INDIGENOUS CAPABILITY BUILDING AS AN INTERVENTION STRATEGY FOR SUSTAINABLE ENERGY IMPLEMENTATION IN VULNERABLE SOCIETIES

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Indigenous Capability Building as an Intervention Strategy for Sustainable Energy Implementation in Vulnerable Societies

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Abstract

Geospatial regions have different requirements for energy development due to variations in environmental, economic, social, and political constraints which influence their energy demand profiles and generation capacities. These constraints determine the policy, strategy, and implementation priorities for sustainable energy consumption, generation, and distribution. This PhD research project focuses on the role of interfaces between sustainable energy policy and appropriate technology; and its iterative feedback loop mechanism to encourage the implementation of sustainable energy systems in a vulnerable society.

As a novel contribution to knowledge and practice, this PhD work concludes that:

1. Establishing a local business case for indigenous, appropriate technology, utilising a solid network which receives committed, political support, is an effective intervention strategy to fast track the deployment of sustainable energy systems, which breaks the cycle of vulnerability through social transformation and community empowerment.
2. Being aware of their own Western-Educated-Industrialised-Rich-Democratic (WEIRD) mindsets is a first step for knowledge exchange practitioners to overcome cultural differences and to introduce the intervention strategy.

This was synthesised from the following new understandings which were obtained as the outputs of this PhD research:

1. Re-interpretation of the theory of vulnerable societies in relation to sustainable energy;
2. Re-interpretation of the theory of sustainable energy in relation to the proposed fourth dimension of sustainability;
3. Re-interpretation on the theory of appropriate technology in relation to technological independence and indigenous wisdom;
4. Novel conceptual model of a vulnerable society's problem system;
5. Novel conceptual model of the interfaces between sustainable energy policy and appropriate technology in vulnerable societies.

It is expected that the outcome of this PhD research can bridge the gaps identified in theoretical sustainable energy policies whilst in practice provide sound advice and confidence for policy makers and initiative implementers in grounding equal access to energy as a fundamental agent of change towards sustainable societal development.

Acknowledgement

The time has now come when I have proof-read this thesis too many times, re-written it far too often, and hid it behind closed laptops for far too long. What is left to do tonight is to write these highly subjective remarks before surrendering this piece of work with commitment.

There is great humility in writing this thesis, as the further and the deeper I tried to understand the underlying problem system of a vulnerable society, the more overwhelmed I am with the great wisdom shared amongst the indigenous, traditional, communities. It is this wisdom in interacting with all living creatures, land, air, and water with respect and in viewing objects as interdependent, systemic webs that had brought me to a glimpse of a sustainable society.

I admire the people who work for their land, farmers and fishermen whose daily lives interact with the wise earth and ocean. I envy the work of a fieldworker who can stay and stray into the realms of the big knowledge beyond our confined minds. I would be most honoured if this small piece of work finds its way into doing something useful for them.

In this long journey which has demanded unrelenting will, unbending trust, and unlimited giving, I would like to acknowledge the support of my partner in everything, my best friend, my safest place, strongest protector, and greatest inspiration. I would also like to acknowledge the kindness of various near and far individuals who had seen and shared the weights and rewards of my climb and descent during these past few years. I humbly ask the universe to grant each one of you the balance between fulfilment and aspirations in life.

In the end, it is a gift to be simple, to own very little, and to be free. With this I hope for a tomorrow, where time indeed forgets what time helps to forgive and where once again courage and determination embraces change, welcomes its consequences, and rejoices in the new dialectic cycles.

To Pak Jito, Pak Alan, Mas Wibi, and Athar... thank you.

To Mbak Indri, Reza, Naomi, Marzena, and Sharon... thank you.

To Slim, Leo, Patrick, Laura, Nathan, Morgan, Eurena, and Sarah... thank you.

To Bang Yakob, Cathy, Joanne, David, and Peter... thank you.

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Leuserina Garniati

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Glossary

ADCP	Acoustic Doppler Current Profiler
AGTP	Aceh Government Transformation Programme
ASEAN	Association of South East Asian Nations
ASELI	Asosiasi Energi Laut Indonesia (INOCEAN)
ASTEC	Andaman Science and Technology
CBA	Cost Benefit Analysis
CCHP	Combined Cooling Heating and Power
CDM	Clean Development Mechanism
CUSP	Centre for Understanding Sustainable Practice
EC	European Commission
EIA	Environmental Impact Assessment
ESDM	Office of Mining and Energy
DECC	Department of Energy and Climate Change
DFID	Department for International Development
DEN	Dewan Energi Nasional (National Energy Council)
FCO	Foreign Commonwealth Office
GAM	Gerakan Aceh Merdeka (translated into Free Aceh Movement)
IA	Impact Assessment
IDP	Internally Displaced People
IEA	International Energy Agency
INOCEAN	Indonesian Ocean Energy Association (ASELI)
ITS	Institut Teknologi Sepuluh November (10^{th} November Institute of Technology)
MDG	Millennium Development Goal
NGO	Non-Governmental Organisation
NM	Numerical Modelling
PDPA	Perusahaan Daerah Pembangunan Aceh (Aceh Provincial Development Enterprise)
PLN	Perusahaan Listrik Negara (Indonesia State Electricity Company)
RGU	Robert Gordon University
RISTEK	Kementrian Riset dan Teknologi (Indonesian Ministry of Research

	and Technology)
SA	Statistical Analysis
SEA	South East Asia
UNSYIAH	Syiah Kuala University
TDMRC	Tsunami Disaster Mitigation Research Centre
UKCCU	United Kingdom Climate Change Unit
UKP4	President's Delivery Unit for Development Monitoring and Oversight
UN	United Nations
UNAS	Universitas Nasional (National University), Indonesia
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WEIRD	Western Educated Industrialised Rich Democratic

1 Introduction

“My mind is not to be imprisoned”

(Pramoedya Ananta Toer)

1.1 Background

Chapter 1 sets out the context of the PhD thesis with a specific emphasis on the rationale for research and its original contribution to knowledge. Included in this chapter are the study scope, aim, objectives, research questions, and thesis structure.

The underlying study explores intervention strategies for sustainable energy implementation in vulnerable societies. A vulnerable society is characterised by a number of factors (which will be thoroughly discussed in chapter 3), the most significant being susceptibility to recurring natural disasters and socio-political conflicts. Research shows that there is a strong correlation of occurrence between the two events (Brathwaite et al. 2010).

A generally accepted term for areas with high volcanic activities centred on the basin of the Pacific Ocean is the Ring of Fire. The ring of fire's geological formations are rich with natural resources but more affected by volcanic activities, the earth's tectonic plate movements, and climate change events. Those areas are also most attractive to external exploitative interests, creating internal socio-political-economic stress and strain. A number of countries are located in this so-called Ring of Fire creating situation that can be described as the root causes of a vulnerable society's problem system.

For those vulnerable societies, access to energy is the critical enabling element to re-engage with their economic and social support systems. This cannot be achieved simply by acquiring technology from Western, Educated, Industrialised, Rich, and Democratic (WEIRD) sources (Diamond 2012). Rather, the knowledge and skills must be embedded in the impacted communities, not just high in academic and government levels. Sustainable energy has been increasingly identified by the governments of vulnerable societies as an area for growth within their sustainable development strategy (United Nations 2014; World Bank 2014). The instability of regions affected by disasters and/or conflicts has proven to cause significant difficulties in investing time, efforts, and financial capital. Therefore, although technological solutions exist, they are not sufficient. Interfaces must be built between indigenous appropriate technology and sustainable energy policy as the corresponding measure.

As a novel contribution to knowledge and practice, this PhD work argues that establishing a business case for indigenous, appropriate technology, utilising a solid network which receives committed, political support at sub-national, national, and regional policy levels, is an effective intervention tool for social transformation and community empowerment towards fast tracking the deployment of sustainable energy systems.

However, working with vulnerable societies meant that the research itself dealt with a complex system, limited by multifaceted constraints. In many cases the research project was confronted by multiple, though possibly shared truths/realities amongst groups of stakeholders. Defining the issues, needs, and potential avenues became more of a challenge given the highly subjective boundaries around volatile and unstable environmental, social, economic, and political systems. Therefore, a specialised approach to analysing situations and synthesising solutions was required. Working with post conflict, post disaster regions, also entailed the necessity for interacting with and being immersed in various elements of their indigenous communities. Interactions with former freedom fighters or combatants, and internally displaced people (IDP) were inevitable. Moreover, targeting to diffuse knowledge and skills in these regions meant that the collaboration of existing local higher education sector (universities and polytechnics) was required.

To create a robust business case, the local private sectors must come on board. The in-country sustainable development network is the primary key to bridging the gaps between those indigenous, academic, and business communities and the elected government. It is not uncommon for a single actor in this network to have multiple roles spread amongst the various stakeholder groups.

1.2 Scoping the study

Referring back to the understanding of a vulnerable society as described in section 1.1, and more detailed in section 3.2, the base load for vulnerability is dictated by the combination of substantial internal limiting factors (i.e. high population density, limited financial means) and minimum access to resources (i.e. food, water, energy as an interdependent nexus). These main characteristics are generally found in societies with developing economies globally. The two additional external triggers for vulnerability are recurrence of natural hazard (natural disaster) and human induced catastrophes (otherwise termed as socio-political conflicts).

South East Asia (SEA) is one of the most natural disaster prone regions in the world; with Cambodia, Indonesia, Philippines, Thailand, Timor Leste and Vietnam being the countries that have the majority of impacted communities (European Commission 2012). It is also one of the most conflict prone regions globally due to its multi-ethnicity, multi-kingdom historicity and arbitrary country boundaries drawn after the colonisation era (Brathwaite et al. 2010; Croissant and Trinn 2009). South East Asian countries cited for having been in conflict and receiving funds related to crisis prevention and recovery by the United Nations Development Programme (UNDP) are: Timor Leste, Aceh-Indonesia, West Papua-Indonesia, Cambodia, Myanmar, the Philippines, and Thailand (BCPR 2012). Therefore, when putting a South East Asian geographical scope to cover all four elements of vulnerability as discussed previously, six regions can be categorised as vulnerable societies:

1. Timor Leste
2. Aceh – Autonomous province of Indonesia
3. West Papua – Province of Indonesia
4. Cambodia
5. Philippines
6. Thailand

Although at different stages of development, these societies have the following commonalities:

1. Continuous social political tensions and the potential of recurring natural disaster increases vulnerability and creates the cycle of economic underdevelopment – social conflict – political instability – environment degradation.
2. Localised programmes have been initiated by international aid communities but have not addressed access to sustainable energy in the light of indigenous design, manufacturing, business cases, and network governance.

Until 2002, Timor Leste was a province of Indonesia. It achieved its independence through decades of armed and political struggles. To a degree, the Acehnese and the East and West Papuans socio-political conflicts resemble that of the Timorese prior to its independence.

Without intervention both at implementation and policy levels, the cycle of economic underdevelopment, socio-political conflict, and environmental degradation is unavoidable (Owen and Garniati 2012). More and more, decision makers in these societies realise that sustainable energy is the key element of any effort to emerge out from this cycle. A sustainable energy regime is seen as the solution to their current energy trilemma. This is because SEA is a rapidly-developing region, characterised by increasing energy demand but at the same time facing competing demands for (1) secure access to electricity, cooling, and liquid fuel, (2) low carbon systems to mitigate climate change, and (3) low-cost energy systems to alleviate energy poverty (Gunningham 2013). Although SEA is an area rich in natural sustainable energy resources, the fore mentioned situation is especially prevalent in its remote and marginalised regions. Technical capabilities to a degree exist, but are not equally distributed across the region. Where basic technical capabilities exist, there is still a lack of a holistic and coherent strategic approach to sustainable energy policy and implementation strategy. Knowing where to start, where to get to, and how to get there is yet another set of questions (Owen and Garniati 2012).

Aceh has been selected as the case study for this thesis on the grounds that:

- Both external triggers (potential for recurring natural disaster and social/political conflicts) are present at equally high recurrence; exacerbating their internal limitations due to weak economies, fragile state, and minimal access to food-water-energy resources.
- Although the province has the autonomy to manage its own natural resources, Aceh is not yet an independent nation. It still has to adhere to the Indonesian national government for some elements of their decision making. This creates the multi-level interests and conflicting priorities found amongst local actors and stakeholders.

Competent and internationally recognised local actors and stakeholders in the sustainable development network have been identified and collaborations building on conservation, land use, and social justice issues have been established.

The research project started in Aceh as an area where the researcher has previously worked, because learning from and exchanging knowledge with fragile states and communities in vulnerable societies was most conducive to be done in a setting where the researcher is most familiar with and accepted in. The researcher has significant experience working in the sustainable development area, with both engineering and science background knowledge, applied to energy policy and strategy for social development. Prior experience in working with indigenous communities over land use and conservation issues has brought about the interest to this applied research in energy sustainability.

1.3 Applicability of research finding

The research findings provide an intervention strategy to implement a sustainable energy system, applicable in vulnerable societies. Utilising the same methods, the researcher expects to extend the understanding gained from Aceh and initiate future work in other vulnerable societies such as Timor Leste and West Papua. The identification of actor-driven processes in a vulnerable society's problem system provides a mechanism of identifying where themes arise as the weakest points, thereby where linkages need to be built to break that cycle of vulnerability. This finding is applicable in addressing vulnerability of societies globally.

Furthermore, the 'WEIRD' mindsets of actors involved in knowledge exchange activities in vulnerable societies, have been found to influence the outcome of assessments in the appropriateness aspects of a given technology. This finding is applicable in addressing technology transfer and resources assessments, specifically in the energy sector.

It is also expected that the action research processes, which involved engaging with local actors in a vulnerable society settings (more specifically those who have experienced historical oppression) is beneficial to inform practitioners and academics who work with these vulnerable societies to conduct field-work based research in other subject areas.

1.4 Defining the PhD (originality)

In practice, answering the growing needs of policy makers and implementers in vulnerable societies, this study focuses on providing a firm base to plan the long-term policy and the implementation of a fully integrated strategy for building indigenous, appropriate sustainable energy capabilities. Theoretically, based on the definitions and criteria of originality and original contribution to knowledge (Cryer 2006; Philips and Pugh 2000), this study fulfils the conditions of originality as outlined in Table 1-1.

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Table 1-1: Study's originality and novel contribution to knowledge

Conditions of originality	Study's contribution	Publications
A new or reinterpretation or re-testing of existing theory	1. Re - interpretation of existing theories of vulnerable societies focussing on sustainable energy (Chapter 3)	
	2. Re - interpretation of existing theories of sustainable energy in relation to the political dimension of sustainability (Chapter 3)	KRUIJSEN, J.H.J., OWEN, A., TURNER, N. and GARNIATI, L., 2012. *The Fourth Dimension of Sustainable Practice.* http://cesun2012.tudelft.nl/images/d/d0/Kruijsen.pdf [accessed 12 July 2013]. OWEN A., and GARNIATI, L., 2013. Energy resources in societies with developing economies. In: T. LETCHER, ed. *Future Energy.* New York: Elsevier. 2013
	3. Re - interpretation of the theory of appropriate technology in relation to technological independence and indigenous wisdom (Chapter 3)	
A new or improved: • Research tool • Research technique • Observation	Application of multi methods approach to Aceh as a post conflict, post disaster vulnerable society One of the significant contribution is in the research technique for identifying appropriate data sources and accessing information during data collection and analysis (Section 2.4.2.2)	
An in-depth study	In depth case study of a vulnerable society in South East Asia: Aceh, Indonesia	
A new synthesis	The research has generated an emergent synthesis from the case study and produces:	

	1. Novel conceptual model of a vulnerable society's problem system (Chapter 6)	
	2. Novel conceptual model of the interfaces between sustainable energy policy and appropriate technology in vulnerable societies (Chapter 6)	GARNIATI L., OWEN, A., KRUIJSEN, J.H.J., ISHADAMY, Y. and WIBISONO, I., 2014. Interface between Appropriate Technology and Sustainable Energy Policy in Vulnerable Societies. *International Journal of Sustainable Cities and Societies,* 12, pp. 9-15.)
A portfolio of work based on research	The researcher has published various reports and initiated implementation programmes as part of the research efforts:	
	1. Aceh Energy Outlook Scoping Report	1. Aceh Energy Outlook Scoping Report commissioned by the United Nations Development Programme (UNDP) (Owen and Garniati 2012)
	2. Indonesia Marine Energy Feasibility Study	2. Indonesia Marine Energy Feasibility Study commissioned by UK the Climate Change Unit (UKCCU): DFID, DECC, FCO (Owen and Garniati 2013)
	3. South East Asian Environmentally Sustainable Cities; Sustainable Energy; and Climate Change and Disaster Mitigation identification mission in preparation and dialogue with the European Commission (EC) (confidential material)	
A fact or conclusion or a collection of facts or conclusions	This research led to two important conclusions : 1. Establishing a local business case for indigenous, appropriate technology, utilising a solid network which receives committed, political support, is an effective intervention strategy to fast track the deployment of	

	sustainable energy systems, which breaks the cycle of vulnerability through social transformation and community empowerment. 2. Being aware of their own 'WEIRD' mindsets is a first step for knowledge exchange practitioners to overcome cultural differences and to introduce the intervention strategy.	
Taking existing concept or technique and applying it to new areas (countries/regions)	Using the concept of vulnerability in relation to efforts in establishing the most appropriate sustainable energy systems in Aceh, Indonesia. This has never been used previously as a case study in sustainable energy policy and appropriate technology.	
Being cross-disciplinary and using different methodologies	1. Addressing cross-disciplinary issue of sustainable energy systems (policy and technology; environment, society, politics, and economics) 2. Utilisation of a combination of the following methods in research methodology: • Grounded theory • Statistical analysis and numerical modelling • Interpretive analyses (language, object, and act analysis; actor network analysis; stakeholder analysis) • Emergent synthesis	

1.5 The study

1.5.1 Research aim

This study aims to synthesise a new understanding of the sustainable energy problem system faced by a vulnerable society and to design an intervention strategy for policy makers to implement a sustainable energy system, which enables social transformation and community empowerment.

To achieve this aim, the study was conducted in 3 stages. This was done to enable data collection results and analysis from the previous stage to inform the next stage of objectives and their subsequent research questions (Figure 1-1).

The research itself is a bidirectional iterative process, where both the research environment and the researcher influence the research findings at each stage. Because of this iterative exchange process, it is acknowledged that the research environment has shaped the research and that the researcher has changed her research environment by conducting the research itself. An outline of how the researcher has contributed to both the research process and research environment is given as Figure 1-2. Throughout the research, plan of actions were produced, and strategic reports, a book chapter, and a journal paper were published as immediate outputs of individual stages.

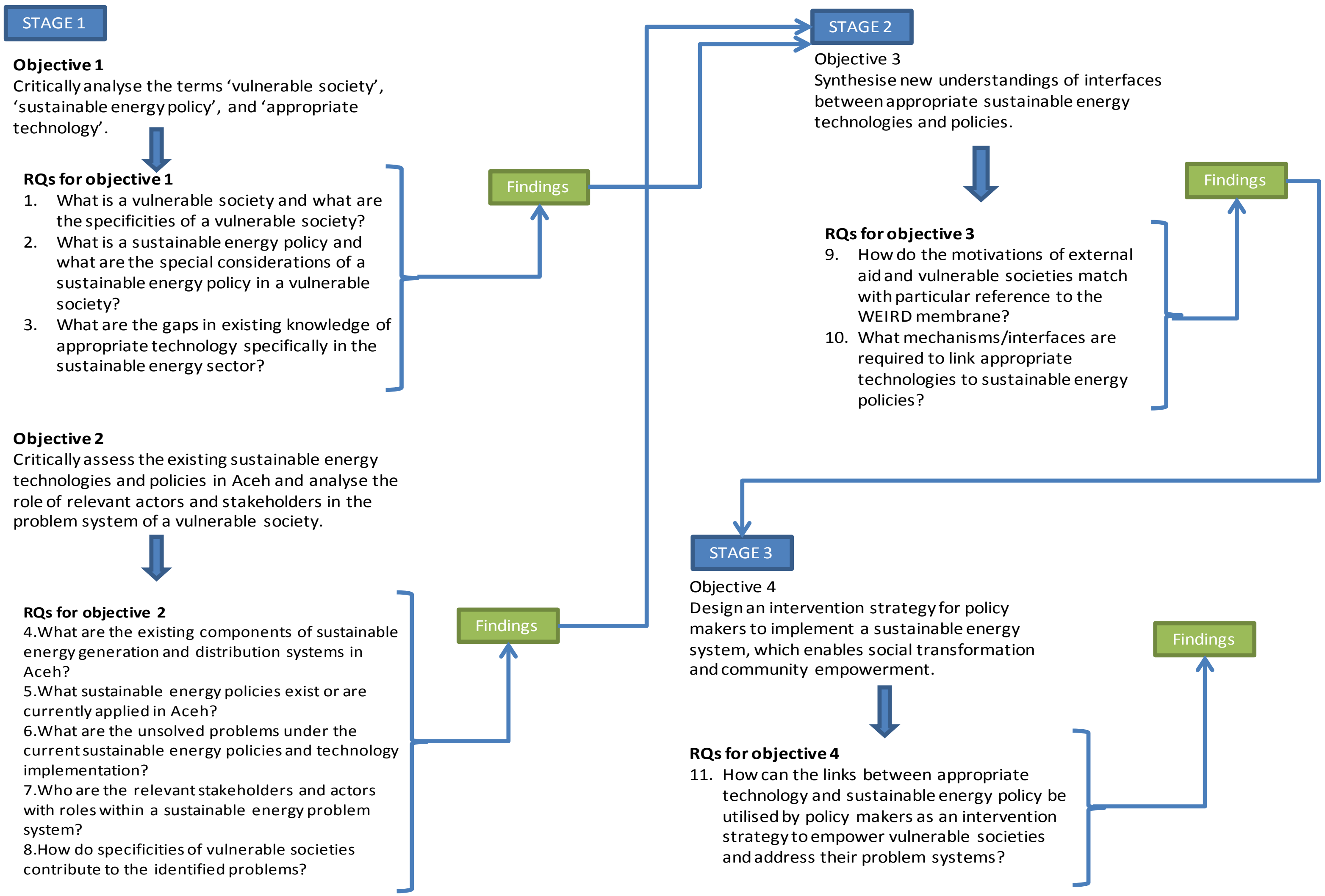

Figure 1-1: Development of Research Questions

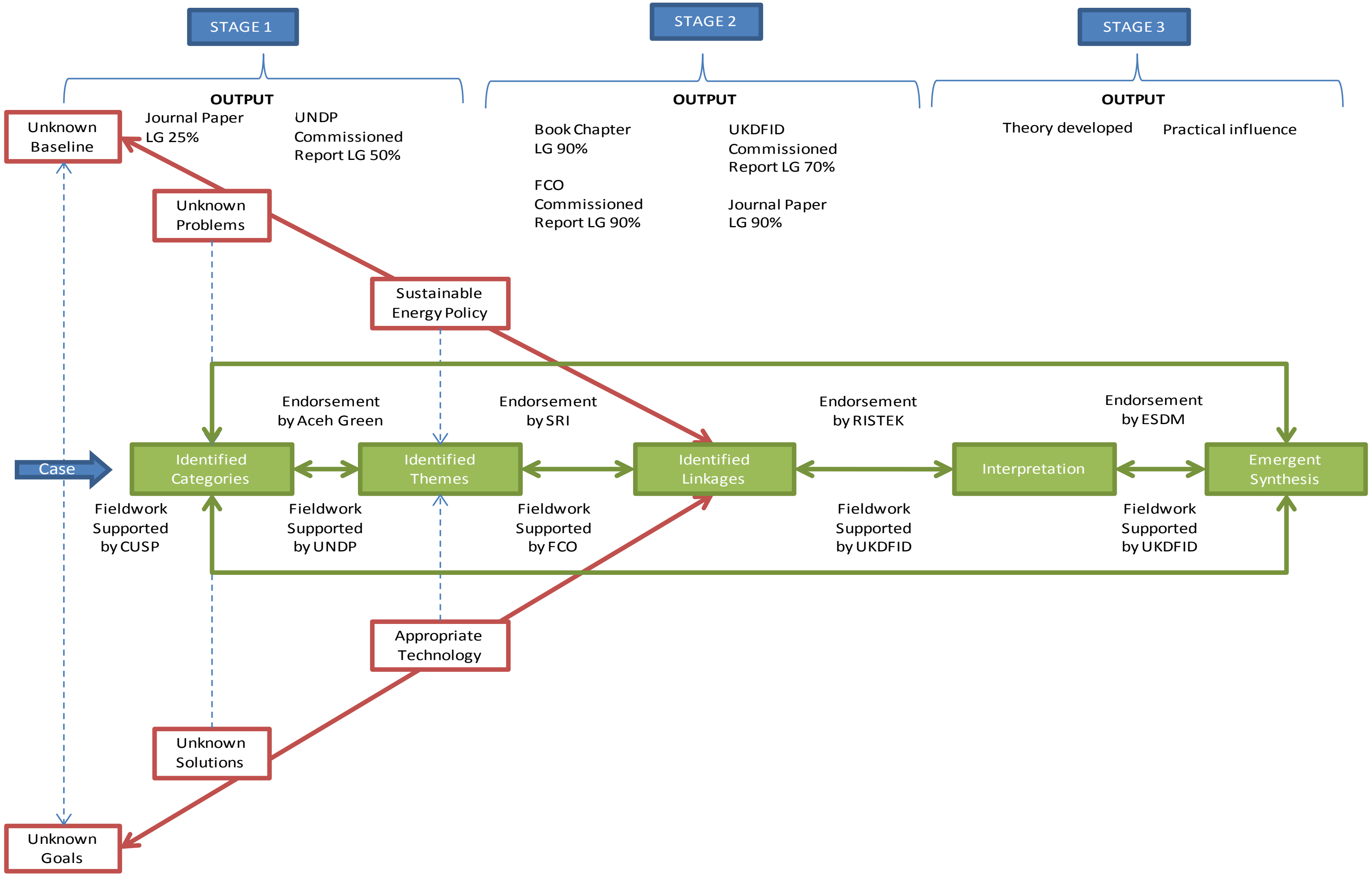

Figure 1-2: Research process and research environment (identifying Researcher's contribution)

This diagram highlights the researcher's contribution to the research process and research environment. The research process started with a case study by which steps were built towards identifying categories, identifying themes, identifying linkages, integration of ideas, and synthesising emergent theory whist establishing practical influence. The fieldworks necessary in conducting the research process were supported by various organisations providing funding sources and other in-kind contributions. Meanwhile, the research environment has also evolved during the duration of the research. Because of the work undertaken, a number of the unknowns have gradually become known categories and themes, where it the gaps were eventually identified and linked.

1.5.2 Objectives

Based on the above mentioned aim and the 3 stages of research design, four objectives have been identified. Objective 3 set in Stage 2 was informed by the results of Stage 1, and Objective set in Stage 3 was informed by the results of Stage 2.

STAGE 1

1. Critically analyse the terms 'vulnerable society', 'sustainable energy policy', and 'appropriate technology'.
2. Critically assess the existing sustainable energy technologies and policies in Aceh and analyse the role of relevant actors and stakeholders in the problem system of a vulnerable society.

STAGE 2

3. Synthesise new understandings of interfaces between appropriate sustainable energy technologies and policies.

STAGE 3

4. Design an intervention strategy for policy makers to implement a sustainable energy system, which enables social transformation and community empowerment.

1.5.3 Research questions

The following research questions (RQs) have been developed through conducting the research in a staged process. The questions are generated through a looping mechanism to follow objectives stated in sub section 1.4.2.

STAGE 1

RQs for objective 1

1. What is a vulnerable society and what are the specificities of a vulnerable society?
2. What is a sustainable energy policy and what are the special considerations of a sustainable energy policy in a vulnerable society?
3. What are the gaps in existing knowledge of appropriate technology specifically in the sustainable energy sector?

RQs for objective 2

4. What are the existing components of sustainable energy generation and distribution systems in Aceh?
5. What sustainable energy policies exist or are currently applied in Aceh?
6. What are the unsolved problems under the current sustainable energy policies and technology implementation?
7. Who are the relevant stakeholders and actors with roles within a sustainable energy problem system?
8. How do specificities of vulnerable societies contribute to the identified problems?

STAGE 2

RQs for objective 3

9. How do the motivations of external aid and vulnerable societies match with particular reference to the WEIRD membrane?
10. What mechanisms/interfaces are required to link appropriate technologies to sustainable energy policies?

STAGE 3

RQs for objective 4

11. How can the links between appropriate technology and sustainable energy policy be utilised by policy makers as an intervention strategy to empower vulnerable societies and address their problem systems?

1.6 Thesis structure

This PhD thesis is structured so that the content, context and methodology employed in this study are made clear starting from chapters 1 and 2. Theoretical sensitivity which is derived from literature review, immersion in data, and researcher's prior knowledge and experience is presented next through chapters 3 and 4. Analysis of sustainable energy systems and functions in Aceh are given in chapter 5. These lead to the emerging synthesis that is further discussed in chapter 6. In conclusion, chapter 7 evaluates the PhD research concept, content and context, the achieved aim and objectives, the answered research questions, concluding remarks, and statements of identified future work.

Chapter 1: Introduction

Chapter 1 sets out the context of the PhD thesis with a particular emphasis on the rationale for research and its original contribution to knowledge. Included in this section are the study scope, aim, objectives, research question, and thesis structure.

Chapter 2: Research design

Chapter 2 aims to determine and justify the research framework appropriate to conduct this study. The research's philosophical stance (ontology and epistemology), methodology, approach, strategy, nature of inquiry, and paradigm are presented in more depth in Chapter 2. The methods and techniques for data acquisition, analysis, and synthesis are reviewed then the methodological challenges confronted and overcome in carrying out this study are explained.

Chapter 3: Literature review

Chapter 3 provides the answers to RQs 1, 2, and 3 based on a narrative review of pertinent literature. This, together with the data collected provides the foundation to a theory development. This chapter identifies gaps in current knowledge and understanding of theories in vulnerability, sustainable energy, and appropriate technology. This chapter also establishes the underlying principles for selecting the case study used in this research.

Chapter 4: Case study (work undertaken and results)

Chapter 4 summarises interviews, workshops, observations, and desk based data acquisition. This chapter provides answers to RQs 4 and 5. Results of work undertaken and data interpretation are critically discussed and iteratively fed back to theory development.

Chapter 5: Analysis (problem systems and functions)

The problem system of sustainable energy policy and appropriate technology in Aceh is elucidated in chapter 5 and the functions within this system are defined. Chapter 5 provides the answers to RQs 6 and 7. First, the chapter discusses the results derived from the following analytical approaches: statistical analysis, numerical modelling, interpretive policy analysis (language, object, and act analysis), and actor analysis (network analysis and stakeholder analysis). This chapter also discusses results derived from the case study in relation to the specific clusters of literatures which are also treated as data. Both theory and practice are treated as data and are critically analysed to generate new understandings.

Chapter 6: Synthesis

Chapter 6 provides the description of how the novel conceptual model and intervention strategy have been developed. Furthermore, future research avenues are given in chapter 6. This chapter provides the answers to RQs 8, 9, 10, and 11. A novel conceptual model describing the new unravelled understanding provides the basis for designing a sustainable energy policy and appropriate technology implementation intervention strategy.

Chapter 7: Closing

Chapter 7 concludes the concept, content, and context of the PhD thesis. It highlights the way in which the aim and objectives have been achieved by evaluating the answers to the research questions. Finally, future work has also been identified.

1.6.1 Referencing

Referencing is done per chapter and the referencing style follows the Robert Gordon University’s (RGU’s) guideline on Harvard Referencing Style (Brown 2010).

2 Research Design

"When in doubt, observe and ask questions.

When certain, observe at length and ask many more questions."

(George Patton)

2.1 Introduction to chapter two

Chapter two aims to determine and justify the research framework appropriate to conduct this study. The chapter first reviews the philosophical stance, paradigm, and methodology in more depth. It goes on to review the methods and techniques for data acquisition, analysis, and synthesis. The methodology which employs a multi methods approach selected to best address the research questions, including the non-recorded interviews, is one of the novel contributions of this PhD. Finally the methodological challenges confronted and overcome in utilising selected methodology to out this study are explained.

In a study focussing on indigenous coastal communities, McGoodwin (2001) states that the core essence of a research methodology lies in seeking answers to the basic question of how trustworthy and reliable information can be studied about a particular group or community. This involves decisions on how phenomena can be investigated for true and useful, and how others can know about the researcher's idea, propositions, and theories.

There are a number of factors governing the selection of an appropriate research methodology ('how to research') to answer a research problem ('what to research'). The selection of this research methodology involves a deeper reasoning than just practicalities – it calls for a philosophical justification to 'why research' (Holden 2004). Among the influencing factors shaping the discussions in this chapter are 'nature of research objects' and 'researcher's prior knowledge and experience'. The two factors, together construct the research philosophical stance, paradigm, and subsequent research methodology. These considerations have become the basis for selecting the most appropriate methods and techniques, employed and adapted to achieve this study's aims and objectives, and answer the research questions.

2.2 Philosophical stance

A researcher's intentions, goals, and philosophical assumptions are inextricably linked with the research that the researcher does. This is because how the researcher views the constructs of social realities and knowledge affects how she will go about uncovering relationships among phenomena and social behaviour, as well as how she evaluates her own and others' research (Grix 2004).

Understanding the philosophical reasoning which informs the choice of research questions and methodology is therefore an important first step of developing a clear and precise research. Developing the philosophical justification to conduct this PhD research has required the researcher to make a number of assumptions clustered in two groups of dimensions, (1) the nature of science and (2) the nature of society.

2.2.1 The nature of society

Assumptions about the nature of society are made according to the following two groups of concepts on how a researcher views or perceives society: (1) sociology of regulation and (2) sociology of radical change (Burell and Morgan 2005). This theory is about characterising societies according to their predicted approaches in engaging with social phenomena: whether it is the stabilising effects of social order, or the pro-change effects of radical change, although in reality there is a continuum between these dichotomies. Burell and Morgan (2005) have framed four types of paradigms in social behaviour based on the traditional theory on the sociology of regulation, which emphasises stability, integration, functional coordination, and consensus; and the sociology of radical change, which emphasises change, conflict, disintegration, and coercion. These four paradigms of social theory analysis are: radical humanist, radical structuralist, interpretive, and functionalist. All four are explained below.

- Radical humanists look for means of empowering individuals by increasing their self-awareness to change restrictive social structures. The assumptions shared in this stance are that there are structures below the surface which drives individuals in their social interactions, e.g. communication patterns and behaviour (Jonsson and Macintosh 1997). It is committed to removing restrictive conditions, systems, and ideologies preventing their human potentials to be fully realised (Chua 1986). Radical structuralists aim to directly change the concrete restrictive structures (outside the human mind) in order to uplift restricting conditions which prevents individuals fulfilling their full potential. This is done with the goal of increasing individual’s consciousness.
- The radical structuralist together with the radical humanist understands that oppression and discrimination are the products of socio-economic status and class (Tashakkori and Teddie 2003).

- The interpretive stance perceives society as it is and considers social reality as emergent and created subjectively (Baldvinsdottir et al. 2003). To this stance, conflict needs to be resolved as it is disfunctioning societies (Hooper 2001). By interpreting structures made by human, deeper meanings and explanations are sought from observation and linguistic cues. Being interpretive holds the notion of not having the belief in neutrality of facts but rather in individual's interpretation of meanings (Baker and Bettner 1997).
- The functionalist stance takes the view that human interactions can be studied in the way that natural science can use a deductive logic where hypotheses are tested in a cause and effect order (Chua 1986; Guba and Lincoln 1998). In this case, hypotheses and their variables are chosen prior to conducting any studies.

In conclusion, because the scope of this PhD research is around vulnerable societies with experience in conflict and disaster, the researcher analyses a society based on the assumption of the sociology of radical change and subjectivity. This assumption utilises the concept of human as social constructor, actor, and processor.

2.2.2 The nature of science

There are five fundamental assumptions in looking into the nature of science. Utilising the fundamental assumptions on scientific dimensions most relevant to defining a research framework (Creswell 1998; Guba and Lincoln 2005) and the network of basic assumptions characterising the subjective-objective debate within social science (Morgan and Smircich 1980), this PhD study is built on the philosophical stance explained below and summarised in Table 2-1.

Assumptions about human functions are assumptions made on human's role in the social world (Vasilachis de Gialdino 2011). Ontological assumptions are assumptions made about the form and nature of reality and, therefore, what is there that can be known about it (Grix 2004; Vasilachis de Gialdino 2011). Because the assumption made on human function is that human serves as social constructor, actor, and processor, the researcher views that individuals and/or groups of individuals within a society construct realities. As such, these realities are not absolute, where one is no more true than the others. Epistemological assumption relates to who or what can produce knowledge and the relationship between the ‘knower’ and the ‘what can be known’ (Crotty 1998; Vasilachis de Gialdino 2011). Axiological assumptions highlight values of both the researcher and object of research throughout the research process (Vasilachis de Gialdino 2011). Meanings of realities constructed by social actors can only be discovered through close interactions between the researcher and research objects (Vasilachis de Gialdino 2011).

In conclusion, the background work and current scope of this PhD research became the basic considerations for the researcher to determine her ontological, epistemological, axiological, and methodological assumptions. The research object (sustainable energy policy, appropriate technology, and vulnerable societies in South East Asia) are products of human interactions. Because of the characteristics of the research subject (vulnerable societies with experience in human conflict and natural disaster), the researcher considers human functions as social constructor, actor, and processor. Based on the researcher’s previous knowledge and experience working with local communities, interactions between the researcher and the objects of research can affect the objects of research themselves. The findings or the ‘would be known’ are the end products of this interaction. From the consistencies of previous work undertaken by the researcher prior to this PhD research, it is clear that the researcher has acquired ingrained respect for indigenous norms, wisdom, and principles in sustainably empowering local communities. Therefore, the way which will best serve the researcher in looking for the ‘what can be known’ is through observations, in depth interviews, and document content analyses, performed iteratively and collaboratively adjusted to accommodate social complexity.

Table 2-1: Research's philosophical stance

Types of fundamental assumptions Creswell (1998); Cohen 2007; Guba and Lincoln (2005); Grix (2004); Morgan and Smircich (1980)	**Researcher's assumptions underpinning the research framework**
Group 1 - The nature of society	
Assumptions about human (nature of human functions)	The research is based on the assumption of the nature of human functions as social constructor, actor, and processor
Group 2 - The nature of science	
Ontological assumptions (nature of reality)	The research is based on the ontological assumption where reality is seen as a social construction
Epistemological assumptions (relationship between the knower and the would be known)	The research is based on the epistemological assumption where the relationship between the knower and the would be known is (1) to map context of understandings and (2) to study systems processes – changes.
Axiological assumptions (nature of ethics)	The research is based on the axiological assumption where respect for indigenous norms, wisdom, and principles
Methodological assumptions (nature of inquiry)	The research is based on the axiological assumption where the nature of inquiry is iterative, collaborative, and adjusted to accommodate social complexity

2.3 Paradigm

The assumption about human (nature of human functions), the ontological assumption (view of reality), the epistemological assumption (understanding of the nature of knowledge), the axiological assumption (position on ethics), and the methodological assumption (nature of inquiry) are the main components which define a research paradigm (Creswell 1998; Grix 2004; Guba and Lincoln 2005). These also characterise the subjective or objective approaches to a particular research (Morgan and Smircich 1980).

According to Weaver and Olson (2006) paradigms regulate inquiries through providing processes based on patterns of beliefs and practices until investigations are completed. Furthermore, the concept of paradigm itself is related to a certain point of view or perspective (Taylor et al. 2006). Therefore, a researcher's beliefs and perceptions can be considered as the main components of his/her undertaken research paradigm.

Research paradigms can be grouped according to their foci as follows: theory driven, concept driven, or application driven (function-driven) (Akinsete 2012; Denzin and Lincoln 1998). According to Creswell (2009) the application driven group tries to deal with social justice issues and puts forward a suggestion that enquiries need to be intertwined with politics and political agenda; and the process may well change the participants and researcher's life. Grouped in this cluster of paradigms are: critical theory, praxis, and transformative paradigms (Akinsete 2012). Transformative paradigm looks into realities from a standpoint of how they are defined, by whom they are defined, whose realities have been given privileges, and what the social justice implications of accepting these realities are (Mertens 2007). The paradigm argues that realities may be depicted when viewed by researchers who ignore the complexity inherent in indigenous expressions, ignore participant's communities' subjective involvement, and their diverse responses (Chilisa 2005). On inequalities of voice representation among stakeholder groups, the paradigm bases practices on social justice ethics as it provides a chance for the least advantaged groups in a society to be heard and represented (Simons 2006). It considers trust building between researchers and their research subjects as paramount (Silka 2005).

In conclusion, both the nature of research subjects and the researcher's prior knowledge and experience, have contributed to the shaping of this PhD research methodology through a transformative paradigm. The researcher therefore addresses the PhD research problems (research questions) through the basic beliefs in the existence of multiple realities, inequities, conflicting priorities, and the value of trusts. All of the issues surrounding a transformative paradigm discussed in the above paragraph have been considered and become the foundations of designing this PhD research approaches, methods, and techniques.

2.4 Methodology

The application driven, transformative paradigm adopted by this PhD research sees reality as something that is shaped by socio-political, economic, ethnic, cultural, and gender based structures. Within this paradigm, the researcher is also seen to be actively participating in the situation encountered and to have a stake in resolving the problems found (Cohen and Crabtree 2006).

This study is an action research, in line with the explanation provided by Kumar (2005) in which community development is the goal, where research agenda is planned and implemented in a cyclical process to identify issues, develop strategy, and implement programmes. Contrary to the traditional research process which poses a research question, gathers and analyses data, interprets results, judges its relevance to context and applies those results within their remit, an action research enables a researcher to instigate changes whilst simultaneously collecting and processing data. In this PhD research process, the researcher alongside the local academic counterparts had to deal with multiple realities, issues of inequities, and the complexities of conflicting priorities. In amongst these constraints, trust remains one of the key issues that dictate the ability of the research to continue. This is consistent with the ethical reasoning that researchers performing action oriented research should ultimately be responsible to members of the indigenous communities used as the case study and should therefore put their interests first (McGoodwin 2001).

At the same time, this research also adopts a grounded theory methodology, which focuses on generating a theoretical idea as opposed to testing a hypothesis (Charmaz 2006). However, it does not adhere strictly to the detailed process of a traditional grounded theory, and thereby may not be considered a pure grounded theory study. It seeks to inductively construct a theory emergent from a case study as data by recognising patterns of relationships among constructs along with their underlying logical arguments (Eisenhardt and Graebner 2007) then feeds back the generated theory back into an action, The approach determined to be most appropriate to answer the research questions is fieldwork supported by document review. The strategy chosen to complete the selected approach is using a case study to develop new concepts and understanding.

2.4.1 The one case study strategy

The use of one case study as a strategy in generating new theories fits with the study’s philosophical stance and its research questions’ nature. A combined action and adapted grounded theory research such as this benefits from utilisation of one case study because they emphasise the real-world context where the phenomena occur (Eisenhardt and Graebner 2007), thus providing a way to address the lived experience (Travers 2001). It particularly suits situations where the research looks for answers to "hows" and "whys" (Edmonson and McManus 2007), such as this PhD research. Sense is achieved in a human world through how it is ascribed by culture and an interpreted reality in one society may mean something else in another; highlighting again the need for thorough and detailed case-study-based insights into a single society and culture (Malinowski and Bronsilaw 1961).

According to Merriam (1998), a case study has the following four essential characteristics:

1. Particularistic – focuses on one event, process, or situation
2. Descriptive – details a phenomenon extensively
3. Heuristic – enhances understanding of phenomena through being particularistic and descriptive
4. Inductive – generalises and conceptualise an idea from data

These characteristics emphasise learning in great detail from a single case, but at the same time do not claim to be representative (Tellis 1997). A single case study is most appropriate for broadening understandings, not for proving previous concepts (Stufflebeam et al. 2000). There are several reasons for the criticism surrounding the use of a single case study in a research design. It has criticised been for being non-representative and lacking statistical generalisability due to different interpretations and researcher bias of its data complexity and richness (Conford and Smithson 1996). However, supported by Yin (2003), Denzin and Lincoln (2000) argue that case studies do in fact enhance generalisability by looking at multiple actors in multiple settings. The advantages of using a case study includes the level of details that can be derived from the unique perceptions and concerns of individuals in a real-world situation which would otherwise would have been lost in controlled, experimental strategies.

Due to the nature of this PhD research questions and the interpretive stance adopted by the researcher, the single case study approach is seen as the most appropriate research strategy.

2.4.2 Methods and techniques

In a combined action and adapted grounded theory research such as this action oriented PhD project, the methods and techniques are designed to acquire the necessary information about various aspects of a situation, issue, problem or phenomenon so that it can be used for purposes such as identifying needs, advising policy, and developing strategies (Kumar 2005). The transformative paradigm and subsequent approach of synthesising emergent theories from data prescribes the need for a mixed method to be employed to ensure that the research questions are answered (Mayer 2007). This study is designed to gain valuable insights of available resources, technology, and policy through quantitative methods, while at the same time it is designed to understand the society members' realities and meanings through qualitative methods.

A summary explaining the selected methods for literature review designed and undertaken in this research is given in Table 2-2, for data acquisition in Table 2-3, data analysis in Table 2-4, and synthesis in Table 2-5.

2.4.2.1 Literature review

The choice between literature review methods lies in the breadth of research topics and emphasis on the need for transparency of research techniques. Systematic reviews are more able to draw attention to the methodological limitations of primary studies and publication bias than narrative reviews, thereby producing more conservative conclusions than narrative reviews (Cipriani and Geddes 2003). Systematic reviews' strength in transparent and replicable methods include: narrow focus of question, comprehensive evidence search, results validity, and rigorous means of performing appraisal, quantitative summary and evidence-based inferences (Cook et al. 1997). However, these strengths may become systematic reviews' weaknesses when used for some review topics, as it does not allow for comprehensive coverage (Collins and Fauser 2005). These topics would need a narrative review method where less explicit methods are the trade-off for broader coverage. Where systematic reviews are more suitable for focused topics, narrative reviews are more appropriate for comprehensive topics. Narrative reviews can cover a given topic broadly though not following any rules about searching for evidence and validity in original study.

Therefore, based on the broad, cross-disciplinary nature of this PhD research, a narrative review of literature was chosen over a systematic review. A narrative literature review was performed with the knowledge that its limitations include poor specifications of review topic, selective uses of evidence, inadequate specifications of criteria for including or excluding studies, limited attention to methodology, and lack of transparency in presenting results (Sorell 2007). To minimise these limitations, this PhD literature review section specifically states the purpose and scope of review, specifies the criteria and boundaries of included or excluded studies, and presents a step-by-step technique to the review process.

Table 2-2: Selected method for literature review to answer RQ1, RQ2, and RQ3

Research questions	Literature review approach	Literature review sources	Literature review results
RQ1: **What is a vulnerable society and what are the specificities of a vulnerable society?** **RQ2:** **What is a sustainable energy policy and what are the special considerations of a sustainable energy policy in a vulnerable society?** **RQ3:** **What are the gaps in existing knowledge of appropriate technology specifically in the sustainable energy sector?**	NARRATIVE REVIEW	Journal papers Government publications Organisational reports	(Sub-section 3.2.1) Factors influencing vulnerability (Sub-section 3.2.2) Triggers of vulnerability (Sub section 3.2.3) Conclusion (re-interpretation) of vulnerability (Sub-section 3.3.1) Sustainability (Sub-section 3.3.2) Sustainable energy in practice (Sub-section 3.3.3) 4 Sustainable energy resources (Sub-section 3.3.4) Sustainable energy policies in vulnerable societies (Sub-section 3.3.5) Conclusion (re-interpretation) of sustainable energy policy (Sub-section 3.4.1) Appropriate technology policy (Sub-section 3.4.2) Perceptions, preferences, and directions of appropriate technology's elements (Sub-section 3.4.3) Conclusion (re-interpretation) of appropriate technology

Table 2-3: Selected methods for data acquisition to answer RQ4 and RQ5

Research questions	Data acquisition approaches	Data acquisition sources	Data acquisition methods	Data acquisition results
RQ4: **What are the components of energy generation and distribution systems existing in Aceh?** **RQ5:** **What sustainable energy policies exist or are currently applied in Aceh?**	DOCUMENT REVIEW	Journal papers	Online research	Policy statements' activity/plan and target sector (Table 4-3) Policy measures' activity/plan and target sector (Table 4-4) Official and/or commissioned reports (Table 4-5)
		Government publications	External desk study	
		Organisational reports	External desk study	
			Internal desk study	
	FIELD WORK	Marine energy resources	Site survey & Participatory observation	Summary of survey and observation (Table 4-6)
		Human resources	Site survey & Participatory observation	Summary of survey and observation (Table 4-6)
			Workshops and formal meetings	Summary of workshops and formal meetings with Aceh Stakeholders (Table 4-7)
				Summary of meeting with Indonesia Stakeholders (Table 4-8)
			Interview	Summary of interview (Table 4-9)

Table 2-4: Selected methods for data analysis to answer RQ6 and RQ7

Research questions	Data analysis methods	Data analysis results
RQ6: **What are the unsolved problems under the current sustainable energy policies and technology implementation?**	Statistical Analysis (SA)	(Sub-section 5.2.1) Geothermal, waste, solar, hydro ,and wind energy resources
	Numerical Modelling (NM)	(Sub-section 5.2.2) Marine energy resources
	Cost Benefit Analysis (CBA)	(Sub-section 5.2.3) Building indigenous capabilities in Aceh
	Language, Object, and Act Analysis (LOA)	(Sub-section 5.3.1) Human resources - skills required (Table 5-3) Technical resources – energy generation technologies (Table 5-4) LOA of policy statements (Table 5-5) LOA of policy measures (Table 5-6) LOA of implementation programmes (Table 5-7)
RQ7: **Who are the relevant stakeholders and actors with roles within a sustainable energy problem system?**	Actor Analysis – (1) Network Analysis	(Sub-section 5.3.2) Relationship direction of influence (Figure 5-10) Relationship frequency and intensity (Figure 5-11)
	Actor Analysis – (2) Stakeholder Analysis	(Sub-section 5.3.2) Interest, expertise, and influence (Figure 5-12) Sub-national, national, regional connections and cooperative potential (Figure 5-13)

Table 2-5: Selected methods for data synthesis to answer RQ8, RQ9, RQ10, and RQ11

Research questions	Data synthesis methods	Data synthesis results
RQ8: **How do specificities of vulnerable societies contribute to the identified problems?** **RQ9:** **How do the motivations of external aid and vulnerable societies match with particular reference to the WEIRD membrane?**	Aceh's sustainable energy categories determination Aceh's sustainable energy problem system themes determination	(Sub- section 6.2.1) Lessons learnt from case study (Sub-section 6.2.2) Specificities of vulnerable societies and their problem system (Section 6.4) Crossing the WEIRD membrane
RQ10; What mechanisms/interfaces are required to link appropriate technologies to sustainable energy policies?	Creation of themes linkages Data interpretation	(Sub-section 6.4.1) The missing links (Sub-section 6.4.2) The proposed interfaces
RQ11; **How can the links between appropriate technology and sustainable energy policy be utilised by policy makers as an intervention strategy to empower vulnerable societies and address their problem systems?**	Theory generation	Section (6.5) Intervention method: building indigenous capabilities Section (6.6) Intervention technique: business case and solid network Section (6.7) Intervention vector: agent of change's roles and significance

2.4.2.2 Data acquisition

Document review

Document review is a relatively inexpensive means to a good source of background information. It is unobtrusive and may bring up issues that are not noted by other means of data collection. Data were collected through document review as secondary sources. Internal desk research, external desk research, and online research were all performed to obtain the required information. These sources of data include:

1. Journal papers;
2. Government publications;
3. Organisational reports;
4. Survey data

Field work

Because the empathetic understanding gained through fieldwork serves as an entry point for a humanistic approach, non-anthropologists including engineers have been known to use fieldwork techniques when implementing policies and technical projects involving indigenous communities in complex societies (Channa 1998). The major goal of fieldwork is to understand how a culture operates their systems of meanings. After understanding the major goal of fieldwork, the next important factor is what a field worker should record in these circumstances. Contrary to the earlier beliefs that truth has to be presented as an objective fact which cannot be contested, the positivist approach which suggests not getting emotionally involved in the society and remaining ethically neutral is found to be irrelevant in the reality of studying a marginalised society (Channa 1998). It is because of this process of witnessing in person and experiencing the pains and suffering of societies in marginal positions, many marginalised communities' causes have been highlighted and taken up by fieldworkers.

Because the truth in one situation may not be so in another, a participant observation approach is seen to be more appropriate to answer this PhD's research questions compared to the positivist, objective approach. However, as suggested by Channa (1998), in studying a marginalised society, it is seen that performing a quasi-participant observation is enough to obtain this perspective as opposed to performing a full participant observation approach. A quasi-participant observation is a process where the researcher enters the field as a researcher, stays on and off in the field, but maintains his/her identity. Because of this, a rapport establishment marks the beginning of the fieldwork, where the ability to empathise and look at the world from the perspective of the people studied is present in the researcher. In this case, the researcher coming from a similar cultural background in a way helps this process, but also at the same time presents some difficulties in separating the biases within.

Adopting the ethics found in anthropology, the fieldwork based methodology in itself is humanistic (Mencher 1975). How impossible it is to completely overcome the limitation of a field researcher's own subjectivity is today an accepted part of fieldwork descriptions, up to a state where fieldworkers are encouraged to record their fieldwork experience in a reflective manner (Channa 1998). A solution to this limitation is for any aspect of subjectivity to be made clear to the readers so that they are able to evaluate the effects of the researcher's subjectivity by having knowledge of it. In any case, it is these inter subjectivity which is now acknowledged to be the strengths of conducting a fieldwork based research, not its objectivity. In the light of the above, primary data were derived from direct measurements of marine energy, participatory observations, and interviews of groups of human resources actively involved in the sustainable energy policy and appropriate technology sector within the case study. Starting to fill in the gaps in sustainable energy resource assessment in Aceh, direct measurement was performed for tidal current potential off the coast of Banda Aceh.

Quasi-participatory observations were mainly conducted to find out how the indigenous communities respond to various aspects of sustainable energy generation versus the mainstream consensus. The researcher's interpretation of being an insider versus an outsider of particular communities is also obtained through this technique (Mayer 2005). One of the main limitations of participatory observation is the length of time and the resources invested in becoming immersed with the communities being studied. The field works for this PhD study were carried out in 6 field visits, with on-site days amounting between 10 to 40 days per visit, spread over a three-year period, thereby requiring rapid-assessment techniques. Although this shortened field-work limits the amount of information collected, this limitation can be minimised by increasing the researcher's effectiveness by entering the field situation already familiar with her community and culture (McGoodwin 2001). Meeting this requirement, the researcher is an Indonesian national, familiar with the Acehnese communities and culture through previous historical interactions in sustainable development related projects.

Meetings and interviews were conducted with indigenous coastal and rural off grid communities (farming and fishing villages), ex combatants, local community (cultural sovereign) leaders, internally displaced persons (IDPs), local businesses, academic communities, local non-governmental organisations (NGO) and decision making government officials. The local leaders in Aceh include:

1. "Panglima Laut" (translated as "Commanders of the Sea") who have cultural authority over "Customary Waters";
2. “Panglima Wilayah” (translated as “District Commanders”) who each commands one of the sixteen Acehnese terrestrial Districts and their armed forces;
3. Sultanate descendants (Teuku) who are the leaders in the Acehnese cultural sovereign kingdom;
4. Village elders, who are part of the Acehnese cultural sovereign structure, usually present in rural/coastal/island villages.

Most of the conversations took place in Indonesian and Acehnese (where 3 tiered translations were needed). Notes were taken for some formal meetings that involved local academics, NGOs, and the government. These were then distributed amongst stakeholders to approve before treated as sources of information. No records were taken during other informal meetings and during all of the interview sessions. However, adopting the ethnographic techniques for constructing jot notes and field note proper, results of these discussions were summarised after every session as a record (Emerson, Fretz and Shaw 2001). The informal meetings and interviews were conducted across sections of communities (more often than not presenting different perceptions on the same event) to get a more holistic picture about the society.

The methods outlined above have generated the following data:

1. Direct measurement records (numerical dataset);
2. Site survey and observation notes and photographs;
3. Summary of formal and informal interviews;
4. Summary of formal and informal meetings and workshops

2.4.2.3 Data analysis

Analyses were designed based on the framework created by Mayer et al. (2004). The ability to explicitly recognise which activities are relevant in a particular policy analysis enables conscious choices to be determined for analysis styles and for subsequent selection of methods (Mayer et al. 2004). Based on the PhD project's research questions, 'research and analyse', 'design and recommend', and 'strategically advise' have been identified as the three main activities which will be undertaken. Therefore the policy analysis is mostly appropriately approached through rational and client advisory styles. Quality of analysis will be assessed by its validity-reliability, usability-action orientation, and workability-feasibility. This approach is recognised to serve as general guidance to specifically tailored policy analysis methods as will be described in the following sections.

Although analysis styles were identified using the framework developed by Mayer et al. (2004), further considerations when performing policy analysis on sustainable livelihood related problems were addressed based on recommendations put forward by Shankland (2000). These considerations include working from existing policies towards recommendation as the best approach in this PhD study context. Inclusion of measures for implementation as an integral part of the policy process ensures analyses do not stop at formulation. To further avoid any broad brushing, disaggregation is needed between specific sectors analyses and cross-sectors analyses, between sustainable energy policy measures and the policy itself, and between impacts of measures to different stakeholder groups.

There are two analysis approaches used in this PhD study. The first is a 'quantitative approach' which consists of statistical analysis (SA), numerical modelling (NM), and cost and benefits analysis (CBA). The second is a 'qualitative approach' which consists of language, object, act analysis, network analysis, and stakeholder analysis. Both analysis approaches are explained in further details in the next sub sections.

Quantitative approach

Statistical analysis and numerical modelling

A quantitative approach through SA and NM was performed to construct a baseline of existing energy consumption patterns and resources available, as determinants in evaluating efficiency, future sizing, and impact of sustainable energy technologies. The baseline was used to analyse appropriate technology as guided by the energy resource-technology matching process for remote, rural societies (Ashworth 1982). One main limitation is the impracticality of performing a complete analysis for time-restricted projects such as this PhD work. Therefore, SA and NM for energy consumption and available resources were performed in selected groupings of communities based on current limited access to energy and potential roles in future pilot projects.

Cost benefit analysis

One of the key items in establishing business cases is an analysis of the costs of a project, which normally includes some considerations of costs and payback time. Cost benefit analysis (CBA) compares the total costs and total benefits associated with an initiative, namely those reflected in market prices (private cost or benefit) (Diakoulaki and Karangelis 2007).

It has been highlighted that the payback method is simple and best used as an initial screening tool (Levitan 2010). One of its weaknesses is that it only takes into consideration the cash flow as opposed to other investment opportunity, which Net Present Value (NPV), Internal Rate of Return (IRR), and Average Rate of Return (ARR) considers. Regardless of its limitations, the payback method is seen to be the most appropriate method for the purpose of achieving the objectives of this PhD research. The payback method was used to analyse the potential costs and benefits of creating an indigenous, appropriate sustainable energy technology manufacturing capability in Aceh.

Qualitative approach

A qualitative approach through interpretive policy analysis (language, object, act analysis) and actor analysis (network analysis and stakeholder analysis) is seen to complement the traditional quantitative approaches, in which the outcome leads to the justification for interventions. These methods were chosen based on the necessity of analysing policies in a society where formulation takes place based on professional judgement and conducted in the midst of social and political tensions. This raises the issue of multiple stakeholders' motives and interpretations thereby requiring a method that can relate actor analysis to policy problems (Van der Lei 2009).

Language, object, and act analyses

The steps involved in conducting the interpretive policy analysis for this research follows the sequence as explained by Yanow (2000):

1. Identification of language, objects, acts, as significant carriers of meaning for a given policy issue;
2. Identification of interpretation groups relevant to analysed issue;
3. Identification of specific meanings communicated through thought, speech, and act;
4. Identification of conflicting points and their causes for differences (affective, cognitive, moral)
5. Intervention:
    a. Presentation of different interpretations' implications
    b. Presentation of reasoning behind that different interpretation.

Words, symbolic objects, and acts of policy-relevant actors together with policy texts are the data collected for language, object, and act analyses, thereby engaging groups of people sharing understandings of policy ideas and language is the first steps in interpretive policy analysis. It is followed by steps to discover how members of each group (e.g. tribe, profession, and organisation) categorise the social world (Yanow 2000). Document review, conversational interviews, and participatory observation are interactive methods to generate rich data, with many researcher-analysts preferring not to record (on tape or notes) at the time of interaction with subjects (as subjects may say more and freely express their views, especially controversial ones, when not being recorded). Instead, examples are given for encouragement of training oneself to be able to follow conversations with jotted notes, to be summarised with the researcher's understanding afterwards (Yanow 2000). Whichever analytical method chosen (as described in more detail in the following sub sections), the process' success depends on the immersion of the researcher-analysts in the details of her data.

Network and stakeholder analyses

Actor analysis for this research was performed based on the method defined by Hermans and Thissen (2009) and Van der Lei (2009) as a method that allows studies of characteristics of multiple actors. There are two types of actor analysis methods: one that describes multi-actor decision-making and one that describes structural actor relationships. Van der Lei (2009) categorises the actor analysis methods further into two groups as represented on Figure 2-1: network analysis and stakeholder analysis.

In network analysis (known also as social network analysis), graphs (nodes and lines) are used to describe relationships between actors. The relationships may represent different things (e.g. value, friendship, kinship, etc.), making network analysis a multi-dimensional approach (Kenis and Schneider 1991; Scott 2000; Van der Lei 2009). For research purposes, usually one type of relationship is chosen for an analysis (Van der Lei 2009). Stakeholder identification is usually done in simple, descriptive, grids. It is used to map different actors based on their interests, resources, and/or power (Bryson 2004; MacArthur 1997; Van der Lei 2009). The technique equips the researcher-analyst to obtain an idea of stakeholders under study at a snapshot view. Although lacking in depth, it provides a robust overview of the overall situation (Van der Lei 2009).

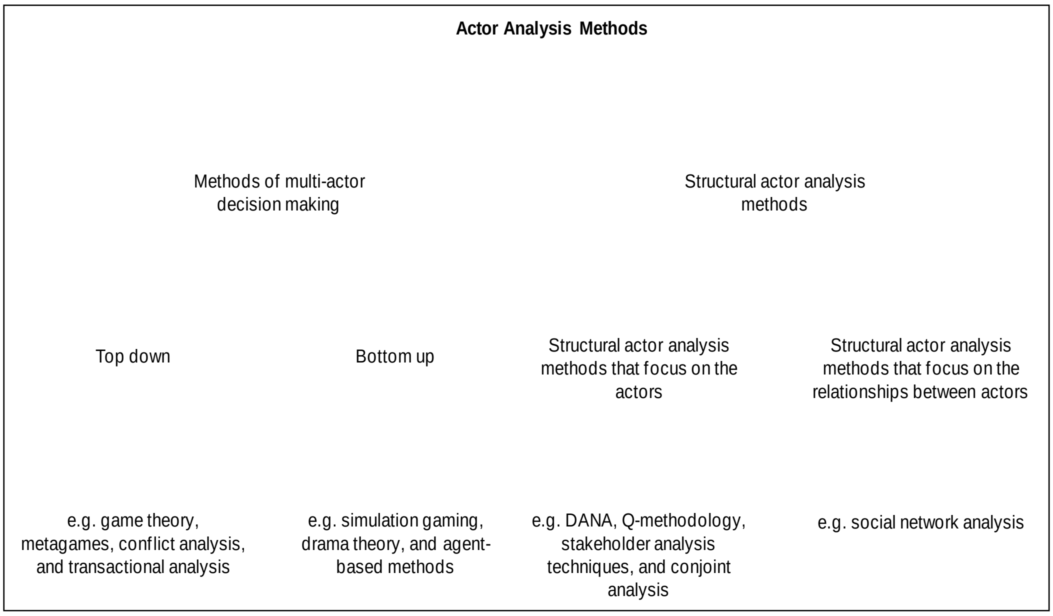

Figure 2-1: Groups of actor analysis methods

Reproduced from Van der Lei (2009)

2.4.2.4 Grounded theory for emergent synthesis

Using data from the case study (primary data - field work) simultaneously with data from literature (secondary data - desk based), the research constructs a theory based on the emergent concepts coming from the data, which is produced within the case study's context. Contrary to the process of deductively testing a theory or hypothesis, the research views theory as a process and an ever-developing entity (Akinsete 2012). In grounded theory, the use of mixed methods is also embraced as this is considered to be necessary and supplementary for verification and generation of theory (Glaser and Strauss 1967 pp. 17-18). Theory building from cases is thought to produce a theory which is more accurate and testable due to its close loyalty to the data (Eisenhardt and Graebner 2007). However, it also has it shortfalls, including: the involvement of the amount of energy and time spent collating and preparing the data; as well as the validity and generalisability of findings (Miles 1979).

2.5 Methodological considerations

A summary of each chosen method's suitability, limitations, and measures taken to minimise limitations for the literature review is given in Table 2-6, for data acquisition Table 2-7 and for data analysis in . Some methodological challenges related to cross language research and drawing conclusions from one case study is also given in this section.

2.5.1 Methods' suitability, limitations, and measures taken to minimise limitations

2.5.1.1 Literature review

The method chosen for literature review for this PhD research is narrative review. Whilst the reasoning behind choosing the narrative review method over systematic review has been given in section 2.4.2, its suitability and limitations is further explained in Table 2-6. Measures which have been taken to minimise the limitations are also outlined.

Table 2-6: Literature review method's suitability and limitations

Method for literature review	Techniques	Suitability	Limitations	Measure taken to minimise limitation
Narrative review	• Internal desk study	• Comprehensive topics	• Poor specification of topic	• Stating purpose of review
		• Limited available literature	• Inadequate specification for inclusion / exclusion of literature	• Specifying criteria and boundaries for selecting articles; • Arrange subject matter in series of objective questions
			• Limited attention to methodology	• Clearly presented, step by step technique and procedure
			• Lack of transparency in presenting results	

2.5.1.2 Data acquisition

Data acquisition methods chosen to conduct this PhD research consist of document review (internal desk study and external desk study) and field work (direct measurement, observation, interview, formal meetings, and workshops). A complete description of the chosen data acquisition methods and the reasoning behind those choices were given in section 2.4.2. Meanwhile, each of the techniques utilised to perform the chosen methods, their suitability and limitations are given in Table 2-7 overleaf. Measures which have been taken to minimise the limitations are also outlined.

2.5.1.3 Data analysis

Data analysis methods chosen to conduct this PhD research consist of statistical analysis (SA), numerical analysis (NA), cost and benefit analysis (CBA), actor analysis, and language, act, and object analysis. A complete description of the chosen data analysis methods and the reasoning behind those choices were given in section 2.4.2. Meanwhile, each of the techniques utilised to perform the chosen methods, their suitability and limitations are given in Table 2-8 overleaf. Measures which have been taken to minimise the limitations are also outlined.

Table 2-7: Data acquisition methods' suitability and limitation

Methods for data acquisition	Techniques	Suitability	Limitations	Measure taken to minimise limitation
Document review				
	• Online research • Internal and external desk research	• Creation of baseline • Compilation of historical data • Provision of a 'behind the scenes' look at programmes which are not directly observable	• Differences of quality and standards used by authors • Incomplete or inaccurate information	• Need to cross reference for credibility
Field work				
Direct measurement	• Tidal current profile	• Getting information for unchartered area	• Time consuming • Resource consuming	• Shorten length of data gathering
Observation	• Participatory observation	• Collecting soft data: expressions, gestures, quality of objects • Providing overall picture as common platform • Access to information without relying on informants' cooperation	• Susceptible to observer bias • Differences of people's behaviour when they are aware of being observed	• Treat subjectivity as data to complement objective analysis (statistical analysis and numerical analysis)
Interview	• Unstructured • informal, unrecorded	• Gathering verbal information when written communications inhibit data sharing • Covering broad ranges of issues in the order of importance according to informants • Providing a chance for any sensitive information which	• Unfocused • Time consuming • Susceptible to interview bias • Need prior trust-building before meaningful information can be shared • Transcription and translation issues	• Spend extra time to gain trust and give extra effort to maintain trust • Fluency of researcher in interview language and in written report language

		would otherwise not be detected to be captured		
Formal meetings	• Recorded	• Capturing information from interaction of different sectors and/or communities at one time • Providing data for actor analysis (network analysis and stakeholder analysis)	• May create barriers between actors to speak freely on perceptions and visions	• Careful arrangement of meeting / workshop attendees • Informal introductions of contributors prior to arranged formal meetings and workshops
Workshops	• Recorded			

Table 2-8: Data analysis methods; suitability and limitations

Methods for data analysis	**Techniques**	**Suitability**	**Limitations**	**Measure taken to minimise limitation**
Statistical Analysis (SA)	• Basic statistical techniques (means and percentages)	• Reassessing secondary dataset and identifying trends	• Relying on other people's analysis through their primary work	• Cross check any calculations
Numerical Analysis (NA)	• Tidal power numerical modelling	• Tidal current resource assessment	• Requiring field work for data input. Limitations regarding conducting fieldwork is mentioned in Table 2-7	• Mobilising resources or adjusting work field work time to available financial, physical, and/or means
Cost and Benefit Analysis (CBA)	• Material, equipment, building, time, travel, and staff costing • Projected income from energy generation	• Provide clear defining line of return of investment	• Measurement is only focused on monetary value	• Complementing conclusions derived from CBA with conclusions derived from language, object, and act analysis which should cover some of the unquantifiable benefits (those that do not have monetary value)
Language, object, and act analyses	•	• Interpreting different perceptions within a society	• Subjectivity of researcher • Dependant on researcher's language skills	• Explicitly stating researcher's potential bias through being a national from the nation, speaking their language (national or dialect, and part of the initial network of relevant actors
Actor analysis	• Network analysis • Stakeholder analysis	• Identifying influential key players based on their interests and capabilities	• Subjectivity of researcher	

2.5.2 Methodological challenges

2.5.2.1 Issues related to cross language research

Culture is always understood by interpretation, and consciously or unconsciously a researcher involved in cross language research translates not just words but also her interpretation of the events and actions into the framework. Translating involves transferring meanings from a source language to a target language, where the translator is actually an interpreter who considering individual situation and overall cultural context processes the vocabulary and grammar of the words (Esposito 2001).

According to Squires (2009), there are three considerations when conducting a research involving translations between languages. These considerations are:

- clear information to reader of translation occurrence and actions taken to manage the related issues;
- more issues arise when someone other than the researcher translates written or spoken words;
- because translation consists of construction of meaning, analysis is happening during the process.

Although English is not the primary language used in Aceh-Indonesia, some members of the local communities taking part in this PhD study are able to interact in discussions and interviews in English. It is however recognised that conversations taking place in their native language will bring out more information, including the nuances which otherwise cannot be captured. This research addresses the above issue by utilising the researcher's native language (Indonesian) to conduct interviews wherever possible. Where this is not possible (in cases where respondents only speak their native tribal dialect (Acehnese), a trusted member of the local partners was asked to translate from Acehnese to Indonesian. Summaries from interviews were directly written in English by the researcher. For observations, the researcher took jot notes in English, then transferred them to field note proper and summaries also directly in English. Meetings and workshops were conducted using mixed languages (native dialect, Indonesian, and English). In these instances, the researcher took meeting notes directly in English then transferred them to summaries also in English. Most of the documents reviewed are written in English. For publications written in Indonesian, translations were performed by the researcher into English.

2.5.3 Issues related to drawing conclusions from a single case study

A single case study strategy was chosen as the strategy for this PhD research while acknowledging its constraints and limitations. According to Yin (2003), the skills required to employ a single case study based research is mainly a good knowledge of the phenomenon as there are no routines in the research procedures. These were met by the researcher’s familiarity with the formally taught Indonesian national history and its alternative version. The researcher is also familiar with the sensitive phenomenon of social dynamics in Aceh as a sub nation of Indonesia. This good background knowledge of Aceh has assisted the researcher in developing the sensitivity necessary for new and unexpected issues encountered in data collection, asking non-intrusive but open questions, being a good listener to sometimes long and not directly relevant conversations, and being adaptive to and comfortable with flexibility of time and place.

The issues relating to generalisability or transferability of a single case study approach in research was addressed by exercising rigour on the study’s design and methods through validity, reliability, and employing triangulation in accordance to Patton (2002). It was also addressed by appropriately developing the theory emerging from findings (Johnson and Christensen 2004). To perform this in utilising Aceh as the single case study as above, the researcher has performed the following actions:

- To address construct validity in research design, mixed methods in triangulation to search for converging findings from different sources were utilised;
- To address reliability in data collection, a case study database was created containing case study notes, tabular materials, and narratives of original study questions. A chain of evidence was maintained by linking initial research questions to case study procedure and sufficient referrals to the case study result data base;
- To address internal validity in data analysis, pattern matching through descriptive processes were established, sets of causal links were explained, and theoretical statements were iterated.

3 Literature Review

3.1 Introduction to chapter three

To answer the research questions collated for Objective 1 (RQs 1, 2, 3), a narrative review of pertinent literature is presented in chapter 3. This chapter critically reviews the literature on vulnerable society (section 3.2), on sustainable energy policy (section 3.3), and on appropriate technology (section 3.4) based on the selected method as outlined in Table 2-2. Gaps in current knowledge and understanding of theories are subsequently presented in section 3.5. Finally the chapter establishes the underlying principles for selecting the case study used in this research (section 3.6). This, together with the data collected, provides the foundation for theory development in chapters 5 and 0.

Objective 1

Critically analyse the terms 'vulnerable society', 'sustainable energy policy', and 'appropriate technology.

RQs for objective 1

1. What is a vulnerable society and what are the specificities of a vulnerable society?
2. What is a sustainable energy policy and what are the special considerations of a sustainable energy policy in a vulnerable society?
3. What are the gaps in existing knowledge of appropriate technology policy and its implementation specifically in the sustainable energy sector?

The structure of chapter three is explained through a flowchart given on Figure 3-1 overleaf. Sections are linked to the research question it answers and to other contributing sections.

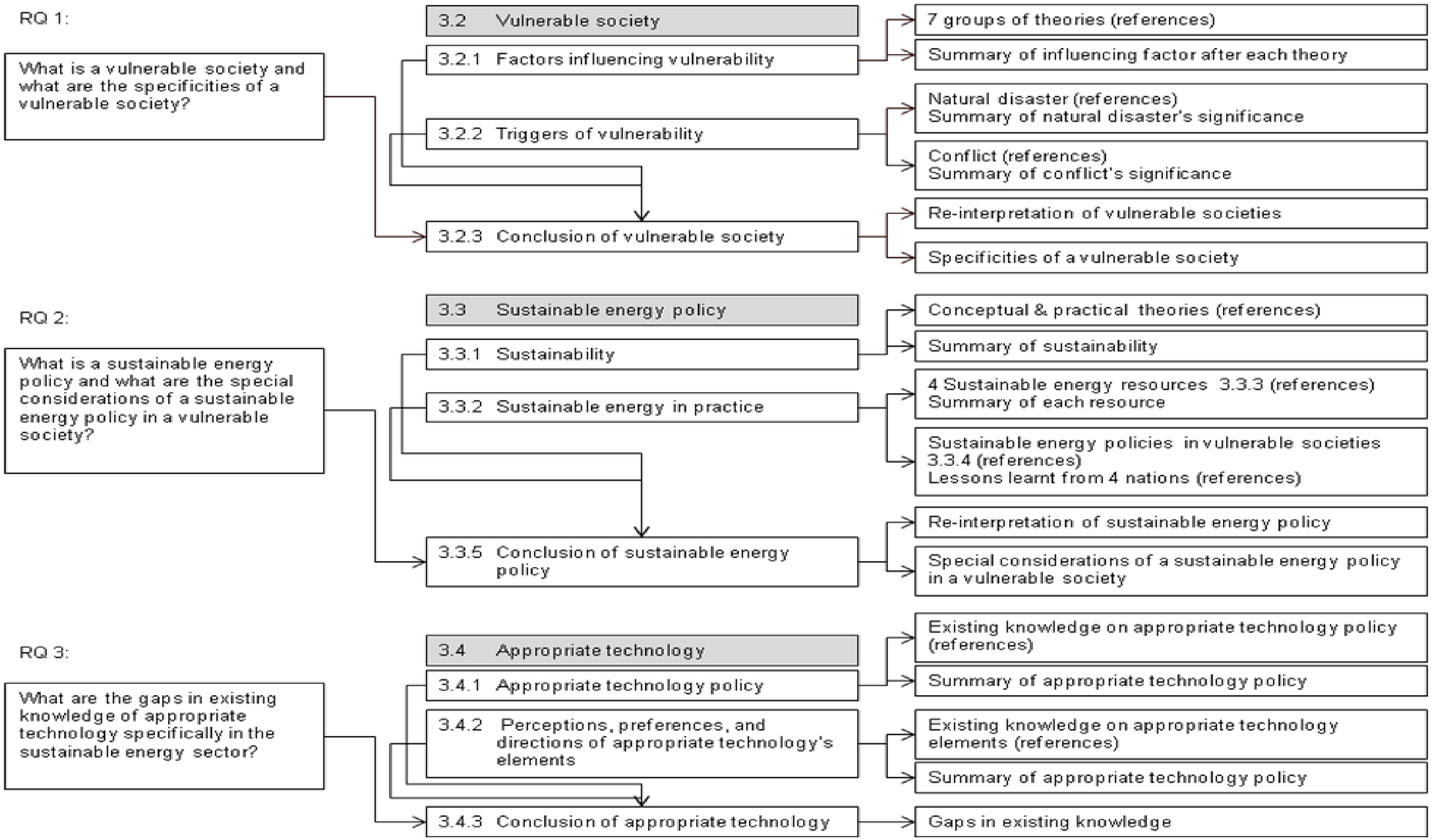

Figure 3-1: Flowchart of chapter three

3.2 Vulnerable society

Section 3.2 provides the knowledge foundations for defining vulnerable societies. It starts with Sub-section 3.2.1 which looks into the factors influencing and determining the vulnerability of a society. Then in the following Sub-section 3.2.2 two dominant triggers of vulnerability i.e. natural hazard and human induced catastrophe are explored more in detail. Finally in Sub-section 3.2.3 the reviewed understandings of vulnerability are used to newly define and scope vulnerable societies.

3.2.1 Factors influencing vulnerability

To provide a full picture of the current knowledge in vulnerability, this sub section reviews the conceptual and analytical frameworks of vulnerability available in published literature. There are currently seven groups of theories surrounding vulnerability. These groups are summarised as follows:

1. The conceptual framework of double structure for vulnerability
2. The sustainable livelihood framework for vulnerability
3. The conceptual framework of vulnerability in disaster risk community
4. The analytical framework for vulnerability assessment in global environment change
5. The pressure and release (PAR) model
6. The holistic approach to risk and vulnerability assessment
7. The Bogardi-Birkmann-Cardona (BBC) vulnerability links to sustainable development

3.2.1.1 The conceptual framework of double structure for vulnerability

This concept stresses that vulnerability is multifaceted (Figure 3-2). The internal side (coping factor) relates to the capacity of anticipating, coping with, resisting, and recovering from impacts of hazards (Bohle 2001). On the contrary, the external side relates to exposures to risks and shocks. Bohle (2001) views that although vulnerability cannot be adequately characterised without simultaneously considering coping capacity, exposure to hazard is the key component of vulnerability. The term exposure in itself also relates to social and institutional features and processes that lead to defencelessness (Birkmann 2006).

In summary, this framework sees vulnerability as mainly to be determined by exposure to hazard. However, it also recognises that coping factor which mainly relates to a condition of defencelessness caused by social and institutional features and processes, influences vulnerability.

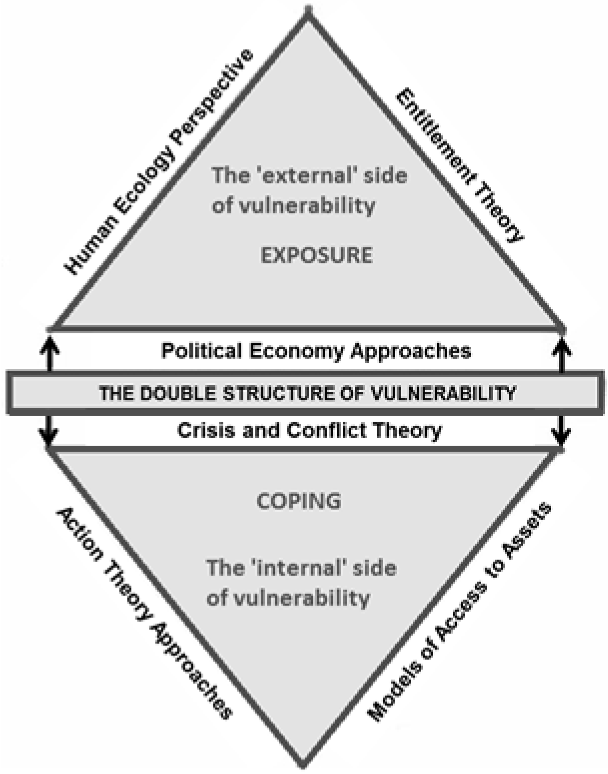

Figure 3-2: Double Structure - conceptual framework for vulnerability.

Source: Bohle (2001)

3.2.1.2 The sustainable livelihood framework for vulnerability

Coping ability to recover from pressures is linked to sustainability (Chambers and Conway 1992; Department for International Development 1999). The sustainable livelihood framework (Figure 3-3) emphasises that vulnerability and livelihood assets of local communities are especially influenced by the transformation of structures in governmental or private sectors systems and their respective processes e.g. law and culture (Birkmann 2006). It also argues that empowering local marginalised groups is necessary to effectively reduce vulnerability (DFID 1999; Schmidt 2005). Linkages between human and the environmental system play major roles in developing resilience (Adger et al. 2005; Allenby and Fink 2005; Folke et al. 2002). In relations to other frameworks of vulnerability, shocks in this framework represent hazard components. Shocks in this framework also represent the five livelihood assets (human capital, natural capital, financial capital, social capital, and physical capital) and the elements that are exposed and susceptible. Meanwhile, transforming structures and processes in this framework represents root causes, dynamic pressures or driving forces.

In summary, this framework sees vulnerability as interactions between human and their environment systems. The influencing factors of vulnerability are presented as livelihood assets which are unable to provide strong support mechanisms in facing dynamic pressures.

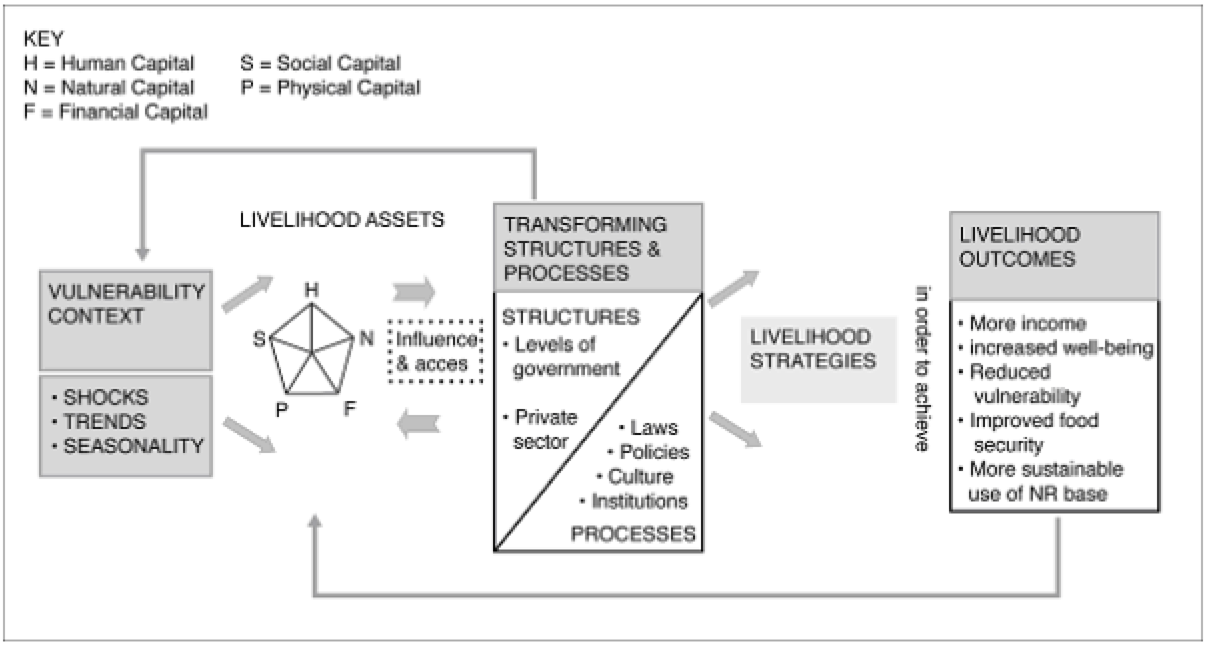

Figure 3-3: The sustainable livelihood framework

Source: Department for International Development (1999)

The conceptual framework of vulnerability in disaster risk community

This conceptual framework (Figure 3-4) views hazard, exposure, vulnerability, and capacity measures as components to risk. Contrary to the framework of the double structure of vulnerability developed by Bohle (2001), this framework differentiates between exposure, vulnerability and coping capacity (Bollin et al. 2003; Davidson 1997). A hazard is measured by its severity; whilst exposures to hazard is characterised by structures, population, and the economy. Capacity measures (comparable to that of coping capacity in the double structure framework) consists of physical planning, social and economic capacity, and management. Birkmann (2006) explains that the term “deficiencies in preparedness” captures the lack of coping capacities.

In summary, this framework sees vulnerability as a component to risk, in which the influencing factor is a pre-existing condition that makes infrastructure, processes, services and productivity more susceptible to external hazards.

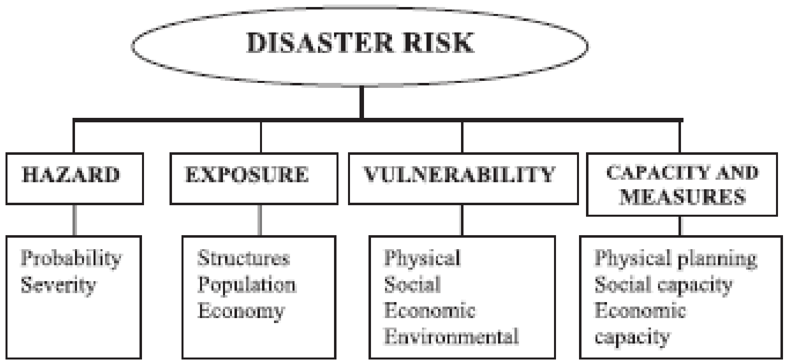

Figure 3-4: The conceptual framework to identify disaster risk

Source: Bollin et al**. (2003) and Davidson (1997)**

3.2.1.3 The analytical framework for vulnerability assessment in global environmental change

The discussions of vulnerability in the context of climate change and sustainable communities have shaped this concept of vulnerability into something that does not only capture susceptibility and coping capacity; but also adaptive capacity, exposure, and interaction with perturbation and stresses (Turner et al. 2003). This framework’s connotation (Figure 3-5) is in contrast with the disaster risk community. Here, vulnerability is addressed in the context of a human-environmental joint system, where adaptation influences sensitivity and increases resilience (Turner et al. 2003; Kasperson 2005).

In summary, this framework shares the view of “The sustainable livelihood framework for vulnerability” where vulnerability is taken as a human-environment joint system. However, this framework then takes the concept further to include adaptation as the determinant factor for increasing resilience to vulnerability.

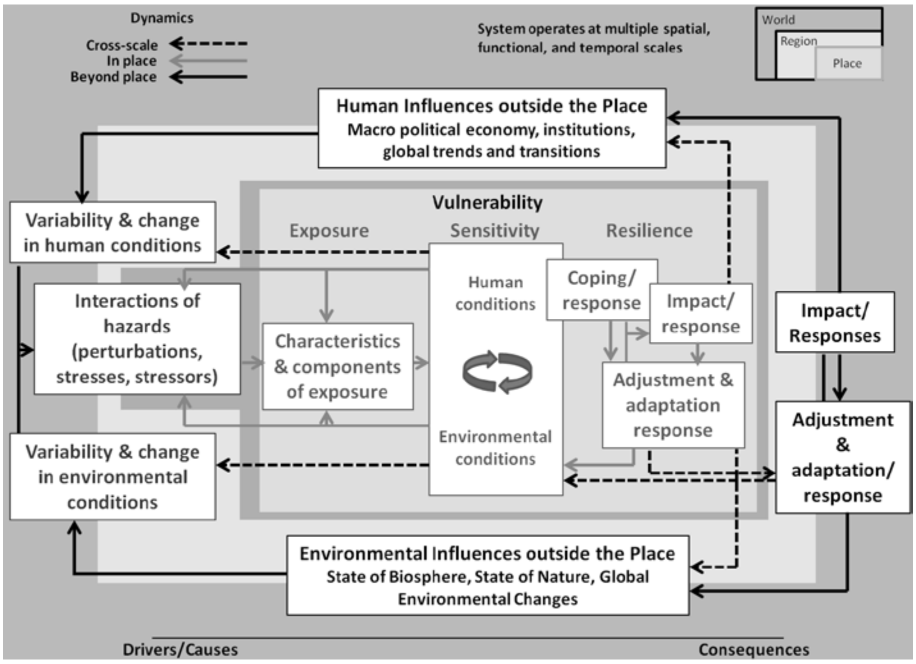

Figure 3-5: The analytical framework for vulnerability assessment in global environmental change (Turner et al. 2003)

3.2.1.4 The Pressure and Release (PAR) model

One of the best-known conceptual models focussing on vulnerability and its driving forces is the PAR model. The model defines vulnerability in three sequences: (1) identification of root causes, (2) contribution of existing dynamic pressures, and (3) additional considerations of unsafe conditions (Birkmann 2006). Root causes (e.g. economic, demographic, politics) determine access to and distribution of power and resources (Wisner et al. 2004). Dynamic pressure includes all activities and processes that transform and channel effects of root causes into unsafe conditions (e.g. epidemics, urbanisation, and conflicts) (Wisner et al. 2004). Unsafe conditions are situations where vulnerability of societies is expressed in a temporal and spatial dimension. It highlights the roles of political and economic systems in reducing vulnerability, and they are not viewed as root causes (Birkmann 2006). PAR puts a significant weight on national and global level dynamic pressures and unsafe conditions, although they might also be determined by local situations (Birkmann 2006). The conceptual model (Figure 3-6) is especially beneficial in addressing contributors to disaster.

In summary, this framework sees vulnerability as a sequential process which starts from the existence of root causes at local, national, or global level, all contributing to the ability to interact to dynamic pressures and additional unsafe conditions.

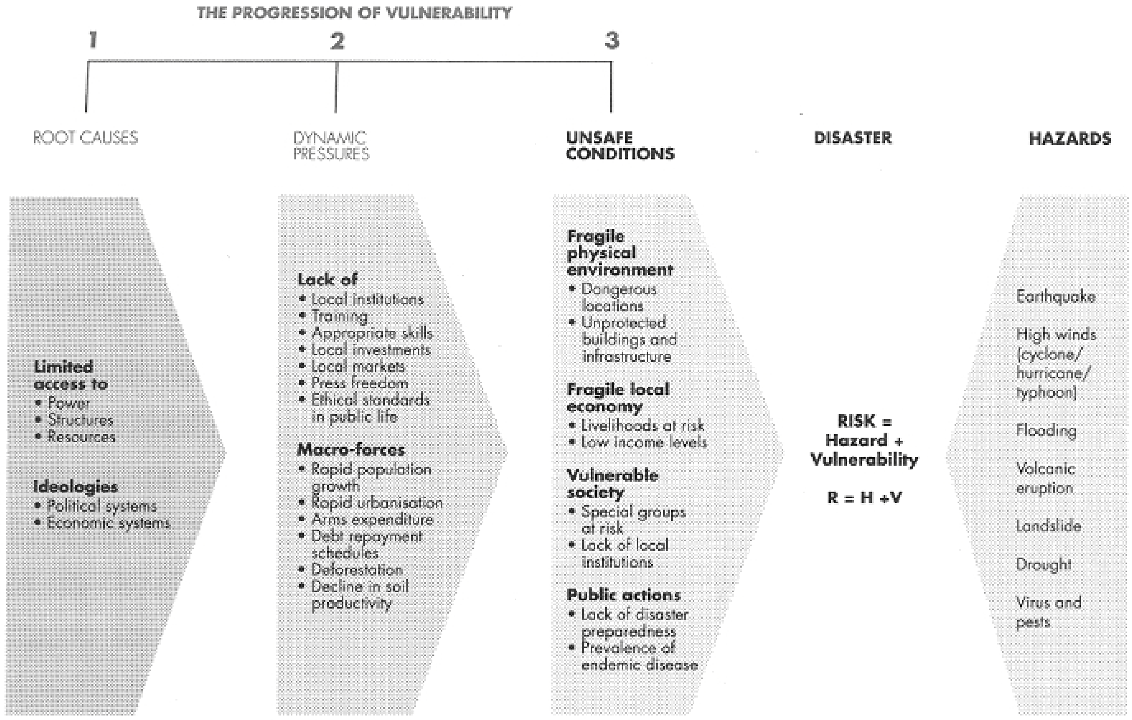

Figure 3-6: PAR vulnerability framework

Source: Wisner et al. (2004)

3.2.1.5 The holistic approach to risk and vulnerability assessment

Wilches-Chauz (1989), considers vulnerability to consist of exposed elements containing many dimensions and aspects including:

- Physical exposure and susceptibility (viewed as hard risk and hazard dependent)
- Fragility of the socio-economic system (viewed as soft risk and non-hazard dependent)
- Lack of resilience to cope and recover (viewed as soft risk and non-hazard dependent)

According to this framework (Figure 3-7) vulnerability conditions depend on the exposure and susceptibility of physical elements in hazard-prone areas on the one hand, and on the other, on socio-economic fragility as well as on a lack of social resilience and abilities to cope (Birkmann 2006).

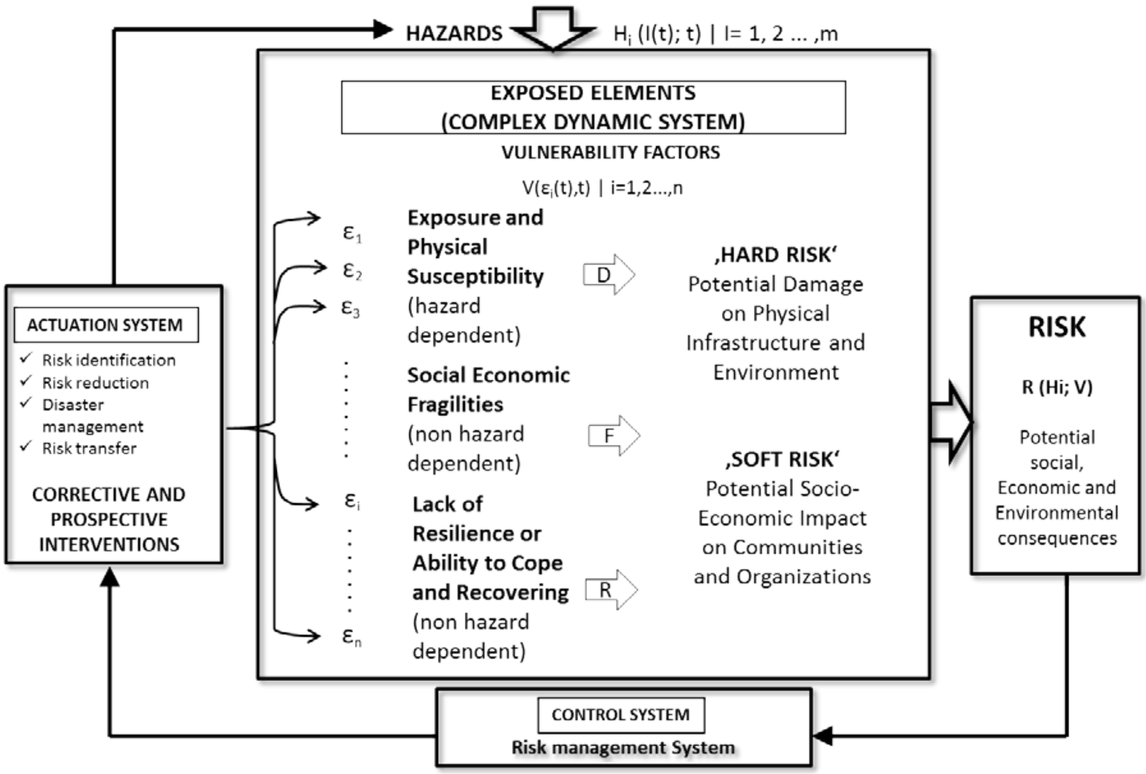

Figure 3-7: Theoretical framework for holistic approach to disaster risk management

Source: Roxana et al. 2013

The framework highlights that vulnerability must be measured using a comprehensive and multidisciplinary perspective. The physical (hard) risks exist when exposure and susceptibility are present; whereas (soft) risks results from socio-economic fragilities and inadequate coping ability.

In summary, this framework sees vulnerability as the combined effect of fragility of existing socio-economic system and of susceptibility to hazard in relation to hard risks and soft risks.

3.2.1.6 The Bogardi-Birkmann-Cardona (BBC) vulnerability links to sustainable development

The BBC vulnerability framework (Figure 3-8) emphasises on the needs for considerations on environmental issues which society depend on (Turner et al. 2003). While some approaches view vulnerability primarily with regard to the degree of experienced loss of life and economic damage, the BBC conceptual framework views organisational and institutional aspects to be as important as physical vulnerabilities; and they should be analysed within economy, society, and environmental spheres. Probable losses and deficiencies of elements, their coping capacities, and potential measures analyses suggest that the framework promotes a problem-solving perspective (Birkmann 2006). Pointing out that dominant Western views of human-nature relationship often place them opposite from one another, implies that the understanding of dividing human and environmental issues is also culturally determined (Oliver-Smith 2004). Opposite from the pre-analytic vision of separating the human and environmental systems, the BBC framework views the environment as where a natural hazard starts and the vulnerable recipients of hazards (Birkmann 2006).

In summary, this framework sees the influencing factor of vulnerability to consist of organisational and institutional as well as physical aspects (coping capacity). Exposure to hazards is the eventual determining factor.

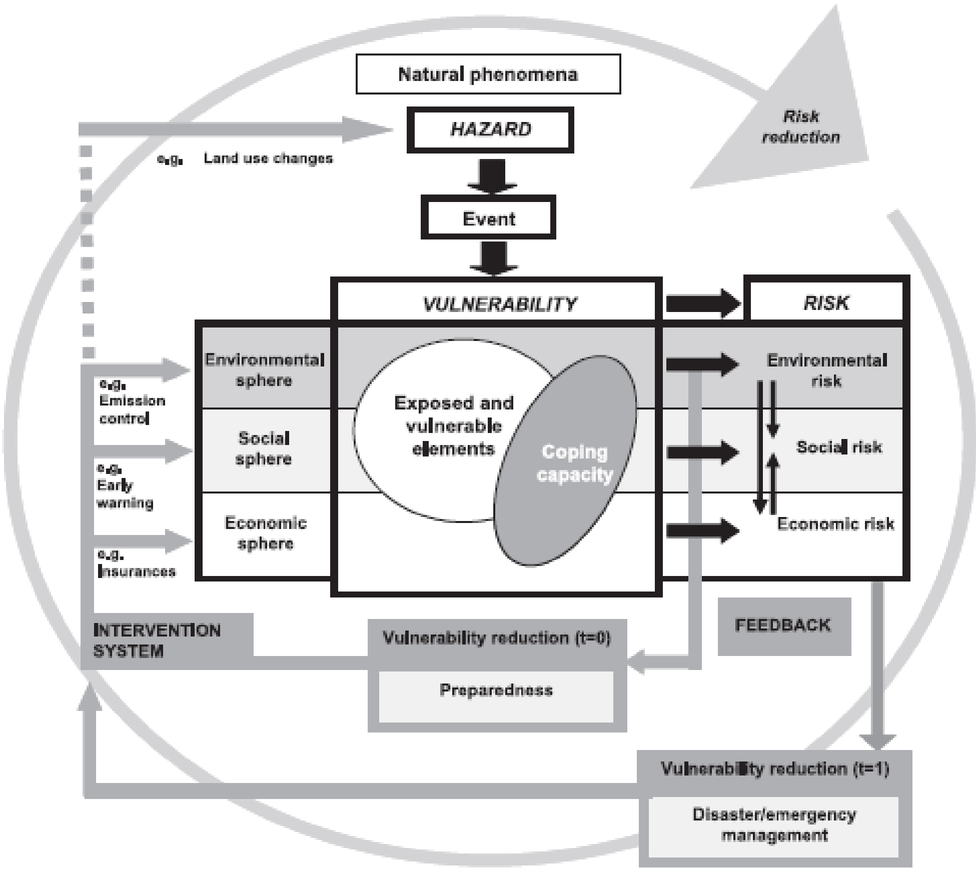

Figure 3-8: The BBC conceptual framework for vulnerability

Source: Birkmann (2006)

3.2.2 Triggers for vulnerability

3.2.2.1 Natural hazards (disaster)

Shrinivas and Nakagawa (2008) highlighted in their study that natural disasters have multi-layered impacts towards societies and their environment. The damage caused by disasters varies with the geographical location, climate and the type of the earth surface/degree of vulnerability, which influences the socio-economic, political and cultural state of the affected area (Shankar 2011). Although natural disasters occur in all parts of the globe, impacts on developing countries are much greater because of the higher vulnerabilities in the region (Alcantara-Ayala 2002). Asia has been highlighted as a region with the highest occurrence of all natural disasters (Alcantara 2002; Shrinivas and Nakagawa 2008). Located between the Pacific and the Indian Ocean, the ASEAN region is susceptible to earthquakes, volcanic eruptions, typhoons and tsunamis, which can easily wipe out economic advancement. At the same time the region's population continues to grow significantly. Urbanisation levels are unprecedented as is population migration. This situation presents a number of serious challenges relating to resource (food, water, and energy) needs, security, and risk. Greening the infrastructure and economy, and increasing preparedness to overcome disasters become important not only to mitigate natural catastrophes but also social risks due to sharply raised conflicts induced by wealth and income disparities.

Recurrence of even small scale disasters can push vulnerable communities into further spirals of vulnerability and damage, especially where inequity is concentrated in a given area (rural, remote, urban shanty) or social groups (traditional, indigenous ethnic groups) (European Commission 2012).
Natural disasters are geophysical events (volcanic activity, flooding, earthquake, landslide, tsunami (Alcantara-Ayala 2002) and are usually an inherent feature of the region. Hence, there is also a cyclical effect between the environment quality and natural disaster risks, and this should be utilised to enhance preparedness in planning stages (Shrinivas and Nakagawa 2008). In general, societies with a history of post-disaster mitigation activities have the following lasting effects (Shankar 2011):

- Disrupted day-to-day livelihood;
- Negatively influenced emergency systems;
- Deteriorated processes for food production, shelter construction, and health

In summary, a natural disaster's significance in determining vulnerability is given by its ability to wipe out the basic infrastructure. For those societies that already have little resilience due to its inherent characteristics, coping mechanisms after such major events are extremely low.

3.2.2.2 Human induced catastrophes (conflict)

A post-conflict period starts when main hostilities have ended and the period ends when basic legal frameworks and policy development capacities are reasonably in place (United Nations Development Programme 2008). Post-conflict areas face more serious challenges compared to other developing societies, even to those with lower economic development (Food and Agricultural Organisation 2005). A continuing risk of relapsing into conflict exists and the extent of this risk very much depends on political state and capacity as well as human and social capital (United Nations Development Programme 2011).

For the purpose of this review, countries and/or provinces considered as post-conflict areas are those that are listed in the UNDP's Crisis Prevention and Recovery Report 2011 (United Nations Development Programme 2011). Common characteristics of countries emerging from a history of social-political conflict include (Food and Agricultural Organisation 2005):

- Continuing fear of violence;
- Displacement of people;
- Unresolved political and ethnic tensions in places where populations who used to be in conflict are forced to co-exist;
- High levels of environmental degradation;
- Government with limited numbers of trained staff;
- Displacements of records and information

During reconstruction processes, new governments in post-conflict regions begin to prioritise policies and interventions (Schwartz and Bannon 2004). However, the key priorities for improvement in policies, which is relatively to similar societies without any history of recent conflict, should be structured so that social and government policies are given priority, followed by structural policies, and macro policies last (Collier and Hoeffel 2004).

For post conflict areas, access to energy is the key to progress, as provision of energy has been strongly linked to global social, economic, and eventually political development (Weynand 2007). Although non-governmental organisations (NGOs) have the flexibility and freedom to be innovative, they lack the resources to undertake major reconstruction activities after such conflicts (McDonald 2005). It is therefore vital to identify all relevant stakeholders in the addressed society, as credible local and/or national government bodies must drive major activities (McDonald 2005). This potentially leads to the necessity of developing policy process type policies for creation of viable institutions and policies targeted initially at framework sector.

The long-term goal of energy provision in post-conflict societies is to support economic growth and social development (Collier and Hoeffler 2004). Access to energy is a key component because provision of energy is strongly linked to global social, economic, and ultimately political development (Weynand 2007). The creation of a complete and overarching policy governing energy therefore, requires the setting of a trajectory over time. However, evidence has pointed out that the optimum time for investment in infrastructure to benefit growth is at the very least 2 years (McDonald 2005). In the meantime, certain foundations and mechanisms for the mid-term and short-term necessities need to be put in place. These immediate needs of energy provision can be fast-mitigated by early engagement and preparatory planning. Such short-term interventions should be designed to achieve the determined long-term goal whilst at the same time not jeopardising the much needed foundation building. Mid-term foundation for energy services should include the adoption of a nation-wide energy vision, which addresses the economic and political needs of both cities and rural areas (Weynand 2007).

In summary, a conflict’s significance in determining vulnerability is dictated by its ability in causing instability on the state’s performance and creation of mistrust between members of the particular society.

3.2.3 Conclusion on vulnerable society

Based on the literature reviewed in the previous sections (3.2.1 and 3.2.2), it is concluded that ingrained economics, social and political characteristics in the form of mindsets, views and capabilities, and the resulting behaviour from these characteristics provide the foundations for vulnerability. Natural disasters and/or human induced catastrophes such as social/political conflicts act as triggers to susceptibility of a society to damage. Lack of access to energy is suggested as an additional reason for vulnerability in societies.

The conclusion above is in agreement with the concept that in addition to the definition of fragile societies (United Nations Development Programme 2008), according to the United Nations Millennium Development Goal Report (2011), (Birkmann 2006), Brooks (2003), and Hovden (2004), vulnerability is determined by access to resources and the levels of pressures they encounter. It also supports Smit and Wandel (2006) and Handmer (1999), that amongst the diverse current understandings on vulnerability the three main characteristics of vulnerability which are consistently and clearly portrayed are: **(1) Relativity -** Vulnerability is context specific. It is qualitatively different for different individuals. Food security is a factual matter in survival, in the poorest parts of the world it is a threat to livelihoods and healthy economies. However, because basic living standards are taken care of by the government, in the developed economies, it is risks and costs for individuals and public/private organisations which becomes the key matter. **(2) Variability -** Equally, some societies are more vulnerable than others creating national vulnerabilities which diverges along familiar lines of developing, transitional, newly industrialised, and developed nations. **(3) Dynamic -** Vulnerability has the characteristics that are completely the opposite of static. Vulnerability responds to changes in population pressures and resource depletion. It evolves in the long term; improving or regressing.

Therefore, this thesis proposes a re-interpretation of a vulnerable society as a group of communities in a disadvantaged position due to its inherent geospatial characteristics mindsets, views, and capabilities; which influences its coping capacity and adaptability to facing population and financial pressures in the limited access to food, water, and energy (F-W-E) resources. This situation thereby creates a condition where they are especially susceptible to damage, physical and/or social collapse when exposed to additional triggers in the form of natural hazards and/or human induced catastrophes (political/social conflicts) (Garniati et al. 2012; Garniati et al. 2014; Owen and Garniati 2012). This concept is represented by Figure 3-9.

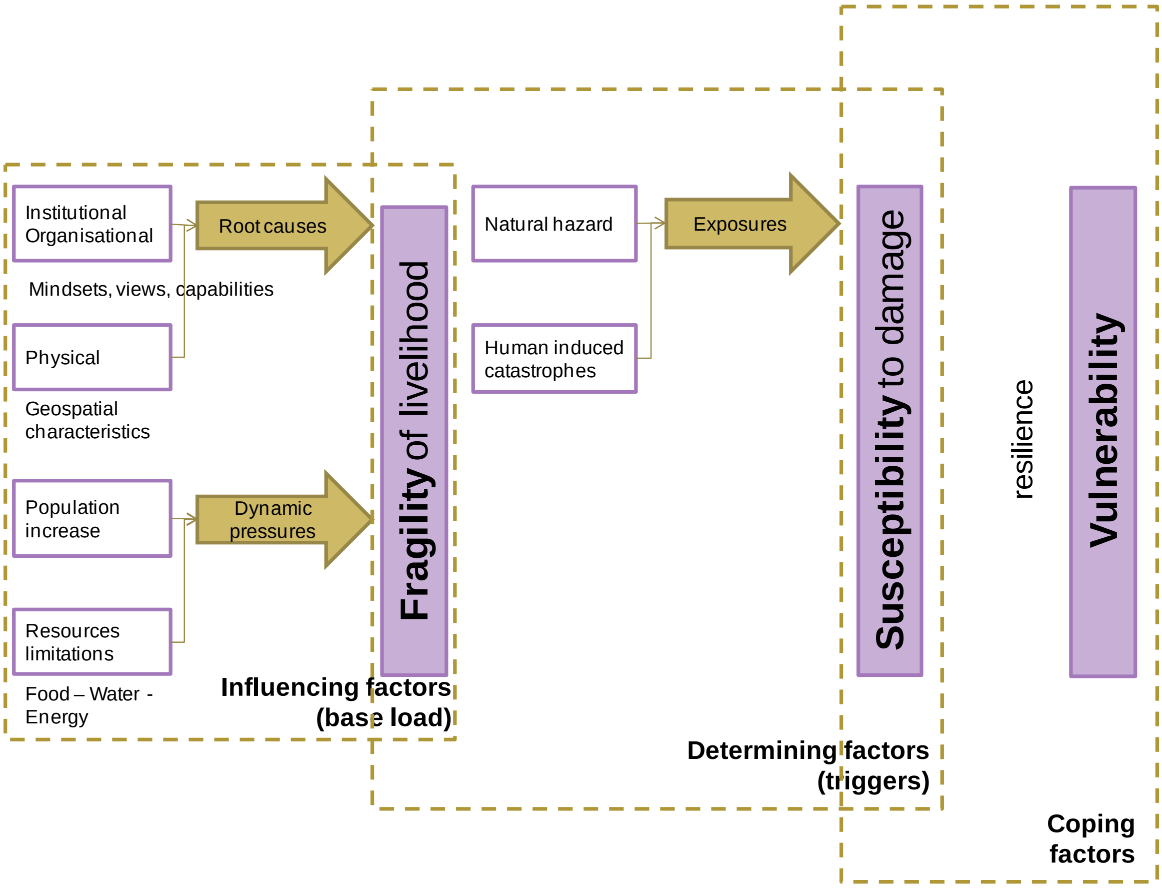

Figure 3-9: Re-interpretation of vulnerability concept developed for the PhD research's context

Referring back to the understanding of a vulnerable society as described above (Figure 3-9), the base load for vulnerability (influencing factor) is thereby dictated by the combination of:

- high limiting factors (i.e. high population density, limited financial means);
- minimum access to resources (i.e. food, water, energy as interdependent nexus).

These main characteristics are generally found in societies with developing economies globally. The two additional triggers (determining factors) for vulnerability are:

- recurrence of natural hazard;
- human induced catastrophes.

As previously discussed in Sub-section 3.2.2, recurrences of natural disasters are most found in South East Asia and socio-political conflicts are more prevalent in Asian and African nations. Because of those considerations, the review of literature on sustainable energy policy (3.3) and appropriate technology (3.4) is performed for societies with developing economies in South East Asia. Special emphasis is also given to those societies in South East Asia with historical experience and future recurring possibilities of natural disaster and socio/political conflicts.

3.3 Sustainable energy policy

Further to re-interpretation of vulnerable societies given in section 3.2, section 3.3 provides a holistic picture of a sustainable energy system that is relevant to vulnerable societies in South East Asia. In order to achieve that, the section starts with providing explanations on sustainable energy related terminologies. Sub section 3.3.1 reviews the concept of sustainability, and 3.3.2 the concept of sustainable energy in practice, covering sustainable energy resources and their crucial progression elements which need to be addressed as priorites for considerations in societies with developing economies. Sub section 3.3.3 reviews current knowledge in sustainable energy resources, and is a published book chapter in Future Energy 2nd edition (Owen and Garniati 2013). Sub section 3.3.4 looks at what policies exist in South East Asian vulnerable societies to enable the sustainable, equal, and dignified utilisation of these resources.

3.3.1 Sustainablility

Sustainability is a dynamic meta-story line, not a fixed condition (Moore et al. 2007). This concept proposes that sustainability should not be seen as a scientific condition which maps the evolution of a society's social, political, environmental, and technological stories. It also brings to attention the temporal aspects of sustainability in relation to a place. The International Institute of Sustainable Development (2012) has also used this concept and highlighted the connection between time and space within past, present, and future systems.

Thompson (2010) puts forward two different theoretical constructs for the term sustainability, namely; *"resource sufficiency"* and *"functional integrity"*. He first views sustainability in terms of resource efficiency and interprets it from a utilitarian perspective where sustainability is understood as *"a measure of the duration of practices that produce wellbeing".* Significantly different to the first view, he then puts forward a second view of sustainability as a functional integrity where it directly relates to *"the mechanisms that allow whole systems such as societies and ecosystems to maintain their activity over time"*.

In practical terms, the Environmental Protection Agency (EPA) suggests that the core principle of sustainability is centralised around survival and wellbeing, depending directly or indirectly, on the natural environment (Akinsete 2012). This concept therefore proposes that sustainability creates and maintains *"conditions under which humans and nature can exist in productive harmony that permits the fulfillment of the social, economic and other requirements of present and future generations"* (EPA 2011).

In summary, sustainability by various philosophical and practical definitions reflects relative equilibriums among social and natural subsystems. However, if sustainability is to achieve its stated goals of "dealing with the interactions between natural and social systems" to accommodate the needs of present and future generations while reducing poverty and conserving the earth's life support systems, it must take account of the ecological limits on human systems and the inherently ecological nature of the human system. This conclusion is in line with the research findings presented in Burger et al. (2012), where the human social, economic, and political spheres depend on flows of energy and materials extracted from the environment sphere, which are then transformed by technology. These flows are governed by global-biosphere scale, physical conservation law, emphasising that a macro ecological perspective which highlights three principles needs to be integrated into the concept of sustainability:

1. Physical conservation laws govern the flows of energy and materials between human systems and the environment;
2. Smaller systems are connected by these flows to larger systems in which they are embedded;
3. Global constraints ultimately limit flows at smaller scales

For the purpose of this PhD research, the conceptual and practical understandings of sustainability becomes the basic foundation for analysing the sustainable energy systems relevant to vulnerable societies and subsequently constructing an intervention strategy for the implementation of a sustainable energy system to cater the specificities of these vulnerable societies (Chapter 5 and Chapter 0). The principles of conservation, embedded sub-systems, and 'just' enough expressed as smaller scales, are most important in assessing the existing limitations and projected goals of sustainable energy systems through analysis of the case study. Flows of energy and material from the natural environment to the human system through technology provide the framework for assessing the levels of technology appropriateness in generating different types of energy to meet consumption and distribution requirements.

3.3.2 Sustainable energy in practice

A sustainable energy future requires the spread of energy services to reach disadvantaged populations, implementation of rational pricing strategies, and actions for structural reform to ensure facilitation and financing of technology transfer (Saha 2003). The social component of sustainable energy can thereby be expanded to cover community involvement, affordability, social acceptability, lifestyles, and aesthetics (Rosen 2009). A fourth dimension of sustainable energy accounted for in this research is political commitment (Kruijsen et al. 2012). The sustainable energy systems discussed in this thesis consist of:

1. Sustainable energy *consumption*, which includes energy conservation measures;
2. Sustainable energy *generation*, which includes renewable energy provision;
3. Sustainable energy *distribution*, which includes equal and secure access to energy resources

Based on the understanding of sustainable energy in practice, the main components for a critical review of literature in vulnerable societies are: (1) sustainable energy resources and (2) sustainable energy policies, and how the two component interfaces with applied technology become the main components for review.

3.3.3 Sustainable energy resources in vulnerable societies

This section was previously published as chapter 29 in OWEN A., and GARNIATI, L., 2013. Energy resources in societies with developing economies. In: T. LETCHER, ed. *Future Energy.* New York: Elsevier. 2013. The contribution of the researcher into the chapter is estimated to be around 90%, consisting of background material, data collected, analysis, and conclusion sections of the chapter, whilst acknowledgement is given on Dr. Alan Owen's contribution in proof reading the material and refining concluding remarks. Specifically on energy resources in vulnerable societies, the researcher has discussed aspects as is presented in the section 3.3.3 of this PhD Thesis.

There are various definitions for 'resources' available in literature; some are broader in their scope, some more practical; and others, are more topic-focussed and philosophical in nature. For the purpose of this chapter, we refer to the term resources as defined by the Merriam Webster dictionary,

*"**a:** a source of supply or support**:** an available means, **b:** a natural source of wealth or revenue, **c:** a natural feature or phenomenon that enhances the quality of human life, **d:** computable wealth, **e:** a source of information or expertise"* (Merriam Webster 2013).

Energy that is securely provided in an environmentally acceptable way and is produced at locally appropriate socio-economic levels is the main challenge facing societies with developing economies globally (Kaygusuz 2012; Paleta et al. 2011). Known as the energy trilemma, the three often conflicting priorities for energy provision mentioned above are the essential key to achieving the sustainable development of these nations (Karakosta and Askounis 2010). Therefore, in the context of providing sustainable energy for the future, resources for energy supply in societies with developing economies need to be discussed in the light of sustainability, equity, and dignity concepts. These relate to the energy resources' relationships with the ecosystem from which it originated and within which it is processed, including its human and physical surroundings. Hence, this chapter discusses energy resources in societies with developing economies through the following groupings of information:

1. Natural resource – what is the energy availability? e.g. hydro, solar, marine etc.

2. Human resource – what is the indigenous skills base and its potential capacity?
3. Technological resource – what technology is appropriate for the need?
4. Capital-infrastructure – what is the business capability and what infrastructure exists?

3.3.3.1 Natural energy resources

This section selects three of the renewable energy resources available in most societies with developing economies based on their priorities for progress: marine energy, bio-energy, and energy from waste.

Marine energy for coastal/island regions

In general, marine energy has one of the biggest gaps in knowledge and experience compared to the other renewable energy resources. The marine environment usually found in societies with developing economies is a complex construct between natural and sociological systems. Existence of “Customary Waters” areas, local tourism and fisheries economic sectors, harbour and port activities, and national security are often found to create overlapping leaderships and conflicts of interests (Owen and Garniati 2012; Kruijsen et al. 2011). This situation produces a multidimensional matrix of risks, benefits, barriers, drivers, and priorities.

Importance of rural bio-energy

In many rural areas of the developing world, access to energy can be difficult and expensive; thereby provision of locally produced bio-energy can offer a viable alternative. In these rural remote areas, traditional biomass (fuel wood and animal dung) is still the main energy supply for cooking and heating fuels in households and small businesses (Ruanne et al. 2010). These sources can be upgraded to the more convenient solid bio-fuels (e.g. briquettes, wood chips, pellets), gaseous bio-fuels (e.g. syngas, biogas, hydrogen), and liquid bio-fuels (e.g. bio-ethanol, biodiesel). Figure 3-10 summarises biomass, bio-fuel (biodiesel and bio-ethanol), and biogas sources available as energy resources along with their relevant production technologies.

Land availability has become the main attraction for bio-energy development in societies with developing economies (Ardnt et al. 2009). Affordability and availability of resources has often become the justification put forward for production and utilisation of bio-energy in societies with developing economies (Jumbe et al. 2009). Adopting bio-energy strategies is suggested as a way to create employment while providing an alternative to imported mineral oil based fuels (where drivers for bio-energy development are different) (Doku and Di Falco 2012). Other benefits, which have been suggested in developing bio-energy in rural areas of societies with developing economies, include: job creation, increase of rural incomes, and reduction of poverty. Others argue that increased production from marginal lands and export earnings contributes to development in these regions (Doku and Di Falco 2012). However, it is worth noting that bio-energy projects can only facilitate socio-economic development when designed and planned using participatory processes (local input and cooperation) (Dermibas and Dermibas 2007). Field based experience shows that many bio-energy projects failed to deliver their goal of enhancing the local communities' welfare through affordable, secure, and environmentally energy supply when such projects are developed on an overly large scale and managed purely by externals.

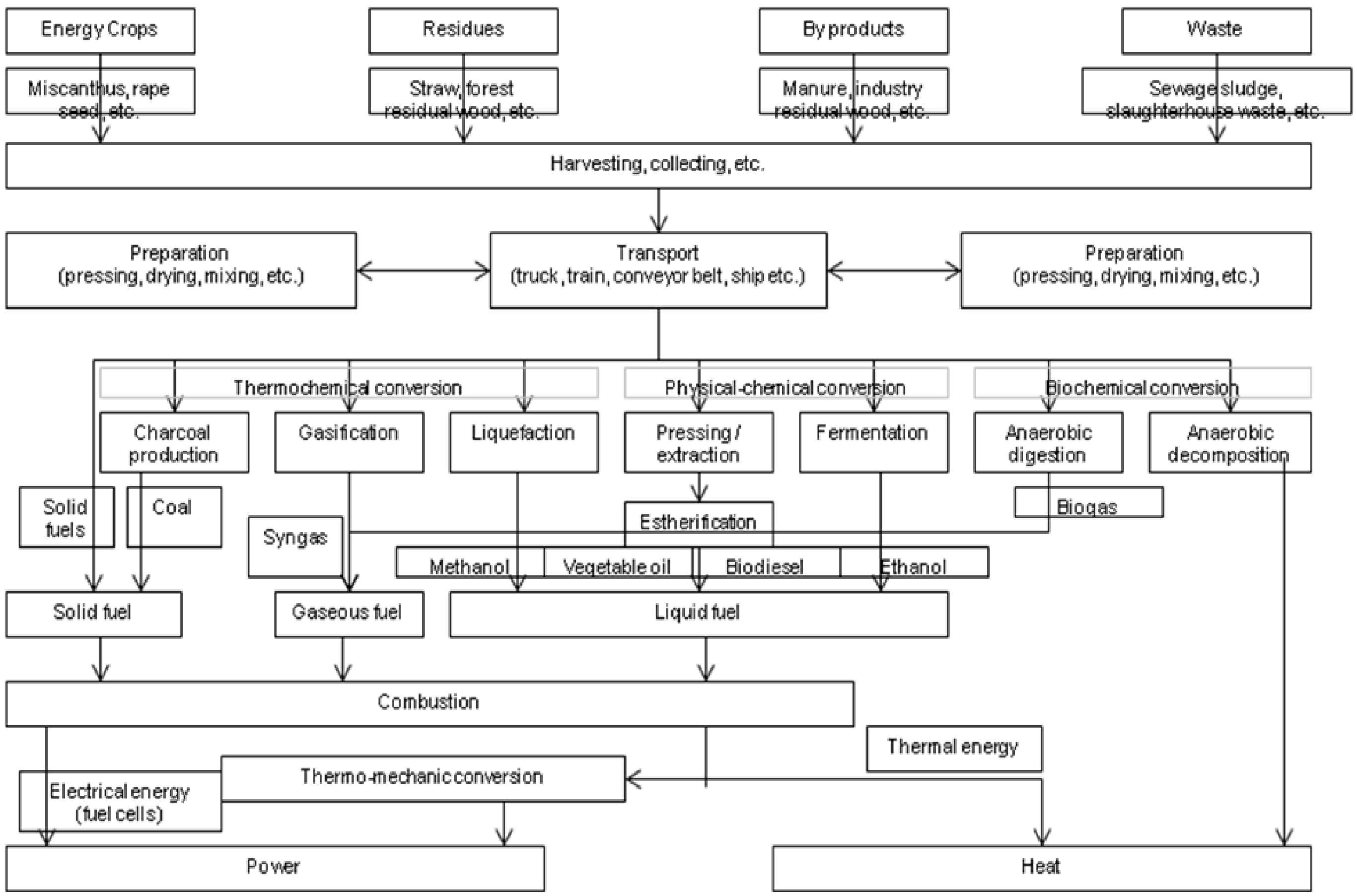

Figure 3-10: Power and heat generation process from residues, by-products, and wastes

Reproduced from Karagiannidis et al**. (2009)**

Waste as energy resource

Climatic conditions and infrastructures in societies with developing economies have created situations whereby organic waste substrates are often found to be abundant (Karagiannidis et al. 2009). Waste organic substrates from rural and urban regions of societies with developing economies come from sources grouped as residues (straw, forest residual wood), production by-products (manure, industrial residual wood), and waste stream (sewage sludge, slaughterhouse waste). Fuel production from waste can take place either by decomposition (gasification/pyrolysis/hydrolysis) or biological process (anaerobic digestion/fermentation). The most economically feasible energy (power/heat/cooling) generation from this fuel are through incineration of mixed waste, anaerobic digestion of organic waste, and gasification of part of the refuse derived fuel (Tabasova et al. 2012).

For example, organic wastes coming from both rural and urban regions, domestic or industrial, offer suitable feedstock for energy processing through anaerobic digestion combined with municipal water treatment. Another robust technology by which energy can be generated from waste is capturing methane directly from landfills. Combustion of the biogas or biomass derived from waste organic substrates is usually the technology of choice to produce power and direct heat in these nations.

Meanwhile, urbanisation induces a consumer-based society (Barton et al. 2008). In societies with developing economies where the urban population is high and continues to grow, waste is generated at elevated levels across all areas. In the more central urban regions, municipal wastes generated from domestic activities and organic industrial activities have created significant challenges in disposal management. However, these organic wastes can be turned into a sustainable source of energy, and should be treated as such. Figure 3-11 provides a comparison between various scenarios for product and by products of solid wastes. When generating sustainable energy from wastes, some resource inputs are required in addition to the input waste itself. The balance between energy input and energy output often becomes the decision making factor in choosing scenarios of wastes management.

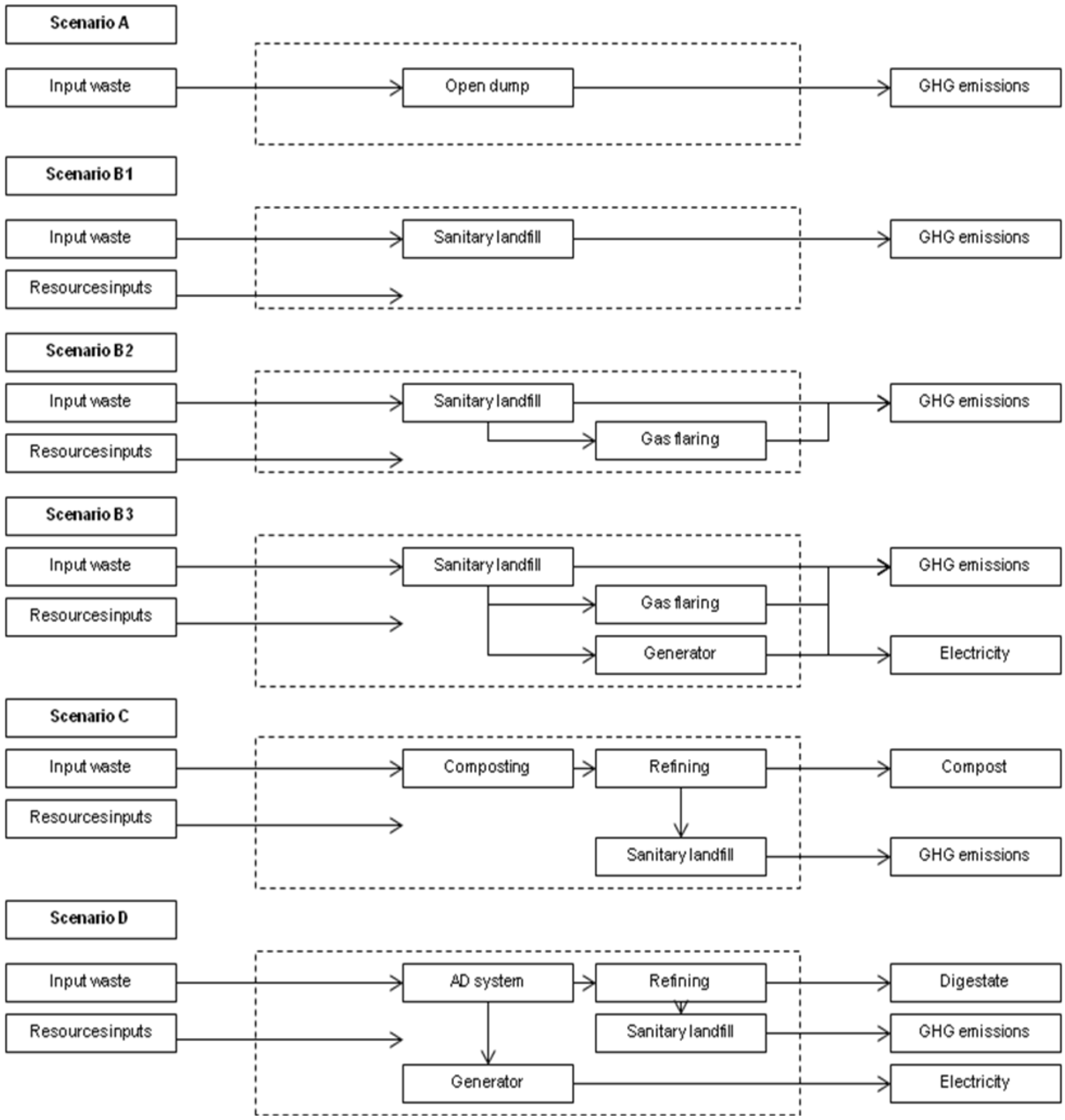

Figure 3-11: Scenarios of products generated from solid wastes

Reproduced from Barton et al**. (2008)**

In summary, Marine energy (offshore wind, tidal, and wave energy) is one sector of renewable energy resources that many societies with developing economies of the world have access to and are racing to close the knowledge gap. Bio-energy on the other hand is one of the most mature renewable energy sectors in societies with developing economies. However, due to its multiple roles in rural remote areas of societies with developing economies, it has increasingly grown in significance over recent years. Finally, as societies with developing economies generate a large amount of waste due to their high population density, waste management has become more of a challenge in recent years. Therefore, treating these waste products as energy resources is a considerable contribution to energy supply and security as well as reducing the climate change impact of the gaseous emissions.

3.3.3.2 Human resources

Availability of skills

In the case for natural resources, information on the availability of skills in societies with developing economies is typically segregated in nature. Overlapping and conflicting information between one institution and another are common, thereby requiring another layer of resolution mechanism to some basic baselining exercise to capture the complete picture from which decision making can be based.

The lack of capacities locally is the major obstacles for energy services expansion in societies with developing economies (United Nations General Assembly 2012). Strengthening the institutions, infrastructures, along with their human resources is a must and international public-private cooperation should become a way forward in enhancing this need.

Knowledge management

Information sharing between private and public entities in societies with developing economies continues to be challenging. This has initiated many national and international aids in allocating support in coordinating efforts to enhance awareness, sharing, and co-assistance. Knowledge generation and exchange are promoted by regional and global key players in governmental and non-governmental organisations, networks and partnerships, research and financial institutions, private sector representatives, and local initiatives. Information sharing and awareness-raising have been concentrated around technologies and examples of best practices and to a lesser degree on policies and incentives (El Fadel et al. 2013). The key entities in the renewable energy knowledge generation and exchanges have been grouped into the following:

1. Networks and partnerships with main mandate of collecting, analysing, updating, and disseminating renewable energy related information, knowledge, and practices (e.g. Global Bio-Energy Partnership (GBEP); Global Forum for Sustainable Energy (GFSE); Global Village Energy Partnership (GVEP); Renewable Energy and Energy Efficiency Partnership (REEEP); Renewable Energy Policy Network for the 21st Century (REN21); UN Energy.

2. Regional governmental and non-governmental organisations (e.g. Energy Environment and Development Network for Africa (AFREPREN); The Economic Community of West African States (ECOWAS), Regional Centre for Renewable Energy and Energy Efficiency (ECREEE); United Nations Economic Commission for Latin America and the Caribbean (UNCLAC) tend to concentrate on barrier analysis which is often conducted in support of the partnerships with international organisation focusing on enabling environment and performing assessments on policy and policy measures (e.g. International Energy Agency (IEA); International Renewable Energy Agency (IRENA).

3. International financial institutions (e.g. Asian Development Bank (ADB); African Development Bank (AfDB); Global Environment Facility (GEF); Inter-American Development Bank (IADB); and the World Bank provide funding for promoting clean development projects identified in the documents produced networks and partnerships in group 1, while regional organisations and initiatives provide information and advice on available funding mechanisms (e.g. United Nations Economic Commission for Africa (UNECA); Asia Pacific Partnership on Clean Development and Climate (APP); REEP; REN21; UN Energy).

In summary, the trend in human resources development and knowledge management for renewable energy in societies with developing economies is around efforts to facilitate technology transfer (i.e. demonstration projects), capacity building (through training and education), policy advocacy (analyses and reviews) and enabling (formulation), information sharing at international levels (readily available databases and platforms). Meanwhile, gaps are still found within these efforts include: lack of enabling environment due to limited infrastructure, unequal geographical distribution of initiatives, stringent market regulations limiting penetration of technologies, lack of effectiveness evaluations on capacity building and policy formulation, and duplication of efforts.

3.3.3.3 Technological aspect: relevance, innovation, adaptation

In addition to the emphasis on efficiencies, technologies developed in industrialised countries are designed for capital intensive and labour minimal (Kaygusuz 2012). However, the societies with developing economies have different supply and demand requirements for renewable energy, thereby often creating a mismatch between the proposed technology to be implemented and the technology that will create optimum impact. Adapting complex and sophisticated technologies to the local contexts remains a challenge. On the other hand, the engineering capabilities of the indigenous communities to design, manufacture, install, operate, and maintain their own tailor-made technologies for their specific contexts are also still very limited, especially in the most vulnerable regions of the developing world. These two contradictory issues have become the precursor for the needs and priorities for appropriate technology.

In summary, sustainable energy technical resources has outlined issues related to energy in societies with developing economies in a way that may not be immediately obvious to a western, educated, industrialised, rich, and democratic (WEIRD) mindset. It is clear from field experience that simply transferring complex technology is of little help without the indigenous skill-sets being developed to support the subsequent service life. Substantial indigenous wisdom exists which can be used if the external fieldworker takes the time to engage and form constructive relationships with local communities.

3.3.3.4 Capital and infrastructure: market, access, grid

Capital and infrastructure as resources are necessary in promoting sustainable energy generation. This is especially determinant in the context of societies with developing economies, where usually there is not only the lack of investment funds, but also the non-existence of proper conditions for investment. Exploration of alternatives utilising local technologies, taking into account involvement of beneficiaries are often needed, as dissemination of renewable energy in societies with developing economies does not mean using the same models as in developed nations (Monroy and Hernandez 2008). This means that financial mechanisms need to be adapted to decentralised systems to overcome barriers from high initial price of implementation. Furthermore, because existing infrastructure dictates the limit and scope of technology implementation, they need to be addressed and adjusted if necessary at initial stages.

As financing has historically been known to be one of the main barriers for sustainable energy implementation in societies with developing economies, greater efforts should be addressed towards attracting actors and agents with ability to mobilise adequate financing: private sector, governments, and international institutions. A balance needs to be struck between public subsidies, aid sector, and private investments in accessing the wide-ranging social and economic benefits for developing countries (Kamiski 2010).

Working towards supply chains, there are several development stages which require financing mechanisms to be in place. The stages consist of: research and development, demonstration, investment, dissemination, and operation. Based on its level of coordination, financing mechanisms to move one developmental stage to another can be grouped into: local (micro financing, end use financing), national (investment funds, corporate financing, commercial banks), and global efforts (global funds, international financing, and official aid funding bodies).

Developing sustainable energy projects for the long term necessitates the emphasis on cost-benefit analysis for the whole cycle of project, but on the other hand, market decisions are based on short term planning (Monroy and Hernandez 2008). Therefore financial project designs must be able to perform appropriate roles within both the relevant stakeholders and markets.

To attract private capital to sustainable energy projects, government of societies with developing economies are promoting public-private relationships and financial plans based on micro financing (Monroy and Hernandez 2008). At least three action levels should form a concentrated effort: development of public-private agreements for financing sustainable energy projects, increased role of international aid providing the necessary conditions to stimulate investment in remote areas, and the impulse of models of innovative financing. Involving international aid and micro financing programmes at long-term interventions and programmes (as opposed to the traditional isolated cooperation projects), should significantly increase access of energy services to the poorest communities of societies with developing economies.

In summary, secure, environmentally acceptable, sustainable energy sources are as important to the social, political and economic future of societies with developing economies as they are to the over-developed nations. However, ironically at present limitations in financing is known to be one of the major barriers in implementing sustainable energy systems, creating a more difficult terrain for a sustainable energy system's foundation to be built.

3.3.4 Sustainable energy policies in vulnerable societies

Available literature on sustainable energy policies is found to be extensive in relation to economically developed countries and newly industrialised countries (NIC's), but publications are limited for those that are considered to be countries with developing economies (Kaygusuz 2012). Global reports on policies specific to sustainable energy have also been produced by the International Energy Agency (IEA) (International Energy Agency 2011) and the World Energy Council (WEC) [World Energy Council 2011a; World Energy Council 2011b; World Energy Council 2010), though not all of these reports have specifically addressed country groups with history and/or potential for socio-political conflict and natural disaster. Few discussions exist on the sustainable energy policies of developing countries located in South East Asia. Fewer still are those documented for areas, which have undergone social and/or political unrest, or which have survived major natural disasters.

By most definitions, South East Asian countries are those who are listed as members of the Association of South East Asian Nations (ASEAN) plus Timor Leste, also known as East Timor. We therefore define South East Asia as consisting of the members of ASEAN: Brunei, Cambodia, East Timor, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. Countries considered to be developing economies are those listed in the IMF World Economic Outlook Report 2011 (International Monetary Fund 2011) and in the IMF Working Paper on Classifications of Countries based on their levels of development (Nielsen 2009). This includes all of the ASEAN nations with the exception of Brunei and Singapore.

In performing this part of the literature review, the researcher has identified relevant, peer-reviewed publications and global reports on sustainable energy consumption, generation, and distribution policies relevant to vulnerable societies. Boundaries based on policy development constraints were set to determine the breadth and focus of literature search. These boundaries are: policies in societies with developing economies, countries located in South East Asia, and areas with recent history and potential for disaster and political/social conflicts. Sustainable energy policies in NICs are also discussed to provide what policy development trends exist in the region as an addition to the above.

Policy databases from IEA and WEC were accessed for countries receiving funding assistance from the United Nations Development Programme (UNDP) Crisis Prevention and Recovery (United Nations Development Programme 2012). Policies in force for energy conservation and renewable energy incorporation into energy mixes were compiled, labelled, and synthesised into tables. Graphs were produced to capture the range of applied policy types and the proportion of sectors, which those policies cover. Comparative analyses of published theoretical articles and applied policies in force were carried out to identify gaps and synthesise future directions for research.

3.3.4.1 Sustainable energy policies in South East Asia

Policies intended to manage energy consumption through energy conservation and those directed to diversify energy generation through incorporation of renewable energy are grouped according to the following types (International Energy Agency 2011; World Energy Council 2011b).

- Financial (incentives, subsidies / soft loans, grants, Feed-in-Tariffs);
- Fiscal (tax credit and accelerated depreciation, tax exemption, tax reduction, and tax on inefficient items);
- Regulatory (labels, minimum energy efficiency standard, mandates, quota systems, assessment, monitoring, auditing);
- Policy process (institutional creation, project-based programmes, strategic planning, enhancement of existing policies);
- Research, development, and demonstration (RD&D) (research programme, technology deployment, technology diffusion);
- Education / outreach (information dissemination, promotion);

- Tradable permits (certification trading);
- Voluntary agreements

Sectors commonly targeted by energy conservation policies are commercial / public, residential, industry, transport, framework, and multi-sector (International Energy Agency 2011; World Energy Council 2011b). Meanwhile, sectors commonly targeted by renewable energy policies comprise of electricity, heating / cooling, transport, framework, and multi-sector (International Energy Agency 2011; World Energy Council 2011b). Figure 3-12 and Figure 3-13, were produced according to the above databases, for policies being practiced in developing countries on energy conservation measures (which addresses energy consumption issues) and renewable energy generation (which addresses energy generation issues).

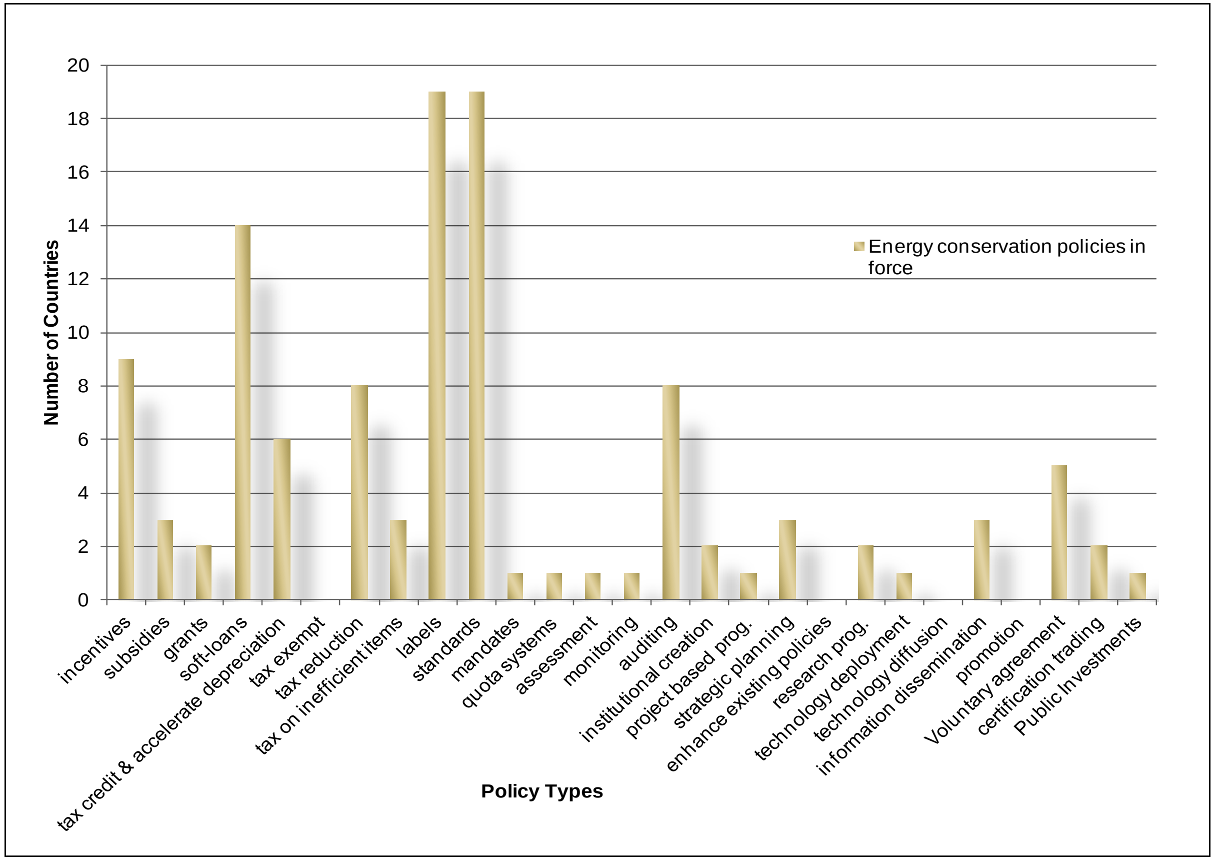

Figure 3-12: Summary of sustainable energy conservation policy types in force for countries with developing economies

Adapted from International Energy Agency (2011) and World Energy Council (2011b)

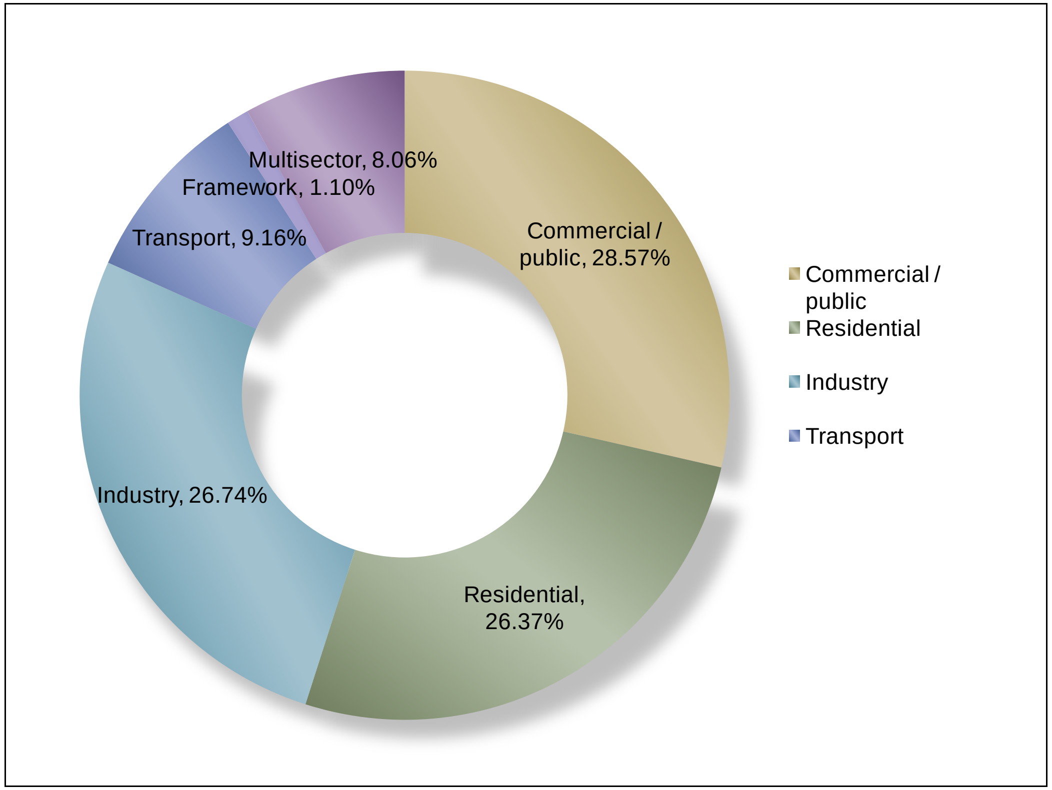

Figure 3-13: Proportion of sustainable energy conservation policy target sectors in force for countries with developing economies

Adapted from International Energy Agency (2011) and World Energy Council (2011b)

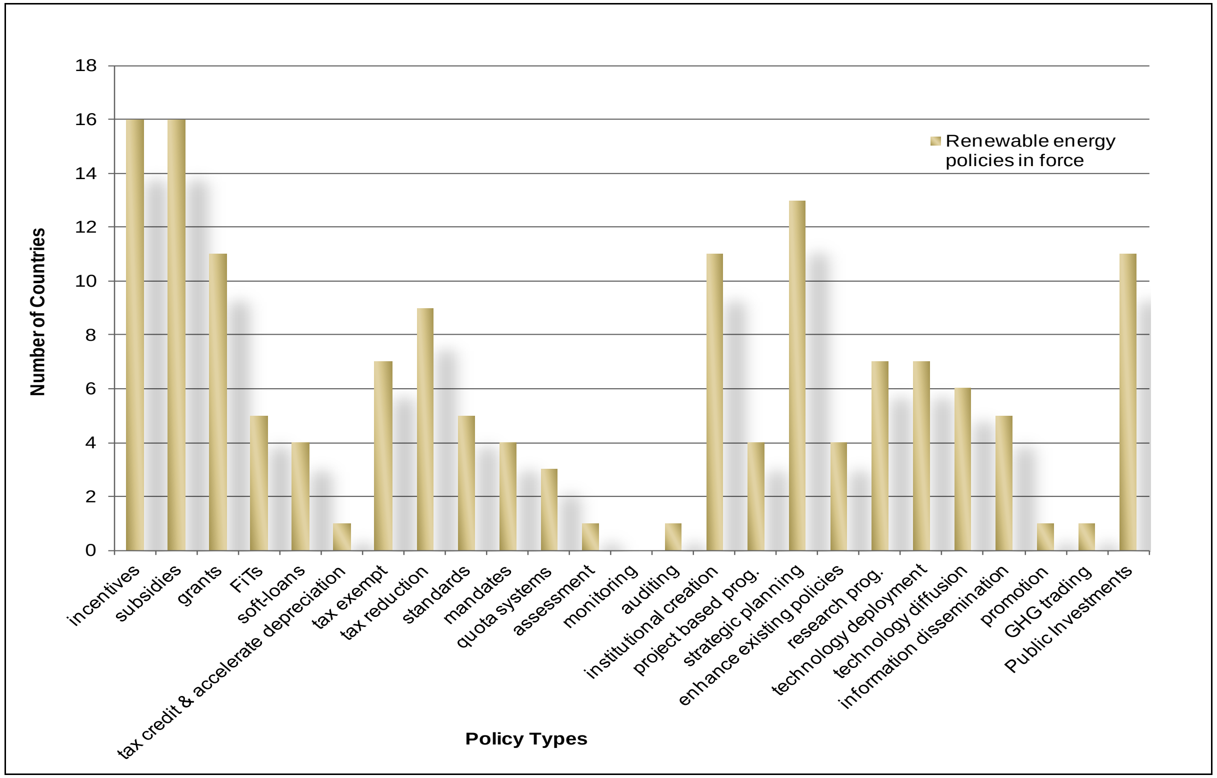

Figure 3-14: Summary of renewable energy generation policy types in force for countries with developing economies

Adapted from International Energy Agency (2011) and World Energy Council (2011b)

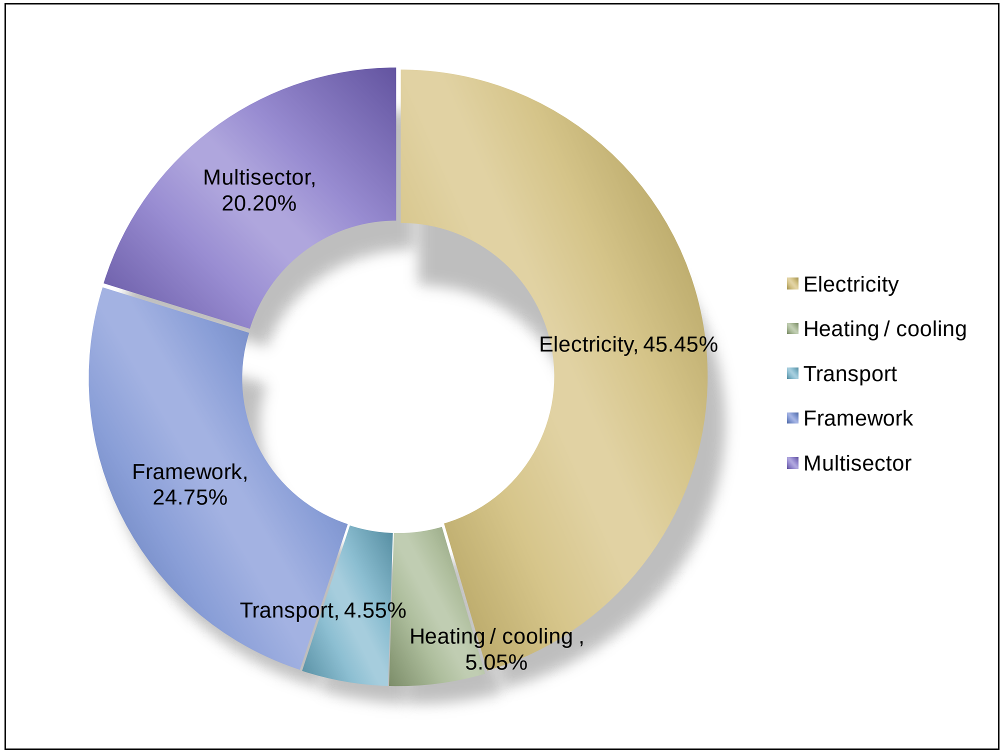

Figure 3-15: Proportion of renewable energy generation target sectors in force for countries with developing economies

Adapted from International Energy Agency (2011) and World Energy Council (2011b)

3.3.4.2 Specificity of South East Asian environment

Studies and development of energy policies for the member countries of ASEAN are coordinated under the Regional Strategic Energy Policy Planning Department of the ASEAN Energy Centre (Atchatavivan 2009; Sovacool 2009). These include applications of energy efficiency technology and behavioural change for a sustainable energy consumption pattern, as part of the implementations of demand and supply management initiatives (Keong 2005). There are significant variations between countries across the South East Asian region in approaching sustainable energy policies, which include policies to address energy use and renewable energy generation (Lidula et al. 2007).

Energy consumption in South East Asia

Specific energy conservation programmes are only practiced by Indonesia, Vietnam, and Thailand whilst financial assistance is provided in all countries except for Lao and Brunei (Lidula et al. 2007). Although it has not put in force any policies, the Union of Myanmar has recently highlighted its future plan for energy conservation (Kyaw et al. 2011). Except for Brunei, energy efficiency policies through legislation have been implemented in all Association of South East Asian Nations (ASEAN) members (Lidula et al. 2007) though decision making on these regulations is still within government input scope only.

Promotion of building energy regulations through appropriate implementation is suggested for developing countries to achieve energy use reduction and efficiency (Iwaro and Mwasha 2010). Singapore has a mandatory standard for building regulations, but Indonesia, Malaysia, Thailand, and the Philippines all have mixed standards (Iwaro and Mwasha 2010).

Energy conservation in Indonesia is considered broadly to cover efficient and rational energy use (Lubis 2007), incorporating policies for energy audit in generation processes, reduction in electricity use for consumerism and comfort, replacement of inefficient equipment, and adjustment for electrical use timing (Lubis 2007). The national energy policy, which covers energy efficiency throughout Indonesia, sets the national target of 1% reduction of energy intensity per year (United States Agency for International Development 2007). Initial investments in energy savings through efficiency strategies, including support for minimum standards and labelling, have been identified by USAID to yield large benefits and avoid market confusion (United States Agency for International Development 2007).

Included in Malaysia's national energy policy is the efficient utilisation of energy and discouragement of wasteful energy consumption in socio-cultural and economic contexts (Mohamed and Lee 2006). Energy efficiency is also explicitly addressed in the 9th Malaysia Plan (2006 - 2010) and designed to cover efficient management of electrical energy regulations, uniform building law amendments, and specifications for accurate electrical appliance labelling (Oh et al. 2010). Making information on energy efficiency accessible to the general public is identified as one important policy target sector in Malaysia (Ahmad et al. 2011).

Energy generation in South East Asia

No specific sustainable energy policies are found in countries where there is limited space for renewable energy, such as Singapore, or limited demand due to abundant fossil-fuels as in the case of Brunei (Sovacool 2009). However, sustainable energy is seen as the best way forward for countries faced with rapid economic expansion and with abundant renewable resources, e.g. Union of Myanmar, and that sustainable sources based energy planning will streamline a country's economic and social development (Keong 2005).

Both Indonesia and Malaysia have instigated a range of renewable energy policies for various sectors in recent years and because of the increasing transport fuel demands, governments of both nations have emphasised policies for the development of bio-fuels (Abdullah 2005; Daryanto 2005, Prastowo 2007; Shafie et al. 2011). The government of Indonesia has for some time identified that policies on the diversification of energy sources need to be enforced (Lubis 2007; Sugiyono 2004; Wahyuningsing 2005), and has therefore given considerable attention to renewable energy generation (Kyaw et al. 2011). Policies in energy diversification include those for replacing fossil fuels with bio-diesel, micro hydro and wind power projects in remote areas, and reducing diesel generators (Lubis 2007).

Historically, one of the challenges to the implementation of renewable energy generation policies in Indonesia was the lack of engagement by PLN, the country's national electricity company, on procedures and terms of sale for electricity generated by renewable sources (United States Agency for International Development 2007). However, recent discussions (2012) in Aceh province suggest that PLN is now open to negotiating grid connections and to purchasing electricity from renewable sources. Both Suhaemi (2010) and Soentono and Aziz (2008) have brought the issue of using nuclear technology for ensuring future energy security into the discussion of sustainable energy policies in Indonesia. Introduction of nuclear power plants (Suhaemi 2010) and use of nuclear technology in other renewable energy sectors such as bio-energy and hydropower (Soentono and Aziz 2008) have been included in the analyses.

Adam (2009) has strongly recommended that in developing a policy for alternative energy, the Indonesian government should redefine the concept of sustainable energy according to specific regions. This recommendation fits with the condition of the country, where general and centralised definitions cannot be utilised due to provincial differences in natural environment and cultural expectations.

The Malaysian government is incorporating renewable energy into its energy mix policy, which is aligned to the national budget planning and the national Malaysia Plan (Chua and Oh 2001; Mohamed and Lee 2006). Malaysia has identified that eliminating fossil fuel subsidies, which provide inconsistent and unfair political support, will overcome one of the barriers to renewable energy, (Ahmad et al. 2011). To a similar extent, effective policies in the form of attractive incentives for renewable energy are crucial in promoting and developing their application (Hashim and Ho 2011).

Policies translated through legislation including renewable energy bills, non-fossil fuel obligations, and power sector restructuring are implemented most in the Philippines, followed by Indonesia and Thailand (Lidula et al. 2007). Policies in financial assistance for renewable energy development, which includes loans, incentives, and grants, are implemented in Malaysia, Indonesia, Lao, Cambodia, Vietnam, Thailand, and Philippines, although the levels vary greatly amongst those countries (Lidula et al. 2007).

Energy distribution in South East Asia

Two significant issues dominate sustainable energy distribution policy literature in the South East Asian region. The first being electrification of rural, off grid areas and the second being some form of regional collaboration for transmission.

In the Philippines, with the Pangan-an Island as a case study, off grid, rural electrification capacity is determined by the development and support that enables users to be commercially productive using available electricity and by the institutional capacity in managing the system (Hong and Abe 2012). The study concluded that in centralised power systems, the number of connections and household consumption influence both plant viability and affordability of supply. In off-grid rural areas, user attributes influence their consumption behaviours (Hong and Abe 2012).

Prioritisation of rural electrification is not seen in Timor Leste's energy distribution policy, but the services and activities in rural areas are listed as policy priorities (Fang et al. 2004). This suggests that in Timor Leste, distribution of energy relates more to policy implementation which matches renewable energy resources than to the needs and services which enhance rural communities' quality of life (Fang et al. 2004).

Members of ASEAN have also come together in combating energy insecurity through pooling, sharing, and interconnecting resources (Hashim and Ho 2011) e.g. the large scale project trans-ASEAN gas pipeline (TGAP) network. Hashim and Ho (2011) suggest that the answer to the problems surrounding the distribution of energy in Southeast Asia lies in cooperation between ASEAN member countries. Weaknesses of the ASEAN Energy Cooperation include the following (Atchatavivan 2009):

- Lack of commitment to sustainable energy technologies and projects;
- Exclusion of social and environmental costs;
- Dominance of stronger economies

Challenges include conflicting goals and priorities, differing concepts of energy security, increasing protectionism, and intensifying suspicions between stakeholders (Sovacool 2009).

3.3.4.3 Lessons learnt from three vulnerable societies in Asia

Three vulnerable societies in Asia - Nepal, Sri Lanka, and Papua New Guinea - were chosen to provide sources of lessons learnt from the sustainable energy policy formulation and implementation. The three countries were chosen because they have similarities with Aceh, Indonesia in being societies with developing economies and having experience with natural disaster and/or conflict, whilst having a regional geographical proximity.

1. Nepal
   Nepal experienced conflicts between the years 1996 to 2006 (United Nations Development Programme 2011). The nation held its first elections in April and July 2008 (United Nations Development Programme 2011). Political instability as

part of the characteristics of a post-conflict society and increasing electricity demand are two major issues faced by Nepal (Nepal and Jamasb 2012). The Nepalese government has prioritised rural and remote electrification using renewable energy technologies (Mainali and Silveira 2011). Prevailing policies and implementing agencies have become the largest influence to the choice of technology used along with financing institutions and private sectors, as well as household economy at micro levels (Mainali and Silveira 2011) The study has shown that awareness of renewable energy technology and willingness to contribute to the cost of energy produced has increased significantly throughout recent years. As regulatory agencies in Nepal are susceptible to political interventions, improvement in governance structure and institutional creation are considered to be a vital necessity (Nepal and Jamasb 2012). This is followed by the crucial needs of bridging the gap between the cost of access to electricity and affordability.

2. Sri Lanka

   Sri Lanka, a country stated as experiencing an on-going insurgency, according to the UNDP, has experienced ethnic conflicts within the years: 1983-2009 (United Nations Development Programme 2011). In the case of Sri Lanka, non-conventional renewable energy targeted policy intervention were reported to not have caused much strains in the Government budget (Wijayatungga and Prasad 2009). The country approaches this sustainable energy implementation strategies through Clean Development Mechanism (CDM) routes; whereby the different technologies are promoted through separate allocations to ensure that not only the mature and economically competitive, but all renewable technologies are able achieve the desired penetration levels.

3. Papua New Guinea

   Through the experience in Papua New Guinea, a country in conflict between 1989-1996, which is currently at a peace status (United Nations Development Programme 2011) it is acknowledged that the social, political, and cultural barriers present more complex challenges to a renewable (solar home systems) energy policy, compared to technical and financial barriers (Sovacool et al. 2011). This implies that policy makers must put more attention into policy types for a renewable energy system, which accommodate information dissemination to the public, improvement of institutional capacity, and consistent regulatory framework, rather than concentrating only on increasing incentives and improving the chosen technology.

3.3.5 Conclusion on sustainable energy policy

A paper was jointly published in 2012 by Kruijsen, J.H.J. Owen, A., Turner, N., and Garniati, L. In this paper, the researcher has collated international targets and their progress to date on sustainable practice. A more focused discussion in the area of sustainable energy was also written by the researcher using the case study of Aceh to illustrate current assessments of: (1) population needs, (2) availability of resources, and (3) sustainable practice.

Therefore, taking into account the fourth ‘P’ of sustainable practice (Kruijsen et al. 2012), this thesis gives a re-interpretation of the sustainable energy in practice as energy (not simply electricity) from renewable sources that is not, in its life-cycle, a net contributor to climate change and does not have substantially negative environmental, social, economic, and political impacts. Therefore, sustainable energy policy in practice is subsequently defined as sets of decisions, which encourage investments from the private sectors, present clear business cases to its strategies, and is developed through participatory, transparent, and accountable way, to achieve energy use, generation, and distribution, which are economically viable, environmentally responsible, socially acceptable, and politically committed for the long-term (Figure 3-16).

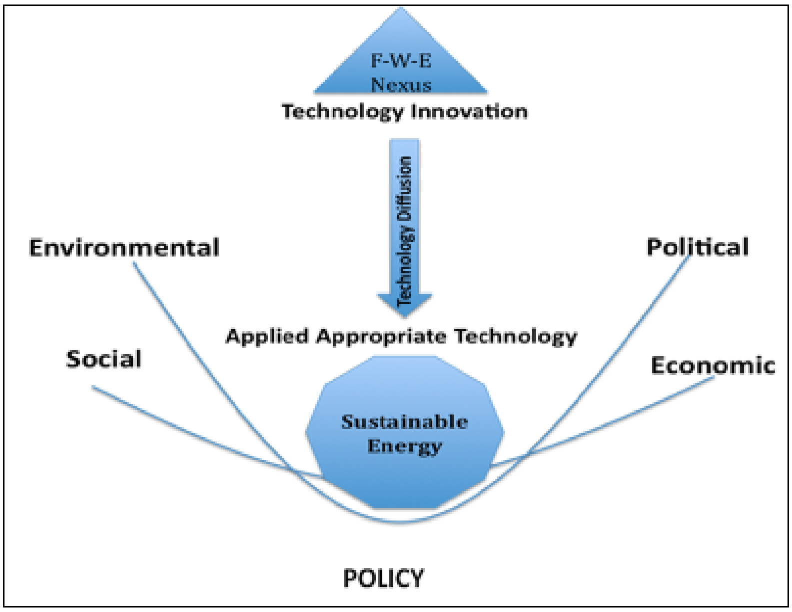

Figure 3-16: Sustainable energy in practice

Modified from Kruijsen et al**. (2012) for sustainable energy**

The diagram explains how food-water-energy (FWE) resources need to be utilised for sustainable energy implementation through technology inovation and diffusion towards applied appropriate technology and policy. This process are dependent on the balancing act between the four "P"s of sustainable practice (i.e. Politics, People (social aspect), Planet (environmental aspect), and Profit (Economic aspect).

A large number of stakeholders are involved and will eventually be affected by policies in the sustainable energy sector. Decision-making on priorities of actions are very much dictated by historical and cultural background, state of economic development, and physical environment limitations. Case studies are therefore significantly important in providing an in depth knowledge of the intricate and detailed approaches to policy formulation.

Based on the literature review, no case studies have been presented on sustainable energy policy intervention in a region, which has the unique features of a province located in a South East Asian developing nation, which has autonomy over energy policy, strategy, and implementation, but which also has the structural dependency of existing transmission systems out with its territory. Another gap in sustainable energy policies are the discrepancies between researched and practiced policy types. Although these are the types of policies being discussed most frequently in literature, institutional creation, enhancement of existing policies, project based programmes, and strategic planning are the least being practiced in South East Asian societies with developing economies.

Overall, in societies with developing economies, more policies have been designed for renewable energy generation than for energy conservation to reduce consumption. The least policies found both in theoretical discussions and practical situations are those that are designed for sustainable energy distribution. From the gathered information, a few areas of discrepancy lie between theoretical discussions and the practical situations of applied sustainable energy policies.

Incorporation of renewables in the energy sources mix has dominated the policies placed for sustainable energy generation. Within the range of renewable energy policies, financial type policies dominate existing policy types in place. Contrary to the amount of academic literatures on renewable energy policy types, research and development type policies, which incorporate research projects, technology deployment, and technology diffusion, are the second least placed policies in societies with developing economies, while regulatory type policies are amongst the least placed, together with education / outreach and tradable permit types. In practice, policy development processes, voluntary agreement, certification trading, and public investments have not received any significant attention from policy makers. The electricity sector, which dominates discussions in peer-reviewed articles, is also the most addressed sectors in practice. The least addressed sectors both in academic literatures and in practice are heating and/or cooling and transport.

Within the range of energy conservation policies, regulatory type policies dominate existing policy types in place. There are minimum levels of policies in place surrounding research and development, education and outreach, voluntary agreement, tradable permits, and public investments. Interestingly, policy processes types which cover institutional creation, project based programmes, strategic planning, and enhancement of existing policies are neither discussed at any great length at any academic publications on energy conservation in societies with developing economies, nor are they significantly put in place in practice.

Policies on sustainable energy distribution are not found to any great extent in societies with developing economies. Studies around access to electricity for rural, off grid areas have been found to form the second strand of implemented policies on the ground. Policy types other than financial, fiscal, and regulatory and targeted sectors other than electricity in sustainable distribution however, have not been addressed to any great breadth and/or depth.

3.4 Appropriate technology

Section 3.4 provides the knowledge foundations to understanding the concept and context of appropriate technology in relation to energy and policies. Sub section 3.4.1 explores appropriate technology in energy policies in societies with developing economies. Then in the following Sub-section 3.4.2 explores the current perceptions, preferences, and directions of the two elements of appropriate technology in relations to energy policy: technology matching and technology transfer.

Appropriate technology has historically been viewed to not prioritise growth and consisting more of elementary techniques (Kaplinski 2011). In many strands of discussions, it possesses the connotation of low cost technologies for meeting the needs for the world's poorest populations (Jequier 1981; Kaplinski 2011). These subjective definitions of appropriate technology since the beginning of its existence have been influenced by culture and politics (Bowonder 1979). However, as a general agreement, appropriateness is considered fulfilled when either traditional, intermediate, or advanced technologies uses existing local natural resources, workforce, skills, and capital (Bowonder 1979). From the opposite angle, inappropriateness of technologies also has been well identified and documented. It consists of the following: not fulfilling market needs, not using local material, difficult to produce in a small scale, insufficient labour employment, and unsuitable machineries due to technology acquisition restrictions (Teitel 1978).

The concept has historically evolved from standing against the system, into an internationally supported movement in businesses and governments (Jequier 1981). Studies have included selection mechanisms and introductions of appropriate technology in the productive sector (Bruun and Mefford 1996) and assessments of schemes for technological policies (Trak and MacKenzie 1980). The majority were in fact targeted at countries with developing economies.

The soft side of appropriate technology (i.e. cultural knowledge, organisational forms, managerial tools, financial incentives, and legal structures) dictates the appropriate technology's implementation success rate (Jequier 1981). As technology is essentially also a political issue, policy needs to address this accordingly to promote and develop the concept in practice (Jequier 1981). Policies for appropriate technology in clean development mechanism (CDM) started later with concerns raised globally on sustainable development. Technology transfers from west to east, north to south as well as investments, have formed significant part of discussions surrounding the matter (Luken and Van Rompaey 2008). Although appropriate technology consideration is relevant to all societies, whether they are at elementary, intermediate, or advanced technological capabilities, it has long been established that it is especially determinant in the context of societies with developing economies (Bowonder 1979).

A comprehensive definition for appropriate technology and demonstration for its application and relevance is given by Murphy et al. (2009). Authors of this paper have asserted the concept and necessity of augmenting traditional engineering approaches with more flexible trial and error techniques, user participation, and multi-disciplinary learning. Local capabilities (material and other resources), affordability, local participation, cultural/social appropriates of technology and transfer considerations are some of the main topics covered in the discussion. Given the significant implication of appropriate technology on the direction and extent of a society's development, a re-conceptualisation of terminology is therefore required to put appropriate technology as a holistic concept. Reconsiderations must first be given to the goal and extent of growth itself, as well as its implications (Meadows et al. 1972; Meadows et al. 1992; Meadows et al. 2004).

Based on the conceptual and practical understanding of sustainability given in section 3.3.1, this thesis views appropriate technology in the light of United Nations Development Programme's (UNDP) vision of building human capabilities through technological innovation and economic growth (UNDP 2001) and Technologies for Freedom's (T4F) community driven process of technology conceptualisation to implementation in achieving the goal of social transformation (Fernandez-Baldor et al. 2009). This interpretation of existing theories also incorporates the direct connections between appropriate technology and sustainable development principles derived through the process of strengthening communities by implementation of appropriate technology in order to reach empowerment as developed by Pematang et al. (2013). In this role, appropriate technology is positioned as the bridge connecting each of the developmental stages of community empowerment.

3.4.1 Appropriate technology policies

Appropriate technology's ability to form and modify its environments was the main reasoning behind the start of policy development in the area (Trak and MacKenzie 1980). Policy's role in this context is to plan strategies relating to appropriateness in terms of intensity factors, skill requirements and developments, and produced goods (Trak and MacKenzie 1980). Ideally, policy formulation and analyses must be preceded with technological assessments and institutionalised development methodology (Bowonder 1979). However, for societies with developing economies, policy making in appropriate technology may not be able to come first and act as drivers for implementation due to time and resource constraints. Well-integrated and comprehensive technological assessments tools, therefore, must be present to enable policy makers, technology designers, and decision makers select the most suitable and sustainable appropriate technology (Musango and Brent 2011).

Coverage of appropriate technology policy development in countries with developing economies is limited (Hipkin 2004). In these regions, technology and strategy is linked by the non-technical political and social issues (Hipkin 2004). Ideas shaped by political and social issues, however are often treated as theories which are seldom taken up directly by policy makers (Mytelka and Smith 2002). Where these ideas are taken up, it is usually preceded by policy makers' own learning and experiments rather than by advisory processes (Mytelka and Smith 2002). What is acknowledged to be more common is technology policy formulation that results from multiple factors contributing to theoretical ideas, as the combination of factors presents stronger justifications for the design and implementation of specific policy instruments (Laranja et al. 2008).

Policy environment influences the technological products and processes chosen in a specific society (Stuart and Ranis 1990). Theoretically, in most countries with developing economies, inappropriate decision makings had been led by prevailing policies which are grouped as micro interventions; as opposed to macro and meso policies that when formulated, introduced, and implemented correctly create environments where micro decision units will choose appropriate technologies (Stuart and Ranis 1990). This leads to a concept which states that creating a decision making scheme for developing technological policy needs the inclusion of variables such as capital/labour intensity, skill requirement and development, and production against types of goods comprising of consumer goods, capital goods, and technological change goods (Trak and MacKenzie 1980). In summary, technology is developed in social, cultural, legal, and administrative contexts, and social economic problems of developing countries are technological dependent (Trak and Mackenzie 1980).

Finally, short and long term strategies are determinants in establishing appropriate technology bases in developing countries (Hipkin 2004). Therefore, forecasting and impact analyses of these technologies have long since been identified as the balancing measure in policy development to gauge the complexities and priorities of targeted sectors (Bowonder 1979).

3.4.2 Perceptions, preferences, and directions of appropriate technology's elements

The following sub-sections present the perceptions, preferences, and directions of appropriate technology elements in relations to energy policy. These two elements are: (1) technology matching and (2) technology transfer. The most common elements included in South East Asian societies with developing economies' energy policies are technology matching and technology transfer.

3.4.2.1 Technology matching

Due to lack of confidence in deciding which technology is practical and affordable in local contexts, timescales have presented major barriers in countries with developing economies to adopt sustainable energy technologies (van der Gaast et al*.* 2009). It has early on been identified that approaches are needed to incorporate social culture, cultural limitations, and technological skills (i.e. the appropriateness aspects of technology) into policies (Bowonder 1979). This fact was highlighted again around a decade later by outlining how policies relating to technological change (which is technological assessments' broader focus), have rarely been practiced and that institutionalised technology assessment for policy making needs to be present (Goonatilake 1994). It is therefore clear that institutionalised technology assessment and matching activities is needed in developing energy policies. Policy makers and stakeholders in such countries need access to tools for identifying the most appropriate technologies to be implemented at certain points in time, thereby creating awareness in the options and implications of satisfying the required energy services (van der Gaast et al 2009). These arguments reinstate that capabilities in policy making and policy analysis must be initiated with technical assessment sand institutionalised appropriate technology development methods (Bowonder 1979).

When assessing whether a technology is appropriate for a given society, the process draws discussions nearer to the guiding principles of sustainable development in its aim of responding to the societal needs in social, economic, environmental, and political issues (Bolay et al. 2012). Whether technologies can be implemented in a specific geopolitical context creates the scope for their evaluation for relevance and adaptability; not only their technical performance (Bolay et al. 2012). This especially presents challenges in institutionalising technology assessment into energy policies, as most available technologies are dependant (completely or mostly) on global trade and market.

3.4.2.2 Technology transfer

Even with the increasing number of publications on technology transfer, research in the area has not provide answers to the politics of appropriate technology transfer, its critical impacts in scientific and technical human capital over long periods of time, and the impacts of transfer to communities' structure and capabilities (Bozeman 2000). Knowledge and skills transfers usually accompany technology transfer in projects involving clean development mechanism (Dechezleprete et al. 2008). In this case, technological dependence resulting from relying on suppliers' expertise is replaced by indigenous personnel having the opportunity to develop and improve their technical skills in operation and maintenance stages (Al-Ali 1991). A long term and wide ranging investment beyond information distribution and training is required as the basics for technology transfer (Cromwell 1992). Cromwell (1992) also states that development of suitable mechanisms include the adaptation of technology to specific socio-economic and technical environments. This argument is supported by (Worrell et al. 2000) which reassert that adaptation and capacity building, which includes the incorporation of research and development capabilities, helps ensure the success of technology transfer. However, the same study admits that strengthening local capacity is often seen as a way to open new export markets; thus creating the environment for policy making in technology transfer as part of economic and trade policies (Worrell et al. 2000).

More recent studies have been published around best technology transfer practices. However, these studies focus largely on transfer of technology between organisations, businesses, and industries located in developed nations. A theoretical framework and analysis tool has been developed to improve efficiency and effectiveness of transfer which takes into consideration influences such as internal culture and education in the development of the best transfer practices (Resende et al. 2013).

The United Nations has identified that establishment of national technological policies are important for the transfer and development of technologies (Chatel 1979). Policy frameworks for acquiring, using, adapting, and generating appropriate technology have been developed to support developing countries (Chatel 1979). The transfer of technology to developing countries in unilateral or multilateral policies has also been discussed in Hoekman et al. (2005). Various practical developmental and economic issues relating to the push for technological transfer have been discussed, but natural resources conservation has not appeared to be one of the essential criteria to the choice of technologies and their transfer mechanisms (Bolay et al. 2012).

Addressing technology transfer through community development mechanism (CDM) in societies with developing economies, Ramanathan (2002) advises that technologies should be relevant to the local needs and that sufficient expertise need to be made available in local markets to maintain the technologies. Another CDM driven technology transfer area is around low-carbon energy technologies where the low-carbon energy technologies should meet the perceived needs and priorities for low-carbon technologies in the country context, i.e. host countries' development priorities such as culture, resistance to innovation and technology priorities (Van Der Gaast et al. 2009). A closely related vehicle for technology transfer to societies with developing economies is through climate change issues, which allow these nations countries to move quickly to environmentally sound and sustainable institutions and technologies (Karakosta et al. 2010). Small and medium enterprises (SMEs) have also been addressed and framework created in analysing the key factors and influential elements of acquiring foreign technologies in the context of societies with developing economies (Khabiri et al. 2012). Although much earlier difficulties have been encountered when non indigenous renewable energy technologies are transferred to rural areas where there are cultural and organisational differences and shortages of appropriate institutional and financial support mechanisms (Green 1999).

3.4.3 Conclusion on appropriate technology

Two elements of appropriate technology namely technology matching/assessment and technology transfer exist in energy policies. However, these policies have not addressed significant determinants of appropriate technology which includes respect for indigenous wisdom and technological independence. Therefore, appropriate technology so far has not holistically been integrated into energy policies. Literatures should be revisited if not started, in the light of necessity in integrating these neglected aspects of appropriate technology into energy policy formulation and implementation with the aim of achieving a sustainable society.

Conceptual studies on appropriate technology have been in literature for the last few decades. However, the fact is that elements contributing to the topic are so disparate, with more relevant material written in the 1970s and 1980s. At implementation levels, appropriate technology has also been addressed in many energy projects, more specifically so in vulnerable societies. However, review of material in these societies strongly suggests that at policy levels appropriate technology as a holistic concept potentially has a determinant role in the success of sustainable energy provision for both on-grid and off-grid communities. As thoroughly reviewed in the previous sections, it was found that this topic is not currently a distinct academic subject on its own. It currently lives across disparate areas of academic research outputs.

3.5 Gaps identification

Based on the conclusions on vulnerable society (sub-section 3.2.3), sustainable energy policy (sub-section 3.3.5), and appropriate technology (3.4.3), the following gaps in knowledge have been identified. Figure 3-17 represents the identified gaps between sustainable energy policies in literature and in practice. To date, no peer reviewed study has been published on the strategy for incorporating appropriate technology into sustainable energy policy sectors in practice through institutionalisation and/or enhancement of existing policies in post-conflict, post disaster societies. However, methodologies of developing a new sustainable energy policy in these post-conflict regions can potentially be derived from similar pathways in constructing new policies in health, social, and political services in affected regions. The pathway, which is not too different from that outlined by Collier and Hoeffler (2004), consists of considerations and management of the following issues respectively (Schwartz and Bannon 2004; Weynand 2007).

- Security;
- Infrastructure;
- Investment – private;
- Governance.

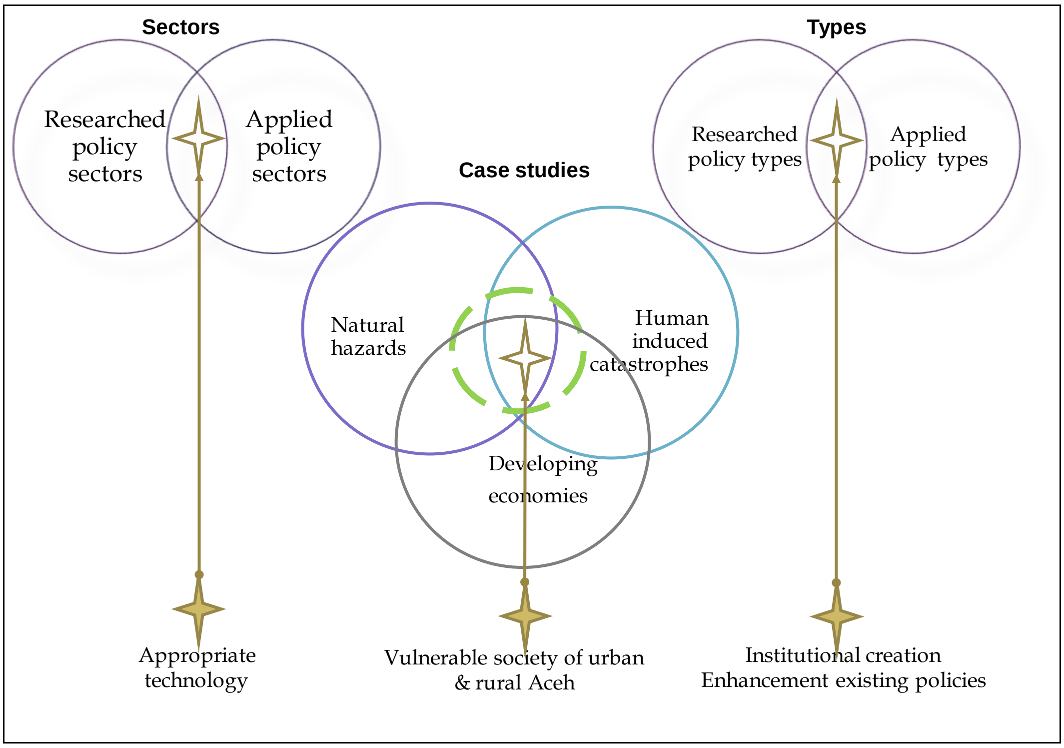

Figure 3-17: Gaps in sustainable energy policies types, sectors, and case studies represented by the three stars

3.6 Rationale for case study selection

Referring back to the understanding of vulnerable societies as described by (Figure 3-9), the base load for vulnerability is generally found in societies with developing economies globally. Meanwhile, the two additional triggers for vulnerability are most found in South East Asia as previously discussed in section 3.1.2 and in Asia-African nations as previously discussed in section 3.1.3.

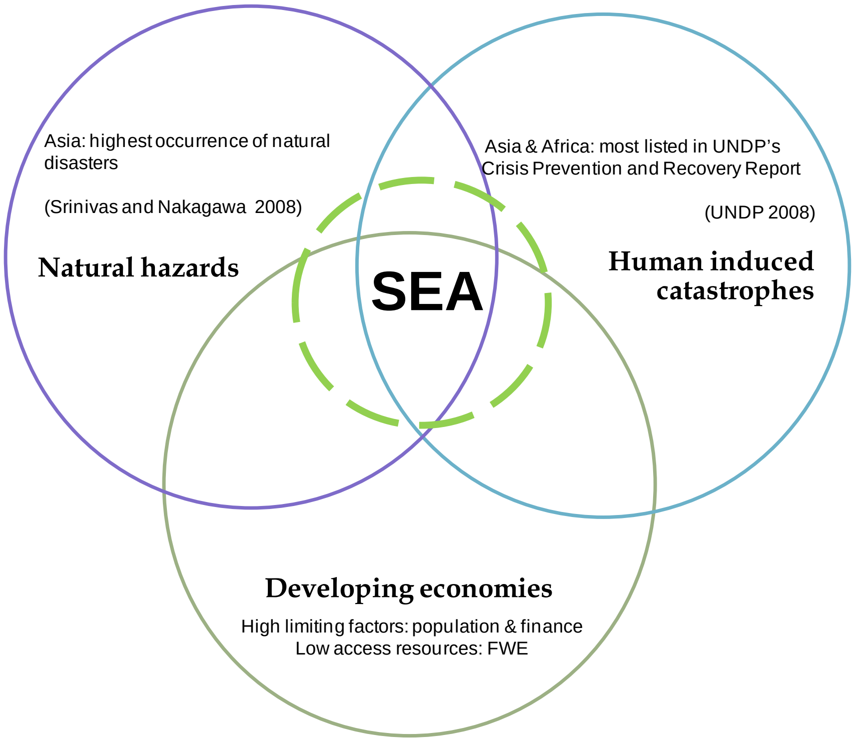

Figure 3-18: Scope for case study

Putting a South East Asian (SEA) geographical scope to cover all three elements as illustrated on Figure 3-18 above, four nations and two sub-nations can be categorised as vulnerable societies as represented in Figure 3-19

1. **Timor Leste**: A new country, internationally acknowledged being independent in 2002. Although significant assistance in funding for development has been received, poverty increases in recent years and is found more prevalent in rural areas, more so due to the lack of access to energy (Datt et al. 2008; Loy and Correia 2008; Shum et al 2007). Additional pressures include the potential for recurring social/political conflict (UNDP 2009; US Department of State 2011).

2. **Aceh (Indonesia)**: An autonomous province of Indonesia with authority of managing its own natural resources. It is listed as a region of conflict by the UNDP (2008) from 1996-2004; further faces the recurring triggers of social/political conflict and the potential for natural disaster.

3. **West Papua (Indonesia):** West Papua is a province of Indonesia, located on the western half of the island of New Guinea. In the past it had been known as the Dutch New Guinea (during Colonial Period), as West Irian (from 1969 – 1973),

then renamed as Irian Jaya. In 2003, Irian Jaya was divided into two provinces: West Irian Jaya (which occupies the western part of the region) and Papua (which occupies the eastern part). West Irian Jaya was renamed West Papua on 18 April 2007 (Human Rights Watch 2007a). Exploitative mining corporations operating in West Papua and abusive Indonesian security forces serve as triggers for West Papuan separatist's movements. In a multi-ethnic state such as Indonesia, ethnic nationalism is the response to situations of structural inequality and uneven development (Trajano 2010). This unequal development widens the gap between the dominant and minority ethnic groups and thus creates social conflicts.

4. **Cambodia:** Listed as a region of conflict by the UNDP (2008) from 1970-1975 and 1978-1990. No formal documents in English on sustainable energy policy/strategy have been found, but availability of workshops reports on the web suggests that there is work being done.

5. **Philippines:** In the Philippines, the breakdown of peace negotiations in 2008 had initiated another conflict in the Southern Region which is similar to that in Thailand where it is largely categorised as ethnicity conflict with strong religious lines (Santos 2001).

6. **Thailand:** The conflict in Thailand revolves around ethnic lines with strong religious elements. In Thailand, the issue has again been the subject of much attention because of its recent intensification since 2004 after it was thought to have subsided by the 1990s (Human Rights Watch 2007b).

Differing in sustainable energy development stages, these societies have the following commonalities. Continuous social political tensions (ADB 2004; Hla Kyaw 2009) and the potential of recurring natural disaster increases vulnerability and creates the cycle of economic underdevelopment – social conflict – political instability – environment degradation. Localised programmes have been initiated by international aid communities (ADB 2004; Hla Kyaw 2009) but have not addressed access to energy in the light of indigenous design, manufacturing, business cases, and governance.

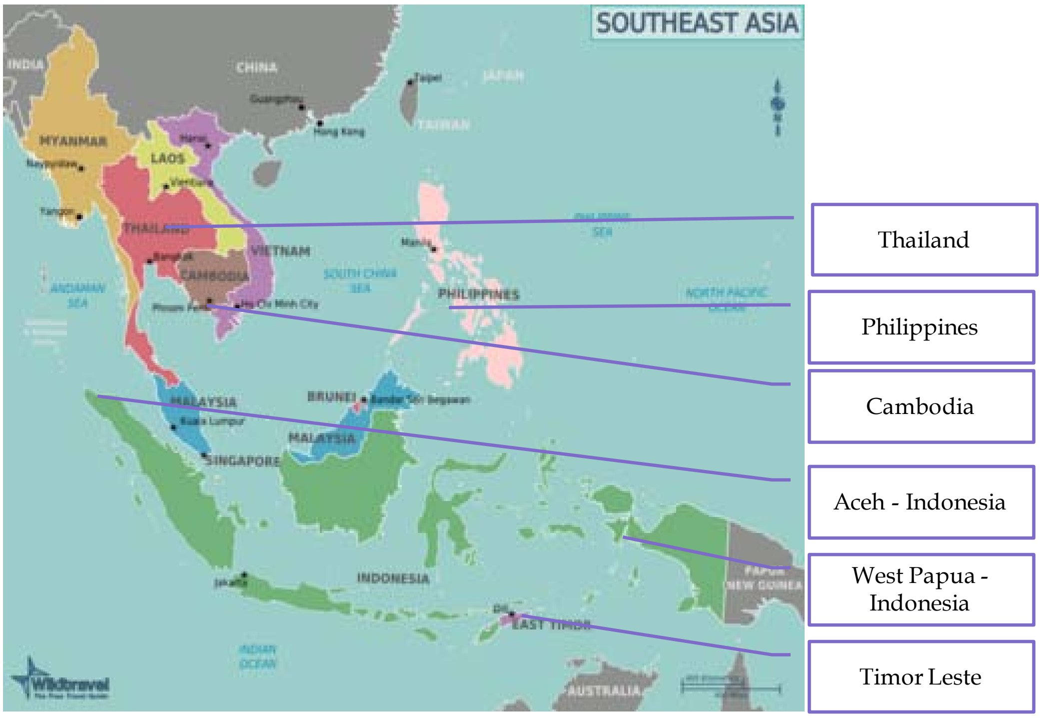

Figure 3-19: Vulnerable societies in SEA

However, Aceh has the following distinct features compared to the others:

- Both determining factors and triggers of vulnerability (natural disaster and social/political conflicts) are present at equally high recurrence. This exacerbates their internal limitations due to weak economies, fragile state, and minimal access to FWE resources;

- Although the province has the autonomy to manage its own natural resources including energy, Aceh is not an independent nation. It still has to adhere to the Indonesian national government for some elements of their macro policy decision making.

The scope for work based on the identified areas of gaps between theoretical and applied sustainable energy policies and appropriate technology in vulnerable societies should encompass the following elements:

1. Case studies covering the unique features and intricate constraints of policy intervention of an area located in a South East Asian developing economy, with

potential of facing recurring natural disaster and social/political conflict (Chapter 4).

2. Clear road maps showing how to adjust goal and framework setting in policy intervention to shift energy security paradigm to follow the sustainability concept
3. Policy types: institutional creation, enhancement of existing policies, project based programmes, strategic planning;
4. Policy target sectors: distribution to off-grid areas, transport, heating/cooling, framework;
5. Appropriate technology incorporation into energy policy, in the efforts of achieving community engagement, affordability, and acceptability (Chapter 0).

3.7 Summary of Chapter 3

<u>Answering RQs for Objective 1</u>

To answer the research questions collated for Objective 1, a narrative review of pertinent literature has been presented in chapter 3. This, together with the data collected has provided the foundation to theory development. This chapter has identified the gaps in current knowledge and understanding of theories in vulnerable societies (Section3.2), sustainable energy (Section3.3), and appropriate technology (Section 3.4).

RQ 1: What is a vulnerable society and what are the specificities of a vulnerable society?

Vulnerable societies is understood as a group of communities in a disadvantaged position due to its inherent geospatial characteristics mindsets, views, and capabilities; which influences its coping capacity and adaptability to facing economic and population pressures in the limited access to food, water, and energy resources; thereby creating a condition where they are especially susceptible to damage, physical and/or social collapse when exposed to additional triggers in the form of natural hazards and/or human induced catastrophes (political/social conflicts)

RQ 2: What is a sustainable energy policy and what are the special considerations of a sustainable energy policy in a vulnerable society?

Sustainable energy policy in practice is defined as sets of decisions, which: encourage investments from the public and private sectors; attach a clear business case to its strategies and deliver (in a participatory, transparent, and accountable way) improved energy consumption, generation, and distribution systems which are economically viable, environmentally responsible, socially acceptable, and politically committed for the long-term

RQ 3: What are the gaps in existing knowledge of appropriate technology policy and its implementation specifically in the sustainable energy sector?

Two elements of appropriate technology namely technology matching/assessment and technology transfer exist in energy policies. However, these policies have not addressed significant determinants of appropriate technology which includes respect for indigenous wisdom and technological independence. Therefore, appropriate technology so far has not holistically been integrated into energy policies. Literatures should be revisited if not started, in the light of necessity in integrating these neglected aspects of appropriate technology into energy policy formulation and implementation with the aim of achieving a sustainable society.

4 Case Study

Rich people, poor nation.

"Our nation, and the world as a whole, shall not be the play thing of one small corner of the world"

(Soekarno)

4.1 Introduction to chapter four

Taking the gaps and scope of future work identified at the end of Chapter 3 (Sections 3.5 and 3.6) and to answer the research questions (RQs 4 and 5) collated for Objective 2, datasets were collected from Aceh, Indonesia as the chosen case study according to the methods outlined in Table 2-3. The researcher has performed the data collection activities in Aceh as part of a research team from the Centre for Understanding Sustainable Practice (CUSP) – Robert Gordon University (RGU) facilitated by the Aceh Green Secretariat (AG) and Strategic Resources Initiatives (SRI).

Objective 2

Critically assess existing sustainable energy technology and policy in Aceh and analyse the role of relevant actors and stakeholders in the problem system of vulnerable societies.

RQs for objective 2

4. What are the existing components of sustainable energy generation and distribution systems in Aceh?
5. What sustainable energy policies exist or are currently applied in Aceh?

A summary of the work undertaken in Aceh is given in section 4.2 and the data interpretation for document reviews and fieldwork are given in section 04.2. Summaries of documents reviewed and observations, interviews, and workshops are presented in sub sections 4.3.1 and 4.3.2. These results are iteratively fed back to theory development in chapters 5 and 0.

The structure of chapter four is explained through a flowchart given on Figure 4-1 overleaf. Sections are linked to each research question it answers and to other contributing sections.

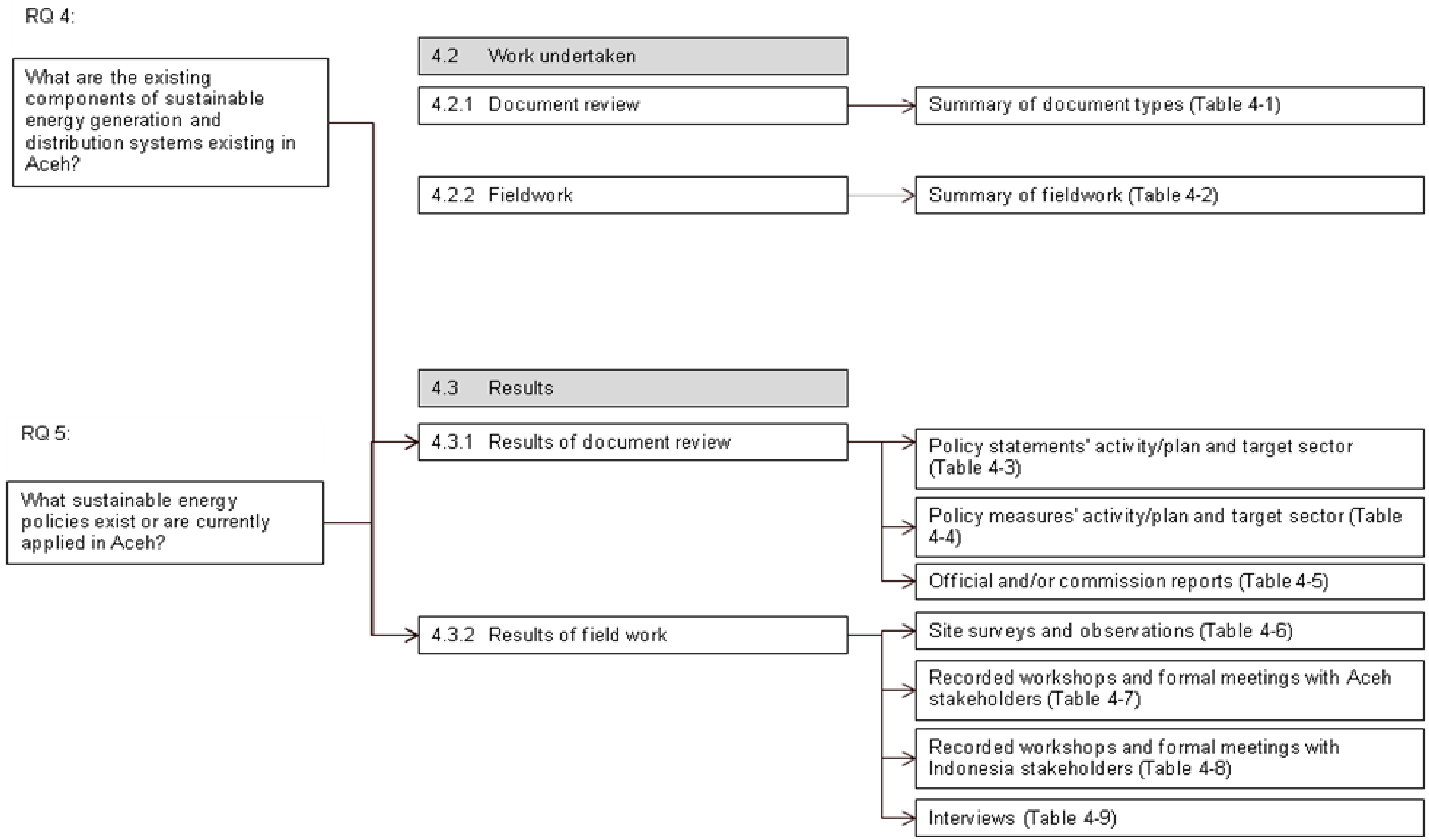

Figure 4-1: Flowchart of chapter four

4.1.1.1 Background to the case study area: Aceh, Indonesia

Approximately 40% of the world's natural forests have disappeared in the last 300 years (Food and Agricultural Organisation 2006) and the rate of biodiversity loss continues unabated (Butchart et al. 2010). Natural forests and biodiversity are two of the main determinant contributors to availability of ecosystem services (Food and Agricultural Organisation 1999). These services include (1) regulating climate, water cycle, flood, and disease, (2) provisioning of food, fresh-water, fuel, and wood/fibre, and (3) supporting primary production, nutrient cycling, and soil formation. All of these factors contribute to the fragility of livelihood and susceptibility to damage, and therefore to vulnerability (Figure 3-9).

Indonesia, with the fourth highest population in the world, has a strong political and economic role in South East Asia. It is an emerging nation, rich in biodiversity, with a high energy demand to support its economic activities, but also unequally distributed energy in its remote regions, which often interfaces with the management of natural resources and land uses (Department for International Development 2013). Indonesia has a significant bridging role between the developed and developing world, more specifically in collaborative initiatives to achieve global climate change mitigation objectives (Department for International Development 2013). It has plentiful and accessible sustainable energy resources, but suffers a shortage of indigenous capability and capacity to be able to utilise these resources in a consistent and sustainable manner. Capacity at all levels of technology implementation is one of Indonesia's weaknesses (Department for International Development 2013). However, emphasis has been given by the Indonesian Government that priority sectors for development in the country is on poverty reduction and remote region infrastructure and basic food/water/energy systems development (National Development Planning Agency 2012).

Aceh is Indonesia's most western province. It has a population size about 4.2 million, who are mostly Muslims (Schulze 2004). The majority of the population survives from agriculture, aquaculture, and mineral exploitation. Because of its Islamic devoutness and rich natural resources, Aceh is one of Asia's longest-running internal conflicts. Religions reasons and allocations of resource revenues have become points of conflicts between the Acehnese and the formal Indonesian Government starting from 1976, when Indonesia's territorial sovereignty over the province was contested by the Free Aceh Movement (GAM) (Schulze 2004).

Historically, Aceh like many of the other provinces of Indonesia was part of the Dutch East Indies, but the Acehnese Sultanate which has been a powerful Islamic state helped the Indonesian in fighting off the Dutch Colonial Empire through decades of war lead by the Sultans and Ulama (religious scholars) territory' was granted after the Darul Islam revolt in 1953, but the current separatist conflict began in 1976 led by Hasan di Tiro when he returned from exile from the United States to form GAM. This started a brutal counterinsurgency by the Indonesian military claiming thousands of Acehnese civilian lives which lasted for several periods of war-cease fire periods until a Special Autonomy was granted in 2001 (Schulze 2004). After the signing in 2001, the peace process broke down and a large scale military offense was launched. The tsunami which hit Aceh in 2004 started the Acehnese indigenous reconciliation. Aceh's religious leadership played an important part alongside the resilient wide circle of civil society in the sequential peace building processes afterwards (Brathwaite et al. 2010).

On 26 December 2004, an earthquake with magnitude of around 9.0 on the Richter scale struck off the western coast of North Sumatra, triggering massive waves coming into coastal areas in countries around the Indian Ocean rim. By July 2005, official figures were issued registering that 128,645 people in Aceh had lost their lives, 37,063 were missing and 532,898 had been displaced (Rofi et al. 2006). The tsunami-affected population has since then faced multifaceted problems which include loss of family members, loss of homes, assets, livelihoods and community infrastructure, displacement and relocation in temporary homes and shelters.

Figure 4-2: The Republic of Indonesia (International Energy Agency 2008)

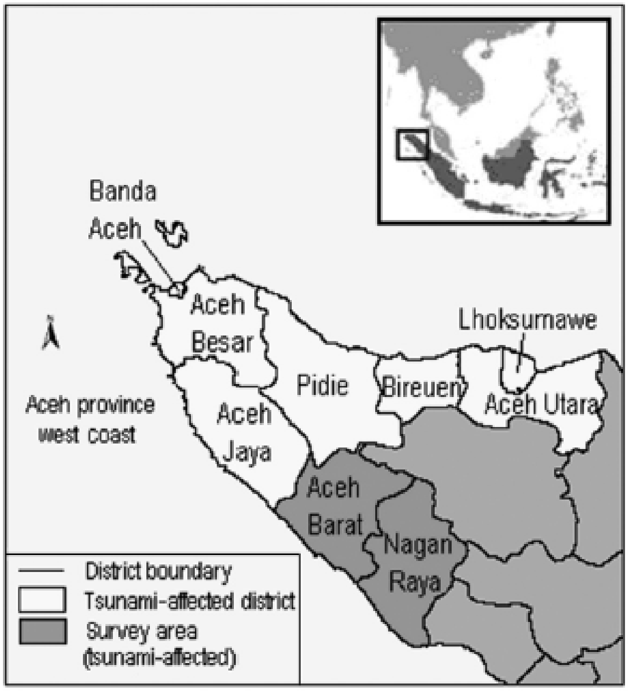

Figure 4-3: Aceh tsunami-affected areas and survey region (Rofi et al. 2006)

In summary, because of its inherent characteristics and historicity, Aceh is repeatedly subjected to the influencing factors of vulnerability. It continuously faces the threat of increasing State fragility and susceptibility to damage. The people of Aceh have never acknowledged the governance or rule of the Dutch or the Javanese (read: Indonesia). GAM went into this unsettled power game when the feudal Acehnese aristocracy (Sultan and Ulama) also cannot fully gain this legitimacy. On top of this, in 2004, the tsunami that occurred in Aceh took most of its basic livelihood structures. This again re-iterates how Aceh exhibit the determining factors of a vulnerable society i.e. exposure to triggers in the form of natural disaster and human induced catastrophes (Figure 3-9) and therefore is an appropriate case study for this PhD research. For security reasons, a number of actors and stakeholders involved in this PhD research are unable to be named due to their past and/or present GAM affiliations and/or IDP circumstances.

4.2 Work undertaken

From the work in Aceh, data were collected and grouped based on two distinct activities: (1) document review and (2) fieldwork (Table 2-3). Data mining was done through a thorough review of documents obtained from non-governmental agencies' websites and official documents requested from Aceh governmental agencies and international Non-Governmental Agencies operating in Aceh. Data reliability, suitability, and adequacy of the documents are assessed as presented in Table 4-1. The summary results of this review are presented in: Table 4-3, Table 4-4, and Table 4-5.

The documents were obtained following the procedure as outlined below:

- Internal desk study was performed through accessing publications available online
- External desk study was performed through accessing publications available from stakeholders involved. To achieve this the following steps were undertaken:
    1. Identify areas of information relevant to research, outline potential sources of documents and note where the documents may be stored, who was involved in generating the documents, and who has the authority for release of information;
    2. Informally request for information providing explanations on what the purpose for data gathering;
    3. Formally request for document sharing referring to the informal request;
    4. Formally request further references cited in shared documents

Data were also collected through fieldwork involving on-site surveys and observations, workshops (both formal and informal), meetings, and interviews which were conducted with stakeholders representing specific strands of Acehnese society. The Acehnese society engaged in the fieldwork include: indigenous communities, business communities, academic communities, as well as governmental and non-governmental organisations. The results of site surveys and observations are described in text and the results of workshops and meetings are presented in Table 4-6 and Table 4-7. The list of people interviewed is given in Table 4-8.

The fieldwork was conducted following the procedure as outlined below:

- Invites for capacity building and field work were obtained from the Aceh Governor's Office through the Aceh Governor's Special Envoy for Sustainable Technology and Resources Management, and from Aceh Green Secretariat, a department responsible for delivering Aceh's Sustainability Strategy.

- The observation sites were selected following the procedure as outlined below:

  1. Appropriate physical data to be collected were outlined (i.e. sites which is related to micro hydro generation, solar PV generation, biomass generation, wind power generation, and marine energy potential);

  2. Types of information and types of informants required to complement physical observations were communicated (i.e. community perceptions from community leaders and members, implementation programmes recorded by local authority, etc.);

  3. Sites were selected based on the appropriateness in accessing information. These are jointly decided between the researcher and local key actors who have the local knowledge and appropriate credentials to make the necessary arrangements.

- The actors and stakeholders were engaged following the procedure as outlined below:
  1. Two key actors were identified and contacted prior to fieldwork being started. These actors were selected based on:
  - Knowledge of Aceh's environment and society;
  - Experience in working with Aceh's local communities, governments, academics, and businesses;
  - Presence during the insurgence era and during the tsunami;
  - Visible integrity through proven track record of being respected and trusted by other stakeholders;
  2. Other relevant actors and stakeholders were identified through summarising, discussing, and communicating the types of specific

information required and who would be most appropriate in providing and making decisions on those issues.

3. Actors and stakeholders were gathered for workshops, meetings, and interviews by:
   - Highlighting and communicating the need for certain area of knowledge and expertise to the key actors in Aceh;
   - Putting forward the requests of bringing local actors and stakeholders into workshops, meetings, and interviews respectively.

- Information was extracted from actors and stakeholders following the procedure as outlined below:
  1. Formal workshops, meetings, and interviews were set up
     - Lists of relevant issues for discussions were prepared;
     - Agenda were structured loosely to allow for improvisations by attendees;
     - Records were taken and summaries were distributed to relevant individuals for approval.
  2. Informal meetings and interviews were organised
     - Time and venue of meetings and interviews were set to be very flexible and were decided based on local advice and input, based on availability of actors, and based on the settings preferred by actors involved;
     - Unless specifically invited to, the researcher did not take any recording and/or any form of documentation;
     - Observations and conversations were recalled after meetings and interview results, then written as summaries;
     - The key points in those summaries were the used again by the researcher and brought up in next meetings with the same actors to revoke discussions on the same topic as well as to ensure data capture was as intended by informants.

Table 4-1: Summary of document types

Document type (detailed in Table 4-3**,** Table 4-4**,** Table 4-5**)**	**Generated data**	**Reliability**	**Suitability**	**Adequacy**
1. Indonesian Energy Policy	• Indonesia's sustainable energy policy	• Government source • Detailed	• National scope • Descriptive	• Wider coverage than present study
2. Aceh Green Policy	• Aceh's sustainable energy policy	• Government source • Detailed	• Provincial scope • Descriptive	• Exact sustainability concept
3. Rehabilitation and reconstruction reports	• National and provincial energy policy measures	• Multinational NGO • Detailed	• Provincial scope • Quantitative	• Exact historical-social context
4. Other sustainable development initiatives	• Energy implementation programmes	• Multinational NGO • Detailed	• Provincial scope • Quantitative	• Wider in topic than present study
5. Renewable energy resource report	• Energy consumption, generation, and distribution assessments	• Local consultancy • Detailed	• Provincial scope • Quantitative • Qualitative	• Narrower in topic than present study
6. PLN electricity generation and distribution strategy	• Energy generation and distribution plan	• Local energy company • Not robust	• Provincial scope • Quantitative	• Exact geospatial focus

Table 4-2: Summary of fieldwork

		ACTIVITIES	OUTPUTS
1.	**INTRODUCTION**		
1.1.	Identification of appropriate stakeholders input and interests	• Workshop undertaken with Acehnese stakeholders in May 2011 (Table 4-6) • Workshop undertaken with Indonesian stakeholders in October 2012 (Table 4-7) • Interviews with key decision makers in sustainable energy (Table 4-8) • Interviews with key actors with roles as change agents and advisors (Table 4-8)	List of stakeholders Capability and credibility analyses Contact person in relevant institutions
1.2.	Identification of local communities requirements	• Site survey undertaken in Aceh in May 2011 and October 2011 • Observations of local on-grid urban and off-grid rural/coastal areas	Situation analyses on local communities experience and aspirations on energy
2.	**SCOPING**		
2.1.	Baseline establishment	• Site survey Undertaken in Aceh in May 2012 Quantifying: – Existing renewable energy resources – Existing energy needs – Existing human resources skill sets – Existing technological capabilities	Baseline of natural, human, and technological resources for equal access to energy
2.2.	Target setting	• Workshop undertaken with Acehnese stakeholders in May 2012 (Table 4-6) • Workshop undertaken with Indonesian stakeholders in October 2012 (Table 4-7) Analysing: – Government's aspiration – Business community's buy in	Aceh's goals for sustainable energy in a 5, 10, 15, 20 years' timeframe

		– Academic community's role in research and development – Local community's energy provision threshold	
2.3	Road map formulation	• Workshop undertaken with Acehnese stakeholders in October 2012 (Table 4-6) • Workshop undertaken with Indonesian stakeholders in May 2013 (Table 4-7) – Identifying appropriate financing mechanisms – Exchanging stakeholders expertise experience	Plan of action to generate: • Technology manufacturing strategy • Capacity building strategy • Appropriate funding streams (investment, soft loan, grant)
3.	**CONSOLIDATION**		
3.1.	Formally acknowledge collaboration	• Workshop undertaken with Acehnese stakeholders in October 2012 (Table 4-6) • Workshop undertaken with Indonesian stakeholders in June 2013 (Table 4-7)	• MoUs between network partners • Capability statement of partners ability to provide support
3.2.	Detailed project formulation	• Workshop undertaken with Acehnese stakeholders in May 2013 (Table 4-6) • Workshop undertaken with Indonesian stakeholders in October 2013 (Table 4-7)	Detailed work packages for: • Establishing joint research-development, technology demonstration, and indigenous manufacturing centres • Initiating knowledge exchange programmes in renewable energy technology and management
3.3.	Concept validation and improvement	Site survey undertaken in Aceh in October 2012 and October 2013	Consolidation reports and recommendations

4.3 Results

4.3.1 Results of document review

A document review was performed to obtain information for RQ5 regarding what sustainable energy policies, policy measures, and implementation programmes exist or are currently applied in Aceh. The data collected provides information on the level of policies in place, what activities and plan of actions those policies are aimed at, and the policies' targeted sectors. Table 4-3 summarises the results of document review performed on sustainable energy policy statements, which are relevant to the case study: Aceh. Table 4-4 summarises the results of document review performed on policy measures. Table 4-5 summarises the results of document review of official and/or commissioned reports.

Table 4-3: Policy statements' activity/plan and target sector

No.	Description of existing policy statements	Level	Activity/Plan	Target sector
1	Presidential Decree No. 4 of 2010 Original document	National	Aims for increasing electricity supply to support increasing demands and diversifying power stations energy sources through a Fast-Track Programme to add 10 000 MW capacity from Geothermal, hydro and biomass (incorporates and supersedes Presidential Decree No. 5 of 2006 on National Energy Policy and Blueprint of National Energy Management 2005-2025).	Energy Economy
2	Presidential Decree No. 5 of 2006 on National Energy Policy and Blueprint of National Energy Management 2005-2025 Original document and cross referenced to International Energy Agency (2008)	National	Aims for securing only the supply side by reducing oil use by 20% by 2025 Increase the new and green capacity mix to 15% by 2025 - 5% biofuel - 5% geothermal	Energy Economy

			- 5% biomass, nuclear, hydro, solar	
3	Aceh Green Policy Original document and cross referenced to Aceh Green (2008)	Provincial	Integration of climate change mitigation themes through renewable energy, land use management, community development, commerce, and conservation.	Energy Environment Economy Community
4	Provincial General Budget Policies / Budget Planning Priorities document (Kebijakan Anggaran Umum / Plafon Prioritas Anggaran KAU-PPAS) Original document and cross referenced to Aceh Green (2008)	Provincial	• General policy and planning framework • Outline of state of economy, revenue, and expenditure • Development policies and priorities	Energy Economy Social Cultural Disaster management

Table 4-4: Policy measures' activity/plan and target sector

No.	Description of existing policy measures	Level	Activity/Plan	Target sector
1	Ministry of Energy, Regulation No. 7 of 2010 Original document and cross referenced to DIFFER (2012)	National	Cross-subsidy through electricity tariff	Electricity
2	Ministry of Energy, Regulation No. 31 of 2009 Original document and cross referenced to DIFFER (2012)	National	Small scale hydropower generation up to 10 MW	Renewable electricity
3	Law No. 30 of 2009 Original document and cross referenced to DIFFER (2012)	National	Partial liberation of electricity sector Risk sharing between private and state investors	Energy
4	Law No. 30 of 2007 Original document and cross referenced to DIFFER (2012)	National	Management of energy to support national sustainable development and improve national energy resilience	Energy diversification Energy conservation
5	Government Regulation No. 26 of 2006 Original document and cross referenced to DIFFER (2012)	National	Prioritisation of renewable energy for electricity generation	Renewable energy generation
6	Presidential Regulation No. 71 of 2006	National	10.000 fast-track programme	Electricity generation

	Original document and cross referenced cross referenced to DIFFER (2012)		Cash programme Reducing PLN's need for electricity supply	
7	Ministerial Decree No. 2 of 2006	National	Obligation for PLN to purchase electricity generated from renewable energy from facilities 1MW<Cap<10MW	Small scale electricity generation
8	Presidential Regulation No. 5 of 2006 Original document and cross referenced to DIFFER (2012)	National	20% oil reduction by 2025 Increase mix of renewable to 15% by 2025	Energy diversification
9	Energy and Mineral Resources Ministerial Decree No. 2 of 2004 Original document and cross referenced to DIFFER (2012; 2007)	National	Maximum use of renewable energy Public awareness of energy efficiency	Green Energy Energy efficiency
10	Energy and Mineral Resources Ministerial Decree No. 954K/30/MEM of 2004 Original document and cross referenced to UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (2007)	National	Maximum use of renewable energy Public awareness of energy efficiency	Green Energy Social development
11	Energy and Mineral Resources Ministerial Decree No. 1122K/30/MEM of 2002 Original document and cross referenced UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (2007)	National	Small power generation using renewable energy	Distributed generation
12	Law No. 11 of 2006 Original document and cross referenced to Aceh Green (2008)	Provincial	Governing of Aceh	Aceh Government

Table 4-5: Official and/or commission reports

No.	Report title	Content
1	PT. Cipta Multi Kreasi 2008 Laporan Akhir Studi Potensi energy Listrik Alternatif di Pedesaan sebagai Upaya dalam Mendukung Percepatan Diversifikasi Energi di Propinsi Nangroe Aceh Darussalam. Translated as: *Final Report on Alternative Electricity Potentials in Rural Areas as an Effort to Support Acceleration of Energy Diversification in the Province of Aceh Nangroe Darussalam.*	In total, there are currently 195 villages in Aceh province located out with the PLN grid coverage, a few of which have rented small-scale diesel generators or solar panels to generate a limited amount of electricity. A report has been provided based on a previous survey commissioned by PLN as part of its efforts to profile energy use and potential resources in villages across Aceh Province. The study concluded that based on water debit and head, 73 off-grid villages have micro hydro resource potential, and, based on availability of farmland and farming waste, 34 villages have palm waste, maize, and cassava energy resources potential. However, methodologies for data collection and subsequent analysis used in the reports are seriously lacking in rigor and integrity, leading to severe potential errors in results and conclusions. Therefore, CUSP cannot recommend taking significant investment decisions based on the report written by PT Cipta Multi Kreasi or the PLN report which is based on the conclusions of PT Cipta Multi Kreasi. Reassessments need to be performed to capture the true potential of renewable energy for Aceh off-grid remote areas as well as the correct form and quantity of energy utilisation.
2	ESDM, 2009. Master Plan Ketenagalistrikan 2010-2014 Translated as: *Electricity Master Plan 2010-2014*	The actual capability of the existing electricity distribution grid and the performance of its generator network are poorly understood. The Department of Mining & Energy (ESDM) provides information that frequently differs considerably from that of the electricity distribution company (PLN) (Figure 4-4) and, in one particular document, the PLN disagrees with itself. It is therefore proposed that meetings be arranged with ESDM and PLN in an attempt to understand the issues surrounding quantification of generation capacity and outputs, without any implication of blame. The system cannot be accurately modelled if the parameters vary by significant amounts, and understanding grid capacity is fundamental to renewable energy projects being bankable.

		 **Figure 4-4: Deficits for Isolated Systems in Aceh, Modified from Ministry of Energy and Mineral Resources (ESDM) 2009. Master Plan ketenagalistrikan 2010-2014, page 17.**

4.3.2 Results of fieldwork

4.3.2.1 Site surveys and observations

Site surveys and observations were performed to identify the answers for RQ4 on what the existing components of sustainable energy generation and distribution systems in Aceh are. Sustainable energy generation sites for micro hydro, solar PV, biomass and biogas, micro wind, and marine energy sites were observed during the fieldwork period.

Present situation in remote rural areas in Aceh

- Energy is utilised mainly for basic needs which include clean water and minimum lighting, as well as an economic development mechanism in the form of requirements to drive grinding and drying processes for competing with next village for coffee bean production
- Policy is already in place for rural electrification
- Failure of donor-funded (imported) Solar PV is found in the form of deteriorating bulbs and batteries
- Non-existent local maintenance skills are found in the area and surrounding premises

Present situation in urban Banda Aceh

- Energy is mainly used for lighting, cooling, service, and production
- Policies already exist for reducing deficiency of power and CO_2 reduction through renewable energy
- Failure of donor-funded (imported) wind turbine is caused by incompatible AC-DC converter to low current and non-existent material and local maintenance skills

Site survey May 2011: Micro hydro site Jantho

Jantho micro hydro plant was a project subsidised by Coca Cola for small scale electricity generation in a small village near Banda Aceh (Figure 4-5, Figure 4-6). As part of the installation, the local community was trained on operating the micro hydro devices. However, since design and maintenance were not built into the knowledge transfer strategy, whenever there are problems associated with the generator and/or other related equipment, the power generator has to be shut down. Technicians are imported from outside the village expertise are purchased at a cost which at the moment is paid for by the locals and the village level government.

Figure 4-5: A community member operating Jantho micro hydro plant

Figure 4-6: Source of water for micro hydro plant in Jantho

Site survey October 2011: Off grid rural/coastal & on grid urban

Terangengon is a village located in the centre of Aceh Province. It is located about 1km from a small river, which runs at the bottom of the village. The surrounding landscape is still covered in local vegetations, with a new access road only recently under construction (less than 1 year prior to field visit in October 2011) from the nearest town.

Fifty-one families currently reside in the village. Most of the villagers produce building materials as their source of living. As the Government of Aceh had aimed to provide electricity to as many of its off-grid villages as it can during Aceh post tsunami rehabilitation and reconstruction programmes, through collaborations between the government and local/international nongovernmental organisations, electricity was at one point supplied by micro scale solar photovoltaic (PV) systems (Figure 4-7), which are now unusable, as the bulbs and other components aside from the panels themselves have started to deteriorate. Systems maintenance requires spare parts (specific typed bulbs and storage batteries) and skills, which do not exist in the local area.

From an informal interview conducted with 7 of the villagers (2 village elders, 1 local government's village level representative, 1 community leader, and 3 other members of the local community), it was discovered that electricity, when available, is mostly used as source of lighting during the night and as is planned to become a mean of enhancing the villager's home industry productivity during the day.

Clean water is currently being provided by a very simple water supply system constructed by the locals based on their knowledge and limited resources. A 5mm diameter rubber pipe collects water from a spring uphill into a 5L plastic barrel (**Figure 4-8**). The water is then distributed to households using other 5mm diameter rubber pipes as pictured in. No pumps or filters have been located on site.

In the case of Terangengon, it is clear that electricity provision relates directly to the day-to-day basic necessities, which includes access to minimum lighting and usable water. However, electricity also directly relates to income generation, which is the most important factor in ensuring that the community is able to sustainably ensure its economic development and social resilience.

Lack of coherent policy, policy measures, and implementation strategy, for utilisation of appropriate energy generation technology has created the non-sustainability of the selected renewable energy system (solar PV). Clearly policies on energy should support more in depth analyses to match availability of local materials and skills to the identified resources, demand, and technology, before any political commitment pushes for implementation without clear goals, which can be maintained sustainably.

Figure 4-7: Unusable solar PVs in Terangengon Village

Figure 4-8: Terangengon water distribution system

Conversely, a different set of issues are encountered in the urban area of Aceh, particularly in Banda Aceh. Banda Aceh is where most of the government, academic, and business communities are based. The main locally owned economic activities of cities like Banda Aceh in Aceh Province are trade, services, and small scale industries. There is currently a vertical axis wind turbine placed on top of the tsunami refuge building. It has never generated power throughout its lifetime (Figure 4-9).

Figure 4-9: Non-operational vertical axis wind turbine in Banda Aceh

Site survey May 2012: ADCP Deployment

The tidal currents in Ujung Pancu, Aceh are not shown on the UK Hydrographic Office (UKHO) charts used for navigation and there is no available dataset of accurate velocity measurements. Local knowledge suggests that the stream runs at around 5-6 knots and is roughly 30m deep at its narrowest point. An Acoustic Doppler Current Profiler (ADCP) was deployed at Lat/Long 05^o 34.777, 95^o 13.322 in approximately 18 m water depth (Figure 4-10,Figure 4-11, Figure 4-12, Figure 4-13, Figure 4-14).

The ADCP was deployed on a frame made by Syiah Kuala University using local boat capability and located using the knowledge and expertise of the local fishing community. One of the objectives of the work was to engage indigenous capability in the site assessment process rather than to bring in all capability from outside Banda Aceh. The ADCP sampled flow velocities at 10 minute intervals for 2m bins to surface level.

Figure 4-10: Students from UNSYIAH, boating school, and fishermen in Ujung Pancu carrying ADCP unit into fishing boat

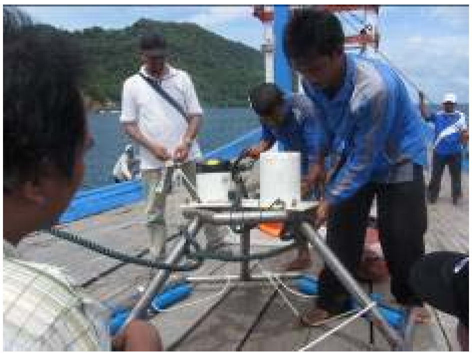

Figure 4-11: Local fishermen and UNSYIAH researchers preparing ADCP unit

Figure 4-12: Students from UNSYIAH, boating school, and fishermen in Ujung Pancu putting ADCP unit into water

Figure 4-13: Students from UNSYIAH, boating school, and fishermen in Ujung Pancu on fishing boat to retrieve ADCP unit

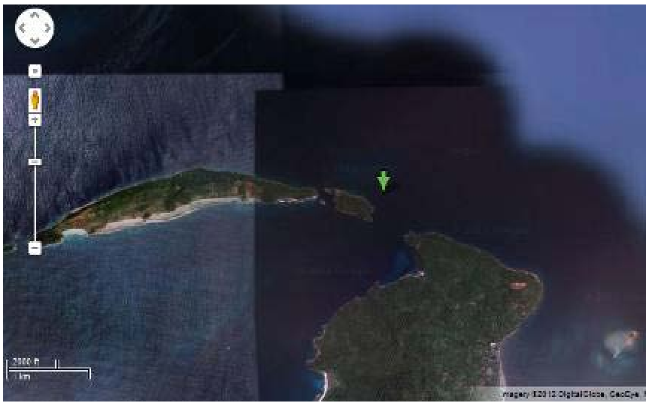

Figure 4-14: Location of ADCP for preliminary resource study

Site survey October 2012: ASTEC site selection

Andaman concession land is located 46km away from Banda Aceh and its driving time is about 45 minutes from Banda Aceh. It is located off the east coast of Aceh Province, just after the Malahayati Port. The total area is 900 ha and it has been indicated by Aceh Green and that it is an appropriate site for development of Science and Technology Park as long as 10-15 years due to excavation of pozolic soil for cement production timeline. Site observations are documented as Figure 4-15, Figure 4-16, Figure 4-17, and Figure 4-18.

Based on the participatory stakeholder engagement and interviews conducted with local community members, a suitable community engagement / community development plan is proposed to involve the following initiative (1) fish pond rehabilitation, (2) cow rearing, (3) fast growing tree plantation:

<u>Fish pond rehabilitation– 200ha CSR ground ex-ore mining</u>

Rationale:

- Pond structure already exist on site
- Fish pond will provide the community will income from fish sales
- Energy for water circulation can be derived from high density wind turbine suitable for low speed wind; may be installed along the coastline of pond area

Requirements:

- Existing fish ponds to be lined with limestone and lime mortar
- Existing fish ponds to be regenerated by seeding it with new fish stocks
- Circulation system to be built to pump water out of and into ponds

<u>Cow rearing – land surrounding villages</u>

Rationale:

- Many cows are reared without organisations and management
- Cow manure is a rich source for biogas production and can be utilised as a standalone or mixed with human sewage waste
- Patches of land will be supplied with appropriate grass to collect cows in one place, therefore enabling efficient collection of manure
- Increasing capability for cow rearing will benefit the community in accessing energy derived from its waste and in producing more cows

Requirements:

- Initiating new cow rearing methods
- Adapting local culture to new strategy

<u>Fast growing tree – 200ha Corporate Social Responsibility (CSR) ground ex-ore mining</u>

Rationale:

- Clearing of land in the surrounding area is needed to prevent invasive species of plants from invading further into the mainland

- Cleared land will provide enough soil nutrients and area for growing biomass crops
- Fast growing trees have been identified to be most suitable for pozolic soil which has very thin top soil; thereby preventing growth of higher classes of vegetation
- Community can gain economic profit from wages paid for rearing the trees

Requirements:

- Deals to be made with Lafarge to take in biomass from site
- Policy to be made on tracing tree cutting and selling activities

Figure 4-15: Location of Andaman concession land

Figure 4-16: Andaman concession land boundary 1

Figure 4-17: Andaman concession land boundary 2

Figure 4-18: Andaman concession land boundary 3

Renewable energy generation potential identified is to be developed alongside community development activities and will be located in the remaining 700 ha.

Site Survey October 2013: Beurenut and Lampanan

A site survey was conducted to the villages of Beurenut and Lampanan.

Records of the surrounding environment are captured by Figure 4-19 and Figure 4-20. Community engagement was conducted (Figure 4-21) discussing:

1. Availability of clean water provision
2. Availability of power for lighting and pumping
3. Utilisation of energy for agriculture and aquaculture activities
4. Willingness to contribute time and resources for project development
5. Potential complementing unsustainable building material and techniques identified in using lime mortars and/or using lime stone.
6. Possibilities of establishing business cases for indigenous communities benefits which aims at:

- Increased production from agriculture
- Rehabilitation of fish ponds
- Clean water
- Improved sanitation

Figure 4-19: Lampanan rice paddy field

Figure 4-20: Lampanan housing area

Figure 4-21: Lampanan community engagement

Wind turbine - Three blade turbines to produce electricity are to be installed on hill tops across site. High density fan turbines are to be installed on coastline nearby fish pond site for water circulation.

Micro hydro - A river has been identified suitable for installation of micro hydro turbine for electricity. Lift pumps are to be used to pump water up to water storage area on coiffed coastlines for electricity generation.

Biogas - Biogas is to be derived from a standalone cow manure digestion system, or a combination between cow manure and human sewage waste digestion system. Biogas as an end product can be used as fuel to drive existing gas powered generators and/or as a mixed component of a hybrid combustion engine system for motorbikes and cars. A side product of biogas generation process is biosolids; this if consisting of human waste then directly used as fertiliser will not be accepted by local community due to religious reasons; therefore the idea is to co-semicompost it with ash from biomass burner and finally used as saleable soil fertiliser.

Biomass - Clearing of land in the surrounding area is needed to prevent invasive species of plants from invading further into the mainland. Cleared land will provide enough soil nutrients and area for growing biomass crops. Fast growing trees have been identified to be most suitable for podzolic soil which has very thin top soil; thereby preventing growth of higher classes of vegetation. Community can gain economic profit from wages paid for rearing the trees.

Algae biodiesel - Microalgae is proposed to be the source for biodiesel developed on site. Tests will need to be done to determine the most suitable indigenous species / consortium of species for the purpose of generating the highest lipid content possible. Combining fish and algae cultivation in one aquaculture system (existing fish ponds) needs to be explored at lab scale, bench scale, and pilot scale.

4.3.2.2 Workshops and formal meetings

Workshops and formal meetings were performed to identify the answers for RQ4 on the existing components of sustainable energy generation and distribution systems in Aceh and for RQ5 regarding what sustainable energy policies, policy measures, and implementation programmes exist or are currently applied in Aceh. Results from these workshops and formal meeting were categorised into two main groupings: (1) Aceh sub-national stakeholders and (2) Indonesian – national stakeholders. Table 4-6 summarises the results of fieldwork undertaken by conducting recorded, face to face meetings held between stakeholders in Aceh. Their significance and final relevant outputs are included in the table. Table 4-7 summarises the results of fieldwork undertaken by conducting recorded, face to face meetings held between stakeholders in Jakarta, Indonesia. Their significance and final relevant outputs are included in the table.

Aceh

Table 4-6: Recorded workshops and formal meetings with Aceh stakeholders

No.	Stakeholder meeting description	Organisations involved	Meeting attendees and their roles	Meetings' significance	Items concluded
1.	**Scoping visit by invitation by the Governor of Aceh** **Banda Aceh, May 2011** 	Aceh Green Secretariat Aceh Governor's Office Aceh Mining and Energy Office (ESDM) State Electricity Company	1. Irwandi Yusuf (Aceh Governor 2006-2011) 2. Yakob Ishadamy (Director - Aceh Green) 3. Ilarius Wibisono (Director – UNDP AGTP) 4. T. Syakur (Deputy Head of Aceh ESDM) 5. Head of Aceh ESDM 6. Deputy Head of State Electricity Company	To scope areas of collaborations between CUSP-RGU and Aceh Government in initiating a sustainable energy policy and strategy in Aceh Province of Indonesia	1. Scoping report on resources available in Aceh to develop sustainable energy systems is required 2. Specific programmes for establishing sustainable energy in Aceh should be

	Figure 4-22: Meeting with Governor Irwandi Yusuf  **Figure 4-23: Meeting with Aceh Governor's advisory team**		(PLN) 7. Director of PDPA		developed 3. Engagement of Aceh government, local communities, indigenous businesses, technology practitioners, and academic expertise are required
2.	**Urban, remote rural and island community** **Banda Aceh, Sabang Island, Terangengon Village, October 2011**  **Figure 4-24: Meeting with Terangengon Village leader 1**	Aceh Green Secretariat Sabang Island community Terangengon Village community	1. Yakob Ishadamy 2. Ilarius Wibisono 3. Members of Sabang Island Community Centre 4. Flora Fauna International – Sabang 5. Members of Terangengon Community Centre 6. Terangengon Village elders	1. To consolidate materials collected by Aceh ESDM and PLN 2. To identify suitable contacts for driving policy making in sustainable energy 3. To observe Aceh provinces energy requirements (quantity and patterns) in urban, remote rural, and island areas	1. Energy should enable local community (urban, remote rural, and island) to meet basic needs and increase productivity, therefore selection of appropriate to supply energy from renewable resources is crucial 2. Incorporation of appropriate technology development (human and

	 **Figure 4-25: Meeting with Terangengon Village leader 2**				technological) in energy policy is of paramount importance to ensure sustainability 3. Marine energy is one of the biggest gaps in resource analyses for Aceh province
3.	**Sustainable energy resources preliminary assessment, Banda Aceh, May 2012**  **Figure 4-26: Assessment meeting with Government, academics, NGOs, local businesses 1**	Aceh Green Secretariat Strategic Resource Initiative Ujung Pancu Fishing Village Aceh Marine and Fisheries Department Tsunami Disaster Recovery and Monitoring Centre TDMRC Syiah Kuala University Polytechnic Aceh (PA) Boating and Fishing School	1. Yakob Ishadamy 2. Ilarius Wibisono 3. Panglima Laut (Ujung Pancu Fishing Village Community Leader) 4. M. Syakur (Head of Aceh Marine and Fisheries Department) 5. Dr. Dirham (TDMRC Director) 6. Tadjuddin (Head of Production Lab Syiah Kuala University (UNSYIAH) 7. Dr. Syamsu (Dean of Faculty Engineering Syiah Kuala University 8. Dr. Hanaffi (PA Rector) 9. Lecturers from UNSYIAH, PA, and	1. To outline scope for indigenous renewable energy development in Aceh 2. To establish a preliminary assessment on marine energy off the coasts of Aceh province 3. To initiate collaborations between universities, colleges, and vocational training providers	1. Existing skill sets identified in UNSYIAH (civil engineering, mechanical engineering, chemical engineering, electrical engineering); PA (electronic engineering, information technology, mechatronics); POLIVEN (agricultural industry technology, animal husbandry technology) 2. A cohesive group

	 **Figure 4-27: Seminar with UNSYIAH 1**  **Figure 4-28: Seminar with UNSYIAH 2** 		Boating School		for undertaking strategic renewable energy development programmes in Aceh is urgently needed 3. Practical skills in manufacture, installation, operation, and maintenance of renewable energy devices are identified to be the most urgent aspect of human resources needing development in Aceh 4. Professional and research skills in renewable energy resource assessment, environmental impact, business management, and policy making should form the next component of human resources development in Aceh

	Figure 4-29: Assessment meeting with Government, academics, NGOs, local businesses in Banda Aceh 2				
4.	**Consolidation of project partners Banda Aceh, October 2012**  **Figure 4-30: Consolidation meeting Banda Aceh 1**  **Figure 4-31: Consolidation meeting Banda Aceh 2**	Aceh Green Secretariat Strategic Resource Initiative Aceh Mining and Energy Office State Electricity Company Andaman Business Group Syiah Kuala University Polytechnic Aceh (PA) Polytechnic Venezuela (POLIVEN)	1. Yakob Ishadamy 2. Syakur (Head of Mining and Energy Office) 3. Sulaiman Daud (General Manager – Aceh PLN) 4. Andaman (Owner – Andaman Business Group) 5. Dr. Dirham 6. M. Tadjuddin 7. Dean of Engineering Faculty UNSYIAH 8. Dr. Sulaiman Thalib (Head of Mechanical Engineering Department UNSYIAH) 9. Dr. Hanaffi	1. To negotiate commitments from State Electricity Company and Office of Mining and Energy in developing policy and financing mechanisms for renewable energy in Aceh 2. To create a business case for developing a synergic renewable energy system in Aceh 3. To unite UNSYIAH, PA, and POLIVEN in collaborating for capacity building in renewable energy	1. A demonstration project is needed to prove a business case for developing a synergic renewable energy system in Aceh 2. Researchable elements of renewable energy policy and implementation strategy should be carried out with the aim of developing indigenous capabilities to enhance technology which is appropriate for local requirements 3. Buy ins from local community on renewable energy development site is detrimental in projects safety and sustainability

	 **Figure 4-32: Consolidation meeting Banda Aceh 3** **Consolidation of project partners Banda Aceh, October 2013**  **Figure 4-33: Consolidation meeting Banda Aceh 3**				

Indonesia

Table 4-7: Recorded workshops and formal meetings with Indonesia stakeholders

No.	Stakeholder meeting description	Organisations involved	Meeting attendees and their roles	Meetings' significance	Items concluded
1.	**Introductory meeting with UKP4 and the Indonesian Presidential Advisory Unit Jakarta, May 2013**  **Figure 4-34: Meeting with Indonesian Presidential Advisory Unit**	UKP4 Presidential Advisory Unit	1. UKP4 Unit Head: Prof. Dr. Kuntoro Mangkusubroto 2. UKP4 Director: Dr. Yanuar Nugroho (Manchester University Research Fellow) 3. Presidential Advisory Unit Director for Environment and Economy: Prof. Dr. Emil Salim	Overview of Indonesia's development policy 1. Bureaucracy reformation 2. Food-water-energy nexus 3. Environment 4. Green infrastructure	Room for Policy intervention 1. Energy policy which incorporates appropriate technology (indigenous wisdom for social transformation) 2. Marine energy potential in Indonesia 3. Database and decision making tool for Indonesia's sustainable energy resources (natural, human, capital)

2.	**Workshop with INOCEAN and RISTEK Bandung, May 2013**  **Figure 4-35: Meeting with Deputy Minister RISTEK and Chairman INOCEAN**  **Figure 4-36: Workshop INOCEAN, Bandung** **Workshop with INOCEAN and RISTEK Jakarta, October 2013**	RISTEK INOCEAN SIEW	1. Deputy of Research and Technology (RISTEK): Prof. Dr. Agus R. Hoetman MT 2. Director for Science and Technology and Regulation Institute Network: Dr. Ir. Anny Sulaswatty, M.Eng 3. Dr. Idwan Suhardi (Advisor – RISTEK) 4. Prof. Dr. Mukhtasor (National Energy Council, Chairman Indonesian Ocean Energy Association (INOCEAN)) 5. Dr. Erwandi (Director BPPH-BPPT) 6. Dr. Wahyu Pandoe (BPPT) 7. Ir. Agus Cahyono Adi, M.T. (Secretary for Research ESDM) 8. Dr. Susilohadi	1. To consolidate materials collected by Aceh Mining and Energy Office and State Electricity Company 2. To identify suitable contacts for driving policy making in sustainable energy 3. To observe Aceh provinces energy requirements (quantity and patterns) in urban, remote rural, and island areas	4. Energy should enable local community (urban, remote rural, and island) to meet basic needs and increase productivity, therefore selection of appropriate to supply energy from renewable resources is crucial 5. Incorporation of appropriate technology development (human and technological) in energy policy is of paramount importance to ensure sustainability 6. Marine energy is one of the biggest gaps in resource analyses for Aceh province

	 **Figure 4-37: Workshop INOCEAN, Jakarta 1**  **Figure 4-38: Workshop INOCEAN, Jakarta 2**		(Director PPPGL ESDM) 9. Drs. Yanuardi (Deputy Chairman INOCEAN) 10. Dr. Ir. Aryo Hanggono (Deputy Chairman ASELI 11. Dr. Rudi Waluyo (ITS) 12. Irfan Syarif Arief ST., MT. (ITS) 13. Zamrisyaf (State Electricity Company - PLN) 14. Agung Iswadi, S.Si., M.Sc (INOCEAN) 15. Dr. Ir. Agus Puji Prasetio (Assistant Deputy, Ministry of Research and Technology)		

3	**Workshop with UNAS** **Jakarta, October 2012**  **Figure 4-39: Meeting, National University, Indonesia (UNAS) Jakarta** **Workshop with UNAS** **Jakarta, May 2013**  **Figure 4-40: Meeting UNAS, Jakarta 2** **Workshop with UNAS** **Jakarta, October 2013**	UNAS	1. Deputy Rector: Drs. Faldy Rasyidie 2. Director of International Cooperation: Dr. Sugardjito 3. Dean of Faculty of Science and Technology: Ir. Ajat Sudrajat MT 4. Deputy Dean of Faculty of Science and Technology: Cahyono, ST, MT 5. Head of School of Physics: Ucuk Darusalam ST, MT 6. Head of School of Electronics: Fuad Djauhari ST, MT 7. Head of School of Mechanical Engineering: Masyudi ST 8. Faculty members: 9. Dra. Purwatiningsih, MSi 10. Endang Retno Nugroho, SSi 11. Achmad Jayadi	1. Renewable energy development in UNAS (biodiesel and hydrogen) 2. EPB (Eco Power Booster) 3. MoU follow up, to MoA 4. Potential research collaboration	1. UNAS can take leadership in building indigenous capabilities in the sector of applied sustainable energy technology, economy, and policy. 2. RGU in partnership with UNAS can then initiate collaborative work with other Indonesian universities with similar intent in strengthening in-country expertise and accessing further support for knowledge exchange.

	 **Figure 4-41: Workshop UNAS, Jakarta**		ST 12. Prof. Budi Santoso 13. Fitri Handayani, SSi, MSi 14. Drs. Muzilman 15. Edi Arifin, Dip.Ing 16. Drs. Karsono MSc 17. Dra. Diah Widiastuti		
4.	**Workshop with DFID and EC Jakarta, October 2012** **Workshop with DFID and EC Jakarta, May 2013** **Workshop with DFID and EC Jakarta, October 2013**  **Figure 4-42: Meeting, DFID, Jakarta**	EC ASEAN, Brunei Darussalam, Timor Leste DFID	1. Funding and programme developer: Muammar Vebry, EC Jakarta 2. EC Programme Manager : Ilarius Wibisono 3. Senior Energy and Climate Change Advisor: Dr. Paul Chambers 4. Asih Budiati	EC 1. EC's framework for collaboration with ASEAN 2014-2017 2. Funded work packages for sustainable energy policy, strategy, and implementation development in South East Asia DFID 1. DFID's framework for collaboration with Indonesia 2. Marine energy development support mechanisms 3. Timeline and fund allocations for Rapid Response Fund	Sustainable energy policy strategy for South East Asia as climate change mitigation measure Appropriate technology for sustainable energy Special expertise for vulnerable societies and emerging nations

4.3.3 Interviews

As part of the fieldwork (refer to Table 4-7), to answer RQ4 and RQ5, informal interviews were carried out to determine the results intended by policy makers, the perceptions of implementing agents, and the expectations of target groups on sustainable energy initiatives and programmes. Within the duration of this PhD research study, the researcher has interviewed relevant sustainable energy policy formulation and appropriate technology implementation actors and stakeholders at sub-national (Aceh), national (Indonesia), and regional (South East Asia) levels as summarised in Table 4-8.The results of these informal interviews were recorded as note summaries by the researcher and were incorporated in the analysis section of this thesis given in Chapter 5.

Table 4-8: Actors and stakeholders interviewed

Roles	People interviewed	Number of people
- Chairperson, The Advisory Council to President of Indonesia - Head, President's Delivery Unit for Development Monitoring and Oversight - Director, President's Delivery Unit for Development Monitoring and Oversight - Chairperson, Indonesian Ocean Energy Association; Unit Head, Indonesian Energy Council - Deputy Minister, Indonesian Ministry of Research and Technology	Prof. Dr. Emil Salim Prof. Dr. Ir. Kuntoro Mangkusubroto Dr. Yanuar Nugroho Prof. Dr. Mukhtasor Dr. Agoes Hoetman	5
- Aceh Governor 2007 – 2012	Irwandi Yusuf	1
- Advisor, Aceh Governor (2007-2012); Director, UNDP-AGTP (2012-2013) - Special Envoy, Aceh Governor (2007-2012); Director, Aceh Green (2007-2012); Director, Strategic Resources Initiative (2012-present)	Ilarius Wibisono Yakob Ishadamy	2
- Office of Mining and Energy - Office of Marine and Fisheries - General Manager, Aceh PLN (State Electricity Company) - Director, Environmental Impact Agency (BAPEDAL)	Teuku Syakur Ahmad Syakur Sulaiman Dr. Yunardi	4
- GAM commanders	2 persons – anonymous	2
- GAM combatants	4 persons – anonymous	4
- Village leaders - Ujung Pancu - Terangengon - Sabang	 2 persons – anonymous 2 persons – anonymous 3 persons – anonymous	 2 2 3

- Village community members - Ujung Pancu - Terangengon - Sabang - Beurenut - Lampanan	4 persons – anonymous 3 persons – anonymous 2 persons – anonymous 2 persons – anonymous 2 persons – anonymous 2 persons – anonymous 3 persons – anonymous	4 3 2 2 3
- Union secretary, Panglima Laut - Union deputy secretary, Panglima Laut - Panglima Laut Ujung Pancu	Umardi Muslahuddin 1 person - not named	3
- Local and International NGOs	Geumala Yatim Hendri Yuzal Zulfan Herman Bakti Thomas Fricke	5
- Academics (researchers, lecturers)	Dr. Dirhamsyah Tadjuddin Syamsu Hanafi Bakhtiyar Dr. Sugardjito	5
- Students	Akram 5 persons - not named	6
- Business leaders	Nusa Andaman Teuku Rafly	3
- Senior Advisor, UK Climate Change Unit (UKCCU) - DFID - DFID - Programme Manager - Disaster Management, Border Management and Climate Change, European Commission - United Nations Development Programme (UNDP) - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	Dr. Paul Chambers Asih Budiati Arum Sari Muamar Vebry Vera Adriana Adrisman Taher	7
TOTAL		67

4.4 Summary of Chapter 4

<u>Answering RQs for Objective 2</u>

To answer the research questions collated for Objective 2, summaries of interviews, workshops, observations, and desk based data gathering have been presented in chapter 4.

RQ 4: What are the existing components of sustainable energy generation and distribution systems in Aceh?

The components of sustainable energy generation and distribution systems existing in Aceh are given in Summary of site surveys, Recorded workshops and formal meetings with Aceh Stakeholders (Table 4-6); Recorded workshops and formal meeting with Indonesia Stakeholders (Table 4-7); Actors and stakeholders interviewed (Table 4-8).

RQ 5: What sustainable energy policies exist or are currently applied in Aceh?

The sustainable energy policies existing in Aceh as a sub-nation and Indonesia as a nation are discussed in Policy statements' activity/plan and target sector (Table 4-3); Policy measures' activity/plan and target sector (Table 4-4); Official and/or commissioned reports (Table 4-5).

5 Analysis

Time does not forget what time helps to forgive.

“My voice will be louder from below than on earth”

(Tan Malaka)

5.1 Introduction to chapter five

Analysis is described as the process of separating any whole into its parts, examining those parts to explore and explain their nature, proportion, function, and relationships (Ueda 2001). To answer the research questions (RQs 6 and 7) collated for Objective 2, the results of document review and fieldwork presented in sub-sections 4.3.1 and 4.3.2 were analysed in chapter 5 using a combination of methods as selected in Table 2-4. The analyses performed include: statistical analysis (SA) (5.2.1), numerical modelling (NM) (5.2.2), cost benefit analysis (CBA) (5-166), language, object, and analysis (5.3.1), and actor analysis (network analysis and stakeholder analysis) (5.3.2). As part of these analyses, project reports have been published by Aceh Green Secretariat for the UNDP and the Aceh Government addressing Aceh sustainable energy outlook (Owen and Garniati 2012a) and off-grid action plan (Owen and Garniati 2012b). The technology and policy assessments which have been performed as parts of the two reports are summarised in sections 5.2 and 5.3, grouped according to their quantitative or qualitative natures.

Objective 2

Critically assess existing sustainable energy technology and policy in Aceh and analyse the role of relevant actors and stakeholders in the problem system of vulnerable societies.

RQs for objective 2

6. What are the unsolved problems under the current sustainable energy policies and technology implementation?
7. Who are the relevant stakeholders and actors with roles within a sustainable energy problem system?

The structure of chapter five is explained through a flowchart given on Figure 5-1 overleaf. Sections are linked to each research question it answers and to other contributing sections.

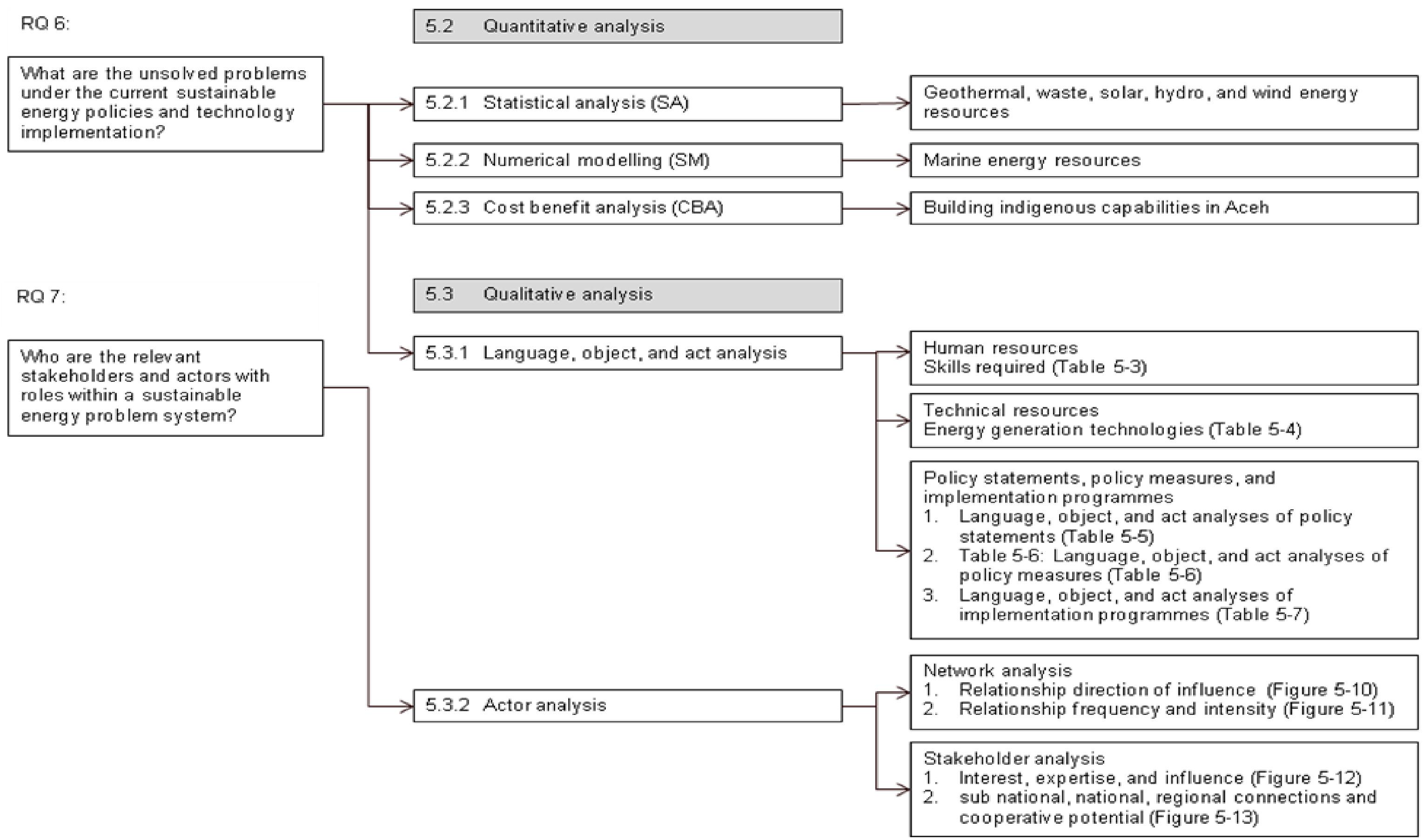

Figure 5-1: Flowchart of chapter five

Energy use

In general, energy utilisation for the whole Aceh Province is minimal and is at a level, which is currently insufficient to meet day-to-day basic necessities. At present, energy resources that are used consist of biomass, diesel, kerosene and liquefied petroleum gas (LPG). Combinations of these energy sources are used for lighting, cooking, and transport fuels. Different from the on-grid rural or urban areas, the main issue in most of Aceh's remote areas is not how to reduce energy consumption but how to provide secure access to, and improve the availability of reliable sources of energy. As with both the urban and rural on-grid areas, the remote off-grid regions will also require a robust numerical model to project the temporal and spatial profile of future energy demand. This model must be developed with the same expected quality and standards of performance, which enable decision makers to prioritise investment and strategy for access to sustainable energy.

Energy distribution

Similar to that of rural on-grid areas, the issue of energy distribution in remote off-grid areas in Aceh is currently addressed by the government, academic, and business communities with a heavy focus on electricity. However, this should be widened to include the distribution of biofuels too. Since extending grid networks to these off-grid villages may create significant financial challenges to the government, establishing energy storage mechanisms for on-site generated renewable energy is seen as more appropriate in ensuring local energy security until further grid expansion becomes more feasible. Reassessment of this situation needs to take place with regular intervals to determine appropriate strategy in energy distribution based on future constraints and requirements.

Energy generation

Generation of energy in remote off-grid areas need to focus on providing access to the right format of energy in a quantity that is sufficient to sustain basic living requirements whilst at the same time increasing the capacity for producing economically valuable goods. Water provision is often interlinked with the availability of electricity. Therefore, access to micro generated electricity from a range of renewable resources such as solar, wind, hydro, tidal, and wave power, matched with appropriate technology for water pumping and cleaning, is considered to be an important minimum standard for a remote off-grid community.

5.2 Quantitative analysis

Quantitative analysis was performed on the natural energy resources, human skills and knowledge, and technical requirements existing in Aceh to indigenously harness sustainable energy resources. These were done through performing statistical analysis (SA) (5.2.1) and numerical modelling (NM) (5.2.2). A quantitative analysis method through CBA (5.2.3) was also performed to provide insights into the financial aspects of creating such an initiative.

5.2.1 Statistical analysis (SA) of geothermal, organic waste, solar, hydro, and wind energy resources

This section was previously published as a report commissioned by the UNDP and Aceh Green Secretariat: OWEN A. and GARNIATI, L., 2012. *Aceh Sustainable Energy Outlook*: *Scoping Report for Aceh Green Secretariat*. Banda Aceh: Aceh Green Secretariat. The contribution of the researcher into the whole report is estimated to be around 50%, consisting of written material for data collection in all sections of the report, partial analysis and conclusions, whilst acknowledgement is given on Dr. Alan Owen’s contribution in proof reading the material, complementing the analysis, and refining concluding remarks. Specifically on geothermal, organic waste, solar, hydro, and wind energy resources in Aceh, the researcher has discussed aspects as is presented in the section 5.2.1 of this PhD Thesis.

As a result of its geographical location, Aceh has the advantage of having a variety of renewable energy resources. According to the results given in sub-sections 4.3.1 and 4.3.2, some of these natural energy sources are already exploited and/or analysed to differing degrees i.e. geothermal, organic waste, solar, hydropower, and wind (Table 4-5). However, four resources have not been evaluated in the report written by PT. Cipta Multi Kreasi (2008), i.e. marine energy, algae bio-diesel, and solar thermal for combined cooling, heating, power (CCHP), and waste heat to energy technologies.

The development of sustainable energy systems requires the robust analyses of available resources. The dataset that supports a substantial report for PLN has been analysed (Perusahaan Listrik Negara 2009) and found to contain significant errors and/or unsubstantiated assumptions leading to the rejection of it as a suitable foundation for decision making. For example, the graph below shows the claimed hydropower potential of various villages in the Bener Meriah Regency (one of the largest regencies in Aceh Province), more than half (13 out of 25 villages) of which are claimed (without explanation) to be identical (Figure 5-2). Similarly, the same villages are found to be exactly the same distance from the existing electricity grid (Figure 5-3).

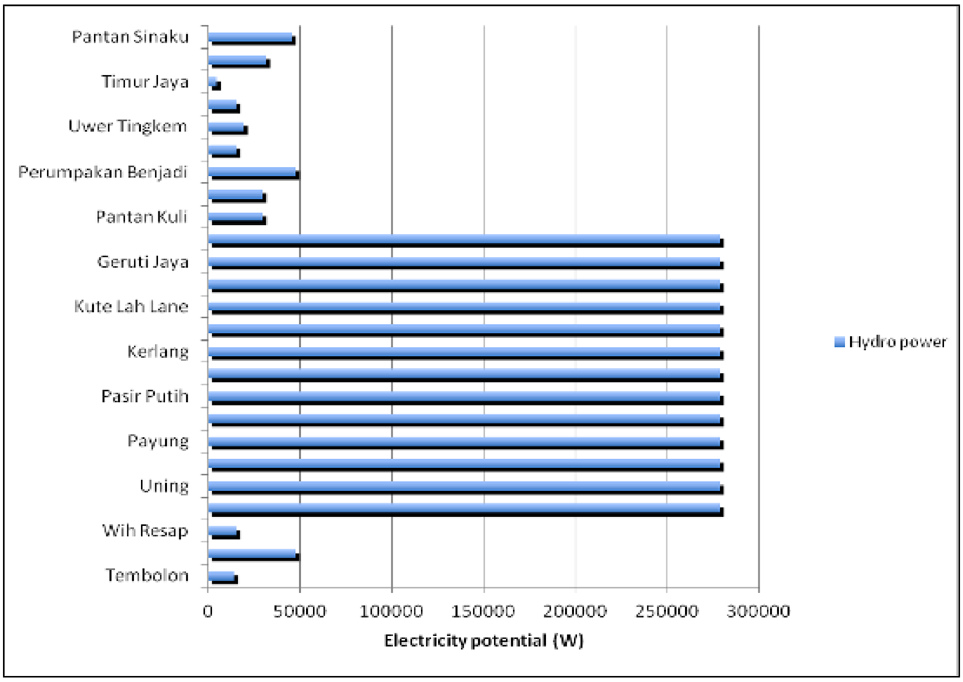

Figure 5-2: Hydropower potential of villages in Bener Meriah regency

(Adapted from PT. Cipta Multi Kreasi 2008)

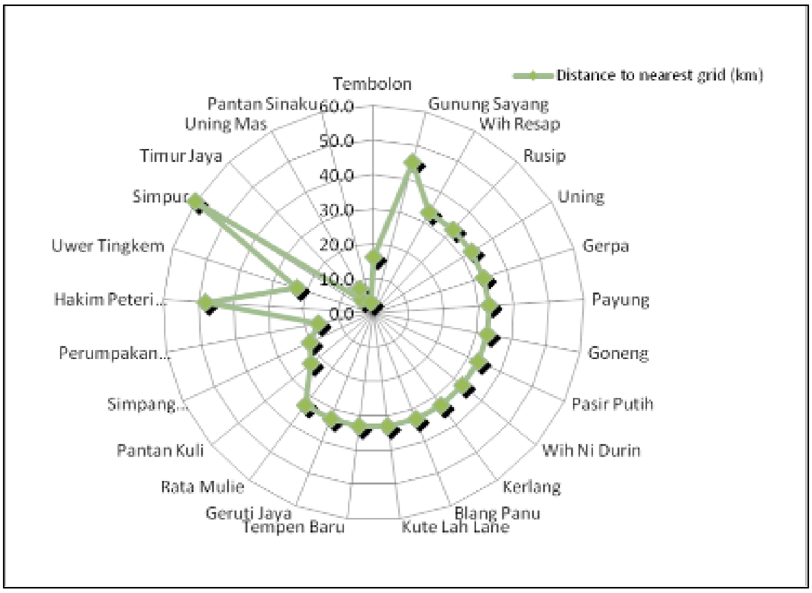

Figure 5-3: Distance from grid (adapted from PT. Cipta Multi Kreasi 2008)

Therefore, given the credibility required for future investment, the research is unable to support the use of the PT Cipta Multi Kreasi (2008) report for decision making purposes, and hereby re-iterate that new work must be undertaken.

Due to the lack of rigor in the preparation of datasets made available for analyses through existing reports provided by PT Cipta Multi Kreasi (2008), the following assessment of the current situation in Aceh was conducted with complementary information (e.g. resources potential, distribution constraints, and existing energy prioritisation) based on observations undertaken during site visits, interviews with policy makers, implementation agencies, local communities as end users, and other secondary data taken from scientific publications as referenced in related sections.

Geothermal & waste resources

Based on document review (Table 4-5) geothermal and organic waste as sources of energy (from farming and/or urban domestic activities) are believed to have been analysed and are seen as potential energy resources to generate base load electricity in urban areas and in rural, coastal, and/or islands in Aceh Province where the State Electricity Company (PLN)'s grid exists (PT. Cipta Multi Kreasi 2008). It is understood that proposals have been submitted for the utilisation of these resources and Aceh should further carry out detailed feasibility studies on determining likely energy yields, optimum sites and connection to distribution networks.

Until April 2014, there is only one development site for geothermal which has progressed close to a tendering stage, and no progress was found for any organic waste site development. For the one geothermal proposed site (Seulawah Agam), the Aceh Government through the Indonesian central Government was indicated to have received financial support from Germany (interview with officials in ESDM; Table 4-8). However, it is observed that the pace in geothermal development in Aceh is notably very slow. This may have been caused by any number of factors in combinations, including the change of Aceh Provincial Government in 2011, which may have initiated chains of effect.

5.2.1.1 Solar resources

Solar energy (both ultra-violet and infra-red spectra) is considered to be one of the most readily and constantly available energy resources throughout Aceh. It can be used to generate electricity from the ultra-violet spectrum and heating from the infrared spectrum. In addition, the infrared spectrum can also be utilised to create cooling inputs. As cooling systems are amongst the largest energy demand drivers in urban areas, a study is underway to investigate the feasibility of utilising solar thermal directly into cooling, bypassing the electricity generation stage. This would lower the demand for electricity for cooling and allow for the replaced electricity to be used for other electrically powered equipment.

From interviews during workshops and meetings (Table 4-6), it is understood that to start up solar energy generation in Aceh, licences have been issued by the Aceh Government through ESDM as the province's regulatory body in energy resources management. However these licenses to develop solar energy sites have not materialised in actual power plants and/or other energy generating facilities being built. Communications with ESDM authorities (Table 4-8) in the province have confirmed that foreign investments are associated with these proposed development sites. Whilst new investors (most of these new applications come from local investors) cannot develop those sites as the licenses to operate in those locations are already owned by other private companies, these private companies (until April 2014 are all foreign investors) have done nothing to develop those highly potential sites. In such cases, the progress of solar energy generation sites are hindered by the Despite this non ideal situation, the Aceh Provincial Government has indicated that through legal procedures, these unused licenses are able to be revoked and taken back after 3 years of non-productivity.

Table 5-1: NASA monthly averaged weather data for Banda Aceh (GAISMA, 2012)

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Insolation, kWh/m²/day	5.32	5.97	5.97	5.75	5.08	5.09	5.04	4.97	4.72	4.61	4.39	4.45
Clearness, 0 – 1	0.57	0.6	0.58	0.55	0.5	0.51	0.51	0.49	0.46	0.46	0.47	0.49
Temperature, °C	27.01	26.88	27.02	27.3	27.89	27.99	27.76	27.56	27.12	26.72	26.54	26.86
Wind speed, m/s	5.65	4.53	3.61	3.13	4.02	5.38	5.01	5.42	4.64	4.01	4.14	5.71
Precipitation, mm	256	114	117	139	143	84	95	90	161	200	225	321
Wet days, d	8.5	5.9	7.8	8.8	12.4	10.3	9.2	10.6	12.5	15.5	14.3	12.7

Solar energy up to 6kWh/m^2 per day (Table 5-1) is easily accessible in urban, rural, coastal, and island areas of Aceh. However, further site dependent technical assessments need to be performed for assisting decision makers in selecting the most appropriate technology and adaptation strategy of harnessing solar energy.

5.2.1.2 Hydropower resources

Annual rainfall in Aceh varies from around 1.7m in Aceh Besar, 1.4m in Aceh Utara and 3.3m in Aceh Barat Daya (Hutcheon 2005), giving an indication of the likely best sites for hydro exploitation. Streams and small rivers as water resources are obviously available in many of off-grid rural villages as identified by PT. Cipta Multi Kreasi (2008), primary data collection through site observation, and desk based map reading. However, the associated total potential concluded in the report is flawed due to the unreliable information presented for Bener Meriah Regency. Further work is therefore required to assess the realistic hydropower resource availability and magnitude for Bener Meriah as well as other regencies in Aceh Province. In spite of this quantification reliability issue, the availability of flowing water with water debit and head availability as a dominant feature found in these regions means that pico-hydropower is considered to be one of the most appropriate technologies to harness water for electricity generation. A university in the province, Syiah Kuala University has designed, built and installed a 1kW cross-flow, undershot turbine (Figure 5-4 and Figure 5-5) that has produced electricity consistently at its rated capacity since late 2011. This demonstrates that the skill-sets for local pico-hydro power production are available internally in Aceh, just not yet in sufficient quantity for the rapid expansion required.

Figure 5-4: Syiah Kuala University engineering staff and students evaluate a small rural site

5.2.1.3 Wind power

Wind power is available in many areas of Aceh, varying with terrain and vegetation cover and frequently highly turbulent due to significant physical and thermal flow disturbances. Wind speed data are available but is not consistent for all areas Aceh-wide. Simeulue Regency in Aceh is the only one reported to have the potential for wind energy by PT. Cipta Multi Kreasi (2008), in which all the 24 villages in Simeulue Regency have the exact same energy potential from wind of 0.08 kW/m^2. Again because of the report's doubtful data quality, existing energy potential analysis from Aceh cannot be used for decision making. A more robust data collection and analysis to assess the wind energy potential for the area is needed.

A preliminary work done for the new cement factory near Banda Aceh in 2006 (PT. Semen Andalas 2006) suggests a strong range of wind-speeds from 4-8m/s from the North/West quadrant 70% of the time. Other data for Banda Aceh, Meulaboh and Sabang are given in the report and suggest a range from 1m/s to 6.5 m/s, though no indication is given of direction or distribution. Monthly averaged meteorological data from NASA (Table 5-1) suggest typical ranges from 3.1m/s to 5.7 m/s.

Being a proven and mature concept, wind power is highly suitable for utilising appropriate technology based on local materials and expertise. Once more, Syiah Kuala University has demonstrated a clear lead in this field compared to the other locally operational academic institutions in the province, by designing and testing a locally manufactured micro wind turbine to capture the wind resource in Banda Aceh site (Figure 5-6).

Figure 5-5: Syiah Kuala engineer checking the new 1kW turbine

Figure 5-6: 5kW wind turbine from Syiah Kuala University

The British Wind Energy Association (2012) asserts that an average site wind-speed of 4-5m/s is sufficient to justify the installation of a turbine with energy output appropriate for Aceh's needs, which is below the UK average energy demand. Therefore, based on this basic guideline, Aceh has the opportunity to harness wind energy as part of its sustainable energy generation strategy. However, improvement to the understanding of realistic wind resource is still needed, for example through the identification of existing stations that can be relied upon to produce good quality data sets.

5.2.2 Numerical modelling (NM) of marine energy resources

This section was previously published as a report commissioned by the UNDP and Aceh Green Secretariat: OWEN A. and GARNIATI, L., 2012. *Aceh Sustainable Energy Outlook*: *Scoping Report for Aceh Green Secretariat*. Banda Aceh: Aceh Green Secretariat. The contribution of the researcher into the whole report is estimated to be around 50%, consisting of written material for data collection in all sections of the report, partial analysis and conclusions, whilst acknowledgement is given on Dr. Alan Owen's contribution in proof reading the material, complementing the analysis, and refining concluding remarks. Specifically on marine renewable resources in Aceh, the researcher has discussed aspects as is presented in the section 5.2.2 of this PhD Thesis.

The following analysis was performed based on the results of primary and secondary data collection derived from document review and fieldwork activities as presented in sub-sections 4.3.1and 4.3.2.

5.2.2.1 Marine renewable resources

Tidal Energy - Beginning to address a significant gap in energy resources analysis (Table 4-5), CUSP, Aceh Green Secretariat, and UNDP have undertaken a preliminary tidal current energy resource study in collaboration with Mechanical Lab of Syiah Kuala and local fishing communities in Ujung Pancu. Using tidal height data from the UKHO Totaltide software for 5°17'N 95°12'E Pulau Rusa, 5°34'N 95°17'E Uleelheue and 5°54'N 95°20'E Sabang, it is possible to construct a general tidal height data set over 7 days at 10 minute intervals (Figure 5-7: Ujung Pancu numerical model from tide data). Local knowledge suggests that the stream runs at around 5-6 knots and is roughly 30m deep at its narrowest point. An Acoustic Doppler Current Profiler (ADCP) was deployed at Lat/Long 05^{o} 34.777, 95^{o} 13.322 in approximately 18 m water depth. Assuming an extraction rate of 10% suggests at the channel could drive an installed capacity of 15-25MW.

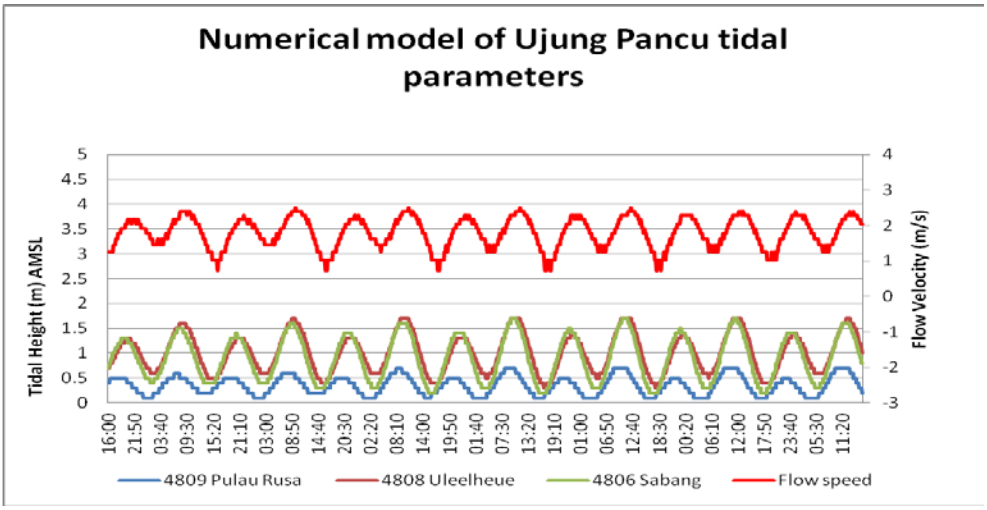

Figure 5-7: Ujung Pancu numerical model from tide data

The gravity (*g*) driven velocity (*U*) through a channel of length (*L*) due to head difference (*h*) through a water depth of (*z*) and a seabed drag coefficient of (C_D), can be approximated by equation 1.

$$U = \sqrt{\frac{zgh}{C_D L}}$$ ....Equation 1

This approximation gives a conservative estimate of flow velocities for the site of up to 2.5 m/s which is of the same order of magnitude as a report by Sea Defence Consultants (2009). Given that the channel is approximately 400m wide, and taking the density of seawater to be 1025kgm^{-3} gives an average power flux (over the tidal cycle) through the channel of around 200MW +/- 25%. Assuming an extraction rate of 10% suggests that the channel could drive an installed capacity of 15-25MW.

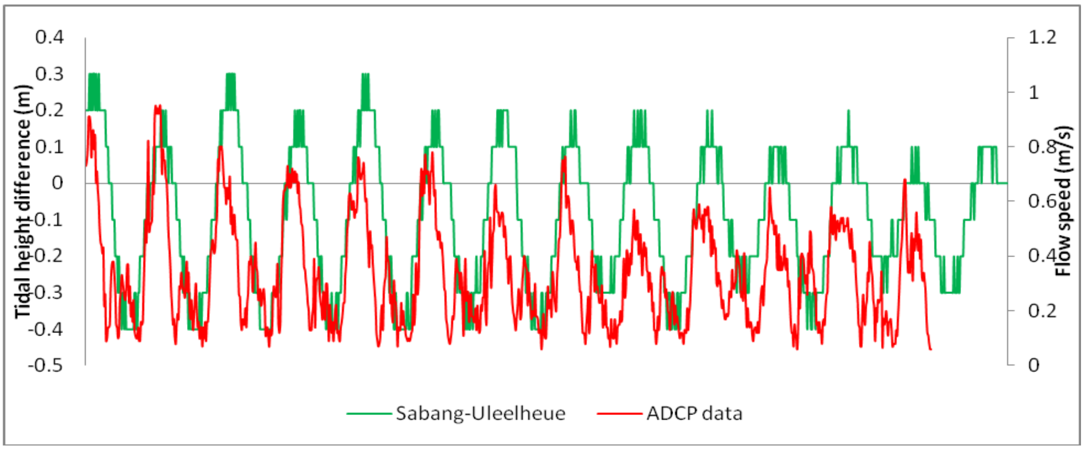

Figure 5-8: Comparison of numerical model with ADCP data

The numerical model clearly fits well with the ADCP data (Figure 5-8) in terms of pattern (including picking up the reflected wave effects thought to be induced as the tidal wave echoes between Sabang and mainland Aceh. The magnitude varies but this is likely to be due to the ADCP not being in the main flow area.

The 7 days of ADCP data were retrieved and transferred to .CSV format for post processing. The data include flow velocity components, East North Up (ENU), temperature and pressure, though these latter two parameters have no real bearing on the energy availability. Depth averaging of the data over each 10 minute sample gives a data pattern from the ADCP data that equates to the difference in tidal height data from the two neighbouring ports closest to the site. The ADCP was, for operational reasons (mainly depth and crew knowledge) positioned to the north of the main flow, thus not being subject to full flow conditions. Figure 5-9 indicates that the flow at the ADCP site is subject to considerable twist, with a 45^{o} variance between the surface flow and the seabed flow.

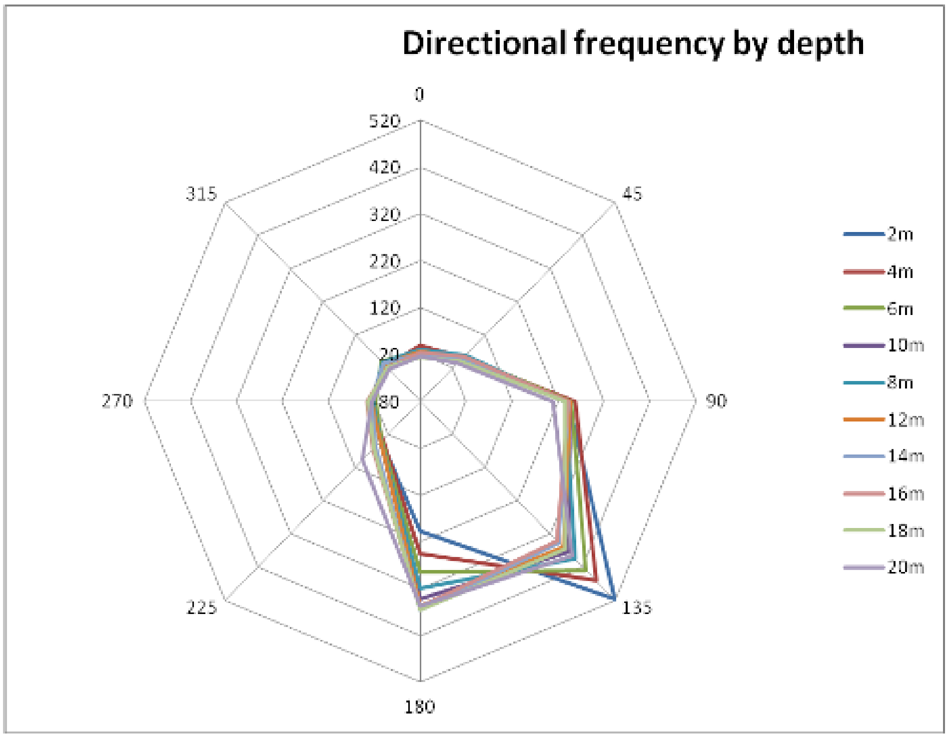

Figure 5-9: Directional frequency

This preliminary work suggests that there are other potential sites in Aceh which needs to be analysed for tidal energy

Wave energy - According to modelling work carried out by Sea Defence Consultants (2009), wave energy is a strong potential energy source along the entire west coast of Aceh. Utilising the data given, it is indicated that a 1.5m wave height exceedency of approximately 70% equating to a wave power density of 25-65kW per linear meter. The consistency of direction found for the western coasts of Aceh is also a beneficial feature for designing wave energy systems. Comparing this with UK data (BERR 2008) suggests that Aceh has a wave energy resource on a par with the UK resource, which is considered to be one of the best in the world.

Offshore wind – Based on the model produced by Sea Defence Consultants (2009), there are some areas in Aceh which have the potential for offshore wind, particularly off the northernmost tip. There are areas within these identified potential locations, where the water depth is sufficiently shallow to permit anchorage points to be inserted. Offshore wind resource is generally stronger and of more consistent quality than onshore wind resource, though cost of power generated is generally higher. However, offshore wind development requires complex engineering requirements, both in manufacture and installation of offshore wind device. This suggests that exploitation of this resource would be better kept back for future development.

Other sources of information on wave, tidal current, and offshore wind energy potential around Aceh, is found within nationwide marine energy resource assessment reports. Supported by RISTEK and INOCEAN, the UK Climate Change Unit for Indonesia (UKCCU), which consists of UK Department for International Development (DFID), Department of Energy and Climate Change (DECC), and the Foreign and Commonwealth Office (FCO) has funded a Feasibility Study of Marine Energy in Indonesia. However, the findings of this report are at present confidential and unable to be presented until it is ratified by both the Indonesian Government and approved by the funding bodies involved (estimated to be published in November 2014).

5.2.3 Cost and benefit analysis (CBA) of building indigenous capabilities in Aceh

Utilising the results of document reviews and field work given in Sub-sections 4.3.1and 4.3.2, a simplified CBA was performed to assess the feasibility of building sustainable energy indigenous capabilities in Aceh. The proposed scheme focuses on the long-term development of indigenous business and manufacturing capabilities using renewable energy technology (wind, pico-hydro, and solar) as a central theme. A range of renewable energy technologies is available and preliminary work has demonstrated the availability of the required natural and human resources in Aceh. Within the context of Aceh, the proposed initiative is intended to link together the principal educational institutions, the business community, national electricity supply, and relevant government departments to initiate and expand a fully costed, business based proposal that will re-invest its own profits back into further research and business developmental works. The proposed scheme has two distinct phases:

- Phase 1: Design, build, install wind, pico-hydro and solar technologies to create an income stream via the agreement with PLN to purchase any power generated from renewable resources. Establish CUSP-RGU office in Banda Aceh for project management and capacity building.

- Phase 2 onwards: Continue with Year 1 activities and use the increasing income stream to match fund proposals for wave, tidal, biomass/gas, fish farm and clean water technology streams.

The stakeholders involved in this proposed initiative are:

- Academics: UNSYIAH, PA, POLIVEN
- Aceh indigenous community: Represented by SRI
- Aceh provincial government: Represented by the Governor's Office and Aceh ESDM
- Aceh business community: Represented by Aceh PLN
- External input for capability building: CUSP-RGU

This sub-section presents the initial budget requirements and the projected financial returns for establishing an indigenous renewable energy technology manufacturing capabilities in Aceh. Other benefits (i.e. break of social tension/conflict cycle, energy security, political stability, environmental health) are not included in this PhD thesis analysis, but will be presented separately as part of a detailed project proposal. Overall, this proposed scheme is analysed based on the following considerations:

- Technology is to be designed, manufactured, and maintained locally in Aceh.
- Advisors proposed to come from CUSP-RGU are to provide technical and strategic input in developing in-house capabilities at resource assessment, design, manufacture, installation, operation, monitoring, and maintenance stages for identified renewable energy technologies. Advisors are to be based in an office located in Aceh to maintain well-grounded networks.
- Renewable technology production is to be selected based on appropriateness, and phases of available local natural, human, technological, and financial resources (solar, wind, and hydro initially to generate maximum financial gains, followed by tidal and wave as pilot projects).

An agreement has been reached with PLN that they will purchase renewable energy at a rate of 1,000.00 IDR per kWh (price quoted in October 2013). Assumptions used in this income projection are based on the following two phases:

Phase 1

1. Solar PV panels (income calculated per 1 hectare of PV panels);
2. Wind turbines (income calculated per 1 turbine);
3. Micro hydro turbines (income calculated per 1 turbine).

Phase 2

1. Tidal devices (cost calculated for feasibility study and demonstration deployment);
2. Wave devices (cost calculated for feasibility study and demonstration deployment).

A summary of this initial budget is provided in Table 5-2. Detailed assumptions and calculations used in the financial analysis are given in Appendix 9.2.

Table 5-2: Summary of expected costs and return

Heading		Year 1	Year 2	Year 3	Year 4	Year 5
		USD	USD	USD	USD	USD
Staff time		$137,168	$197,151	$252,400	$314,420	$314,420
Equipment		$660,800	$66,080	$66,080	$66,080	$66,080
Materials		$1,141,025	$2,282,050	$4,703,075	$7,104,100	$7,448,920
Building		$400,000	$40,000	$40,000	$40,000	$40,000
RGU input		$524,080	$533,519	$514,227	$563,842	$588,775
Total Cost		$2,863,073	$3,118,800	$5,575,781	$8,088,442	$8,458,195
Income	PV	$375,430	$1,126,291	$2,628,011	$4,880,592	$7,133,173
	Wind	$308,322	$924,966	$1,849,932	$3,083,220	$4,563,166
	Hydro			$135,155	$405,465	$810,929
Total Income		$683,752	$2,051,257	$4,613,098	$8,369,277	$12,507,269
Return		-$2,179,321	-$1,067,543	-$1,097,838	-$124,629	$3,238,145

Having established a viable business model in Phase 1, Phase 2 will further extend the indigenous capacity and capability by performing further feasibility studies and developing new areas of energy generation applicable to resources available in Aceh. Investigative work in May 2012 shows that Aceh has a potentially large marine resource (wave & tidal) as well as biomass/gas. CUSP-RGU costs as initial advisors are clearly defined and deliverables discussed in the main project document. The CUSP-RGU members of staff are expected to be present in Aceh for extensive periods in order to provide consistent support for the duration of this indigenous capacity building project.

Based on this cost model, the largest single cost centre is that of fabrication materials for the production of wind, pico-hydro, and solar energy generation devices. However, these will only be purchased once an order or generation site is confirmed, thereby minimising the commitment risk. Building the indigenous renewable energy technology manufacturing capabilities centre itself and equipping the workshops, teaching areas and accommodation are significant, but is largely a one-off costs in Year 1. Further on, local staff will need to be recruited and trained on an incremental basis. As the main outcome of this CBA, the early stage investment for building business and manufacturing capabilities using renewable energy technology in Aceh is of the order of 3-5million USD and the venture is expected to be profitable by year 5.

5.3 Qualitative analysis

As part of the qualitative methods for performing the second part of technology and policy assessment, results presented in Sub-sections 4.3.1 and 4.3.2 were analysed using the language, object, and act analyses in policy formulation and implementation. To date, data acquisition through and comparative analysis with other vulnerable societies has not been obtained. Difficulties arise from locating and accessing published reports available for vulnerable societies through desk studies. Ongoing correspondence and long-term contacts with organisations working in those sensitive areas are being established for access to publications that are not available online and for access for conducting field work as primary data collection method. This process and its results will not be presented as part of this PhD thesis, but will become a major component of future work in taking the conclusions of this PhD research further.

5.3.1 Language, object, and act analyses

Data collected through document review and fieldwork (observations, workshops, meetings, and interviews) were processed towards language, object, and act analyses following the procedure listed below:

- Texts in policy, policy measure, and implementation programme - related documents, were summarised by grouping their meanings according to the different understandings of each stakeholder group. These meanings were then categorised into groups and labelled as policy makers, implementers, and target groups' perceptions;

- Texts contained in other document types were summarised and grouped according to the issues they discuss and categorised into the main topics. They were then cross-referenced with the information collated through interviews;

- Intensities of meanings were also interpreted by the selections of words strata used in verbal and written communications;

- Symbols, logos, and other attributes found in documents, within proximity of actors, or found within a site being observed were used to associate individuals with existing groups of stakeholders;

- Indonesia and Acehnese have different levels of formal languages which determine the position of the speaker in relation to the other party. The language syntax and grammar used in verbal communications and/or written documents, therefore provide information on quality of analysis and the hierarchical relationships between actors involved;

- Gestures and other non-verbal communications were observed amongst actors themselves and between the actors and the researcher. This is used to assess if or to what level interviewees were comfortable to what was being discussed, and where to direct the next sets of conversations towards.

5.3.1.1 Human resources

Human resources have as significant role to play as the natural energy resources in determining the success of establishing sustainable energy generation and distribution systems. Following the main areas of human resources assessment discussed by the International Labour Office and European Union (2011, for the purpose of this PhD research, components of human resources discussed consist of: technical skills, adaptation aptitude, knowledge transfer methods, frame of mind and paradigm setting. Based on site meetings, workshops, and interviews with Acehnese stakeholders (Table 4-6 and Table 4-8), to promote ownership and to minimise dependency on external agencies, the energy generation systems need to consist of appropriate technology and, wherever possible, any fabrication/installation works should be undertaken by the local communities themselves.

At present the main skill set suppliers in Aceh are: UNSYIAH, PA, and POLIVEN. Based on workshops conducted with academic and vocational education providers in Aceh (Table 4-6), there are existing capabilities within Aceh through programme studies currently available in UNSYIAH, PA, and POLIVEN. Matching these existing skill sets against the required skill set to develop a renewable energy implementation scheme and supply chain (ILO and EU 2011), the skills and provision of training/expertise needed in Aceh fall into the 7 categories shown in Table 5-3Table 5-3: Skills required to develop a renewable energy system in Aceh

(Owen and Garniati 2012)

Subject area	Specific skills
1. Mechanical engineering	Fabrication, machining, welding, hydraulics, system design & optimisation, turbines, hydrodynamics, thermodynamics, resource modelling
2. Electrical engineering	Power generation, transmission, storage, component articulation, system design & optimisation, Smart grid systems
3. Electronic engineering	Power conditioning, system control, Smart grid management, data acquisition
4. Civil engineering	Foundations, structures, lades, soils & geology, roads, access,
5. Marine systems	Workboats, cranes, installation, retrieval, repairs/maintenance, subsea operations
6. Environmental science & GIS	Environmental impact/benefit, site characterisation, water/air/soil quality, resource measurement, bathymetry, topography
7. Biotechnology and Chemical Engineering	Biochemical process design
8. Social sciences	Working with communities, assessing need/impact of power provision, policy, legal aspect, and financing

Based on discussions with Acehnese academic, business, local community, and government sector stakeholders (Table 4-6) these skill set categories required to now be developed according to following path:

- Development for a cohesive group for strategic renewable energy development programmes in Aceh is urgently needed
- Practical skills through pilot projects which enable hands-on experience in manufacture, installation, operation, and maintenance of renewable energy devices
- Professional and research skills through pilot projects with enable hands-on experience in renewable energy resource assessment, environmental impact, business management, and policy making should form the next component of human resources development in Aceh

Data collection through document review (Sub-section 4.3.1) (internal and external desk studies) and fieldwork (Sub-section 4.3.2) (observations, meetings, and interviews) have identified that to develop and embed the necessary skills and knowledge, relevant expertise are seen best to come from individuals trained in polytechnics in urban areas who are then distributed as required to initiate new energy systems and perform the second layer of knowledge transfer to target local communities. As this level of required knowledge/expertise is not, at present, available, some international-local collaborative support mechanism needs to be present for the development of the necessary renewable energy course and/or training material. Looking further ahead, the creation of a renewable energy vocational school should be considered.

5.3.1.2 Technological resources

Data collection through document review (Sub-section 4.3.1) (internal and external desk studies) and fieldwork (Sub-section 4.3.2) (observations, meetings, and interviews) have identified that Aceh as a nation, already has the knowledge of most of the necessary sustainable energy technologies it needs to develop, though these are often in small pockets (Table 4-5, Table 4-6, and Table 4-8). The principal energy generation technologies appropriate to harness the locally available renewable energy resources are shown in Table 5-4.

This PhD research has identified that the major knowledge gap in Aceh is found in marine energy, algae bio-diesel, and solar thermal for combined cooling, heating, power (CCHP), and waste heat to energy technologies. It is also seen that in Aceh, there is a significant gap between sustainable energy policies and implementation of appropriate sustainable energy technologies. An iterative feedback mechanism between strategic plans and implementation should act as the interface to bridge in this highlighted gap. The mitigation actions should take place in practice at community levels and business sectors, with competent field operators acting as buffers and mediators.

Table 5-4: Energy generation technologies (Owen and Garniati 2012)

Technology	Output
1. Wind turbine, pico/micro hydro, solar PV, marine, geothermal	Electrical power
2. Solar thermal (flat plate, thermal mass, parabolic)	Heating/Cooling
3. Cassava bio-ethanol, algae bio-diesel, waste and biomass for heat	Bio-ethanol/diesel, combustion heat

On the other hand, the actual capability of the existing electricity distribution grid and the performance of its generator network are poorly understood. This therefore highlights the importance of further work to be undertaken as an attempt to understand the issues surrounding quantification of generation capacity and outputs. The system cannot be accurately modelled if the parameters vary by significant amounts. In Aceh, understanding grid capacity is one of the fundamental knowledge gaps to be bridged for renewable energy projects being bankable.

5.3.1.3 Policy statements, policy measures, and implementation programmes

Furthermore, policy statements, measures, and implementation programmes from Governmental and Non-governmental agencies collected through document review (Sub-section 4.3.1) (internal and external desk studies) and fieldwork (Sub-section 4.3.2) (observations, meetings, and interviews), were also analysed using language, object, and act analyses (LOA).

Only a proportion of the results intended by policy makers through policy statements, policy measures, and implementation programmes are achieved. LOA has identified that these are potentially caused by disconnects between policy makers' intention and the differing perceptions of implementers and expectations of the target groups. These disconnects are given as summaries in Table 5-5 (for policy statements), Table 5-6 (for policy measures), and Table 5-7 (for implementation programmes).

At the national scale, through the Presidential Decree 2006, the Indonesian Government has put in place a policy on developing biofuels and geothermal energy (5% of energy mix should come from biofuel and 5% from geothermal by 2025). The Indonesian Government has also targeted increase of electrification from 64% in 2009 to 95% by 2025 (Table 5-5). In Aceh, through the Aceh Green policy statement, financed public-private partnerships for infrastructure, urban development, and clean energy are seen as means to achieve sustainable livelihoods for the people of Aceh. Where implementers concentrate on managing distribution and energy security for integrated sustainable development objectives, target groups' expectations are basically around equal and reliable access to electricity and liquid fuels.

Indonesia's new Electricity Law has also shifted opportunities for regional and local governments, cooperatives, and private entities to generate power then sell them to PLN. ecurity and distribution management. Energy regulatory policies including tariffs are determined by the Ministry of Energy and Mineral Resources (ESDM). Meanwhile, renewable energy resources development are under the responsibility of the Ministry of Forests and the Ministry of Agriculture. Through the National Energy Council which was established in 2007 (Table 5-6), renewable energy policies at national scale are coordinated between the aforementioned three ministries. Since 2009, through the power purchase obligation, PLN is required to purchase electricity from small-scale (up to 10MW capacity) renewable energy generated by power generator (including cooperatives, local communities, and private businesses). These are all intended by policy makers to increase confidence in the renewable energy sector. However, difficult local situations are seen by implementers to potentially create barriers to the policy goals. Thereby they perceive that there should be commitments of support made available by both national and provincial government to develop local programmes and initiatives in renewable energy. Meanwhile, at the receiving end, the target sectors' expectations largely lie on reliable access to electricity and liquid fuels specifically.

A large number of projects on renewable energy in Indonesia (including some local initiatives in Aceh) are developed through the support of international donors and development aid (Table 5-7). These are intended by policy makers independent producers to enter the market whilst empowering communities to develop their local power generation, and thereby reducing the Government's burden of providing subsidies for fossil fuels. As financing is Indonesia's biggest gaps in developing renewable energy systems accross policy statements, policy measures, and implementation programmes, subsidies to fossil fuel remains to be the cause for distortion in the energy market in Indonesia until the present day. Translated into Aceh as one of Indonesia's province, a policy subsidy reform must take place which allows government budget to provide more support towards the renewable energy development. Policies on renewable energy pricing and power purchase obligations are intended by policy makers to open market for private entities, but implementors may not accurately translate these into policy measures, resulting in less reliable and robust financial incentives at regulatory levels.

In summary, within the scope of Aceh provincial and Indonesian national policy staments, policy measures, and implementation programmes, there is a general tendency for mis-matches between the results intended by policy makers, perceptions of implementers, and the expectations of target groups. The differing levels of breadth and depth of intentions, perceptions, and expectations from each policy statement, policy measures, and implementation programmes are seen to be the major contributor to the areas of disconnects amongst the three.

Table 5-5: Language, object, and act analyses of policy statements

Description of existing policy statements	Level	Target sector	Intended results by policy makers	Perceptions of implementers	Expectations of target groups
Presidential Decree No. 4 of 2010 and No. 5 of 2006 on National Energy Policy and Blueprint of National Energy Management 2005-2025 aims for securing only the supply side.	National	Energy Economy	• Increased oil production • Coal power plant development • Bioenergy development	• Route to achieve energy security • Means of enhancing economic growth	• Reliable access to electricity • Reliable access to liquid fuels
Aceh Green will integrate climate change mitigation themes through renewable energy, land use management, community development, commerce, and conservation.	Provincial	Energy Environment Economy Community	• Environmental sustainability through sustainable livelihoods for the people of Aceh. • Financed public-private partnerships for infrastructure, urban development, clean energy, integrated land use and sustainable agriculture, aquaculture and coastal fisheries, reforestation, and avoided deforestation.	• Means of achieving integrated sustainable development objectives • Means of ensuring energy security • Means of strategically managing equal distribution and utilisation of local resources	• Equity in resource allocation • Insurance of welfare from government • Mitigation of socio-political tensions
Provincial General Budget Policies / Budget Planning Priorities document (Kebijakan Anggaran Umum / Plafon Prioritas Anggaran KAU-PPAS) • General policy and	Provincial	Energy Economy Social Cultural Disaster management	• Mid-term Development Plan containing infrastructure management supporting energy resource development	• Financially supported commitment of regional government to development of local programmes and initiatives in energy development	• Funded programmes which benefit local communities

planning framework • Outline of state of economy, revenue, and expenditure • Development policies and priorities					

Table 5-6: Language, object, and act analyses of policy measures

Description of existing policy measures	Level	Target sector	Intended results by policy makers	Perceptions of implementers	Expectations of target groups
Law No. 30 of 2007 on Energy	National	Energy	• Established National Energy Council • Constructed National and Regional Energy Master Plans • Established rules for energy diversification and conservation • Clarified central and local government authority	• Well written and formulated national policy • Lack of confidence in existence of real and committed support for implementation	• Reliable access to electricity • Reliable access to liquid fuels
Regulation No. 26 of 2006	National	Electricity	• Licensed energy generators must ensure energy supply for its operational region	• Unrealistic targets set by national government • Difficult local situations create barriers to goals of policy	• Reliable access to electricity • Reliable access to liquid fuels
Presidential Decree No. 5 of 2006	National	Energy Environment	• Energy diversification • Energy conservation • Renewable energy • Fossil fuel exploration • Environmental impact	• Financially supported commitment of national and provincial government to development of local programmes and initiatives in energy development	• Reliable access to electricity • Reliable access to liquid fuel
Energy and Mineral	National	Green Energy	• Promoted renewable	• Financially supported	• Reliable access to

Resources Ministerial Decree No. 002 of 2004			energy and energy conservation through investments, incentives, business cooperation	commitment of national and provincial government to development of local programmes and initiatives in energy development	electricity • Reliable access to liquid fuels
Energy and Mineral Resources Ministerial Decree No. 954K/30/MEM of 2004	National	Green Energy Social development	• Regional-based energy development • Energy infrastructure development • Community empowerment	• Financially supported commitment of national and provincial government to development of local programmes and initiatives in energy development	• Reliable access to electricity • Reliable access to liquid fuels
Energy and Mineral Resources Ministerial Decree No. 1122K/30/MEM of 2002	National	Distributed generation	• Community participation in small scale energy generation	• Financial and managerial support to develop and start isolated energy systems	• Reliable access to electricity • Reliable access to liquid fuels
Law No. 11 of 2006	National	Aceh Government	• Authority of provincial government for management of all natural resources • Ownership of necessary governmental body to carry out natural resources management • Involvement of local human resources	• Independent decision making in extraction and utilisation of Aceh's natural resources • Knowledge transfer in data acquisition and analysis of natural resources assessments	• Reliable access to electricity • Reliable access to liquid fuels • Independent decision making in extraction and utilisation of Aceh's natural resources

Table 5-7: Language, object, and act analyses of implementation programmes

Description of implementation programmes	Level	Target sector	Important outputs targeted by initiators	Perceptions of implementers	Expectations of target groups
Improved energy efficiency of brick kilns	Provincial	Energy Economy	• Reduced energy requirements and emissions by: Applying alternative energy source for brick kilns (rice husk) Fitting firing holes dampers • Higher productivity and economic competitiveness of local material production	• Method to increase productivity and economic development • Means of achieving emission reduction and environmental protection	• Income generator • Reduction in energy bill
Community based micro hydro projects	Provincial	Energy Environment Economy Community	• More secured energy source • Reduced emissions from using renewables • Community ownership	• Showcase of community based project • Demonstration of micro renewable reliability • Field training for local community and educational institution	• Recreational site • Reliable source of electricity
Biodiesel from coconut waste	Provincial	Energy Environment Economy Community	• More secured energy source • Reduced emissions from using renewables • Community ownership	• Showcase of local business based project • Demonstration of micro renewable reliability • Field training for local community and educational institution	• Income generator • Accessible source of liquid fuel

5.3.2 Actor Analysis

The actor analysis performed for this PhD research consists of: (1) network analysis and (2) stakeholder analysis. Both network analysis and stakeholder analysis are determinant in creating a holistic understanding of the interactions between different groups within the case study's communities which influences implementation of sustainable energy appropriate technology and/or formulation of policy and policy measures.

Data collected through observations, workshops, meetings, and interviews were processed towards actor analysis following the procedure listed below:

- Objects and language found were used to establish relationships between actors
    1. Symbols, logos, and other attributes found in proximity of actors or found within a site being observed were used to associate individuals with existing groups of communities;
    2. Indonesia and Acehnese have different levels of formal languages which determine the position of the speaker in relation to the other party. The language syntax and grammar used, therefore once observed and recorded provide information on hierarchical relationships and directions of influence used in the analysis.

- Relational data were used represent direction, frequency, and intensity:
    1. Signatures on formal documents were used to identify authority and responsibility of certain actors towards certain issues therefore, signifying directions of influence;
    2. Invites sent out on formal and informal meetings were used to determine the frequency at which actors interact with one another and the intensity of their relationships;
    3. Meeting records were used to collate the number of times an actor is present at different meetings and the role the actor plays in each meeting. These were then used as indicators for associating an actor's breadth and depth of involvements in certain issues as their interest, expertise, and influence;

- Information gathered were then grouped and labelled according to their similarities. Contrasting and complementary characteristics were then analysed within each group as well as between different groups.

5.3.2.1 Network analysis

Based on the results obtained through fieldwork (observations, meetings, and interviews) presented in sub-section 4.3.2, an analysis was performed on the relationships between actors who are influential to the PhD research case study. Most of these actors are primarily based in Aceh, but many are also Indonesian and South East Asian based. The network analysis was performed based on the analytical framework given by Hermans and Thissen (2009) and this sub-section focuses discussions on:

1. Identifying relevant relationships between actors;
2. Analysing relational data to represent direction, frequency, intensity to create network structure;
3. Framing/structuring relational characteristics of actors network by creating nodes graph

The relationship represented by line a1 was established from the researcher being embedded as a permanent research employee of CUSP-RGU. This relationship has enabled the research project to be supported with the academic rigour and credibility necessary for a PhD degree. Introduction to the network in Aceh starts with relationships built through lines a2 and a3 where the researcher has interacted with the two primary actors in Aceh through previous sustainable development based projects. Both actors have significant embedded trust held by Aceh indigenous society and also amongst their external counterparts. Both actors have also extended their network to the various academic and business communities in the Acehnese society. The two main actors in Aceh during the time of this project's data collection served as the Aceh governor's technical advisor and special envoy for sustainable development, climate change mitigation, and energy resources management. During the progression of this thesis, the roles of these two actors have changed into the director for UNDP-Aceh Government Transformation Programme and the director of Aceh Strategic Resources Initiative.

Line a4 was established through previous sustainable development programmes conducted in Indonesia. This line of relationship has introduced relationships with the Indonesian academic community, which are built through the involvement of the National University of Indonesia (UNAS). Relationships were also established with the Governor of Aceh and the Acehnese provincial government's department, in charge of all energy resources related matters, signified by the presence of the energy and mining office (ESDM) management team (lines f5 and f8).

Other lines of relationships in the network are connections built with the Acehnese local leaders (e1 – e13), signified by the supports received from a number of 'Panglima Laut' and 'Panglima Wilayah', of Aceh's major districts. It is understood that embedded relationships from these indigenous populations of Aceh's urban, rural, coastal, and island districts have been built by the local actors over for over 30 years, through various sustainable development related initiatives. The network in Aceh started with the involvement of a number of actors in the biodiversity environment conservation movements in the 1980's. It was then extended to the marine environment conservation movements in the 1990s. At present the network is maintained and developed towards the efforts of policy formulation and appropriate technology implementation for sustainable energy resources conservation. The sustainable development network represented in the diagram has gained the trust and support of this very difficult and complex, vulnerable society, withstanding intense periods of civil war and anomies, changes of political powers, and shifts of societal paradigm.

Relationships with the Acehnese academic communities include connections with the directors of Tsunami Disaster Mitigation Research Centre (TDMRC) (d1), Syiah Kuala University (Unsyiah) (d2 and d3), and Polytechnic Aceh (PA) (d4). Meanwhile in the business sector, trust based relationships exist with the Aceh PLN managing director (g4) as well as the owners and senior management teams of two cement factories operating in Aceh (g5).

The Acehnese actors have also extended this network into the Indonesian and South East Asian actors through existing and historical relationships built within the common goals of sustainable development. This extended Indonesian network consists of relationships built with the national government through support received from the Presidential Unit for Monitoring and Oversight and the

Presidential Advisory Unit (f6), the Ministry of Research and Technology (f4), the Indonesian Ocean Energy Association (INOCEAN), and the Indonesian Energy Council (f8). The business sector at the national level is built through the engagement of owners of a chain of data centres and a nation-wide enterprise (g3 and g4). Support from aid funding agencies is gained through relationships built with international based aid organisations operating in Indonesia and South East Asia as a region (c1 - c5).

Relationships' direction of influence

Within their lines of relationships, actors in the network have various degrees of influencing capabilities and directions (Figure 5-10). These influencing directions can be bidirectional, one-direction, or bi-directional but with one stronger than the other. In the Acehnese society, the cultural leadership via the 'Ulama', 'Teuku', 'Panglima Wilayah' and 'Panglima Laut' (e6-313) is the main direction of influence. These directional lines are more influential compared to those of the decision making authorities in the Aceh Provincial Government. This is also found to be the reason why the Acehnese society was at its most stable state when Governor Irwandi Yusuf (an ex GAM freedom fighter) was in government. His position and roles within the network has made the governmental and cultural leadership directionally aligned. Irwandi managed to maintain the directional relationship strong, both through his cultural leadership and also through his formal provincial government leadership.

Historical mentoring roles also provide ways of influencing the directions of relationships. Many of the actors relevant to the network have previous and/or ongoing mentoring roles through academic or professional interactions. These relationships are shown by lines a1, b2 and b3. Based on observations and dialogues with associated actors, one other parameter which dictates the directions of relationships between actors in the network is through historical camaraderie during the time of oppressions. These relationships are shown by lines b1 and e1 – e13. In many cases the ex-combatants chain of command is still effectively the biggest influencing direction in decision making and execution of actions.

Relationships' frequency and intensity

The frequency and intensity of relationships between actors in the network determine the extent and continuity of supports both in principles and in practice (Figure 5-11). The frequency and intensity of particular relationships within the network is especially significant for resource mobilisation. The ability to mobilise resources is a crucial element in starting up and managing a new initiative. Mobilising resources include movements of financial and human capitals between different organisations and/or institutions. Resource mobilisation also includes movement of financial capitals and human capitals within designated activity clusters.

It was observed that the ability to strongly influence resource mobilisation in practice is gained through alignment of vision, embedment of respect, and consistency of loyalty to the actors' land, people, and their trusted network. These signifiers are present in the network as the result of long-term relationship building processes that have been moulded in particular 'vulnerable' situations. These unique circumstances are indeed difficult to replicate, create, or condition. It was also observed and derived from informal interviews that the determining key in engaging with such a network is the identification of the right actors who possess one or more signifiers detailed above. These actors enable entry and provide insight into their individual and/or collective network members by first conjuring initial introductory contacts and sequentially shaping follow up initiative building.

Relationships built with external actors as extensions to the existing local relationships are also an important component to the network. The primary driver for building relationships with national and regional actors is to invite and access political and financial support in realising the local network's internal goals. The ability of external actors to support a vulnerable society's identified collective needs is dependent on the trust held between the external actors attached to supporting agencies and the local actors within the network. To allocate financial and technical supports, decision makers from aid agencies aim for high confidence in the local actors' capabilities in maintaining stability and positive collaborations between all societal elements through their influential relationships. In the case of Aceh, and in the duration of this PhD research project field work (2010-2013), the Acehnese key local actors have managed to hold and maintain the trust and cooperation of important local leaders, government decision makers, senior academics, and local businesses, although in some instances, political instability have proven to present stresses and strains to these relationships .

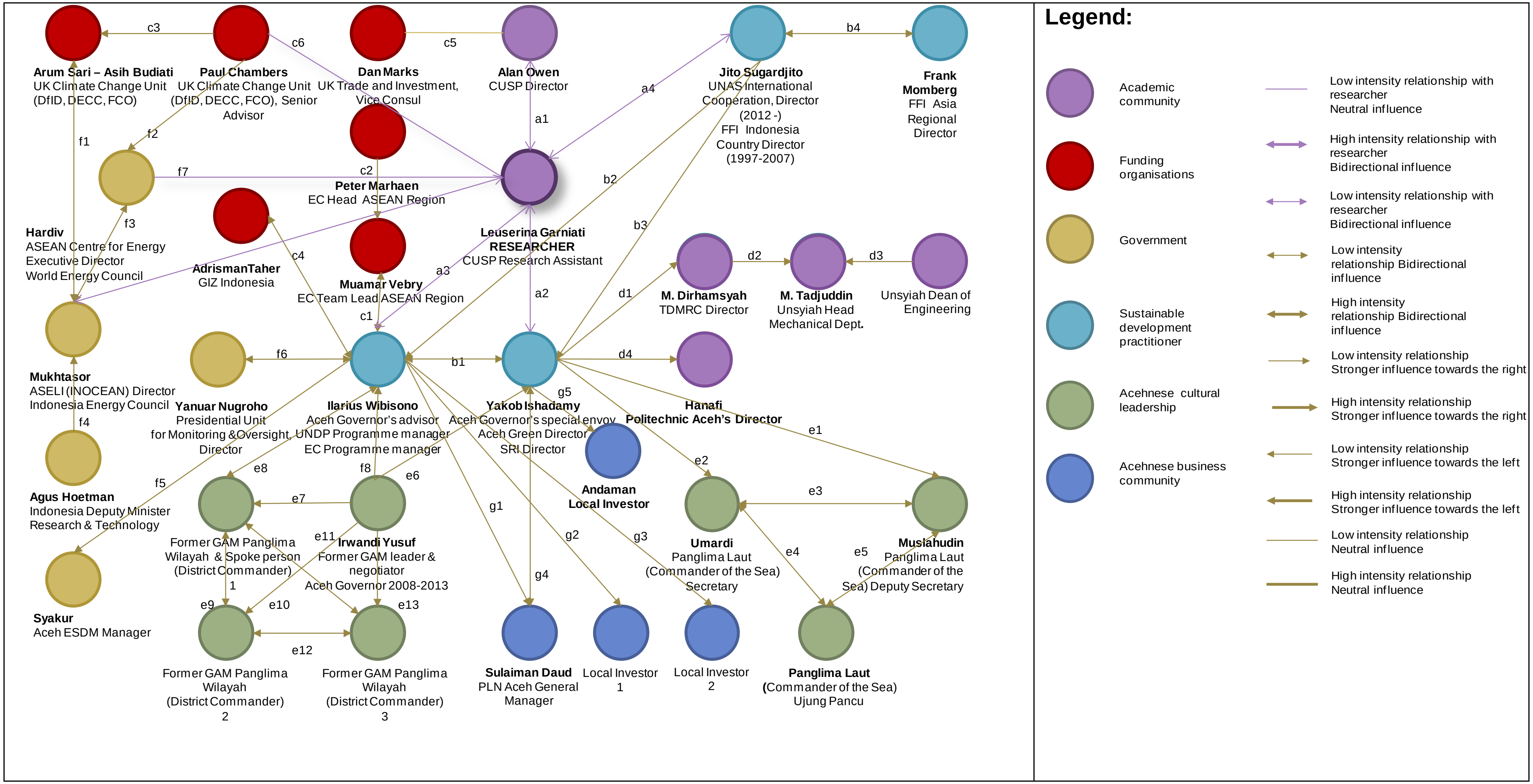

Figure 5-10: Network analysis 1 – direction of influence

This diagram explains the relationships between actors in the case study area. The direction of influence is determined by arrows. A larger arrow head represents bigger influence towards that direction. More detailed discussions on the individual direction of influence are given in Section 5.3.2.1.1.

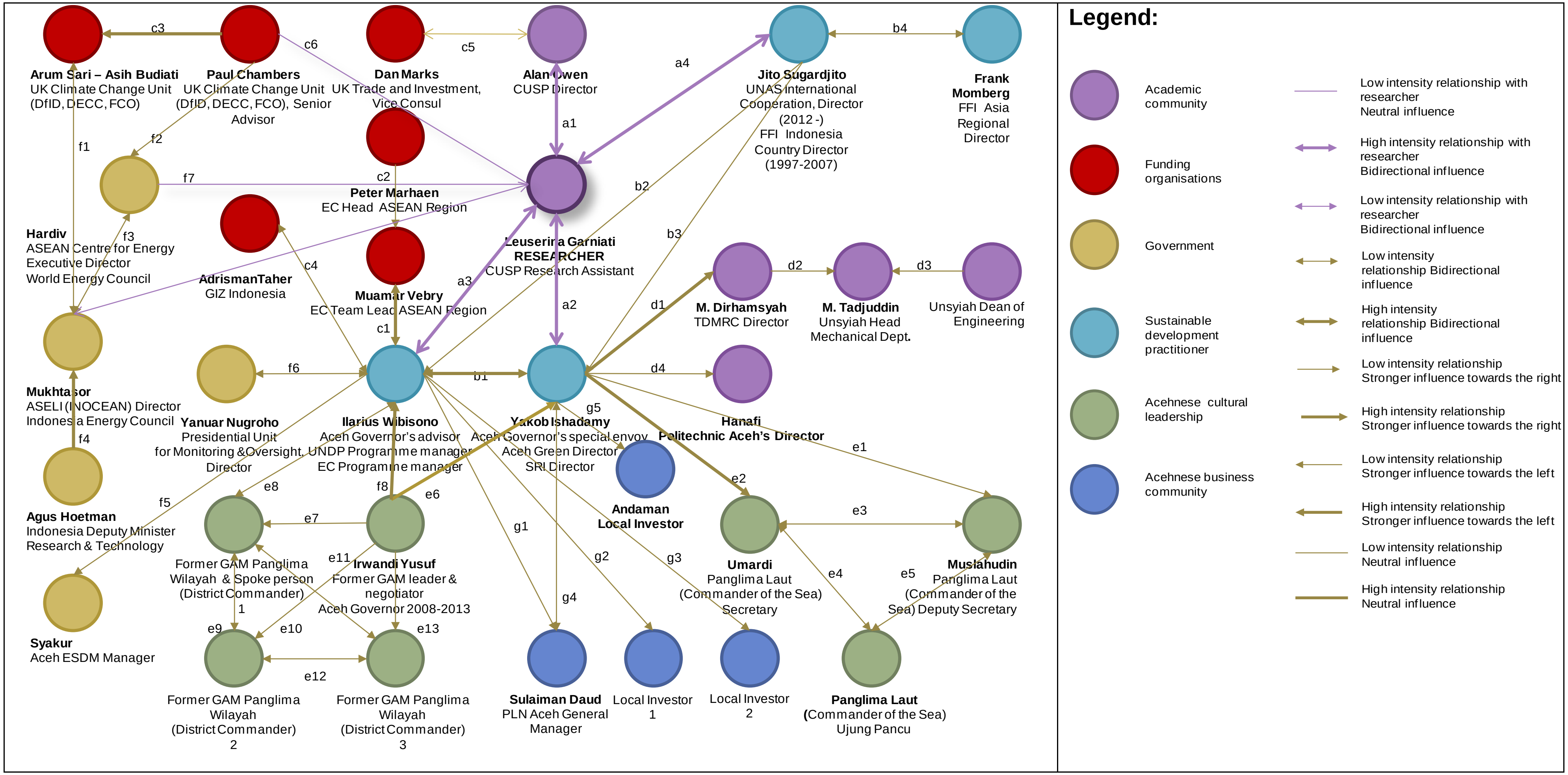

Figure 5-11: Network analysis 2 - frequency and intensity

This diagram explains the relationships between actors in the case study area. The frequency and intensity of interactions between actors connected are determined by thickness of lines. A thicker line represents a bigger influence towards that direction. More detailed discussions on freaquency and intensity of interactions are given in Section 5.3.2.1.2.

5.3.2.2 Stakeholder analysis

The stakeholder analysis is performed based on the analytical framework given by Hermans and Thissen (2009). This sub-section focuses on:

1. Identifying relevant stakeholders, assuming that stakeholder with interest and influence on initiative's success exist
2. Analysing stakeholder interest and influence to create specific participation strategy
3. Framing/structuring of actors' environment and assessing cooperative potential and threat by forming tables

Interest, expertise, and influence for a participation strategy

The stakeholders in the case study can be analysed based on the interest and expertise groupings of key actors in the society (Figure 5-12). Based on document reviews, observations, interviews, meetings, and/or workshops six interest and expertise groups have been identified:

- Sustainable energy capacity building (A);
- Sustainable energy device manufacture (B);
- Sustainable energy appropriate technology research and development (C);
- Sustainable energy consultancies (D);
- Rural, coastal, island off-grid energy supply (E);
- Urban on-grid energy supply (F).

Alongside these six groups, there are discernible and precise areas that join actors with specific niche of capabilities in mobilising resources. There are 5 groups of these specific niches existing in the network:

- Policy and implementation strategy (circle 1 which crosses over with circles 2,3,4,5 at present, and potentially with circle 6 in the near future)
- Knowledge exchange (circle 2);
- Business unit (circle 3);
- Engineering (circle 4);
- Community empowerment (circle 5);
- Environmental conservation (circle 6).

The abilities of actors in providing support to the network are based on these groups of interest and expertise. However, overlaps between interest and expertise groupings exist between Acehnese (sub-national), Indonesian (national), and South East Asian (regional) actors. Thereby, interest and expertise based meetings and/or workshops need to be strategically facilitated to create optimum engagement levels of these various actors in the specific topic areas, which are going to be investigated, and acted upon.

Issues relating to multifaceted baselines and conflicting priorities that exist in Aceh as a vulnerable society can be traced back to the existence of these groupings. This fact emphasises that to understand the background and process to differing beginnings and ends, it is crucial to engage the key actors located within each group in a continuous, face-to-face contacts. Engaging the key actors according to their interest and expertise groupings also provides a thorough and holistic understanding of various internal and/or external perceptions of a given situation, the way each group reacts, and the types of solutions they prefer.

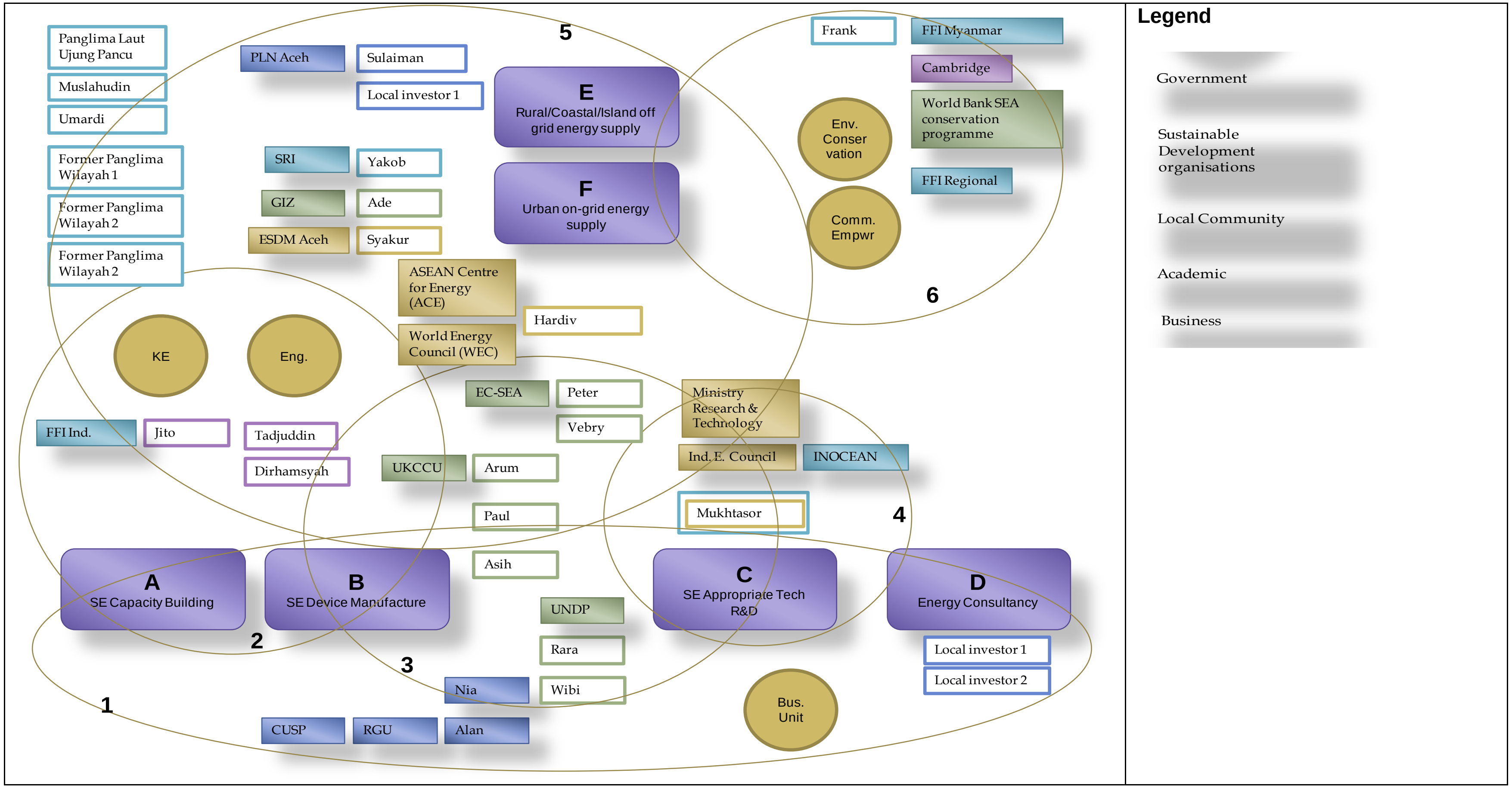

Figure 5-12: Stakeholder analysis 1 – interest, expertise, and capabilities

This diagram explains the groupings of various actors as key stakeholders in the case study area. There are 2 groupings identified based on (1) interest and expertise (2) capabilities in mobilising resources. The first grouping is presented as blocks A to F and the second grouping is presented as circles 1 to 6. The 2 groupings overlap in various places and actors are found to have multiple roles and positions as stakeholders in these groupings. A more detailed discussion of the two groupings and their relevance is given in section 5.3.2.2.1.

Frame and structure for cooperative potential and possible threats

Sub-national (Aceh), national (Indonesia), regional (Timor Leste, Malaysia, and Myanmar) connections are discussed based on the stakeholder analysis as represented by

Figure 5-13. Stakeholders observed and interviewed are grouped into the following:

- Funding bodies (aid funding organisations at national and regional levels);
- Private investors;
- Government (government departments at sub national and national levels);
- Sustainable development organisations and the local community (NGOs and indigenous community organisations);
- Academic community (Indonesian and foreign universities and research centres);
- Business community (at sub national and national scales).

The function of identifying the groups of stakeholders is to be able to determine what Aceh as society (being part of Indonesia and ASEAN), needs, where it wants to go, and how it can reach its goal and destination. As the Acehnese society consists of various governmental and private sectors, there are also many groups interested in Aceh at various levels, not only within Aceh itself, but also those which are external to the province.

Because of its geographical location and political implication, Aceh is seen as an area of significance to the Indonesian Government and eventually, the regional ASEAN community, and globally. Aceh sits on the most northern and eastern tip of the Indonesian Archipelago, thereby functioning as a border to the Indonesian territory, an entry port, and access to Indonesia's natural resources and economic goods. Aceh is also a politically powerful province, with influential global networks extending to Sweden, Malaysia, and the Middle East. Because of that state, external stakeholders have varying degrees of interest in Aceh. The scales of interest and thereby the support extended depend on the desired outcomes and potential benefits that will be gained by each of the stakeholder.

Starting the analysis from the outer layer stakeholders, aid funding organisations have been observed to provide supports depending on the vision and priority that they have on sustainable energy in Aceh, Indonesia, and South East Asia. Formal guidance can be accessed through region/country strategic documents. However, in depth information and the step-by-step guidance to fulfil the necessary criteria can only be accessed through iterative communications and negotiations with the existing region/country/provincial network of actors. In practice, many of the focus programmes are in fact jointly designed by both funding agencies experts and local actors who have identified the necessary initiatives through bottom-up and top-down approaches.

Continuing the analysis, on engagement levels, funding bodies with current interests in Aceh have in general expressed their preference for operating on a region-to-region scale; or at a minimum on a country-to-country scale (interviews and personal communications with aid funding agencies actors). The United Kingdom Climate Change Unit (UKCCU) for example through their funding support mechanism in Jakarta for Indonesia would look to fund initiatives that are on a national scale. Similar to that of the UKCCU, the European Commission (EC) looks to support initiatives that are at ASEAN level instead of national. However, the World Bank (WB) community through its philanthropists and the United Kingdom Trade and Investment (UKTI) are open to supporting smaller scale, local, implementation-based initiatives. Overall, on funding types and modalities the two issues considered most important in developing a sustainable energy intervention strategy are policy support and device deployment.

This situation has specifically presented considerable challenges for Aceh. Aceh itself is a sub-nation, an autonomous province which is still part of Indonesia's country administrative system. Therefore in order to receive support at a national and regional scale, Aceh must align some of its priorities with its Indonesian and ASEAN sectoral counterparts. This is a significant challenge, because Indonesia and ASEAN at times have conflicting priorities regarding Aceh's interests. Another challenging factor is that because Aceh is not yet a stable society, it is extremely difficult to design and shape an initiative directly at application levels. With the exception of solar photovoltaic (PV) micro generation, contradictory to external support's preferences for deployment scales, most of the sustainable energy development areas in Aceh are still at research, pre-feasibility and/or pilot project stages.

Another group of stakeholders is the provincial and national government. The Acehnese government has the autonomy to control its own natural resources, including energy. Therefore, the provision of sustainable energy to its urban and remote rural/coastal/island populations is one of its main interests. Because of this primary reason, the Acehnese Government has initiated an Aceh Green initiative that champions the implementation of renewable energy and natural resources conservation strategies. Support provided includes facilitation of cross-department information sharing and utilisation of their government infrastructural facilities. At the national scale, the Indonesian Government has also initiated policies, policy measures, and specific programmes towards implementing sustainable energy strategies. Unfortunately, the Indonesian Government does not have a specific support mechanism for Aceh in the sector. During the period of this PhD research; the Indonesian Government support comes into Aceh in the form of endorsement for activities relating to sustainable energy to take place in the province.

Taking the discussion into local community based organisations as stakeholders; analysis is performed on the following sub groupings within Acehnese local communities: indigenous people of rural/coastal/islands, NGOs, and other non-profit organisations. The indigenous communities have one main common interest. These communities need sustainable energy provision to support their basic livelihood and economic activities. The NGOs and non-profit organisations' main interest is in empowering the Aceh local communities to increase their resilience towards internal/external pressures and achieve human development which is sustainable. The types of support provided generally include technical expertise, voluntary time for capacity building, and project assistance.

The Acehnese, Indonesian, South East Asian, and European based academic communities also have interests in engaging with Aceh in its sustainable energy. Contribution to applied research is one of the main drivers of this stakeholder groups to join hands in supporting Aceh. Contribution to extending the body of knowledge into Aceh, which is not an easily accessed area, is also one of the main drivers for support provided by this group of stakeholders. Support is given mostly through accessing research and teaching grants, technical assessments, feasibility studies, validation steps and credibility assistance through publications and scientific workshops.

Finally, various sub-national and national businesses have major interests in Aceh, because it is one of the most prospective areas with minimum competition in business activities due to its lucrative natural resources. However, at the same time, conducting business in Aceh entails highly risky investments due to its sensitive cultural and political dynamics. Therefore, when businesses have identified the right actor to assist in bypassing these difficulties, investments for sustainable energy service and manufacturing are the suggested avenues for support for a new initiative in Aceh.

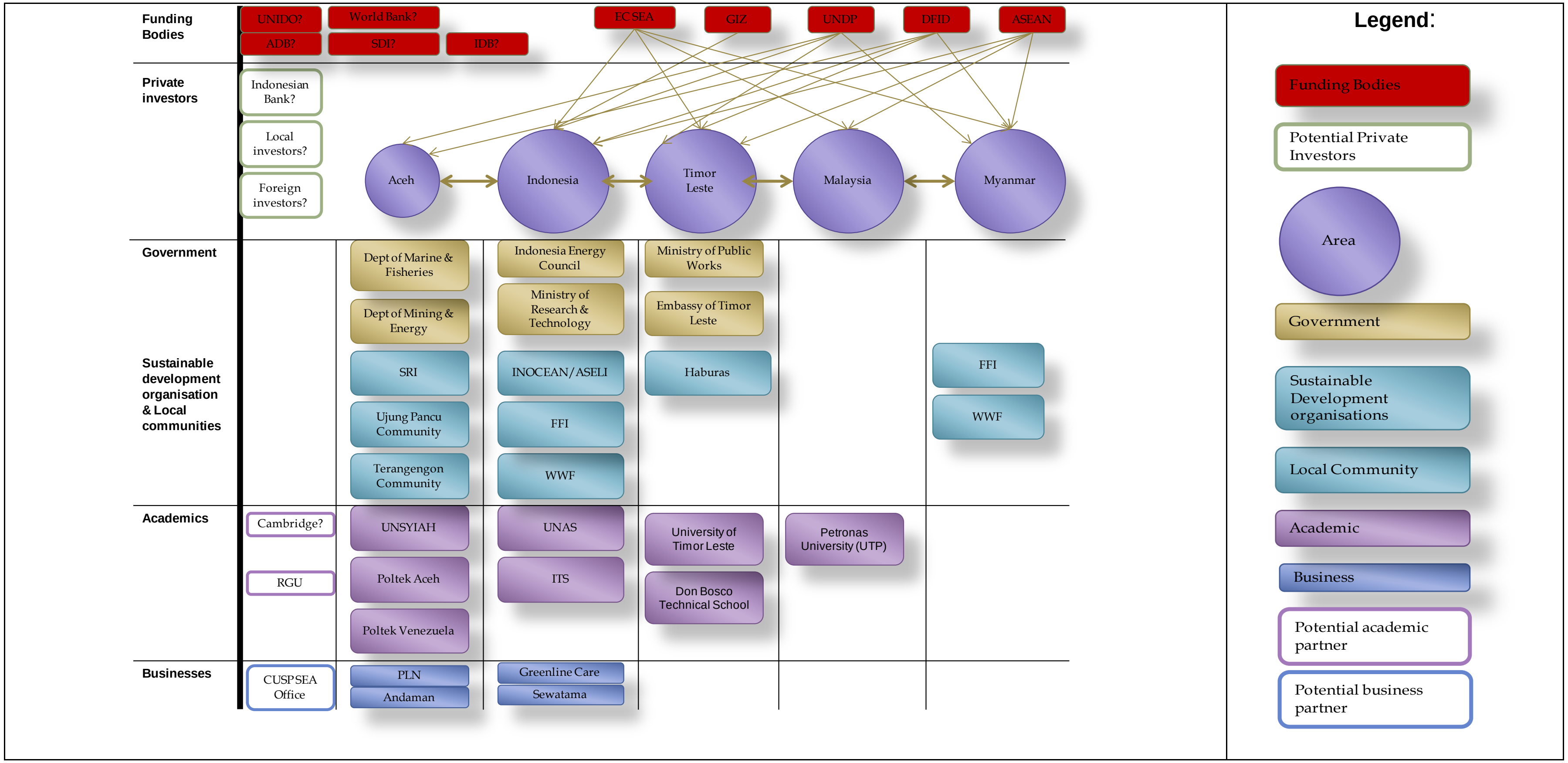

Figure 5-13: Stakeholder analysis 2 – sub national, national, regional connections and cooperative potential

The diagram illustrates the different groups of stakeholders based on their sub-national, national, and regional cooperative potential. It connects cooperative potential to the ability of each stakeholder group to mobilise resources based on their geographical coverage and professional platforms. This also helps in identifying potential threats to competing interests.

5.4 Summary of Chapter 5

Answering RQs 6 and 7 for Objective 2

Chapter 5 has discussed the results derived from the following analytical approaches: numerical modelling, interpretive policy analysis (language, object, and act analysis), and actor analysis (network analysis and stakeholder analysis).

RQs 6: What are the unsolved problems under the current sustainable energy policies and technology implementation?

The unsolved problems under the current sustainable energy policies and technology are incoherent policy making and inappropriate technology implementation

RQ 7: Who are the influential stakeholders and actors in Aceh regarding sustainable energy problematic situations and/or solutions?

The key stakeholders and actors in influencing problems and/or solutions can be grouped into the following:

- Funding bodies (aid funding organisations at national and regional levels): UNDP, EC, UKCCU (DFID, DECC, FCO), and GIZ);
- Private investors: World Bank, Local Banks;
- Government (government departments at sub national and national levels);
- Local community (NGOs and indigenous community organisations): villagers in Ujung Pancu coastal area, Sabang island, Terangengon remote rural village; village leaders, Panglima Laut, Panglima Wilayah;
- Academic community (Indonesian and foreign universities and research centres): UNSYIAH, PA, UNAS, RGU;
- Business community (at sub national and national scales).

6 Synthesis

“The evolutionary quest for greater unity in truth is achieved by dialectic, positing something (thesis), denying it (antithesis), and combining the two half-truths (synthesis) which will contain necessarily a greater portion of truth in its complexity”

(Georg Wilhelm Friedrich Hegel)

6.1 Introduction to chapter six

A methodology has been designed for the research project's specific context. This research design was outlined and explained in detail in Chapter 2. A robust groundwork has also been performed to construct the foundations for theoretical framework development in Chapter 3 and results of data collection have been provided in Chapter 4. Building on the combination of analysis methods in Chapter 5, a conceptual model of a vulnerable society's problem system and function can be developed and subsequently utilised as the platform for intervention justification and synthesis. To answer the research questions (RQs 8, 9, 10, and11) collated for Objectives 2, 3, and 4, identification of emerging synthesis as this PhD study's novel contribution and future research avenues are given in chapter 6, following the selected methods given in Table 2-5.

Objective 2

Critically assess existing sustainable energy technology and policy in Aceh and analyse the role of relevant actors and stakeholders in the problem system of vulnerable societies.

RQs for objective 2

8. How do specificities of vulnerable societies contribute to the identified problems?

Objective 3

Synthesise new understandings of interfaces between appropriate technology and sustainable energy policy

RQ for objective 3

9. How do the motivations of external aid and vulnerable societies match, with particular reference to the WEIRD membrane?
10. What mechanisms/interfaces are required to link appropriate technologies to sustainable energy policies?

Objective 4

Design an intervention strategy for breaking the problem system cycle towards social transformation and community empowerment for resilience towards internal and external pressures.

RQs for objective 4

11. How can the links between appropriate technology and sustainable energy policy be utilised by policy makers as an intervention strategy to empower vulnerable societies and address their problem systems?

As outlined in Table 2-5: Selected methods for data synthesis to answer RQ8, RQ9, RQ10, and RQ11, the following step-by-step synthesis process were followed:

1. Aceh's sustainable energy categories determination;
2. Aceh's sustainable energy problem system themes determination;
3. Creation of themes linkages;
4. Data interpretation;
5. Theory generation.

Discussions presented in Chapter 6 embark from those main findings in Aceh as the chosen case study, extrapolated to the conditions of vulnerable societies in general based on their similar characteristics. Section 6.2 takes into considerations all the analyses performed in Chapter 5 and attempts to elucidate the problem systems and functions of vulnerable societies in the context of sustainable energy policy and appropriate technology implementation through the construction of a new conceptual model of problem system (input-function-output) (Figure 6-2). To start building the framework for interfaces between sustainable energy policy and appropriate technology in a vulnerable society, Section 6.3 discusses the main points of how to cross the WEIRD membrane which are apparent in the exchanges of knowledge and capabilities.

As the next step of synthesis construction, interfaces between appropriate technology and sustainable energy policy are outlined as the major themes; and links between those themes are created (Section 6.4). Information incorporated in those linkages is then interpreted. From there, as part of the new developed theory, explanations are given of why (Section 6.5) and how (Section 6.6) building indigenous capabilities in the sustainable policy formulation and appropriate technology implementation to utilise locally available resources serve as an intervention method to break the cycle of identified problem system and function. Finally, forming the final part of the new theory development, agents of change's roles and significance are highlighted as the next crucial step in driving the intervention process (Section 6.7).

The structure of chapter six is explained through a flowchart given on Figure 3-1overleaf. Sections are linked to each research question it answers and to other contributing sections.

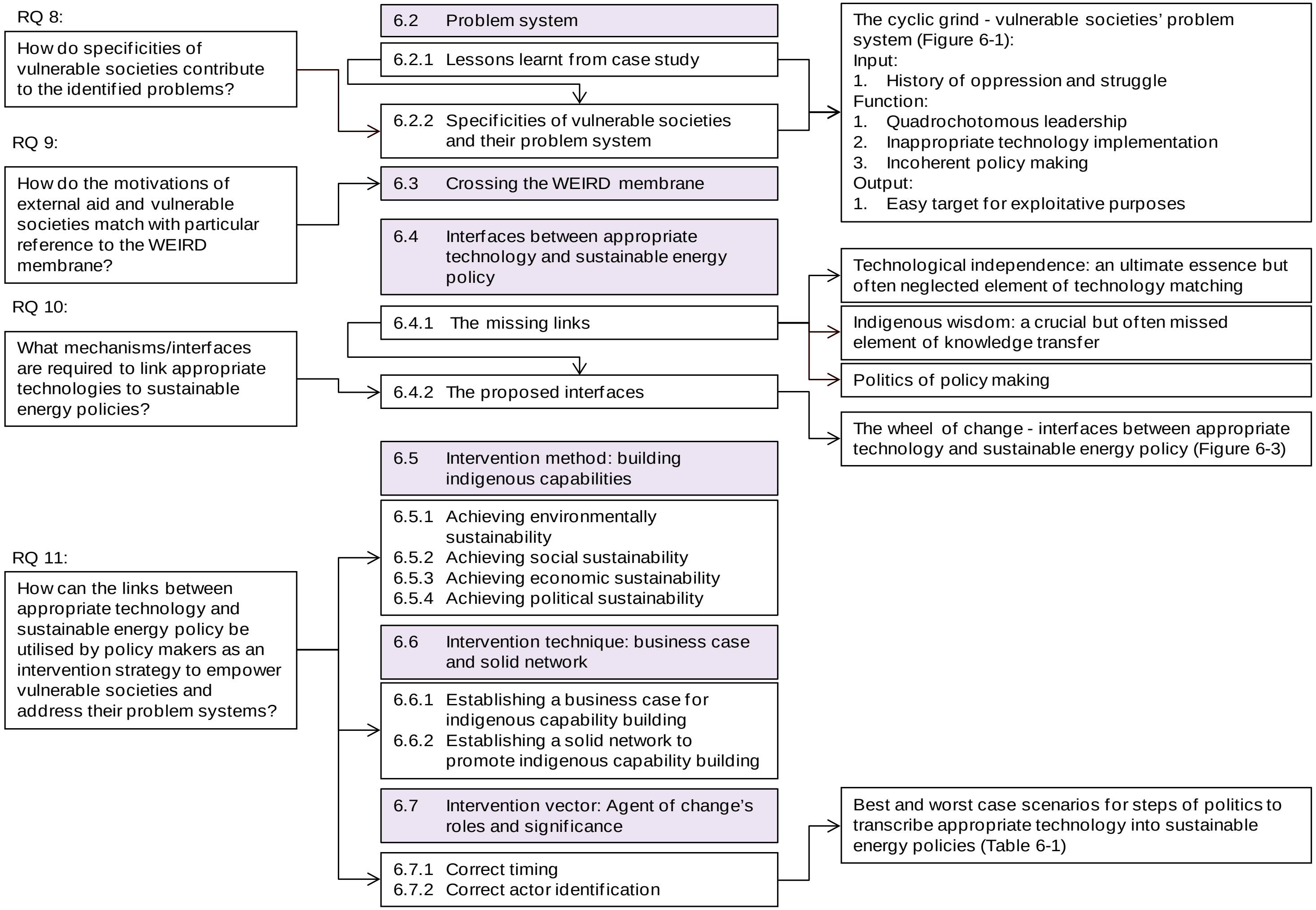

Figure 6-1: Flowchart of chapter six

6.2 Problem system

Both quantitative and qualitative analyses performed for this research have strongly identified the challenges and failings of viewing and extrapolating energy related research, policy, and practice from a WEIRD background into vulnerable societies that have very different societal models. WEIRD societies are those described by Diamond (2012) and Henrich et al. (2009). The contrasting characteristics of WEIRD societies to small-scale, non-WEIRD societies are summarised and put in context as below.

The WEIRD perspective is analytic at psychology, neuroscience, and linguistic, in which they attend more to objects than fields; explain behaviour in more decontextualised terms; and rely more on rules over similarity relations to classify objects; (for further discussion of the cross-cultural evidence (Henrich et al. 2010). For example, Westerners engage brain regions associated with object processing to a greater extent relative to East Asians who are less likely to focus exclusively on objects within a complex visual scene (Chiao and Cheon 2010). Meanwhile, fine grained segmentations of objects than minimal segmentations of objects found in other languages (Majid and Levinson 2010)

The WEIRD perspective is also independent at psychology, neuroscience, and linguistic (Chiao and Cheon 2010; Henrich et al. 2010; Majid and Levinson 2010) – which holds positively biased views of themselves; a heightened valuation of personal choice; and an increased motivation to “stand out” rather than to “fit in” (Henrich et al. 2010). Westerners show differences in medial prefrontal activity when thinking about themselves relative to close others, but East Asians do not. In the WEIRD cases, egocentric spatial frames of reference are employed rather than allocentric as found in non-WEIRD languages. A number of non – WEIRD dominant societal characteristics and potential values, consist of technology and policy support which are holistic, interdependent, and allocentric,

There have been many attempts to provide remote communities with off-grid renewable energy solutions capable of supplying a few kilowatt-hours for lighting and water pumping, but these often prove to be inappropriate in terms of both the technology and in meeting the societal and cultural needs of the community.

6.2.1 Aceh's sustainable energy categories determination - lessons learnt from case study

In summary, what has been learnt from Aceh, as a vulnerable society in developing its sustainable energy policy and appropriate technology implementation strategy are explained as follows:

Approximate size of natural sustainable energy resources in Aceh

Based on the analysis performed in sub-sections 5.2.1 and 5.2.2, solar energy in Aceh is a given at any location; the main question is what application (PV or heat/cooling) and what size (standalone or industrial size)? Pico/micro hydro offers very rapid, cost effective localised solution in many areas, especially rural locations. Micro-wind is readily available in most of Aceh and is suitable for application in rural/off-grid areas. If it is assumed, very conservatively, that in any area of $10km^2$ it is possible to install 10kW each of solar, wind and hydro, at capacity factors of 0.4, 0.3 and 0.9 respectively, then Aceh can easily produce 800 GWh per year from isolated small devices.

Longer term, large sites are suggested to be:

- Tidal – North coast of Aceh, Ujung Pancu and similar sites, 50MW installed is likely
- Wave – West coast of Aceh and its islands, 200MW installed is probable
- Offshore wind – North of Aceh, again 200MW is not over ambitious.

Given that typical capacity factors for these technologies, (0.4, 0.4 and 0.3 respectively), Aceh has approximately 1.4TWh available annually from its marine resources alone, an additional 800GWh from isolated small-scale generation projected geothermal generation of around 34 GWh, gives a total of around 2.5 TWh per annum.

Grid supplied electrical energy sales throughout Aceh in 2009 amounted to 1.3 TWh, with a peak load of 272MW. The above analysis, though very simplistic, is nonetheless very conservative, and suggests that Aceh can, given the right investment become a net energy exporter and remains so, well into the future. Grid management and base load provision means that there will still be a need for some import from Sumatra, but overall net energy flows will be to Sumatra.

Summary of Aceh's future strategy

- Estimates show that Aceh has the renewable energy resources to generate around 2.5TWh per year, whilst it consumes around 1.3TWh per year, providing excess energy for securing future local consumption and export purposes;
- Although some renewable energy resources are readily available throughout Aceh: solar, wind, and micro/pico-hydropower, there is a gap in resource and technology assessments for marine energy (wave, tidal and offshore wind), algae bio-diesel, and solar thermal for combined cooling, heating, and power (CCHP);
- Grid provision needs to be planned based on a long-term energy management analysis of resources, loads and grid capacity;
- There is a significant skills gap to be bridged regarding the knowledge/skills required to design/build/install/operate the technologies;
- Appropriate technology, indigenous capability and the social dimensions of exploiting energy resources have not been consistently included in decision-making processes of designing and implementing energy generation systems; as well as in any energy related policy and policy measures.

Based on the above findings, a vulnerable society such as Aceh should strive for maximum possible self-sufficiency in sustainable energy production. This implies that there are at least three sustainable energy categories of issues for attention in Aceh:

- Wherever possible, the energy system and infrastructure should be designed, installed, managed, and maintained human resources indigenous to the region. Therefore, valuation of the likely size of sustainable energy industry and thereby the training programmes required to supply the expertise and manual labour at vocational levels, polytechnic degrees, bachelor degrees, MSc degrees, and PhD programmes should be modelled, prepared, and catered for and, only where absolutely necessary, international experts, could be hired for a limited time and specific knowledge transfer purposes.
- Wherever possible, the general outlook should be around building a whole new energy industry in the region, using indigenous material, skills, and technology to provide energy security for the people of Aceh.

- The government and community leaders of a vulnerable society such as Aceh should ensure that existing and future policies in developing the sustainable energy sector provide support for and facilitate this approach.

6.2.2 A vulnerable society's problem system

The results of document review and fieldwork performed in Aceh suggest that the dynamics in a vulnerable society are influenced by specific characteristics which contribute to a particular problem system. Based on the re-interpretations of theories developed on vulnerable societies in Sub-section 3.2.3 , sustainable energy policies in Sub-section 3.3.5, and appropriate technology in Sub-section 3.4.3, data interpretation given in Section 4.3, and the analyses performed in Section 5.2 and Section 5.3, a novel conceptual model for a vulnerable society's problem system can now be visualised as in Figure 6-2. This model is built on the lessons learnt from Aceh, a vulnerable society that is developing its sustainable energy policy and implementation strategy (Sub-section 6.2.1). Detailed explanations of the specificities of a vulnerable society's problem system and the functions of its contributing components that are represented by the conceptual model are given in Sub-section 6.2.2. This then becomes the basis for identifying the areas of disconnects (missing links) between the two major components of this problem system.

A vulnerable society, which is characterised by fragile livelihoods and additional exposure to human-induced catastrophes and natural disaster, has 'historical oppression and struggle' as an input to its problem system. This input then fuels the system's function, which is driven by 'quadrochotomous leadership' along with its two interlinked results: inappropriate technology implementation and incoherent policymaking. The output of this system is inequity, resulting from the relative easiness of these societies in becoming targets for exploitative purposes. As already widely established, inequity directly links back to social marginalisation and environmental degradation, both of which are the main root causes and pressures towards fragility of livelihoods, leading to susceptibility to damages caused by exposures to human induced catastrophes and natural disasters. The following sub sections explain and elaborate in detail the components of the problem system and their components' functions as represented by Figure 6-2.

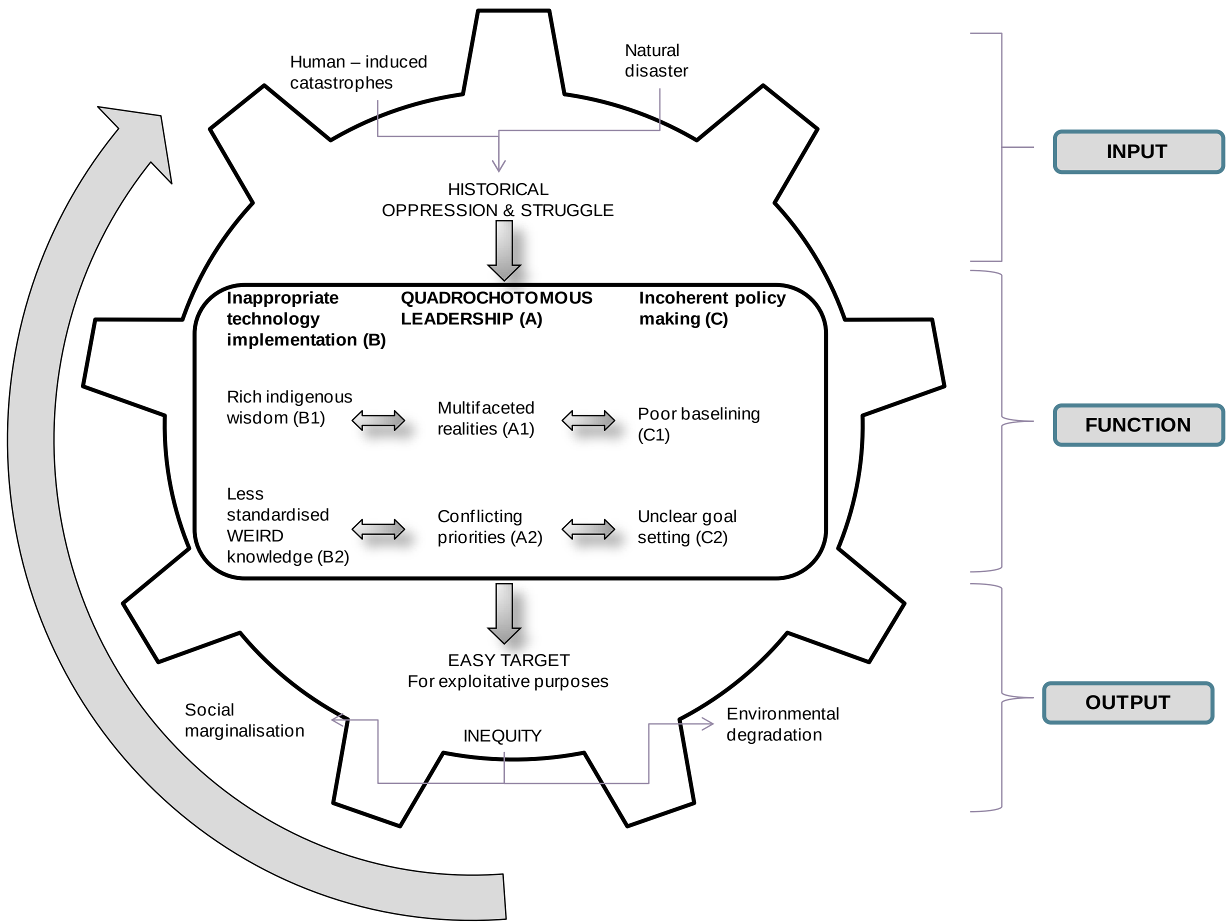

Figure 6-2: The cyclic grind - a vulnerable society's problem system

The cyclic grind is a diagram illustrating how any issue (e.g. sustainable energy) entering a vulnerable society will encounter interactions driven by a function of multiple leaderships (i.e. quadrochotomous leadership). These actor driven processes are significantly determinant in dictating the continuity of the vulnerability cycle. Detailed discussions on every element and the processes taking place in the system are given in sections 6.2.1 to 6.2.5. An understanding of each component characteristics and how they interact between one another, is the determining factor to the identification of how and where an intervention strategy can be inserted to break the cycle of vulnerability utilising the linkages built between policy and technology (Sections 6.3, 6.4, and 6.5).

6.2.3 Input: History of oppression and struggle

Historical oppression and struggle to recover from socio-political conflict and/or natural disaster act as the input into a vulnerable society's problem system. Various conversations (during formal and informal meetings and interviews) with actors and stakeholders in Aceh repeatedly put forward the saying "we forgive, but we never forget". This very strong message portrays that the Acehnese society, multi layered as it may be, shares the similar view that the historical events of being under oppression and struggles (section 4.1) are deeply rooted wounds which time has not healed.

6.2.4 Function: Constants and variables

As represented in Figure 6-2, when entering the sustainable energy domain, historical oppression and struggle immediately starts an interrelated chain of events, where a 'quadrochotomous leadership' function (A) transforms constants and variables within a vulnerable society. Multifaceted realities (A1) and conflicting priorities (A2) are the two constants found under a 'quadrochotomous leadership function'. Its variables consist of: rich indigenous wisdom (B1) but poor standardised WEIRD knowledge (B2); and poor baselining (C1) and unclear goal setting (C2). When interacted with policy and technology, the four variables (B1 and B2) and (C1 and C2) are driven by the two constants (A1 and A2) towards inappropriate technology implementation (B) and incoherent policy formulation (C).

6.2.4.1 Quadrochotomous leadership - current government, opposing parties, GAM chain of command, and ulama (A)

The most influential characteristic of a vulnerable society is the existence of a 'quadrochotomous leadership' structure. 'Quadrochotomous leadership' here is used to explain the presence of four almost equally powerful chains of influence (Figure 6-3). Leaderships are born from the instinct and drive to understand the needs of those under stagnation to transform. For generations, Aceh has been under oppression and in struggle for independence. Within this timeframe, leaderships from the cultural sovereign lineage (included in this are the Ulama and Teuku) came through as one of the strongest resisting forces against oppression. Another line of leadership grew at a similar time within the 'ex combatants' of the Gerakan Aceh Merdeka (GAM) translated as the Free Aceh Movement. GAM was and to a degree is still the main resistant force against the Indonesian occupation. Adding to the previous two existing leadership lines, as one of the provinces in Indonesia, Aceh Province nominally has an elected Aceh Provincial Government. Further to the three leaderships outlined previously, because of the dynamic social and political movements in Aceh, opposing parties to the ruling Indonesian provincial government also act as another leadership line.

Based on the existing four lines of leaderships, for Aceh to progress forwards, all of the four separate forces need to work timely, coherently, and complementary towards the same direction. However, as seen in Aceh, this is rarely the case found in a vulnerable society. At its best, at certain times, one or two dominant leading forces will pull the society towards one direction, while the other two towards another. At other times, all four leading forces may pull the society towards all four different directions.

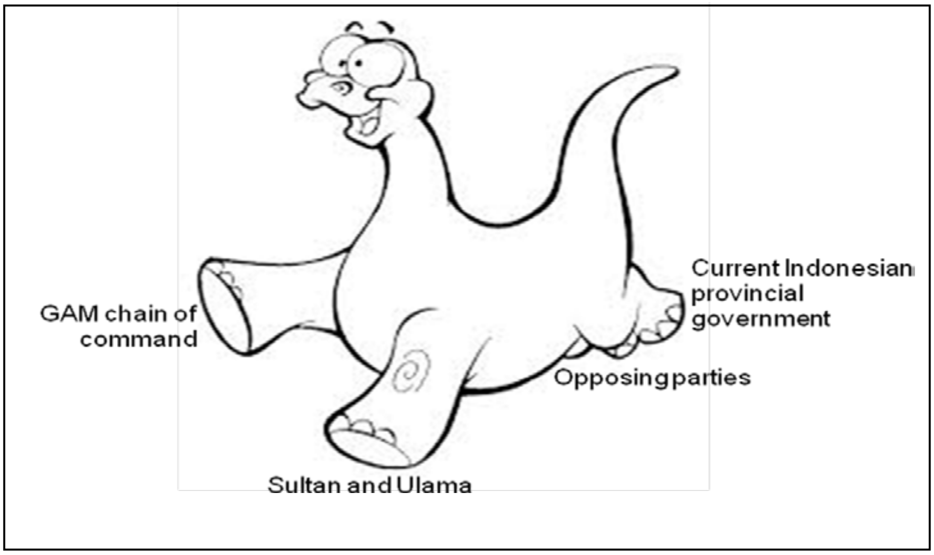

Figure 6-3: Quadrochotomous leadership in a vulnerable society

Multifaceted realities (A1)

Based on the Ontological assumptions made in conducting this PhD research (

Table 2-1), realities are understood the products of a social construct. Therefore, what might be considered to be ‘real’ by a group of individuals, may not necessarily shared by other groups of individuals. This is especially the case when the different groups within a particular society have undergone differentiating experiences from various angles. In the case of Aceh, the GAM and cultural sovereign leaders experienced different realities from those of the leaders from Aceh Provincial Government and their opposing parties during the time of Indonesian occupation in Aceh. Therefore, each of these lines of leadership has differing points of references when addressing Aceh’s current energy needs, supply sources, and suitable distribution schemes.

Although in most cases the Acehnese sovereign leaders and GAM’s ex combatants are part of the same indigenous leadership structure and may share the same chain of commands in executing orders, they often have separate strategic priorities. This observable fact is also apparent when addressing the issues on sustainable energy provision. More differences in perceptions and priorities are found between the Indonesian provincial government and the Acehnese indigenous leadership structure. Whilst the indigenous Acehnese leaderships search for mechanisms to empower their local communities, there are tensions amongst the Provincial Government leaders, who may or may not of Acehnese origins surrounding the issue.

Generally, data management and strategic decision making are not held within Aceh Provincial Government officials’ authority, but are done remotely through the Indonesian Central Government in Jakarta (Indonesia’s capital city). Only operational matters are found to be locally controlled by the Aceh Provincial Government. This circumstance creates the perception within the Aceh Provincial Government that in reality, Indonesia is still operating at a highly centralised manner, controlling and managing information flows, and limiting the knowledge traffic into Aceh. Meanwhile, there is a perception within the Indonesian Central Government that the Aceh Provincial Government is not yet capable in managing complex datasets and utilising them according to required standards, and thereby controlled access is a way of assisting the Acehnese in providing a service in a way which a centralised government is expected to.

In summary, different points of references generate different end points for planning purposes. Therefore, multifaceted realities in the end mean that as a vulnerable society, Aceh is segregated according to different perceptions of its own history, its current situations (baselines), and its intended goals. This is primarily because Aceh as a society is pulled into different directions by its own indigenous Acehnese and Indonesian leaders.

Conflicting priorities between actors, networks, and stakeholders (A2)

Actors and stakeholders in the Aceh Province network are connected in relationships, by influence, by interests, and by capabilities. Because of the differing types of connections holding the network together, they often have conflicting priorities. The existence of a ‘quadrochotomous leadership’ increases the chances of conflicting priorities to take place. Even when they have managed to align goals and vision, the four corners of leadership groupings can have differing priorities of actions. The Ulama and Teuku, and GAM, due to their unified political and social vision, have less chances of having different perceptions on realities and ideals. However, because of their different disciplinary backgrounds and methods of practice, conflicting priorities between this two leadership groups often take place.

However, conflicting priorities are found to be most frequent between the current Aceh Provincial Government and its opposing parties; as well as between the two leadership lines above and the Ulama and GAM joint together. Issues prone to conflicting priorities in these cases are often related to religious matters and resource revenue allocations. In relations to establishing a sustainable energy system, the areas of major conflicts can be grouped into one or more of the following:

- Energy resource, technology, and supporting policy focus;
- Choice of pilot programmes;
- Off-grid, remote rural/coastal/island site selection;
- Human resources supply;
- Source of capital investment.

6.2.4.2 Inappropriate technology implementation (B)

Less standardised WEIRD knowledge (B1)

Most of the current research on societies (e.g. behaviour, psychology, and policy) is based on WEIRD subjects (Diamond 2012 and Henrich et al. 2009). Therefore the standards of knowledge used globally, including those relating to sustainable energy technology implementation are those based on such WEIRD perspectives.

In Aceh, due to years of insurgencies, knowledge transfer through formal education has been absent from the indigenous communities for generations. Educational institutions were destroyed during the conflict-era by both sides of the power structure to intentionally seize the transfer of idealism between generations. This situation was made worse by the tsunami in 2004, which had wiped out even the basic educational infrastructure (physical, financial, and human capabilities). In the context of a sustainable energy system, both the conflict period and the tsunami had created a lack of capabilities in energy technology selection, design, installation, operation, and maintenance from a WEIRD standard of measurements of progress and achievement. Layers of Acehnese society (cultural leaders, formal governmental leaders, academics, and businesses) have to familiarise themselves with the current WEIRD based energy technologies to be able to implement imported technology correctly. In these cases, misinterpretation of resource analyses and unfit sustainable energy generation technology adoptions are commonly encountered. Issues surrounding distribution techniques are also as significant due to minimum design capabilities within the province.

To extrapolate the outcomes of one group with its own societal norms and cultural practices, to another group with different norms and practices, cannot be expected to give reliable results. Based on the document review (Sub-section 4.3.1)and field work (Sub-section 4.3.2) results; and further actor analysis (Sub-section 5.3.2), this PhD suggests that the WEIRD approach to sustainable energy development in a vulnerable society is currently flawed due to poor understanding of societal and cultural differences between the two, as well as the shortages of indigenous material, capacity, and capability. This is often exacerbated by WEIRD funding and support mechanisms, some of which were observed to provide assistance by exporting WEIRD technical assistance and products.

From participatory observation and based on the data collected through informal interviews and meetings (Sub-section 4.3.2), a number of government decision-makers perceive that WEIRD nations have little concern for the societies with developing economies and its people, being primarily interested in selling their energy technology products into an expanding market. Often those products are inappropriate for the target nation and/or for the particular application or location. When the system fails, there is limited or no external support, parts/materials are not available, and the indigenous capacity is not trained to repair or service the equipment, resulting in redundant, abandoned technology, of no value to the local communities. The industrial scale of WEIRD energy systems is also frequently misaligned with the needs of a vulnerable society, many of which are already grid constrained with scattered, low-density populations unsuitable for grid supply.

Rich indigenous wisdom (B2)

Although limited in the comprehensive, up to date WEIRD knowledge, the Acehnese has on the other hand a significant indigenous wisdom in managing their resources and people. Dialogues between actors and stakeholders surrounding forestry and marine sustainable resources management were found to have been built on top of this indigenous wisdom foundation.

Indigenous communities generate local wisdom in Aceh through years of observations and practice. Knowledge of their environment is handed down through generations of practical applications. The fishing communities in coastal areas have advanced maritime knowledge, resulting in indigenous expertise in seasonal marine characteristics, boat crafting, sailing, and diving. All of which are specialised capabilities applicable for a marine based renewable energy implementation. On the other hand, inland communities have advanced tropical forestry and ecology based knowledge, contributing to indigenous expertise in seasonal terrestrial and freshwater characteristics, civil constructions appropriate for Aceh (e.g. humid, tropical, monsoonal, earth quake prone area of South East Asia), and impact of certain structures on soil and ground water. All of which are particularly useful for on-shore renewable energy systems' design and implementation

There is a great bottom up needs for external input in gauging and sieving this local wisdom, to determine their optimum interfaces in the context of sustainable energy provision. External experts are initially and temporarily required to organise a systematic sequence to such an initiative, as this is one of the main limitations found in local capabilities.

6.2.4.3 Incoherent policy making (C)

As shown in Aceh, poor base lining and goal setting in a vulnerable society is both the product and cause of incoherent policy making.

Poor base lining (C1)

Based on the language, object, and act analysis (Sub-section 5.3.1) though various initiatives have taken place to implement some of the sustainable energy policy and policy measures set by the national and sub-national (Aceh Provincial) governments, very few of these initiatives have actually match the expectations of the targeted societal components of Aceh. When put into the framework of a vulnerable society problem system, the mismatch of perceptions and expectations comes back to the inability to construct a robust baseline of existing situations. Some or all of the following reasons potentially cause this lack of ability:

- Insufficient time to accommodate detailed and thorough activities in capturing present situations across the whole region in question;
- Insufficient resources to carry out the levels of depth and breadth needed in performing baselining activities;
- Inappropriate advice and/or assistance provided by external contributors;
- Biased influence from prominent actors with particular agenda;
- Unavailability of cross-referencing materials to ensure validity of current situation analysis.

Unclear goal settings (C2)

In summary, based on the language, object, and act analysis (Sub-section 5.3.1) the incorporation of appropriate technology into the energy generation, consumption, and distribution sectors has been identified as the largest gap within all of the Aceh (sub-national) and Indonesia (national) energy policy statements, policy measures, and implementation programmes. Through both LOA (Sub-sections 5.3.1) and actor analysis (Sub-section 5.3.2), it was found that segregated policies between addressing energy systems and environmental and/or socio-political impacts have potentially initiated these gaps. Different perceptions on targeted outputs and their meanings to targeted sectors based on differing backgrounds and interests of various stakeholders have also potentially caused priority disorientation in implementing formulated policies and policy measures.

At the national level, energy policy statements do not directly incorporate environmental aspects. Connection with environmental policies is found separately in other policy statements addressing environmental impact assessment (EIA), air quality monitoring, and clean development mechanisms (CDM) of energy generation projects. The decentralisation concept has also brought independence of strategic approach to natural resources management and thereby sustainable energy policy measures and implementation. Both at national and provincial (sub-national) levels, policy statements are relatively well-formulated and backed up with comprehensive policy measures, but without sufficient strength in implementation. The document review results (Sub-section 4.3.1) and the subsequent LOA (Sub-sections 5.3.2) have provided a consistent perspective on this issue, both at national and provincial (sub-national) levels.

6.2.5 Output: Easy target for exploitative purposes

The output of a vulnerable society's problem system is being an easy target for exploitative purposes. Any type of activity, which is primarily driven by purely exploitative purposes, induces inequity. When these exploitative intended activities are done in a society that is vulnerable, the gaps created between groups receiving profit and those being exploited are enhanced. There is no basic security in place that could maintain a standardised minimum quality of livelihood, developing situations where inequity is easily created. The dilemma confronted by a vulnerable society in regards to exploitative activities is that they need whatever form of capital prepared to enter their region. These high risks investments are usually only taken by investors at a very high price. To ensure high returns for their high-risk investment, investors expect profits to be generated many times more than in more stable societies. Because of this, in a vulnerable society, investors have always had the power to control the market.

A vulnerable society has very limited options, leading to a minimum expectation, where decisions are made to accept investments at high costs (financial and non-financial). This is the cycle which a vulnerable society confronts and has difficulties in breaking away from. A specific concern lies in the fact that corporate and businesses exploit this situation further by deliberately ignoring the direct implications of their activities in the region, more so when these activities are overly done for profit making. Another concern is when regional, national, and sub-national politicians choose to allow these to continue by not creating enabling conditions for coherent policy statements, policy measures, and implementation programmes to protect the interests of indigenous communities.

Left to its natural course, inequity will eventually result in social marginalisation and environmental degradation. Social marginalisation and environmental degradation is the first trigger for competition of resources. In these situations, environmental systems cannot provide the service in equal proportions because it has become so degraded. There will be very minimum resource (quality and quantity) to be distributed. Those with access to resources will thrive whilst those without left behind. The efforts to maintain power over limited resources for the benefits of certain groups of individuals directly link environmental degradation to social marginalisation. This competition for resources is the fundamental reason for most socio-political conflicts. On top of that, given their geographical locations, the potential for socio-political conflicts in a vulnerable society is augmented by the potential of recurring natural disasters. With this, the cycle represented by the problem system continues.

6.3 Crossing the WEIRD membrane

As identified in Sub-section 5.3.1, there are renewable energy implementation programmes in Aceh which are supported by external aid funding organisations. External aid/NGO works in a vulnerable society have generally found to bring the necessary improvement of social, political, economic, and environmental situations. These were carried out with intentions to increase social security and development. However, these programmes carried some un-intended consequences of actions. The un-intended effects of external aid/NGO work in a vulnerable society can be summarised into the following groupings:

- Societal change towards stagnation in productivity;
- Increased dependency on external support;

- Temporary interest-based cohesion of actors and stakeholders;
- Increased in tertiary consumptions whilst primary and secondary are not sustainably fulfilled;
- Mirroring effects in achieving progression towards a biased 'developed' state.

In general, external aid communities/NGO work matches the needs of the communities when the following circumstances are in place:

- Ideas are developed through participatory, grass root, bottom up approaches;
- Embedded local actors play important roles in decision making;
- Mobilisation of resources are made possible between groups of activities;
- External input in terms of concept development and technical assistance is provided as start-ups to initiative rather than a continuous support mechanism over long periods of time;
- The on-site network exists between indigenous people, business, and academic communities.

On the other hand, external aid communities/NGO work does not match the needs of the communities when the following circumstances take place:

- Ideas are developed through instructional, foreign, top down approaches;
- Embedded local actors are not given roles in decision making capacities;
- Mobilisation of resources are institutionally difficult between groups of activities;
- External input in terms of concept development and technical assistance is provided as a continuous support mechanism over long periods of time;
- The on-site network does not exist or not yet built between indigenous people, business, and academic communities

Based on participatory observations, site visits, and interviews, the external aid/NGO work undertaken in a vulnerable society as discussed above, although having the genuine motivation of alleviating poverty, reducing environmental degradation, supporting better governance, and strengthening social structures, can still very much confined to the standard practices of a WEIRD paradigm. The WEIRD paradigm is found to have influenced implementation programmes (most of the time unintentionally) through choices made on implementation methodology and technology. The un-intended consequences of external aid/NGO work along with the mis-match between their initiative and the local community needs, is argued for in this thesis to be the product of a deeply embedded WEIRD paradigm.

The understanding of the aid agencies activities' impacts in a vulnerable society is also found to have formed a major argument to a movement for reformation in the aid funding organisation assistance for development. It is estimated that technical assistance (TA) makes up more or less 25% to 50% of all aid (ActionAid 2006). TA refers to personnel involved in the implementation and the management of technical cooperation services. TA provision by aid funding organisations have often been criticised as being supply-driven, expensive, poorly planned and integrated, and failing to promote country ownership. Meanwhile, technical cooperation (TC) is often associated with actions aimed at strengthening individual and organisational capacity by providing expertise (short and long term TA personnel, institutional twinning arrangements, mobilisation of diaspora, etc.), training and related learning opportunities (peer exchange, tertiary education, etc.), and equipment (European Commission 2008).

In response to the main criticism received for provision of TA, donors have been taking steps to reform their TC policies so that capacity building rather than technical support becomes their main purpose in providing assistance (OECD/DAC 2009). The term TC has evolved in the last twenty years into knowledge transfer activity with a more equal partnership implied in the change process. Although aid agencies and donors have taken steps to change their approach, this change is slow. Unequally practiced by external aid agencies and donors, some trends however, can be observed in the way that: policies are encouraged to greater local participation in planning and designing intervention, management, evaluation, and accountability; national consultants and South-to-South cooperation are now encouraged; Sector budget support grows more in proportion to TC; pooling of TA funds to improve coordination and encourage country leadership; Short term TC to avoid substitutions; Shifting TC to capacity building initiatives; and Encouraging untying aid practices.

In essence, external aid for sustainable energy policy and appropriate technology in a vulnerable society with marginal communities must respond to different criteria from that paradigm held in WEIRD nations. The general assumption (from a WEIRD standpoint) is that selling WEIRD technology to less developed societies is good for them and the WEIRD sources. However, many societies can only afford WEIRD technology if they receive external grants from aid organisations, or borrow the money under soft-loan agreements to do so. This simply increases dependence on external support and/or debt and does nothing to develop indigenous capability. Many of the imported WEIRD technology simply fail after 2 to 3 years. Most of the times there is no in-country material and/or skill to repair it and the vulnerable society still owes the money from having purchased it in the first place. Therefore this PhD study argues that the optimum approach is to transfer knowledge and skills for indigenous development of locally appropriate technology. However, there are significant cultural differences which must be respected and managed in order to achieve this. Answers to what they are, when the practitioners of knowledge transfer themselves are intrinsically influenced by this mindset, is the first step in answering the question of how to cross the WEIRD membrane.

6.4 Interfaces between appropriate technology and sustainable energy policy

This section was previously published as a journal paper in: GARNIATI L., OWEN, A., KRUIJSEN, J.H.J., ISHADAMY, Y. and WIBISONO, I., 2014. Interface between Appropriate Technology and Sustainable Energy Policy in Vulnerable Societies. *International Journal of Sustainable Cities and Societies,* 12, pp. 9-15. The contribution of the researcher into the journal paper is estimated to be around 90%, consisting of written material for data collection in all sections of the report, analysis and conclusions, whilst acknowledgement is given on Dr. Alan Owen, Dr. Joanneke Kruijsen's contribution in proof reading the material; and on Yakob Ishadamy and Ilarius Wibisono's input in data collection process.

The cyclic grind (Figure 6-2) has highlighted that inappropriate technology implementation and incoherent policy formulation are the major contributing elements to a vulnerable society's problem system. An understanding can then be derived that appropriate technology and sustainable energy policy are the two key elements determining the functions which exist in a vulnerable society's problem system. From narrative literature review (Sub-sections 3.2.3, 3.3.5, and

3.4.3), document review (Sub-section 4.3.1) and field work (Sub-section 4.3.2), and the subsequent quantitative and qualitative analyses (Sections 5.2 and 5.3) there are at least three main areas creating the missing links between appropriate technology and sustainable energy policies in a vulnerable society: (1) technological independence, (3) indigenous wisdom, and (3) politics of policy making. These three areas are discussed in detail in the following sub-sections.

6.4.1 The missing links

Striving for societal development, similar in the way of societies with developing economies, a vulnerable society is confronted with the multi-layered challenges of providing sustainable energy to low income and scattered population, with minimal environmental impact. Adaptability of the selected provision and distribution systems to climatic and geographic conditions has become a determining key to the success or failure of attempted solutions to this challenge. To begin in defining targets for energy provision and distribution development in these societies, first there is the need to revisit the necessity for growth and its implications and where to set the limits to growth. An exploratory concept needs to be launched in specific contexts (in this case energy as a vehicle for development) to decide whether the destination of a developed society is as currently understood by communities. As a determinant step to view technology implementation and policy formulation in the right developmental context, there is also the need to redefine the developed state as the goal for appropriate technology policy development.

Implementation of technology and formulation of policies should evolve towards these redefined goal posts of development. Appropriate technology considerations in energy policies serves as the corresponding measure to technical solutions which often neglect individual complexities which exist within a society’s physical, social, political, and financial boundaries.

6.4.1.1 Technological independence: an ultimate essence but often neglected element of technology matching

Starting off with the concept of knowledge based determinants of technology sourcing (Doranova et al. 2010), development of appropriate technology should wherever possible start with local knowledge (indigenous wisdom). In agreement with this context oriented perspective, appropriate energy technology planning (inherent in policy making) needs to be carried out and be rooted in the cultural traditions and values of a particular society, such as the ethics of communal care and ethics of nature relatedness.

The hard (material, equipment, facilities) and soft (knowledge, organisation, management) aspects of energy technology cannot be separated from one another in providing solutions to equal energy access. Referring back to the dimensions of a sustainable energy system illustrated in Chapter 3, even when both hard and soft aspects of technology can be developed in balance, technological solutions for energy access are not necessarily sustainable. Different regions and communities will have different technology needs and should be, wherever possible, independent of international supply chains, which, in general, reflect the energy intensive final journey of resource intensive and exploitative practices.

In a vulnerable society, there are specific additional issues around policy formulation and implementation strategy in technology for development. The problems, constraints, and opportunities used for decision making processes are found to be largely based on perceptions and preferences. In such society, technology development is value dependent. When not carefully implemented, import of exogenous planners initially intended to fill in the skill gap, amplifies the lack of indigenous policy formulation and strategic planning capabilities; and as a result, widens the exact gap.

Moreover, although may be perceived by the general population as such, appropriate technology does not mean crude technology. The optimum match between availability of resources (raw material, human), local needs (present situation and future projection), and applicable technology, which is independent from international supply chain, is the ultimate essence, but an often neglected aspect of appropriate technology. A set of methodologies for selecting the most appropriate technology to match local raw materials and social requirements must be developed alongside a supportive sustainable energy policy to avoid exhausting capital without sufficient gains in terms of monetary values and community welfare.

Technological independence starts with the trust that any knowledge transfer process takes place in a two-way mutually beneficial relationship. This leads to movements from knowledge transfer into a bi-directional (exchange) relationship. Hence, this brings forward the discussion of indigenous wisdom being a crucial but often missed element of knowledge transfer.

6.4.1.2 Indigenous wisdom: a crucial but often missed element of knowledge transfer

One of the most significant roles of appropriate technology in creating access to sustainable energy for a vulnerable society is to benefit the local population. Wherever possible, there should be universal access to knowledge of developing sustainable energy technologies for locally appropriate use. These technology systems must be developed with the desire to encourage independence, not just for financial gain, thus ensuring that the skills for developing technologies are available to all and any restrictions due to economics/politics are removed. Access to energy, which is reliable and affordable, will potentially increase economic activities and thereby reducing the potential for social/political conflict in these vulnerable regions.

Understanding the indigenous characteristics of local communities in interacting and adapting to technologies is an often-missed aspect of knowledge transfer in sustainable energy systems. Promoting the rights of indigenous communities in acquiring the basic knowledge in both technical and management aspects of appropriate sustainable energy systems brings forward the ability to implement appropriate technology, utilise it optimally based on their own local contexts, and improve design for future requirements. This entails the need for correct technical know-how and managerial capabilities transfer mechanism for capacity building and human development in the technology deemed appropriate for the local situation. The mechanism must be able to incorporate and accommodate indigenous wisdom of the local resources and processes to any energy policy formulated.

As an example to the usefulness of existing indigenous wisdom, the preliminary work that CUSP (Centre for Understanding Sustainable Practice) and Aceh Green Secretariat, funded by the United Nations Development Programme (UNDP) undertook in May 2012 in collaboration with Mechanical Laboratory of Syiah Kuala University and local fishing communities in Ujung Pancu, Aceh is a good example of how indigenous wisdom exist and can be tapped to support a sustainable energy initiative. The site was selected as a “test” site in many senses; the boat skipper and crew had no experience of deploying subsea data devices and the boat was poorly equipped for maintaining position in fast moving flows. Insufficient on-site bathymetric data was available at the time to make a low-risk assessment of the deployment site and depth-sounding equipment was not available on the boat. To resolve this, and as an example of appreciating local knowledge, the Acoustic Doppler Current Profiler (ADCP) was positioned by telling the local fishermen/divers what conditions were sought and they identified a location that suited. Despite these unusual WEIRD-based research practice, sufficient data was acquired to give a meaningful insight into the flow and much was learned by both crew and research staff.

Issues relating to energy in a vulnerable society may not be immediately obvious to a WEIRD mindset. It is clear from the field work conducted for this PhD project, that simply transferring complex technology is of little help without the indigenous skill-sets being developed to support the subsequent service life. Secure, environmentally acceptable, sustainable energy sources are as important to the social, political and economic future of a vulnerable society in nations with developing economies as they are to the (over)-developed nations. Substantial indigenous wisdom exists which can be used if sufficient time is taken to engage and form constructive relationships with the local communities.

6.4.1.3 Politics of policy making

In a vulnerable society, due to financial and time constraints, policy formulation is often superseded by direct technology implementation without any robust, strategic, planning. Lack of political fore-sighting to support policy making, creates unclearly and insufficiently embedded organisational structures of implementing agents and procedures for appropriate technology utilisation. The process then creates energy generation, distribution, and utilisation systems, which are not thoroughly planned and often temporarily designed to quick-fix major problems. The process is also more negatively influenced by changes of people, roles, and positions. Politics should instead act as the persistent but subtle force in shaping ideal environments for:

- Evaluations on agent of change and initiator of policy modification;
- Decisions on start-up programmes for modifying existing policies;

- Identification (or facilitation/creation if necessary) of timeframe for modifications of existing policies based on local political atmosphere and social readiness to accept changes;
- Ensuring process design's flexibility and robustness for transfer of knowledge and paradigm between governments.

6.4.2 The proposed interfaces

As a vulnerable society, the Acehnese society has been under significant pressures due to its historical oppression and struggle experiences. The most evident reaction from experiencing pressures for a long period of time is that the society yearns for freedom. There is a significantly powerful and relentless energy contained within this thirst of gaining independence from pressure. It is this energy that must be tapped into in initiating an intervention measure to Aceh's problem system.

To intercept and break the cycles of the defined problem system in a vulnerable society, a novel framework of interfaces between appropriate technology and sustainable energy policies has been developed (Figure 6-4) based on the identified missing links explained in Sub-section 6.4.1, This conceptual model is a modified and refined version of the model previously published as a peer reviewed paper in the International Journal of Sustainable Cities and Societies (Garniati et al. 2014) and was presented as a seminar topic in the 11th Annual Sustainable Energy Technology Conference, Vancouver 2012 (Garniati et al. 2012).

The wheel of change presents a platform for the following links to be built:

1. Link between both politics and technological independence and indigenous wisdom;
2. Link between technological independence and local resources;
3. Link between politics and socio-cultural context.

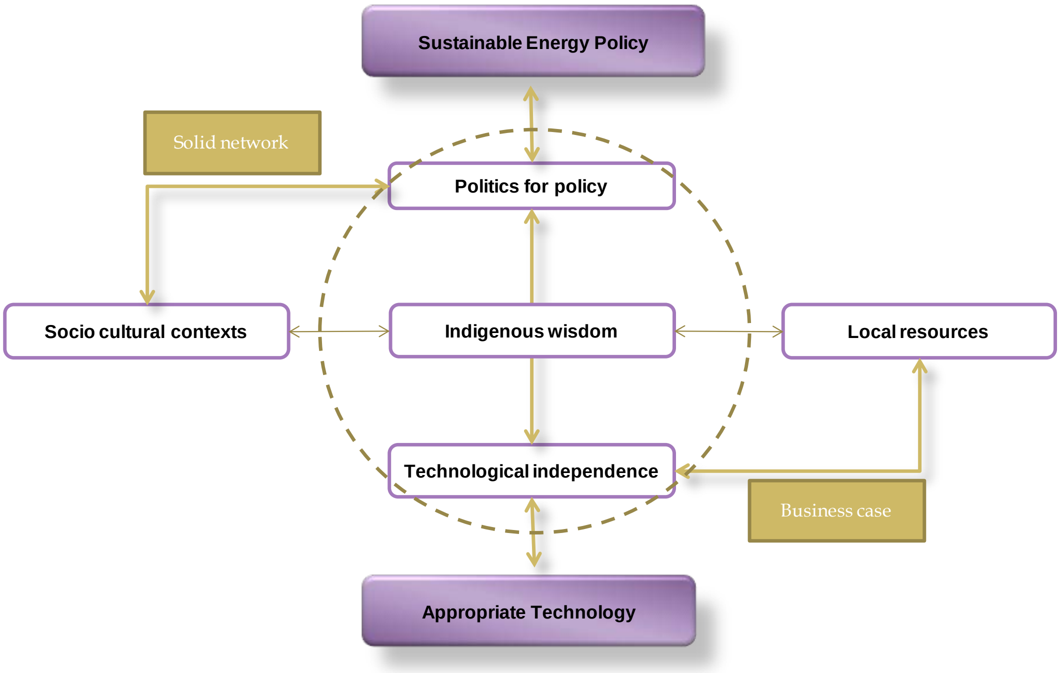

Figure 6-4: The wheel of change - interfaces between sustainable energy policy and appropriate technology

The diagram identifies the weakest points in a vulnerable society's problem system (Figure 6-2) and outlines the interfaces on which the two main themes arising (1) sustainable energy policy and (2) appropriate technology need to be firmly connected. Informed by the problem system the linkages built in this interface answers the question of where a strategy need to be applied to break the cycle of vulnerability (i.e. politics for policy, indigenous wisdom, and technological independence). The reasoning why the linkages become the platform for solution is explained in detail in Section 6.5. How the linkages are best utilised to achieve this (i.e. through business case and solid network) is further explained in detail in Section 6.6.

This synthesis argues that through the wheel of change, the problem system identified in a vulnerable society can be intercepted and intervened. However, this wheel of change needs to turn and the links necessary within have to be built. To turn the wheel and start building the above links, an intervention strategy needs to be designed. The method for intervention identified is through indigenous capability building for sustainable energy appropriate technology implementation and its corresponding policy formulation. The technique to drive this intervention method consists of establishing a strong business case and solid network for indigenous capability building. Agents of change and their roles need to be identified as the main drivers and vectors for getting this wheel of change to turn.

6.5 Intervention method: building indigenous capabilities

Referring back to the conceptual model of a vulnerable society's problem system (Figure 6-2), an intervention strategy is necessary to break the cycle of environmental degradation – social marginalisation – economical underdevelopment - political instability. The following sections explain why building indigenous capabilities in policy making and appropriate technology for sustainable energy implementation serve as a mechanism for this desired intervention of breaking the cycles of vulnerability.

Energy access increases the chance for societal transformations (Fernandez-Baldor et al. 2009; Owen and Garniati 2012; Urmee 2008). It influences economic growth, social and political stability, and environmental health (Dincer and Rosen 1999; MacDonald 2005; WEC 2011), more so in a vulnerable society. Technological solutions exist to ensure equal access to energy, but it alone is not sufficient (Collier and Hoffler 2004; Kruijsen et al. 2011). Appropriateness of selected technology is paramount (Kaplinski 2011; Musango 2011; Weynand 2007) and interfaces must be built between indigenous appropriate technology and sustainable energy policy as the corresponding measure (Garniati et al. 2012). One of which is by addressing the importance of technological independence, decision making which is based on indigenous wisdom, and utilising cultural sensitive politics in paving evidence based, coherent, nation-wide sustainable energy policy making and local community based implementation strategy (Garniati et al. 2012; Garniati et al. 2014).

Based on this concept, a vulnerable society, despite of its present constraints, needs to look forward to a future where it can create its own internal market for energy industry with its indigenous capability in design, installation, manufacturing, operation, and maintenance stages. This process provides a way for achieving human development and eventually social transformation towards a secure energy future through technological independence.

Schemes to prepare the skills and knowledge necessary to support the industry should be built into the master plan of encouraging investments for renewable energy generation. Therefore, creation of an internal market for sustainable energy will be met by availability of indigenous capabilities to fill in the gap of human resources requirement, not only at research and design stages but also more urgently at field management, installation and application levels. In this case, indigenously developing energy provision policy, implementation strategy, and capabilities in the design, manufacture, installation, operation, and maintenance of appropriate technology for using locally available energy resources then becomes the vehicle for sustainably developing a society. This signifies the role of human resources in determining the success of establishing sustainable energy generation and distribution systems. Included in human resources are technical skills, adaptation aptitude, knowledge transfer methods, frame of mind and paradigm setting. Schemes to prepare the skills and knowledge necessary to support the industry should be built into the master plan of encouraging investments for renewable energy generation.

Bridging the identified gaps within human and technological resources in building an indigenous sustainable energy industry and its corresponding policy measure serves as means to fulfil the sustainability and equity aspects of sustainable development. It is achieved through the ability of such an initiative in providing a healthier environment, more stable interactions in the midst of existing social tensions, higher and more equally distributed economic benefits, as well as more committed and integrated political support.

6.5.1 Achieving environmentally sustainability

Designing, manufacturing, and installing the correct appropriate technology; avoiding imports of managerial and technical skills; and maximising the use of locally available natural resources properly administers the environmental corner of sustainable development through bypassing energy intensive processes and ensuring acceptability levels of final energy products. Export of natural resources for financing energy development and import of human and/or technological resources for filling in the gaps in energy production are in themselves energy intensive processes. The environmental costs associated with non-indigenously supported energy production consist of among others carbon dioxide footprints from fuels and water consumption as embedded energy needs to be accounted for in transport of materials between regions. Energy generated through using non-indigenous materials and/or skill sets possesses the risks of being energy negative.

Meanwhile, decommissioning and final disposal is an integral aspect of sustainable energy generation. When energy production inputs are sourced from locally available resources, the amount and types of by-product generated during operational stages and the waste generated after their lifetime will theoretically still be at the levels which their surrounding can relatively more accommodate compared to when inputs are brought in from foreign sources to the region. To ensure that energy generation can uptake locally available resources, the technology must be appropriate to local conditions and the human resource operating the technology must be prepared in advance or as initiatives take off.

6.5.2 Achieving social sustainability

Being socially sustainable holds the implications that an initiative will last beyond the project lifetime and will serve as a mechanism to hold a society intact by preventing the continuation of social conflict cycles. Creating an internal knowledge and skill exchange in the establishment of indigenous appropriate technology implementation for capturing locally available energy sources, will ensure that this capability in sustainable energy development stays in a society even after certain training programmes are completed. If at all possible, internationally sourced managerial and/or technical expertise should be limited to a period of time where gaps in knowledge and skills need to be bridged initially. Initial identification of correct sources of information and agents of transformation is also crucial to determine whether the technological independence goal will be achievable, as the vision in advancing a society needs constant drive and persistence. It is the essential first step in establishing an indigenous knowledge exchange mechanism. However, when the methodologies for internal knowledge exchange has been established and tested, the follow up processes should be able to be carried forward by local communities, thus ensuring that local human capabilities are supported equitably and sustainably.

A vulnerable society with history of and further potential for social conflicts will benefit from building indigenous capabilities in the implementation of appropriate technology particularly in providing means of breaking the conflict cycles. In these societies, cycles of social conflicts are usually triggered by unequal distribution of profits. Therefore, creating jobs by establishing local manufacturing and servicing industries, backed up by a standardised skill force with the abilities both in managerial and technical aspects of energy generation will generate well distributed benefits throughout the surrounding local communities. Areas of operation become an important issue and a determining factor to the success of an energy system initiative. Sensitivities to borderlines between villages have historically driven communities into conflict. While economically providing local communities with income for improving their quality of life, generating an indigenous sustainable energy industry correctly across borders provides a method of gradual social integration and collaboration through a commonly shared interest.

Preventing cycles of social conflict also means that more natural, human, and technological resources can be kept intact and undivided. Thereby providing more secure capital from which more benefits can be shared amongst interested parties. Because when the capital is split up and broken into smaller territorial areas, resource management becomes more difficult and further conflict of interests may arise. The end result of such situations will be less generated and distributed benefits.

6.5.3 Achieving economic sustainability

Little net benefit will be gained by allowing unmanaged flows of resources into and out of any society. Simply importing material, skills, and technology and utilising these components to extract the region's valuable natural resources which are then either sold back to its own people (and the profits banked overseas) or exported (and the profits banked overseas), will result in the same social disintegration and environmental protection failure that the fossil fuel extraction industries had brought. Instead, a vulnerable society should look into the option of doing everything in its powers to keep all financial resources within its own remit. If all capital generated is used to source the necessary raw materials locally, prepare the human resources indigenously, create income schemes to boost market internally, and generate benefits which is able to be distributed equally, all generated financial gains are available for maximising profits internally.

Building indigenous capabilities presents in itself the need to include a justifiable business case for investment purposes. Such bankable initiatives should not completely dependent on aid funding type grants. Soft loans as capital development funds and private investments encourage sustainable business operations, where stakeholders' commitment drives the continuity and levels of financial benefits. This internally driven function in the economic sector becomes one of the primary strengths in sustainably developing the financial sector of any vulnerable society.

6.5.4 Achieving political sustainability

To survive changes of political situations and shifts of powers, any start-up programmes in a vulnerable society must be attached strongly to community-based organisations. Although governmental affiliations serve their purpose in compiling political support during their time of power, community support provides longer-term commitments and continuity to an initiative. Community based cultural organisations, business affiliations, and academics are all points of contacts for building local community trust and strong foundations.

Establishing local competence in the implementation of sustainable generation using appropriate technology requires the commitments and active engagements of various elements of a society. The initiative must have the buy ins of the local communities where energy will be generated and distributed, the involvement of businesses to drive the economic rotor, and the active inputs from academic institutions in developing relevant knowledge exchange materials. This situation suggests that in a vulnerable society, the process of building an indigenous energy industry itself creates the opportunity of uniting various community groups in one long-term effort which is independent from the fluctuations taking place in the government which often undergoes phases of transformations.

As their leaderships are gained through long-term, historically established trust and respect, engaging highly regarded and widely accepted community leaders provides more assurance that the initiative will sustain regardless of changes and shifts in the political domain. This also builds a deeply rooted inter-generational relationship. However, at the surface level, local NGO's may initially also serve as contact point for connecting the initiative to the right individuals within a community.

6.6 Intervention technique: business case and solid network

This section explains how building indigenous capabilities in the implementation of appropriate technology and policy making can be done in a vulnerable society.

To achieve the desired intervention, two important techniques need to be established:

1. A business case for indigenous capability building (Sub-section 6.6.1.)
2. A solid network promoting indigenous capability building (Sub-section 6.6.2)

Both business case and solid network ideally need to be present simultaneously as one feeds into the other in an iterative, closed loop, feed-back mechanism.

6.6.1 Establishing a business case for indigenous capability building

This section is represented by a proposal for business development (Appendix ASTEC Proposal 9.1).

A business case in this context is understood as potential return of investment, profit generation, sustainability of operation and room for development from a proposed initiative. This complete business case should consist of information, analysis, and recommendations on the problem to be solved, illustrating relevant policies' significance, as well as each problem component's severity and complexity. It should identify potential customers and other stakeholders; and also how the defined problem affects them. The case should clearly states assumptions, estimates, and weaknesses in the underlying data. It needs to present the options available to decision maker. Options need to be compared based on their features, costs and benefits, and impacts on stakeholders. The business case should be concluded with a recommended justification and the course of action complete with its strengths and weaknesses.

The work of establishing a business case has benefits beyond the business case itself. The case-building process is an opportunity to view the gaps or weakness in current system's thinking. It serves as well as a toolbox to identify possibilities and opportunities to problem solving that had not been obvious before. Therefore, to establish a business case, projections of future income, expenditure, costs, and benefits are as important as the present baselines. Establishing a business case also means that both local investors and policy makers in a vulnerable society must be engaged in such a way that they facilitate the internal market creation for its own indigenous capability. Valuing ones local expertise needs to be encouraged and facilitated. Only when value is placed on indigenous capabilities, the human development process can be seen as having a strong business case.

Initiating a market means, that potential buyers of either the services or products resulting from building indigenous capabilities in energy technology and policy must be identified and already secured. In the case of indigenous capability in energy technology and policy, the most important buyer of this service and product is potentially the government owned Electricity Company. The state electricity company holds the mandatory obligation to supply electricity to even the remotest regions of a nation. Thereby, a commitment of the electricity company to buy any power generated by local processes (equipment and human resources) is a crucial factor of establishing this business case. Secondary to that, private and/or public owned businesses utilising electricity and/or other means of energy (liquid / gaseous fuels) serve as the next group of most important buyers. When micro generation of energy can be supplied by local processes and is requested by local businesses, a business case for developing indigenous capability is further supported.

Starting up a new initiative in itself holds a significant amount of risk caused by a high degree of uncertainty and high levels of failure impact. This also applies to developing indigenous capability in sustainable energy technology implementation and policy formulation. Notably, local investors are usually very careful up to a level of reluctance in funding a new initiative containing an indigenous capability-building element. Likewise, policy makers are usually not immediately attracted in facilitating the idea through introducing policy measures because there is no immediate financial gain obtained from local investments. There is even an almost visible fear of a backfiring situation, where if policy and its measures are formulated to support indigenous capability building in the business sector, local investors will be driven away from injecting funds into associated area of work.

In this situation, a mitigation strategy may consist of accessing aid funding to reduce initial risks of groundwork, feasibility studies, and pilot cases. Once a feasible scenario has been sufficiently proven, the result could then be utilised as a proof case to attract sufficient commitment from local investors and policy makers. Having argued those points, both local investors and policy makers already have to be engaged from the start of fund raising processes. An important point to make to donors is that, in line with the principles of sustainability, equity, and dignity, aid funding is only requested to help initiate a sustainable business case, not on charitable basis over a long period of time. All three stakeholders in this situation must be clear about the initiative's goal and objectives, so that a true business case can be developed out of local content and within local context.

6.6.2 Establishing a solid network to promote indigenous capability building

This section is represented by MoUs and MoA drafts with stakeholders in Aceh and Indonesia (Appendix 9.5 and Appendix 9.6).

A solid network is identifiable by the commitments of actors involved in a network to work in coherence towards a unified goal. Therefore, the presence of a solid network in a vulnerable society needs to be initiated and further advertised and promoted when established. Steps towards building this network can start from various different angles. The most important element in building a dependable network is consistency and determination. This method of goal setting and work ethic development has been proven in difficult communities to be most effective in attracting the right actors and their affiliations to the intended initiative. This is especially the case with a vulnerable society, where trust is the foundations for all interactions at all levels of the society. Historical relationship is held as valuable as, if not more than professional interactions.

One of the special features of a vulnerable society is that the network is strong if historical relationship between relevant actors provides significant power in channelling interests and priorities towards the same vision and goals. On the contrary, it is weak, when the relationships between relevant actors are only based on financial and/or professional contractual ties. According to document review and field work conducted, as well as the case study analyses, the types of relationships which support a strong network are those which are based on personal commitment and dedication to the goals of sustainable development and community empowerment. A solid network needs to be maintained at sub-national, national, regional, and international basis to ensure that resource mobilisation (in the form of financial and expertise supports) is enabled. A solid network that serves as an intervention technique needs to contain the following societal elements:

- Funding organisations;
- Government;
- Local community organisations including NGOs;
- Academic community;
- Local businesses.

6.7 Intervention vector: Agent of change's roles and significance

Correct timing and accurate actor identification encapsulated as the politics of policy making, are also pre-requisite to ensure policy goals in sustainable energy access is practiced at ground levels. Politics as the fourth component of sustainable energy systems in practice needs to understand how technology works: how devices are manufactured, operated, and maintained, and how engineering systems affect its social/natural surroundings. It needs to value how community functions and interact with its social/natural surroundings. Politics needs to be aware of how the natural environment behaves, dictates limiting factors, and sets boundaries to constraints. Therefore, indigenous capabilities in technical assessment, which enables the selection of appropriate technology, is the set of skills required not only by implementing agents but also by policy makers to formulate coherent and enhance existing sustainable energy policies. This actor – timing dynamics serves as the vector and driving force of this intervention strategy.

The determining factor that dictates the success or failure of an initiative is the availability of agent/s of change within an identified network. To utilise this fully, a momentum must be identified or otherwise 'engineered' through the crossovers between correct timing and correct actor identification (Table 6-1).

6.7.1 Correct timing

Because of the instability in political and social sectors, timing in vulnerably societies becomes a crucial aspect of programme planning. Correct timing refers to the ability to identify the most beneficial time to propose initiative, socialise work packages for support, align network, fund raising, and conduct feasibility studies. Timing does not necessarily run parallel with any particular stakeholder's time frame. It also does not necessarily have to fit in with funding mechanisms required. However, in building indigenous capabilities for sustainable energy technology and policy, timing usually aligns with the ability of agent of change to have enough influence over significant actors in the network. In practice, it is also about utilising moments where certain issues become priorities amongst different networks and stakeholders groups.

6.7.2 Correct actor identification

Key actors and agents of change usually have multiple roles within a vulnerable society. As a common feature, he/she would usually hold multilevel responsibilities and influences across his/her network. An agent of change's formal roles may vary, ranging from government officials, consultants, NGO workers, aid funding bodies' officers, to local business owners and village leaders. Although varying in their roles, an agent of change's significance is constant. Whatever the role the agent is holding at the time, it most likely offers the strength of influence to steer goals and objective, as well as offering flexibility in resource mobilisation and management. He/she must be able to move between different communities within the society and be trusted equally by each one. His/her integrity and loyalty will always be under detailed scrutiny by various stakeholder groups. Therefore, by character, the person must have strong interpersonal quality within and a strong relationship with significant leaders within each community. Influencing opinion and decision making is a large part of an agent of change's role. He/she must possess a broad yet deep knowledge on the overall aim of the society and external perspectives on what needs to happen. These agents of change can be indigenous or foreign to the society, but in either case must have significant attachment to and historical immersion in the social-political dynamics.

There is no fixed formula available to correctly identify such actors. However, there are certain measures that can be applied to help search and identify these characteristics in significant actors. Based on the characteristics described previously, the most likely places where these actors may be found are non-profit organisations. Most of these agents of change, regardless of their titles and roles within formal institutions, would have some form of affiliations with these non-profit organisations. It is based on these affiliations that they utilise and build network on top of existing ones for driving changes as required.

Once building indigenous capabilities in implementing technology and formulating coherent and enhancing existing sustainable energy policies have been created as a concept, its adoption in practice and policy needs to be facilitated by other actors with roles such as:

- testers – to apply it empirically and reporting the results;
- developers – to expand and extend the concept to enhance its relevance;
- champions – promote and support commitment to the concept;
- communicators – to express it in ways that enhanced its appeal to different audiences;
- interpreters – to relate it to different issues and contexts;
- advocates – build more support

Table 6-1: Best and worst case scenarios for steps of politics to transcribe appropriate technology into sustainable energy policies (Garniati et al. 2014)

Step	Explanation	Best case scenario	Worst case scenario
1. Who is responsible for policy modification ?	Evaluations need to be carried out on who is considered to be the agent of change and who would be most likely to succeed in initiating a new paradigm.	Identification of an individual or a group of individuals having the influence and credibility within their society	Discovery that there is no one in the society respected and/or trusted enough to take up this responsibility
2. How will policy modification be initiated?	Decisions need to be made on the start-up of modifying existing policies, whether it should be initiated legally or culturally; nationwide or locally.	A bottom up approach is considered best, especially if there is already some grass root level movement and development	No grass root level activities are found and top down approaches from externals are influenced by profit-making agenda
3. When is the best timing to modify existing policy?	To modify existing policy, certain indication of suitable timeframe is required for optimum effect and sustainability of actions. Knowledge is needed on when a policy to be modified will be influenced and dictated by the local political atmosphere and social readiness to accept changes.	Community based field workers are sensitive to political issues and are embedded in the political decision making process	If such a time has not been identified, it would eventually need to be created and facilitated/constructed
4. What is required to ensure process design's flexibility and robustness ?	Flexibility and robustness allow transfer of acquired knowledge and paradigm between new and old governments, enough to survive shifts of political power	Coherent scope for sub-national, national, and regional priorities for action; this significantly increases flexibility and robustness in process design	Conflicting priorities exist between sub-national, national, and regional priorities for action; this greatly reduces flexibility and robustness in process design

6.8 Summary of Chapter 6

Chapter 6 has given answers the following RQs as outlined below.

As part of the synthesis, a problem system was elucidated in chapter 6 and the functions of this system were defined and detailed. To answer the research questions collated for Objectives 3 and 4, identification of emerging synthesis as this study's novel contribution and future research avenues were also given in chapter 6.

Answering RQ8 for Objective 2

RQ 8: How do specificities of vulnerable societies contribute to problems identified by RQ6?

A vulnerable society, which is characterised by fragile livelihoods and additional exposure to human-induced catastrophes and natural disaster, has 'historical oppression and struggle' as an input to its problem system. This input then fuels the system's function, which is driven by 'quadrochotomous leadership' along with its two interlinked results: inappropriate technology implementation and incoherent policymaking. The output of this system is inequity, resulting from the relative easiness of these societies in becoming targets for exploitative purposes. As already widely established, inequity directly links back to social marginalisation and environmental degradation, both of which are the main root causes and pressures towards fragility of livelihoods, leading to susceptibility to damages caused by exposures to human induced catastrophes and natural disasters. The following sub sections explain and elaborate in detail the components of the problem system and their components' functions as represented by Figure 6-2.

Answering RQs 9 and 10 for Objective 3

RQ 9: How does the external aid match with vulnerable societies with particular reference to the WEIRD membrane?

Based on participatory observations, site visits, and interviews, the external aid/NGO work undertaken in a vulnerable society as discussed above, although having the genuine motivation of alleviating poverty, reducing environmental degradation, supporting better governance, and strengthening social structures, can still very much confined to the standard practices of a WEIRD paradigm. The WEIRD paradigm is found to have influenced implementation programmes (most of the time unintentionally) through choices made on implementation methodology and technology. The un-intended consequences of external aid/NGO work along with the mis-match between their initiative and the local community needs, is argued for in this thesis to be the product of a deeply embedded WEIRD paradigm.

RQ 10: What mechanisms/interfaces are required to link appropriate technologies to sustainable energy policies?

As part of the synthesis construction, interfaces between appropriate technology and sustainable energy policy were outlined; and links created (Figure 6-4: The wheel of change - interfaces between sustainable energy policy and). Following that, explanations were given to why and how building indigenous capabilities in the sustainable policy formulation and appropriate technology implementation to utilise locally available resources serve as an intervention method to break the cycle of identified problem system and function.

Answering RQ11 for Objectives 4

RQ 11: How can the links between appropriate technology and sustainable energy policy be utilised by policy makers as an intervention strategy to empower vulnerable societies and address their problem systems?

The links created between sustainable energy policy and appropriate technology can be utilised to empower vulnerable societies and increase their resilience towards internal and/or external, human induced and/or natural pressures through indigenous capability building for sustainable energy appropriate technology implementation and its corresponding policy formulation. The technique to drive this intervention method consists of establishing a strong business case and solid network for indigenous capability building. Agents of change and their roles need to be identified as the main drivers and vectors for getting this wheel of change to turn.

Appropriate technology is linked to sustainable energy policy by building the following links within the wheel of change:

1. Link both politics and technological independence to indigenous wisdom

2. Link technological independence to local resources

3. Link politics and socio-cultural context

7 Closing

"The only thing that does not change is change itself."

(Heraclitus)

7.1 Introduction to Chapter 7

The research was carried out in 3 stages. This was done to enable data collection results and analysis from the previous stage to inform the next stage of objectives and their subsequent research questions (Figure 1-1). Because of this iterative exchange process, it is acknowledged that the research environment has shaped the research and that the researcher has changed her research environment by conducting the research itself. An outline of how the researcher has contributed to both the research process and research environment is presented as Figure 1-2. The research process started with a case study by which steps were built towards identifying categories, identifying themes, identifying linkages, integration of ideas, and synthesising emergent theory whist influencing policy and capacity building in practice. The fieldworks necessary in conducting the research process were supported by various organisations providing funding sources and other in-kind contributions. Meanwhile, the research environment also evolved within the duration of the action research through capacity building and network integration.

Data collection in this PhD research was enabled by the significant trust established between the researcher and the research subject. To achieve this condition, respect for indigenous knowledge, sensitivity, and humility are the key personal characters that a researcher working in this area must have. Flexibility in time management, planning, and use of techniques are necessary to mitigate the many uncertainties that can be encountered during such field work.

The role of local key actors in facilitating this trust building is one of the most determining factors to the success of information gathering in Aceh. Introductions to extended networks were determinant in assessing the breadth and depth of the core issues, enabling more holistic and coherent analysis. Therefore, correct actor identification as further discussed in section 6.7.2, is crucial to the understanding of a vulnerable society's problem system and the subsequent intervention strategy.

7.2 Conclusion of PhD research

The PhD research has led to 2 important concluding points:

1. Establishing a local business case for indigenous, appropriate technology, utilising a solid network which receives committed, political support, is an effective intervention strategy to fast track the deployment of sustainable energy systems, which breaks the cycle of vulnerability through social transformation and community empowerment.
2. Being aware of their own 'WEIRD' mindsets is a first step for knowledge exchange practitioners to overcome cultural differences and to introduce the intervention strategy.

Creation of intervention strategy

An intervention strategy is necessary to break the cycle of vulnerability. Breaking this cycle of a vulnerable society's problem system requires that links to be built between sustainable energy policy and appropriate technology. This is achieved by building indigenous capabilities through establishing a business case and solid network in the implementation of appropriate technology and policy making to utilise locally available resources.

<u>Intervention method:</u>

This PhD work argues that establishing a business case for indigenous, appropriate technology, which receives committed, political support at sub-national, national, and regional levels, is an effective intervention tool for social transformation and community empowerment towards fast tracking deployment of sustainable energy systems in a vulnerable society.

<u>Intervention techniques:</u>

To achieve the desired intervention, two important techniques need to be established:

- A business case for indigenous capability building (discussed in Sub-section 6.3.1)
- A solid network promoting indigenous capability building (discussed in Sub-section 6.3.2)

Intervention driver and vector:

The determining factor which dictates the success or failure of an initiative is the availability of agent/s of change within an identified network. To utilise this fully, a momentum must be identified or otherwise 'engineered' through the crossovers between correct timing and correct actor identification.

7.3 Limitations to conclusion

The conclusion to this PhD research was derived from Aceh, the chosen, single case study, where the research is conducted in more than one language. Therefore the conclusion potentially has the following limitations:

- The use of mixed methods in triangulation to search for converging findings from different sources may result in less focused assessment when compared to using a particular method;
- Because some elements of this thesis were derived from conclusions and/or lessons learnt from implementation programmes, chain of evidence in the form of summaries of interview and meeting results may contain joint practical notes intended to support a number of different initiatives;
- Iteration of theoretical statements may present too detailed descriptions of conditions and arguments to ideas; causing difficulties when generalising results;
- Because translations were sometimes performed by other than the researcher, certain technical terminologies may be mis-interpreted and/or mis-communicated during data acquisition;
- Because translations occurred during data acquisition and analysis, the researcher's subjectivity may cause an incomplete process of construction of meaning.

7.4 Impact of research

The impact of the intervention strategy proposed in this PhD thesis is assessed on the basis of concept acceptance, initiative progression, and collaborative work taken up by different government and non-governmental organisations, as well as funding bodies operating in Aceh Province, Indonesia, and South East Asia.

7.4.1.1 Government policy and policy measures (regulation) on marine energy

Between the years 2010 to 2014, there have been new policies and policy measures put in place to support marine energy development in Indonesia which incorporates elements of "appropriateness" of selected energy technology in the context of Indonesia's physical and social environment as a maritime, distributed, society.

<u>Targets for supply and utilisation of primary and final energy</u>

- On the targets for supply and utilisation of primary and final energy, the development of renewable energy sources such as solar, water, wind, biomass, and ocean becomes the government's priorities as, according to the new regulation, the use of renewable energy will be increased from 6 percent at present to at least 23 percent in 2025 and at least 31 percent in 2050. Source: *The Jakarta Post, January 29 2014;*
- Specifically on marine energy, Government Regulation on National Energy Policy - National energy resources use is conducted by National and/or Local Government based on the following strategy;
- Utilisation of renewable energy from water, geothermal, ocean, and wind are directed for electricity (Article 12, paragraph 1(a));
- Utilisation of ocean energy resources should be fast-tracked by pilot project and connection to electricity grid (Article 12, paragraph 7);
- Energy infrastructure is developed by focusing on Indonesia's geographical condition which largely consists of marine waters by strengthening exploration, production, transport, distribution, and transmission in the archipelago (Article 23 paragraph 3). It is achieved by also strengthening energy industry capacities by supporting solar and ocean energy systems and components (Article 24, paragraph 2(d)).

7.4.1.2 Creation of decision-making network

The impact of this PhD research is also represented by the fact that the intervention strategy has attracted the support and buy-ins from the Indonesian Government to establish capacity building programme in the sustainable energy sector:

- ESDM – INOCEAN commitment for South East Asia Marine Energy Centre (SEAMEC);
- ESDM – P3GL budget preparation for 1MW marine energy pilot project
- Development of Centre of Excellence in marine energy as a partnership between ITS and RGU. MoU in place, MoA in final stages of agreement, expected implementation September 2014;
- Two universities in Indonesia, Universitas Nasional (UNAS) and Institut Teknologi Sepuluh November Surabaya (ITS) have signed MoUs and are finalising MoAs with RGU to collaborate in developing indigenous capabilities in the research, teaching, and training for sustainable energy policy development and appropriate technology implementation through the establishments of in-country Centres of Excellence Development;
- Indonesian Ocean Energy Association (INOCEAN) and the Ministry of Research and Technology (RISTEK) have endorsed and agreed to collaborate as active counterparts to the preliminary work funded by UKCCU in marine energy. These partnerships are based on the mutually shared vision of influencing policy development in the context of providing equal energy access to both urban and remote societies spread out in the Indonesian archipelago. The partnership and endorsement of activities within the Indonesian territory is an explicit support for the concept development of vulnerable society, sustainable energy policy in practice, and appropriate technology for development (Endorsement letter from RISTEK presented in section 9.7).

The impact of this PhD research is also represented by the fact that it has attracted the support and buy ins from international stakeholders for Acehnese, Indonesian, and South East Asian policy development and sustainable energy initiatives start up in the area of climate change mitigation, disaster management, and green infrastructure:

- United Nations Development Programme (UNDP) has funded an initiative to create a sustainable energy outlook for Aceh utilising the basic concepts of vulnerable society, sustainable energy policy in practice, and appropriate technology for development. This substantial piece of work has shown that there is confidence given by an international development organisation to the argument put forward in this PhD thesis. Furthermore, the novel concept developed by this PhD thesis is taken as a suitable approach to influence the future of sustainable energy strategy in Aceh; a sub-nation of Indonesia, which itself is a vulnerable society;
- UK Climate Change Unit for Indonesia (UKCCU), which consists of UK Department for International Development (DFID), Department of Energy and Climate Change (DECC), and the Foreign and Commonwealth Office (FCO) has funded the Feasibility Study of Marine Energy in Indonesia as part of a three-phased support programme to the sector. The assessment methodology is largely based on the concepts of vulnerable society, sustainable energy policy in practice, and appropriate technology for development, put in context to marine energy development. This clearly demonstrates that the intervention strategy argued for through this PhD thesis is accepted by a UK based international organisation as the appropriate means to achieve the desired goal of energy sustainability and climate change, whilst at the same time addressing the issues of energy security and policy development ;
- European Commission (EC) Delegation for ASEAN is currently preparing to accommodate and support the concepts of vulnerable society, sustainable energy policy in practice, and appropriate technology for development, in the context of energy, climate change, and disaster preparedness based on ongoing discussions with the researcher (Confidential Material);
- Supported by the EC, Indonesian Energy Council (DEN) and ASEAN Centre for Energy (ACE) have expressed the interest in engaging with and supporting an initiative tailored to assist the renewable energy

strategy development for South East Asia which promotes the concepts of vulnerable society, sustainable energy policy in practice, and appropriate technology for development. (Confidential Material);

- In relations to the strategy supported by DEN and ASEAN, the Presidential Unit for Monitoring and Oversight (UKP4) and the Presidential Advisory has expressed the interest and specifically discussed the development of this PhD research outcome as an important intervention strategy for Indonesia's sustainable energy framework, particularly in appropriate technology and sustainable energy policy for vulnerable societies (Aceh and other relevant sub-nationals) (Confidential Material).

7.5 Implications of research findings

Implications of research to theory

- The research contributes to the theory of vulnerability. The identification of actor-driven processes in a vulnerable society's problem system provides a mechanism of identifying where themes arise as the weakest points, thereby where linkages need to be built to break that cycle of vulnerability;

- The research findings contribute to the field of sustainable energy in practice. It provides an intervention strategy to implement a sustainable energy system, applicable in other vulnerable societies. Utilising the same methods, the researcher expects to initiate future work in other vulnerable societies such as Timor Leste and West Papua;

- Furthermore, it contributes to the field of appropriate technology. The "WEIRD" mindsets of actors involved in knowledge exchange activities in a vulnerable society, have been found to influence the outcome of assessments in the appropriateness aspects of a given technology.

Implications of research to policy in practice

The research finding is expected to give confidence to the governments of vulnerable societies in designing policies that incorporate indigenous wisdom as the central link between sustainable energy and appropriate technology. To fast track of energy technology deployment towards community empowerment and social transformation, it is expected to give confidence to policy makers and initiative implementers to incorporate local knowledge in building a business case which is based on sustainable utilisation of locally available resources using appropriate technology. It is also expected that the research encourages new networks to be built connecting politics in policy making to socio-cultural contexts.

Implications of research to policy process

The research has shown that in a vulnerable society, a policy change needs to be approached from both “bottom up” and “top down” processes in continuous iterations. The bottom up process ensures that indigenous wisdom is captured and accommodated, thereby creating buy-ins from the local communities as the final beneficiaries. Meanwhile, the top down approach ensures that any implementation strategies are in line with both micro and macro policies, ensuring sub-national and national coherence thereby allowing equal access to and optimising distribution of resources.

7.6 Future work

Ongoing correspondence and long-term contacts with organisations working in other vulnerable societies are being established for access to publications that are not available online and for access for conducting field work as primary data collection method. This process and its results will become a major component of future work in taking the conclusions of this PhD research further. There are three major grouping of further work that can potentially be carried on to extend the knowledge generated from this PhD research:

1. **Validation of synthesis in other vulnerable societies as case studies.** There are currently 3 PhD students testing the synthesis of this research focusing on: (1) Appropriate micro hydro technology in remote regions of Indonesia, (2) Role of network building in incorporating socio-cultural context in the politics of policy making in North Togo, and (3) Establishing

a business case for marine energy technology which links appropriate technology to locally available resources in areas around Niger Delta.

2. **Investigation of possible antitheses for the new formulated understanding (thesis).**

   The role of sustainable energy in a vulnerability society as a complex and dynamic issue can be addressed from multiple perspectives. Besides acquiring the buy-ins of sustainable energy policy makers and development implementers as this thesis has demonstrated, it would be beneficial to open this proposed intervention strategy to assessments from other point of views e.g. individual economic and/or political angles.

3. **In-depth study on the transferability of intervention strategies amongst vulnerable societies**.

   Working on the basis that the intervention strategy has been tested in a number of other vulnerable societies and assuming that assessments from other point of views have validated the thesis, it would be beneficial to perform an in-depth study on the factors determining which characteristics of a vulnerable society dictates the transferability of this intervention strategy.

8 References

8.1.1.1 References for Chapter 1

BRATHWAITE, J. et al., 2010. *Anomie and violence: non-truth and reconciliation in Indonesian peace building*. Canberra: Australian National University E Press.

BROWN, C., 2010. *Harvard referencing for the Robert Gordon University*. Aberdeen: Robert Gordon University

BUREAU FOR CRISIS PREVENTION AND RECOVERY (BCPR), 2012. *Annual report 2011*. New York: UNDP.

CROISSANT, A and TRINN, C., 2009*. Culture, identity, and conflict in Asia and South East Asia*. International Culture Dialogue.

CRYER, P., 2006. *The research student's guide to success*. 2nd ed. Maidenhead: McGraw-Hill International.

DIAMOND, J., 2012. *The world until yesterday: What can we learn from traditional societie?* New York: Viking Penguin.

EUROPEAN COMMISSION, 2012. *General guidelines on operational priorities for humanitarian aid in 2013 (working paper 405).* Brussels: European Commission.

GUNNINGHAM, N., 2013. Managing the energy trilemma: the case of Indonesia. *Energy Policy,* 54, pp. 184–193.

OWEN A. and GARNIATI, L., 2012. *Aceh Sustainable Energy Outlook*: *Scoping Report for Aceh Green Secretariat*. Banda Aceh: Aceh Green Secretariat.

OWEN, A. and GARNIATI, L., 2014. *Marine Feasibility Study for Indonesia*. Jakarta: UK Climate Change Unit (unpublished strategic documents)

PHILIPS, E. and PUGH, D., 2000. *How to get a PhD: a handbook for students and their supervisors*. 3rd ed. Buckingham: Open University Press.

WORLD BANK, 2014. The Africa Renewable Energy and Access Program (AFREA). [online]. Available from: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/EXTAFRREGTOPENERGY/0,,contentMDK:22500298~menuPK:8913746~pagePK:34004173~piPK:34003707~theSitePK:717306,00.html [Accessed 7 April 2014].

8.1.1.2 References for Chapter 2

AKINSETE, E., 2012. *Approaches to regeneration and sustainable development: a study of impact assessment and evaluation in the Northwest of England*. Unpublished D.Phil thesis, University of Bolton.

ASHWORTH, J.H. and NEUENDORFFER, J.W., 1982. Escaping the rural energy dilemma: a process for matching technologies to local needs and resources. *World Development*, 10(4), pp. 305-318.

BAKER, R.C. and BETTNER, M.S., 1997. Interpretive and Critical Research in Accounting: a commentary on its absence from mainstream accounting research. *Critical Perspectives on Accounting*, 8 (4), pp. 293-310.

BALDVINSDOTTIR, G., HAGBERG, A., JOHANSSON, I., JOHANSSON, K. and MARTON, J., 2003. The role of trust in accounting research. *Proceedings presented at the 26th Annual Congress of the European Accounting Association.* April 2-4.

BRYSON, J.M., 2004. What to do when stakeholder matter. Stakeholder identification and analysis techniques. *Public Management Review*, 6(1), pp. 21-53.

BURELL, G. and MORGAN, G. 2005 (reprint). *Sociological paradigms and organisational analysis elements of the sociology of corporate life*. Burlington: Ashgate Publishing Company.

CHANNA, S., 1992. The classical ethnographies. In Subhadra Mitra ed. *Nagaland: a contemporary ethnography*. New Delhi: Cosmo. pp. 11-41.

CHANNA, S., 1998. Gender and social space in a Haryana Village. *Indian Journal of Gender Studies.*

CHARMAZ, K., 2006. *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis.*

London: Sage Publications.

CHILISA, B., 2005. Educational research within postcolonial Africa: a critique of HIV/AIDS research in Botswana. *International journal of qualitative studies in education*, 18, pp. 659-684.

CHUA, W.F., 1986. Radical Developments in Accounting Thought. *The Accounting Review*, 61 (4), October.

CIPRIANI, A. and GEDDES, J., 2003. Comparison of systematic and narrative reviews: the example of the atypical antipsychotics. *Epidemiologia. e psichiatria sociale*, 12(3), pp. 146-153.

COHEN, D. and CRABTREE, B., 2006 *Qualitative Research Guidelines Project.* [Online]. Available from: http://www.qualres.org/HomeCrit-3518.html [Accessed 1 March 2011].

COHEN, L. MARION, L and MORISSON, K., 2007. *Research methods in education 6th edition.* London: Routledge.

COLLINS, A.J. and FAUSER, B.C.J.M., 2005. Balancing the strengths of systematic and narrative reviews. *Human reproduction update*, 11(2), pp. 103-104.

COOK, D.J., MULROW, C.D., and HAYNES, R.B., 1997. Systematic reviews: synthesis of best evidence for clinical decisions. *Ann intern med*, 126, pp. 376-380.

CORNFORD, T., SMITHSON, S., 1996. *Project research in information systems*. London: Macmillan.

CRESWELL, J., 1998. *Qualitative inquiry and research design: choosing among five traditions*. London: Sage Publications Ltd. pp.74.

CRESWELL, J., 2009. *Research design qualitative, quantitative, and mixed methods approaches*. Thousand Oaks: Sage Publications Ltd.

CROTTY, M., 1998. *The foundations of social research*. London.: Sage Publications.

DENZIN, N.K. and LINCOLN, Y.S., 1998. *Strategies of qualitative inquiry*. London: Sage Publications Ltd.

DENZIN, N.K. and LINCOLN, Y.S., 2000. Introduction: the discipline and practice of qualitative research. In DENZIN, N.K. and LINCOLS, Y.S., ed. *Handbook of qualitative research*. Thousand Oaks: Sage Publications. pp. 1-28.

DIAKOULAKI, D. and KARANGELIS, F., 2007. Multi-criteria decision analysis and cost–benefit analysis of alternative scenarios for the power generation sector in Greece. *Renewable and Sustainable Energy Reviews,* 11(4), pp. 716-727.

EDMONDSON, A. C. and McMANUS, S. E., 2007. Methodological Fit in Organizational Field Research, *Academy of Management Review,* 32(4), pp.1155–1179.

EMERSON, R.M., FRETZ, R.I. and SHAW, L.L., 2001. Participant observation and filed notes. In ATINSON P., COFFEY, A., DELAMONT, S., LOFLAND, J., LOFLAND, I., ed. *Handbook of ethnography.* Thousand Oaks: Sage Publications pp.. 356-357.

EISENHARDT, K. and GRAEBNER, M., 2007. Theory Building from Cases: Opportunities and Challenges, *Academy of Management Journal*, 50(1), pp.25-32.

ESPOSITO, N., 2001. From meaning to meaning: the influence of translation techniques on non-English focus group research. *Qualitative Health Research*, 11(4), pp. 568-79.

GLASER, B. and STRAUSS, A., 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Researc*h. New Jersey: Transaction Publishers.

GUBA, E.G. and LINCOLN, Y.S., 1998. Competing Paradigms in Qualitative Research. In DENZIN, N. K. and LINCOLN, Y.S. ed. *The Landscape of Qualitative Research: Theories and Issues.* London: Sage Publications.

GUBA, E.G. and LINCOLN, Y.S., 2005. Paradigmatic controversies, contradictions and emerging confluences. In DENZIN, N.K. and LINCOLN, Y.S. ed. *The Sage Handbook of Quantitative Research*. London: Sage Publications.

GRIX, J., 2004. *The foundations of research*. London: Palgrave Macmillan.

HERMANS, L.M., THISSEN, W.A.H., 2009. Actor analysis methods and their use for public policy analysts. *European Journal of Operational Research*, 196, pp.808-818.

HOLDEN, M.T, 2004. Choosing the appropriate methodology: understanding research philosophy. *The Marketing Review*, 4, pp. 397-409.

HOOPER, K., 2001.Positivist, interpretative and case study research. In HOOPER, K.; DAVEY, H., JOHNS, S., OLDFIELD, W. ed. *Issues in Accounting: A New Zealand Perspective*. New Zealand: Dunmore Press.

JOHNSON, B. and CHRISTENSEN, L. 2004, *Educational research: Quantitative, qualitative, and mixed approaches, Research Edition*, 2nd ed. Boston: Allyn & Bacon.

JONSSON, S. and MACINTOSH, N.B., 1997. Cats, rats, and ears: making the case for ethnographic accounting research. *Accounting, Organizations, and Society* 22 (3/4), pp. 367-386

KENIS, P. and SCHNEIDER, V., 1991. Policy networks and policy analysis: Scrutinizing a new analytical toolbox. In: Marin, B., Mayntz, R. eds. *Policy Networks*. *Empirical Evidence and Theoretical Considerations.* Frankfurt: Campus Verlag.

KUMAR, R., 2005. *Research methodology: a step by step guide for beginners.* 2nd ed. London: Sage Publications Ltd.

LEVITAN, B., 2010. *Cost Benefit Analysis.* [Online]. Available from: http://www.mmu.ac.uk/bit/docs/Cost-Benefit-analysis-toolkit-v2.pdf [Accessed 2 December 2013].

MACARTHUR, J., 1997. Stakeholder analysis in project planning; Origins, applications, and refinements of the method. *Project Appraisal* 12(4), 251-265.

MALINOWSKI, B., 1961 (reprint). *Argonauts of the Western Pacific*. New York: E.P.Dutton

MAYER, I.S., VAN DAALEN, C.E. and BOTS, P.W.G., 2004. Perspectives on policy analyses: a framework for understanding and design. *Journal of Technology, Policy and Management*, 4 (2) pp 169-191.

McGOODWIN, J.R., 2001. *Food and Agricultural Organisation fisheries technical paper 401*. Rome: Food and Agricultural Organisation of the United Nations.

MENCHER, J.P., 1975. Viewing hierarchy from the bottom up. In BATEILLE, A. and MADAN, T.N. ed. *Encounters and Experience: Personal Accounts of Fieldwork*. Delhi: Vikas.

MERTENS, D.M., 2007. Transformative paradigm: mixed methods and social justice. *Journal of mixed methods research*, 1(3), pp. 212-225.

MERRIAM, S., 1998. *Qualitative research and case study applications in education*. San Fransisco: Jossey-Bass Publishers.

MILES, M.B. 1979. Qualitative data as an attractive nuisance: The problem of analysis. *Administrative Science Quarterly*, 24(4), pp. 590-601.

MORGAN, G. and SMIRCICH, L., 1980. The case for qualitative research. *Academy of management review*, 5(4), pp. 491-500.

PATTON, M., 2002. *Qualitative research and evaluation methods*. 3rd ed. Thousand Oaks: Sage Publication.

SCOTT, J., 2000. *Social Network Analysis*. *A Handbook*. 2nd ed. London: Sage London.

SHANKLAND, A., 2000. *Analysing policy for sustainable livelihoods: IDS research report*. Brighton: Institute of Development Studies.

SILKA, L., 2005. *Building culturally competent research partnerships*. Paper presented at the annual meeting of the American Psychological Association, Washington DC.

SIMONS, H., 2006. Ethics in evaluation. In: SHAW, I., GREENE, J., and MARK, M., ed. *Handbook of evaluation: policies, programs, and practices*. London: Sage Ltd. pp. 243-265.

SORELL, S., 2007. Improving the evidence base for energy policy: The role of systematic reviews. *Energy policy*, 35(3), pp. 1858-187.

SQUIRES, A., 2009. Methodological challenges in cross language qualitative research: a research review. *International Journal of Nursing*, 46(2), pp. 277-287.

STUFFLEBEAM, D.L., MADAUS, G.F. and KELLAGHAN, T., 2000. *Evaluation models: Viewpoints on educational and human services evaluation*. *2nd ed*. Boston: Kluwer Academic Publishers.

TASHAKKORI, A. and TEDDIE, C., 2003. Mixed *methodology: combining qualitative and quantitative approaches*. Thousand Oaks: Sage publications.

TAYLOR, B., KERMODE, S. and ROBERTS, K., 2006. *Research in nursing and health care: evidence for practice*. South Melbourne: Thomson.

TELLIS, W., 1997. *Introduction to case study. The Qualitative Report.* [online]. Available from: http://www.nova.edu/ssss/QR/QR3-2/tellis1.html [Accessed 8 July 2013].

TRAVERS, M., 2001. *Qualitative Research through Case Studies.* London: Sage Publication.

WEAVER, K. and OLSON, J.K., 2006. Understanding the paradigms used for nursing research. Journal of Advanced Nursing, 53(4), pp. 494-469.

YANOW, D., 2000. *Conducting interpretive policy analysis*. California: Sage Publications.

YIN, K.R., 2003. *Case study research: Design and methods*. 3rd ed. Thousand Oaks: Sage Publication.

VAN DER LEI, T., 2009. Relating actor analysis methods to policy problems. Unpublished D.Phil thesis. Technische Universiteit Delft.

VASILACHIS de GIALDINO, I., 2011. *Ontological and Epistemological Foundations of Qualitative Research.* [online]. Available from: http://nbn-resolving.de/urn:nbn:de:0114-fqs0902307 [Accessed 8 July 2013]

8.1.1.3 References for Chapter 3

References for vulnerable society

ADGER, W.N., HUGHES, T.P., FOLKE, C., CARPENTER, S.R. and ROCKSTROM, J., 2005. Social-ecological resilience to coastal disasters. *Science* 309, pp.1036–1039.

ALCANTARA-AYALA, I., 2002. Geomorphology, natural hazards, vulnerability and prevention of natural disasters in developing countries. *Geomorphology*, 47(2-4), pp.107-124.

ALLENBY, B. and FINK, J., 2005. Towards Inherently Secure and Resilient Societies. *Science* 309, pp. 1034–1036.

ASEAN, *Roadmap for an ASEAN community 2009-2015*. Jakarta: ASEAN Secretariat, 2010.

BIRKMANN, J., 2006. Measuring vulnerability to promote disaster-resilient societies: Conceptual frameworks and definitions. In: Birkmann, J, ed. *Measuring Vulnerability to Natural Hazards – towards Disaster Resilient Societies*. United University Press. pp. 9-54.

BOHLE, H.G., 2001. Vulnerability and criticality: perspectives from social geography. *IHDP Update 2/2001*, Newsletter of the International Human Dimensions Programme on Global Environment Change: 1-7.

BOLLIN, C., CA´ RDENAS, C., HAHN, H. And VATSA, K.S. *Natural Disaster Network; Disaster Risk Management by Communities and Local Governments.* Washington, D.C.: Inter-American Development Bank; 2003. available at http://www.iadb.org/sds/doc/GTZ%2DStudyFinal.pdf.

BROOKS, N., 2003. *Vulnerability, risk, and adaptation: A conceptual framework*. Tyndall Centre for Climate Change Research.

CHAMBERS, R. and CONWAY, G.R. 1992. Sustainable Rural Livelihoods: Practical Concepts for the 21st Century. Discussion Paper 296. Brighton, UK: Institute of Development Studies.

COLLIER, P. and HOEFFLER, A., 2004. Policy and growth in post-conflict societies. *European Economic Review*, 48(5), pp. 1125-1145.

DAVIDSON, R. *An Urban Earthquake Disaster Risk Index*, The John A. Blume Earthquake Engineering Center, Department of Civil Engineering, Report No. 121, Stanford: Stanford University; 1997.

DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID), 1999. Sustainable Livelihood Guidance Sheets, London: DFID, available at http://www.livelihoods.org/info/info_guidancesheets.html.

EUROPEAN COMISSION, *Commission of working document: General guidelines on operational priorities for humanitarian aid in 2013*. Brussels: European Commission, 2012.

FOLKE, C., CARPENTER, S., ELMQVIST, T., GUNDERSON, L., HOLLING, C.S. and WALKER, B., 2002. Resilience and sustainable development: building adaptive capacity in a world of transformation, *Ambio* 31(5), pp. 437–440.

FOOD AND AGRICULTURAL ORGANISATION (FAO). *Access to rural land and land administration after violent conflicts*. *FAO land tenure studies.* Rome: Food and Agricultural Organisation of the United Nations, 2005.

GARNIATI L., OWEN, A., KRUIJSEN, J.H.J., ISHADAMY, Y. and WIBISONO, I., 2012*. Interface between appropriate technology and sustainable energy policy SET*; *2012 Sept 2-5; Vancouver, Canada*. Sustainable Energy Technology; 2012.

HANDMER, J.W., DOVERS, S. and DOWNING, T.E., 1999. Societal vulnerability to climate change and variability. *Mitigation and Adaptation Strategies for Global Change*, 4, pp. 267-281.

HOVDEN, J., 2004. Public policy and administration in a vulnerable society: regulatory reforms initiated by a Norwegian Commission. *Journal of Risk Research,* 7(6), pp.629-641.

KASPERSON, R., 2005. *Human Vulnerability to Global Environmental Change: The State of Research, Presentation at the Fifth Annual IIASA-DPRI Forum Integrated Disaster Risk Management*, Sept 14–18; Beijing, China, Innovations in Science & Policy: 2005.

OLIVER-SMITH, A., 2004. Theorizing Vulnerability in a Globalized World: A Political Ecological Perspective. In: G. Bankoff, G. Frerks and D. Hilhorst, ed.

Mapping Vulnerability: Disasters, Development and People, London: Earthscan, pp. 10–24.

OWEN, A. and GARNIATI, L., 2012. *Aceh Sustainable Energy Outlook*: *Scoping Report for Aceh Green Secretariat*. Banda Aceh: Aceh Green Secretariat.

ROXANA, L., SCHROTER, D. and GLADE, T., 2013. Conceptual Frameworks of Vulnerability Assessments for Natural Disasters Reduction, [Online]. Available from: http://www.intechopen.com/books/approaches-to-disaster-management-examining-the-implications-of-hazards-emergencies-and-disasters/conceptual-frameworks-of-vulnerability-assessments-for-natural-disasters-reduction. [Accessed on 15 June 2013].

SCHMIDT, A., BLOEMERTZ, L. and MACAMO, E., 2005. Linking Poverty Reduction and Disaster Risk Management, [Online]. Available from: http://www.preventionweb.net/files/1092_enlinkingpovreddrm.pdf. [Accessed 20 July 2013].

SHANKAR, G. Post disaster management, poverty, and food. Posted on March 22nd, 2011 in Disaster Management, Earth Observation, and Health. Eartzine [Online]. Available from: http://www.earthzine.org/2011/03/22/post-disaster-management-poverty-and-food/Washington, D.C. [Accessed 29 December 2012].

SHRINIVAS, H. and NAKAGAWA, Y., 2008. Environmental implications for disaster preparedness: from the Indian Ocean Tsunami. *Journal of Environmental Management*, 89(1), pp. 4-13.

SMIT, B. and WANDEL, J., 2006. Adaptation, adaptive capacity, and vulnerability. *Global environmental change*, 16, pp. 282-292.

TURNER, B. L., KASPERSON, R.E., MATSON, P.A., MCCARTHY, J.J., CORRELL, R.W., CRISTENSEN, L., ECKLEY,, N., KASPERSON, J.X., LUERS, A., MARTELLO, M.L., POLSKY, P C., PULSIPHER, A and SCH ILLER, A., 2003 ‘‘A framework for vulnerability analysis in sustainability science’’, Proceedings of the National Academy of Sciences, 100(14), pp. 8074–8079.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP), 2008. *UNDP Post-Conflict Economic Recovery. Crisis and Recovery Report 2008*. New York: UNDP.

UNITED NATIONS*. The Millennium Development Goals (MDG) Report 2011*. New York: UN; 2011.

WISNER, B., BLAIKIE, P., CANNON, T. and DAVIS, I., 2004. *At Risk: Natural hazards, People's Vulnerability, and Disasters,* 2nd ed. London: Routledge.

WEYNAND, G. *Developing energy programme in post-conflict countries. Energy team of Office of Infrastructure and Engineering Bureau for Economic Growth Agriculture and Trade Presentation*. USAID; 2007.

References for sustainable energy

ABDULLAH, K., 2005. Renewable energy conversion and utilisation in ASEAN countries. *Energy* 30(2-4), pp. 119-128.

ADAM, L. *Pengembangan energi alternatif dalam meningkatkan kinerja UMKM. Katalog dalam terbitan pustaka dokumentasi dan informasi ilmiah*. Jakarta: Indonesian Institute of Sciences (LIPI) 2009.

AHMAD, S., KADIR, M.Z.A.A. and SHAFIE, S., 2011. Current perspective of the renewable energy development in Malaysia. *Renewable and Sustainable Energy Reviews,* 15(2), pp. 897-904.

AKINSETE, E., 2012. *Approaches to regeneration and sustainable development: a study of impact assessment and evaluation in the Northwest of England*. Unpublished D.Phil thesis, University of Bolton.

ARNDT, C., BENFICA, R., TARP, F., THURLOW, J. and UAIENE, R., 2009. Biofuels, poverty, and growth: a computable general equilibrium analysis of Mozambique. *Environment and Development Economics,* 15(1), pp. 81–105.

ATCHATAVIVAN, P. *ASEAN energy cooperation: An opportunity for regional sustainable energy development* 2009. [Online]. Available from:

http://pon.harvard.edu/wp-content/uploads/images/posts/ASEAN_Energy_Cooperation.pdf. [Accessed 22 December 2012].

BURGER, R.J., ALLEN, C.D., BROWN, J.H., BURNSIDE, W.R. and DAVIDSON, A.D., 2012. The macro ecology of sustainability. PLoS Biol 10(6): e1001345. doi:10.1371/journal.pbio.1001345

CHUA, S.C. and OH, T.H., 2010. Review on Malaysia's national energy developments: Key policies, agencies, programmes, and national involvement. *Renewable and Sustainable Energy Reviews*, 14(9), pp. 2916-2925.

COLLIER, P. and HOEFFLER, A., 2004. Policy and growth in post-conflict societies. *European Economic Review*, 48(5), pp. 1125-1145.

DARYANTO, A. *Analisis kebijakan pemerintah di bidang energi: penanaman jarak pagar sebagai solusi alternatif pengadaan sumber daya eneri terbarukan, Pengembangan Jarak Pagar untuk Biodiesel dan Minyak Bakar*. Bogor: Institut Pertanian Bogor 2005.

DEMIRBAS, A.H. and DEMIRBAS, I., 2007. Importance of rural bio-energy for developing countries. *Energy Conversion and Management*, 48(8), pp. 2386-2398.

DOKU, A. and DI FALCO, S., 2012. Bio-fuels in developing countries: are comparative advantages enough? *Energy Policy*, 44, pp. 101-117.

EL FADEL, M., RACHID, G., EL SAMPRA, R., BOU BOUTROS, G. and HASHISKO, J., 2013. Knowledge management mapping and gap analysis in renewable energy: towards a sustainable framework in developing countries. *Renewable and Sustainable Energy Reviews*, 20, pp. 576-584.

FANG, J., MACGILL, I. and OUTHRED, H. *Sustainable Energy Services Delivery in East Timor*. Sydney: School of Electrical Engineering and Telecommunications, The University of New South Wales; 2004.

GARNIATI L., OWEN, A., KRUIJSEN, J.H.J., ISHADAMY, Y. and WIBISONO, I., 2012*. Interface between appropriate technology and sustainable energy policy SET*; *2012 Sept 2-5; Vancouver, Canada*. Sustainable Energy Technology; 2012.

GARNIATI L., OWEN, A., KRUIJSEN, J.H.J., ISHADAMY, Y. and WIBISONO, I., 2014. Interface between Appropriate Technology and Sustainable Energy Policy in Vulnerable Societies. *International Journal of Sustainable Cities and Societies,* 12, pp. 9-15

HASHIM, H. and HO, W.S., 2011. Renewable energy policies and initiatives for a sustainable energy future in Malaysia. *Renewable and Sustainable Energy Reviews*, 15, pp. 4780-4787.

HONG, G.W. and ABE, N., 2012. Sustainability assessment of renewable energy projects for off-grid rural electrification: The Pangan-an Island case in the Philippines. *Renewable and Sustainable Energy Reviews*, 16(1), pp. 54-64.

INTERNATIONAL ENERGY AGENCY (IEA), 2011. *International Energy Agency, Renewable energy policy considerations for deploying renewables*. Paris: International Energy Agency; 2011.

INTERNATIONAL ENERGY AGENCY (IEA), 2011. *Energy efficiency, policies, and measures* [online]. Available from: http://www.iea.org/textbase/pm/?mode=pm&action=result [Accessed 15 December 2011].

INSTITUTIONAL INSTITUTE OF SUSTAINABLE DEVELOPMENT, 2012. *What is Sustainable Development* [online]. Available from: http://www.iisd.org/sd/. [Accessed 1 December 2013].

INTERNATIONAL MONETERY FUND (IMF). *International Monetary Fund, World economic outlook report. IMF world economic and financial surveys.* Washington DC: International Monetary Fund; 2011.

IWARO, J. and MWASHA, A., 2010. A review of building energy regulation and policy for energy conservation in developing countries. *Energy Policy*, 38(12), pp. 7744-7755.

JUMBE, C.B.L., MSISKA, F.B.M., and MADJERA, M., 2009. Biofuels development in Sub- Saharan Africa: are the policies conducive? *Energy Policy,* 37(11), pp. 4980–4986.

KAMISKI, I., 2010. Getting the balance right in developing countries. *Renewable Energy Focus*, 11(5), pp. 50-53.

KARAGIANNIDS, A., WITTMAIER, M., LANGER, S., BILTEWSKI, B. and MALAMAKIS, A., 2009. Thermal processing of waste organic substrates: developing and applying an integrated framework for feasibility assessment in developing countries. *Renewable and Sustainable Energy Reviews*, 13(8), pp 2156-2162.

KARAKOSTA, C. and ASKOUNIS, D., 2010. Developing countries' energy needs and priorities under a sustainable development perspective: A linguistic decision support approach. *Energy for Sustainable Development*, 14(4), pp. 330-338.

KAYGUSUZ, K., 2012. Energy for sustainable development: A case of developing countries. *Renewable and Sustainable Energy Reviews*, 16(2), pp. 1116-1126.

KEONG, C.Y., 2005. Energy demand, economic growth, and energy efficiency – the Bakun dam-induced sustainable energy policy revisited. *Energy Policy*, 33(5), pp. 679-689.

KRUIJSEN, J.H.J., OWEN, A. and TURNER, N., 2012. *The potential of Marine Energy in the Maldives*. CD ROM World Congress on Water, Climate and Energy, 13-18 May 2012, Dublin, Ireland.

KRUIJSEN, J.H.J., OWEN, A., TURNER, N. and GARNIATI, L., 2012. *The Fourth Dimension of Sustainable Practice.* http://cesun2012.tudelft.nl/images/d/d0/Kruijsen.pdf [accessed 12 July 2013].

KYAW, W.W., SUKCHAI, S., KETJOY, N. and LADPALA, S., 2011. Energy utilisation and the status of sustainable energy in Union of Myanmar. *Energy Procedia*, 9, pp. 351-358.

LIDULA, N.W.A., MITHULANANTHAN, N., ONGSAKUL, W., WIDJAYA, C. and HENSON, R., 2007. ASEAN towards clean and sustainable energy: Potentials, utilisation, and barriers. *Renewable Energy*, 32, pp. 1441-1452.

LUBIS, A., 2007. Energi terbarukan dalam pembangunan berkelanjutan, *Jurnal Teknik Lingkungan,* 8, 155-162.

MAINALI, B. and SILVEIRA, S., 2011. Financing off-grid rural electrification: Country case Nepal. *Energy,* 36(4), pp. 2194-2201.

MCDONALD, M., Provision of infrastructure in post-conflict situations. London: Department for International Development 2005.

MERRIAM WEBSTER DICTIONARY, 2013. http://www.merriam-webster.com/dictionary/resource. [Accessed 27/06/2013].

MOHAMED, A.R. and LEE, K.T., 2006. Energy for sustainable development in Malaysia: Energy policy and alternative energy. *Energy Policy* 34(15), pp. 2388-2397.

MONROY, C.R. and HERNANDEZ A.S.S., 2008. Strengthening financial innovation in energy supply projects for rural exploitations in developing countries. *Renewable and Sustainable Energy Reviews*, 12(7), pp. 1928-194.

MOORE, S., WINDERS, J., FROEHLING, O., JONES III, J.P. and ROBERTS, S.M., 2007. Mapping the grassroots: NGO formalisation in Oaxaca Mexico. *Journal of International Development,* 19, pp. 223-237.

NEPAL, R. and JAMASB, T., 2012. Reforming small electricity systems under political instability: The case of Nepal. *Energy Policy* 40(1), pp. 242-251.

NIELSEN, L., 2009. *Classifications of countries based on their levels of development: How it is done and how it could be done (working paper)*. IMF

OH, T.H., PANG, S.Y. and CHUA, S.C., 2010. Energy policy and alternative energy in Malaysia: Issues and challenges for sustainable growth. *Renewable and Sustainable Energy Reviews* 14(4), pp.1241-1252.

OWEN A. and GARNIATI, L., 2012. *Aceh Sustainable Energy Outlook*: *Scoping Report for Aceh Green Secretariat*. Banda Aceh: Aceh Green Secretariat.

OWEN A., and GARNIATI, L., 2013. Energy resources in societies with developing economies. In: T. LETCHER, ed. *Future Energy.* New York: Elsevier. 2013

PALETA, R., PINA, A. and SILVA., C.A., 2011. Remote Autonomous *Energy* Systems Project: Towards sustainability in developing countries. *Energy*, 48(1), pp. 431-439.

PRASTOWO, B., 2007. Potensi sektor pertanian sebagai penghasil dan pengguna energi terbarukan. *Perspektif*, 6, pp. 84-92.

ROSEN, M.A., 2009. Rosen, Energy sustainability: a pragmatic approach and illustrations, Sustainability. pp. 55-80.

SAHA, P.C., 2003. Sustainable energy development: a challenge for Asia and the Pacific region in the 21st century. *Energy Policy*, 31, pp. 1051-1059.

SCHWARTZ, J., HAHN, J. and BANNON, I*.,* 2004*. The private sector's role in the provision of infrastructure in post-conflict countries: Patterns and policy options (CPR Working Paper)*. Washington DC: CPR.

SHAFIE, S.M., MAHLIA, T.M.I, MASJUKI, H.H. and ANDRIYANA, A., 2011. Current energy usage and sustainable energy in Malaysia: A review. *Renewable and Sustainable Energy Reviews* 15(9), pp. 4370-4377.

SOENTONO, S. and AZIZ, F., 2008. Expected role of nuclear science and technology to support the sustainable supply of energy in Indonesia. *Progress in Nuclear Energy,* 50, pp. 75-81.

SOVACOOL, B., 2009. Energy policy and cooperation in Southeast Asia: The history, challenges, and implications of the trans-ASEAN gas pipeline (TAGP) network. *Energy Policy*, 37, pp. 2356-2367.

SOVACOOL, B.K., AGOSTINO, A.L.D. and BAMBAWALE, M.J., 2011. The socio-technical barriers to solar home systems (SHS) in Papua New Guinea: Choosing pigs, prostitutes, and poker chips over panels. *Energy Policy,* 39, pp.1532-1542.

SUGIYONO, A. *Perubahan paradigma kebijakan energi menuju pembangunan yang berkelanjutan. Makalah Seminar Tahunan Ekonomi I*. Jakarta: BPPT 2004.

SUHAEMI, T., SYUAKAN, A., 2010. The acceptance strategy for nuclear power plant in Indonesia: 2nd International Conference on Advances in Nuclear Science and Engineering 1244, pp. 326-342.

THOMPSON, P.B., 2010. What sustainability is (and what it isn't). In: Moore, S.A. ed. *Pragmatic sustainability: Theoretical and practical tools*. London: Routledge pp. 20-22.

UNITED NATIONS GENERAL ASSEMBLY, 2012. *Resolution adopted by the General Assembly on 27 July. The future we want. E/CN.17/2001/19 - Energy.* United Nations 2012.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP). *United Nations Development Programme, Post-Conflict Economic Recovery. Crisis and Recovery Report 2011.* New York: United Nations Development Programme 2011.
http://www.undp.org/content/dam/undp/library/crisis%20prevention/BCPRAR2011_final.pdf

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID). *Indonesia county report, from ideas to action: Clean energy solution for Asia to address climate change*. USAID; 2007.

WAHYUNINGSIH, R. *Potensi wilayah kerja pertambangan panas bumi di Indonesia. Kolokium Hasil Lapangan* 2005.

WORLD ENERGY COUNCIL (WEC) (a), Policies for the future: 2011 Assessment of country energy and climate policies. London: World Energy Council; 2011.

WORLD ENERGY COUNCIL (WEC) (b), Energy efficiency policies and measures, Retrieved December 20, 2011 from website: http://www.wec-policies.enerdata.eu/

WORLD ENERGY COUNCIL (WEC), Energy efficiency: A recipe for success. London: World Energy Council 2010.

WEYNAND, G. *Developing energy programme in post-conflict countries. Energy team of Office of Infrastructure and Engineering Bureau for Economic Growth Agriculture and Trade Presentation*. USAID; 2007.

WIJAYATUNGGA, P.D.C. and PRASAD, D., 2009. Clean energy technology and regulatory interventions for greenhouse gas emission mitigation: Sri Lankan power sector. *Energy Conversion and Management,* 50(6), pp.1595-1603.

References for appropriate technology

AL ALI, S., 1991. Technological dependence in developing countries. *Technology in Society,* 13(3), pp. 267-277.

BOLAY, J.C., 2012. Appropriate technology for sustainable development. In: Bolay JC, et al., editor. Technologies and Innovations for Development. Springer-Verlag 2012. pp. 3-15.

BOZEMAN, B., 2000. Technology transfer and public policy: a review of research and theory. *Research Policy* 29, pp. 627-655.

BOWONDER, B., 1979. Appropriate technology for developing countries: Some issues. *Technological forecasting and social change 15*, 55-67

BRUUN, P. and MEFFORD, R.N., 1996. A framework for selecting and introducing appropriate technology in developing countries. *International Journal of Production Economics*, 46-47.

CHATEL, B.H., 1979. Technology assessment and developing countries. *Technological Forecasting and Social Change*, 13(3), pp. 203-211.

CROMWELL, G., 1992. What makes technology transfer? Small-scale hydropower in Nepal's public and private sectors. *World Development*, 20 (7), pp. 979-989

DECHEZLEPRETRE, A., GLACHANT, M. And MENIERE, Y., 2008. The clean development mechanism and the international diffusion of technologies: An empirical study. *Energy Policy* 36(4), pp. 1273-1283.

FERNANDEZ-BALDOR, A., HUESO, A. and BONI, A., 2009. *Technologies for Freedom: collective agency-oriented technology for development processes. Proceedings of the Annual Conference of the Human Development and Capability Association; 2009 Sep 10-12*; Lima, Peru.

GOONATILAKE, S., 1994. Technology assessment: some questions from a developing country perspective. *Technological Forecasting and Social Change*, 45(1), pp. 63-77.

GREEN, D., 1999. Cross cultural technology transfer of sustainable energy systems: A critical analysis. *Renewable Energy*, 16 (1–4), pp. 1133-1137

HIPKIN, I., 2004. Determining technology strategy in developing countries. *Omega the International Journal of Management Science*, 32(3), pp. 245-260.

HOEKMAN, B., MASKUS, E.K. and SAQQI, K., 2005. Transfer of technology to developing countries: unilateral and multilateral policy options. *World Bank Policy Research Working Paper,* 33(10), pp. 1587-1602.

JEQUIER, N., 1981. Appropriate technology needs political ‘push’. *World Health Forum*, 2(4), pp. 541-543.

KAPLINSKI, R., 2011. Schumacher meets Schumpeter: Appropriate technology below the radar. *Research Policy* 40(2), pp. 193-293.

KARAKOSTA, C. et al., 2010. Technology transfer through climate change: Setting a sustainable energy pattern. *Renewable and Sustainable Energy Reviews*, 14 (6), pp. 1546-1557.

KHABIRI et al., 2012. Identifying Main Influential Elements in Technology Transfer Process: A Conceptual Model. In: CHIU, ed. *International Conference of the Asia-Pacific-Business-Innovation-and-Technology-Management-Society.* 13-15 January 2012. Pattaya, Thailand: Procedia Social and Behavioral Sciences, 40 pp. 417-423

LARANJAA, M., UYAMA, B. E. and FLANAGAN, K., 2008. Policies for science, technology, and innovation: Translating rationales into regional policies in a multi-level setting. *Research Policy*, 37(5), pp. 823-835.

LUKEN, R. and VAN ROMPAEY, F., 2008, Drivers for and barriers to environmentally sound technology adoption by manufacturing plants in nine developing countries. *Journal of Cleaner Production* 16 pp. 66-77.

MEADOWS, D.H., MEADOWS, D.L., RANDERS, J. and BEHREN, W.W. III., 1972. *The Limits to Growth*. New York: Universe Books.

MEADOWS, D.H., MEADOWS, D.L. and RANDERS, J., 1992. *Beyond the limits*. Post Mills, VT: Chelsea Green Publishing Company.

MEADOWS, D.H., RANDERS, J. and MEADOWS, D.L. 2004. *Limits to Growth – The 30-Year Update*. London: Eearthscan.

MURPHY, H. et al., 2009. Appropriate technology – A comprehensive approach for water and sanitation in the developing world. *Technology in Society*, 31 (2) pp.158-167.

MYTELKA, L.K. and SMITH, K., 2002. Policy learning and innovation theory: An interactive and co-evolving process, Research Policy, 14(23), pp 1-13.

MUSANGO, J. K. and BRENT, A. C., 2011, A conceptual framework for energy technology sustainability assessment, *Energy for Sustainable Development*, 15(1), pp. 84-91.

PAMATANG, C. et al., 2013. Community Empowerment through Appropriate Technology: Sustaining the Sustainable Development. *Procedia Environmental Sciences*, 17 pp. 1007-1016.

RAMANATHAN, R. 2002. Successful transfer of environmentally sound technologies for greenhouse gas mitigation: a framework for matching the needs of developing countries. *Ecological Economics*, 42 (1–2) pp. 117-129.

RESENDE, D. et al., 2013. BTP—Best Transfer Practices. A tool for qualitative analysis of tech-transfer offices: A cross cultural analysis. *Technovation*, 33(1), pp. 2-12.

TEITEL, S., 1978. On the concept of appropriate technology for less industrialized countries. *Technological Forecasting and Social Change*, 11(4), pp. 349-369.

TRAK, A., MACKENZIE, M., 1980. Appropriate technology assessment: A note for policy considerations. *Technological Forecasting and Social Change*, 17(4), 329-338.

VAN DER GAAST, W., BEGG, K. and FLAMOS, A., 2009. Promoting sustainable energy technology transfers to developing countries through the CDM. *Applied Energy* 86(2), pp. 230-236.

WORELL, E., VAN BERKEL, R, FENGGI, Z., MENKE, C., SCHAEFER, R. and WILLIAMS, R.O., 2001. Technology transfer of energy efficient technologies in industry: a review of trends and policy issues. *Energy Policy*, 29(1), pp. 29-43.

References for case study selection

ASIAN DEVELOPMENT BANK (ADB), 2004 *Power sector development plan for Timor-Leste*. ADB.

DATT, G., CUMPA, M., NEHRU, V., ROBERTS, N., FRANCO, A. and DHAR, S., 2008. Timor-Leste: Poverty in a young nation. *Final Statistical Abstract: Timor-Leste Survey of Living Standards 2007*. Timor Leste.

HUMAN RIGHTS WATCH, 2007 (a). *Out of Sight: Endemic Abuse and Impunity in Papua's Central Highlands.* New York: Human Rights Watch.

HUMAN RIGHTS WATCH. 2007 (b). No One Is Safe: Insurgent Attacks on Civilians in Thailand's Southern Border Provinces. Human Rights Watch.

HLA KYAW, U., 2009. *Greater Mekong sub region economic cooperation program. Myanmar: country assessment on biofuels and renewable energy*. Department of Agriculture and Planning, Ministry of Agriculture and Planning.

LOY, D. and CORREIA, L., 2008. *Rural energy policy for Timor-Leste. UNDP and Government of Timor-Leste, Timor-Leste. Addressing energy poverty in Timor-Leste*. Timor Leste.

SANTOS, S.Jr., 2001. *The Moro Islamic Challenge: Constitutional Thinking of the Mindanao Peace Process.* Quezon City: University of the Philippines Press.

SHUM, S., TERRADO, E., OPENSHAW, K. and TUNTIVATE, V., 2007. *Timor-Leste Issues and Options in the Household Energy Sector: A Scoping Study*. Timor Leste.

TRAJANO, J.C.I., 2010. Ethnic nationalism and separatism in West Papua, Indonesia. *Journal of Peace, Conflict and Development* 16, pp. 12-35.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP), 2008. *UNDP Post-Conflict Economic Recovery. Crisis and Recovery Report 2008*. New York: UNDP.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP), 2009. *UNDP Country Programme for Timor-Leste (2009-2013)*. UNDP; 2009.

US Department of State, 2011. *Background Note: Timor-Leste*.

8.1.1.4 References for Chapter 4

ACEH GREEN, 2008. Aceh Green Policy. Banda Aceh: Aceh Green Secretariat.

BRATHWAITE, J. et al., 2010. *Anomie and violence: non-truth and reconciliation in Indonesian peace building*. Canberra: Australian National University E Press.

BUTCHART, S.H.M. et al., 2010. Global biodiversity: Indicators of recent declines. Science, 328 pp. 1164-1168.

DIFFER, 2012. The Indonesian electricity system: a brief overview. Differgroup.

DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID), 2013. Operation Plan 2011 – 2015 UK Climate Change Unit Indonesia (UKCCU) [Online]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/208924/Indonesia.pdf [Accessed 18 November 2013].

FOOD AND AGRICULTURAL ORGANISATION (FAO), 2006. *Global Forest Resources Assessment 2005, Main Report. Progress towards Sustainable Forest Management.* FAO Forestry paper 147, Rome: FAO.

FOOD AND AGRICULTURAL ORGANISATION (FAO), 1999. *Tropical forest management techniques: A review of the sustainability of forest management practices in tropical countries.* Rome: FAO.

INTERNATIONAL ENERGY AGENCY, 2008. Energy policy review of Indonesia. Paris: International Energy Agency.

INDONESIAN ENERGY AND MINERAL RESOURCES MINISTRIAL DECREE NO. 954K/30/MEM OF 2004.

INDONESIAN ENERGY AND MINERAL RESOURCES MINISTRIAL DECREE NO. 2 OF 2004.

INDONESIAN ENERGY AND MINERAL RESOURCES MINISTRIAL DECREE NO. 1122K/30/MEM OF 2002.

INDONESIAN GOVERNMENT REGULATION NO. 26 OF 2006.

INDONESIAN MINISTRIAL DECREE NO. 2 OF 2006.

INDONESIAN MINISTRY OF ENERGY, REGULATION NO. 31 OF 2009.

INDONESIAN MINISTRY OF ENERGY, REGULATION NO. 7 OF 2010.

INDONESIAN PRESIDENTIAL DECREE NO. 4 OF 2010.

INDONESIAN PRESIDENTIAL DECREE NO. 5 OF 2006 ON NATIONAL ENERGY POLICY AND BLUEPRINT OF NATIONAL ENERGY MANAGEMENT 2005-2025.

INDONESIAN LAW NO. 11 OF 2006.

INDONESIAN LAW NO. 30 OF 2007.

INDONESIAN LAW NO. 30 OF 2009.

INDONESIAN PRESIDENTIAL REGULATION NO. 5 OF 2006.

INDONESIAN PRESIDENTIAL REGULATION NO. 71 OF 2006.

INTERNATIONAL ENERGY AGENCY (IEA), 2008. *Energy policy review of Indonesia*. Paris: International Energy Agency: 2011.

MINISTRY OF ENERGY AND MINERAL RESOURCES (ESDM), 2009. Electricity Master Plan 2010-2014. Jakarta: Ministry of Energy and Mineral Resources

NATIONAL DEVELOPMENT PLANNING AGENCY, 2011. Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011 – 2025. Jakarta: Coordinating Ministry for Economic Affairs.

PERUSAHAAN LISTRIK NEGARA (PLN), 2009. *Rencana penyediaan tenaga listrik 2010-2019.* PLN; 2009.

PT. CIPTA MULTI KREASI, 2008. *Laporan Akhir Studi Potensi Energi Listrik Alternatif di Pedesaan sebagai Upaya dalam Mendukung Percepatan Diversifikasi Energi di Provinsi Nanggroe Aceh Darussalam*. Banda Aceh:

Badan Rehabilitasi dan Rekonstruksi (BRR) NAD-Nias, Deputi Keuangan dan Perencanaan; 2008.

ROFI, A.M.A., DOOCY, S., and ROBINSON, C., 2006. Tsunami mortality and displacement in Aceh Province, Indonesia. *Disasters,* 30(3) pp 340−350.

SCHULZE, K.E., 2004. *The free Aceh movement (GAM): Anatomy of a separatist organisation*. Washington DC: East-West Centre: 2004.

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID), 2007. Indonesia country report. From ideas to action: clean energy solutions for Asia to address climate change.

8.1.1.5 References for Chapter 5

BERR, 2008. *Atlas of UK Marine Renewable Energy Resources*. Available from: http://www.renewables-atlas.info/downloads/documents/Renewable_Atlas_Pages_A4_April08.pdf. [Accessed 10 May 2012].

BRITISH WIND ENERGY ASSOCIATION, 2012. *Wind Energy Technology. British Wind Association*. Available from: http://www.bwea.com/ref/tech.html. [Accessed 9 May 2012].

HERMANS, L.M. and THISSEN, W.A.H., 2009. Actor analysis methods and their use for public policy analysts. *European Journal of Operational Research*, 196, pp.808-818.

HUTCHEON, A., 2005. *Annual and monthly rainfall. ETESP Background Paper.* Uniconsult International Limited (UCIL).

INTERNATIONAL LABOUR OFFICE (ILO) and EUROPEAN UNION (EU), 2011. *Skills and occupational needs in renewable energy*. Geneva: ILO

OWEN A. and GARNIATI, L., 2012 (a). *Aceh Sustainable Energy Outlook*: *Scoping Report for Aceh Green Secretariat*. Banda Aceh: Aceh Green Secretariat.

OWEN A. and GARNIATI, L., 2012 (b). *Aceh Off grid Action Plan.* Banda Aceh: Aceh Green Secretariat.

PERUSAHAAN LISTRIK NEGARA (PLN), 2009. *Rencana penyediaan tenaga listrik 2010-2019.* PLN; 2009.

PT. CIPTA MULTI KREASI, 2008. *Laporan Akhir Studi Potensi Energi Listrik Alternatif di Pedesaan sebagai Upaya dalam Mendukung Percepatan Diversifikasi Energi di Provinsi Nanggroe Aceh Darussalam*. Banda Aceh: Badan Rehabilitasi dan Rekonstruksi (BRR) NAD-Nias, Deputi Keuangan dan Perencanaan; 2008.

PT. SEMEN ANDALAS, 2006. *Environmental Assessment Report. Reconstruction of Cement Production Facility in Aceh Project.* 2006. Available from: http://www.aceh-eye.org/data_files/english_format/acheh_disaster/aceh-eye_disaster_donor/tsunami_donor_agencies_adb/tsunami_donor_adb_reports/tsunami_donor_adb_reports_2006_12_00.pdf. [Accessed May 10 2012].

SEA DEFENCE CONSULTANT, 2009. *Hydraulic Conditions*. Available from: http://seadefenceconsultants.com/wp-content/uploads/2009/12/SDC-R-70040A-Vol-II-Hydraulic-Conditions-EN.pdf. [Accessed 9 May 2012].

UEDA, K., 2001. Synthesis and emergence – research overview. *Artificial intelligence in engineering*, 15, pp. 321-327.

8.1.1.6 References for Chapter 6

ACTIONAID, 2006. *Real Aid: Making technical assistance work* [online]. Available from: http://www.actionaid.org/sites/files/actionaid/real_aid_2.pdf [Accessed 1 January 2014].

CHIAO, J.Y., CHEON, B.K., 2010. *The weirdest brains in the world. Commentary / Heinrich, Heine, Norenzayan: The Weirdest People in the World.* [Online]. Available from http://culturalneuro.psych.northwestern.edu/ChiaoCheon_BBS_inpress.pdf. [Accessed 30 December 2013].

COLLIER, P. and HOEFFLER, A., 2004. Policy and growth in post-conflict societies. *European Economic Review*, 48(5), pp. 1125-1145.

DINCER I. and ROSEN M.A., 1999. Energy, environment, and sustainable development. *Applied Energy* 64(1-4), 427-440

DIAMOND, J., 2012. *The world until yesterday: what can we learn from traditional societies*? New York: Viking Penguin.

DORANOVA A., COSTA I. and DUYSTERS G., 2010. Knowledge base determinants of technology sourcing in clean development mechanism projects. *Energy Policy*, 38(10), pp. 5550-5559.

EUROPEAN COMMISSION, 2008. *Reforming technical cooperation and project implementation units for external aid provided by the European Commission: A backbone strategy*. Belgium: Europe Aid, Directorate E, European Commission.

FERNANDEZ-BALDOR, A., HUESO, A. and BONI, A., 2009. *Technologies for Freedom: collective agency-oriented technology for development processes. Proceedings of the Annual Conference of the Human Development and Capability Association; 2009 Sep 10-12*; Lima, Peru.

GARNIATI L., OWEN, A., KRUIJSEN, J.H.J., ISHADAMY, Y. and WIBISONO, I., 2012*. Interface between appropriate technology and sustainable energy policy SET*; *2012 Sept 2-5; Vancouver, Canada*. Sustainable Energy Technology; 2012.

GARNIATI L., OWEN, A., KRUIJSEN, J.H.J., ISHADAMY, Y. and WIBISONO, I., 2014. Interface between Appropriate Technology and Sustainable Energy

Policy in Vulnerable Societies. *International Journal of Sustainable Cities and Societies,* 12, pp. 9-15

HEINRICH J., HEINE, S.J. and NORENZAYAN, A., 2009. *The weirdest people in the world* [Online]. Available from: http://www2.psych.ubc.ca/~henrich/pdfs/Weird_People_BBS_final02.pdf [Accessed 3 December 2013].

HENRICH J., HEINE, S.J., and NORENZAYAN, A., 2010. Most people are not WEIRD. *Nature* 466, pp.29.

KAPLINSKI, R., 2011. Schumacher meets Schumpeter: Appropriate technology below the radar. *Research Policy* 40(2), pp. 193-293.

KRUIJSEN, J.H.J., OWEN, A., TURNER, N. and GARNIATI, L., 2012. *The Fourth Dimension of Sustainable Practice.* http://cesun2012.tudelft.nl/images/d/d0/Kruijsen.pdf [accessed 12 July 2013].

MACDONALD, M. , 2005. *Provision of infrastructure in post-conflict situations*. Department of International Development.

MAJID, A., LEVINSON, S.C., 2010. *WEIRD languages have misled us too*. The Netherlands: Max Planck Institute for Psycholinguistic. DOI:10.1017/S0140525X1000018X

MUSANGO, J. K. and BRENT, A. C., 2011, A conceptual framework for energy technology sustainability assessment, *Energy for Sustainable Development*, Volume 15(1), pp. 84-91.

OECD/DAC, 2009. *Inventory of donor approaches to capacity development: What we are learning* [Online] Available from: http://www.deza.admin.ch/ressources/resource_en_202116.pdf [Accessed 3 January 2014].

OWEN A. and GARNIATI L., 2012. *Aceh Sustainable Energy Outlook*: *Scoping Report for Aceh Green Secretariat*. Banda Aceh: Aceh Green Secretariat.

URMEE, T., HARRIES, D. and SCHLAPFER A., 2009. Issues related to rural electrification using renewable energy countries of Asia and Pacific. Renewable Energy, 34, pp. 354-357.

WEC. 2011. *Policies for the future: 2011 Assessment of country energy and climate policies*. London: World Energy Council.

WEYNAND, G., 2007. *Developing energy programme in post-conflict countries. Energy team of Office of Infrastructure and Engineering Bureau for Economic Growth Agriculture and Trade Presentation*. USAID.

8.1.1.7 References for Chapter 7

OWEN A. and GARNIATI, L., 2012 (a). *Aceh Sustainable Energy Outlook*: *Scoping Report for Aceh Green Secretariat*. Banda Aceh: Aceh Green Secretariat.

OWEN A. and GARNIATI, L., 2012 (b). *Aceh Off grid Action Plan.* Banda Aceh: Aceh Green Secretariat.

OWEN, A. and GARNIATI, L., 2014. *Marine Feasibility Study for Indonesia*. Jakarta: UK Climate Change Unit (unpublished strategic documents)

9 Appendices

9.1 Jot notes from fieldwork

Appendix 9.1 consists of example jot notes taken during field work in Aceh. This section provides some evidence of data authenticity and record keeping.

Welcome on board

KLM

Cape Town

Bangkok

Dallas

data extraction follows ~~methods~~ techniques used in field observation (methods) ('because data sources ~~are [illegible]~~ ← (common knowing)

data analysis follows policy + technical analysis (

~~[illegible]~~ cross disciplinary challenge matching/~~bringing~~ each and technique to the same level

Disposal bag

Work w/ INOCEAN

FIELD work

EC + UNDP

Scattered

both and big small

1 demonstration project

needed

2.

SEA CORE

South East Asian Collaboration for Ocean Renewable Energy

Structured

ensure

If not then who??

- Technology → • Appropriate

~~Appropriateness~~

- Policy → • Strategic

Prevent

Mitiga

- Capacity → • In house !!!

- Impact → • Holistic

alternate

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MARINA BAY San
SINGAP

May 2011

PLN

Bappeda

Dinas Pertambangan & Energi

Aceh Green

Tim Geothermal

Waste /wastewater

Kampus

ACEH

1 → Rough Timeline → project start_ Finish → May 22/23 UK Ambassador EU +

Critical Stage

Financial for each.

2 Funding Possibilities

EU Finance meeting July

Look at potential Funders / SEnterprise

Project outlines

3 Wibi → MOU

4 Risk Assesment → TRAVEL

maps

cost → car - driver weeks

transport accomodation for fieldwork

5 Oct / ~~Nov~~ 8th → 22nd

- Formal meeting w/ Tue
- Distant → Schools Communities → off grids

subsistence farming type /

Risk Assesment ✓

1st august Alan Black

Mar 2012

Questions :

1. Priority for access to energy
2. Policy measures facilitate policy context
3. Implementing structure existence + function
4.

① - Economic growth
- social development } rank? → find out, whether any gaps exist
→ what influences priority selection?
- Political stability
- changes?
- what causes/changes / prevent

② Regulation < National / Provincial

Incentives? / Businesses < user / producers.

③ - mainstreaming new concept
- maintaining through government changes. } Ask Yakob + Wiki for case study.

Appropriate Tech

Gaps in literature / temporal —→ why stops at / in 1970's
\ spatial

NGO reports

↳ Temporal /Gap/ → Historical

1. academic literature.
2. NGO reports → secondary data /
3. Research Council's requirement for funding research [database]

commercial viability & aspect

1. Demonstrate current policy not sufficient → CURRENT policy analysis ←
2. Justify need for intervention → PROJECTION of using current policy / more general context ←
3. Suggest / Recommend Changes → Alternate plan. / introduce gaps in policy formulation / address AT → concept of experience in gaps IL
4. ~~Recommend rethinking~~ MODEL IMPACT of Changes → PROJECTION of alternate plans
↳ IA

SUST. ENERGY

(1) Demonstrate how current policies in Energy ~~does not~~ shot insufficient to achieve Sust E System → POLICY ANALYSIS →

Assess

LA CBA LOA FA

~~Justification of mega framework~~

(2) Justify the need for intervention → GAP / FUTURE ANALYSIS

(3) Recommend changes in policy formulation, implementation.

Road map
Planning Action

(4)

Investment

↳ Obligations with further → Techno independence

↓

AID for AID

~~AID~~ AID for market creation

Investment = basic capital { equipment, knowledge, stretch } → local society will produce what is appropriate

4th/June → 1 month

* ADCP → Get data acquisition/. 50 – 60 – 100 m wrap /
→ Boats w/ control

- $\boxed{\text{ADCP}}$ + $\boxed{\text{frame}}$
- White nylon
-

Strategic

business

Infrastructure

RTO

- Zul van
- Hendri

} speedboat for guards /

feasibility studies analysis

Wednesday

23 2

- Put ADCP → frame → data acquisition /.
- early morning Wednesday.
-

① AG → Strategic resources initiative.
Manufacturing capacity Unsyiah Lab
Tsunami + disaster Research centre

Unsyiah x RGU x Mining Agency

Bout 11th /

M

Isse ination → Realistic { true / not / uni is } opening

ec

[redacted]

Methodology
Outline of stuff
Recent project

in the ig
Submission economic
— What is in
technical of Remaining ambi
on/off grid Power cut.

day for Tues.
Mon

[redacted]

ectibility of output /

scales
size
applicability /

optimal size
system
oversized

— of fuel cells
(exclusion improve
types)

ex

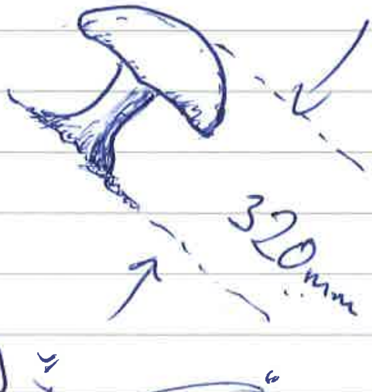
[redacted]

identify questions
dema
of info of
access
reca

m

* UNDP /

→ Sample : P.T. Cipta Multi Kreasi
Jl. Kalibata Raya 11-12 B
Indonesia
+62 021 7949534 /



PRESENT SITUATION [ACEH Province] :

248 MW : — 150 kV Sumut Aceh (North Sumatera)

192 MW — North Sumatera
40 MW — PLTD [Diesel Electricity Generator]
Banda Aceh, Sigli, Lhok Sumaw

— 86 MW PLTD isolated

NT
ine]

- Village case study -

Demand / E use

① ~~Present situation~~

- ~~[illegible]~~, Population size
- Watts required for electricity
- cooking → need quantificatn
- travel → -||-
- economic sector ← fish farm ?
- income average / month

↓

DEMAND PROFILES

Supply / E generation

Resource availability ~~[illegible]~~
Energy ~~[illegible]~~ potential
Technical feasibility
Economical feasibility -
Socio-Political aspect.
Env. Protection -

↓

SUPPLY POTENTIAL

Distribution

Distance to nearest grid
Surplus / deficit
Access < Transport, communicat
Clusters / decentral
[settlement pattern]

↓

DISTRIBUTION MODEL

URE
ction]

based on
pop growth
economic growth

- Village case study -

Demand / E use

① ~~Present situation~~
- ~~Regency~~ Population size
- Watts required for electricity
- cooking → need quantification
- travel → -"-
- economic sector ← fish farm ?
- income average / month

↓

DEMAND PROFILES

Supply / E generation

Resource availability ~~potential~~
Energy ~~generation~~ potential
Technical feasibility
Economical feasibility -
Socio-Political aspect.
Env. Protection -

↓

SUPPLY POTENTIAL

Distribution

Distance to national grid
Surplus / deficit
Access < Transport, communication
Clusters / decentralised [settlement pattern]

↓

DISTRIBUTION MODEL

NT
ine]

URE
ction] } based on pop growth, economic growth

6 prim

3

16 → 5 std grade
m O levels

18 → 5 Higher / Advance
m A levels

3

18

General

L S S

Practical
Occupation

...ege / Polytechnic

University

...y {Guilds

...NC
...ND

Basic → 3
Bachelor → 4
(Hons)

Masters
Doctorate
Professorship

Vocational

Polytechnic

D1 —
D2 —
D3 —

Uni

3

4

Sanjar

Unsyiah

* Scoping → overview < Resources / Policy / Infrastructure + institution

* E generation / → local manufacturing
management

Collaboration < Uni / Govt

Policy → Govt.

Academic < Research / Lab

Community < Market / Investment / technical manufacturing /

* Marine Renewables

RA
Seabed
Technology

X Community

* early warning system
adapted technology → < E / Telecommunication

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komplek binaharga
Gatsu kav 71-73

✓ASELI → Direct +62 (0) 21 830 5610
+62 (0) 21 837 92729

~~8 May 2013~~ 13/5/2013 Tentative

DFID ✓

✓UNAS →

ay 2013

WWF

✓ BUSINESS UNIT

ACEH

✓ NOTARIS — LAWYER confirmed
same day as UNAS

MINISTRY of PUBLIC WORKS

UNIVERSITY of TIMOR LESTE

IGN. LOYOLA TECHNICAL SCHOOL

Teknik Dekan

Tim Pengembangan

Funded project
Scholarship / education
E Kementrian Keuangan
LPDP

ITEMS for discussion

4 → 6
8 ASELI

251 8370390

dr RGU apa?

SOLAR
↳.

Nelayan
Research
↳

Pertamina
Telkom
Hydrogen fuel station

ITEMS for discussion

4 – 5 travel
8 ASELI 8.
DFID

6.
TIMOR

6, 7, Rep

35 { 35 A.

ARUM - DFID

↳ Request meeting < ~~Rena~~ T / RRF

DFID

↳ Orignal RRF doc → Mar

JU

8}

FS

Policy Strategic

'EMEC'

PF

Meeting for ↑

DFID

~~Welcome for~~

Thing PF

Bring context w/ Mekong

positioning of strategic approach across ASEAN

We would like to use RRF to further develop that

(2) MEBITA

- Alan to check MY Mamadud TV timeframe
- Check also Shiraz timeline

15 - 25

• Still (7)

• Expert

(3)

Lega

Arun	+62 812 997 1394
Arum	+62 817 997 1394

Meskipun gak dapet → ping tetap menjalankan source of fund u/ mengurus bantuan

Follow up → tawaran [illegible]

Mbah Arum Terimakasih sdh dpt kabar u/ PF
result → Fair enough [illegible]

Tidak masalah Arum aku hari tetap berencana u/ terus follow up initiative ini dan menggali dukungan dari funding lain.

Explanation on OFID < PF X / RRF
↓
EMEC
↓
EC – SEA consultancies ✓

AT in EP
SEP in VS }

Strategic ACS → Prep tmrw ✓
Strategic SEA → edit ✓

sdh
dari

- Book Appointment VFS ✓
- Gather supporting Docs
↓
stamped + signed
- Fill in forms < electronic / paper
- Ask HR for Ref + COS stated in writing ✓
- Ask Meldrum Primary for Recording Athari's enrollment ✓

GIZ → GRID

contact Ade!

UNFCC

↳ fully funded GCF

4 pillars

Funding Match → JAICA !

Carbon value from abatement !!!

↳ Funding Mechanism from ACE

↳ National level funding priorities

NSM BY

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UNFCC

Which COMMUNITY?

RESOURCES?

POLITICS

POLICY →

IMPLEMENTA

I D

← MARKET

BUSINESS

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BPPT   Surabaya
Pak Erlangga
Est. 1949
Ask for present

UNIVERSITAS NASIONAL

Agency

17/2/2014

Assessment + Application of Technology

BAPPENAS →

kepala unit BPPH →

Hydrodynamic/.

tow tank/.

11

5.5 m

9 m/s

- Maneuvering
  - deep water
  - shallow water basin

- Wave generator

Ask for copy of presentation

* wave motor + tidal current !!!

9.2 ASTEC Proposal

Appendix 9.2 consists of Costing for Developing Indigenous Renewable Energy Technology Capabilities in Aceh: Manufacturing and Capacity Building. This section provides the supplementary material to CBA discussed in Section 5.2.3 and represents the business case element of the intervention strategy (Figure 6-4: The wheel of change - interfaces between sustainable energy policy and appropriate technology).

SUMMARY

This document presents the initial budget requirements and the projected financial returns for establishing an indigenous renewable energy technology manufacturing capabilities in Aceh. Other benefits (i.e. break of social tension/conflict cycle, energy security, political stability, environmental health) are not included in the document, but will be analysed separately in accordance to appropriate dissemination process. This proposal is composed with the following considerations:

- Technology is to be designed, manufactured, and maintained locally in Aceh
- RGU Advisors are to provide technical and strategic input in developing in-house capabilities at resource assessment, design, manufacture, installation, operation, monitoring, and maintenance stages for identified renewable energy technologies. RGU Advisors to be based in an office within Banda Aceh to maintain well-grounded networks.
- Renewable technology production is to be selected based on appropriateness phases of available local natural, human, technological, and financial resources (solar, wind, and hydro initially to generate maximum financial gains, followed by tidal and wave as pilots)

A summary of this initial budget is provided in Table 1. Detailed assumptions and calculations used in the financial analyses are given in sections 1-5 of this document. This document should be read in conjunction with "The ASTEC Project proposal[1]" and "ASTEC Timeline and Costings".

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[1] Astec Project Proposal LG_AO draft (5)

Table 1: Summary of expected costs and return

Heading	Sub-Heading	Year 1	Year 2	Year 3	Year 4	Year 5
		USD	USD	USD	USD	USD
Staff time		$137,168	$197,151	$252,400	$314,420	$314,420
Equipment		$660,800	$66,080	$66,080	$66,080	$66,080
Materials		$1,141,025	$2,282,050	$4,703,075	$7,104,100	$7,448,920
Building		$400,000	$40,000	$40,000	$40,000	$40,000
RGU input		$524,080	$533,519	$514,227	$563,842	$588,775
Total Cost		$2,863,073	$3,118,800	$5,575,781	$8,088,442	$8,458,195
Income	PV	$375,430	$1,126,291	$2,628,011	$4,880,592	$7,133,173
	Wind	$308,322	$924,966	$1,849,932	$3,083,220	$4,563,166
	Hydro			$135,155	$405,465	$810,929
Total Income		$683,752	$2,051,257	$4,613,098	$8,369,277	$12,507,269
Return		-$2,179,321	-$1,067,543	-$1,097,838	-$124,629	$3,238,145

INTRODUCTION

The project focuses on the long term development of indigenous business and manufacturing capability using renewable energy technology as a central theme. A range of technologies are available and preliminary work[2] has demonstrated the availability of the required natural resources and human capability. Within the context of Aceh, the project will link together the principal educational institutions, the business community, national electricity supply, and government departments to initiate and expand a fully costed, business based proposal that will re-invest its own profits back into further research and business developmental works. The early stage investment is of the order of 3-5million USD and the venture is expected to be profitable by year 4. Much of the development foundation has already been put in place over 18 months by Robert Gordon University(RGU) – Centre for Understanding Sustainable Practice (CUSP), Aceh Green, SRI, (more in here?) thereby

[2] UNDP Aceh Energy Outlook – Scoping Report

eliminating most of the early-stage project risk. Networks have been created and a solid emphasis placed on co-operation between the actors.

The project has two distinct phases:

- Phase 1: Design, build, install wind, pico-hydro and solar technologies to create an income stream via the agreement with PLN to purchase any power generated from renewable resources. Establish RGU-CUSP office in Banda Aceh for project management and training.

- Phase 2 onwards: Continue with Year 1 activities and use the increasing income stream to match fund proposals for wave, tidal, biomass/gas, fish farm and clean water technology streams.

LOCAL STAFF TIME

With the stated intention being to develop a sustainable indigenous capability, most of the work will be done in-country with native individuals and communities who will emerge from the project as the leaders and mentors for their particular geographical and technological area(s).

9.3 Local staff time allocation assumptions:

- The project will run over 5 years for its initiation phase, thereafter will be a stand-alone driver of similar works throughout Aceh
- Staff time required is measured by fractions of full time equivalents (FTE)
- Day rates will increase year on year and are at full economic cost (or higher) so that ASTEC will recover full costs of projects
- An office for co-ordinating local project management with RGU staff in Scotland will be established. This office will also provide support and training around Project Management skills. Staff travel and transport per year are estimated as are office running costs.
- Subsistence rates are set at Aceh local daily levels to avoid distortion by cross-contamination from UK rates
- Local working days are assumed to be as outlined in Table 2, overleaf:

Table 2: Number of days in working year[3]

WORKING YEAR	DAYS
MANUAL	297
PROFESSIONAL	245

- Local staff time costs are assumed to be at the 2012 local rates outlined in Table 3[4]:

Table 3: Local salaries for types of labour

SALARIES	USD/ YEAR	USD/DAY
UNSKILLED	4,800.00	16.16
SEMI-SKILLED	6,400.00	21.55
SKILLED	8,400.00	28.28
SUPERVISORY	10,000.00	33.67
ACADEMIC	20,000.00	81.63
ADMIN SUPPORT	6,000.00	24.49
EXECUTIVE	24,000.00	97.96

9.4 Local staff time allocation calculations:

Local staff time allocations as presented in Table 4 overleaf are generic, and may vary between years requiring fine tuning.

[3] Pers.comm. Syiah Kuala University

[4] Pers.comm. Syiah Kuala University

Table 4: Estimated local staff time costs

	STAFF REQUIRED (FTE)						Staff cost (USD)					ACTIVITIES
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	
FUNDING MANAGEMENT	0.94	0.78	0.78	0.78	0.78	SKILLED	7,885.71	6,514.29	6,514.29	6,514.29	6,514.29	
MARKET RESEARCH	0.33	0.16	0.16	0.16	0.16	SKILLED	2,742.86	1,371.43	1,371.43	1,371.43	1,371.43	
BUSINESS MANAGEMENT	3.41	2.69	2.65	2.65	2.65							
	0.04	0.00	0.00	0.00	0.00	SKILLED	342.86	0.00	0.00	0.00	0.00	BUSINESS MODEL
	0.12	0.08	0.04	0.04	0.04	SKILLED	1,028.57	685.71	342.86	342.86	342.86	LEGAL
	0.04	0.00	0.00	0.00	0.00	SKILLED	342.86	0.00	0.00	0.00	0.00	PARTNERSHIP
	0.16	0.08	0.08	0.08	0.08	SKILLED	1,371.43	685.71	685.71	685.71	685.71	POLICY & STRATEGY
	0.82	0.41	0.41	0.41	0.41	SKILLED	6,857.14	3,428.57	3,428.57	3,428.57	3,428.57	SALES & LEASING Energy
	0.69	0.90	0.90	0.90	0.90	SKILLED	5,828.57	7,542.86	7,542.86	7,542.86	7,542.86	SALES & LEASING Product
	1.53	1.22	1.22	1.22	1.22	ADMIN	9,183.67	7,346.94	7,346.94	7,346.94	7,346.94	ADMIN SUPPORT
KNOWLEDGE EXCHANGE	3.59	4.67	4.18	4.18	4.18							
	1.14	1.31	0.82	0.82	0.82	ACADEMIC	22,857.14	26,122.45	16,326.53	16,326.53	16,326.53	MODULE WRITING
	1.22	2.14	2.14	2.14	2.14	ACADEMIC	24,489.80	42,857.14	42,857.14	42,857.14	42,857.14	TEACHING
	1.22	1.22	1.22	1.22	1.22	ADMIN	7,346.94	7,346.94	7,346.94	7,346.94	7,346.94	ADMIN SUPPORT
INDUSTRIAL ACTVITY												
NEW BUILDING	0.12	0.00	0.00	0.00	0.00	UNSKILLED	587.76	0.00	0.00	0.00	0.00	

MANUFACTURING	5.66	10.10	17.51	25.59	25.59	SEMI SKILLED	36,202.02	64,646.46	112,053.87	163,771.04	163,771.04
TESTING & CERTIFICATION	1.01	0.00	0.51	0.67	0.67	SUPERVISORY	10,101.01	0.00	5,050.51	6,734.01	6,734.01
SALE OF PRODUCTS	0.00	2.45	2.45	2.45	2.45	SEMI SKILLED	0.00	15,673.47	15,673.47	15,673.47	15,673.47
INSTALLATION	0.00	2.02	4.04	5.39	5.39	SEMI SKILLED	0.00	12,929.29	25,858.59	34,478.11	34,478.11
TOTAL ANNUALLY	**22.05**	**30.24**	**39.12**	**48.71**	**48.71**		**137,168.34**	**197,151.27**	**252,399.70**	**314,419.90**	**314,419.90**

MATERIALS

Material costing assumptions:

- Project is over 5 years
- Wherever possible materials are to be sourced locally in Aceh but where not applicable should be sourced from nearest available area
- Materials to be sourced including those for locally designed:

  Phase 1

  1. Solar PV panels (cost calculated per 1 ha)
  2. Wind turbines (cost calculated per 25 machines)
  3. Micro hydro turbines (cost calculated per 20 machines)

Material costing calculations:

The estimated cost of materials is based on a combination of local, internet and UK prices to establish a reasonably realistic value. Given the location of Banda Aceh, an early-stage component of this project will be to establish supply chain capability to reduce prices and improve reliability. Table 5 provides approximates of material costing used in this context.

Table 5: Example materials costings

Materials to be used by PV, Wind, Hydro	Unit cost (USD)
PV CELLS	2.00
6MM ALUMINIUM SHEETS	200.00
3X50 ALUMINIUM FLAT BARS (3m)	15.00
48.6 X 6 STEEL TUBES 6m	40.00
50X6 STEEL EQUAL ANGLE	40.00
6X50 STEEL FLAT BARS	40.00
200X6 STEEL TUBES	40.00
10MM STEEL FLAT PLATES	161.00
6MM STEEL FLAT PLATES	100.00
10KW GENERATOR 24V	600.00
200X75MM TIMBER	20.00
24V VOLTAGE REGULATORS	500.00
CONCRETE PER m^3	160.00
ASSUME DIGGER HIRE OR MANUAL LABOUR	120.00

EQUIPMENT

Equipment costing assumptions:

- Project is over 5 years
- Wherever possible equipment are to be sourced locally in Aceh but where not applicable should be sourced from nearest available area
- Manufacturing include utilisation of workshop, office, classroom and accommodation for:

  Phase 1

  1. Solar PV panels (cost calculated per 1 ha)
  2. Wind turbines (cost calculated per 25 machines)
  3. Micro hydro turbines (cost calculated per 20 machines)

  Phase 2

  1. Tidal devices (cost calculated for feasibility study and demonstration deployment)
  2. Wave devices (cost calculated for feasibility study and demonstration deployment)
- Equipment maintenance is 20% of total equipment cost

Equipment costing calculations:

As in section 2.2, the estimated cost of materials is based on a combination of local, internet and UK prices to establish a reasonably realistic value. Table 6 provides approximates of equipment costing in meeting the objectives of phase 1 and 2.

Table 6: Example workshop, teaching and office equipment

	Qty	USD/Unit	USD
WORKSHOP EQUIPMENT			
200 AMP MIG WELDER FOR STEEL	4	3,000.00	12,000.00
200 AMP TIG WELDER FOR ALUMINIUM	4	4,000.00	16,000.00
PILLAR DRILL	2	2,500.00	5,000.00
3M FOLDING/BENDING	2	15,000.00	30,000.00
2M BED LATHE	2	15,000.00	30,000.00
3M SHEET METAL PRESS	2	10,000.00	20,000.00
POWER HACKSAW	1	4,000.00	4,000.00
MILLING MACHINE	1	20,000.00	20,000.00
FORKLIFT (GAS POWERED)	2	25,000.00	50,000.00
FLAT BED TRUCK 7.5 TONNES	2	25,000.00	50,000.00
HAND TOOL KIT (X3)	3	2,000.00	6,000.00
TOTAL workshop equipment			**243,000.00**
OFFICE EQUIPMENT			
DESKS	10	200.00	2,000.00
TABLES	6	50.00	300.00
CHAIRS	20	80.00	1,600.00
PCS	14	900.00	12,600.00

CABINETS	12	300.00	3,600.00
TOTAL office equipment			**20,100.00**
TEACHING EQUIPMENT			
PROJECTORS	6	3,000.00	18,000.00
WHITEBOARDS	6	100.00	600.00
DESKS	240	50.00	12,000.00
TABLES	30	50.00	1,500.00
CHAIRS	240	40.00	9,600.00
PCS	80	700.00	56,000.00
TOTAL teaching equipment			**97,700.00**
ACCOMMODATION EQUIPMENT			
Beds, Tables, Kitchen, Bathroom per Flat	60	5,000.00	**300,000.00**
TOTAL EQUIPMENT			**660,800.00**
MAINTENANCE			
Repairs & renewals			**132,160.00**
TOTAL EQUIPMENT & MAINTENANCE			**792,960.00**

RGU-CUSP ADVISORS

RGU-CUSP advisors time allocation assumptions:

- Project is over 5 years
- Day rates will increase year on year and are at full economic cost (or higher) so that RGU-CUSP will recover full costs of projects
- Flights per year are estimated as are flight costs
- Subsistence rates are set at RGU daily levels
- Staff time is set at Principal Investigator (PI), Research Fellow (RF) and Research Assistant (RA) level with varying degrees of input. This cannot be accurately planned in advance, and may vary between years requiring fine tuning. For example the level of RA input may increase if RF time is less available. However this will be managed within the total staff budget. It is assumed that 80% of staff time will be spent in Aceh and 20% at RGU
- Equipment and Consumables relate to the RGU-CUSP team only and is for team use. E.g. computers, mobile phones, GPS devices, cameras etc. These can be identified as items which could be brought back to the UK at the end of the project. It is not equipment

relating to direct project activity such as building of devices, hire of boats and transport, the equipping of the centre and so on.

- Administration costs are set at 8% of the total direct cost each year (i.e. staff costs + travel & subsistence + equipment / consumables) Administration support will range from practical arrangements such as travel booking, diary management to working on financial data and presentations for reporting to funding bodies.
- Some of the admin support will contribute towards the capacity building part of the project with the by setting up templates / good practice systems for local monitoring of expenditure and reporting on funding.

Table 6: Calculations of RGU-CUSP time costs

		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTAL TIME (DAYS)
							VISITS						
TIME PI	days	135	135	135	135	135	AO	4	4	4	4	4	675
TIME RF	days	150	150	150	150	150	LG	4	4	4	4	4	750
TIME RA	days	10	20	40	60	60	SK	1	1	2	2	2	190
SUBSISTENCE RATE	GBP	£100	£110	£120	£130	£140							
FLIGHT (ABZ TO ACEH)	GBP	£2,200	£2,300	£2,400	£2,400	£2,400							
TOTAL T&S	GBP	£49,300	£54,250	£63,000	£68,850	£72,300						T&S	£307,700
DAY RATE PI	GBP	£675	£700	£725	£750	£775							
DAY RATE RF	GBP	£520	£545	£570	£595	£620							
DAY RATE RA	GBP	£485	£510	£535	£560	£585							
TOTAL TIME COST	GBP	£173,975	£186,450	£204,775	£224,100	£232,725						TIME	£1,022,025
Admin Support	GBP	£17,944	£19,900	£22,080	£23,584	£24,592					ADMIN		£108,100
MATERIALS	GBP	£10,000	£10,000	£10,000	£10,000	£10,000						MATERIALS	£50,000
Marine Equipment		£35,000	£28,125										
Marine ADCP Hire	GBP	£12,500	£12,500									MARINE	£88,125
CUSP Office (Banda Aceh)	GBP	£28,831	£22,224	£21,537	£25,867	£28,367						OFFICE	£126,826
												CHECKSUM	£1,702,776
TOTAL	GBP	£327,550	£333,449	£321,392	£352,401	£367,984				(TOTAL 5 YEARS)			**£1,702,776**
	USD	$524,080	$533,519	$514,227	$563,842	$588,775							**$2,724,442**

INCOME PROJECTION

An agreement has been reached with PLN that they will purchase renewable energy at a rate of 1000IDR per kWh. Assumptions used in income projection:

Phase 1

1. Solar PV panels (income calculated per 1 ha)
2. Wind turbines (income calculated per 1 machine)

Micro hydro turbines (income calculated per 1 machine)

Phase 2

3. Tidal devices (cost calculated for feasibility study and demonstration deployment)
4. Wave devices (cost calculated for feasibility study and demonstration deployment)

Established technologies

Based on accepted methodologies for calculating outputs from renewable energy systems, wind, solar PV and pico-hydro, income has been evaluated as follows:-

Solar	Data
Installed area (m^2)	10,000.00
PV m^2/kW	7.50
installed capacity kW/ha	1,333.33
operational hr/day	10.00
operational days/yr	300.00
kWh/ha yr	4,000,000.00
USD/Rupiah	9,589.00
Rupiah/kWh	1,000.00
USD/kWh	0.10
USD/ha yr	417,144.64

Wind	Data
No. Of machines	1.00
Rated output (kW)	50.00
Installed capacity (Kw)	50.00
Capacity factor	0.30
operational days/yr	365.00
kWh/yr	131,400.00
USD/Rupiah	9,589.00
Rupiah/kWh	1,000.00
USD/kWh	0.10
USD/yr	13,703.20

Pico-Hydro	Data
No. Of machines	1.00
Rated output (kW)	10.00
Installed capacity (Kw)	10.00

Capacity factor	0.90
operational days/yr	300.00
kWh/yr	72,000.00
USD/Rupiah	9,589.00
Rupiah/kWh	1,000.00
USD/kWh	0.10
USD/yr	7,508.60

A forecast for the project as presented on Table 7 is derived from calculations performed in sections 1-5. The largest single cost centre is that of fabrication materials. However, these will only be purchased once an order or generation site is confirmed, thereby minimising the commitment risk. Building the Centre itself and equipping workshops, teaching areas and accommodation are significant, but largely one-off costs in Year 1 and local staff will need to be recruited and trained on an incremental basis. RGU-CUSP costs are clearly defined and deliverables discussed in the main project document. The RGU-CUSP members of staff are expected to be in-country for extensive periods in order to provide consistent support for the project.

Table 7: Income/Expenditure forecast for ASTEC project

Heading	Sub-Heading	Year 1	Year 2	Year 3	Year 4	Year 5
		USD	USD	USD	USD	USD
Staff time		$137,168	$197,151	$252,400	$314,420	$314,420
Equipment		$660,800	$66,080	$66,080	$66,080	$66,080
Materials		$1,141,025	$2,282,050	$4,703,075	$7,104,100	$7,448,920
Building		$400,000	$40,000	$40,000	$40,000	$40,000
RGU input		$524,080	$533,519	$514,227	$563,842	$588,775
Total Cost		$2,863,073	$3,118,800	$5,575,781	$8,088,442	$8,458,195
Income	PV	$375,430	$1,126,291	$2,628,011	$4,880,592	$7,133,173
	Wind	$308,322	$924,966	$1,849,932	$3,083,220	$4,563,166
	Hydro			$135,155	$405,465	$810,929
Total Income		$683,752	$2,051,257	$4,613,098	$8,369,277	$12,507,269
Return		-$2,179,321	-$1,067,543	-$1,097,838	-$124,629	$3,238,145

FURTHER BUSINESS RESEARCH AND DEVELOPMENT, PHASE 2

Having established a viable business model in Phase 1, Phase 2 will further extend the indigenous capacity and capability by developing new areas of energy generation applicable to resources available in Aceh. Investigative work by RGU-CUSP in May 2012[5] shows that Aceh has a potentially large marine resource (wave & tidal) as well as biomass/gas. In addition, TiO2 water cleaning technologies developed by RGU, driven by renewable energies can be used to revive a fish farm that was destroyed by the 2004 tsunami.

[5] UNDP Aceh Energy Outlook – Scoping Report

9.5 MoUs with Acehnese and Indonesian Stakeholders

Appendix 9.5 consists of signed MoUs between the network in Aceh and Indonesia. This section provides the evidence of the solid network element of the intervention strategy (Figure 6-4: The wheel of change - interfaces between sustainable energy policy and appropriate technology).

UNSYIAH

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Gate 10-012-A11

Memorandum of Understanding

between

The Robert Gordon University (Scotland, UK)
a body corporate incorporated under The Robert Gordon University (Establishment) (Scotland) Order 2006 and having its main administrative offices at Schoolhill, Aberdeen, AB10 1FR and a registered Scottish Charity; SCO13781

and

Syiah Kuala University (Banda Aceh, Indonesia)
A state University registered in Indonesia and having its principal address at Jl. T. Nyak Arief Darussalam, Banda Aceh, 23111

and

Politeknik Aceh (Banda Aceh, Indonesia)
A Polytechnic registered in Indonesia and having its principal address at Jl. Tanggul, Pango Raya, Banda Aceh, 23119, Indonesia

Purpose of the Memorandum

This 'Memorandum of Understanding' has been drawn up following preliminary discussions held between the Syiah Kuala University, Politeknik Aceh and the Robert Gordon University. It reflects the wishes of the all three parties to collaborate in areas of mutual strategic interest.

Background

Based on initial discussions between the three parties, and subject to further in depth exploration, the initial key area(s) of collaboration between the three parties shall be as follows:

1. To develop academic and educational cooperation, and to promote mutual understanding among the three parties in the field of sustainable energy solutions in developing countries.

2. In the medium term it is anticipated that the collaboration will extend to the following activities in academic areas of mutual interest:

a) The exchange of researchers, students and academic staff between institutions;
b) The conclusion of collaborative research projects;
c) The organisation of lectures and symposia/workshop/training;

d) The exchange of academic information and materials (subject to appropriate confidentiality obligations to be put in place); and
e) The promotion of other academic cooperation as mutually agreed.

3. The cooperation to be formed pursuant to this Memorandum will be managed by the steering committee consisting of at least one representative for each party.

Principles

1. The implementation of any proposed collaborative activity will be dependent upon the availability of resources and financial support at each of the three parties' institutions.

2. The development and implementation of specific activities based on this memorandum shall be separately negotiated between the respective organizations in accordance with the regulations of The Robert Gordon University, Syiah Kuala University and Politeknik Aceh.

3. Prior to implementation, all proposed collaborative activity which arises from this Memorandum of Understanding will be developed into a formal written agreement. Any such formal written agreement shall specify the arrangements regarding confidentiality and intellectual property as agreed among the three parties. The three parties shall endeavour to seek an equitable and fair understanding in relation to any such intellectual property arrangements.

4. Once an agreement is negotiated and agreed in accordance with the regulations of all three parties, it will be signed on behalf of each party by an authorised signatory. Both parties acknowledge that, until such an agreement is signed by their authorised signatory, all the discussions, understandings (including this Memorandum of Understanding) and agreements will not be legally binding.

5. Both parties agree to keep any discussions, including information and materials disclosed in the course of these discussions, confidential. They further agree not to disclose or use any information, knowledge or materials gained in the course of the discussions, at any time in the future unless it becomes publicly available from another source.

Duration

This Memorandum of Understanding shall remain in force for an initial period of five (5) years following formal signing by all parties unless terminated in writing at an earlier date in terms with this Memorandum of Understanding.

All parties acknowledge that the duration of this Memorandum of Understanding may be extended by the agreement of all three parties.

ROBERT GORDON UNIVERSITY·ABERDEEN

Termination

Any of the three parties may terminate this Memorandum of Understanding by giving to the other party(ies) no less than ninety (90) days prior written notice.

Other

This Memorandum of Understanding has been drawn up and shall be executed by all three parties in the English language, as will any subsequent amendments.

Signatories

Signed for and on behalf of:

ROBERT GORDON UNIVERSITY

Signature: ....

Name: FERDINAND VON PRONDZYNSKI

Designation: Principal and Vice-Chancellor

Date: 20/2/13

SYIAH KUALA UNIVERSITY

Signature: ....

Name: PROF. DR. IR. SAMSUL RIZAL, M.ENG

Designation: RECTOR

Date: 06 / 03 / 2013

POLITEKNIK ACEH

Signature: ....

Name: Zainal Hanafi

Designation: Principal and Vice-Chancellor

Date: 04 / 03 / 2013

GATE10-012-A06

Memorandum of Understanding (the "MoU")

between

The Robert Gordon University (Scotland, UK)
a charity registered in Scotland with charitable number SC013781 and incorporated under the Robert Gordon University (Establishment) (Scotland) Order 2006 and having its main administrative offices at Schoolhill, Aberdeen, AB10 1FR

and

Universitas Nasional, Indonesia
an institution of higher learning, established under the laws of the Republic of Indonesia, having its address at Jalan Sawo Manila, Number 61, Pasar Minggu, Jakarta Selatan 12520, Indonesia

(hereinafter referred to as "the Parties" and each of them being "a Party")

The Parties are delighted to have the opportunity to develop links with each other and look forward to a long and successful collaborative relationship which is hoped will be of great benefit to all parties.

This MoU has been drawn up following preliminary discussions held between the Parties. This MoU is intended to record on a non-legally-binding basis, the terms upon which the Parties intent to collaborate in areas of mutual interest. Accordingly, this MoU is not legally binding with the exception of the provisions of Clause 4 (Confidentiality) which are legally binding on both Parties.

1. Purpose of the Memorandum

The Purpose of this MoU is to strengthen ties between the Parties and to promote academic collaboration and understanding of cultures between Indonesia and Scotland.

2. Scope of Activities

The scope of the activities of the MoU shall include:

a) Collaborative Research

The Parties will seek opportunities to cooperate in research. Based on initial discussions between the Parties, and subject to further in-depth exploration, the potential key area of future collaboration between the Parties relates to sustainable energy solutions in developing countries. The Parties will seek funding opportunities to cooperate in this area of research.

The details of further specific research areas will be determined by the mutual agreement of the Parties.

b) Academic Staff Program

Both Parties will co-operate to support and train the Masters and PhD candidates of the counterpart in all fields of common interest.

Visits by academic staff from both Parties will be encouraged for the mutual benefit of the parties.

The host University will assist in arranging accommodation for the visiting scholar and will assist the visiting scholar in matters of immigration, stay and working permit, medical emergencies language and local custom.

c) Student Program

The Parties will seek opportunities to hold a student exchange program which will include one semester at both Universities and the provision of library access and academic assistance. Such exchanges shall be negotiated and agreed to by Parties on a case-by-case basis.

3. Principles

All discussions regarding potential collaboration seek to:

1. advance the aims of the collaboration;
2. have as a background the common interest of the parties in relation to the aims;
3. add value to each Party' organisations;
4. share knowledge and expertise in pursuance of the aims.

All matters on which agreement is ultimately reached regarding collaboration including intellectual property matters will be set out in writing and both parties will provide input to the drafting of the agreement to ensure each party is fully satisfied it reflects the understanding reached during discussions. Once an agreement is finalised it will be signed on behalf of each party by an authorised signatory. Both parties acknowledge that, until such an agreement is signed by their authorised signatory, all the discussions, understandings (including this MoU) and agreements will not be legally binding.

4. Confidentiality

Both parties agree to keep any discussions, including information and materials disclosed in the course of these discussions, confidential. They further agree not to disclose or use any information, knowledge or materials gained in the course of the discussions, at any time in the future unless the information:

a) has become public knowledge other than through any fault of the Receiving Party;
b) was already known to the receiving party prior to the disclosure;

c) was independently developed by the receiving party prior to the disclosure;
d) is required to be disclosed by law or by a requirement of a regulatory body.

5. Effective Date, Duration and Termination

The MoU shall commecnce on the last date of signature hereof and shall continue for a period of five (5) years, unless terminated in advance by either Party. This MoU may be extended by written mutual consent of the Parties.

The MoU may be terminated by either Party by giving written notice at least six (6) months in advance to the other Party. The even t of termination of this MoU will not affect participants from completing their activities at the host institutions.

Governing Law

Clause 4 of this MoU shall be governed by and construed in accordance with Scottish Law.

This MoU is signed for and on behalf of:

THE ROBERT GORDON UNIVERSITY

....
Professor Ferdinand von Prondzynski
Principal and Vice-Chancellor

....
Witness

Witness Name

HANAH ELFELLAH

Witness Address

SCHOOLHILL, ABERDEEN,

UK, AB10 1FR

1 OCTOBER 2012
....
Date

Place: Aberdeen

UNIVERSITAS NASIONAL, INDONESIA

....
Drs. El Amry Bermawi Putera, M.A.
Rector

....
Witness

Witness Name

SUGARDJITO SOEKOHARDJO

Witness Address

66. PERMATA KAMURANG NO 3

RT 03/04 PUSPANEGARA CITEUREUP

KAB BOGOR JAWA BARAT

4 OCTOBER 2012
....
Date

Place: Jakarta

Memorandum of Understanding

between

THE ROBERT GORDON UNIVERSITY,
a body corporate incorporated under The Robert Gordon University (Establishment) (Scotland) Order 2006, a Scottish Charity (Charity Number SC013781) and having its principal administrative office at Garthdee House, Garthdee Road, Aberdeen, AB10 7QB ("RGU")

and

INSTITUT TEKNOLOGI SEPULUH NOPEMBER,
an institution of higher education in Indonesia, having its principal place of business at Jalan Its Raya, 60111, Indonesia **("ITS")**

Purpose of the Memorandum

This 'Memorandum of Understanding' has been drawn up following preliminary discussions held between **ITS** and RGU. It reflects the wishes of both parties to collaborate in areas of mutual strategic interest.

Based on initial discussions between the parties, and subject to further in depth exploration, the initial key area(s) of collaboration between the two parties relates to **RGU and ITS developing joint PhD and MSc programmes for marine renewables in Indonesia, and is expected to lead to joint research programmes around the design, development and installation of marine renewables in Indonesian waters.**

In the medium term it is anticipated that the collaboration will extend to RGU contributing to the delivery of new and existing joint PhD and MSc programmes in Indonesia and the UK. There is also potential for RGU delivering existing **postgraduate courses in offshore oil and gas training in Indonesia and the UK.**

Principles

Prior to implementation, all proposed collaborative activity which arises from this Memorandum of Understanding will be developed into a formal written agreement. Once an agreement is finalised it will be signed on behalf of each party by an authorised signatory. Subject to the terms of the Confidentiality provisions in this Memorandum of Understanding, which the Parties intend to be legally binding, both parties acknowledge that, until such an agreement is signed by their authorised signatory, all the discussions, understandings (including this Memorandum of Understanding) and agreements will not be legally binding.

Both parties agree to keep any discussions, including information and materials disclosed in the course of these discussions, confidential. They further agree not to disclose or use any information, knowledge or materials gained in the course of the discussions, at any time in the future unless it becomes publicly available from another source.

Duration

This Memorandum of Understanding shall remain in force for an initial period of three (3) years following formal signing by all parties unless terminated in writing at an earlier date in terms with this Memorandum of Understanding.

Termination

Either party may terminate this Memorandum of Understanding by giving to the other partyno less than thirty (30) days prior written notice.

Signatories

Signed for and on behalf of:

ROBERT GORDON UNIVERSITY		**INSTITUT TEKNOLOGI SEPULUH NOPEMBER**	
Signature:		Signature:	
Name:	F. VON PRONDZYNSKI	Name:	TRI YOGI YUWONO
Designation:	Principal and Vice-Chancellor	Designation:	President/Rector
Date:	11 FEBRUARY 2014	Date:	18 February 2014

9.6 MoA and Centres of Excellence drafts

Appendix 9.6 consists of agreed draft MoAs between the network in Aceh and Indonesia. This section provides the evidence of the solid network element of the intervention strategy (Figure 6-4: The wheel of change - interfaces between sustainable energy policy and appropriate technology).

UNAS

ITS

Memorandum of Agreement (“MoA”)

Between

The Robert Gordon University, a body corporate incorporated under The Robert Gordon University (Establishment) (Scotland) Order 2006, a Scottish Charity (Charity Number SC013781) and having its principal administrative office at Garthdee House, Garthdee Road, Aberdeen, AB10 7QB (“RGU”)

And

Universitas Nasional, Indonesia, an institution of higher learning, established under the laws of the Republic of Indonesia, having its address at Jalan Sawo Manila, Number 61, Pasar Minggu, Jakarta Selatan 12520, Indonesia (“UNAS”)

(hereinafter referred to individually as a “Party” and collectively as “the Parties”).

Background

(A) The Parties entered into a Memorandum of Understanding dated 4th October 2012 for the purposes of promoting academic collaboration and Understanding Culture.

(B) The Parties intend to create [insert new purpose] Centre (“Centre”) The Centre will not be a separate legal entity but will remain a virtual institute governed by the Parties.

(C) The Universities now wish to define their rights and obligations with respect to the operation and management of the Centre (“the Project”).

The Parties intend to enter into legally binding collaborative terms and conditions in relation to the points of agreement noted in this MoA within six (6) months of the effective date of this MoA. This Agreement takes effect on xxxxxx

1. Statement of Objectives of the Centre

1.1 The Centre will lead the delivery and deployment of the …… industry by building intellectual capacity to support the expanding …… industry.
1.2 The Centre will provide a hub to coordinate and integrate …… research and consultancy across the three Parties.
1.3 The Centre will promote interdisciplinary approaches between the fields of engineering, economics, law, management and environmental science in order to solve a complex of industry challenges.
1.4 The Centre will collect, analyse and disseminate data and information to Government, Industry and NGO’s.
1.5 The Centre will provide training to industry through CPD and training seminars.
1.6 The Centre will support and facilitate the participation of existing academic units in [insert field]
1.7 The centre will seek external grant funding and support for its operations as detailed in the Centre’s Business Plan.

2. The governance structure of the Centre:

2.1 A Governance Board - comprised of up to two senior representatives from each Party and representatives of any major funding bodies. This Governance Board will meet every six months/twice a year. Decisions of the Governance Board will be decided by simple majority. The quorum for the Governance Board will include one representative from each Party. The Governance Board can make decisions on the running of Centre which are consistent with this Memorandum of Agreement and subsequent contract, and make recommendations to the Parties on other decisions relating to the management, funding and performance of the Centre.

2.2 A Management Group - The Centre Director, Project Development Managers and Office Manager (both identified in section 4.2 below), together with a senior representative of each Party will form a Management Group to coordinate the day-to-day activities of the Centre. The Management Group will be responsible for the delivery of the business plan as per Annex 1. The quorum for the management will include one representative from each Party

2.3 An Advisory Board - comprised of invited senior industry, Governmental and non-Governmental key opinion leaders will be formed. The role of the Centre Advisory Board will be to shape the strategic direction of the Centre by providing guidance and advice on project selection and priCentretisation and to ensure that the activities of the Centre continue to be aligned with the needs of the …… industry.

2.4 No business shall be transacted at any Governance meeting unless a quorum is formed at the time when the meeting proceeds to business. Three persons entitled to vote upon the business to be transacted, each being a Member or a proxy for a Member of each of the Parties shall form a quorum.

2.5 Day to day running of the Centre will be managed by the Centre Director with support from the PDM(s) and PA (both identified in section 4.2 below)

3 Location and Contact

3.1 The Centre will be located in the ….. building at the …………. UNAS/RGU will provide office space for the Centre staff and potentially additional researchers, as well as meeting room space as required.

3.2 Contacts at the RGU shall be xxxxxxxxxx and at UNAS xxxxxxx.

4 Staffing

4.1 <u>The Director</u>

4.1.1 ………….. will be the interim Director of the Centre. He will be seconded into the the Centre from UNAS/RGU and will direct the Centre on a part-time basis until …… 2014, or, by agreement, until a full time Director is appointed.

4.1.2 From ……. 2015 the plan is to appoint a full time Director for the Centre. If this is a new appointment the Director will be employed by UNAS/RGU. If an existing member of staff of one of the Parties takes on the role of full time Director of the Centre, he/she will remain a member of staff of his/her current Party and be seconded to the Centre.

4.2 The Project Development Manager(s) ("PDM") and Office Manager/Personal Assistant ("PA")

4.2.1 Where appropriate, and agreed by the Centre Governance Board, existing staff from any of the Parties may be seconded to the Centre PDM post(s) and PA post. If these post(s) are new appointments then the individuals will be employed by UNAS/RGU, and will be staff member of the UNAS/RGU's Centre for Understanding Sustainable Practice but will be under the management of the Centre Director for strategic and day to day operations. The Centre PDM(s) will work closely with the ……… in UNAS and RGU.

4.3 Further recruitment

4.3.1 The recruitment of additional PDMs for the Centre is conditional on a sufficient level of income being generated for the Parties and any decision of further recruitment of PDM resources will be determined by the Governance Board based on the information contained in the Director's quarterly reports. For indicative purposes only it should be noted that the Centre Business Plan envisages that second and third PDM appointments might be triggered on the achievement of annual income (core and programme) of £500,000 and £800,000 respectively.

5 Specific responsibilities of each Party

5.1 Each Party agrees that all costs for 2014/15 will be met by the respective Party as part of its contribution to the creation of the Centre.

5.2 From …. 2015, any cost that any Party incurs in relation to secondees to the the centre staffing, and in the case of UNAS/RGU direct recruitments to the Centre staffing, shall form part of that Party's contribution to the Centre's running costs.

5.3 Each Party will contribute to the costs of the centre from …………. Onwards.

5.4 Each Party will facilitate the access of the Centre staff to its own staff, and will encourage joint working with the Centre among the Parties.

5.5 UNAS/RGU will provide office accommodation and administrative support (IT, phone, postage etc.) to the Centre staff whilst based in the Centre offices in UNAS/RGU. The cost of this provision shall form part of UNAS/RGU's contribution to the Centre's running costs.

6 Financial commitments

6.1 From the [insert date] the Parties agree that the annual operating loss or profit for the Centre will be shared equally between the Parties.

6.2 At the 2014/2015 year end the costs incurred in support of the Centre will be calculated less any "Centre Income" (that is income generated by the Centre from its core activities and credited to the Centre's Cost Centre (defined in section 7 below) - and not income which relates to research, consultancy or CPD work attributed to researchers in either Party's institution). The net cost of the Centre will be split twoways between the Parties, for example:

	£K
Salary costs	
Other costs	
Total costs	
Total core income (worst case)	_________
Net cost	

Each Party's share of costs for the year based on this example would be £….. At year end, reimbursements will take place between the Parties to reflect in year contributions – secondments, services etc.

7 For year 2015/16, and each subsequent year thereafter, an operating budget will be prepared by the Centre Director for the Centre Governance Board by [Insert Date] with respect to the forthcoming financial year starting [insert Date]. This will detail the planned expenditure for the following academic year, to enable the Centre Governance Board to discuss and agree the financial commitment for the Centre for the next year.

7 Financial stewardship

7.1 The Centre will be established as a separate cost centre within the UNAS/RGU (the "Cost Centre"), to which will be charged the staff costs of the Centre PDM(s) and the Centre PA, plus Centre related travel, marketing, administrative support and costs incurred due to the hosting of the Centre at UNAS/RGU. Regular statements of income and expenditure will be drawn up by UNAS/RGU accountant as required.

7.2 It is the responsibility of the Director to ensure that Centre operates within its agreed budget.

8 Reporting

The Parties require information on new business delivered by the Centre in order to determine if it is a success and to justify continued financial support. The Centre Director will prepare quarterly reports which detail activity and awards won by each of the Parties as a result of the efforts of the Centre, where the Centre can clearly demonstrate to have added value. These reports will identify individual projects and also the notional value of each project to each of the Parties. These quarterly reports will be provided to members of the Governance Board and will be discussed at the six-monthly meetings of the Governance Board.

9 Research income arrangements and profit sharing

9.1 When the Centre identifies and facilitates projects to be taken forward by non-Centre staff the financial administration will be done according to the usual processes and regulations of the employing Party and the income will be retained by the employing party not the Centre. It is foreseen that the majority of activity will be in this category.

9.2 When the Centre identifies and facilitates projects for cross-Party teams the academics in the team will select the Party through which the proposal will be administered (usually the employing Party of the Principal Investigator) and will abide by that Party's usual processes and regulations. The income generated will be split between the participating Parties as per standard practice and will not be retained by Centre. Costing will be prepared and signed off by each Party for its own employees and facilities.

9.3 For that minority of activity where income is generated by the Centre through substantive work carried out by Centre staff and delivered by the Centre without recourse to resources or staff of any of the Parties, then that income shall be retained within the Centre and credited to the Centre Cost Centre. An example of this might be payments for the use of data collected by Centre, or consultancy undertaken by the Centre Director on his/her own on behalf of a company. The administration of such work will be led by the UNAS/RGU.

10 Intellectual property arrangements

10.1 The ownership and/or control of intellectual property used or generated in connection with the Centre (including jointly-owned intellectual property) will be in accordance with:-

10.1.1 The party that creates or generates any Result will own the Intellectual Property in that Result, and may take such steps as it may decide from time to time, at its expense and sole discretion, to register and maintain any protection for that Intellectual Property, including filing and prosecuting patent applications for any Result, and taking any action in respect of any alleged or actual infringement of that Intellectual Property.

10.1.2 Where any Result is created or generated by two or more Parties jointly and it is impossible to distinguish each Party's intellectual contribution to the creation of the Intellectual Property in that Result, the Intellectual Property in that Result will be owned by those Parties in equal shares. The owners may take such steps as they may decide from time to time, at their joint and equal expense, to register and maintain any protection for that Intellectual Property, including filing and prosecuting patent applications for any Result, and taking any action in respect of any alleged or actual infringement of that Intellectual Property. If one or more of the owners does not wish to take any such step or action, the other owner(s) may do so at their expense, and the party not wishing to take such steps or action will provide, at the expense of the party making the request, any assistance that is reasonably requested of it.

10.1.3 Nothing in this Agreement shall affect ownership of any Background IP which shall remain the property of the Party introducing the same.

10.1.4 Notwithstanding the terms of clause 10.1.4 above, each Party shall, subject to the provisions of clause 10.1.2 and clause 10.1.3, and where they are free to do so, grant a non-exclusive, royalty free licence to use its Background to the other Parties, as is reasonably required to enable the other Parties to carry out their respective part of the arrangement and for no other purpose whatsoever.

10.2 For the avoidance of doubt, Background means such Information (other than the Results) and Intellectual Property Rights, which is introduced to or is used in implementation of the Project and which at the date hereof is in, or during the continuance, and other than as a result of, the Project comes into the ownership or control of a Party and which such Party is free to disclose while Result means such Information as is generated in implementation of the Project, whether through externally funded research projects or otherwise, together with any Intellectual Property Rights arising in relation thereto.

10.3 The Parties shall each individually confirm that strict confidentiality will be observed in all communications relating to portable or potentially commercially valuable intellectual property created within the Centre. No disclosures will be made to third parties without permission of the appropriate signatories of the relevant Party.

10.4 Proportionality of inventive contribution for intellectual property developed jointly by individuals will be identified as early as possible and can then be used subsequently to determine the split of any IP-generated income between the Parties.

10.5 Commercialisation and structuring of deals relating to IP will be undertaken by the respective …… of the Parties, liaising closely with Centre. Where there is joint IP and/or IP and input from more than one Party, the …. will agree a lead for commercialisation.

10.6 Any decision to file a patent application, together with the responsibility for the payment of all associated patent costs, will be met by the Party(s) owning the IP and not the Centre.

10.7 Royalty income between the Parties will be distributed based on inventive contribution.

10.8 Each Party shall be responsible for sharing any income with its inventor(s) alone, in accordance with the Party's published guidelines.

11 Conflict resolution

11.1 At the level of operations conflicts should be resolved internally by the Centre Management Group, but, if this is not possible, will be resolved by the Centre Governance Board.

11.2 The final level of arbitration would involve the Principals of the two Parties.

12 Termination

12.1 Should any Party wish to leave Centre it will give six months notice in writing to the other Party, and will make payment of its share of the operating costs incurred in support of Centre for the financial year in which the end of the notice period falls, as detailed in section 6 above.

12.2 Should both Parties decide mutually to terminate Centre, the financial obligations relating to the Centre will be shared between the Parties.

13 Legal relationship of the Parties

13 Although the terms "………..." and "Centre" are used, nothing in this MoA is intended to, or shall, operate to create a partnership (in a legal or taxation sense) between the Parties and no action taken by the Parties pursuant to this MoA shall constitute, or be deemed to constitute, a partnership (in a legal or taxation sense) or constitute one Party as an agent, or representative of the other.

14 Confidentiality

14.1 The Parties agree that the subject matter of this MoA is of a confidential nature and agree to maintain the confidentiality of all discussions relating to the content of this MoA, where such materials ought reasonably to be considered as being confidential. Furthermore, any future contractual arrangements agreed between the Parties in relation to the content of this MoA shall include formal confidentiality provisions.

14.2 Where any Party is in receipt of an information request pursuant to the Freedom of Information (Scotland) Act 2002 or any analogous regulations in respect of Confidential Information (or any other information) relating to this MoA (the "Request") it shall make an analysis as to whether the Confidential Information or other information requested is capable of benefiting from an exemption from disclosure. In the event that the Party in receipt of the Request considers that disclosure is legally required and makes the requested disclosure, no liability shall attach thereto.

15 General

15.1 Save for the provisions of section 14 above, which shall be binding amongst the Parties, this MoA is not intended to create or imply any legal relationship or contract amongst the Parties.

15.2 Each Party may withdraw without liability from any negotiations which may from time to time be entered into with a view to exploring further collaboration, as envisaged in this MoA or otherwise, subject to each Party being liable for its share of the operating costs incurred in support of Centre for the financial year 2014/2015, as detailed in section 6 above.

15.3 Should any Party become aware of a conflict of interest it shall advise the other Party as soon as reasonably possible.

15.4 To the extent that any legal issue arises in connection with this MoA, it will be governed by and construed in accordance with Scots law.

SIGNED FOR

Robert Gordon University at Aberdeen	Witness
Signature:	Signature:
Name:	Name:
Position:	Position:

Date:	Date:
UNAS	Witness:
Signature:	Signature:
Name:	Name:
Position:	Position:
Date:	Date:

Memorandum of Agreement ("MoA")

Between

The Robert Gordon University, a body corporate incorporated under The Robert Gordon University (Establishment) (Scotland) Order 2006, a Scottish Charity (Charity Number SC013781) and having its principal administrative office at Garthdee House, Garthdee Road, Aberdeen, AB10 7QB ("RGU")

And

Institut Teknologi Sepuluh Nopember, an institution of higher education in Indonesia, having its principal place of business at Kampus ITS, Keputih, Sukolilo, Surabaya, 60111, Indonesia ("ITS")

(hereinafter referred to individually as a "Party" and collectively as "the Parties").

Background

(A) The Parties entered into a Memorandum of Understanding dated 4th October 2013 for the purposes of promoting academic collaboration.

(B) The Parties intend to create joint degree MSc and PhD programs in Marine Renewable Energy and to establish a capacity building program.

(C) The Parties intend to create a new Centre for Marine Renewable Energy, ("Centre"). The Centre will not be a separate legal entity but will remain a virtual institute governed by the Parties.

(D) The Parties now wish to define their rights and obligations with respect to the operation, management and any activity of the Centre ("the Project").

The Parties intend to enter into legally binding collaborative terms and conditions in relation to the points of agreement noted in this MoA within twelve (12) months of the effective date of this MoA. This Agreement takes effect on 1st December 2014.

1. Statement of Objectives

1.1 The Centre will provide teaching and training to implementers and community groups through joint courses including Undergraduate & Post Graduate degree programs, Continuing Professional Development, fieldwork and training seminars.

1.2 The Centre will lead the research, development, delivery and deployment of appropriate marine renewable energy technology for use in South East Asia and elsewhere by building indigenous intellectual and practical skills capacity.

1.3 The Centre will provide a hub to coordinate and integrate relevant research and consultancy between the Parties.

1.4 The Centre will promote interdisciplinary approaches between the fields of engineering, economic, social, political and environmental aspects to address a complex range of marine energy implementation challenges.

1.5 The Centre will collect, analyse and disseminate data and information to Government, Business, Academia and NGO's.

1.6 The Centre will support and facilitate the participation of existing academic units within the Parties.

1.7 The Centre will seek external grant funding and support for its operations as will be detailed in the Centre's Business Plan.

2. The governance structure of the Centre:

2.1 A Governance Board - comprised of up to two senior representatives from each Party. This Governance Board will meet every six months/twice a year. Decisions of the Governance Board will be decided by simple majority. The quorum for the Governance Board will include one representative from each Party. The Governance Board can make decisions on the running of Centre which are consistent with this Memorandum of Agreement and subsequent contract, and make recommendations to the Parties on other decisions relating to the management, funding and performance of the Centre.

2.2 A Management Group - The Centre Director, Project Development Managers (PDMs) and Personal Assistant (PA) (all identified in section 4.2 below), together with a senior representative of each Party will form a Management Group to coordinate the day-to-day activities of the Centre. The Management Group will be responsible for the delivery of the business plan as per Annex 1. The quorum for the management will include one representative from each Party.

2.3 An Advisory Board - comprised of invited senior Academics, Business, Governmental and non-Governmental key opinion leaders will be formed. The role of the Centre Advisory Board will be to shape the strategic direction of the Centre by providing guidance and advice on project selection and prioritisation and to ensure that the activities of the Centre continue to be aligned with the needs of the sector, region and indigenous communities.

2.4 No business shall be transacted at any Governance meeting unless a quorum is formed at the time when the meeting proceeds to business. Two persons entitled to vote upon the business to be transacted, each being a Member or a proxy for a Member of each of the Parties shall form a quorum.

2.5 Day to day running of the Centre will be managed by the Centre Director with support from the PDM(s) and PA (all identified in section 4.2 below).

3 Location and Contact

3.1 The Centre will be located in the ***Marine Research Center*** building at the ITS campus in Surabaya. ITS will provide office space for the Centre staff and potentially additional researchers, as well as meeting room space as required. ??? (Will be discussed with Vice Rector IV)

3.2 Contacts at the RGU shall be Dr Alan Owen and at ITS Prof Mukhtasor.

4 Staffing

4.1 The Director

4.1.1 "To Be Decided"??? will be the interim Director of the Centre. He/She will be seconded into the Centre from ITS/RGU and will direct the Centre on a part-time basis until December 31st 2014 (?????), or, by agreement, until a full time Director is appointed.

4.1.2 From January 1st 2015 (?????) the plan is to appoint a full time Director for the Centre. If this is a new appointment, the Director will be employed by either of the Parties. If an existing member of staff of one of the Parties takes on the role of full time Director of the Centre, he/she will remain a member of staff of his/her current Party and be seconded to the Centre.

4.2 The Project Development Manager(s) ("PDM") and Personal Assistant ("PA")

4.2.1 Where appropriate, and agreed by the Centre Governance Board, existing staff from any of the Parties may be seconded to the Centre PDM post(s) and PA post. If these post(s) are new appointments then the individuals will be employed by either of the Parties, and will be a staff member of the Parties but will be under the management of the Centre Director for strategic and day to day operations.

4.3 Further recruitment of additional staff

4.3.1 The recruitment of additional staff for the Centre is conditional on a sufficient level of income being generated for the Parties and any decision of further recruitment of staff resources will be determined by the Centre Director.

5 Specific responsibilities of each Party ?????

5.1 Each Party agrees that all costs for 2014/15 will be met by the respective Party as part of its contribution to the creation of the Centre.

5.2 From January 1st 2015 (????), any cost that any Party incurs in relation to secondees to the centre staffing, and in the case of ITS/RGU direct recruitments to the Centre staffing, shall form part of that Party's contribution to the Centre's running costs.

5.3 Each Party will contribute to the costs of the centre from September 1st 2014 onwards.

5.4 Each Party will encourage joint working with other parties.

5.5 ITS/RGU will provide office accommodation and administrative support (IT, phone, postage etc.) to the Centre staff whilst based in the Centre offices in ITS/RGU. The cost of this provision shall form part of ITS/RGU's contribution to the Centre's running costs.

6 Financial commitments

6.1 From the 1st September 2014 the Parties agree that the annual operating loss or profit for the Centre will be shared proportionally.

7 Reporting

The Parties require information on new business delivered by the Centre in order to determine if it is a success and to justify continued financial support. The Centre Director will prepare quarterly reports which detail activity and awards won by each of the Parties as a result of the efforts of the Centre, where the Centre can clearly demonstrate to have added value. These reports will identify individual projects and also the notional value of each project to each of the Parties. These quarterly reports will be provided to members of the Governance Board and will be discussed at the six-monthly meetings of the Governance Board.

8 Research income arrangements and profit sharing

8.1 When the Centre identifies and facilitates projects to be taken forward by non-Centre staff the financial administration will be done according to the usual processes and regulations of the employing Party and the income will be retained by the employing party not the Centre. It is foreseen that the majority of activity will be in this category.

8.2 When the Centre identifies and facilitates projects for cross-Party teams the academics in the team will select the Party through which the proposal will be administered (usually the employing Party of the Principal Investigator) and will abide by that Party's usual processes and regulations. The income generated will be split between the participating Parties as per standard practice and will not be retained by Centre. Costing will be prepared and signed off by each Party for its own employees and facilities.

8.3 For that minority of activity where income is generated by the Centre through substantive work carried out by Centre staff and delivered by the Centre without recourse to resources or staff of any of the Parties, then that income shall be retained within the Centre and credited to the Centre Cost Centre. An example of this might be payments for the use of data collected by Centre, or consultancy undertaken by the Centre Director on his/her own on behalf of a company. The administration of such work will be led by the ITS/RGU.

9 Intellectual property arrangements

9.1 The ownership and/or control of intellectual property used or generated in connection with the Centre (including jointly-owned intellectual property) will be in accordance with the following:

9.1.1 The party that creates or generates any Result will own the Intellectual Property in that Result, and may take such steps as it may decide from time to time, at its expense and sole discretion, to register and maintain any protection for that Intellectual Property, including filing and prosecuting patent applications for any Result, and taking any action in respect of any alleged or actual infringement of that Intellectual Property.

9.1.2 Where any Result is created or generated by two or more Parties jointly and it is impossible to distinguish each Party's intellectual contribution to the creation of the Intellectual Property in that Result, the Intellectual Property in that Result will be owned by those Parties in equal shares. The owners may take such steps as they may decide from time to time, at their joint and equal expense, to register and maintain any protection for that Intellectual Property, including filing and prosecuting patent applications for any Result, and taking any action in respect of any alleged or actual infringement of that Intellectual Property. If one or more of the owners does not wish to take any such step or action, the other owner(s) may do so at their expense, and the party not wishing to take such steps or action will provide, at the expense of the party making the request, any assistance that is reasonably requested of it.

9.1.3 Nothing in this Agreement shall affect ownership of any Background IP which shall remain the property of the Party introducing the same.

9.1.4 Notwithstanding the terms of clause 9.1.3 above, each Party shall, subject to the provisions of clause 9.1.1 and clause 9.1.2, and where they are free to do so, grant a non-exclusive, royalty free licence to use its Background to the other Parties, as is reasonably required to enable the other Parties to carry out their respective part of the arrangement and for no other purpose whatsoever.

9.2 For the avoidance of doubt, Background means such Information (other than the Results) and Intellectual Property Rights, which is introduced to or is used in implementation of the Project and which at the date hereof is in, or during the continuance, and other than as a result of, the Project comes into the ownership or control of a Party and which such Party is free to disclose while Result means such Information as is generated in implementation of the Project, whether through externally funded research projects or otherwise, together with any Intellectual Property Rights arising in relation thereto.

9.3 The Parties shall each individually confirm that strict confidentiality will be observed in all communications relating to portable or potentially commercially valuable intellectual property created within the Centre. No disclosures will be made to third parties without permission of the appropriate signatories of the relevant Party.

9.4 Proportionality of inventive contribution for intellectual property developed jointly by individuals will be identified as early as possible and can then be used subsequently to determine the split of any IP-generated income between the Parties.

9.5 Commercialisation and structuring of deals relating to IP will be undertaken by the Parties, liaising closely with Centre. Where there is joint IP and/or IP and input from more than one Party, the Parties will agree a lead for commercialisation.

9.6 Any decision to file a patent application, together with the responsibility for the payment of all associated patent costs, will be met by the Party(s) owning the IP and not the Centre.

9.7 Royalty income between the Parties will be distributed based on inventive contribution.

9.8 Each Party shall be responsible for sharing any income with its inventor(s) alone, in accordance with the Party's published guidelines.

10 Conflict resolution

10.1 At the level of operations conflicts should be resolved internally by the Centre and the Parties.

10.2 The final level of arbitration would involve the Principals of the two Parties.

11 Termination

11.1 Should any Party wish to leave Centre it will give six months notice in writing to the other Party, and will make payment of its share of the operating costs until the end of the financial year.

11.2 Should both Parties decide mutually to terminate Centre, the financial obligations relating to the Centre will be shared between the Parties.

13 Legal relationship of the Parties

Although the terms "Centre" are used, nothing in this MoA is intended to, or shall, operate to create a partnership (in a legal or taxation sense) between the Parties and no action taken by the Parties pursuant to this MoA shall constitute, or be deemed to constitute, a partnership (in a legal or taxation sense) or constitute one Party as an agent, or representative of the other.

14 Confidentiality

14.1 The Parties agree that the subject matter of this MoA is of a confidential nature and agree to maintain the confidentiality of all discussions relating to the content of this MoA, where such materials ought reasonably to be considered as being confidential. Furthermore, any future contractual arrangements agreed between the Parties in relation to the content of this MoA shall include formal confidentiality provisions.

15 General

15.1 Save for the provisions of section 14 above, which shall be binding amongst the Parties, this MoA is not intended to create or imply any legal relationship or contract amongst the Parties.

15.2 Each Party may withdraw without liability from any negotiations which may from time to time be entered into with a view to exploring further collaboration, as envisaged in this MoA or otherwise, subject to each Party being liable for its share of the operating costs incurred in support of Centre for the financial year 2014/2015, as detailed in section 6 above.

15.3 Should any Party become aware of a conflict of interest it shall advise the other Party as soon as reasonably possible.

15.4 To the extent that any legal issue arises in connection with this MoA, it will be governed by and construed in accordance with Scots and Indonesian law.

SIGNED FOR

Robert Gordon University at Aberdeen	Witness
Signature:	Signature:
Name:	Name:
Position:	Position:
Date:	Date:

ITS	Witness:
Signature:	Signature:
Name:	Name:
Position:	Position:
Date:	Date:

9.7 RISTEK endorsement letter

Appendix 9.7 consists of signed endorsement letter from RISTEK to influencing policy development in the context of providing equal energy access to both urban and remote societies spread out in the Indonesian archipelago. The partnership and endorsement of activities within the Indonesian territory is an explicit support for the concept development of vulnerable society, sustainable energy policy in practice, and appropriate technology for development.

THE MINISTRY OF RESEARCH AND TECHNOLOGY
DEPUTY MINISTRY FOR SCIENCE AND TECHNOLOGY NETWORK
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Telephone +62-21-3169238 Facsimile +62-21-31923902
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Jakarta, July 2013

Reference No. : /D-JIPT/VII/2013
Attachment : 1 (one) file

To:
Jenny Yates
Head of UK Climate Change Unit
Jakarta

Dear Ms. Jenny Yates,

Concerning the project “Marine Energy Feasibility Study – Indonesia” with partners:

1. Asosiasi Energi Laut Indonesia (ASELI) (also known as the Indonesian Ocean Energy Association (INOCEAN));
2. Centre for Understanding Sustainable Practice (CUSP) – Robert Gordon University (RGU);

The Indonesian Government, through the Ministry of Research and Technology (Ristek) c.q. Deputy Ministry for Science and Technology supports the collaborative project proposed by CUSP and ASELI based on the attached project outline.

Ristek views that the output of this initiative will feed into the Indonesian Government policy formulation for the advancement of marine energy implementation in Indonesian waters.

Therefore Ristek endorses the work packages proposed and aims to contribute the following to the initiative as an in kind contribution through support for ASELI to access information/data /reports and to provide summaries as required for the completion of the work.

Thank you for your kind attention.

Sincerely Yours,

Dr. Agus R. Hoetman
Deputy Minister for Science and Technology Network
The Ministry of Research and Technology