14.135	5,00	35.282	6,01
Household-management	26602	40,35	32.437	38,38	98.619	34,86	193.539	32,97
Other	2324	3,53	3.383	4,00	13.046	4,61	26.523	4,52
Total	65926	100,00	84.522	100,00	282.865	100,00	587.094	100,00
Base case								
Agriculture-forestry-fishery	661	1,00	1.125	1,21	2.752	0,78	4.313	0,60
Industry-construction	33110	50,22	45.794	49,45	189.538	53,69	372.391	51,80
Commercial-service	3229	4,90	5.536	5,98	22.203	6,29	48.885	6,80
Household-management	26602	40,35	35.219	38,03	116.441	32,98	215.671	30,00
Other	2324	3,53	4.933	5,33	32.090	9,09	77.641	10,80
Total	65926	100,00	92.607	100,00	353.023	100,00	718.902	100,00
High case								
Agriculture-forestry-fishery	661	1,00	1.210	1,21	3.505	0,78	5.519	0,60
Industry-construction	33110	50,22	49.439	49,45	228.657	50,86	476.470	51,80
Commercial-service	3229	4,90	5.982	5,98	28.277	6,29	62.548	6,80
Household-management	26602	40,35	38.010	38,02	148.298	32,98	275.948	30,00
Other	2324	3,53	5.337	5,34	40.869	9,09	99.341	10,80
Total	65926	100,00	99.978	100,00	449.607	100,00	919.826	100,00

Source: KHANH TOAN ET AL., 2010: 8.

Table 4.4: Projected overall energy balance as in Power Development Master Plan 6.

	2010	2020	2030
Primary energy demand (ktoe)	**59.440**	**135.317**	**234.205**
Domestic energy resources (ktoe)	**77.063**	**107.317**	**129.384**
Coal (ktoe)	28.000	42.000	56.000
Crude Oil (ktoe)	20.217	21.073	22.396
Gas (ktoe)	7.046	13.368	16.200
Hydro (ktoe)	6.458	12.814	14.993
Small hydro (ktoe)	428	2.105	3.423
Renewable energy (ktoe)	14.914	15.740	16.372
Surplus/deficit (ktoe)	**17.623**	**-28.000**	**-104.821**

Source: KHANH TOAN ET AL., 2010: 6.

To meet the needs, which arise from these projections policymakers are urged to support other energy resources for reasons of energy security and a good degree of independence. Considering neighbouring countries and other fuel exporters is on the agenda as well. Energy Master Plan 6 aims at developing the range of domestic energy output for 2020 and 2030 as follows (KHANH TOAN ET AL., 2010: 5):

- Coal: 75-86 million tons/year
- Crude oil: 20.7-22 million tons/year
- Natural gas: 14.85-18 billion m^3/year
- Hydropower: 59.6-69.7 TWh/year
- Uranium potential:
  - Reasonably assured resources: 113 tons
  - Estimated additional resources: 16.563 tons

For the future coal is expected to be the dominant resource for electricity generation (NGUYEN AND MINH, 2009: 15-16). To further diversify electricity supply, Vietnam chose to invest in nuclear power. The country plans to start constructing the first of several nuclear power plants in 2014 with four units running by 2025, each having a capacity of about 1000 MW. Even though it is not shown in the figures available, this way nuclear electricity should account for 15-20% of total commercial energy consumption nationwide by 2050 (KHANH TOAN ET AL., 2010: 8-9). A recent survey in

Hanoi and Ho Chi Minh City showed that 90% of the people consider nuclear power to be necessary for economic development, 47% consider it safe and useful and only 4,6% of the population thinks that this technology is dangerous. However, in the wake of the nuclear catastrophe in Japan and global discussions about nuclear safety this survey is somehow out-dated and the plans for installing nuclear power capacities are now revised at least in extent and timeline (VIETNAMNET, 2011). Due to the switch from biomass energy to commercial fuels and most of the suitable large hydropower sites already being developed, renewable energy (hydropower and biomass) is expected to account for an ever-decreasing proportion of total energy, dropping from over 40% in 2005 to less than 10% in 2030 (KHANH TOAN ET AL., 2010: 5). The slow progress in application of renewable technologies like wind, solar power contributes to this development. Vietnam aims at achieving a share of renewable energy (excluding hydropower and biomass) of 5% in the total commercial primary energy supply in 2020, increasing to 11% in 2050 (KHANH TOAN ET AL., 2010: 8). However, a detailed plan of how this will be reached does not exist. Solar and wind power are not considered to make significant contributions to electricity generation in the scope of Master Plan 6 and compared to the overall need, the amounts of projected electricity production from these sources are quite low. Furthermore, the planning does not show a serious attempt to make use of the wind, solar and biomass power potentials in the future. A planning beyond 2020 is not shown in the Energy Master Plan (see Table 4.5). As of now coal is subsidised in Vietnam, which artificially creates low prices for electricity. So electricity from conventional resources is comparatively cheap and incentives for investment in renewable energy little. A state driven investment into renewable energy technologies seems to have low priority. With limited budget the authorities have obviously prioritized to cover the socio-economic needs for electric power first. For the government, in short term the cheapest way is to utilize conventional energy resources.

Table 4.5: Projected renewable energy resources as in Power Development Master Plan 6.

	2005	2020	2030
Small/mini hydro (MW)	185	1000-1200	
Wind power (MW)	0,80	300-400	
Solar power (MW)	1,15	4-6	
Biomass (MW)	150	310-410	
Geothermal (MW)		100	
Total (MW)	**336,95**	**1700-2100**	**3500**

Source: KHANH TOAN ET AL., 2010: 7.

To boost network efficiency, reliability shall be enhanced with the installation of 220-500 Kilovolt (kV) lines for economically important regions and the change of 6 and 10 kV lines to 35 and 22 kV (KHANH TOAN ET AL., 2010). As part of further grid extension the development of transmission interconnections with neighbouring countries, including Laos, Cambodia and China aims to add flexibility to the exchange of electricity supply in the region. Another important aspect on the demand side is the promotion of energy efficiency and energy conservation. Tax deductions and funds for investment in energy efficiency are already in place and planned to be expanded as incentives for domestic and commercial energy consumers to invest in energy efficient equipment (KHANH TOAN ET AL., 2010: 9). Despite all these somewhat promising plans, it needs to be taken into account that concrete policies or laws are far away from being enforced.

Considering the energy goals for the year 2020 and the time needed to develop electricity generation facilities, especially in terms of development of renewable energy, precise and reliable frameworks are needed soon in order the achieve these goals. Up to now only scattered, but not universally valid agreements are in place between the government and investors.

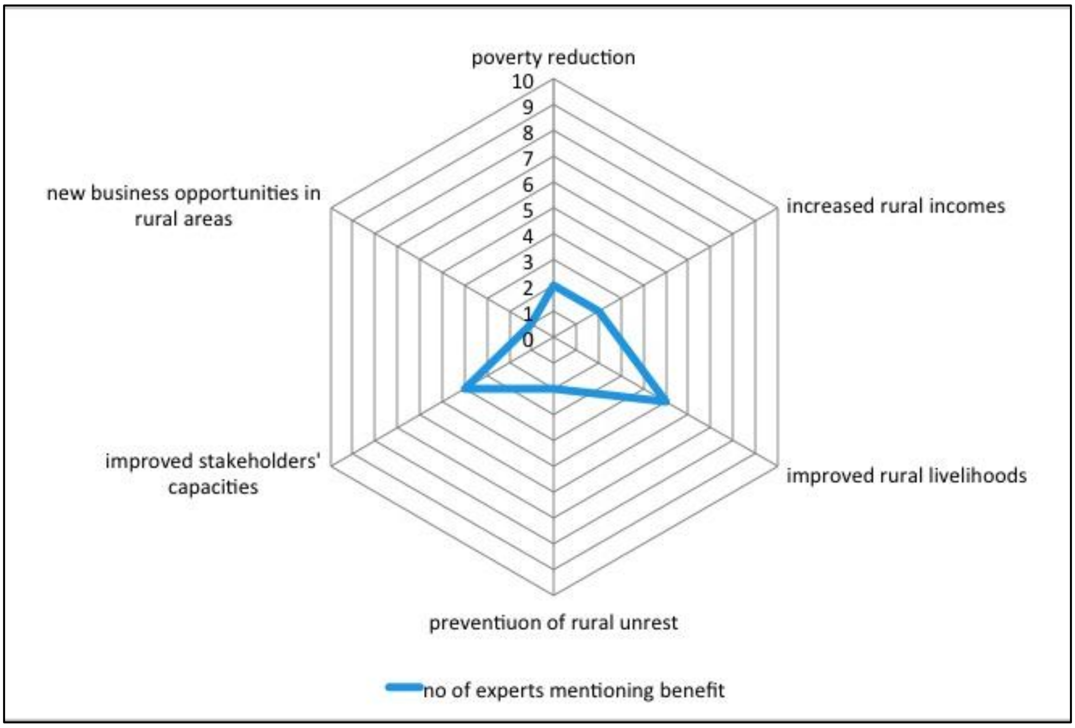
5 Rural electrification and resulting challenges – empirical results

5.1 Benefits and beneficiaries of rural electrification

The benefits brought to rural regions were the central concern of the government in the scope of rural electrification. Moreover the Vietnamese development in rural electrification is considered very successful in this respect. The reduction of poverty, increased rural incomes and enhanced public services resulting in improved livelihoods are the main benefits of providing rural Vietnam with electricity. As expected, the perception of involved experts in regards of the benefits of rural electrification is generally in line with the findings from reports (see Figure 5.1). However, most experts clearly perceive improved rural livelihoods as the most valuable benefit (see appendix B: E3Q4, E5Q3; E8Q3; E9Q2; E10Q2). While the aspects of poverty reduction, increased rural incomes and possible new business opportunities in rural areas receive recognition as well, the livelihoods aspect is dominant in the experts perception of benefits of rural electrification. The livelihoods approach is closely connected to the aspect of sustainability. For lasting sustainable livelihoods, it requires a sustainable basis, ergo sustainable electricity supply.

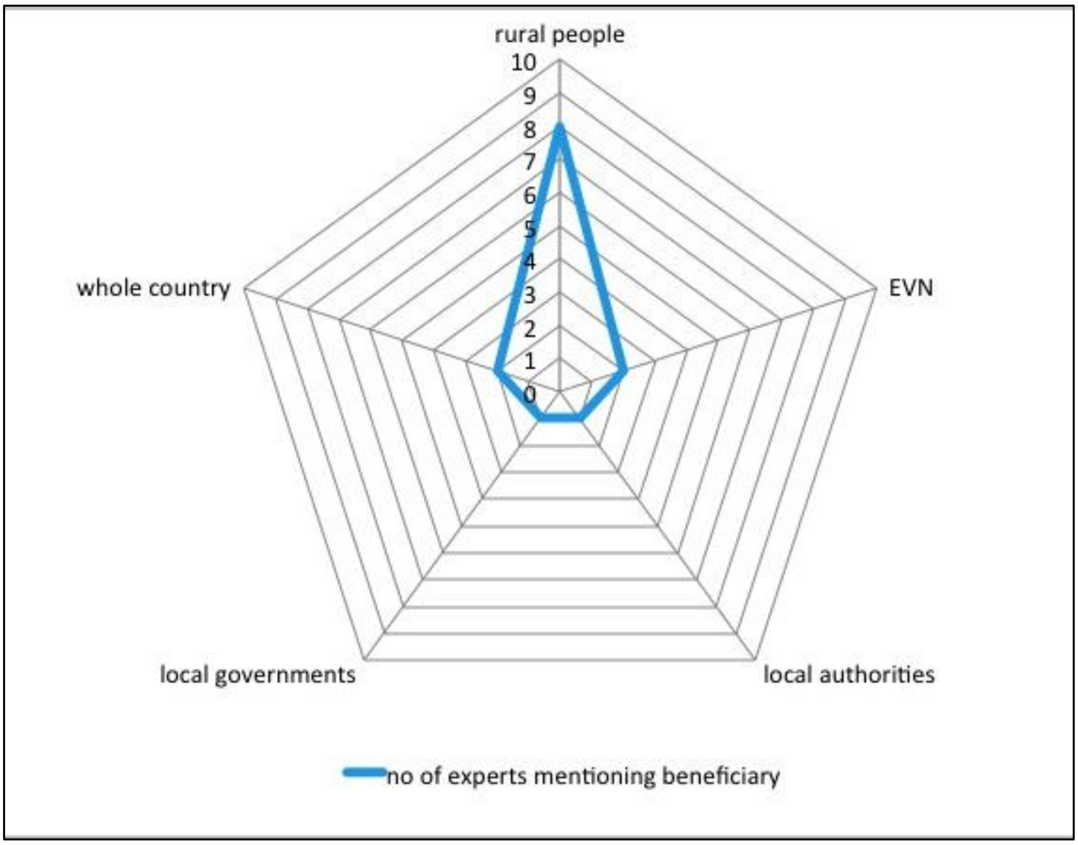
Another central benefit of the rural electrification efforts recognized among the experts was improved capacities for various stakeholders, explicitly in terms of technical expertise, management skills or analysis techniques (see Appendix B: E5Q4; E6Q11; E9Q4; E10Q3-Q6). These enhanced capabilities and capacities support societal sustainability and the Vietnamese ability to maintain development at least partly from the country's own expertise. Interestingly two experts explicitly mentioned rural electrification as a political instrument for pacifying unstable regions with strong socio-economic tensions. Many different ethnical minorities live in the remote regions of Vietnam. Vietnam is a country with high ethnic diversity, but strong public national Vietnamese emphasis. Consequently there is a benefit for these groups in terms of living conditions and perceived recognition by government and authorities. Hence, rural electrification can also be seen as a governmental instrument to develop regions with high populations from ethnic minorities to prevent protests, which can eventually threaten national stability to a certain extent (see appendix B: E3Q9; E7Q4).

Figure 5.1: Main benefits from rural electrification in Vietnam as perceived by experts.



Source: Own graph.

Figure 5.2: Main beneficiaries from rural electrification in Vietnam as perceived by experts.



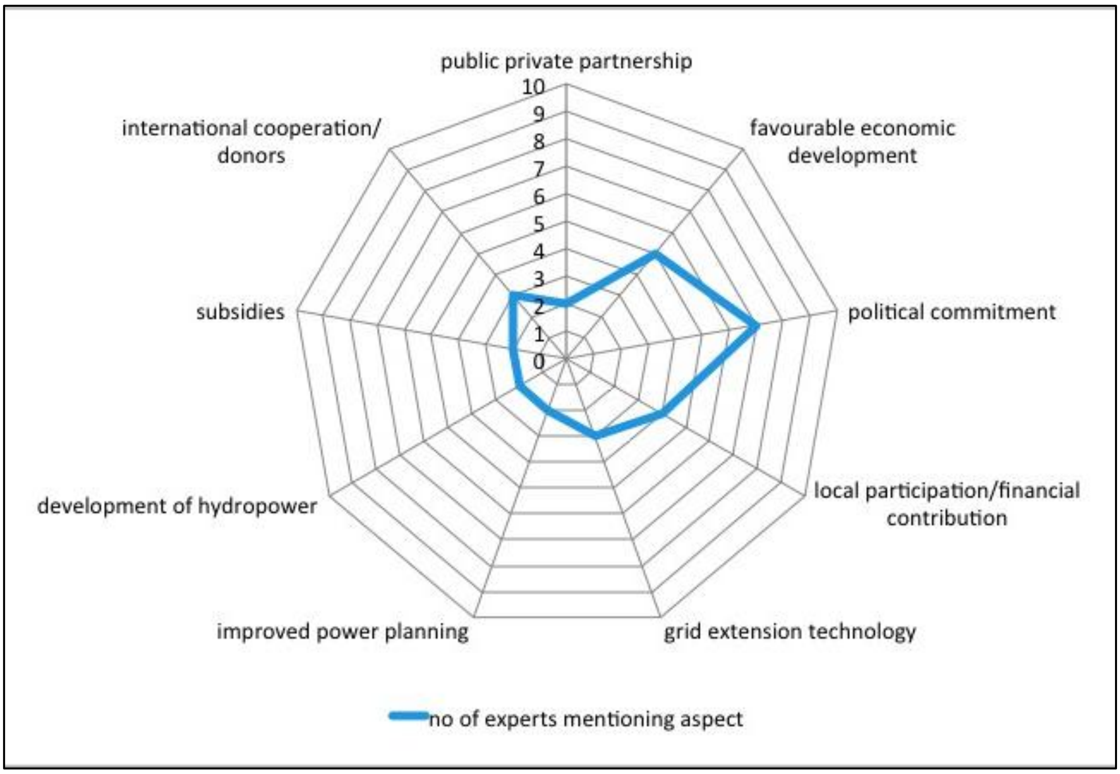
Source: Own graph.

The perceptions regarding the beneficiaries of rural electrification correspond to the benefits (see Figure 5.2). Unsurprisingly the rural people are considered the main beneficiaries with major recognition from the experts. The positive development eventually falls back to the whole country, so Vietnam as a nation is considered a beneficiary as well. Nevertheless, side effects of rural electrification are being noticed. The role of EVN is ambivalent. Acting on a basis of governmental social obligation, it seems to have benefited from experiences with improved capacities in managing the power network by closely cooperating with international consulting and receiving technical assistance. Capacity building triggered institutional development, enhancement of technical design and local operation of rural networks, which significantly reduced the costs in managing these networks (see Appendix B: E2Q5; E5Q4; E6Q6; E6Q11; E10Q5). Interestingly the Ministry of Industry and Trade as a government representative considered itself, so the central and provincial governments and local authorities, as beneficiaries of rural electrification projects (see Appendix B: E10Q4; E10Q5; E10Q6). Accordingly, deriving from the data as well as from expert perception, Vietnam is close to fulfilling the self-set goals in rural development with the means of rural electrification. Rural development was triggered and side-effect-benefits could be gained. However, sustainability of rural development now depends on national energy policy. If electricity is considered as a basis for sustainable development, electricity itself needs to be sustainable.

5.2 The drivers of the process

Vietnam's remarkable success in electrifying rural regions does raise questions about what the reasons are and which institutions in Vietnam were substantial contributors to this development. Indeed there seems to be one very central aspect to the Vietnamese case – the governmental and political commitment (see Figure 5.3). Concordantly experts stressed the importance of the governmental role and that this represents the major difference to other countries in the region, which opted for a market oriented approach (see Appendix B: E1Q7; E2Q6; E3Q9; E4Q5; E7Q5; E8Q5; E9Q8). With a market oriented approach most of the rural regions in Vietnam, which are mostly very poor, would not have been provided with access to electricity for years. The rural poor simply would not have been able to afford a connection to the power network or the application of off-grid systems. This rather political approach is what apparently marks the main difference to neighbouring countries like Cambodia or Laos, whose governments do not offer a framework for subsidies in the power sector or for electricity consumers and follow a market approach, selling electricity at least at generation cost.

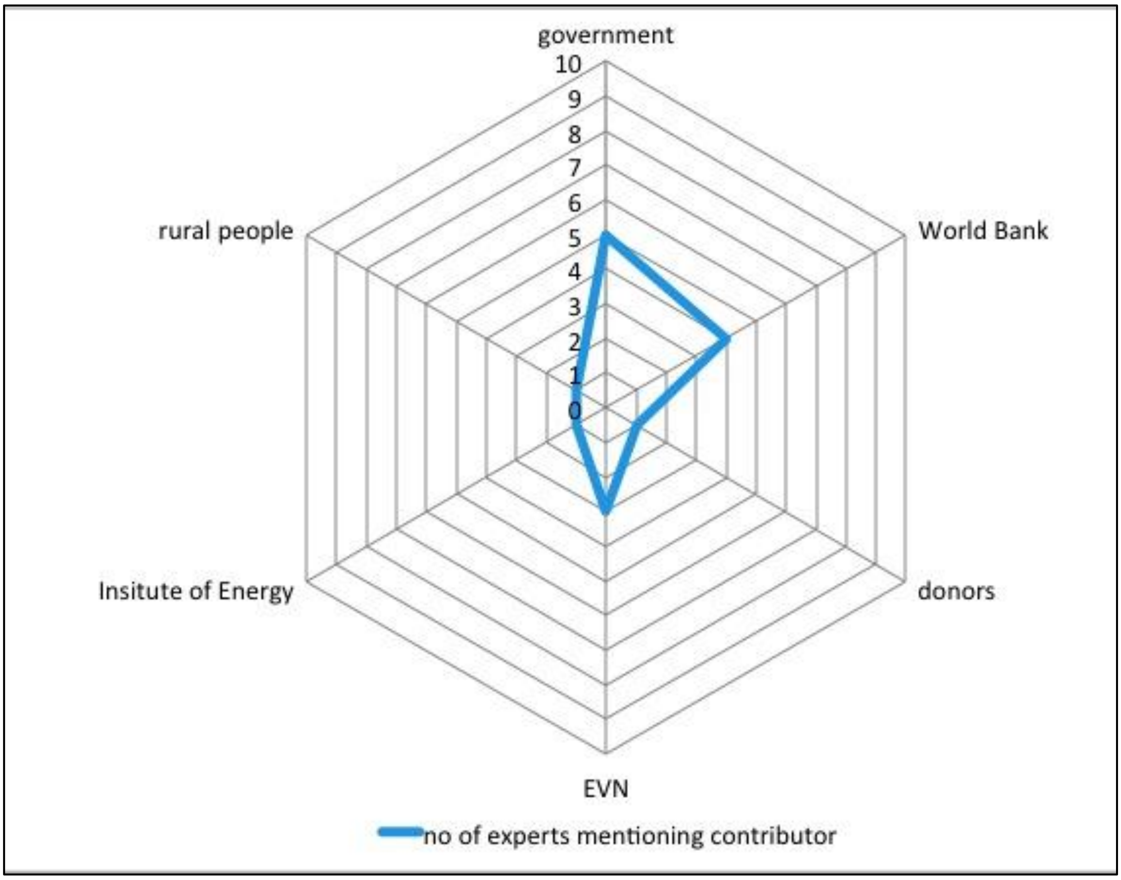
Figure 5.3: Crucial aspects of the success of rural electrification as perceived by experts.



Source: Own graph.

Alongside political commitment the willingness of rural people to contribute is considered a major driving force of rural electrification in Vietnam. Local contribution through connection fees is considered important for financing the rural electrification. The local contribution is reflected in the cooperation between private and public stakeholders as well, namely the sharing of the economical burden between EVN, private investors and the households (see Appendix B: E1Q5; E1Q8; E2Q6; E6Q7). EVN provides MV and main LV lines, while each household is responsible for the wiring to the house including the meter (NGUYEN, 2010). This viewpoint is supported adding the fact that subsidized tariffs and financial assistance from the government apparently enabled the local people to financially contribute to the connections and thus progress in rural electrification (see Appendix B: E3Q10; E3Q11).

Figure 5.4: Main contributors to Vietnamese rural electrification as perceived by experts.



Source: Own graph.

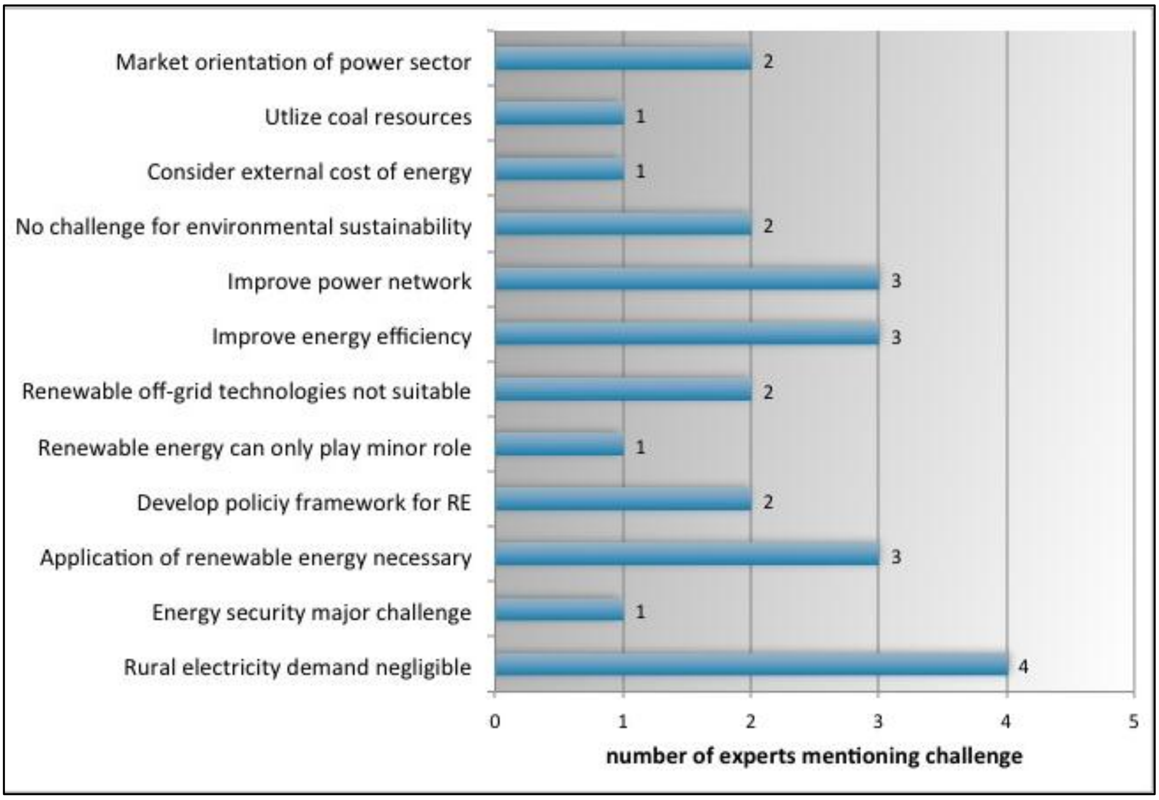
The overall economic development of Vietnam since 1986 created favorable conditions for the success of the electrification projects as well, providing the government with funds (see Appendix B: E1Q6; E5Q6; E6Q8; E7Q7; E9Q7). Obviously, without the funding by international donors, the speed of the development would not have been possible. Considering the volume of funds from the World Bank of over 700 million US Dollars and from ADB of 151 million US Dollars, this component is not to be underestimated. Correspondingly the World Bank is considered one of the major driving contributors for rural electrification next to the government driving the process with political commitment (see appendix: E2Q13; E3Q14; E6Q10; E7Q10) (see Figure 5.4). Interestingly only one expert recognized the donors in general (see Appendix B: E5Q8), which highlights the special and shaping role of the World Bank in financing and supporting the electrification projects. Besides the loans and the technical and professional assistance, the involvement of the World Bank reportedly had another effect: It made the progress "more aggressive" (see Appendix B: E2Q13). The loans were bound to certain criteria, a transparent management and detailed reporting on how the money was spent. This way the funds were more likely to be invested effectively and efficiently, as the spending needed justification. From a technical perspective there seems to be a general agreement, that extension of the power network was the cheapest and economically most feasible way (see Appendix B: E4Q4; E7Q6). However, this approach was heavily subsidized by the government, which posed a major disadvantage for renewable off-grid solutions (see Appendix B: E2Q7, E2Q11). Moreover off-grid systems are considered hard to maintain and too costly (see Appendix B: E4Q14; E6Q14). Consequently subsidies and local capacities to operate the systems would be needed in this case. In this context the availability of energy resources needs to be mentioned. According to two experts the abundance of pico and mini hydropower (definition given in chapter 6.5.3) potential does play a vital role (see Appendix B: E3Q8; E6Q8). The hydropower potential supported schemes for remote regions, where mini hydropower was applied. However, often operating micro and pico hydropower facilities were abandoned, once grid connection was established, because power supply from the grid is considered more reliable (MARTINOT ET AL., 2000: 15). Already utilized potentials for electricity generation were abandoned, while still 75% of hydro-electricity potential were considered untapped in Vietnam in 2004 (WORLD BANK, 2006: 9).

Besides the mentioned major contributors (the central and provincial governments and the international donors and the World Bank in particular), experts consider the national Vietnamese electricity provider EVN and the Institute of Energy (see Figure 5.4) to have made considerable contributions to the success of rural electrification (see Appendix B: E1Q9; E3Q13; E9Q10). These stakeholders planned and eventually established access to electricity in rural regions. However, the Vietnamese government is deemed to have been the main driver of the development in rural electrification. EVN as well as the Institute of Energy are in charge of fulfilling the government's targets. Without the political commitment, the enforcing policies and financial support for the performing parties such as EVN or the Institute of Energy, the velocity of the increase in community and household electrification would not have been possible. As the policy making body the government can be considered the most crucial part of the chain.

5.3 Challenges induced by rural electrification

The fast development and the tremendous achievements do leave Vietnam with some challenges in terms of energy and rural development in the years to come. The subjective viewpoints of the experts vary widely at certain points, given the multitude of responses. This is due to the open semi-structured character of the interviews. Some main statements can be derived, giving a comprehensive overview of the experts' perceptions (see Figure 5.5). The challenge of energy security seems to be self-evident, but the experts largely agree, that the challenge mentioned is not a direct result of the development in rural electrification. Many experts consider the rural domestic electricity demand negligible (see Appendix B: E1Q10; E2Q14; E4Q9; E6Q12). Nevertheless in the mid and long term future rural electricity needs may increase as industrial structures might form in rural areas as a result of improved infrastructure, higher incomes and increasing demand for goods (see Appendix B: E6Q13).

Figure 5.5: Main expert statements about challenges for power sector.



Source: Own graph.

Further improved reliability of electricity provision is needed to prevent blackouts (power outages) and brownouts (drops in voltage). This includes improvement of the power network for reduction of transmission losses (see also Figure 4.9) as well as progress in energy efficiency (see appendix B: E2Q16; E3Q15; E4Q10; E5Q9; E8Q9; E9Q14).

One barrier for renewable energy to enter the electricity market is the lack of consideration of the external cost compared to conventional energy sources (see Appendix B: E2Q15). Consequently the relatively high generation cost from this perspective leads to missing policy support, which would be needed to promote renewable energy in Vietnam (see Appendix B: E7Q13). Hydropower systems take higher priority in the Master Plan 6 thanks to the relatively cheap price of electricity generation and the experience with hydropower in Vietnam. Some experts fear that most hydropower potential might soon be tapped (see Appendix B: E4Q11; E6Q15). This however applies only to hydropower potentials, which are suitable for grid connection. Potential of micro or pico hydropower, typically used for communities or single households, needs to be considered separately. So the need for alternative energy resources is evident, despite the fact that the planned role of coal as the main resource in the future is still estimated important and crucial for meeting future energy demand by at least one expert (see Appendix B: E4Q12). Coal is subsidized in Vietnam, as are the tariffs (Decree 45, see chapter 4.3). This aspect is directly linked to a major challenge, which is widely accepted and targeted by the government with the creation of ERAV – the transformation to a market oriented power sector that covers the generation cost (see Appendix B: E5Q11; E8Q8). A non-market oriented power sector does not leave the possibility for alternative energy sources to be cost-competitive against conventional sources that are subsidized by the government (see Appendix B: E2Q15; E7Q13). In this context there seems to be no considerable awareness for environmental issues so far (see Appendix B: E3Q16 and E10Q7, quotes from experts, who represent government and advisory). Only few experts explicitly referred to the importance of renewable energy and the barriers renewable energy faces in Vietnam (see Appendix B: E2Q16; E5Q10; E6Q16). However, there seems to be a tendency in favour of renewable energy given the experts mentioning this, even though the contribution of renewable energy in comparison with the overall power supply is mostly considered little (see Appendix B: E2Q16; E3Q17; E4Q13; E5Q13; E6Q16). In general experts rate the benefits of small-scale decentralized off-grid and grid-connected electricity generation as relatively low, while larger and centralized power generation is considered more appropriate. There are still households without officially recognized access to electricity (see Appendix B:

E9Q12). Many experts seem to have lost sight of this challenge with such a tremendous development already achieved. The households still not connected until now belong to the most remote and poorest in Vietnam. They and the other poor rural people are to be supported in case of a transition to a market-oriented power sector. Higher electricity tariffs could be unaffordable and thus impede the benefits of rural electrification for the rural poor (see Appendix B: E5Q12).

5.4 Summary

The impressive development in terms of rural electrification in Vietnam is documented and widely recognised. The World Bank report on rural electrification in Vietnam (GENCER ET AL., 2011) is a comprehensive source covering several aspects about developments and benefits. During the first part of the interview the experts largely shared the perception stated in the report. The rural people are recognized as the main beneficiaries and their improved livelihoods and poverty reduction as the main benefits. The benefits in terms of rural development and poverty reduction are measurable and evident. So far the experts' view on the benefits and beneficiaries is no surprise. Beyond that, one aspect came up, which is important and has hardly been covered in corresponding literature. Many experts think that the stakeholders' capacities improved through the process of rural electrification. Organizations like EVN or the government and related bodies went through a learning process gaining new capacities in management. Technical capacities were developed with the introduction of new network technologies. While the rural population is still considered to be the main beneficiary, the mentioned organizations and connected individuals are beneficiaries as well. The government and its political commitment are considered the main driver of the process, while favouring economic conditions, extensive support by donors in general and the World Bank in particular are recognized. The involvement of international donors did have the specific effect that the whole process of electrification in Vietnam had to become more efficient. Investments in the frame of international cooperation needed justification and thus supported a transparent and efficient management as well as standardized and efficient technologies. From the technological perspective grid extension is considered to have been the only possible way to electrify the country quickly and in a cost-efficient way. All this is what makes Vietnam a showcase in successful rural electrification.

However, the success leaves the country with certain challenges arising on the background of the overall energy situation in Vietnam. In this respect the experts' perceptions are harder to interpret due to the semi-structured character of the interviews. Nevertheless, general tendencies can be derived and contradictions become obvious. In general the rural electricity demand due to newly connected communes and households is considered negligible for the overall electricity consumption. Only one expert mentions rural socio-economic development and related new business and industry structures, which will increase rural electricity consumption in mid-term. So in general the challenges for the energy sector are not considered connected to rural electrification. In the scope of overall energy supply and consumption the need for improving energy efficiency and further technological enhancement of the power grid are widely recognized. On the one hand, application of renewable energy solutions and their institutional and legal support is considered important. On the other hand, small-scale off-grid solutions are perceived as being unfeasible. The need for alternative energy sources to support the socio-economic development is recognized and called for, but small-scale potentials neglected. However, in general the experts seem to acknowledge the need for alternative sources of electricity to cover the power needs in the future. Only one expert mentioned the importance of coal and its inevitable dominance in the future, which is in line with the official energy planning in the Power Development Master Plan. In the perception of some experts market orientation of the power sector is needed in the long term to make electricity generation and consumption more efficient. This means that the government needs to abandon the mechanisms that made the rural electrification process so successful and fast. For a more intensive and efficient application and development of renewable energy technologies the consideration of external cost would eliminate a structural disadvantage of renewable. Costs which are induced by fossil fuel, need to be mirrored in the price of electricity generated from these sources. On top supportive initiatives for renewable energy are considered important.

In summary, the results of the interviews show that in terms of rural electrification the experts unanimously agree to the major aspects described in most official reports, while they mentioned some individual aspects that were left disregarded until now. Regarding the challenges for the future the need for renewable energy solutions in conjunction with improvement in energy efficiency and technological enhancement is the main aspect noticed and appreciated among experts.

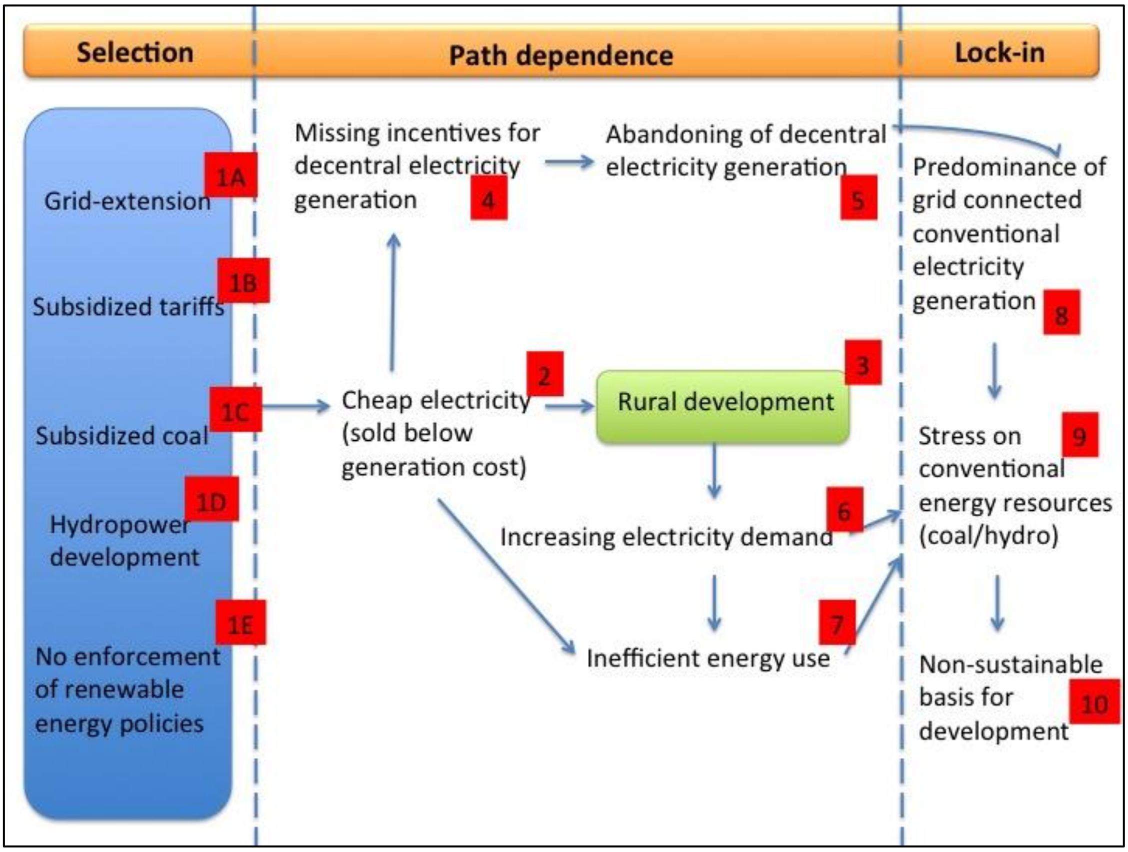
6 Path dependence and path alteration in the power sector

6.1 How rural electrification created a path

The prime goal of Vietnam's power sector efforts in the last years was to provide rural parts of the country with access to electricity as an enabler for rural development. International programmes with impressive funds, political commitment, local will and a dedication to grid extension are the ingredients of the success story of rural electrification in Vietnam. There is no doubt, that the rural electrification programmes triggered rural development and helped to improve the living standards and livelihoods. The experts' statements in this respect strongly support this perspective. However, considering the current energy situation and the plans the government has for the years to come, these benefits come at a price in terms of long-term sustainability. In the opinion of most experts improved energy technology and efficiency is needed alongside the application of renewable energy solutions. So indirectly the experts acknowledge the danger of path dependence in the Vietnamese power sector. In fact, deriving from the overall power sector background, a multitude of aspects shaped that path, Vietnam's energy sector is likely about to follow in years to come. Extension of the power network was a major aspect and factor of success in rural electrification. However, grid-extension, being a large infrastructure project, has created path dependence already, because of the very large embedded costs and investments that were needed. The lifespan of the network and the connected large, medium and small-scale power plants is generally considered to be about 40 years. This enforces the probability of a continuation in the current technological situation regarding the mentioned timeframe. The decision for grid extension is considered crucial for the success in rural electrification, but in conjunction with the energy sources results in technical and economical path dependence. The topic of electricity supply will to the largest part be bound to grid based supply. This path dependence created by extension of the power grid creates barriers for decentralized or off-grid alternatives.

Another aspect is the fuel mix in a country at a specific point in time. It is a result from the available resources, economic capacities, political choices and history (VERBONG ET AL., 2002: 10). Hence, the energy mix in Vietnam is a result of country specific conditions and decisions: The country applied various sizes of hydropower facilities on a broad scale thanks to the resource abundance and experience with hydroelectricity. The utilization and subsidization of coal was a political choice and the use of biomass is a result of geographical and economic conditions as well as historical development.

Figure 6.1: Path dependence of the Vietnamese energy sector.



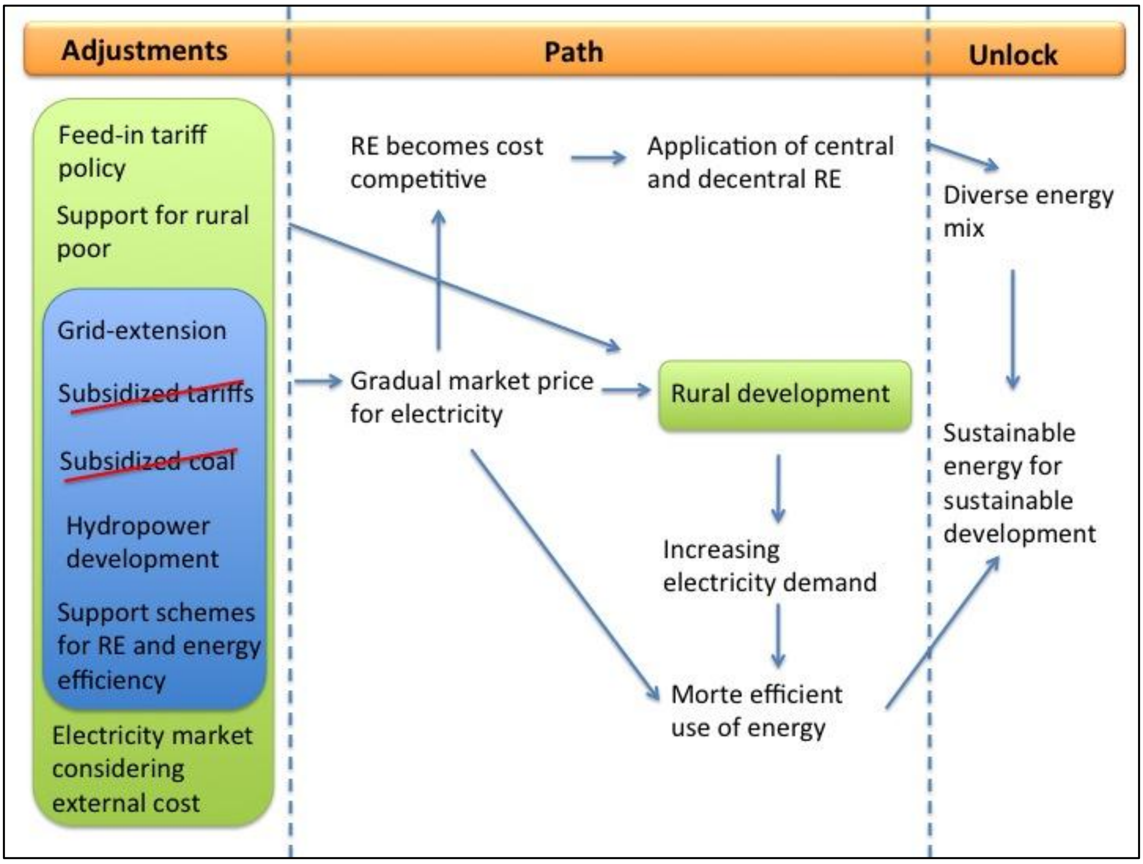
Source: Own figure.

In the specific case of Vietnam this means that the central government's decision on grid extension (1A) (in accordance with the donors) creates a long-term dependence on national grid-based electric power provision (see Figure 6.1). This, in conjunction with the subsidized tariffs for rural residential consumption (1B), strong subsidization of coal as an energy resource (1C) and the broad application of cheap large and small hydropower (1D) leads to very cheap electricity (2), which is sold below economic generation cost. Of course this is one of the factors why rural dwellers can afford electricity as an enabler for poverty reduction and rural development (3). On the other hand this reduces incentives for investing in alternative resources and decentralized electricity generation (4) such as solar home systems, small wind power units or micro and pico hydropower. Their economic cost of electricity generation cannot compete with the artificially low tariffs from the grid. Some micro and pico hydropower facilities, which were in use prior to grid connection, were abandoned with grid connection and their potential thus wasted (5). Missing enforcement and dedication of policies on application of renewable energy (1E) contribute to the dominance of conventional ending resources and hydropower. As a result, not only potentials for renewable decentralized electricity generation are left unused, but renewable energy potential as a whole is neglected for the sake of artificially cheap energy. Reduction of poverty, rural development and increasing incomes will result in increasing electricity consumption in the mid-term (6). This hypothesis is supported by the findings of the World Bank that the average electricity consumption of rural households in Vietnam increased markedly (up to over 400%) in the cause of the mentioned impact study of the IoS (GENCER ET AL., 2011: 45-47). An increasing demand for electricity in conjunction with extremely cheap electricity tariffs is likely to result in an inefficient use of electricity (7) simply due to lacking incentives for saving energy. In the short-term this especially applies for urban areas with higher incomes and low electricity tariffs. The mentioned conditions and political decisions in favour of hydropower and coal lead to predominance of certain energy resources (8). Considering the Power Development Master Plan 6 coal is expected to be a dominant energy source by 2030. Inefficient use of electricity and the predominance of a limited range of energy sources apply pressure on the conventional energy resources (9). With the prospect of being a net energy importer of primary energy by then, the path leads to threatened energy security. Vietnam will be dependent on coal imports and its own ending resources. Considering the worldwide competition for energy resources, this is likely to result in a political dependence from states exporting coal. Vietnam's energy path leads towards a dead end, because using ending resources is diametrically opposed to the principle of sustainability. The country is not able to maintain or nurture its own development, because it is based on a naturally ending resource. As a result of political decisions and economic conditions in terms of energy and electricity, Vietnam is about to strengthen the path and potentially locks itself into multiple issues like inefficient energy utilization, the dilemma of aiming at sustaining growth with an unsustainable energy mix and the prospect of facing overexploitation of resources, environmental degradation and threatened energy security (10). Consequently, I propose that some experts are wrong in their assumption that environmental sustainability is no major concern for Vietnam and the national energy strategy.

6.2 Possibilities of path alteration

Altering a path and thus escaping a lock-in effect is always dependent on the strength of the path dependence. Considering the dominance coal has in the Vietnamese power strategy, third-degree path dependence (according to the classification from LIEBOWITZ AND MARGOLIS, 2000: 981) would be the result. In the case of the Vietnamese power sector this means that path dependence will strengthen, while conventional energy concepts are followed and the chances for alternative energy concepts are neglected. There will be one dominant energy source, which is not efficient due to its ending character. This error is avoidable, if more efficient and lasting sources of energy supply would be chosen. However, Vietnam is in an early phase of the path and altering it or even creating a new path is still possible, given the fact that Vietnam is still at the beginning of developing large energy capacities for future needs. In order to develop towards providing sustainable energy for sustainable development, there are different measures that can be taken to redirect the path towards this aim (see Figure 6.2)

Figure 6.2: Possibilities of path alteration in the Vietnamese power sector.



Source: Own figure.

To think about strategies to unlock the path dependence of the Vietnamese energy sector, one has to take into account the projections and scenarios for future energy need in Vietnam as described in Power Development Master Plan 6 (see chapter 4.6). It is important to rate the figures shown as scenarios. The projections are derived from population growth and GDP growth scenarios based on the conditions as they are today. Energy saving and progress in energy efficiency seem to be not considered. Moreover the possibilities for un-locking path dependence mentioned in the course of this thesis do not aim to realistically result in a strategy for a complete coverage of the future energy needs. They are rather strategic approaches to prevent or overcome a lock-in and utilize the potentials for a diverse and sustainable energy mix. This is even more important as Vietnam so far still lacks the development and implementation of a national energy policy on the background of ending resources and environmental scenarios. This might be the most important obstacle for a sustainable energy future. Specific targets and strategies of how to meet future energy needs and the role of renewable energy, institutional framework and initiatives are missing (UDDIN ET AL., 2009: 86-88). They are necessary to improve country specific technical performance and market penetration of renewable energy technologies (LAFFERTY AND RUUD, 2008: 25-27). So far the Vietnamese authorities have drawn scenarios and identified technologies that might cover the needs in the most cost-effective way. Currently no strategy is identifiable to make use of the potentials for wind, solar and biomass utilization. In addition a reliable framework is missing that would reduce barriers for private investors.

To consider sustainability as an integral part of energy, policies as well as legal and institutional frameworks should be embedded in a wider environmental context taking into account climate change challenges and environmental degradation with direct link to energy resources. It is not only about how to meet the electricity needs, but also how to adapt the country's needs to the feasible possibilities of electricity generation (EDINGER AND KAUL, 2000: 309). An integrated approach might be capable of creating an alternative path or altering the existing path in favour of sustainable energy supply for sustainable development. A multitude of policies, decisions, and initiatives can shape a path and make use of favourable conditions. As a side effect, dedication for renewable energy would create chances for domestic capacity building in renewable energy and related industries for instance (KARNEØ AND BUCHHORN, 2008: 88-90). To meet the multitude of challenges connected to the power sector, an all-embracing approach should address matters of energy supply, consumption and efficiency in the scope of sustainability. For instance, comprehensive energy efficiency initiatives are necessary to support energy efficient economy, housing and domestic consumption and to reduce inefficient use of energy and electricity. As the expert interviews show, this is already considered an urgent topic (see Appendix B: E2Q16; E3Q15; E4Q10; E5Q9; E8Q9; E9Q14). Efficient energy use and a diverse energy mix lead to a more sustainable energy basis for further socio-economic development in Vietnam. Under an integrated approach, considering energy as well as climate and environmental issues, measures can be taken to minimize the likelihood of a lock-in. Some critical measures and instruments are described in more detail in the following chapters.

6.3 Market orientation and consideration of external cost

The slow but steady development towards a market oriented power sector is considered as one of the major challenges for Vietnam's power strategy (see appendix B: E5Q11; E8Q8). A market oriented power sector would be likely to regulate the value of electricity to a more realistic level. Due to the substantial subsidies for coal, renewables are currently severely handicapped in terms of electricity generation cost. EVN or other electricity generating facilities buy coal for a subsidized price, which has a major impact on the generation cost. With the establishment of ERAV, Vietnam made a first step towards a competitive power market and further steps to establish a competitive power market are planned (WORLD BANK, 2006: 39-41). However, such a market is not a solution in itself. State subsidies veil the real price for power generation from fossil resources and the cost of environmental degradation from resource exploitation and atmospheric pollution is not reflected in the price of fossil resources. In a market oriented power sector the success of an energy resource depends on its cost-competitiveness. External effects include environmental degradation and health care cost as a result of pollution caused by the utilization of fossil energy resources. Hence, the real cost of electricity generation including external cost needs to be considered. The negative externalities for fossil fuels would need to be incorporated in the electricity prices. Internalisation of external cost in the price of electricity is an important instrument towards the sustainable energy development. Environment is an asset that is not considered appropriately yet (see Figure 5.5). Nature itself is not given an appropriate price in the global economy (EDINGER AND KAUL, 2000: 19). If the mentioned external effects would be taken into account the cost of renewables would be considerably lower since years (HOHMEYER, 1992: 367). Furthermore renewable sources like solar or wind power are not subject to fluctuating prices as fossil fuels are. However this approach needs broad international recognition and enforcement to be effective. In Vietnam EVN has no obligation to buy from renewable energy projects at a price reflecting the full social benefits of clean energy sources (NGUYEN AND MINH, 2009). However, a consideration of external cost is an international issue, which Vietnam can hardly address alone.

Probably the first step to be considered would be cutting the subsidies to coal. The diminishing cost advantage of coal would increase the cost-competitiveness of renewable energy applications within a short time frame. This would be a first step to a competitive power market with prices reflecting the real value of an energy resource. This however is not a pleading for an unregulated electricity market, but rather a call for prices shaped by a market considering external cost. A more market oriented power sector would also mean non-subsidized electricity tariffs. In June 2011 the tariff per kWh in Vietnam was staggered depending on the overall consumption between 993 VND and 1962 VND (0,034 Euros and 0,067 Euros). The government aims to increase the electricity tariff on a yearly basis. The most recent price hike was 15,3% in March 2011 (VIETNAM BRIEFING, 2011; VIETNAMNEWS, 2011). With the yearly increase the government tries to resolve the mismatch between production costs and state administered prices in the long term. However, incorporation of externalities in the electricity prices is still far from being considered. Anyhow financial support for the rural poor would be needed in order not to sacrifice rural development and livelihoods for the sake of a power market and realistic electricity tariffs.

6.4 Institutional support for renewable energy and energy efficiency

As stated before, according to Power Development Master Plan IV conventional renewables (e.g. in Vietnam mostly biomass and hydropower) will account for an ever-decreasing share of total power generation, estimated to less than 10% in 2030. On the other hand, the plan aims to increase the share of renewables including modern technologies (e.g. wind power, solar etc.) to 11% in 2050 (KHANH TOAN, 2010: 5). These rather conservative and low-key figures do hardly consider the potential of renewables in Vietnam. Some wind energy projects that are in the pipeline, already exceed the goals described in the Master Plan. To date renewable energy does at least enjoy some governmental interest, but is lacking specific public support and promotion. A number of laws and governmental decisions are in place that shall provide financial support in form of tax exemptions, government loans and grants and free land use to investors in renewable energy projects (GIZ/MOIT, 2011; 16-19). In the scope of rural electrification schemes for micro credits do exist and proved to be very successful. For instance, financing for SHS installed by World Bank projects in the 1990s was provided by a complex credit scheme involving the Vietnam Women's Union (VWU), the Vietnam Bank for Agriculture and Rural Development (VBARD) and a private dealer (MARTINOT ET AL., 2000: 10-11). Such financial support instruments appear to be very suitable especially for decentralized stand-alone systems. However, in a wider scope and under the given circumstances with the massive subsidization of coal, similar initiatives seem not attractive enough for investors, as development is rather slow. The problem however seems to be on a higher level. NGUYEN AND MINH (2009: 19) refer to insufficient co-ordination and the multiplicity of responsible government bodies as the main barrier to the successful application of renewable energy projects. The current policy framework is considered inadequate and a proper framework for promoting renewable energy is missing. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) together with the MOIT is currently working on the establishment of a government agency solely dedicated to the planning and development of renewable energy, including the application of CDM (clean development mechanism) projects and the development of feed-in tariff policies. This would be a first step towards the all-embracing approach, this paper called for earlier. This approach should not only include legal reliability, incentives and support for investors and developers, but also dedicate a part of its work to another aspect, located even earlier in the renewables development process – namely research and development. More dedicated and increased investment for research and development (R&D) might lead to more reliable national estimates of renewable energy sources (NGUYEN AND MINH, 2009: 19). For instance, so far comprehensive wind power potential measurements are scarce and reliable data is only available for some selected sites. This hampers and complicates planning of renewable energy projects development. Investment in R&D training facilities is likely to result in a stronger workforce of skilled labour for renewable energy technologies. As a demand side aspect, accompanying energy efficiency measures would optimize the utilization of electricity.

In this respect first steps have been taken. The "Viet Nam National Energy Efficiency Program" (VNEEP) was set up in 2005 to lay out energy efficiency programs up to 2015. It is the first long-term instrument to improve energy efficiency in industry, housing and other sectors in Vietnam. However, to date achievements in implementation seem not to cover the plans (APEC, 2009: 23). Appropriate enforcement of this program would be a crucial element of an integrative approach.

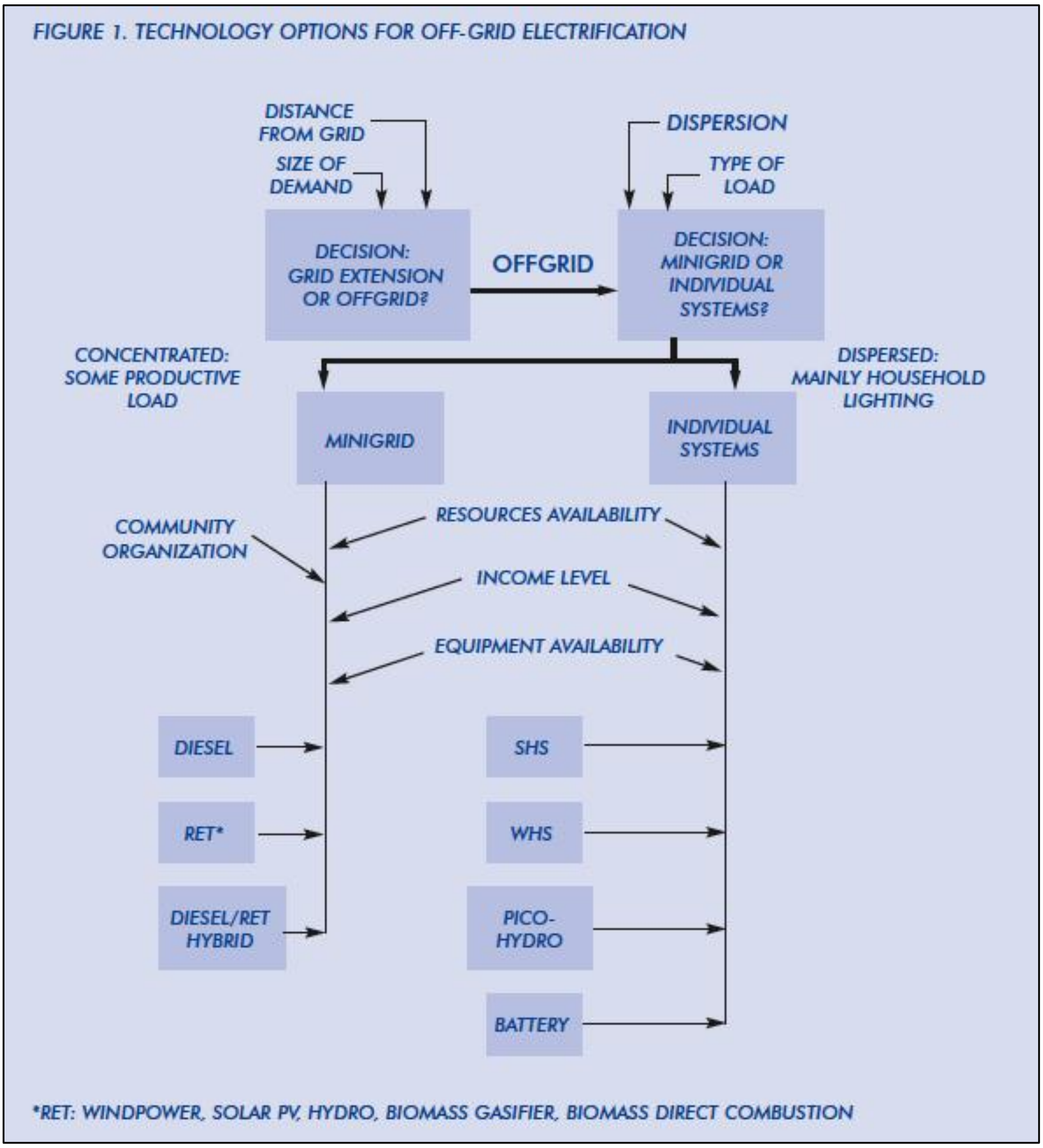
6.5 Decentralized electricity generation

6.5.1 Chances for unelectrified households

Decentralized electricity generation systems (DEG) originated in electrification efforts for remote locations with dispersed population. DEG systems are close to consumers, have no or only very little loss in transmission and do not necessarily need a power grid. They are easily applicable to remote locations because of generation of power close to the site of demand. In many cases, using decentralized technologies is more economical than extending the grid. Among available technologies, renewable energy technologies are often more efficient (NGUYEN, 2005: 155-157). So DEG options are mostly the least-cost options (compared to grid extension), for regions with low population density (NGUYEN, 2007A: 2579; KAUNDINYA ET AL., 2009: 2041-2042). Furthermore they can be set up quite quickly, as they need short construction periods (THONG ET AL., 2007: 1). The comparatively low capacity factor of DEG systems can be matched to the demand in rural areas, which is comparatively low. So the low load capacity factor of a small-scale DEG system is not necessarily a disadvantage. Given a sufficient number of consumers and DEG systems a mini-grid with combined capacities could be set up, facilitating local or regional power distribution (see Figure 6.3).

In Vietnam grid-extension resulted in the share of households that use off-grid electricity dropping from 18,4% in 2002 to 8.4% in 2005 (KHANDKER ET AL., 2008: 7). In 2009 more than 60.000 households in Vietnam were estimated to still use off-grid electricity (NGUYEN, 2010: 37-38). Most of these systems are generating electricity from biomass or are small hydropower systems. To date the role of solar home systems and especially wind energy is small to negligible (see Table 6.1).

Figure 6.3: Technology options for off-grid electrification.



Source: WORLD BANK, 2008B: 7.

The rural areas left not connected to the power grid are often characterised by low population densities with scattered clusters of dwellings. These very remote places, communes and households are mainly found in the northern highlands, the central highlands and parts of Bac Lieu province in the southwest of Vietnam. In regions with a very low population density, grid extension is often too costly relative to the number of end users. In other cases a connection to the national electricity grid is complicated or impossible due to landscape or distance barriers that cannot be overcome or only at a very high cost. For the years to come authorities aim at developing renewable energy off-grid solutions for the very remote areas, where the costs of renewable DEG systems are lower than diesel electricity or connection to the national grid (PHUONG, 2009).

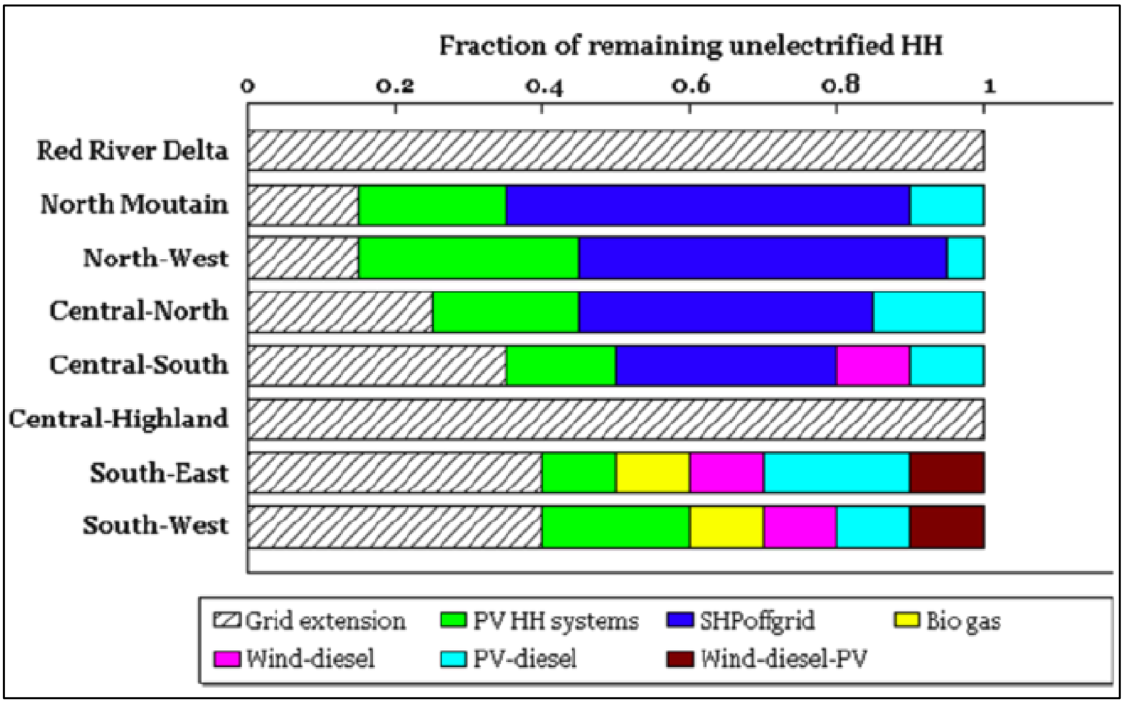
Table 6.1: Off-grid renewable energy in Vietnam as of 2008.

Type of off-grid rural renewable electricity generation	Installed capacity (kW)	Number	Average capacity (kW)
Small hydropower	9393,0	37	253,9
Biomass	121950,0	29	4205,2
Wind	42,0	8	5,3
Biogas	691,5	78	8,9
Solar home system	152,4	17	9,0
Total	132228,9	169	

Source: NGUYEN, 2010: 38.

In the frame of a rural electrification master plan the Institute of Energy estimated the regional potentials for DEG systems in Vietnam. While the remaining households in the Red River Delta and the central highlands shall be connected to the grid in the future, for some areas off-grid schemes are planned, because grid connection would be too costly. Notably, these are small hydropower (SHP off-grid) resources in regions with favourable water resource conditions in the northern areas (northern mountainous, north-west, central-north) as well as central-south (see Figure 6.4).

Figure 6.4: Feasible options for electrification for remaining unelectrified households.



Source: NGUYEN, 2010: 42.

To a lesser extent PV solutions (PV HH systems) and combined PV-diesel systems are likely to be applied in these regions as well as in the southern regions (south-west and south-east). The application of wind power solutions sometimes in combination with diesel generators (Wind-diesel) or PV and diesel generator (Wind-diesel-PV) is limited to the south, where wind speeds are more favourable. The planned utilization of biogas seems limited to the south as well.

6.5.2 Mini-grids, grid connection and the feed-in tariff

Besides rural electrification efforts renewable decentralized electricity generation can play an important role in diversifying the energy mix and contributing to a reliable overall electricity supply and a sustainable energy mix. The official planning as well as some experts' consider coal as the only reliable energy resource for the future (see Appendix B: E4Q12). Furthermore many experts think that renewables can only contribute little to cover the future electricity needs (see Appendix B: E4Q13; E4Q14; E6Q14). What is left unconsidered here is that the renewable energy potential increases, when small potentials for decentralized electricity generation (DEG) are taken into account. Many small capacities could be combined when connected to a grid. A grid-connected DEG system is an independent decentralized power system that is connected to a national or local power grid system (KAUNDINYA ET AL., 2009: 2042). In principle grid-connected systems work in the same ways as grid-connected large power plants do. They generate electricity and feed a local power grid often referred to as mini-grid or even the national grid. These grid-connected systems typically generate considerably lower loads, because most decentralized electricity generation devices, like photovoltaic systems, micro and pico hydropower or wind turbines operate on a relatively low load factor compared to big power plants. Renewable DEG systems have advantages due to their modular character and their ability to increase the overall power capacity incrementally, when jointly connected to a power grid. Hence, the combination of small, maybe formerly unused potentials add up to greater contributions to electricity generation. Outages in several small-scale generation systems are not as severe as outages from big central generation facilities (EDINGER AND KAUL, 2000: 299). Decentralized electricity generation encourages geographic distribution and would change the patterns of resource use. Energy resources would not only be used in a concentrated manner in a certain location, but many small resource potentials will be utilized spread over a wide area. As a positive effect of the substantial grid extension and network improvement in the last decade, Vietnam now has large power network coverage all over the country with some exceptions in very remote areas (see Figure 4.7). This is a favourable precondition, because generally a large power network would provide the possibility to a large range of contributors to feed the grid with decentralized generated electricity. However, the vision of broadly applied decentralized electricity generation does have certain barriers. In a socialist country with strongly centralized authorities like Vietnam the government seems to prefer large and centralized solutions, which are much easier to manage and to control. However, the major barrier for renewables to establish themselves in Vietnam is a lack of favouring policies, a reliable legal framework and the substantial subsidization of coal as mentioned before. While abandoning the coal subsidies would be a step toward a market-oriented power sector and would adjust the price of coal to a realistic level, reliable feed-in tariffs would be needed to utilize and promote decentralized electricity generation potentials. 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 (SIJM, 2002: 6). The independent producer could be a household, a community or another investor. This model could enable the efficient utilization of small electric power generation potentials and is widely applied in some industrial countries like Germany, Denmark or Spain.

A regulated and reliable feed-in tariff is a crucial incentive for investment. Such tariffs reflect a guaranteed return on investment and are an asset for banks to provide loans to households, communities and other investors (MENDONÇA, 2007: 103-104). This way the cost-competitiveness of renewable energy might lead to enhanced investment and application of large and decentralized small renewable energy facilities and thus to a more diverse energy mix. Given the relatively low income (Vietnam is classified as lower middle income country by the World Bank) of households in a developing country like Vietnam, further support schemes of DEG systems might be necessary. Special funding programs, government loans or tax deductions would be possible instruments. In parallel training and capacity building for skilled and trained technicians would be needed.

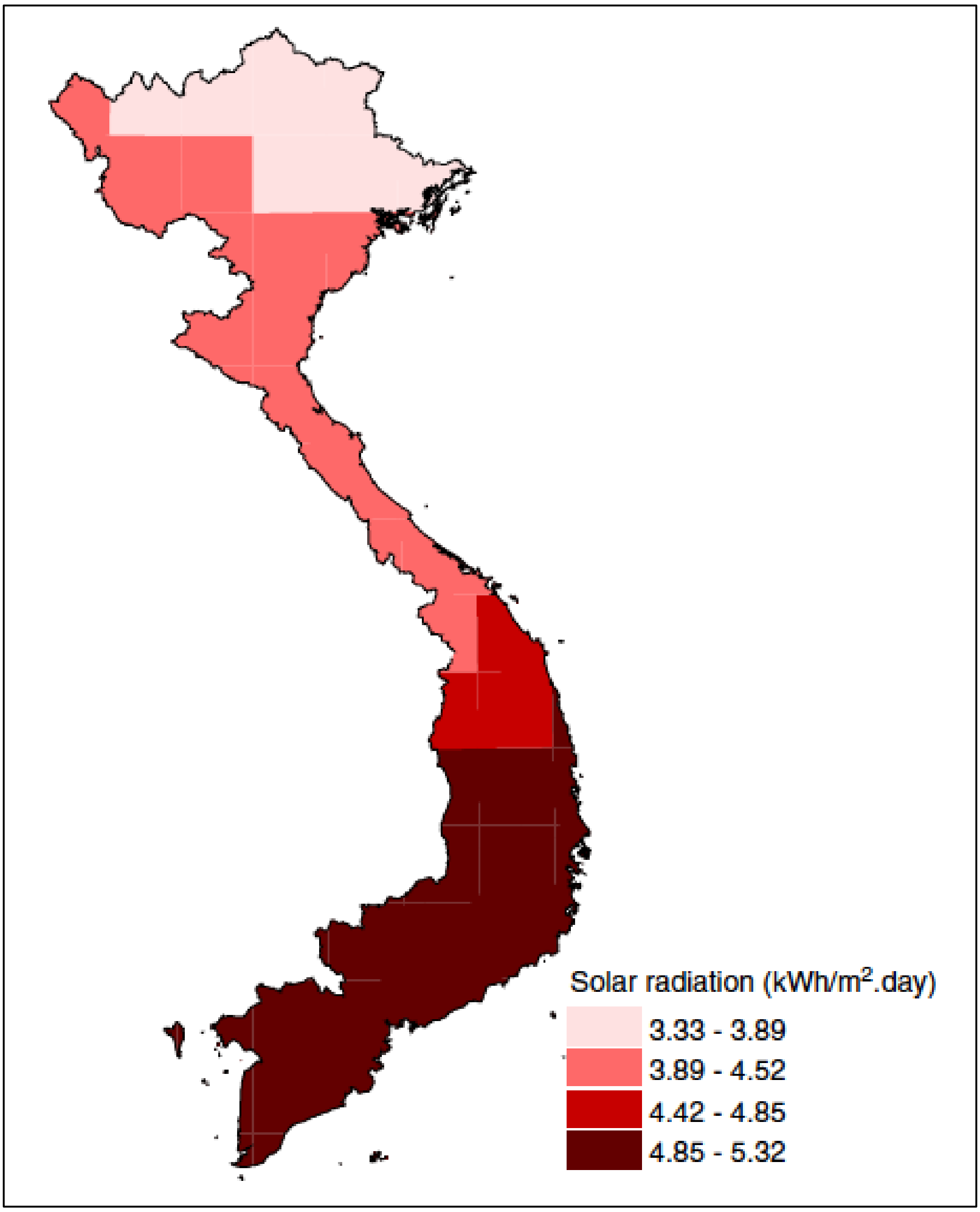
6.5.3 *Technological potential in Vietnam*

In general DEG systems can be powered by renewable or non-renewable energy sources, using both modern and conventional technologies. The choice for a technology depends on the availability of required energy sources, the availability of the equipment, technical capacities of the actors and the financial capabilities in a designated region. While technologies based on fossil energy sources like diesel gen-sets are still widely applied in Vietnam, technologies utilizing renewable energy sources are to be preferred for newly set up projects. This is mainly due to the fact that they cause less or no air pollution and are independent of fossil fuel and thus sustainable (THONG ET AL., 2007).

- *Photovoltaic systems:*

  PV systems, often referred to as solar home systems (SHS) are widespread as a means of rural electrification and by far the most common system based on renewable energy worldwide (REICHE ET AL., 2000: 53). SHS can be set up almost everywhere. They convert solar radiation into electrical energy. Due to its scalability, PV solutions can be used in many less-developed regions to power households or villages not connected to a central electricity grid (PIETZCKER ET AL., 2009: 14). Typically these PV systems provide between 10 and 100 W and the size of a system should be selected according to power needs of certain electric devices. KOLHEA ET AL. (2002: 165) assessed the economic viability of a stand-alone solar PV system along with a diesel-powered system. The sensitivity analysis revealed that, even under unfavourable conditions, the solar PV outperforms the diesel engine for an energy output of 15 kWh per day. Utilizing PV generated electricity rather than fossil fuel is not only cost competitive, but sometime even cheaper. Estimated fuel costs for non-electrified households in developing countries were estimated between six and eight US Dollars per month, while the investment cost for a SHS including a battery and charge controller spread over a period of six to eight years would amount in about seven US Dollars per month (HOFFMANN, 2006: 3290). PV systems are most favourable for areas with high solar radiation rates and many hours of sunshine throughout the year. Solar heating facilities, which generate hot water, can substitute heating water with other means like open fire or electricity.

Figure 6.5: Solar radiation in Vietnam.



Source: NGUYEN, 2007A: 2582.

The potential for application of PV systems in Vietnam varies considerably due to the climate in the country, which differs significantly from north to south (see Figure 6.5). Generally there is a north-south decline with good constant solar resources in the south and central regions ranging from 4.0 to 5.3 kWh/m^2/day. The north of the country shows substantial seasonal fluctuations (KHANH TOAN ET AL., 2006: 10). In the 1990s projects carried out by the World Bank with a private dealer installed at least 500 solar home systems in Vietnam, financed by the scheme described in chapter 6.4 (MARTINOT ET AL., 2000: 10-11). For large grid-connected application solar power solutions are often considered not cost-competitive in Vietnam relative to fossil fuels and other renewable energy technologies (NGUYEN AND MINH, 2009: 13).

- *Hydropower*

Hydropower is a traditional technology, which was in use in many parts of Europe and Asia for some 2000 years, mostly for milling grain. Large and small-scale hydropower remains by far the most important for electrical power production from renewable energy resources worldwide. Especially in Vietnam this technology is widely applied in various sizes owing to favourable conditions. It is considered a major source of electricity and small and mini hydropower facilities are still developed. There is no international consensus on the classification of large, small, micro and pico hydropower. However one classification used in Vietnam is as follows (PECC1, 2005):

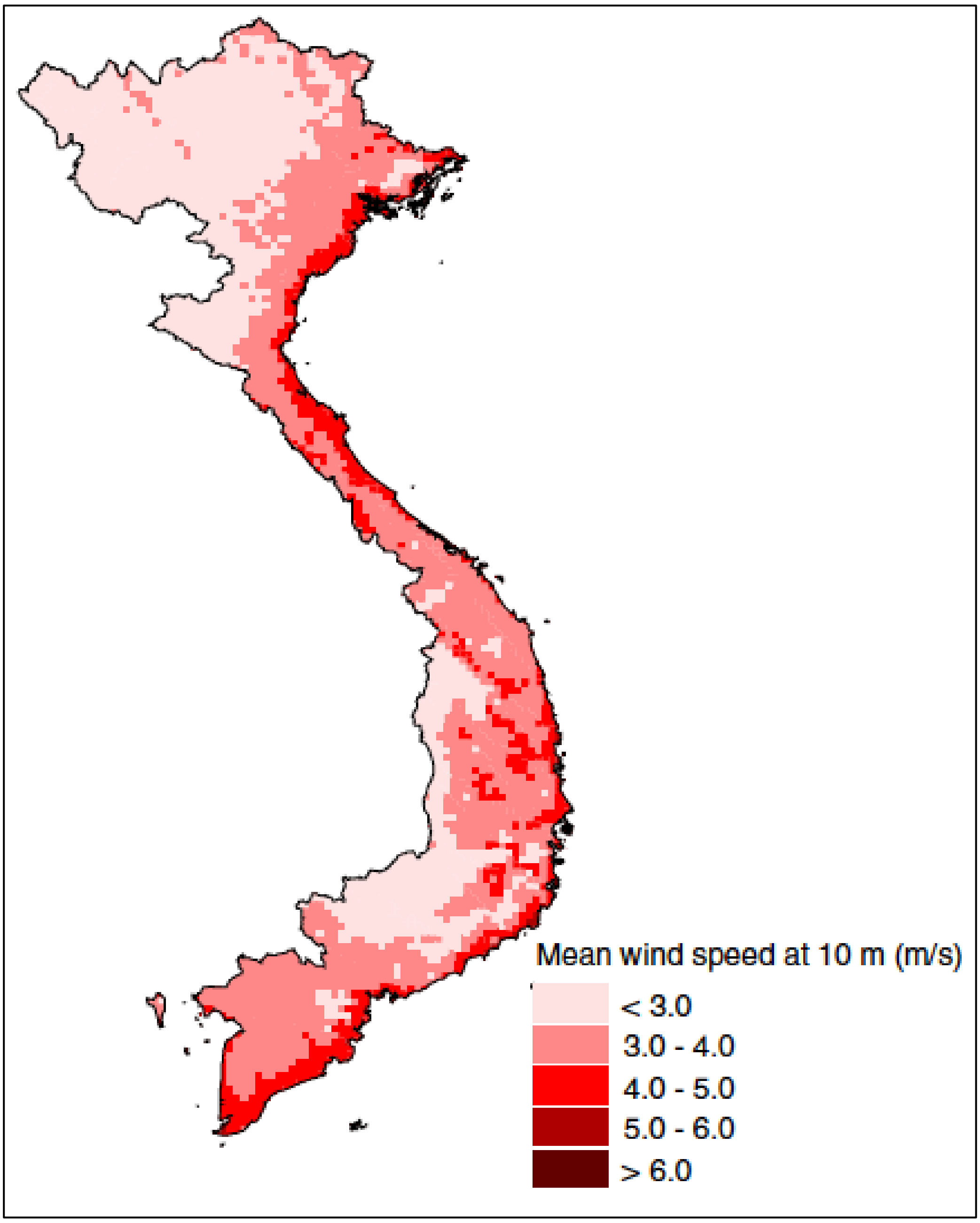
- Large hydropower ≥ 30 MW
- Small hydropower <30 MW, including
    - Mini hydropower 5-100 kW
    - Micro hydropower 0.2-5 kW
    - Pico hydropower ≤500 W

In most cases small hydropower is "run-of-river", with no dam or water storage, and tends to be the most cost-effective with comparatively low environmental impact, even though site-specific effects on the environment need to be considered. Sometimes the use of small hydropower can interfere with fishery and irrigation as well as unfavourable design might cause downstream drying up of rivers, degradation and the impediment of sediments with larger applications. However, hydropower is a site-specific technology and is confined to areas with close proximity to suitable water resources like rivers. River flows often vary considerably with the seasons, especially where there are monsoon-type climates. So there can be high amplitude between peak power and times of low loads (PAISH, 2002: 554-555). On the other hand hydropower is among the means of electricity generation most vulnerable to global warming, because climate change especially affects global water resources (ATSUSHI, 2007: 35). Vietnam is rich in hydropower resources, mostly in the north and central regions near Lao PR and China. It has good potentials for hydropower development with the watershed system consisting of more than 2000 rivers and streams. Regarding the potential official numbers differ and small hydropower potential is considered to be between 2925 MW and 4015 MW (PECC1, 2005). Micro hydropower units and stations with capacity of 0.2 to 5 kW have been extensively developed in remote mountainous areas not reached by the national power grids. In 2007 it was estimated that some 100.000 to 150.000 households obtained electricity from micro and pico hydropower units in Vietnam. Often micro and pico hydropower was used as a transition technology in the 1990s prior to grid connection. However, many were abandoned after connection to the grid, so the number of households using micro and pico hydropower might have dropped due to grid-extension in the meantime (NGUYEN ET AL., 2004: 280; GTZ, 2007: 277). Of the 507 small hydropower stations with less than 10 MW about one third were considered not working in 2005, mostly due to problems with maintenance (PECC1, 2005). There is no incentive for households and communities to run these systems as grid electricity is cheaper and needs less maintenance. These potentials remain unused now and could easily be reactivated and contribute via feed-in tariff policy. Currently there are no support schemes for small hydropower facilities (DENA, 2010: 43).

- *Wind power*

Like hydropower wind power is an ancient technology. Wind power applications with relatively low efficiency for water pumping have already been in use for many decades in Vietnam already (NGUYEN, 2007B: 1410). Due to varying wind speeds wind power applications for rural electrification are often coupled with other technologies. Coupling small-scale wind power devices with other systems like diesel generators, PV systems or appropriate storage systems can greatly enhance productivity. In regions with proper and reliable wind resources, wind energy is considered more cost-efficient than PV systems or diesel gen-sets (NGUYEN, 2007A: 2588). Sites with the most favourable conditions in Vietnam stretch along the northern and southern parts of the coast and parts of the central and south-central highlands (see Figure 6.6). Wind power in Vietnam is estimated to have a competitive production cost ranging from 4 to 8 US cents/kWh in comparison to 50 to 100 US cents/kWh for solar, making it the preferred renewable option (NGUYEN, 2007B: 1405).

Figure 6.6: Mean wind speeds at 10m altitude in Vietnam.



Source: NGUYEN, 2007A: 2582.

Until now only one wind park with a capacity of 18 MW is in operation in the province of Binh Thuan in the south of Vietnam. Several other investors currently plan large wind power application, but the lack of a reliable legal framework and the unattractive feed-in tariff that has been negotiated between EVN, the government and the investor, prevents investors from going. The current investor in Binh Tuan is paid 6,8 US cents per kWh from EVN plus 1 US cent compensation from the government, which does not cover generation cost (EPRONEWS, 2011). Vietnam's estimated total wind energy potential is 513.360 MW, whereas only 500 MW seem currently feasible under technical and economic conditions (DENA, 2010: 25). Figures from the Power Development Plan 6 do not exceed 400 MW (see Table 4.5). Like other renewable energy technologies small and off-grid wind power could enlarge economic and technical capacities. The wind resources are suitable for small and off-grid wind power (up to 100 kW) and are used in Vietnam since the 1980s. As of 2007 about 900 wind power units with 150 to 200 W plus 100 units of different size were installed (DENA, 2010: 27; NGUYEN, 2007B: 1410).

- *Biomass/biogas*

Biomass gasification fuelled by agricultural residues and woody biomass is another possibility to make use of decentralized renewable energy resources. During the gasification process only the amount of CO_2 is emitted, which was taken in from the atmosphere by the biomass before. Hence, biogas can be considered as CO_2 neutral, if it was not for the production, installation and maintenance of the gasifier and the generator. Cost per unit of electricity generation by biomass gasification is often less than diesel generation (ABE ET AL., 2007: 663). On farms for instance biomass can be available for free from livestock manure and other agricultural residues. However, one needs to consider, whether the targeted biomass is already in use for something else. Otherwise biomass gasification resembles only a shift in utilization and another energy resource needs to be found for the purpose the targeted biomass was used for before.

In Vietnam biomass still covered 43% of the primary energy consumption in 2009 (IEA, 2009: 279). To date main biomass resources to generate electricity are sugarcane bagasse and rice husks. The energy potential is estimated to be 400 to 500 MW. There are already 42 existing sugar mills that use residues from sugar cane for electricity generation with a total power of 150 MW (DENA, 2010: 35; KHANH TOAN ET AL., 2006: 10). However, development in biogas utilization is still in the beginning phase. Rural farmers start to use small capacity generators that mostly utilize farm residues and manure from livestock. Capacities of biogas generators vary depending on the size of the farm and the available amount of utilizable biomass.

The application and success of either of these systems depends on the availability of the resource in a place and its technical efficiency. An appropriate site assessment with measurements of resource abundance must forego the choice for a technological approach. Furthermore not every technology might be suitable for certain regions due to missing local expertise for maintenance. If certain development goals do exist some technologies might be preferred to others.

7 Conclusion

The aim of this thesis was to analyse the sustainability of an important fundament of sustainable development in Vietnam – electricity. The recent developments in rural electrification were the basis of the analysis, which was facilitated by a rich source of data and information in conjunction with experts' perceptions. The expert interviews added a subjective view to the facts and figures shown in reports and related literature. Even though government bodies and consumers were underrepresented in the expert interviews a comprehensive overview about the energy situation in general and the rural electrification in particular was generated. The progress Vietnam made in electrifying the country and the rural areas in particular is impressive and much of the recent development of rural Vietnam can be traced back to the provision of access to electricity. Within less than two decades Vietnam pushed the household electrification rate from 14% in 1993 to over 96% in 2009, veritably improving living conditions and livelihoods in rural areas. In this respect the country has been extremely successful and resembles a kind of masterpiece in rural electrification worldwide and the expert views are in line with official reports and data in many aspects. The Vietnamese government was determined to electrify the country with all means of instruments it has to hand and thus broaden development potential throughout the country. For the sake of rural development and the goal of providing the same form of cheap and reliable electricity to the people, it chose political and socio-economic goals over market forces, which supported the pace of electrification. In combination with a dedicated institutional framework this is what differentiates Vietnam from other considerably less electrified nations in Southeast Asia, which still follow market approaches with electricity often being unaffordable for the rural poor. However, Vietnam had strong and committed partners. Among other donors especially the World Bank, they provided funds, capacities and expertise to support and accelerate the process of rural electrification. Extension of the national power grid was considered the quickest and most reliable option for achieving these goals and the renovation and enhancement of the technical facilities surely helps to save energy through increased efficiency and less transmission and distribution losses. With providing access to electricity to the largest share of the population, the Vietnamese authorities were able to trigger poverty reduction and development, impressively shown by the success induced by rural electrification. However, for the socio-economic development to be lasting and durable, a sustainable way of electricity provision is needed. On the background of the overall energy planning of the Vietnamese authorities though, the choice for grid extension and fossil fuels might endanger the socio-economic development not only in rural areas, but in the whole country in the long run. In the course of grid extension many small decentralized electricity generation facilities like micro or pico hydropower were abandoned, because the cost of their installation, operation and maintenance could not compete with subsidized electricity tariffs. It is simply cheaper and more comfortable to the consumers to get electricity from the grid. Nearly all the electricity needs have to be covered by electricity from the national grid and the connected large power generation facilities. Consequently, the short-term success in rural electrification and development generated long-term challenges for the power sector in Vietnam.

Even though experts do not consider rural consumption triggered by rural electrification to be of major influence, they acknowledge the need for alternative energy technologies in conjunction with enhanced energy efficiency and modern power network technology for covering the future needs for electricity. To cover the future electricity needs of the increased number of consumers and the developing economy in the country, the Vietnamese planning officials and authorities want to rely on coal. According to official planning coal is considered to be the dominant primary energy resource in Vietnam in a frame of mostly large centralized electricity generation facilities within the next 20 years. A dedicated motivation to support the development of renewable energy potentials is requested by most experts, but enforcement is missing from the governmental side. Grid extension, increased electrification rates, fast economic development, resulting growing energy needs, accompanying subsidies for rural affordability and missing enforcement to develop renewable energies created path dependence in the Vietnamese power sector. The massive utilization of fossil energy carriers does not provide a sustainable and lasting basis for development, simply because fossil resources are ending resources. The current conditions might lead to the predominance of conventional fossil and ending energy sources in the future, being highly inefficient considering the aim of sustainable and lasting socio-economic development. Consequently, the combination of rural electrification and energy mix results in path dependence of the Vietnamese power sector.

However, Vietnam has the chance to alter this path scenario. An integrative approach is needed to cover the future electricity needs in a way that they support sustainable development. Such an approach has to address the aspects of electricity consumption and generation to optimize both for an efficient and sustainable power supply. Abandoning subsidies for coal and market orientation with consideration of external cost would support the creation of realistic electricity generation cost and help renewable energies to become cost competitive. This cost-competitiveness would be an incentive for private investors as well as the public to invest in renewable energy projects and thus diversifying the overall energy mix. Higher electricity tariffs would have a positive impact on energy saving as well. However, care has to be taken as not to negatively affect the livelihoods of poor Vietnamese. Especially in rural areas the people must not suffer from unaffordable electricity tariffs. A dedicated support scheme for poor households would be needed.

Considering electricity generation from renewable sources, of course there is a natural limit of available space for large electricity generation facilities like wind parks or large hydropower plants. Decentralized electricity generation would be able to contribute to covering the future electricity needs. Many small energy potentials that are unused or were abandoned in the course of recent grid extension could be utilized. There is considerable technological potential for decentralized wind, solar and hydropower as well as biogas utilization. A designated feed-in tariff that allows feeding in of decentralised generated electricity into the grid would encourage the use of small electricity generation potentials and would unlock additional electric power capacities. A resulting diverse energy mix and the utilization of decentralized potentials in conjunction with efficient consumption would form a more sustainable basis for sustainable and lasting socio-economic development in Vietnam. For this to happen dedicated steps need to be taken and institutional measures are needed. However, appropriate steps need to be taken soon as for path dependence of the Vietnamese power sector towards relying on fossil energy source strengthens the longer the country follows this path.

It can be stated that the future challenges for energy sector and a need for alternative energy have been acknowledged, but appropriate detailed actions have neither been taken nor are they planned. The rural electrification effort aimed at enhancing the livelihoods of the rural population and triggering socio-economic development. The next step would be a focus on sustainability of the energy provision. Whilst all efforts towards a sustainable energy basis for Vietnam should be considered, the aim of these efforts should not get out of sight. Supporting the Vietnamese people's livelihoods with a sustainable and affordable energy basis should not suffer.

8 Limits and implications for future research

The constraints in terms of time, budget and professional connection to the Vietnamese power sector do leave this thesis with certain points that could not be covered. Firstly the range of interview partners did not include consumer and government representatives. To complete the picture about the perception of the benefits of rural electrification and its implication for sustainable power supply, a broader assessment of public perception from demand and supply side stakeholders would be useful as well. The perception of government representatives from different levels and areas would be valuable. The consumers' views on the topic can be manifold, depending on their income level, home region and consumption patterns. To gain a representative consumers' perception, an extensive study would be necessary.

The semi-structured character of the interviews naturally gives the respondent a lot of freedom for his answers. Several aspects that came up in the course of the interviews are worth analysing in more detail. On the basis of this more basic and broad analysis dedicated interviews regarding chances, weaknesses and threats of certain energy sources and the possibilities, benefits and cost of application of renewable energy solutions specifically for Vietnam could shed a more detailed an critical light on the aspect of energy generation. Beyond that further future research should focus on the possibilities of institutional and legal support and the technical and economical feasibilities of renewable energy in Vietnam in general. In this respect an assessment of the potential of decentralized electricity generation in particular would be helpful to possibly facilitate the development of new power sources.

Finally the experiences from the Vietnamese electrification programmes could be applied on a broader basis. Other developing countries with low electrification rates in their process of power development could benefit from the experiences and lessons learnt to transfer successful strategies and avoid measures that have been proven inefficient in Vietnam.

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Appendices

Appendix A: Interview guideline

1. In which way are or were you involved in rural electrification in Vietnam?

- Project:
- Region:
- Objective/purpose
- Duration:
- Involved stakeholders/actors:
- Funding:

2. What do you think are the main benefits of the rural electrification process for Vietnam?

- Who are the beneficiaries of rural electrification in Vietnam (people/institutions)?
- In which way did they benefit?

3. What were the crucial aspects of Vietnam's success in rural electrification?

- ...in terms of technology (Were Renewable Energies considered from the beginning?)
    - ...in terms of policy (strategic)
    - ...in terms of management (operative)
    - ...local participation
- Is there a distinctive difference to rural electrification in Asian neighbour countries?
- In 1994 Vietnam started a fast growth in rural electrification. What had happened?

4. Who or which institutions were the main contributors to the successful rural electrification and why?

- Was there a crucial institution/stakeholder?

- What was its contribution?

- Starting in 1995 the World Bank got involved in Vietnam's energy sector. Is there are parallel to the steep increase of electrification rates?

5. What are the challenges imposed by the successful electrification of Vietnam?

- Is there any risk or specific challenge arising from successful rural electrification?
    - Energy security?
    - Environmental sustainability?
    - Socio-economic implications?

- How significant will the share of rural electricity consumption be for overall electricity consumption in Vietnam? What does this mean for the national energy strategy?

- How will Vietnam cover the increasing energy need in the long term in the scope of ending resources, climate change and environmental degradation?
    - Application of Renewable Energy on a large scale?
    - Are decentralized small-scale systems with a feed-in tariff an option?

Appendix B: Interview transcriptions and codification

Table 1: Responses of interview partners to question 1.

Expert	Organization	Category	Analytic generalizations
1	Institute of Energy (IE)	Planning, design and construction	E1Q1: Involved in long term integrated power planning and consultancy with central and provincial government and donors E1Q2: Government funding
2	Freelancer/ former member of Institute of Energy (IE)	Planning, design and construction	E2Q1: Design and implementation of power development plans following government targets. E2Q2: Seven years work in IE. E2Q3: Author of articles on alternatives to grid-extension.
3	Research Center for Energy and Environment (RCEE) (retired)	Planning, design and construction	E3Q1: Involved in countrywide long term management, design and research in electrification since 1960s, now retired E3Q2: Focus on agricultural and small scale business development and enhancement of living standards E3Q3: Work based on governmental funding
4	PECC3	Planning, design and construction	E4Q1: Planning and design of network in southern provinces. E4Q2: Funded by EVN with donor loans
5	Kreditanstalt für Wiederaufbau (KfW)	Donor	E5Q1: Involved as donor for rehabilitation of power network E5Q2: All projects bound to environmental benefit
6	World Bank	Donor	E6Q1: Two projects: Rural Electrification 1 and Rural Electrification 2 (150 and 420 million US$) for grid extension and grid rehabilitation E6Q2: Less electrified provinces were priority E6Q3: Switch to more top-down management in 2009 with LDUs going to EVN E6Q4: Multiple stakeholders including government, EVN and donors
7	Asian Development Bank (ADB)	Donor	E7Q1: Donor with 151US$ loan to government for mini-hydropower development in central and northern highlands and grid-extension in remote regions E7Q2: Stakeholders: government, EVN (PECC1, PECC2, PECC3)
8	SNV (currently)	Donor/impact evaluation	E8Q1: Involved in impact evaluation of rural electrification in the past E8Q2: Working on small-scale electrification with biogas now
9	Empower	Impact evaluation	E9Q1: Involved in comprehensive impact evaluation of rural electrification in Vietnam
10	Ministry of Environment and Trade	Government	E10Q1: Several projects with several donors (World Bank, SIDA, own funding)

Source: Own table.

Table 2: Responses of interview partners to question 2.

Expert	Analytic generalizations	Analytic code	
		benefit	beneficiary
1	E1Q3: Reduction of poverty E1Q4: Increased rural incomes	Poverty reduction Increased rural incomes	Rural people
2	E2Q4: Rural people biggest beneficiary E2Q5: EVN had to do, which is economically not feasible.		Rural people
3	E3Q3: Rural poor people and country as a whole benefit E3Q4: Improved rural livelihoods through increased incomes and better public services (health, schooling, water supply) E3Q5: Reduction of poverty E3Q6: Increased rural incomes E3Q9: Electrification is a tool to prevent unrest from ethnic minorities.	Poverty reduction Improved rural livelihoods Increased rural incomes Prevention of rural unrest	Rural people Whole country
4	E4Q3: Rural communities and businesses		Rural people
5	E5Q3: Improved rural livelihoods E5Q4: Improved capacities at EVN E5Q5: Country as a whole benefits	Improved rural livelihoods Improved stakeholders' capacities	Whole country EVN
6	E6Q5: Rural people E6Q6: Social obligation of EVN E6Q11: Stakeholders gained capacities improvement	Improved stakeholders' capacities	Rural people
7	E7Q4: Government focus on provinces with ethnic minorities to develop and prevent protests. Minimum 50% poor households in targeted regions	Prevention of rural unrest	
8	E8Q3: Improved rural livelihoods E8Q4: Sometimes new business opportunities	Improved rural livelihoods New business opportunities in rural areas	Rural people
9	E9Q2: Improved rural livelihoods E9Q3: Improved public services and social life E9Q4: Enhanced capacities in socio-economic analysis techniques E9Q5: Demand-side stakeholders consulted for first time	Improved rural livelihoods Improved stakeholders' capacities	Rural people
10	E10Q2: Rural households E10Q3: Local enterprises E10Q4: Local authorities E10Q5: EVN & PCs E10Q6: Government	Improved stakeholders' capacities	Rural people EVN Local authorities Local governments

Source: Own table.

Table 3: Responses of interview partners to question 3.

Expert	Analytic generalizations	Analytic code
1	E1Q5: Above all the public-private partnership E1Q6: Favourable economic development E1Q7: Political commitment E1Q8: Consumers willingness to pay	Public private partnership Favourable economic conditions Political commitment Local participation/financial contribution
2	E2Q6: Government policy and local will to develop driving factors. E2Q7: Grid extension cheapest way, because it was subsidized. E2Q8: Local people paid for connection. E2Q10: Asian neighbour countries more market driven and electricity is expensive. E2Q11: Off-grid solutions would need subsidies and more local capacities	Political commitment Grid extension technology Local participation/financial contribution
3	E3Q7: Integrated power planning E3Q8: Application of mini and micro hydropower E3Q9: Political commitment, while other countries chose market approach E3Q10: subsidized tariffs and private sector investment E3Q11: Local participation enabled by financial assistance E3Q12: Development in 1990s due to international cooperation and better management	Improved power planning Development of hydropower Political commitment Subsidies Local participation/financial contribution International cooperation/donors
4	E4Q4: Grid extension was cheapest and best way E4Q5: Government main driver of process E4Q6: Local people contributed with connection fee. E4Q7: Subsidies differentiate Vietnam from other countries, where electrification rate is lower.	Grid extension technology Political commitment Local participation/financial contribution Subsidies
5	E5Q6: Favourable conditions created by government E5Q7: Financial assistance by donors	Favourable economic conditions International cooperation/donors
6	E6Q7: Close collaboration between state, people, provinces and EVN was important E6Q8: Preparation before 1994: Economic development and many hydropower sources and 300kV line were favourable	Public private partnership Development of hydropower Favourable economic conditions
7	E7Q5: Government's policy and commitment as a communist country with focus of social welfare of people E7Q6: Grid extension was way to go, because off-grid solutions too expensive and hard to maintain E7Q7: Economic development favourable E7Q8: Some funds for EVN are grants from government, because project not economically feasible	Political commitment Grid extension technology Favourable economic conditions
8	E8Q5: Vietnamese commitment E8Q6: Political commitment	Political commitment
9	E9Q6: World Bank loan E9Q7: Favourable economic development E9Q8: Vietnamese commitment, talent and work E9Q9: Centralization of energy related responsibilities	International cooperation/donors Favourable economic conditions Political commitment Improved power planning
10	No statement	

Source: Own table.

Table 4: Responses of interview partners to question 4.

Expert	Analytic generalizations	Analytic code
1	E1Q9: Stakeholders involved in public-private partnership (households, government on several levels, EVN and power companies)	Rural people Government EVN
2	E2Q12: Government policies main drivers E2Q13: World Bank made progress more aggressive, because justification for funds	Government World Bank
3	E3Q13: EVN, Institute of Energy and other power companies are key actors E3Q14: World Bank's financial assistance crucial	EVN Institute of Energy World Bank
4	E4Q8: Government was main driver.	Government
5	E5Q8: Donors	Donors
6	E6Q9: Government contribution 70% E6Q10: World Bank contribution 30% with technical assistance and funding	Government World Bank
7	E7Q9: Central government was main driver. E7Q10: World Bank's assistance, funds and expertise were crucial.	Government World Bank
8	E8Q7: No information	
9	E9Q10: EVN was a driver E9Q11: No information	EVN
10	No statement	

Source: Own table.

Table 5: Responses of interview partners to question 5.

Expert	Analytic generalizations	Analytic code
1	E1Q10: Rural electricity demand negligible E1Q11: Energy security major task E1Q12: policy for feed-in tariffs only political instrument without practical viability	Rural electricity demand negligible Energy security major challenge
2	E2Q14: Rural electrification no major contribution to overall electricity consumption E2Q15: External cost needs to be considered to make RE cost-competitive. E2Q16: Challenges: 1. Find option to be more independent of electricity; 2. Energy efficiency; 3. Application of RE.	Rural electricity demand negligible Consider external cost of energy Application of renewable energy necessary Improve energy efficiency
3	E3Q15: Improving power network E3Q16: Environmental sustainability not considered important E3Q17: In favour of large scale Renewable Energy, especially biogas	Application of renewable energy necessary Improve power network No challenge for environmental sustainability
4	E4Q9: Rural consumption negligible E4Q10: Network improvement needed E4Q11: hydropower potential nearly developed E4Q12: Coal unique energy carrier to meet demand E4Q13: Renewable energies can only contribute little E4Q14: Off-grid systems too expensive to play a role	Rural electricity demand negligible Improve power network Utilize coal resources Renewable energy can only play minor role Renewable off-grid not suitable
5	E5Q9: Improving power network E5Q10: Application of alternative energy sources E5Q11: Market conditions for electricity generation and consumption E5Q12: Support rural poor E5Q13: Appropriate policies for renewable energy	Improve power network Application of renewable energy necessary Market orientationof power sector Support for rural poor Develop policy framework for RE
6	E6Q12: Rural consumption negligible for energy security E6Q13: Industry will develop in rural areas and consumption as well E6Q14: Renewable energy off-grid systems too complicated for rural areas E6Q15: Soon all hydropower potential in use E6Q16: Revival of Renewable energy off-grid systems from urban areas. Currently not cost competitive in the moment, but will come in the future with rising cost of conventional resources	Rural electricity demand will grow Renewable off-grid not suitable
7	E7Q11: ADB supports building capacities on how to use electricity. E7Q12: Some people did not want electricity E7Q13: Legal framework and support schemes needed for renewable energy.	Develop policy framework for RE
8	E8Q8: Transfer to market driven power sector E8Q9: Energy saving and efficiency	Market orientation of power sector Improve energy efficiency
9	E9Q12: Connect remaining unelectrified households E9Q13: Improvement of energy supply E9Q14: Energy saving and efficiency	Connection of remaining households Improve energy efficiency
10	E10Q7: No challenge for environmental sustainability	No challenge for environmental sustainability

Source: Own table.

Statutory declaration

I herewith declare that I have completed this thesis independently making use only of the literature and assistance specified and cited in the paper. This thesis has not been published or submitted to an examination body before and all printed copies are identical to the digital version.

Björn Linnemann (signature)

Hamburg, September 7th, 2011