Leapfrog to the Future:

Energy Scenarios & Strategies for Suriname to 2050
– Developing Strategies to 2050 for Energy Security in Suriname
Using the Scenario Planning Methodology –

(Thesis Research Report)

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“Every Epoch Dreams Its Successor”

— Jules Michelet
Preface

The last two decades have been strongly characterized by globalizing efforts through technological innovations, common threats and opportunities, co-operation etc. by all sorts of actors, like governments, Non-Governmental Organizations, private companies and individuals. This process of globalization is accelerating as time passes by, and while many are hailing the benefits of this process, there are some developments that require some caution. So has globalization resulted in stronger competition between economies, intertwining entities, more complex becoming relationships and rapid change which results in a tendency to marginalize the small, weak and poor, while the frequency of unexpected events rises, trends discontinue, and complexity breeds unpredictability. To put it another way, uncertainty is at an all time high.

This has been especially true for global energy security, since its constituents, affordability, availability and reliability, have been compromised in many instances, and many agree that future developments in this regard are difficult to forecast.

The globalization hurricane will have significant effects on small economies, like Suriname, since these countries lack the resilience to cope with sudden changes or deviations from forecasts. It is therefore imperative for the further development of these small economies to deal with looming uncertainties. This thesis provides such a methodology that is applied within the context of energy security in Suriname to 2050 and is bent on developing strategies that are resilient and robust enough to anticipate uncertainties on the road ahead.
Acknowledgements

It has been a long and very exciting experience to execute this project, which has been shaping up very well. However, as the saying goes “looks can be deceiving” and this applies also to the creation of this thesis. Though the assignment took a lot of my effort and time, all of this would have been impossible without the help of some really great people. Though they often had a very crowded schedule, they were still willing to help in any way without any sort of hesitation, even though most of these people hardly knew me. They were resourceful, inspiring and eager to provide input, and to be quite honest, I often received more than I expected. Here is my opportunity to give them my utmost and sincerest gratitude.

All of this would never have happened if Professor Cees Hamelink (Free University of Amsterdam) would not let me take a peak in the kitchen that is called “Scenario Planning. This was the event that triggered it all: with his help, I soon made the connection with energy security and was shown the way to loads of information.

Next, all lot of kudos have to go to Glenn Sankatsing (University of Aruba) who made me “learn to see with different eyes”, as Cees would say it. Being brought up in a Western society, I am glad that he pulled the plug on my “mind control” by indulging me in his paradigm. This has been for instance important in the sections on the Resource Curse, electrification of rural areas and power sector reform.

Also, I am the following people very grateful for their helpful input: Professor Jack Menke, Professor Mark Jacobson, Maikel Soekhnandan, Daniëlle Sumter, Fabien Noordwijk, Subhaas Kalloemissier, Henk Eiloof, Ortwin Telting, Erwin Young A Fat, John Kalpoe, Andrey Danoe, Imro Nibte, Cedric Nelom, Ratna Kewal, Dr. Ferdinand Derveld, Dr. Juliet Chieuw, the knowledgeable Distinguished Professor Clive Y. Thomas, the helpful Professor Rishee Thakur, and the always-patient Fiona Cummings.

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It goes without saying that this entire endeavor would have stranded without the input of the interviews; the respondents have put an important mark on this work. I really need to thank them, since I have used (a lot of) their valuable time, filled their e-mail boxes with requests and fired all sorts of difficult questions at them, while they still provided me the information I required. Though I have digested numerous books, articles and websites for this project, the information I received from these interviews was definitely the most valuable. Information was not the only thing I got from these interviews however, since a couple of instances I received contact information regarding other people I should interview (Lothar Boksteen), books (Eddy Jharap and Roy de Rooy) and a lot of drinks and food, served with a couple of good laughs.

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Though I have tried my best to have included everyone who helped (or dragged) me along the way, I offer my apologies to anyone I have omitted by accident. All people mentioned above have been named in no order of any particular importance, and though they have helped me a lot, omissions and errors in this report fall solely on my account.

Daniël A. Lachman

December, 2009
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<th>Meaning</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>h</td>
<td>Hour</td>
<td>Unit for Time</td>
</tr>
<tr>
<td>G</td>
<td>[prefix] Giga</td>
<td>1 billion</td>
</tr>
<tr>
<td>M</td>
<td>[prefix] Mega</td>
<td>1 million</td>
</tr>
<tr>
<td>W</td>
<td>Watt</td>
<td>Unit for Power</td>
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</tbody>
</table>

## Acronyms and Abbreviations

- **AFD**: French Development Agency
- **Alcoa**: Aluminum Company of America
- **CDFS**: Community Development Fund Suriname
- **CFL**: Compact Fluorescent Lamps
- **DEV**: Dienst Elektriciteitsvoorziening
- **DOE**: Department Of Energy
- **EBS**: Energiebedrijven Suriname
- **ESIA**: Environmental and Social Impact Assessment
- **FDI**: Foreign Direct Investments
- **GDP**: Gross Domestic Product
- **GHG**: Greenhouse Gas
- **HVAC**: Heating, Ventilating and Air Conditioning
- **ICT**: Information and Communication Technology
- **IDB**: Inter-American Development Bank
- **IEA**: International Energy Agency
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>IIRSA</td>
<td>Initiative for the Integration of Infrastructure in South America</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>IRENA</td>
<td>International Renewable Energy Agency</td>
</tr>
<tr>
<td>LCA</td>
<td>Life Cycle Analysis</td>
</tr>
<tr>
<td>LEAP</td>
<td>Long range Energy Alternatives Planning (System)</td>
</tr>
<tr>
<td>LED</td>
<td>Light-Emitting Diode</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
</tr>
<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
</tr>
<tr>
<td>MNC</td>
<td>Multinational Company</td>
</tr>
<tr>
<td>NDC</td>
<td>Now-Developed Country</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>NIGM</td>
<td>Nederlansch Indische Gasmaatschappij</td>
</tr>
<tr>
<td>NOC</td>
<td>National Oil Company</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OGEM</td>
<td>Overzeesche Gas- en Elektriciteitsmaatschappij</td>
</tr>
<tr>
<td>OLADE</td>
<td>Latin-American Energy Organization</td>
</tr>
<tr>
<td>PDCA</td>
<td>Plan-Do-Check-Act</td>
</tr>
<tr>
<td>SMART</td>
<td>Specific, Measurable, Attainable, Realistic and Time-driven</td>
</tr>
<tr>
<td>SOM</td>
<td>Staatsolie Maatschappij Suriname</td>
</tr>
<tr>
<td>SPCS</td>
<td>Staatsolie Power Company Suriname</td>
</tr>
<tr>
<td>SRI</td>
<td>Stanford Research Institute</td>
</tr>
<tr>
<td>STEEP</td>
<td>Social, Technological, Economic, Environmental and Political</td>
</tr>
<tr>
<td>Suralco</td>
<td>Suriname Aluminum Company</td>
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</tbody>
</table>
**Glossary**

**ALTERNATIVE ENERGY**: All forms of energy that are not obtained through the conventional combustion of cheap produced hydrocarbons

**ASSUMPTIONS**: Beliefs, usually implicit, about the current and future environment

**BIO-FUELS**: Solid, liquid, or gas fuel consisting of, or derived from recently dead biological material, most commonly plants

**CLIMATE CHANGE**: A phenomenon relating to global change in weather patterns, about which there is a broad scientific consensus that this mechanism is the result of human activity, primarily the combustion of fossil fuels

**CONTEXTUAL ENVIRONMENT**: The environment with which the organization has no direct interaction, but does so via the transactional environment

**CRITICAL UNCERTAINTIES**: Unpredictable driving forces that will have an important impact on a particular area of interest

**DEDUCTIVE METHOD**: (also known as the “Future Forward method”) The process that combines identified Driving Forces to form the structure upon which scenarios are built

**DEFAULT SCENARIO**: (also known as the “official future”) The explicit articulation of a set of commonly held beliefs about the future external environment that a group, organization, or industry implicitly expects to unfold. Once articulated, the official future captures an organization’s shared assumptions—or mental map

**DENIAL**: Lack of willingness or ability to see the need to change

**DRIVING FORCES**: Forces of change outside the organization that shape future dynamics in predictable and unpredictable ways

**ENERGY**: The capacity to do work

**ENERGY AVAILABILITY**: The degree to which supplies of energy can be delivered from either domestic or foreign sources

**ENERGY CENTRALIZATION**: The process where the energy distribution infrastructure is set up in such a way, that energy is generated at a central location
ENERGY CONSERVATION: A type of behavior that reduces energy by deploying practices that require less energy

ENERGY DECENTRALIZATION: The process where the energy distribution infrastructure is set up in such a way, that energy generation takes place in several locations, which are relatively close to customers

ENERGY EFFICIENCY: The ratio between the amount of output and input (both measured in energy-units) of a particular process

ENERGY RELIABILITY: The extent to which the delivered form of energy meets requirements set by the user

ENERGY SECURITY: The combination of energy availability, affordability and reliability

ENERGY POLICY: The complete array of measures, which need to be implemented, deployed and / or carried out by the Government within a given timeframe in order to address energy security

ENERGY AFFORDABILITY: The extent to which energy is within reach of the consumer in terms of costs

FOCAL ISSUE, DECISION OR QUESTION: The issue, decision or question that the scenario thinking process seeks to address.

HORIZON YEAR: (also known as “scenario timeframe”) The chosen cut-off time of the scenario stories that is used as the end point towards which the scenarios explain how the future develops

HYDROCARBONS: Gas, liquid or solid fossil fuels, that are derived from long dead biological material

INCREMENTAL METHOD: (also known as the “Official Future method”) This is the process where new scenarios are created by introducing issues and / or threats, or so-called “wildcards” (unexpected events) in the default scenario

INDUCTIVE METHOD: (also known as the intuitive or the “Future Backward method”) From observed events and trends, new events are brainstormed that are typical of a certain scenario

INTERNAL ENVIRONMENT: The environment within the organization
LEADING INDICATORS: Signs of potentially significant change that can be monitored in order to determine if a particular scenario is beginning to unfold

MENTAL MAP: (also known as “mental model”) A set of assumptions that in aggregate becomes a framework for how a person or group interacts with the world. Scenarios and outside-in thinking in particular, are a means of challenging mental maps

MONITOR: The process of tracking the development of a particular trend or set of trends over time

MORPHOLOGICAL ANALYSIS: A computerized method of combining all sorts of influences (both predetermined and uncertain) on the organization that have been found through analysis

NORMATIVE SCENARIO: A set of goals in the future that needs to be achieved

PARALYSIS: The lack of willingness or ability to make a choice due to conflict of values and opinions, and dilemmas

PEAK OIL: The peak of the entire planet’s oil production, after which oil production will decline

PREDETERMINED ELEMENTS: Forces of change that are relatively certain. It is a given that predetermined elements will play out in the future, though their interaction with and impact on other variables remain uncertain

RENEWABLE ENERGY: Energy that is obtained from a source that is virtually limitless

RISKS: Situation where, based on historical data, a probability can be assigned that a certain event will happen

SCAN: To do a broad survey of the environment in order to surface new and relevant developments

SCENARIO: This is not a prediction, but rather a hypotheses in the form of a rather provocative, structurally different, but internally consistent and plausible narrative, built upon combinations of uncertain, high-impact Driving Forces, about how the future of issues relevant to an organization or individual might unfold

SCENARIO LOGIC: (also known as “scenario framework”) A structure for developing and communicating stories of the future. A scenario framework is created from the combination of critical uncertainties, and usually results in a set of scenarios
SCENARIO IMPLICATIONS: Insights that capture the learning from scenarios

SCENARIO MATRIX: A two-by-two framework created by crossing two critical uncertainties that structures a set of scenarios

SCENARIO NARRATIVES: Fully developed stories of the future—with a beginning, middle, and end—that are structured by the scenario framework. Scenario narratives tell challenging, diverse, and plausible stories that are relevant to the focal issue or question being addressed by the scenario thinking process

SCENARIO PLANNING: A management thinking tool that acknowledges the existence of uncertainty in the organization’s environment by developing a set of scenarios (internally consistent and plausible, but structurally different narratives), which outline the range of possible futures

SCENARIO THINKING: A process for developing stories of the future and using them, once developed, to inform strategy

STANDBY POWER: The power consumed when a particular appliance, that is not operating, is not completely de-energized

STRATEGIC AGENDA: A set of strategic priorities that will help an organization achieve its desired future state. A strategic agenda can serve as a foundation upon which a strategic plan can be developed

STRATEGIC PLAN: A plan for moving from the present toward a desired future state. A strategic plan is often articulated in an agreement (unwritten or written) between decision-makers that outlines how the organization should move forward on its mission given its circumstances

STRATEGIC PLANNING: A process through which an organization agrees on and builds commitment to a set of priorities essential to fulfilling its mission; these priorities then guide actions that will make progress on the mission

STRATEGIZING: (also known as “strategic thinking”) This refers to the creation of abovementioned framework for future action with respect to a person’s environment

STRATEGY: the chosen framework within which someone tries to overcome challenges and fulfill his / her mission in his / her environment. It guides policy by determining the goals and provides a long-term direction for an organization
STRUCTURAL UNCERTAINTY: An event that is unique in such a way that (judgmental) probabilities of the event happening are unknown.

THEORY OF CHANGE: A tool for clarifying an organization’s scope of activity and the intended impact of that activity. Theories of change define all the elements needed to achieve a long-term goal.

transactional environment: The environment with which the organization has direct interaction. Uncertainty future developments can not be determined or predicted.

UNKNOWNABLES: Unimaginable events.

VISON: A clear statement about the future that an organization is striving to achieve. It can focus on organizational transformation or on external results in the world.

WILD CARD: An unexpected event that could require a change in strategy. Wild cards help surface new uncertainties and different strategies for future action that may not emerge from the more logical structure of a scenario framework.
Executive Summary

The last couple of decades have been characterized by an increasing complexity of relationships, unpredictable events and a high degree of dynamism. This has led to uncertainty regarding the future development of various fields, and all signs indicate that this uncertainty is increasing at an accelerating pace. This era of uncertainty leaves decision makers either in paralysis or in denial, resulting in decisions that actually do more harm than good to a particular organization.

The aspect of uncertainty is something of particular importance for small states, since these are characterized by their high degree of vulnerability to external forces which they can not influence and therefore can not cope with external forces that are uncertain, random and / or sudden in nature. Strategic decision making in these countries is therefore more difficult because bad decisions or decisions that do not hold well in changed circumstances can have significant repercussions on the entire nation.

The aspect of uncertainty certainly rings true for the energy sector where a completely intertwined set of factors, ranging from religious to technological, and from political to geomorphic, influence energy availability, affordability and reliability.

This research focuses on creating strategies for energy security (which is the combination of energy availability, affordability and reliability) in a small state, Suriname, to 2050. This timeframe has been chosen since it is long enough to make the full ramifications of change happen. The methodology used to tackle this objective which exists within in a highly uncertain contextual environment is the so-called scenario planning methodology.

Scenario planning has proved in the past to be able to deal with uncertainty and thus to enable decision makers to craft robust and resilient strategies. However, proof of its use in developing countries has been dismal, though developing countries paradoxically are more in need of such a methodology that deals with risk and uncertainty. Scenario planning identifies driving forces within the contextual environment (which the organization can not influence) and combines the most uncertain, high impact forces to create scenarios. The scenarios are hypothetical depictions of probable and possible
future. As a set, these scenarios cover the entire range of possibilities where the future could be heading. Using leading indicators, decision makers can anticipate future situations and prepare themselves for things to come way in advance before they actually start to happen.

First, the proper method to exercise scenario planning has been investigated, and choice has fallen on the deductive method using the scenario-matrix, since it is the most analytical method and it provides the most challenging scenarios.

Second, the current level of energy security in Suriname has been assessed. Focus has been laid on the institutional framework, actors, plans, opportunities, challenges and threats. It appears that there is an insufficient degree of energy security, but on the short term availability and affordability have been safeguarded due to various windfalls. Unfortunately, there are various signs that these windfalls will not last an eternity and that they even might come soon to an end, thereby jeopardizing energy security.

Third, an investigation has been done to identify driving forces that will impact energy security in Suriname to 2050. This investigation covered literature, local and foreign articles, journals, popular magazines, newspapers, websites and personal interviews. The interviews were conducted in order to grasp the more subtle and localized aspects that influence energy security. The persons interviewed were chosen using purposive sampling with a snowball approach until the so-called saturation point had been achieved, in other words, no new information emerged.

The identified driving forces were grouped into predetermined elements and critical uncertainties. The latter were ranked according to their level of impact and level of uncertainty. Though the quality and capacity of the Government emerged to be the driving factor with both the highest uncertainty and highest impact, this driving force was not chosen since the resulting scenarios would be normative in nature and less challenging. Rather, the entrance / exit of large energy consumers and the impact of environmental degradation were chosen to set up the scenario logic using the matrix-modeling approach. This matrix with scenario dimensions and scenarios is depicted in figure I.1.
These scenarios were used to formulate resilient and robust strategies. The main elements of the strategies included energy efficiency, investment, tariffs, subsidies, taxes, rural electrification, power sector reform, institutionalization, legislation and compatibility with other sectoral policies. Most important conclusions conveyed the setup of an energy institute, banning of subsidies (except for transparent subsidies for the poor for a fixed amount of energy), solar energy deployment to electrify the interior, penalizing inefficient behavior, taxing inefficient appliances and stimulating clean renewable energy development, exploitation and use. Scenario-specific strategies were also provided.

It is recommended to adopt these strategies and formulate policies for deployment using all available resources. However, before implementation, a well-conceived plan to establish two-way communication with society should be set up in order to gain buy-in and support for the decisions and their ramifications. The scenarios can significantly help in this effort. Action must be taken now, since the windfalls appear to be settling down, which implies that tough times might be just ahead.
Samenvatting

De laatste decennia worden gekarakteriseerd door een toenemende complexiteit van verbanden, onvoorspelbare gebeurtenissen en een hoge mate van dynamiek. Dit leidt tot een grote mate van onzekerheid met betrekking tot toekomstige ontwikkelingen op vele gebieden, en alles wijst erop dat deze onzekerheid in een steeds sneller tempo zal toenemen. Dit tijdsrek van onzekerheid zorgt er frequent voor dat leiders van organisaties of de onzekerheid ontkennen, of gewoonweg niet weten wat ze moeten doen, wat dan weer resulteert in besluiten die de organisatie meer kwaad dan goed doen.

Het aspect van onzekerheid is van bijzonder belang voor kleine staten, aangezien deze gekarakteriseerd worden door hun gebrek aan weerbaarheid tegen externe krachten welke zij niet kunnen beïnvloeden, in het bijzonder wanneer deze krachten onzeker, willekeurig en / of plotseling aan de orde zijn. Het nemen van besluiten in deze landen is derhalve extra moeilijk, daar onjuiste besluiten of besluiten die niet passen binnen veranderde omstandigheden extra harde repercussies kunnen hebben voor de gehele natie.

Het onzekerheidsaspect is ook van belang voor de energiesector waar een spinneweb van factoren, variërend van religieus tot technologisch, en van politiek tot geomorf, energie beschikbaarheid, betaalbaarheid en betrouwbaarheid beïnvloeden.

Dit onderzoek focust op het vormen van strategieën voor de energiezekerheid (wat de combinatie is van betaalbaarheid, betrouwbaarheid en beschikbaarheid van energie) in een kleine staat, Suriname, tot 2050. Deze tijdspanne is lang genoeg om de effecten van verandering volledig tot hun recht te doen laten komen. De scenario planning methodologie wordt gehanteerd om deze strategieën voor energiezekerheid (welke zich in een zeer onzekerere omgeving bevinden) te formuleren.

Scenario planning heeft in het verleden bewezen om te kunnen gaan met onzekerheid en biedt dus aan besluitmakers een stuk gereedschap om robuuste en weerbare strategieën te maken. Echter, het gebruik van deze methodologie in ontwikkelingslanden is marginaal, hoewel juist deze landen dergelijk gereedschap hard nodig hebben om te kunnen omgaan met risico en onzekerheid. Scenario planning identificeert zogenaamde drijvende
krachten in de contextuele omgeving (waarop de organisatie geen invloed kan uitoefenen) en combineert de meest onzekere en invloedrijke drijvende krachten om scenario’s te creëren. Scenario’s zijn hypothetische voorstellingen van waarschijnlijke en mogelijke toekomsten. Een set van scenario’s bestrijkt een heel gebied van allerlei mogelijkheden waar de wereld naar toe zou kunnen gaan. Met behulp van indicatoren kunnen besluitmakers zien naar welk scenario toe het heden zich ontwikkelt, waardoor zij zich beter kunnen voorbereiden.

Allereerst zijn de juiste methoden om scenario’s te produceren onderzocht en de keuze is gevallen op de deductieve methode die gebruik maakt van de scenario-matrix, daar deze methode de meest analytische methode is en de meest uitdagende scenario’s kan bieden.

Vervolgens is de huidige stand met betrekking tot de energiezekerheid in Suriname in kaart gebracht. De nadruk is hierbij gelegd op het institutioneel raamwerk, actoren, plannen, mogelijkheden, uitdagingen en bedreigingen. Informatie wijst uit dat er onvoldoende energiezekerheid is in Suriname, maar dat verscheidene meevallers resulteren in een redelijke beschikbaarheid en betaalbaarheid voor de korte termijn. Er zijn echter verscheidene aanwijzingen dat deze meevallers niet altijd aanwezig zullen zijn en dat ze zelfs spoedig tot het verleden zouden kunnen behoren, waarbij de energiezekerheid het onderspit zal delven.

De volgende stap was het vinden van drijvende factoren die energiezekerheid in Suriname zullen beïnvloeden tot 2050. Dit is gedaan door literatuur, lokale en buitenlandse artikelen, vakbladen, tijdschriften, dagbladen en websites te bestuderen. Bovendien zijn er ook persoonlijke interviews gehouden om zo de meer lokale en subtiele aspecten die invloed hebben op energiezekerheid te kunnen achterhalen. De geïnterviewden zijn gekozen met behulp van een selecte steekproef, waarbij er gebruik is gemaakt van sneeuwbal sampling todat er geen nieuwe informatie beschikbaar kwam, met andere woorden, todat het verzadigingspunt bereikt was.

De geïdentificeerde drijvende factoren werden gegroepeerd in “predetermined elements” (factoren waarvan je met redelijke zekerheid kan aangeven hoe de toekomstige ontwikkelingen eruit zullen zien) en “critical uncertainties” (drijvende factoren waarbij je
Deze laatste werden gerangschikt op basis van hun mate van invloed en onzekerheid. Alhoewel de kwaliteit en capaciteit van de overheid de grootste critical uncertainty was, is zij niet meegenomen in het vormen van de scenario’s, omdat deze dan anders normatief van aard zouden zijn en minder uitdagend zouden uitpakken. Derhalve is er gekozen voor de intree / uittree van energie grootgebruikers en de impact van milieu degradatie om de scenario’s te vormen met behulp van de scenario-matrix, wat is weergegeven in figuur I.2.

<table>
<thead>
<tr>
<th>Grote Invloeden door Milieu Degradatie</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scenario IV:</strong></td>
</tr>
<tr>
<td>Tantalus</td>
</tr>
<tr>
<td>Kwelling</td>
</tr>
<tr>
<td><strong>Scenario III:</strong></td>
</tr>
<tr>
<td>Rad van Ixion</td>
</tr>
<tr>
<td><strong>Scenario I:</strong></td>
</tr>
<tr>
<td>Arend van Prometheus</td>
</tr>
<tr>
<td><strong>Scenario II:</strong></td>
</tr>
<tr>
<td>Sisyphus Arbeid</td>
</tr>
<tr>
<td><strong>Uittree van Energie Grootgebruikers</strong></td>
</tr>
<tr>
<td><strong>Intree van Energie Grootgebruikers</strong></td>
</tr>
<tr>
<td>Kleine Invloeden door Milieu Degradatie</td>
</tr>
</tbody>
</table>

*Figure I.2: De vier scenario’s voor Suriname’s energiezekerheid to 2050*

De scenario’s werden vervolgens gebruikt om weerbara en robuuste strategieën te formuleren. Enkele belangrijke elementen zijn efficiëntie, tarieven, subsidies, investeringen, institutionalisering, wetgeving en aansluiting bij strategieën van andere sectoren. De meest belangrijke aanbeveling betrof het opzetten van een energie-instituut, het afzakken van subsidies (behalve voor de allerarmsten), het gebruik van zon-energie voor elektrificatie van het binnenland en het stimuleren van efficiëntie en de ontwikkeling, exploitatie en gebruik van hernieuwbare en schone energiebronnen. Ook zijn er scenario-specifieke strategieën geformuleerd.
Het is aan te bevelen om deze strategieën te laten uitvoeren, na eerst goed met de gemeenschap gecommuniceerd te hebben. De scenario’s kunnen hierbij flink helpen. Er moet nu actie ondernomen worden, daar er indicaties zijn dat er zware tijden aankomen.
**Part I: Research Design**

This part of the research report deals with the manner in which the research will be conducted, also known as the research design. The first section provides an introduction to the topic and the relevance of this research, and is followed by a section on the (sub-)research questions and the construction of the conceptual model. The next section deals with the research strategy, design and methods, while touching a little on the subject of Scenario Planning. After discussing the research themes in brief, the methodology of focus, namely Scenario Planning, will be thoroughly discussed and analyzed in detail in order to determine the specific methods and techniques to be used in this research.
1. Introduction

This section first starts off with the research focus. Next, brief background information regarding Suriname’s current status in the energy sector will be provided, including the importance of energy for Suriname’s economy and society. Hereafter, a connection will be made with scenario planning, a tool to deal with future uncertainties when developing strategies. Finally, the structure of this research is laid out.

1.1. Research Focus

Due to growing uncertainties regarding the international energy sector and its impact on Suriname, it is imperative that (long-term) energy scenarios are created for Suriname. These scenarios can be used to formulate, monitor and adjust energy strategy and policy. More important, utilization of various scenarios enables actors in the Surinamese energy sector to anticipate and react more efficiently and effectively on (sudden) domestic, regional and global developments. This increases chances that Suriname will be able to maintain or even improve its energy security regardless of sudden changes and therefore enlarges guarantees for future (economic) development of Suriname.

The research focuses on the creation of energy scenarios and strategies for Suriname to 2050. This time frame has been selected based on:

- the duration of relative large-scale energy development projects which can range from 10 to 30 years (e.g. the transformation of a power station in order to run on a different type of fuel can take at least 10 years, from desk study to full operationalization (“Kolenombouw centrale Maasvlakte” 1985), whereas the period from desk study to full operationalization of a hydropower plant can easily take 20 to 30 years (Kabalebo hydroelectric power 1981));

- The mining sector in Suriname, consisting of bauxite, oil and gold, is one of the main contributors to the economy and also one of the largest users of energy. Current concessions in and planned for production in these sectors are estimated to last respectively 12, 15 and 10 years;
- There is a strong possibility that large-scale projects will be initiated in Suriname in the near future, such as the construction of an integrated aluminum production facility (Jetinvestment 2008), mining and refining of gold in the eastern part of Suriname and offshore oil exploitation. Some of these could take decades before reaching full development. These will all substantially increase energy demand;

- Prolongation of climate change and the widening gap between supply and demand of fossil fuels, combined with on-going research and development will introduce within the next decades new standards on energy efficiency and greenhouse gas emissions, and (appliances fit for) alternative energy (“Brandstofcel” 2007a and “Dossier Energieopwekking” 2007b);

- Abovementioned points solidify the case that the timeframe is long enough for the full ramifications of change to start to emerge (Lovins 1976).

- Existing energy scenarios utilize approximately the same timeframe (Watson, Tetteh, Dutton e.a. 2004, Global Business Environment 2001, World Energy Council 2007, Gielen, Bennaceur and Tam 2006, Ramsay 2006a, Watson 2003), and are therefore more appropriate for comparison with the strategies conceived in this exercise. The comparison can then show the extent to which the strategies conceived in the research are aligned with the strategies already developed (for primarily developed countries) in other researches;

Creating scenarios, more commonly known as scenario planning, is relatively new and unknown in the public and private sector worldwide. Only a handful of organizations make use of the methodology (Klinec 2004). Furthermore, barely any examples of scenario planning within the context of developing countries exist (Institute of Economic Affairs ea. 2000) and no energy scenarios for developing countries have been found. This research will therefore add to the subject of scenario planning, scenario planning within the context of developing nations and energy scenarios.

Also, the research will have value for both public (the Ministry of Natural Resources and utility companies) and private actors (private-owned energy suppliers) in the energy sector with regard to energy strategy and policy. It will also enhance awareness among
policy makers in both public and private sector regarding general scenario planning and its benefits. This will enable Suriname to prepare better for the future.

1.2. The Energy Dilemma

The last two decades, people around the world have become more aware of the increasing turmoil in the global energy market, in particular due to the recent steep price increases for oil (and oil-derived products) and the increasing efforts undertaken to develop new energy sources. The turmoil is caused by issues regarding energy supply, energy demand and environmental impact of energy use, each of which will be briefly explained.

Approximately 85% of the global energy use is supplied in the form of hydrocarbons, viz. oil, natural gas and coal (National Academy of Sciences 2008). However, these resources are finite, and in the case of oil (good for 40% of global energy supply), experts assume that oil production already has “peaked” or will do so within the next years. “Peaking” of oil production refers to the trend of oil production reaching a maximum (in other words, the oil reserve “peaks”) after which production will inevitably decline (Hirsch 2005). With increasing demand, prices for oil will increase dramatically.

Apart from depletion of finite resources, demand for energy is increasing continuously; since the world population and world economy keep on growing and energy is needed for transport, agricultural and industrial activities and climate control, it can safely be assumed that the need for energy will keep on increasing also. This is especially the case in developing countries, in particular China and India (Haté 2006).

A third factor leading to the growing debate surrounding energy use centers around the environmental impact of energy. This impact can be divided into environmental pollution and climate change. Pollution is primarily caused by disposal of radioactive material, spills and emissions (Bradsher 2007). With regard to climate change (also more commonly known as the global warming phenomenon), there is a broad scientific consensus that this mechanism of global warming is caused by combustion of fossil fuels (Royal Commission on Environmental Pollution 2000). Since fossil fuels deliver globally
the majority of the consumed energy as was explained earlier, their usage has received a negative image since they have a serious impact on the global environment.

Abovementioned causes of the energy dilemma will have their effect on availability, affordability and reliability (quality) of energy for Suriname. Since this mix, known as energy security (Brehm 2006), is one of the cornerstones for (economic) development, special care needs to be taken when drafting a strategy (and the forthcoming policies) with regard to energy security. However, contrary to the former mentioned impacts on the energy security of Suriname, there are also domestic factors that need to be taken into account when conceiving an energy strategy: growing and aging population, urbanization, political ideology, upcoming industries, large-scale investments, inadequate maintenance investments in infrastructure etc. Therefore, conceiving an energy strategy for Suriname that has the focus on maintaining or improving energy security requires the study of (long-term) developments of both foreign and domestic influences.

1.3. Energy Scenarios: Combating Uncertainty

The creation of an energy strategy requires long-term thinking and should anticipate future developments. Usually this was done by simply extrapolating historical data in a linear fashion, see figure 1.1.

![Figure 1.1: Predicting the future through extrapolation of historical data](image-url)
However, as history has shown us, the future does not evolve in a predictable (or linear) fashion, in other words, it is of little use to strategize and plan when having envisioned a single possible future (Schwartz 1996). Examples of sudden – previously unimaginable – events are the Oil Crisis in the 70s, the fall of the Berlin Wall, the terrorist attacks on September 11, the bankruptcy of Enron and WorldCom, and the recent financial and economic crisis.

As stated by Friedman (2007), the increasing globalization rate, where information, people, goods and services are more mobile, can move faster, and are more accessible, social and technological developments on both a global and domestic scale are evolving at an unprecedented pace and are now more than ever subject to sudden changes. The downside of this is that uncertainty regarding the future will continuously increase. Furthermore, the accelerating pace of competition due to globalization also implies that inefficiencies and a lack of effectiveness due to wrong decisions based on miscalculations of the future by companies, countries, individuals etc. will immediately be penalized in the form of losses.

Though in general both public and private sector policymakers are aware of this, little effort has been undertaken to deal with this uncertainty about the future when conceiving a strategy (Star and Randall 2007). Since a couple of decades there is however a methodology that actively deals with uncertainties while formulating a strategy: Scenario Planning.

The scenario planning methodology has been used quite successfully in the past by the RAND Corporation and Royal Dutch Shell (Klinec 2004) and is slowly gaining more ground, since more companies and even Non-Governmental Organizations (NGOs) and the public sector are jumping on the bandwagon. It focuses on so-called (more or less quantifiable) driving factors that influence a certain issue. Combining driving factors (each with a particular value or description) will create a scenario, for which a strategy can be formulated. Doing this iteratively using various values (or descriptions) results in a number of scenarios, for each of which a particular strategy can be formulated. By
tracking the development of the driving forces with so-called leading indicators one can anticipate towards which scenario the future is heading and therefore adjust this strategy in a timely manner (Conway 2004). Even in the wake of sudden changes, the utilization of the already formulated strategies enables one person or organization to make a fast and sound transition between strategies to combat these sudden changed circumstances.

Since the formulation of energy strategies regarding energy security depends on difficult to predict developments on both a domestic and global scale, scenario planning is a sound tool to deal with the large amount of uncertainties surrounding the future of the energy sector (World Energy Council 2007)

1.4. Research Outline

This research is divided into four parts. Part I describes the research design, which starts with this introduction, followed by a section with the research questions, main concepts and the conceptual model (which is derived from the research questions but has also influenced formulating these research questions). The section thereafter covers the research design and methods, and (in the case of surveys) defines the population, sampling frame and type of sampling. The next section describes the general research themes, derived from the research questions that are used in data collection. The fifth section discusses the scenario planning methodology in detail.

The second part of the research deals with constructing energy scenarios for Suriname to 2050. The sections therein cover respectively an overview of contemporary energy security in Suriname, results obtained from interviews and literature, analysis of the obtained data to discover driving forces and the resulting energy scenarios.

Part III uses the scenarios to formulate a robust energy strategy. It also includes so-called early warning signals to anticipate critical events that influence the derived strategy. The research concludes with part IV which provides conclusions and recommendations. This thesis finishes with an overview of used references and the appendices.
2. Research Questions, Conceptual Model, Strategy and Themes

2.1. Research Questions

The research centers on the formulation of a sound energy strategy for Suriname based on future outlooks. The research strategy will be primarily qualitative in nature and shall involve literature study and surveys regarding the area of interest (see next section). The results of this research can be used in formulating, monitoring and adjusting energy and general public and corporate policy (Hoogerwerf and Herweijer 2003).

The research question, which is advisory in nature (de Bies 2008), that forms the backbone of this research is:

What is the most suitable energy strategy for Suriname to 2050 in order to maintain or even improve energy security, when taking into account various future scenarios?

The following more specific sub-questions can be deducted from this general research question:

1. What is the most suitable energy strategy for Suriname to 2050 with regard to energy security?

2. What are they key leading indicators that hint towards which energy scenario the current situation is heading?

3. What are the energy scenarios that can be developed for Suriname to 2050?

4. In what ways can internal and external driving forces of energy security in Suriname develop?

5. What are the internal and external driving forces of energy security in Suriname?

6. What is the best method to create energy scenarios for developing countries?
7. To what extent is there currently an energy security in Suriname?

8. What is the current energy strategy and policy in Suriname?

These sub-questions all shape the conceptual model (see next section) and form guidelines for the conduct of the research.

2.2. Conceptual Model

2.2.1. Introductory Concepts and Definitions

Energy
According to Moran and Shapiro (1992) “Energy” is the capacity to do work. It is intangible and can be stored in various forms within systems. It can also be transferred between systems, in the form of either heat or work. These two forms can then be used directly (e.g. in the case of heat) and be used for the creation of light, motive power (torsion, rotation, directional movement etc.) and chemical reactions (e.g. combustion).

Energy Security
The importance of energy has always been apparent throughout history, but its requirement became critical with the advent of the Industrial Revolution, which increasingly demanded energy for steam engines, vehicles, industrial processes, illumination etc. Since then, industrialization has progressed and spread more or less around the globe, making society become intertwined with technology, as evidenced by the influence on our lives by the automobile, the air conditioning, the television, the internet etc. In other words, the world is now more than ever depending on energy (Friedman 2008).

However, with the depletion of the major source of global energy supply, viz. fossil fuels, and the growing world population, demand for energy is rising continuously while its supply is steadily declining, leading to high energy prices (Scheer 2005). The first time when the world was bluntly faced with this, was the first Oil Crisis in 1973 when the main oil exporting countries deliberately reduced their production in order to gain
substantially more profits. This is where the term “Energy Security” was launched (Ramsay 2006).

Energy security consists of three components:

- **Availability**: the degree to which supplies of energy can be delivered from either domestic or foreign sources;
- **Reliability**: the extent to which the delivered form of energy meets requirements set by the user, e.g. chemical composition of transportation fuels, frequency of (unexpected) electricity blackouts and (unexpected) fluctuations in electricity voltage levels;
- **Affordability**: this relates to the extent to which the energy is within reach of the consumer in terms of costs.

**Energy Policy**

As explained earlier, energy is deeply entrenched within society since it is the main driver behind every type of light, heat, chemical reaction and both mechanical and motive work. Therefore, energy needs to be transported in order to be accessible and also needs to be transformed into the appropriate form, e.g. electricity or gasoline, in order to be properly utilized in a particular process. This requires vast distribution networks, power generation and transfer stations, bulk storage locations etc. In order to support and improve energy security this whole supply chain needs to have sufficient capacity, reliability and efficiency, which requires the combination of sufficient resources, such as land, human capital, financial resources and information. The complexity and resource demanding nature of the energy supply chain, combined with the importance of energy for the economy, has led to a situation where the Government has taken responsibility for energy supply, in particular in developing countries (Scheer 2005, Chang 2008).

The Government formulates therefore an “Energy Policy” which is bent on defining measures, such as agency directives, legislation, taxation, subsidies, contracting, research, awareness etc., which need to be implemented, deployed and / or carried out within a
given timeframe in order to address energy security ("Energy policy" 2009a, and Graaf and Hoppe 2007).

**Energy Strategy**

Whereas policy is only concerned with the decision surrounding the manner to deploy the (type of) resources in order to reach certain goals, strategy actually guides policy by determining the goals and provides a long-term direction for an organization (Dingli 2006). Therefore, as Bisk (2009) has recently explained, an energy strategy selects future energy sources, types of distribution infrastructure, types of power sector reform, standards etc. to pin down the outer limits of future energy security.

**2.2.2. Constructing the Conceptual Model**

This section provides a step by step approach to conceive the conceptual model used for the research.

**The Deming-Wheel**

As stated previously, any type of policy aims at achieving goals using predefined means within a certain period. When this period has expired, and even during policy execution, received (sub-) results need to be compared with the desired results (which have been determined when formulating policy, but which can be changed according to varying circumstances). Any deviations between obtained and desired results need then be corrected. Halfway through the twentieth century Mr. Edward Deming visually represented this on-going process with his so-called Deming-wheel (also known as the Plan-Do-Check-Act- or PDCA-circle). This is depicted in figure 2.1 (Masaaki 1998), and herein:

- “Plan” refers to policy formulation
- “Do” refers to policy execution;
- “Check” refers to the comparison of received results with desired results;
- “Act” refers to adjusting policy formulation and / or execution in order to achieve the desired results.
One drawback of the Deming-wheel is that it does not clearly show the current condition and the desired results. Also missing are influences external to the process from policy formulation to policy adjustment. An attempt to have these omissions included is shown in figure 2.2 (Cool, Schijff and Viersma 1985). Since this schema forms the backbone of policy and the research focuses on energy strategies, which act as guidelines for energy policies, the depiction in figure 2.2 will be used to create the conceptual model that lays the groundwork for the research.

Figure 2.1: The Deming-wheel

Figure 2.2: Reaching a new situation through policy, including continuous improvement

As explained previously, policy makers create an energy strategy which is used for policy formulation. The so-called SMART (Specific, Measurable, Attainable, Realistic and Time-driven) drafting of energy strategies and the transition to energy policy not only request a certain level of management capability from policy makers, but also a certain level of expertise from policy advisors (Hoogerwerf and Herweijer 2003, and Graaf and Hoppe 2007). The formulation, execution, monitoring and adjustment of this policy require human capital, financial resources, information and natural endowments (Hoogerwerf and Herweijer 2003, and Graaf and Hoppe 2007).

When looking at figure 2.2, the current situation is formed by the contemporary energy security, which functions as the baseline upon which the formulated energy policy is applied in order to achieve a certain level of energy security in 2050 (the desired or new situation in figure 2.2). So far, the conceptual model looks like the schema shown in figure 2.3.

![Figure 2.3: Inputs for energy strategy and energy policy towards energy security in 2050](image)

However, as depicted in figure 2.2., factors external to the process from policy formulation to execution can not only disturb the process, but also shift the desired result. In the case of this research factors that can change the desired energy security of
Suriname in 2050 need to be identified. These can be divided in roughly two categories, namely domestic and foreign factors.

**Domestic Factors**
Starting with domestic factors, the level of energy security is heavily dependent upon levels of development and urbanization. These are of importance particularly in developing countries, where:

- a significant portion of the population lives below the poverty level;
- increased income levels (due to economic development) result in increased access to goods, services, which implies an increased demand for energy;
- there is a trend of migration from rural to urban areas, where there are more economic opportunities and there is increased access to public goods.

Government policy in general, which also influences the inputs available for energy policy, is the main determinant for the level of development and urbanization. Furthermore, executed policy also influences development and urbanization indirectly, since it impacts shaping size and level (in terms of technology, craftsmanship, knowledge etc.) of the largest industries in small economies. In the case of Suriname, the largest industries are the mining (bauxite, oil and gold), agricultural (rice and banana) and services (telecommunications, tourism and ICT) sector (de Bruin 2009). For this research the services industry is made up of those industries as specified by the General Bureau of Statistics and can be found in Appendix F (Algemeen Bureau voor de Statistiek, 2004).

However, apart from policy in general, contemporary energy security, which is already included in the conceptual model, also influences, in both direct and indirect ways, the level of development and urbanization. This relationship is therefore also included in the conceptual model.

The influence of domestic factors on energy strategy, energy policy and energy security with reference to Suriname is displayed in figure 2.4.
Foreign Factors

There exist a number of foreign forces that have a strong influence on domestic energy security (both contemporary and future). The oil price is one of them, since it is established on the international market. As indicated by both Pickens (2008) and Friedman (2008), the oil price depends on the international demand for oil and the global oil production (i.e. the amount of oil that is obtained from reservoirs within a certain period). The term “oil” here refers to so-called “crude oil” which is the most important oil from which petroleum derived products are manufactured (International Energy Agency 2005). A change in the price for crude oil therefore results in a change in the price for these oil derivates. These products include transportation fuels, such as automotive diesel and gasoline, industrial fuel and domestic heating fuel (International Energy Agency 2009a), and have their influence of domestic energy security.

Another impact on domestic energy security is technological progress, which has its influence on the supply chain of crude oil and its derivates, for instance by enabling the
oil production industry to extract more oil from reservoirs at lower costs through the application of new techniques. Furthermore, technological progress also influences the extent to which alternative fuels, such as wind and solar power and bio-fuels, become more available, affordable and reliable for use on a large scale (Friedman 2008). In this case, technological progress is both stimulated (e.g. in the case of the search of alternative fuels) and hindered (due to increase research costs) by rising oil prices.

Another development looming over the horizon is the advent of vehicles that run on fuels not derived from oil, such as hydrogen or solar energy. Currently, the transport sector accounts for 60.5% of global oil consumption (International Energy Agency 2009a), and domestic fuel supply infrastructure (e.g. bulk storage and pump stations) is completely centered on hydrocarbon powered vehicles. Taking this into account, and the fact that the major car manufacturers are putting significant research and development effort into the mass production of vehicles powered by alternative fuels (“Brandstofcel” 2007a and Bullis 2009), technological progress will impact the rate at which the domestic infrastructure and transport-related services can adapt to the advent of vehicles that run on alternative fuels. The ability of the domestic market to adapt to this new-fuel technology will affect energy security; if for instance major car manufacturers have established the transition to mass produce affordable cars running on hydrogen, this does not imply that the domestic (referring to Suriname) market, infrastructure and transport related services have adapted to the new technology, since the transition to alternative fuel systems is a capital intensive venture, which can be highly demanding particularly in the case of developing countries. Adding to this issue, if oil prices continue to rise due to declining oil production, energy security in countries slowly adapting new technologies (e.g. due to scarce resources, as in the case of developing countries) might be jeopardized.

Another foreign influence on energy security is climate change and environmental pollution. As stated earlier, there is a growing consensus that climate change exists and that it is caused by the emission of greenhouse gases, which are mainly caused by the combustion of hydrocarbons. Furthermore, energy use also produces environmental
pollutants such as nuclear waste, waste water, emission gases etc. Environmental pollution and climate change often form the basis of agreements (e.g. the Kyoto-protocol) in multilateral institutions, such as the International Energy Agency (IEA) and the Latin American Energy Organization (OLADE), which can put restraints on the application of energy technology and the use of energy, which has its impact on domestic energy security (Barker and Ekins 2004).

The foreign factors that can have their impact on both contemporary and future domestic energy security are displayed in figure 2.5.

![Diagram showing foreign influences on contemporary and future domestic energy security]

**Figure 2.5: Foreign influences on contemporary and future domestic energy security**

**Uncertainty**

When looking at the previously discussed factors that influence energy strategy formulation with the aim of future energy security in Suriname, they all have one common characteristic: as history has shown, their future developments can not be determined or predicted with (a high) certainty (Schwartz 1996). Therefore, as stated by Wilkinson (1995) in his famous paper, appropriately executing strategy, which requires a certain view of the future (in this case with regard to both the local and the international context, since both domestic and foreign factors influence the development towards
future energy strategy, as explained above), is an impossible task when one utilizes only a single depiction of the future. This research deals with the aspect of uncertainty by creating scenarios (see next section); therefore, the aspect of uncertainty is included in the conceptual model.

Combining the previously discussed domestic and foreign forces, while depicting the uncertainty regarding the manner in which these forces develop in the coming decades, the conceptual model, as it will be used for the research, is conceived, and is displayed in figure 2.6. This model will not only be used as a framework to gather (for instance by guiding the formulation of questions for interviews) and analyzing data, it also helps in identifying key actors from whom information needs to be obtained. Furthermore, the model will help in identifying driving forces of Suriname’s energy security.
Figure 2.6: The conceptual model used in the thesis
2.3. Research Strategy, Design and Methods

2.3.1. Research Strategy

Though methods to practice scenario planning advocated by various practitioners may vary, the core methodology nevertheless remains the same. Scenario planning begins with the identification of driving forces that influence key factors, such as processes and behavior, regarding a particular topic (in case of this research, energy security in Suriname). Selecting the top most important and uncertain driving forces and combining these will result in a number of future scenarios. The scenarios are then further fleshed out. The final step includes the identification of leading indicators that let the scenario user know towards which scenario the present is heading as it unfolds (Schwartz 1996, and Wilkinson 1995).

First, as can be remarked from the process described, the identification of driving forces is an exploratory process (Warwick and Bulmer 1993). Second, from an epistemological perspective, assessing how each of these driving forces can evolve over time suggests that the scenario planning methodology is interpretivist in nature. Furthermore, the combination of these forces to draft scenarios, that direct strategy formulation, exhibits the inductive approach of scenario planning. Finally, when looking at the methodology from an ontological viewpoint, drafting and fleshing out the scenarios has a strong constructionist flavor to it.

Abovementioned discussion of the scenario planning methodology indicates that the conduct of this research will have a qualitative orientation (Bryman 2004). During the research, the results of literature study might advocate the use of quantitative methods (e.g. through the application of numerical computer programs) to generate scenarios and to track leading indicators. However, the share of these quantitative methods in the conduct of the research will be marginal compared to the share of qualitative methods, since scenario planning is at its heart a qualitative endeavor.
2.3.2. Research Design

When taking the main research question into account, the research can be split up in two parts. The first part comprises the creation of energy scenarios to 2050 for Suriname. The research design is therefore primarily a case study, since detailed and intensive analysis and synthesis will be done (Bryman 2004) in order to discover driving forces that shape future energy security of Suriname. Suriname will be regarded as the case in question for this design.

The second part deals with the formulation of strategies for each scenario, taking the current energy security in Suriname as the baseline. The second part therefore adds some longitudinal elements to the research since data from two points in time, namely the contemporary period and the year 2050, will be compared in terms of energy security in order to conceive an energy strategy (Bryman 2004).

The research will have in its conclusions a view on the extent to which the current energy strategy in Suriname defers from the strategies formulated in the research. Where necessary, recommendations will be provided on alterations or additions to the current strategy. Therefore, the research also has an evaluative purpose.

2.3.3. Research Methods

The boundaries of creating energy scenarios for this research are formed by the identified driving factors, the timeline from the present till the future and the current state of energy strategy, policy and security. The assessment of the latter requires the study of documents, papers, reports etc. An overview of these writings that will be involved in the literature study is provided in Appendix A (though it must be remarked that this list can be expanded).

Before starting the actual construction of scenarios, an in-depth study will be done on existing literature on scenario planning as a tool to devise strategies (for energy security). This will be done to assess and compare various methodologies, techniques and related critiques, in particular with reference to energy security and the context of developing
nations, and Suriname in particular. The literature study will result in devising a method to conduct scenario planning for the research. Appendix B lists the sources minimally involved in the study.

According to Wilkinson (1995) and Schwartz (1996), determining driving forces requires the gathering of data from literature, an overview of which is provided in Appendix C, but also the inputs of key actors of the sector in question. A preliminary overview of the key actors is provided in Appendix D. Since these actors in the Surinamese energy sector are deliberately chosen, the research methods involve the so-called non-probabilistic survey, which will be further explained in section 3.4.

The driving forces obtained will be used to generate energy scenarios for Suriname to 2050. The next step will consist of formulating strategies corresponding with the developed scenarios. This will be done using sources of information listed in Appendix E.

2.3.4. Purposive Sampling

As explained in the previous section, use will be made of purposive sampling, a non-probability sampling method (Bryman 2004), in order to achieve required information through surveys on driving forces regarding energy security in Suriname. This enables interviewing those people who are relevant to the research questions.

The approach that will be used is the so-called snowball sampling that enables the interviewer to gain access through the initial respondents to other observational units relevant to the research question (Bryman 2004). This process will be maintained until theoretical sampling through the snowball approach does not deliver new information i.e. when the so-called saturation point has been attained (Strauss and Corbin 1998). Next, an effort will be done to find any underlying themes in the data that point toward any type of driving force.
As can be seen from Appendix D, the survey size, taking into account the effect of the snowball-principle, is relatively small, viz. between 20 and 30 people. The data collection techniques employed will be unstructured and rather flexible, and even adaptive to the information received from the respondents, in order to gain in-depth insight (Warwick and Bulmer 1993).

With regard to the purposive, non-probabilistic, sampling using unstructured, flexible and even adaptive techniques, the same results will be difficult to obtain in an exactly repeated manner. Therefore, the method used has a low replicability. However, the validity is regarded to be high, since the method is likely to deliver results relevant to the research question (Bryman 2004).

The following errors, which might occur during the interviews, have been identified:

- Non-response due to refusal, sickness, unavailability etc.;
- Another error stems from the abstract nature of subject of the research and the relatively new and unfamiliar notion of scenarios and driving forces;
- Role-dependent characteristics: the so-called interviewer variance might influence the respondent’s answering (Billiet et. al. 1990).

### 2.4. Research Themes

Though the interviews will have an unstructured, flexible and adaptive setup, the following themes will act as guidelines to assure to receive appropriate qualitative data to address the research questions in terms of being able to retrieve driving factors. However, it should be noted that research themes to be covered by the questions will emerge during the study on (energy) scenario planning and the course of the interview:

- Uncertain international factors driving domestic demand for energy
- Uncertain domestic factors driving domestic demand for energy
- International trends with high uncertainties (economical, political etc.)
- Required energy strategy for Suriname to 2050
3. Scenario Planning and Strategizing

3.1. The Future is Unknown

A perception of the future is a necessary condition to survive. This has been evidenced throughout history, where people always had to look forward in time in order to be able to anticipate looming challenges for their survival. To put it another way, the reasons for action taken today lie in the future (Sankatsing 2009).

This is where strategy comes into play, since it is the chosen framework within which someone tries to overcome challenges and fulfill his / her mission in his / her environment (Conway 2005). This implies that strategizing or strategic thinking refers to the creation of abovementioned framework for future action with respect to a person’s environment (Perrottet 1998).

Thus far, the issue of strategy has only been discussed in relation with persons; however, both formal and informal organizations can also be regarded as living entities that are capable of learning, adapting to changing environments, developing etc. (Mintzberg 2004). Organizations are therefore also necessitated to look into the future in order to anticipate and overcome challenges looming over the horizon, and having a proper strategy is therefore also for them a must. Organizational strategy guides personal behavior of individuals in the organization in such a way that the organization as a whole creates and maintains a good fit with its context in order to achieve its objectives (Fahey and Randall 1998a). For example, in the case of a profit-oriented business in a competitive environment, competitive advantage – and thus impetus for survival – is achieved by being able to adapt faster to the environment than its competitors (Mintzberg 2004).

In our contemporary world, strategy is a necessary tool when taking into account the various challenges that are looming over the horizon, such as environmental pollution and climate change, increased competition due to globalization, decline of hydrocarbon fuel supply, increasing pressure on food and water reserves due to population growth, etc.
These challenges not only affect large bodies such as governments and large corporations, but at an increasing rate also small organizations and individuals. They too should therefore be in need of a proper strategy to gear themselves to overcome future roadblocks.

Usually, strategic plans are formulated with only one perception of the future and are therefore more fixed than fluid (Scearce, Fulton e.a. 2004). However, the environment, which has its impact on organizations by means of opportunities, threats, limiting factors, conditions, etc., is increasingly becoming more complex, turbulent and dynamic, as evidenced by complex interdependencies, chaos, conflicts and unpredictable interactions (Nekkers 2006), and the fact that values, behaviors and social structures are no longer stable and predictable. This often leads to discontinuities in trends (Fahey and Randall 1998b), previously unimaginable events taking place, and unimaginable timing of events (van der Heijden 2005).

The future is therefore uncertain and can unfold in various ways. As explained by the Chaos Theory, complexity breeds unpredictability which implies that forecasting is futile (Fenton 2001). It is thus insufficient to shape the perception of one possible future by studying the past, for instance through the extrapolation the historical data. Conceiving strategy based on one future is a major risk to an organization in particular since it drives the organization to plan for one possible future and thereby lowers its ability to adapt to its changing environment, which – as explained above – is important for its survival. This risk is even more evident when taking the fact into consideration that it can often take years to learn whether or not a particular decision was right or wrong, due to the fact that the future might turn out to be (completely) different from the one envisioned when taking the decision (Wilkinson 1995).

Due to the aforementioned uncertainty of the future, many so-called “mispredictions” have been made (Schoemaker 1995), often leading to significant losses, missed opportunities and even the demise of organizations. This rings especially true for larger organizations which tend to react slower to changes in the environment, but also smaller
organizations which tend to be more vulnerable to environmental changes. Despite these failures, organizations are reserved when taking the aspect of uncertainty into account when strategizing. When faced with uncertainty they display either denial (they are not able or willing to see the need to change) or paralysis (they are unable to make a choice due to conflict of values and opinions, and dilemmas), with the end result that the organization still clings to the old business model, which does not guarantee a proper fit with the environment (Star and Randall 2007). They still depart from a deterministic perception of the future, based on extrapolation of historical data which has often led to strategy failures, due to changing environments.

3.2. Scenario Planning: Dealing with Future Uncertainty

Since reality might turn out in far more ways than the single future taken into account in traditional strategizing, it is imperative that a method is devised that takes the aspect of uncertainty with regard to changes in the environment into account in order to be better prepared for future opportunities and threats, which unexpectedly are occurring (Regis 1995).

This aspect of uncertainty comprises (Schwartz and Ogilvy 1998):
- risks: based on historical data, a probability can be assigned that a certain event will happen;
- structural uncertainty: an event is unique in such a way that (judgmental) probabilities of the event happening are unknown;
- “unknowables”: unimaginable events.

These types of uncertainty exist in all 3 levels of the environment (Turner 2008):
- internal environment: the environment within the organization;
- transactional environment: the environment with which the organization has direct interaction;
- contextual environment: the environment with which the organization has no direct interaction, but does so via the transactional environment.
It is in the contextual environment where so-called Driving Forces exist; these are actors and factors in the environment upon which the environment can not exert any influence, but which do have significant impact on the organization and therefore determine the organization’s future.

![Diagram of the three levels of the environment](image)

*Figure 3.1: The three levels of the environment (Turner 2008)*

There are predetermined and uncertain Driving Forces that can be divided into social, technological, economic, environmental and political (STEEP) factors that form the structure in the contextual environment from which trends and events emerge. This is depicted in Peter Senge’s Systems Iceberg Model (Schwartz and Ogilvy 1998), see figure 3.2. As stated earlier, uncertainties also exist in the contextual environment and so Driving Forces can be subject to uncertainty and can thus change the future of organizations and therefore their required strategy (Morrison and Wilson 1997).

![Diagram of Peter Senge's System Iceberg Model](image)

*Figure 3.2: Peter Senge’s System Iceberg Model (Schwartz and Ogilvy 1998)*
This is where Scenario Planning comes into the picture; it is a management thinking tool that acknowledges the existence of uncertainty in the organization’s environment by developing a set of scenarios (internally consistent and plausible, but structurally different narratives), which outline the range of possible futures (van der Heijden 2005). It aids in avoiding denial and paralysis by enabling to see opportunities and threats in advance (Star and Randall 2007) and helps in generating more robust strategies, policies and plans (Schwartz 1996). Thus, Scenario Planning improves the quality of executive decision making (Wilson 1998a).

The scenarios are not predictions, but rather hypotheses in the form of rather provocative, structurally different, but internally consistent and plausible narratives, built upon combinations of uncertain, high-impact Driving Forces, about how the future of issues relevant to an organization or individual might unfold (Scarse, Fulton e.a. 2004). Each scenario is treated with equal weight instead of being more probable than other scenarios (Schwartz 1996). The scenarios are used to (Fahey, Liam and Randall, Robert M. 1998b, and Scarse, Fulton e.a. 2004):

1. Set the strategic direction and prepare a rough timetable of events;
2. Be more perceptive of the environment when trying to identify towards which scenario the present is evolving, and anticipate new insights and innovations;
3. Accelerate collaborative learning by providing insight in the environment during the scenario building process;
4. Test existing strategies by challenging assumptions upon which they are built;
5. Rehearse the actions that need to be taken in different environments;
6. Describe goals that need to be achieved (so-called normative scenarios).

The scenarios are used to outline the range of possible futures; therefore the scenarios do not have to come true (as stated before, they are not predictions). Rather, they need to be plausible, structurally different, challenging and relevant to the organization.
Scenario Planning can be used by both large and small organizations, in particular when they (Scarse, Fulton e.a. 2004):

- deal with actors within and outside the sector;
- address interdependent and complex issues;
- have a clear interest in external trends;
- feel a responsibility to address diverse points of view;
- manage complex stakeholder relationships, and;
- must develop strategies reflective of diverse needs

Scenario Planning differs from traditional planning (see table 3.1) and helps draft a strategy that is no longer a fixed plan, but a vision of a new way ahead that is capable of being modified at every twist and turn of events while allowing progress (Hodgson 2003). Scenario Planning can thus be used when traditional strategizing based on forecasting does not suffice. Figure 3.3 displays Scenario Planning relative to forecasting methods and speculation.

<table>
<thead>
<tr>
<th></th>
<th>Forecasting</th>
<th>Scenario Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Viewpoint</strong></td>
<td>Piecemeal</td>
<td>Holistic approach</td>
</tr>
<tr>
<td><strong>Variables</strong></td>
<td>Quantitative</td>
<td>Qualitative</td>
</tr>
<tr>
<td><strong>Relationships</strong></td>
<td>Static</td>
<td>Dynamic</td>
</tr>
<tr>
<td><strong>Explanation</strong></td>
<td>Past explain the future</td>
<td>Future is the purpose of the present</td>
</tr>
<tr>
<td><strong>Future</strong></td>
<td>One and certain</td>
<td>Multiple and uncertain</td>
</tr>
<tr>
<td><strong>Method</strong></td>
<td>Economic / mathematical</td>
<td>Structural analysis</td>
</tr>
<tr>
<td><strong>Attitude to the Future</strong></td>
<td>Passive / reactive</td>
<td>Active / creative</td>
</tr>
</tbody>
</table>

*Table 3.1: Differences between forecasting and Scenario Planning (Schoemaker 1995)*
The advantages of the Scenario Planning methodology are (van der Heijden 2005, Wilkinson 1995 and Scearce, Fulton e.a. 2004):

- better understanding of the environment;
- the methodology is able to process qualitative data besides quantitative data;
- the methodology allows conflicting beliefs, ideas, assumptions etc.
- a properly executed Scenario Planning process builds synergy within the organization;
- it does not deny uncertainty;
- existing strategies, policies and plans can be refined;
- the organization is more adaptable to the environment
- it helps to make decisions more effectively.

Some of the misuses and misconceptions of Scenario Planning are:

- the methodology is often downplayed because the scenarios are perceived as a prediction, instead of the result of analysis (Fenton 2001);
- the scenarios are seen as the end result, instead of a part in a complete management system to develop or test strategies (Smadja 2006);
- choosing a too short time horizon, which tends practitioners to simply extrapolate current trends;

Figure 3.3: The position of Scenario Planning relative to forecasting and speculation (van der Heijden 2005)
- creating too many scenarios, which are unmanageable;
- assigning probabilities to scenarios, which tend practitioners to focus solely on one scenario, and thereby not able them to anticipate opportunities and threats in other scenarios;
- developing a complete strategy for each scenario. This will make the organization not as flexible as intended by the methodology, since the organization will still stick to rigid strategies, rather than a strategy to steer through the scenarios. It will therefore be more difficult for the organization to adapt to an environment that is not described in any scenario, but which has elements of the developed scenarios (Wilson 1998a);
- excluding managers from the Scenario Planning process will make it difficult for them to accept the scenarios, since these challenge existing assumptions;
- lack of diverse inputs when gathering data, for instance when focusing only on local knowledge or experts. This will less likely result in various points of view, paradigm shifts, etc. (Peterson 2003);
- pressure from management disables those involved in the Scenario Planning process to march out of line and to “think outside the box”, resulting in so-called “group thinking” (Marsh 1998);
- the scenarios are not structurally different from each other, but rather slight variations of one theme (Schwartz and Ogilvy 1998);
- the scenarios are not global enough in scope (Hodgson 2003);
- the scenarios do not focus on the issue and are therefore not relevant to the organization;
- the scenarios are seen informational and instructional rather than learning tools (Fahey and Randall 1998a);
- lack of support from top management (Schoemaker 1998);
- scenarios should encapsulate all the complexity of the environment (Fahey and Randall 1998a).
These misuses and misconception often occur due to the fact that Scenario Planning is frequently confused with (Davis 2003):
- Sensitivity Analysis: determining the variation in the output when varying one of the variables;
- Uncertainty Analysis: quantifies the uncertainty in the outcome of a model;
- Contingency Planning: creates 1 scenario by looking at one particular uncertainty.

### 3.3. History of Scenario Planning

Scenario Planning has its origins in the United States military, when the US Air force tried to image during the Second World War what their opponents might do, and tried to prepare for that (Schwartz 1996). After the war, the military still used scenarios, but these were now forged by the RAND Corporation think-tank, where the methodology was further elaborated by Hermann Kahn, who pioneered by applying the methodology as a business tool (van der Werff 1998). This was revolutionary at that time, since (business) planning was more of an internal effort, focused on budgets, rather than the environment. In the 1960s focus started to shift towards the environment, but relied more on the study of trends and patterns (Morrison and Wilson 1997). By the mid-1970s, approximately one quarter of the Fortune 100 companies used scenarios (Ringland 1998). However, the methodology experienced a strong decline in the 1980s due to misunderstanding and poor execution, but gained a resurgence (albeit a slow one) in the 1990s (Ogilvy and Smith 2004) to an estimated 20% of observed companies (Schoemaker 2006).

Scenario Planning was put into the picture again by the Royal Dutch Shell. It was introduced in this company by Pierre Wack in 1971 who used the methodology at his former employer, the Stanford Research Institute International (SRI International). The Royal Dutch Shell has used the methodology intensively now for more than 30 years and Scenario Planning has become an intricate part of their business system. The company has even claimed that the methodology is one of the main contributors to their success in becoming one of the largest companies (Flower 1997). The company has for instance
been able to anticipate the Oil Crisis in 1973, the oil price drop in 1986, and the fall of Communism in 1989, much more in advance than their competitors which for the Royal Dutch Shell was a major competitive advantage. The Royal Dutch Shell frequently develops scenarios (for various topics and time horizons) and even publicizes them (Wright 2004).

Another impetus to recognition of the Scenario Planning methodology was provided by the exercise done by Adam Kahane. In 1991 people in South Africa were wondering what would happen upon the release of Nelson Mandela. With the help of Kahane, various Non-Governmental Organizations, exponents from the government and the business world came together in the Mont Fleur Conference Center to think about possible futures after Mandela’s release. These so-called “Mont Fleur” scenarios were so challenging, plausible and widely communicated, that everyone believed that these could be possible futures. Since one of the scenarios, called “Flight of the Flamingos”, described a prosperous South Africa for the entire population, people began to believe that a feasible, positive path forward to a successful national democratic future was possible (Kahane 1998).

Scenario Planning has proven its worth, as evidenced by the application primarily by private companies, but also by governments and Non-Governmental Organizations (Searce, Fulton e.a. 2004). Notable users include Motorola, the Central Intelligence Agency, Novo Nordisk AS, the state of Texas and the Mott Foundation (Ogilvy and Smith 2004).

However, the Scenario Planning methodology is little known, let alone used in developing countries, as few scenarios dealing with realities in developing countries can be found, or any other information that hints towards the use of the methodology in this region. Scenarios that address developing countries are usually scenarios describing the global context, as done for instance by the Intergovernmental Panel on Climate Change (Sims, Schock, Adegbululgte, e.a. 2007, Magrin, Gay García, Cruz Choque, e.a. 2007), the International Energy Agency (International Energy Agency 2003, Ramsey 2006b).
and the World Energy Council (World Energy Council 2007). There are only a few scenario planning exercises to be found that relate to a specific developing country, as is the case with exercises done for Kenya (Institute of Economic Affairs 2000), Iraq (Marcel 2005), Saudi-Arabia (Al-Saleh, Upham and Malik 2008) and China (Tao and Watson 2008). Only a few examples of scenario planning exercises conducted in Suriname exist; one was done for a multinational, another was part of an inaugural speech (Schalkwijk 2009), while some were executed by graduate students.

3.4. Scenario Planning Methods

The scenarios can be classified as follows (Nekkers 2007):

1. External / Environment Scenarios: scenarios that focus on development in the environment external to the organization
2. Internal / Target Scenarios: scenarios that describe the end state of an organization
3. System Scenarios: scenarios that are a combination of Internal and External Scenarios
4. Normative Scenarios: scenarios that depict a preferred future
5. Static Scenarios: scenarios that focus on a singular point in time (Miles 2004)
6. Dynamic Scenarios: scenarios that are concerned with events and trend developments (Miles 2004)

There are various approaches to Scenario Planning, which are often named after their users, such as French School, SRI, Copenhagen Institute, etc. However, all these methods can be ordered in a couple of categories. Below these categories are discussed; each one of them is a collection of creative and analytical techniques with which the types of scenarios as mentioned in section 5.3 can be created (Nekkers 2007):

1. Inductive / Intuitive method, also known as the Future Backward method: from observed events and trends, new events are brainstormed that are typical of a certain scenario (Schwartz and Ogilvy 1998).
2. Deductive method, also known as the future Forward method: identified Driving Forces are combined to form the structure upon which scenarios are built. This can be done in two ways: constructing a scenario-matrix (where the Driving forces are also called scenario dimensions) or an event tree (van der Heijden 2005), see figure 3.4.

![Figure 3.4: Two deductive methods: the scenario-matrix and the event tree](image)

3. Incremental method, also known as the Official Future method: the scenario of the future that is planned for through the use of traditional planning, viz. forecasting, is the so-called “default scenario”. New scenarios are created by introducing issues and / or threats, or so-called “wildcards” (unexpected events) in this default scenario (Scearce, Fulton e.a. 2004).

4. Morphological analysis: a computerized method of combining all sorts of influences (both predetermined and uncertain) on the organization that have been found through analysis (Eriksson and Ritchey 2002).

In this research the deductive method will be applied for the following reasons:

1. due to its nature the method is more likely to produce surprises that challenge existing assumptions (Nekkers 2007);
2. the method is more likely to develop scenarios that cover a wide range of possible futures (Scearce, Fulton e.a. 2004);
3. the method has a strong emphasis on the environment (Nekkers 2007);
4. the deductive approach is the most analytical Scenario Planning method (van der Heijden 2005).

Since the scenario-matrix is most common when practicing the deductive method and is by far featured the most in literature, whereas little can be found in Scenario Planning literature with regard to the event-tree method, the scenario-matrix method will be utilized.

Though computerized models, such as morphological models, are more efficient to develop scenarios, the number of scenarios obtained is often way too much to manage. Furthermore, the models often do not drive the user to think about the underlying forces of everyday events and do not make a distinction between predetermined and uncertain Driving Forces (Paich and Hinton 1998). Also, computer models are based on certain assumptions which might not be applicable anymore in future situations. Hence this research will not involve any computerized modeling to craft scenarios.

3.5. Steps in Deductive Scenario Planning

The deductive Scenario Planning method consists of two phases, the diverging phase and the converging phase. In the diverging phase information is gathered and examined, while the diverging phase is concerned with crafting scenarios, obtained from information gathered in the first phase, and building resilient strategies (Nekkers 2007). It could be argued that these two phases are respectively the analysis and synthesis phase of Scenario Planning (Ritchey 1991).

The steps in these phases are the following ((Scearce, Fulton e.a. 2004, van der Heijden 2005, Nekkers 2007, Davis 2003):

**Diverging / Analysis Phase**

1. **Determine the key decision or issue for which strategies need to be formulated.**
This stage identifies and defines the decision to be taken or the issue at hand. Also, in this stage the horizon year (or scenario timeframe) is determined, which is the chosen cut-off time of the scenario stories and which can be used as the end point towards which the scenarios explain how the future develops (van der Heijden 2005). This cut-off time is determined by taking into account the dynamics and complexity of the environment, the time span during which current decisions in the organization could have influence, and the timeframe within which significant events are expected to take place that will have a significant impact on the decision (Nekkers 2007).

2. Analyze the environment for important forces with respect to the decision / issue.
   This information can be obtained through desk research, (open-ended) interviews, observations, workshops etc.

3. From the previous step, cluster similar forces and identify and study underlying Driving Forces.

4. Make a distinction between predetermined and uncertain Driving Forces.
   Rank the Driving Forces by degrees of impact and degrees of uncertainty.

5. Select the most uncertain Driving Forces with the highest impact (the so-called critical uncertainties) and combine these to form the so-called scenario logic / framework for the scenarios.
   Too many scenarios will be too complex to manage, but a minimum of two scenarios is required to reflect the aspect of uncertainty.

Converging / Synthesis Phase

6. Flesh out the scenarios.
   Develop stories around the scenario dimensions, linking the present with the future description, and include the predetermined Driving Forces in each scenario. The scenarios are depicted as short narratives, because these can (van der Heijden 2005):
   a. quickly capture complex matters;
b. embed qualitative information that cannot be depicted by means of graphs and tables;

c. make unexpected scenarios believable, and;

d. leave a lasting message.

The scenarios need to be internally consistent, structurally different from each other, challenging (be able to display a new and unique perspective), relevant and plausible. Each scenario should have a striking title.

7. Derive implications that each scenario will have on the organization and how the decision might play out in each scenario.

8. Identify early warning signals and leading indicators.

   Early warning signals and leading indicators hint towards which developed scenario the present is heading, so the organizations can start anticipating particular events and developments.

**3.6. Creating Robust Strategies with Scenario Planning**

As stated earlier, a strategy is an overall approach, based on an understanding of the environment in which an individual or organization functions, the strengths and weaknesses of the individuals or organization, the problems the individual or organization tries to address, and the opportunities they try to capitalize. This includes engaging in strategizing in order to react to expected responses of competitors or client organizations to changes in the environment. The strategy provides the framework for policies and action plans (Ringland 1998).

Theories of strategic management can be grouped into 3 schools of thought (van de Heijden 2005):
a. The Rationalist Paradigm: the organization is viewed as a machine resulting in the thought that there is only one right answer and it is the organization’s task to approach that answer as close as possible. The organization is primarily bent on forecasting and has therefore difficulty when confronted with unexpected change.

b. The Evolutionary Paradigm: the organization is viewed as an ecological entity. This school believes that reality is far too complex to grasp, and strategy must therefore be based on past experiences. These organizations tend to be reactive.

c. The Processual Paradigm: the organization is viewed as a living entity. The organization is in a process of continuous learning (from both the past and the environment) and creates synergy through communication and involvement.

The Scenario Planning methodology fits most in the Processual Paradigm category.

The scenarios conceived can be used as follows with relation to strategy (Wilson 1998a and Wilson 1998b):

A. Risk / Sensitivity Assessment: identify the conditions necessary to give the green light to a particular decision. Assess if each scenario contains these minimum requirements to justify the decision.

B. Strategy Evaluation: Dissect the current strategy into various components and assess the relevance and success of each of these components in each scenario. Following this, identify options for changes in the current strategy.

C. Strategy Development (using a “planning focus” scenario): Identify the opportunities and threats in each scenario, and determine what the organization should do regardless of which scenario becomes reality. The next step is to develop a strategy for the most probable scenario. Test this strategy against the other scenarios and include options such as hedging against threats (that are not in the planning focus scenario) and
contingency planning. This is however contradictory to the fundamentals of the scenario planning methodology (and will therefore not be used), where probabilities are not used because of the following:

i. Assigning probabilities give a false sense of understanding reality whereas the external environment is too complex and dynamic to understand;

ii. It directs the focus of management towards one scenario, thereby downplaying the advantage of the methodology to be able to be prepared for a wide spectrum of possibilities.

D. Strategy Development (without using a “planning focus” scenario):
Determine optimal setting for each strategy element in each scenario. Determine the most resilient option for each strategy element so a strategy is formed that can deal with all scenarios.

The derived strategy should be clearly defined with a scope, the main capabilities and instruments necessary for the organization to confront the future with, responsibilities and goals. When determining the robust direction, both the organization (the internal environment), the transactional and contextual environment need to be taken into account, in order to determine whether the organization is equipped for that direction in a particular policy set, and whether anticipated developments are able to take place in the envisioned territory (Fahey and Randall 1998a, van der Heijden 2005). These directions should be coherent, believable, emphasize competencies and leave room for choice (Hodgson 2003).
Part II: Constructing Energy Scenarios for Suriname

This part of the research deals with the construction of energy scenarios through the steps mentioned in section 5. It starts off with a section on contemporary energy security in Suriname. This clear picture of the current situation is necessary for the diverging stage of scenario planning, since it guides the search for data, and therefore is to a large extent an important ingredient to obtain plausible scenarios. Understanding the current situation is also necessary when formulating realistic strategies since these need to build upon the present and highlight a path to the future.

Following the section on energy security in Suriname, trends and driving forces will be identified. Driving forces will be ranked and critical uncertainties will be used to create scenarios using the matrix method. This part will be concluded with a section where the created scenarios are named and fleshed out.

In this section the availability, affordability and reliability of energy in Suriname will be discussed. The majority of the energy supplied comes in the form of electricity, propane (used for cooking) and transportation fuels, such as diesel, gasoline and kerosene (Chin A Lin 2006). Each of these so-called energy carriers will be addressed separately.

4.1. Energy Resources

Suriname is rich in natural resources, such as biodiversity, water, metals, hydrocarbons etc. A report by the United Nations has even nominated Suriname as the 17th richest country in the world with respect to natural resources (Barnes 2005). The country is also rich in natural resources that with current available technology can be converted into energy, such as uranium, hydrocarbons such as oil and gas, sunlight, hydro energy, biomass etc. Appendix G shows a map of Suriname with highlighted locations that are rich in energy resources (Suriname op weg 1983), though many areas still require thorough exploration.

With regard to hydro energy, though the country’s geography differs relatively little in height, studies have shown that many possibilities exist to create hydro reservoirs through the construction of dams (Boksteen 2008a); the potential amount of hydro energy that could be generated in Suriname is estimated at approximately 2419 MW (Chin A Lin 2006). This includes both bulk hydro power and small scale – also called micro – hydro power. The University of Suriname has identified the potential locations for the latter and these are also depicted in Appendix G on a separate map (Naipal 2007). This effort in research on the field of hydro power potential stems forth from the desire from the mining industries in Suriname to have access to low-cost electricity; against this background, the currently operating van Blommenstein reservoir was built in the 1960s to supply the energy-intensive aluminum smelting business with cheap electricity (Lie A Kwie and Esajas 1995).
4.2. Electricity

4.2.1. History of the Surinamese Electricity Sector

In 1929 the Nederlandsch-Indische Gasmaatschappij (NIGM) started with the construction of an electricity plant at the Saramaccastraat, which was at that time the heart of Paramaribo. The plant became operational in 1932, and produced and delivered electricity to a small number of customers living within the center of Paramaribo. In 1950 the name was changed into Overzeesche Gas- en Elektriciteitsmaatschappij (OGEM), and then again in 1968 into the currently still existing N.V. Energiebedrijven Suriname (N.V. EBS). In 1972 the N.V. EBS was granted the concession to install and operate machinery in order to generate electricity and to purchase and distribute electricity to customers. This led the N.V. EBS to generate and deliver electricity outside Paramaribo, such as Nickerie and Albina (Historische Gegevens NV EBS 2009b). In 2005 it also took over the electricity plant at Wageningen, which used to be maintained and operated by the now bankrupt Stichting Machinale Landbouw (Historische Gegevens NV EBS 2009b).

Though the N.V. EBS was granted the concession to install and operate electricity plants outside Paramaribo, the Government still held the right to generate and distribute electricity by itself. This was done by one of its bodies, Dienst Electriciteitsvoorziening, which primarily focused on placing small diesel-powered generators in the interior (consisting of many small villages which are often difficult to reach), maintaining these and regularly supplying fuel.

One of the major events in the history of the Surinamese energy sector was however not directly related to the N.V. EBS, but was rather connected with the private owned Aluminum Company of America (Alcoa) which practically controlled the bauxite industry in Suriname. The company started with the excavation and export of bauxite ore in Suriname. However, with the signing of the Brokopondo Agreement on the 25th of January 1958, Alcoa committed itself to erect a fully integrated aluminum industry in Suriname, which meant that an alumina refinery and an aluminum smelter would be built. However, this industry would only be possible if Alcoa had access to cheap electricity (in
particular for its smelter). The Brokopondo Agreement stated that Alcoa would build a hydro reservoir in order to obtain fairly cheap hydroelectricity for its operations (Lie A Kwie and Esajas 1996).

The dam built for this purpose was approximately 1913 meters long, 54 meters high and had a width at its base of 400 meters. The reservoir (named after Professor van Blommenstein), large 1,560 km$^2$, could contain 8 million cubic meters of water and became operational in July 1965 (Lie A Kwie and Esajas 1996). The dam has an installed capacity of 189 MW (the extra capacity generated through the possible diversion of the Tapanahoni River was taken into account) and it has a long-term average of 100 MW (876 GWh). The long-term average value turned out to be lower than originally intended, since the original design took a too high water flow into account (Boksteen 2008b). The most important aspects mentioned in the Brokopondo Agreement are (Brokopondo Gemeenschappelijke Onderneming 1958):

- The Government of Suriname has the right to obtain 80 GWh at a maximum capacity of 16 MW from Alcoa; all other generated energy is the property of Alcoa and shall be entirely at Suralco’s disposal for use in its own plants or enterprises and for all its activities arising out of or in any way connected therewith;

- The Government needs to mention the amount of energy it will need for the coming year;

- Alcoa has the option to reroute the Tapanahoni River, via the Toso Creek, into the van Blommenstein reservoir in order to be able to generate more energy (more on this in section 6.2.5), and Suriname has the right to obtain an extra 80 GWh at a 16 MW capacity when this project is finished. As long as Alcoa has not mentioned whether it will proceed or not with the project, the Government of Suriname is not entitled to develop the project by third parties;

- After expiration of the Agreement Alcoa has the right to request 90% of the hydroelectricity at a to be determined rate;

- The Agreement will last 75 years and will end on January 25, 2033.
This Agreement gave an enormous boost to the bauxite industry of Suriname which made up a large portion of the economy. The amount of energy that the Government received was more than 4 times the annual consumption of Suriname at that time. Since the hydroelectricity obtained was routed to Paramaribo, there was little need to expand existing generating capacities of the N.V. EBS.

Starting in the mid-1980s the N.V. EBS purchased excess hydroelectricity from Paranam, but the amount increased significantly in 1999, when Suralco L.L.C. shut down its aluminum smelter. This made a lot of energy available, and Suralco made an agreement with the Government of Suriname to obtain the 80 MW (700.8 GWh) of hydroelectricity (Boksteen 2008c) at a cost that was partly dependent on oil prices. It is important to note however, that Suralco has the right to reclaim the hydroelectricity two years after notification. Because of the extra available energy, a new substation and a 161 kV transmission line from Paranam (Suralco) to Paramaribo were built in 2005 and 2006 respectively in order to reduce transmission losses (NV EBS 2004). The Government used the energy to further accelerate the growth of the economy, and since a relative great amount of energy became available, marginal attention was still paid to the N.V. EBS with regard to expansion of their generative capacity.

The state owned oil company, Staatsolie Maatschappij Suriname N. V. (SOM), started their own 14 MW plant called Staatsolie Power Company Suriname (SPCS), in July 2006 (Company Profile. Staatsolie 2009c). The plant’s purpose was to combust heavy fuel oil (obtained from the oil refinery) in order to produce steam for the adjacent SOM refinery. However, during this process, the plant is also able to generate electricity.

### 4.2.2. Current Generative Capacity

Most inhabitants live in Suriname’s coastal area, with a large amount of people living in and around Paramaribo. In the interior, there are numerous maroon and indigenous villages, some of which are being supplied with electricity. Because of this wide dispersion of people, Suriname has a number of independent power systems. Some of
these are interconnected whereas others, often due to their remoteness, are running completely independent (KEMA 2008c).

The main suppliers of electricity are Suralco L.L.C. (a private-owned company), N.V. Energybedrijven Suriname (N.V. EBS), Staatsolie Power Company Suriname (SPCS) and Dienst Electriciteitsvoorziening (DEV). Of these, Suralco’s AfoBaka hydroplant is by far the largest and delivers the majority of the electricity consumed. This electricity is sold to the Government (at a cost that is partly dependent on oil prices), and being distributed further by the N.V. EBS (Chin A Lin 2006).

The largest power systems are relative to each other schematically depicted in figure 4.1

Figure 4.1: The largest power systems in Suriname (KEMA 2008b)
Apart from the relative large power systems depicted above which are concentrated along the coastline (with the exception of some villages in the district Brokopondo that are connected to the NV EBS grid), 111 villages in the interior are equipped with diesel-fueled electricity generators (KEMA 2008b) ranging in capacity from 15 – 149 kW (Chin A Lin 2006).

Suriname has a relative high consumption of energy on a per capita basis when compared to other developing countries (Suriname op weg 1983). The total electricity generation capacity is currently an approximate 210 MW. Table 4.1 depicts the main characteristics of the power systems that make up this total capacity.

<table>
<thead>
<tr>
<th>Operator</th>
<th>Area</th>
<th>Installed Generation Capacity (MW)</th>
<th>Peak Demand (MW)</th>
<th>Consumption (MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBS</td>
<td>EPAR</td>
<td>82</td>
<td>130.3</td>
<td>727,364</td>
</tr>
<tr>
<td>EBS</td>
<td>ENIC</td>
<td>15.9</td>
<td>10.05</td>
<td>47,460</td>
</tr>
<tr>
<td>EBS</td>
<td>Albina</td>
<td>2.9</td>
<td>0.58</td>
<td>3,674</td>
</tr>
<tr>
<td>EBS</td>
<td>Apoera</td>
<td>1.44</td>
<td>0.2</td>
<td>936</td>
</tr>
<tr>
<td>EBS</td>
<td>Boskamp</td>
<td>0.6</td>
<td>0.08</td>
<td>601</td>
</tr>
<tr>
<td>EBS</td>
<td>Brokopondo</td>
<td>0</td>
<td>unknown</td>
<td>462</td>
</tr>
<tr>
<td>EBS</td>
<td>Coronie</td>
<td>3.15</td>
<td>0.54</td>
<td>3,157</td>
</tr>
<tr>
<td>EBS</td>
<td>Moengo</td>
<td>4.7</td>
<td>1.5</td>
<td>8,768</td>
</tr>
<tr>
<td>EBS</td>
<td>Wageningen</td>
<td>4.3</td>
<td>0.56</td>
<td>3,054</td>
</tr>
<tr>
<td>Suralco</td>
<td>Afofaka</td>
<td>189</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Suralco</td>
<td>Paranam</td>
<td>99</td>
<td>49</td>
<td>429,080</td>
</tr>
<tr>
<td>IAMGOLD</td>
<td>Rosebel</td>
<td>0</td>
<td>14.5</td>
<td>118,000</td>
</tr>
<tr>
<td>SPCS</td>
<td>EPAR</td>
<td>15</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>DEV</td>
<td>Interior</td>
<td>+/-1.5</td>
<td>unknown</td>
<td>unknown</td>
</tr>
</tbody>
</table>

*Table 4.1: The characteristics of the different power systems in Suriname (KEMA 2008c)*
EPAR: This system centers on Paramaribo and its surroundings, reaching as far as the Atlantic Ocean in the North, Stolkertsijver in the District of Commewijne in the East, Carl Francois in the District of Saramacca in the West and the Zanderij (Airport) area in the South. The EPAR system has by far the highest consumption of electric power in Suriname. It is fed by EBS, Staatsolie Power Company Suriname (SPCS) and the Afobaka hydro power plant (via a 161 kV transmission line). Due to the high level in the reservoir, SPCS only had to produce 3,000 MWh in 2008, which is just 4.9% of the 61,000 MWh that was expected to be generated (Historische Gegevens NV EBS 2009b). In 2004 however, generators needed to be imported since Suralco was unable to supply hydroelectricity to the N.V. EBS due to low reservoir levels.

ENIC: This network covers New Nickerie and its surrounding areas as far as Groot Henar in West Suriname.

The Rural District Power Systems: Each system operates as an isolated power system with one or more Diesel Generator Sets in a local power house. These are located at Albina, Moengo, Boskamp, Coronie, Wageningen, Apoera (total consumption in these areas is around 22 GWh per year).

Rosebel Gold Mines: This is the mine operation of the private-owned IAMGOLD in the Brokopondo district that has a life expectancy of 15 years. It is contractually supplied electricity via a dedicated 161 kV transmission line coming from the Afobaka hydro power plant. This system is built and owned by IAMGOLD.

The Brokopondo Distribution System: This system supplies some villages in the Brokopondo district from the 13.8 kV system at the Afobaka hydro power plant.

As mentioned earlier, 111 villages in the interior are fed by micro power systems in the interior. These are operated and maintained by the Department of Rural Energy of the Ministry of Natural Resources (Dienst Energievoorziening – DEV).
Furthermore, there are a handful of locations that have equipment to generate electricity from alternative energy (“Schone Energie” 2006a):
- Poeketie, Gran Holo Sula and Palumeu: micro hydro power
- Lely Hills and Galibi: wind turbines
- Kwamalasemutu: solar panels

Unfortunately, of these installed systems, 2 of the 5 wind turbines are out of operation due to lack of maintenance. The solar panels in Kwamala Semutu do not function anymore due to a lack of funds for batteries, save those panels used by people who purchase their own batteries. The micro hydro power project at Gran Holo Sula is in its construction phase, whereas the micro power stations at Poeketie and Palumeu stopped functioning due to design errors and lack of funds for operation and maintenance.

4.2.3. Electricity Access

Table 4.2 provides an overview of the amount of people and households per district supplied by the EBS. Table 4.3 provides an overview of the number of people served by EBS and DEV in the interior (KEMA 2008b).

<table>
<thead>
<tr>
<th>District</th>
<th>Population</th>
<th># Homes</th>
<th># Homes with EBS connection</th>
<th>Electrification Rate</th>
<th>Est. Persons with EBS access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paramaribo</td>
<td>242,946</td>
<td>57,300</td>
<td>54,137</td>
<td>95%</td>
<td>229,584</td>
</tr>
<tr>
<td>Commewijne</td>
<td>24,649</td>
<td>6,293</td>
<td>5,597</td>
<td>89%</td>
<td>21,913</td>
</tr>
<tr>
<td>Wanica</td>
<td>85,986</td>
<td>20,571</td>
<td>17,537</td>
<td>85%</td>
<td>73,346</td>
</tr>
<tr>
<td>Coronie</td>
<td>2,887</td>
<td>925</td>
<td>757</td>
<td>82%</td>
<td>2,362</td>
</tr>
<tr>
<td>Nickerie</td>
<td>36,639</td>
<td>9,228</td>
<td>7,506</td>
<td>81%</td>
<td>29,788</td>
</tr>
<tr>
<td>Saramacca</td>
<td>15,980</td>
<td>4,244</td>
<td>3,225</td>
<td>76%</td>
<td>12,145</td>
</tr>
<tr>
<td>Marowijne</td>
<td>16,642</td>
<td>3,944</td>
<td>2,095</td>
<td>53%</td>
<td>8,837</td>
</tr>
<tr>
<td>Para</td>
<td>18,749</td>
<td>4,338</td>
<td>2,228</td>
<td>51%</td>
<td>9,637</td>
</tr>
<tr>
<td>Brokopondo</td>
<td>14,215</td>
<td>3,656</td>
<td>1,230</td>
<td>34%</td>
<td>4,776</td>
</tr>
<tr>
<td>Sipaliwini</td>
<td>34,136</td>
<td>9,656</td>
<td>139</td>
<td>1%</td>
<td>478</td>
</tr>
<tr>
<td>Suriname TOTAL</td>
<td><strong>492,829</strong></td>
<td><strong>120,157</strong></td>
<td><strong>94,451</strong></td>
<td><strong>79%</strong></td>
<td><strong>387,364</strong></td>
</tr>
</tbody>
</table>

*Table 4.2: Customers served by EBS in each district*
<table>
<thead>
<tr>
<th>Persons</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBS electrified</td>
<td>387,364</td>
</tr>
<tr>
<td>DEV electrified</td>
<td>30,000</td>
</tr>
<tr>
<td>No Access</td>
<td>75,565</td>
</tr>
<tr>
<td>Total Population</td>
<td>492,829</td>
</tr>
</tbody>
</table>

Table 4.3: Persons served by EBS and DEV (estimated) and persons without access

4.2.4. Financial Sustainability

The costs of electricity supplied by EBS (approximately US$ 0.06/kWh) consists for 39% of fixed costs and 61% of variable costs (Boksteen 2008c), such as the purchase of hydroelectricity from Suralco (with the government acting as an intermediary), fuel and lubricants to run generators, etc. However, the electricity tariffs (determined by the Government) cover approximately 60% of the costs involved, and are approximately 39% of the Caricom average (Chin A Lin 2006). This is the main reason why the financial performance of the EBS is significantly below generally accepted standards (KEMA 2008b). Necessary investments are postponed, dismissed or scaled down, resulting in a backlog of maintenance activities, an increasing inability to keep up with the growing demand for electricity and below standard efficiencies (Redjodikromo 2005). Estimates show that energy consumption in Suriname will double within 12 years and to keep up with this increase investments worth US $ 1 billion will be required (KEMA 2008c).

Due to the fact that the EBS operates below its break-even point and the fact that power system capacity is capital intensive, the electricity sector has been forced to be directly or indirectly dependent on development aid (“EBS kan doorstart” 2006b, KEMA 2008c). In this manner, the construction of the 161 kV transmission line was financed through a loan from the Government of India, a backlog of household connections to the electricity grid was being uplifted by the EBS with the help of a state loan from the Government of Suriname, and villages in the interior are equipped with electricity generators and transmission lines by Non-Governmental Organizations (NGOs).
The provision of electricity to villages in the interior is expensive in nature because of low efficiencies of the generating units and high transportation costs. Nevertheless, the villagers receive the electricity free of charge (KEMA 2008b).

The main reasons to maintain inadequate tariffs (and consequently a financially malfunctioning utility company), and free electricity for villagers in the interior, are based on political decisions (KEMA 2008b).

4.2.5. Institutional Capacity

Up until recently, the Surinamese electricity sector was being governed by the Ministry of Natural Resources, the state-owned EBS, and (when taking into account the amount of supply) Suralco. However, due to the complexity of the energy sector, in particular with regard to long-term planning, electricity tariffs, decisions involving large capital, the Government has formed an Energy Advice Committee, which has (however) solely an advisory role (“EBS kan doorstart” 2006b).

Apart from the installation of the Energy Advice Committee, little other actions have been undertaken to build / strengthen institutional capacity in the sector. In December 2007, the University of Suriname organized an energy symposium, as a kick-off for the theme “Energy” of the educational year 2008 – 2009, where energy related issues were discussed, such as regulation, renewable energy in Suriname, hydrocarbons and finance. At the symposium the intention was expressed to form two institutes:

- Intec (Institute for Applied Technology): this institute would have to undertake initiatives with the aim to establish an energy databank and an Energy Institute;
- Caere (Cluster for Alternative Energy Research): a centre where research territories on the field of energy are brought together to create synergy.

Intec, Caere and the later to be founded Energy Institute would provide the scientific argumentation for Government policy, such as energy scenarios, implementation of renewable energy and energy efficiency, strategizing and planning, power sector reform, price and quality monitoring, etc. (“Adekus jaarthe ma” 2008). The need for an
independent institute was already expressed in the Multi-year Development Program of the Government in 2006 (Chin A Lin 2006), and expressed again at the Energy Top (which was held at Overbridge in the period of 22 – 24 June 2008, and involved among others, representatives of EBS, Staatsolie, Suralco, the University of Suriname, the Ministry of Natural Resources and the consultant bureau, KEMA). However, as of today Intec has no actual relevant output, and Caere, the Energy Institute, or any other independent institute with responsibilities as described above still need to be established.

4.2.6. Plans for the Surinamese Electricity Sector

Various studies have been conducted, resulting in a number of plans to strengthen the electricity sector in order to achieve higher efficiencies, keep up with growth in energy demand, improve resilience against foreign influences such as oil price increase, and increase energy generation (both conventional and alternative) and transmission. An overview of these studies and plans and their contemporary relevance are outlined below.

Kabalebo Project

In order to mine and process the bauxite reserves in the western part of Suriname, an integrated aluminum industry, consisting of a refinery and smelter, was projected to be operational in the beginning of the 1980s. In order to supply the energy-intensive industry with inexpensive electricity, 2 hydro reservoirs covering some 2,828 km\(^2\) would be built in the area known as Kabalebo. The project could deliver 800 MW, but was expected to be constructed in phases, starting with a reservoir delivering 500 MW (Ng A Tam 1982). In the mid-1980s the total costs involved were US $ 675.6 million (Kabalebo hydroelectric power 1981).

The plan was abandoned in its infant stages of execution due to withdrawal of financers who feared a potential investment loss caused by the military (that undemocratically took power) that distrusted foreign companies. Nowadays, the project is seen less favorable due to gained knowledge of efficiencies of hydro reservoirs, loss of biodiversity, metals and minerals (van Dijk 2006), and because of political unwillingness, based on bad
experiences concerning the forced migration of maroon villagers (without any suitable compensation) due to the construction of the van Blommenstein reservoir.

**Masterplan 2000**
The Masterplan 2000 targeted the construction of the 161 kV transmission line between Paranam (Suralco) and Paramaribo, which has been realized through a loan from the Indian Government (NV EBS 2004). Another realization has been the expansion of the power station in Paramaribo. Targets that have not been realized are (KEMA 2008b):

- a transmission line between Nickerie and Wageningen (which have independent power systems);
- an interconnection to supply electricity to French-Guyana, which would be a solution for the electricity shortages of French-Guyana and would be financed by the French Development Agency (AFD) on the condition that Suriname would have sufficient energy (Cairo 2008);
- institutional reform, and;
- the installation of an electricity generating unit based on rice husk combustion / gasification.

The Masterplan is currently deemed outdated since it is primarily based on data and trends that are currently invalid (KEMA 2008a).

**Tapajai Hydro Project**
In the Brokopondo Agreement between Suralco and Suriname there was an option to divert the Tapanahoni River via the Toso Creek to the van Blommenstein reservoir. This would increase the reservoir’s capacity and would thus enable to install more generating capacity at the Brokopondo hydroelectric plant (Brokopondo Gemeenschappelijke Onderneming 1958).

The plan has since then been slightly altered and now envisions the diversion of both the Tapanahoni River and its branch – the Jai Creek – (hence the name Tapajai project) into the van Blommenstein reservoir. This would increase the reservoir with 257 km² (16.5%)
and required infrastructure, dams, power stations and transmission lines; total costs were estimated at US $ 875 million in 2001 The diversion would result in an installed capacity at the Afobaka hydro power plant of 305 MW, and an additional 305 MW in the small plants on the trajectory between the Tapanahoni River and the reservoir. In order to have this project realized the next step to be taken is to execute a feasibility study (Boksteen 2008a, 2008b and 2008c). However, as with the Kabalebo project, there is resistance from NGOs and representatives of villagers in the interior, which refrain the Government from executing this feasibility study.

Multi-year Development Program

At the beginning of its governing period the current Government of Suriname presented the Multi-year Development Program (MOP) in 2006, which provides a strategy to guide policy, and is often accompanied by concrete actions. It covers various topics, including energy (security).

The MOP drafted in 2006 was based on the assumption that the demand for energy increased with 8 – 10% annually, and had the following objectives with regard to energy security (Chin A Lin 2006):

- In 2020 the current energy deficit needs to be resolved, which means approximately 200 MW is required. This extra capacity will be achieved through:
  - expand the capacity of the existing EBS power station in Paramaribo;
  - build a new thermal power plant;
  - increase the capacity of SPCS;
  - start with the Tapajai project;
  - improve (efficiency of) transmission and distribution;
  - Start with the execution of the Kabalebo project;
- Build a transmission line to connect Albina, Paramaribo and Nieuw Nickerie;
- Investigate the possible use of solar, wind and bio-energy;
- Upgrade the facilities and services in the interior with the help of the Community Development Fund Suriname (CDFS);
- Increase tariffs to cover production, transmission and distribution costs;
- Establish an independent institute responsible for price and quality monitoring;
- Liberalization of the electricity generation segment of the sector, and;
- Intensify international cooperation.

Most of these projects have not been executed, save the increase of the EBS power station output, and though target dates for some of the goals are set in 2010, it seems unlikely that these projects will meet their deadlines due to lack of finance, pressure of interest groups, changed environmental conditions, political unwillingness and the fact that the CDFS does not function anymore. When looking at the set goals, it could be argued that they were unrealistic to begin with when taking into account the amount of funds required for execution, and the fact that some action items were simply copied from the past without being tested against new standards and insights, as is the case with the Kabalebo project.

**Alternative Fuels**

Though the Government has expressed its interest in alternative methods to generate electricity, little effort has been put in place (Lotens 2007). This also counts for the private sector where interest has been expressed in for instance nuclear plants (Snijders 2006) and even pre-feasibility studies regarding bio-ethanol production from sugar cane have been executed (Coenen and Kastelein 2006), but implementation of plans or continuation of research is lacking. There have been however some wind, solar and micro hydro power initiatives but these have mostly failed as described in section 4.2.2.

Currently, there is an experiment with the cultivation of jatropha as feedstock for biofuels in the interior, but strong results still need to be achieved. Furthermore, Staatsolie Maatschappij Suriname N.V. is readying itself to start the production of ethanol from sugarcane at the former rice production facility in Wageningen (in the West of Suriname), and EBS has submitted a proposal to construct a risk-husk gasification plant in Nickerie with the help of a loan provided by the Government of India.
Power Sector Assessment and Alternatives for its Modernization

In 2008 the Inter-American Development Bank (IDB) financed a study to assess the power sector and to synthesize options for improving energy security. The main conclusions from this study are (KEMA 2008a):

- Planning, coordination and regulation in the sector need to be institutionalized;
- Power supply control should shift from Suralco to EBS;
- Improve tariff and subsidy structure;
- Reform and partly liberalizing the power sector, by introducing Independent Power Producers who generate electricity and sell it to a so-called Single Buyer, which in turn sells the electricity to customers. Maintaining the transmission and distribution network will be the responsibility of a separate entity.

The study is based on the assumption of a 6% growth in electricity demand, which is already outdated. There are as of yet no indications that the recommendations resulting from this study will be followed up on in the short term.

EBS Strategic Plan 2008 – 2012

At the end of the second quarter of 2008 the EBS finalized its Strategic Plan 2008 – 2012 which outlined the framework for actions (of which some are described in the document) regarding generation, transmission and distribution of energy (Strategisch Plan 2009e). However, there are two major shortcomings in the document:

- Some of the strategic targets and actions to be taken seem unrealistic due to 1) the problem, consisting of too low tariffs and the capital intensive nature of these targets, and 2) the fact that the timeframe seems too short to have these targets realized (e.g. the construction of transmission lines to neighboring countries), and;
- The assumptions upon which this document is drafted are nowhere mentioned in the Strategic Plan. This makes it difficult to justify the strategic direction and subsequent actions.

Furthermore, there are plans to construct a thermal plant together with Staatsolie on the premises of the now-bankrupt Bruynzeel (a wood producing and processing plant), in the southern part of Paramaribo next to the Suriname-river. No further information could be obtained regarding this matter, since the plans are in their very infant stages.
4.3. Liquefied Petroleum Gas

In many western countries pipelines have been constructed to transport gas for heating and cooking purposes. Suriname has however no infrastructure to transport gas; heating (of water) is mostly accomplished by using electric boilers and cooking is mostly done using Liquefied Petroleum Gas (LPG), propane, that is distributed in 20, 28, 40 and 100 lbs. cylinders.

The LPG is first imported in bulk containers and then filled in smaller cylinders at a specialized plant. The cylinders are then distributed to retailers, and empty cylinders are returned via the retailers. Propane is also sold in bulk for industrial purposes. Ogane is the company that has the responsibility for import, filling and distribution, and is fully owned by the EBS.

Some key characteristics of the LPG sector are (Historie – Ogane 2009f):

- Annual sale: 12,000 metrics tons
- Net storage capacity: 1,588 metric tons
- Delivery frequency: once every four weeks
- Number of 100 lbs. cylinder customers: approximately 16,000
- Number of Cash & Carry customers: approximately 91,000
- Number of bulk customers: approximately 67

The LPG costs are highly dependent on international hydrocarbon prices, but prices for imported LPG that is locally sold are determined by the Government, and therefore do not tend to fluctuate with the same rate as the international prices. This is done to cushion any negative impact on society. However, this implies that in the case of rising international prices, the LPG prices in Suriname are too low to cover the costs made by Ogane. With the last years being characterized by structurally rising prices for hydrocarbons, Ogane has had difficulty to receive sufficient income to be financially sustainable.
In its Strategic Plan 2008 – 2012 the EBS has put its focus for Ogane on cost reduction, safety, quality and continuity (Strategisch Plan 2009e). Contrary to the strategic targets set for the electricity sector, the targets for Ogane seem fortunately more realistic with regard to the available timeframe and the costs involved, but the assumptions upon which the strategic directions are based are also in the case of Ogane unclear.

### 4.4. Transportation Fuels

The transportation sector in Suriname utilizes mainly diesel, gasoline and – to a much smaller extent – kerosene. These are imported, with the exception of Staatsolie Diesel which is used in primarily heavy (mobile) equipment. Contrary to LPG, the prices for transportation fuels are domestically immediately adjusted when international prices fluctuate. Total amount and costs of fuels imported in Suriname in 2008 on a monthly basis is depicted in respectively 4.2 and 4.3 (Noordwijk 2009).

![Fuels imported in Suriname](image)

**Figure 4.2: The amount of fuels imported in Suriname in 2008**
Transportation fuels are important in the LPG distribution and operations of electricity generating units in the interior. Rising prices for transportation fuels have therefore an immediate effect on the costs of LPG and electricity, especially in the interior where access is a lot more troublesome. But since the prices for electricity are bound by political decisions and LPG prices are not adjusted immediately, rising costs for transportation fuels create greater financial deficits for EBS (including Ogane) and DEV.

There are currently plans to expand the Staatsolie refinery to produce diesel and gasoline for the local market which will mitigate these problems. The construction site is currently being prepared and the refinery design is in progress; the goal is to have the refinery in operation by 2012 (Staatsolie Public Relations 2008).

**4.5. Energy Security**

The energy sector has no independent central strategizing, planning, coordinating, regulating and monitoring entity. In order to tackle problems with regard to energy security this issue needs to be resolved first, especially since the Ministry of Natural Resources has limited resources to effectively undertake these tasks (KEMA 2008b). From the previous sections, some conclusions will be drawn here with respect to the three aspects of energy security, namely availability, affordability and reliability.
4.5.1. Availability

Given the high growth in demand for energy, mostly due to increased economic activities and population growth, availability of energy seems to be troublesome. Though this accounts for transportation fuels and LPG, this is especially of importance for the electricity sector, since keeping up with growth means investing in generation, transmission and distribution, which are not only capital intensive, but also have a long lead time before realization.

Since both the population and economy are relatively small, demand for energy can display an abrupt deviation from past trends (either a sharp increase or decline), as has been evidenced by the closure of the Suralco smelter in 1999, and the start-up of the IAMGOLD Rosebel Gold Mines operations. This could occur again if for instance Suralco notified the Government to reclaim the hydroelectricity after two years. Current exploration of reserves of hydrocarbons in off-shore areas, minerals and metals in the interior, and the intention of the Government to have the bauxite reserves in West-Suriname used as input for a fully integrated aluminum industry, could lead to industries that will seriously uplift current demand for energy.

Regardless of the fact that future expansion in industrial activity could force the demand in an upward direction, the need for investments is already evidenced by:

- the fact that an estimated 15% of the population have no access to electricity, as earlier mentioned in section 4.2.2.;
- demand for electricity outweighing supply, which sometimes forces the EBS to make use of load shedding;
- the villages in the interior, though free of charge, only receive electricity for 4 to 6 hours per day.

4.5.2. Affordability

With regard to electricity and LPG, the Government tries to keep these within reach of the population by subsidizing the price, though the subsidy policy is not clearly defined
(KEMA 2008a). However, as long as tariffs do not cover the costs involved it will be hardly possible to be financially sustainable and to invest to increase availability and reliability, even with development aid. On the other hand, it is expected that the increase of tariffs to accepted standards will place basic needs out of reach for a large part of the population.

Since it can be expected that hydrocarbons will gain more importance (because of the fact that the hydro reservoir does not increase in capacity, unless a project like the Tapajai project is initiated), combined with the fact that prices for hydrocarbons tend to rise on the long run and the price for hydroelectricity obtained from Suralco has an oil-dependent component, the gap between costs and revenue will tend to increase as a result of too low tariffs. This will not only take its toll on Government finance in the form of subsidies, it will also make it harder to digest for society to accept an enormous jump in tariffs by the Government, rather than more frequent but much more subtle increases.

Due to the scattered locations of the villages in the interior (see figure 4.4) the only means of transportation is often the off-road vehicle and / or boat. Any activity undertaken in the interior is therefore highly depending on prices for transportation fuels. Since it is expected that the prices for transportation fuels, such as diesel and gasoline, will increase steadily on the long run because of exhaustion of hydrocarbon reserves, it is reasonable to assume that the interior will be facing much more difficult times in the future if no actions are taken.

High fuel prices also render the electricity in the interior rather expensive. Regardless of this, the villagers receive the electricity free of charge, which also puts stress and strain on the Government budget.
4.5.3. Reliability

Though an earlier study has indicated that operational and maintenance practices are up to standard (KEMA 2008b), reality suggests otherwise, as evidenced by premature failures in the generation, transmission and distribution part of the infrastructure. These failures are the result of (Moore 2004):

- improper and / or outdated practices;
- reactive / corrective maintenance philosophy;
- insufficient funds to execute preventive or predictive (proactive) maintenance, and;
- management acceptance of deviation from standards.

These outcomes have resulted in electricity frequency and voltage fluctuations, (planned and unplanned) blackouts, financial losses due to claims from customers, and lost / broken equipment.
A couple of times the reliability of the delivery of LPG and transportation fuels has also been compromised, due to late payments, cargo handling difficulties etc.

4.6. Comparisons with Other Developing Countries

Many developing countries have conventional and / or unconventional energy reserves which are largely untapped, and are therefore dependent on the import of fuels for both the transportation and power sector (Apergis and Payne 2008). For a time hydro power was hailed as the savior for the energy needs of developing countries, but as the disadvantages of this form of power generation have only recently started to become apparent, it has become difficult to obtain sufficient funds for capital intensive hydro power projects from institutional lenders. Many hydro power plans have therefore been stalled or scrapped (Yüksel 2009).

Relying on energy imports usually results in situations in developing countries where power generation and distribution is badly developed and hence often very inefficient, resulting in too high costs. However, contrary to Now Developed Countries (NDCs) where power sector reform is aimed at attaining higher efficiencies, reform in developing countries serves a different purpose which stems forth from the significantly different environment in developing countries (Nagayama 2008):

1. Significant additional investments are required to keep track with the increase in energy demand due to economic development. These investments are necessary for sustainable economic growth, in particular in the case of developing countries since these adhere to the so-called growth hypothesis, which states that energy consumption plays an important role in economic growth;
2. Government incentives are necessary in rural areas to guarantee profit in order to attract investments;
3. Governments tend to provide a relative large amount of subsidies for large low-income groups in order to keep basic goods and services within reach.

Therefore, power sector reform in developing countries should focus on (Nagayama 2008):
1. Attracting private investors;
2. Adjusting power prices in such a way that they reflect the true cost of generation and distribution, and;
3. reducing poverty.

Since developing countries tend to keep prices low through the use of subsidies (often driven by political motives), in order to keep electricity and fuels within reach of the financially weak, many state-owned utility companies have a poor financial performance (Nagayama 2008). This not only induces inefficiencies, but also results in a backlog in keeping track of increases in demand. This is the beginning of a downward spiraling trend, since inefficiencies tend to get worse which in turn drives prices upward. This causes the Government again to keep prices artificially low, which further worsens the utility company’s financial position. In the end, the consumer senses this through a decreasing energy security, in other words, not only increasing prices (which are then kept low by the Government), but also by inadequate capacity and unreliable supply.

Inadequate capacities lead to rationing, which is usually done in a random way; this is contrary to so-called efficient rationing, and, coupled with low reliability, causes high social costs, in other words loss of materials, production and leisure (de Nooij, Lieshout and Koopmans 2008).

Furthermore, developing countries often have to deal with the so-called “Resource Curse” which not only hampers economic development, but also hinders proper Governmental action, since it induces corruption, decreases democracy and transparency, and does not promote liberalization and privatization which tend to diminish control of vested interests (Lachman 2009). This can also be remarked in the power sector in these countries, because (Nagayama 2008):

- high prices do not automatically give an impetus to power sector reform;
- implementation of liberalization models not automatically lower electricity prices, and;
- certain liberalization models usher corruption.
A lot of the aspects mentioned above are also applicable to the situation of Suriname, in particular the large amount of subsidies given to keep energy within reach of a large group of low-income people, often mandated from a political perspective (KEMA 2008a). Fortunately, Suriname has profited from significant advantages the last couple of years such as high commodity prices and higher than usual power generation at the hydro plant due to higher than average river discharge into the lake, which enabled the Government to keep energy security fairly stable.
5. Constructing Energy Scenarios for Suriname to 2050

5.1. Data Collection

Data has been obtained from literature, news articles and interviews. Literature and (news) articles provide a lot of useful information regarding effects on (Suriname’s) energy security for the coming decades. Nevertheless, personal interviews taken from people (knowledgeable about aspects regarding Suriname’s energy security) are able to give deeper insight into informal, largely unknown, subtle or increasingly important becoming forces specific to the Surinamese context that shape energy security.

The readings span:
- local, regional and foreign newspaper articles (e.g. De Ware Tijd, New York Times, Wall Street Journal);
- articles in popular magazines and scientific journals (e.g. Kijk, Bulletin of Science, Technology and Society, Energy Economics, Energy Policy, National Institute Economic Review;
- reports on diverse energy subjects (e.g. Hirsch, Bezdek and Wendling 2005, Sims, Schock, Adegbululgbe e.a. 2007, Energy Information Administration 2008, REN21 2008, Food and Agriculture Organization of the United Nations 2008);
- articles from websites dedicated to energy related topics (PhysOrg.com, kennislink.nl, kijk.nl, Energy Daily, Organization & Environment);

A little over 500 articles, 15 energy scenario exercises, 13 reports, 15 books and 1 film documentary were reviewed. The topics spanned a wide spectrum and included, among others, rural electrification, alternative and conventional energy, climate change, geopolitics, the future of transport, social impact of energy and energy efficiency.
Though only 4 of the originally intended people were not interviewed due to non-response, 18 persons were available for an interview. Using the so-called snowball sampling method another 4 persons were interviewed. The respondents are active in Non-Governmental Organizations, the Government, and the energy, business, educational and service sector. Their respective backgrounds are provided in Appendix H.

The interviews were conducted between 16 September and 4 December 2009. The amount of interviews was sufficient because during the last couple of interviews no significant additional information was obtained, which implied that the so-called saturation point was obtained (Strauss and Corbin 1998). A summary of the responses is given in Appendix I.

The qualitative nature of this research implied that the interviews were not rigidly structured; however the main questions conceiving the main structure of the interview were:

1. **Which aspects (within the Government, within Suriname, and within the global context) do you deem crucial with regard to their impact on Suriname’s energy security (availability, affordability, reliability) to 2050?**

2. **Which aspects that have a significant impact on Suriname’s energy security to 2050 would you classify under the category of so-called “Predetermined Elements”, i.e. aspects with a relative certainty regarding their future developments?**

3. **Which aspects that have a significant impact on Suriname’s energy security to 2050 would you classify under the category of so-called “Critical Uncertainties”, i.e. aspects which are very uncertain with regard to their future evolution or timing thereof?**

4. **Could you give a description of how a positive yet plausible scenario regarding Suriname’s energy security in 2050 would look like, and could you describe the important events that have led to that scenario?**
5. Could you give a description of how a negative yet plausible scenario regarding Suriname’s energy security in 2050 would look like, and could you describe the important events that have led to that scenario?

6. Could you indicate which so-called “Early Warning Signals” might help us in assessing towards which energy scenario Suriname is heading?

7. If today you were being charged with taking decisions regarding energy security, which decisions you would take within the coming months or years that could / will have a long-term impact on energy security

5.2. Predetermined Elements

From the sources mentioned in 5.1, predetermined elements (in other words, those aspects that are expected to affect energy security in Suriname to 2050 and that can be assumed to have a more or less predictable development until the horizon year), that were deemed relevant for this research, were found and categorized under social, technological, economic, environmental and political driving factors. These predetermined elements are listed below, and where predetermined elements are specific for Suriname, this is explicitly mentioned.

Social

1. Since prices for essential goods and services (in particular food and water) will increase within the next decades (see Economical, item 6), more frequent and more intense conflicts can be expected;

2. People will globally migrate to cities. In the case of Suriname, people will move from the interior to the coastal zone, in particular to the capital Paramaribo. Migration to cities means that more people will have to compete for the resources that these cities offer (housing, job opportunities etc.) which will increase chances of conflict;
3. The increase of the population, with developing countries as the greatest contributors, will continue for the coming decades, thereby increasing the demand for energy;

4. Ongoing globalization will increase the interconnectedness and interdependence of entities. This implies that the Government will be able to use direct and more personal forms of communication (through ICT) to approach the population and will therefore be more capable to foster behavioral change, for instance in the field of energy efficiency through the creation of awareness;

5. The so-called “Millennial Generation” will be heavily characterized by the integration of Information and Communication Technology (ICT) in all aspects of their life, which enables new ways of direct communication. Because of this, the Millennial Generation will be able to circumvent conventional power structures and therefore more likely to articulate their different values and fundamentally distinct needs;

**Technological**

6. Energy efficiency will be available now at no or very low cost, because of the fact that technologies already exist to significantly reduce energy consumption and greenhouse gas (GHG) emissions, and improve energy conversion efficiencies. However, increases in energy efficiency will not outpace the increasing demand for energy;

7. Energy efficiency will increasingly become a major factor in determining the viability of systems;

8. Energy obtained from alternative sources such as wind, solar, tidal, nuclear, and geothermal power and biomass, will increasingly take a greater share in the delivery of heat and work to consumers (this is the result of advancements in technology and an economic viability due to high prices for conventional fuels). A situation where energy supply is provided from various sources is also known as the portfolio approach or energy diversity;
9. In the search for improvements in energy efficiency, the economic viable application of alternative energy sources and decentralizing energy supply, more use will be made of (a combination of) other technological field, such as ICT, biotechnology and nanotechnology. This phenomenon where different technologies are bundled to obtain desired results is also known as convergence technology;

10. Energy supply will steadily be decentralized in order to mitigate impacts as a result of climate change, and reduce transmission and distribution losses. Decentralization will be a necessity in locations where connection to the grid will be too expensive (e.g. rural areas or small villages in the interior), and therefore self-electrification is a must. Convergence technology (see item 8 above) and research into alternative energy sources (see item 9 above) will lead to advancements in self-electrification, bring affordable heat and power to these remote areas;

11. Clean energy technologies will gain ground due to increasing climate change (see Environmental item 18.), but will not be a magic solution. This fact, combined with the fact that it will take years to decades to economically introduce on a large scale alternative fuels or energy conversion devices (such as oil from algae, cheap photovoltaic solar power, bioelectricity and fuel cells), and introduce on a large scale promising energy efficiencies through the use of so-called “smart grids”, while demand for energy keeps increasing, implies that the world will be highly dependent on fossil fuels for the coming decades;

12. The so-called Holy Grail with regard to alternative energy sources will be the economic viability of photovoltaic solar energy. Currently, high construction costs and low efficiency render solar panels often unfavorable among consumers. Fortunately, the abundance of solar energy reaching the Earth’s surface and steady advancements in technology, still have people believe that this form of solar power is the ultimate sustainable form of energy supply;
13. Through the introduction of hybrid vehicles, plug-in hybrid vehicles and pure electric vehicles, a further electrification of non-mass transportation can be expected in the near future;

**Economic**

14. Because of declining conventional oil reserves and the exploitation and marketing of unconventional oil (such as oil from tar sands and shale rock), prices for hydrocarbons will rise. Since these minerals play an important role in the generation of electricity and heat, the production of pharmaceuticals, plastics, food and water, and fueling the transport sector, people will have to spend a significant larger portion of their income on essential goods and services;

15. The majority of the developing countries will experience an increase of their Domestic Gross Product (GDP) within the next decades, with China and India as the frontrunners, which will increase the energy intensity, in other words, the amount of energy consumed per person per year;

16. Currently, approximately 75% of all known oil reserves are in the hands of National Oil Companies (NOCs), and it can be expected that due to increasing scarcity coupled with rising prices, nationalization of hydrocarbon reserves (and other fuels for heat and work production, such as uranium) will display an upward trend;

17. For the coming decades, China will increase its investments in energy sectors in Latin-America, since this region has abundant alternative energy reserves;

**Environmental**

18. Climate change will propagate and result in more frequent and longer durations of extreme weather events, and deviations from regular short- and long-term climate / weather cycles;

19. There is a clear warming trend for the Amazonian region;
20. Due to population growth and rising standards of living in developing countries, the emission of greenhouse gases will increase for the coming years. Population growth and the increase of living standards will outpace the rate at which measures will be implemented to decrease greenhouse gas emissions. However, it is expected that the emission increase will flatten courtesy of improvements in energy efficiency, the introduction of alternative energy (in particular in the transport sector) and the peaking of world oil production (which means the end of the availability of cheap oil);

21. Within the next decades the production of conventional oil (also indicated as “cheap oil”) will “peak” (production will start declining after having reached a maximum), or at least it will become apparent that oil production has peaked in the recent past, as evidences by declining oil production volumes;

22. Even though conventional oil production will peak, there will be sufficient unconventional (but more expensive) oil reserves, in the form of Canadian and Venezuelan tar sands (the Canadian deposits have the equivalent of 250 billion barrels of oil), United States coal reserves (from which 800 billion barrels of oil can be obtained), shale oil, etc.;

23. On a global scale, the increase in energy production capacity of alternative sources will slowly decline, due to site requirements (e.g. land requirements for concentrated solar power, climate conditions for bio-fuel crops, geomorphology for hydropower etc.);

24. Though nuclear energy will be favored by many nations for the next decades, this form of energy will not be a long-term sustainable solution for the production of heat and work on a global scale, due to depletion of traditional fissionable materials. With the current nuclear capacity (therefore not taking into account that India plans to increase its capacity with 12,000%, more developing countries are opting for nuclear fuels and NDCs are increasing the share of nuclear power in their energy mix), known reserves of uranium will be depleted in 120 years. The
nuclear age (based on nuclear fission) can be extended with other fissionable materials, but these are unfortunately not as abundant as uranium;

**Political**

25. NDCs will place more importance on using alternative energy sources, reducing the impact of conventional energy sources and increasing energy efficiency. The most important recent example of this is the United States Obama-Biden Energy Act, which is expected to have its following through the rest of the developed world.

5.3. Critical Uncertainties

From the sources mentioned in 5.1, critical uncertainties (in other words, those aspects that are expected to affect energy security in Suriname to 2050 and that are unclear with regard to their future developments), that were deemed relevant for this research, were found and categorized under social, technological, economic, environmental and political driving factors. These critical uncertainties are listed below, and where critical uncertainties are specific for Suriname, this is explicitly mentioned.

**Social**

1. Perception of alternative energy by consumers (as is for instance strongly the case with nuclear energy);

2. It is unclear if the relatively young Surinamese population growing up in an increasingly globalizing world will clash with traditional political parties and the Government, because of their distinct needs and different values (see 5.2, Social item 5);

**Technological**

3. It is uncertain when technological breakthroughs on particular fields will occur;

**Economical**

4. Due to the small nature of the Surinamese population and economy, any entrance or exit of a large energy consumer / producer will have a significant impact on
energy security. Though Suriname has abundant natural resources, a small consumer base, unclear / unfavorable Government investment policy, inadequate facilities, and insufficient qualitative human resources, make it difficult to determine if / when investments will be done that will effect energy security (either by impacting the energy supply or demand side);

5. There is uncertainty regarding the global economy (and even more particularly fuel supply security), due to possibilities of conflict, that are the result of unpredictable social and political behavior. This also counts for the Surinamese economy (and fuel supply security) which might be put into turmoil because of domestic conflict;

6. Oil price behavior;

7. Suriname’s population consumption patterns;

Environmental

8. It is currently unknown to what extent the climate will continue to change, in particular with regard to the north-eastern Amazonian region, and the subsequent impacts it will have on ambient temperatures (and therefore energy demand) and on alternative energy sources, such as wind and hydro power (respectively due to a change in wind and precipitation patterns), and bio-fuel crop yield. Furthermore, in the case of Suriname a sea level rise will be extremely harmful since the majority of the people live in the coastal zone. Some estimates indicate that in the case of Suriname the sea level will rise an approximate 1 meter (Naipal 2009). This has been acknowledged for some time, and therefore there are advocates for building a new city in the South. This will however require a geographical shift in energy supply;

9. It is unclear at which moment global conventional oil production will peak;

10. It is unclear if any significant natural resource reserves, in particular hydrocarbons, will be found and deemed economical for exploitation.
11. It is unclear when natural resources in Suriname, in particular hydrocarbon reserves, will be depleted;

12. It is unclear what the developments regarding deforestation in Suriname will look like, due to insufficient resources and willingness on behalf of the Government to effectively monitor and control the relatively large forest area, combined with the fact that deforestation takes place by not only companies, but also by maroons and indigenous people in the interior and illegal miners. Furthermore, it is unclear what the short- and long-term effects of this deforestation (with the accompanied environmental pollution) will be on the domestic environment;

**Political**

13. The quality of the Government, in other words the amount of pro-activeness, transparency, corruption, planning, strategizing, foreign influences, lack of capacity etc.;

14. It is unclear when the Government will put efforts in place to transform the education system from an exponent of Western standards to an entity that can give deliverables in response to the local environment;

15. It is unclear if Governments around the world (especially of large greenhouse gas producing countries) have the willingness to address and solve the climate change problem, and place this as a priority over economic gains. In other words, the question is if Governments will subject short-term monetary gains to long-term public interest, and pass this way of thinking on to the people in order to establish behavioral change;

16. Relationship with neighboring countries;
5.4. Ranking Critical Uncertainties

Using the sources mentioned in 5.1, the in 5.3 described critical uncertainties have been ranked according their level of uncertainty and impact (both obtained from the interviews and literature) on Suriname’s energy security to 2050. Both uncertainty and impact are depicted by a four-point scale: very low, low, high and very high. An even number has been chosen to create the scales to avoid the tendency to be conservative and choose the middle value too often when ranking. Table 5.1 displays the ranking of the critical uncertainties, whereby the numbers refer to the critical uncertainties in 5.3.

<table>
<thead>
<tr>
<th>Critical Uncertainty</th>
<th>Impact</th>
<th>Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Perception of alternative energy</td>
<td>Very Low</td>
<td>Very Low</td>
</tr>
<tr>
<td>2 - Acceptance of traditional politics by new generation</td>
<td>Very Low</td>
<td>Very Low</td>
</tr>
<tr>
<td>3 – Technological breakthroughs</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>4 – Entrance / exit of large energy consumers</td>
<td>Very High</td>
<td>Low</td>
</tr>
<tr>
<td>5 – Oil price behavior</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>6 – Consumption patterns</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>7 – Global economy</td>
<td>High</td>
<td>Very Low</td>
</tr>
<tr>
<td>8 – Climate change</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>9 – Peak Oil timing</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>10 – Discovery of natural resources</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>11 – Depletion of natural resources</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>12 – Effects of deforestation</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>13 – Government quality</td>
<td>Very High</td>
<td>Very High</td>
</tr>
<tr>
<td>14 – Willingness to transform the educational system</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>15 – Global willingness to solve climate change issue</td>
<td>High</td>
<td>Very Low</td>
</tr>
<tr>
<td>16 – Relationship with neighboring countries</td>
<td>Very Low</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

*Table 5.1: Ranking of critical uncertainties*

5.5. The Scenario Logic

Figure 5.1 displays the same information as in table 5.1, but in a clearer overview. As can be seen from this figure, Government quality (13, in light green) is the Driving Force with both the highest uncertainty and impact. However, this will not be chosen for use in the scenario logic. The reason for this lies in the fact that the ultimate goal of the scenarios will be to formulate resilient and robust strategies, and subsequent policies and actions will mostly fall under the responsibility of the Government.
Using Government quality in the scenario logic will therefore result in normative scenarios, which will describe future Governmental action which the Government will try to achieve or steer away from. However, since the Government is heavily politicized in Suriname (which is widely known), such scenarios would be far less effective and challenging than scenarios built upon phenomena more or less out of the direct influence by the Government, even considering the fact that the Government has direct or indirect influence on other critical uncertainties (marked by dark green boxes in figure 5.1).

Therefore, the critical uncertainties that will be used to construct the scenario logic are depicted in figure 5.1 in the red boxes (numbers 4 and 8), namely the entrance / exit of large energy consumers and the impacts of climate change. With regard to the entrance / exit of large energy consumers, this critical uncertainty has close ties with the critical uncertainties that deal with the period in which important natural resources in Suriname will be depleted (number 11) and if new large hydrocarbon reserves will be discovered (number 10), since depletion of natural resources will halt energy intensive exploitation and new hydrocarbon reserves will boost the energy intensive oil industry. Both are depicted in figure 5.1 in blue boxes.
With regard to the impact of climate change, this critical uncertainty has parallels with the critical uncertainty that deals with the effects of domestic deforestation (number 12 in the purple box), and therefore both will be handled as one critical uncertainty (named ‘impacts by environmental degradation’).

Using these two critical uncertainties (in red boxes), combined with the less critical uncertainties (in blue and purple boxes), a significant portion of the most uncertain and high impact corner of the graph depicted in figure 5.1 is covered. Furthermore, these critical uncertainties convey both internal (domestic) and external (foreign) factors; hence, the scenarios derived with these critical uncertainties can therefore be regarded to be systemic in nature (see also section 5).

The critical uncertainties will be used as described earlier in section 5 as the dimensions of the scenario logic. This scenario logic is depicted in figure 5.2.

![Diagram of scenario logic]

*Figure 5.2: The Scenario Logic for Suriname’s energy security to 2050*
5.6. Energy Scenarios for Suriname to 2050

Based on the scenario logic displayed in figure 5.2 and using the predetermined elements, the scenarios will be fleshed out. The predetermined elements (which are expected to have the same developments in all four scenarios) will be used for this process. As explained in section 5, the scenarios are provided as narratives and the events and situations therein are challenging, but not impossible, in order to stimulate the essence and impacts of the uncertain driving forces.

The influence of the Government will be left out as much as possible, since the scenarios would otherwise have a normative tenure by including this critical uncertainty. Hence, the sole focus will be the (effects of) the critical uncertainties on energy uncertainty, intertwined with predetermined elements.

In order to captivate the essence of each of the narratives, each of the scenarios is named after one of the Greek mythological characters, whose respective myths hold parallels with these scenarios.

5.6.1. Scenario I: Prometheus’ Eagle

In the first half of the 21st century, Suriname’s most important natural resources, namely gold, oil and bauxite, were completely mined. The mining sector was a major source of income for the country, causing a significant inflow of funds for the Government, creating countless jobs, and increasing all sorts of standards on the field of environmental practices, engineering, safety, etc.

Unfortunately, with the depletion of these commodities, the multinational corporations (MNCs) lost their interest in Suriname and left the country, after having their obsolete assets sold to the Government for a symbolic value. The state-owned Staatsolie Maatschappij Suriname N.V., the nation’s oil pride, did not give up and was still in the search of that hidden jackpot under the ground. Their refinery with a capacity of 50,000 barrels a day (the result of expansion after expansion) was now fed with petroleum
products from Venezuela and Brazil. However, since the world had shifted towards renewable energies, in particular the transportation sector which was electrifying at an increasingly fast rate (with vehicles driven by hydrogen fuel cells primarily used in some niche sectors, like for instance fork lifting trucks), demand for refinery products showed a steady decline. Some were saying that Staatsolie’s days were over and would share the fate of countless other state-owned companies in Suriname that went bankrupt around the turn of the century.

More dramatically, climate change made things worse; even in its first decades into the 21st century, the world was unable to stop their fossil fuel addiction, primarily caused by vested interests of oil, car and steel producers, and the inability of Governments to push renewable technologies forward. This caused a significant output of greenhouse gases (GHG) into the atmosphere, which caused extremes in weather conditions which even most climate models could not predict. One prediction was right however: developing countries would be struck the hardest by the effects of climate change. Suriname was one of these countries and experienced both long periods of drought with high temperatures, and periods with rainfalls which caused floods in the interior (in particular since the ongoing deforestation diminished the rainforest’s water absorption capability), even in the coastal zone area. Even worse, everyone could clearly notice that the weather was each year becoming more extreme.

Since a lot of jobs were lost, combined with the floods in the interior, most people in the interior tried to find their luck in the coastal zone, which was also severely havocked by the sea level rise that annually causes millions of dollars of losses. However, since jobs (because of the departure of MNCs) were scarce in the evermore crowded becoming Great-Paramaribo, crime, corruption within the Government, migration (to primarily Europe and the United States) soared.

Fortunately, the exit strategy of the MNCs had one positive, but frail, effect: the exit unlocked significant energy capacity for the people and small and medium businesses. But the Government was unable to maintain the level of reliability (due to financial
setbacks resulting from severely diminished economic activity) and the majority of the population was unable to pay for the utility services, putting even private suppliers of energy (services) into bankruptcy. Even the supply of the once-trusty Brokopondo Hydro Plant reservoir required significant management efforts due to fast changing precipitation and temperature extremities. And so the health of the utility companies also worsened, though in many eyes it was seen as one of the only companies that guaranteed a job for life. While the electric vehicle was fast becoming the standard, outdated and obsolete power stations and transmission networks forced Surinamese the use of dirty fossil-fueled cars, while prices for fossil fuels soared.

Suriname just could not continue on the development road because it could simply not cope with the returning blows by Mother Nature (who was becoming more devastating). Suriname found itself in the same position as Prometheus, who was tortured by being tied to a rock while an eagle ate his liver. The liver would grow back every night, but every day the eagle would return to torture poor Prometheus by feasting on his new liver.

![Figure 5.3: Prometheus' Eagle](image-url)
5.6.2. Scenario II: Sisyphus’ Labor

After close to 150 years of mining history in Suriname, halfway through the 21\textsuperscript{st} century there is not much left of the once blooming oil, gold and bauxite industry. They not only left huge craters in the earth, but also left hundreds of people without a job (even though the employees with more than 25 years of service received a “golden” handshake), thereby skyrocketing the unemployment rate in Suriname. This had never happened before.

Contrary to the past, where people were dreaming of a job at Suralco, Surgold and Staatsolie Offshore Oil Suriname (some feasible amount of hydrocarbon reserves were found in the offshore region), people were now expanding into the services sector, in particular the tourism sector, which made the interior a booming market.

There are three reasons for this. First, for decades on end Paramaribo kept growing without adequately anticipating infrastructural and social needs. Hence, Paramaribo and its surroundings were completely packed with buildings but little space was left for infrastructure. Thus, there were a lot of traffic jams (one student calculated that these jams cost the economy a whopping US $ 250 million on an annual basis) and there was still insufficient housing. A lot of people were therefore moving to the interior, to villages like Atjoni, Brokopondo, Nieuw-Koffiekamp and Apoera, which were therefore rapidly expanding. Two famous scientists even claimed that within a couple of years the etiquette “village” would be inappropriate. In the beginning of the 21\textsuperscript{st} century this was deemed as impossible due to the threat of climate change, but the effects on the north-eastern Amazone region proved to be marginal at best.

Second, job opportunities in the coastal zone were scarce. One notable exception were the opportunities in the medical sector, where there was an insatiable need for doctors, nurses and surgeons since the frequency and severity of infections kept on increasing (some blamed this to Paramaribo being packed with too much people without adequate water supplying and sewage systems). In the interior the number of infections were much lower (even malaria and yellow fever showed a decline), and, more importantly, the
villages offered a lot of opportunities in the services sector (tourism, commerce, health care etc.).

Third, though the departure of the MNCs resulted in a lot of unemployment, the positive note was that a lot of energy was unlocked for such a small population, namely approximately 350 MW. The majority of the energy was reserved for the villages in the interior, which had to cope without energy for decades on end, even though the energy was sometimes generated right next door! The main motive for this (besides, of course, political reasons) was the belief that electrifying the interior would give the tourism sector a serious boost. Suriname wanted to make the switch from modest accommodations with unreliable energy (supply), to the high-end accommodations as demonstrated by the Berg en Dal resort. Some efforts to this end were done by initiating a lot of renewable energy projects, tapping into wind, solar and hydro power (research was even being conducted into tidal, wave and geothermal power), but this 300+ MW meant big business, in particular since the tourism sector could easily compete with other countries which were often relying on expensive fuel cells due to a lack of decentralized renewable energy resources.

So the point of gravity of the economy slowly shifted from the coastal zone to the interior (though the coastal zone remained important for in- and outflow of goods). However, many were feeling that Suriname should bring back the old days and use the cheap and renewable electricity for its own manufacturing industry, rather than simply exporting it to the French (who were planning their second nuclear plant in French-Guyana anyway).

Thus, arrows were pointed at further development of the interior without damaging the rainforest too much (luckily the Government and the population saw the destructive effects of deforestation on their own habitat, and therefore these practices were quickly abandoned), and at erecting new industries and electrifying the interior with the input of cheap renewable energy (which was abundant in the interior). Suriname was in the position of Sisyphus, who was sentenced to push a boulder to the top of a mountain with his bare hands. Just like him, Suriname had to do some serious work.
5.6.3. Scenario III: Ixion’s Wheel

The first quarter of the 21st century started very exiting, with the evident structural increase of prices for natural commodities, such as gold, oil and bauxite. Gold, oil and bauxite were the so-called “good” commodities, since demand seemed to be steadily increasing. Gold had become the safe haven for investors. Oil remained its importance even though the world was slowly but surely shifting to other means of energy supply, due to the fact that refined hydrocarbon products were still important for lubricants, all sorts of medicines, and the fabrication of plastics. After years of doubt regarding the willingness of multinationals to continue their operations in the Surinamese bauxite industry, companies all over the world were trying to get hold of shares in the bauxite refining, alumina smelting and aluminum processing industries in Suriname, since prices for aluminum were skyrocketing. This was the result of various energy efficiency measures in numerous countries, which drove manufacturers to use the much lighter and durable aluminum in the construction and automotive sector.

Suriname was therefore receiving significant income from these industries and was able to facilitate new industries (mainly in service and manufacturing). There was however
one major problem. Due to the small scale of the economy, the energy requirement of new industries (most notably the energy intensive mining industry) accounted for a significant percentage of the total Suriname energy consumption. The investors had a particular interest in the energy supply from renewable sources, since these had become cheaper than energy from fossil fuels or fuel cells (Suriname barely had the infrastructure in place for the latter). Cheap renewable energy implied that the investor could compete with producers using more expensive or more polluting energy (in the case of polluting energy, they also had to cough up “Environmental Repair Tax”).

Multiple times Suriname was faced with a dilemma: choosing for a secure energy supply (and thus casting the investor away), or inviting the investor (and sacrificing energy supply for the population). Hungry for jobs (and a few notable exceptions aside), the investor was often given preference. There was therefore a real competition for energy between investors and the population. Even without investors, utility companies (often with the help of the Government) could barely keep up with the growing energy demand. This increase was caused by an increase in population (a lot of people from the Netherlands migrated back to Suriname), rising living standards, an increasing tourism sector, the rapidly growing small and medium businesses that delivered goods and services for the multinationals, and electrification of transportation.

Therefore, with the arrival of investors (who were offered a share of the existing energy available), it was mandatory to build new energy production facilities needed in order to secure energy supply for the population and small and medium enterprises. However, building new energy enterprises had a longer lead time than before. The first reason for this is that all proposed projects were required to be screened in order to determine if they were “climate proof”, which took considerable time (often data covering a year or more needed to be collected). Second, renewable sources were the primary choice for energy supply (Suriname was deemed too small for the implementation of a hydrogen infrastructure, and prices for nuclear and fossil fuels were continuously increasing) but renewable energy projects required significant inputs (time, money and manpower) since most renewable sources were located in the interior at large distance from population.
centers. It is important to note here, that most Foreign Direct Investment (FDI) was allocated for the mining and tourism sector, leaving the energy sector primarily in domestic hands.

Because of these long lead times, the increasing costs to have projects realized and the growing demand (which was frequently underestimated by policymakers), the supply for energy structurally lagged behind demand by the population. Furthermore, because the energy sector was shifting their funds from operations and maintenance expenditures to capital projects (e.g. building new power plants), due to the fact that the latter guaranteed more revenue for the same amount of money invested, the end result was a situation where energy supply was unreliable, leaving large parts of Suriname frequent in the dark.

Suriname and its struggle for energy supply could therefore be compared with Ixion who was continuously tortured while tied to his Wheel.

Figure 5.5: Ixion’s Wheel
5.6.4. Scenario IV: Tantalus’ Torment

Energy security in Suriname has been declining at an alarming rate; energy reliability, availability and affordability are in serious peril. On top of that, all scenarios and scientific models show that things are not getting better any time soon.

The first reason for this is the result of the increasing global interest in commodities, such as gold, oil and aluminum. Suriname is gifted generously with these so-called “good” commodities and has received significant investments, worth billions of dollars, building both upstream and downstream gold, oil and bauxite/aluminum industries. This increase in investment automatically lets the investors compete with the population for cheap and renewable energy resources. The era where a couple of generators running on “dirt” hydrocarbons are long over (not only are fossil fuels very expensive, but their use obliges the consumer to pay external cost taxes, which can harm the financial feasibility of investment plans), and renewable energies are therefore the prime choice for large investors. Since Suriname needed these investments badly, they opted to grant the MNCs a guaranteed supply of energy.

The first reason (increase in peak investments in energy intensive industries) caused a search for (renewable) fuels for the population. However, the transportation sector was electrifying at a faster rate than previously imagined (spurred by developed countries), population was growing and its energy intensity was also increasing. Therefore, not only did the supply of energy need to supplement the losses incurred by the energy grants given to investors, it also needed to keep up with the growth in demand.

Unfortunately, a lot of projects (primarily hydro power projects) once deemed feasible in the past, were now scrapped from wish lists. The cause of this were the extremities in weather patterns which completely changed environmental cycles, caused long periods of severe drought and flooded large areas in the interior. This not only made the management of electricity production (from renewable sources like bio-fuels, and hydro and wind power) extremely difficult and thus expensive, but the very construction of power plants became too expensive due to all sorts of affiliated risks concerning
environmental damage. The change in environmental behavior was apparently caused by global CO$_2$ emissions and domestic deforestation.

The only reliable sources of energy that were “climate-proof” (because of their geomorphologic characteristics) were primarily reserved for energy intensive industries. This implies that the coastal zone lacked in energy availability and reliability. This deficit was further enhanced by:

- Environmental damage to infrastructure (transmission and distribution lines) due to increasing wind storms during the El Nino or La Nina periods;
- The fact that the Government could not reserve adequate amounts of funds for the utility sector, since almost all resources were allocated fighting the adverse effects of the sea level rise which threatened the entire coastal zone;
- The migration of villagers in the interior to the coastal zone, since they sought a home away from the floods in the interior.

Availability and reliability were severely jeopardized, but this also counted for affordability. The reason for this lies in the fact the utilities tried to meet demand by operating their age-old fossil fuel driving (turbo-) generators, running on expensive hydrocarbon fuels.

An increasing competition in the coastal zone for housing and job opportunities formed the basis for corruption, crime and social unrest. Combined with a severely damaged energy security, which led to numerous bankruptcies among small and medium enterprises, it became for many apparent that Suriname was spiraling down at an increasing rate. This was evident by the drop in ranking on various indexes, like the Transparency, Human Development, Happy, Moody’s and Standard & Poor’s Index. The dream of a Swit’ Sranan seemed like something from the past, and many were declaring Suriname a failed state. Many Surinamese abroad were not thinking anymore about returning to their once beloved tropical paradise. Rather, the country experienced almost an exodus of people, who were tired of the natural disasters, low energy security and the loss of property due to sea level rise.
Suriname, which used to be a relatively unknown piece of paradise, became a piece of land that could not overcome problems associated with climate change and insufficient energy, just like Tantalus who could not reach the water below or the grapes above.

*Figure 5.6: Tantalus’ Torment*
**Part III: Constructing an Energy Strategy for Suriname**

The scenarios constructed in the previous section will be used (together with the current situation in the Surinamese energy sector) as the background against which a robust strategy will be formulated. First, strategies will be formulated that are optimal for each scenario. The focus here will be on:

1. Policy in general;
2. Institutionalizing the energy sector;
3. Legislation;
4. Energy efficiency;
5. Power sector reform;
6. Investments in generation, transmission and distribution;
7. Tariffs and subsidies;
8. Rural energy supply;
9. Other sectoral policies.

Second, in cases where settings for strategy elements vary among scenarios, the optimal setting for these strategy elements will be formulated in each scenario. The most resilient option for each strategy element will then be identified, which can be used in all scenarios.
6. Energy Strategy for Suriname to 2050

6.1. General Guidelines in Formulating Policy

The following points provide the general guidelines for the development of an energy policy. These points focus on form, rather than content (which will be discussed hereafter), but are nonetheless important to safeguard policy quality:

- One of the main objectives of the energy policy is to construct, improve and safeguard a sustainable energy security by increasing production of renewable energy and decrease energy usage (Lysen 1996);

- It should be embedded in the energy policy that guaranteeing energy security is a basic political function (Scheer 2005);

- Policy formulation must be informed and guided by public participation;

- The energy policy should clearly define the resources and timeframe that will be used to achieve properly defined objectives (Bisk 2009);

- The policy goals need to be defined in a SMART manner (Global Business Network 2007);

- Policy makers must be aware that no single energy policy instrument will ensure the desired transition to a desired future energy security (Sims, Schock, Adegbulugbe, e.a. 2007) and therefore policy makers must overcome the temptation to prescribe and mandate any one particular solution, in particular since the environment is so dynamic (Sperling and Gordon 2009);

- The energy policy must aim to achieve a sound balance between the fast implementation of measures, which might lead to social objections, and long implementation lead times, which might decline the importance of energy security in the perception of the public (Stevens 2009);

- Seek affiliation with other policy makers (KEMA 2008d);

- The process of conceiving the energy policy can be sped up significantly by adopting a standard energy policy template (Piebalgs 2009), which might be
slightly altered due to the special characteristics in the Surinamese energy sector (for instance the difference between energy supply in the coastal zone and the hinterland);

- The policies need to balance social, environmental and environmental effects (Sims, Schock, Adegbululgbe, e.a. 2007);

- The path towards a sustainable energy future is not static, the energy policy needs therefore be reviewed continuously and adjusted where necessary, with revised forecasts, new scenarios, reassessments of progress, identification of new problems and the development of new technical solutions and technologies (OECD/IEA 2008);

- The energy policy must inhibit coherence (OECD/IEA 2009) and must be well formulated, consistent, and be formulated in such a way that the policies are not piecemeal and can be sustained (Sawin 2004).

6.2. Legislation for the Energy Sector

Since the energy sector has many actors involved and shares common ground with other policies, it is of the utmost importance to properly define the roles and responsibilities of all actors, and to clearly describe processes and affiliated procedures. Efforts to create a regulatory framework to support power sector development were proposed in the Masterplan 2000 but never realized (KEMA 2008b). A well formulated legislation for the energy sector is thus imminent, in particular for Suriname where the largest power producer is a private (foreign) company. A clear distinction must be made between energy service supply in the coastal area and the hinterland, and policy making and execution must be made the responsibility of a single autonomous entity (more on this in section 6.3) which hierarchically stands above all other actors involved.

Therefore, legislation needs to be formulated, embedded with the following items:

- Properly define roles and responsibilities of actors within the energy sector;

- Properly define processes and procedures for the energy sector;
- The roles, responsibilities, processes and procedures must provide a stable framework for decision making (OECD/IEA 2009);

- Formulating legislation should take into account future regional harmonization of electricity legislation, regulation, licensing, incentives and administrative procedures (Girvan 2007);

- Clarify licensing and regulatory procedures for small power systems (OECD/IEA 2006);

- Legislation needs to provide clear instruction regarding dispute settlement;

- Legislation needs to be understandable, clear and easy to grasp in order to prevent confusion, misinterpretations and so-called “holes” in the system that leave room for exploitation and gaming, in particular regarding long-term contracts (Aubrecht 2005).

### 6.3. Institutionalizing the Energy Sector

Though the Ministry of Natural Resources is responsible for the energy sector, it is proposed here to have a functioning Energy Institute (this has already been proposed at a number of seminars and in a couple of studies). The reasons for this lie in the fact that:

- Such an institute could operate in a far more autonomous way than a Government department;

- Since the institute would be focused on solely the energy sector, capacity building with regard to energy policy, economy, legislation and technology can be sped up;

- Currently, information regarding the energy sector is scattered. An energy institute could be the centralized location for all information regarding this sector;

- Responsibilities are currently scattered amongst various governmental and private entities (e.g. policy regarding transportation fuels, transportation and electrification are each assigned to different departments).
Such an institute would require an empowered energy director with a good team and sufficient resources (Global Business Network 2007), and its task would primarily convey the following:

**Strategy and Policy Design**

1. Formulate strategies and policies with stakeholder involvement;
2. Adjust strategies and policies where necessary after assessing the development of energy sector parameters and metrics;
3. Test these strategies and policies against various scenarios with the help of stakeholder input;

**Monitoring and Scanning**

1. Improve energy sector parameters and metrics;
2. Identify threats to energy security (Romm 2005).

**Tariffs, Subsidies and Taxes**

1. Advice the Government on tariffs, subsidies and taxes regarding energy related goods and services.

**Legislation**

1. Conceive, maintain and update legislation for the energy sector;
2. Responsible for dispute settlement;
3. Issuing of licenses to importers, wholesalers, retailers and transporters of petroleum and petroleum products (Guyana Energy Agency 2007);
4. Increase capacity to support and strengthen the institution.

**Information Dissemination**

1. Disseminate information regarding formulated energy scenarios, strategies and policies;
2. Involve public participation regarding policy and planning;

3. Publish plans (IEA 2007);

4. Actively promote energy savings and energy efficiency in partnership with NGOs, private sector and utilities (Green Park Consultants GPC Ltd 2007);

5. Promote renewable and clean energy technologies, and encourage local participation in small-scale generation projects;

6. Provide / facilitate training;

7. Facilitate education;

8. Support transfer of technology;


Statistics

1. Maintenance of energy statistics, including relevant social economic data;


Planning and Investment

1. (Facilitate) assessing the energy potential of Suriname;

2. Assessing and advising Government on options (Green Park Consultants GPC Ltd 2007);

3. Execute planning;

4. Draft project plans;

5. Perform Life Cycle Analysis of projects (Lund and Biswas 2008);


Quality Control, Best Practices and Benchmarking

1. Marking and testing of imported gasoline, diesel and kerosene;

2. Administering and monitoring petroleum imports;
3. Place benchmarking targets for actors in the energy sector, with regard to design, operations, maintenance, reliability, efficiency and health, safety and environment (Wagner 2008);

4. Facilitate sharing of best practices;

5. Assess and audit periodically all actors in the energy sector regarding their performance and draft follow-up plans for improvement.

6.4. Energy Conservation and Energy Efficiency

One of the main priorities for any energy strategy should be the focus on energy efficiency (Scheer 2005), since the technology is already available at often low or now cost, and can result in significant savings. However, since it can nevertheless be expected that in particular the middle class will not easily change its ways, a well organized campaign advocating energy efficiency should be deployed. Such a promotion should last sufficient time to ensure respectively awareness, understanding, belief, and finally change. One of the important things is that the Government assumes its leadership position and shows the way regarding measures towards energy conservation and energy efficiency by pioneering the implementation of measures (Ryghaug and Sørensen 2008).

The energy efficiency strategy should convey:

**Behavior**

1. Facilitate the transition to new more efficient systems by providing various incentives (International Energy Agency 2009b);


**Appliances**

1. Adopt the energy efficiency guide by the U.S. Department of Energy (DOE) for appliances, the so-called Energy Star program (Aubrecht 2005);
2. Label energy intensive appliances such as refrigerators, televisions, heating, ventilating and air conditioning equipment (HVAC), etc. (Yungrae 2007), indicating the level of efficiency during operation and stand-by (so-called standby power);

3. Phase out inefficient appliances.

**Lighting**

1. Phase out incandescent bulbs and deploy the use compact fluorescent lamps, so-called CFLs, or the more efficient lighting using Light-Emitting Diodes, LEDs (Wagner 2008);

**Transportation**

1. Since road construction is the least efficient way to spend money in order to achieve energy reduction and employment increase, promote mass transit (Aubrecht 2005), carpooling, smaller cars and biking (Friedman 2008);

2. Charge vehicle owners for the actual use of roads, especially in the downtown of Paramaribo and promote efficient road-use, e.g. through carpooling (Transportation Research Board of the National Academy of Sciences 2006);

3. Phase in high efficiency standards for cars and penalize users of inefficient new-model cars (Fuhs 2009).

**Buildings**

1. Deploy energy efficient construction principles;

2. Phase in the mandated use of energy efficient materials, systems and equipment;

3. Give tax exemptions according to LEED’s (Leadership in Energy and Environmental Design) Green building Rating System (Friedman 2008)
Smart Grids

1. Plan together with actors in utility and ICT sector the implementation of smart grids to provide accurate billing, efficiency promotion, better data for statistics, etc. (Watson 2008).

6.5. Power Sector Reform

Since the 1990s, power sector reform has been a global trend. The reform focuses on, among other things, decoupling of the power generation, transmission and distribution parts in the power supply chain (Nagayama 2008). This has also been proposed for the power sector in Suriname (KEMA 2008a). The main thought behind this is that decoupling combined with the forces of liberalization and privatization would increase competition and thereby reduce prices and improve quality. However, especially in the case of developing countries, rather the opposite has been true: prices skyrocketed and both reliability and availability were becoming unacceptable, leading to random blackouts and cardinal financial losses (Scheer 2005, Beder 2007, Chang 2008, Nagayama 2008, and Castro-Rodriguez, Marín and Siotis 2009).

An in-depth assessment must therefore be undertaken whether reform is actually required, and if this seems to be the case, what type of reform, proven under circumstances comparable with those in Suriname, should be pursuit for implementation. Once there is an agreement on the type of reform, an action plan must be devised for implementation of the new power sector structure.

6.6. Investments in Generation, Transmission and Distribution

The Surinamese energy sector will require significant amounts of investment the coming years to keep up with energy demand. Though there are several low-hanging, high impact fruits regarding energy efficiency and energy conservation, it is however reasonable to assume that demand will by far outstrip the gains from reduced energy consumption. The investment strategy conveys the following:
1. Development of renewable energy projects should have by far a much higher priority than non-renewable and/or environment-unfriendly energy resources (Scheer 2005, Wagner 2009) and prioritize energy technologies according to the energy systems ranking done by Jacobson (2009);

2. Join the International Renewable Energy Agency (IRENA) to improve knowledge, standards, technologies etc. and to look for possible investors;

3. Give high priority to start the (pre-)feasibility study and Environmental and Social Impact Assessment (ESIA) of the development of the following known large energy sources:
   a. Kabalebo-project;
   b. Tapajai-project;
   c. Off-shore wind power (Naipal 2009);
   d. Tidal power (Naipal 2009);
   e. Solar thermal and solar voltaic energy.

4. Feasible projects should be compared to each other based on:
   a. A thorough Life Cycle Analysis of projects (Lund and Biswas 2008);
   b. Thorough assessment of the feasibility of projects in different scenarios (Davis 2003);
   c. Ability of project to adapt to climate change (Magrin, Gay García, Cruz Choque, e.a. 2007);
   d. Environmental impact;
   e. Social acceptance of the project;
   f. Willingness of neighboring countries to partner in the development and exploitation of the project.

5. In case the Tapajai-project is executed, interest investors for the utilization of the unlocked hydro power;
6. Negotiate with investors to co-develop and exploit energy projects, where possible through mergers and acquisitions by local companies (Hira 2007);

7. Use tax holidays, subsidies, loans, grants and other financial incentives to ensure sufficient return on investments from renewable energy projects (Sawin 2004, Vigotti 2007), since these projects:
   a. Take first steps to decentralize the energy supply, since renewable sources are often strongly location-dependent (Scheer 2005);
   b. Diversify fuel supply (KEMA 2008b)

8. Ensure an adequate share of investment is dedicated for transmission and distribution networks, and be able to shift to a higher gear when electrification of the transport sector catches up (OECD/IEA 2006);

9. Explore possibilities for joint investments with neighboring countries in transmission and distribution networks (e.g. the IIRSA-initiative);

10. Investigate benefits of joining other international agencies;


6.7. Tariffs, Subsidies and Taxes

One of the main culprits in the Surinamese energy sector is the fact that electricity is substantially subsidized. Due to the tariff scheme, high-income households obtain a relative larger advantage than the financially weak. Furthermore, the N.V. EBS deficit is funded by the Government, though insufficiently, and is thus unable to cover their costs. In order to survive, money is saved by postponing and canceling maintenance activities. This also disables the utility to invest in structural improvements regarding reliability, capacity and health, safety and environment (this has been discussed in a number of seminars and in a couple of studies). In the end this decreases the level of energy security. In this regard, the following strategy should be followed:

1. Communicate with the public regarding the need of tariff, tax and subsidy adjustment (Lang 2009)
2. Improve collection before raising tariffs, since increasing tariffs first would worsen collection (OECD/IEA 2006);

3. Increase tariffs gradually to reflect costs of the supply of energy-related goods and services (Vigotti 2007);

4. Ensure that prices for goods and services obtained directly from renewable sources are lower in costs than those obtained from depleting and/or polluting resources, by a combination of offering the former financial incentives and taxing the latter (Kammen and Pacca 2004, Scheer 2005, Friedman 2008);

5. Eliminate subsidies to conventional and/or polluting fuels;

6. Support only the financially weak by using more targeted instruments, like offering transparent subsidies for a fixed maximum consumption of energy per month;

7. Rationalize, streamline and upgrade the organization of the N.V. EBS to save costs;

8. Include indirect costs and yields in prices, subsidies and taxes (Bisk 2009).

### 6.8. Rural Energy Supply

The hinterland of Suriname has a number of characteristics that make it stand out from other habited areas:

- It is a vast area;
- People are scattered in small villages (see figure 6.4);
- Its inhabitants are relatively low-educated and poor;
- Access is difficult and time-consuming; some areas can only be reached by water or air.
Because of these characteristics it is impractical to apply the same set of energy policies as used for the coastal area. However, the aim is to electrify the interior in order to improve the standards of living in the interior, without damaging the environment, in particular since the villagers depend to a large extent on their natural environment for their daily living. Designing policies for this area therefore need to take into account abovementioned characteristics. Strategies to electrify the interior convey:

- The interior must be electrified using local renewable energy sources (Scheer 2005, Roberts 2008, Wagner 2009), such as wind (using micro-wind turbines), river currents (using micro-hydro power) and solar thermal and solar (photo) voltaic energy. In particular the latter must be deployed on a large scale, because (OECD/IEA 2006):
  
  o Solar energy is virtually available everywhere;
  
  o Solar energy is virtually non-polluting;
  
  o Solar power systems are relatively easy to install, operate and maintain, which make it less of a hurdle for the local population to take ownership of operations and maintenance. Still, this requires a well setup training program;
  
  o Solar photo voltaic technology, while still expensive per unit of power output than conventional energy generation, is making steady progress to obtain higher efficiencies and lower costs (Staniford 2008). Investing in solar power right now can therefore be regarded as investing in human development and can be utilized at its maximum right away when small-scale solar power becomes competitive (and then therefore will not require any form of financial incentive).

- Each project must have local involvement in order to prevent any unforeseen effects of the project, and to guarantee its sustainability (Friedman 2008);

- Tap on foreign (in particular India, Brazil, Guyana, French-Guyana) experiences in more or less similar rural environments regarding organizational structure, transparent subsidy schemes (since electricity supply without any form of subsidy
is unlikely to be viable) and communicate these with the local population before deployment (Bhattacharyya and Srivastava 2008);

- As with supply in the coastal area, tariffs must reflect costs involved; for the financially weak, subsidies must be used for a maximum consumption per month;

- Financial incentives must be used to lower installation costs of (renewable) energy systems for the interior (International Energy Agency 2009b).

6.9. Other Sectoral Strategies

Energy strategy must be in unison with other sectoral strategies. Thus, some measures must be embedded in other strategies falling under the responsibility of other departments (such as the Ministry of Finance, Foreign Affairs and Trade and Industry) in order to improve energy security (Jollands and Pasquier 2008). Examples are:

- The education sector should support and continuously improve education in and research of energy-related fields, such as technology, social impact, legislation etc. This means that natural sciences must be promoted among students and that strategic partnerships must be made with foreign education and research institutes and the public and private sector. Furthermore, a special focus must be placed on the assessment and optimum exploitation of domestic energy resources, in order for policymakers to make informed decisions;

- (Commercial) deforestation should be re-reviewed and kept at a minimum; illegal deforestation must be banned immediately and be heavily penalized;

- Import of energy-inefficient cars, home appliances and building materials must be discouraged, while encouraging efficient behavior like mass transit and carpooling;

- Urban planning must be more effective with a long-term outlook and take into account its ramification on energy supply and energy use (Kammerer 2003)

- Introduce payment for parking and road use (especially downtown Paramaribo);

- Aim to develop industries that are not energy-intensive (Wagner 2009);
All of the measures mentioned above must not be simply imposed upon the population. Rather, debates, public hearings and informative two-way communication are required to convince the public regarding the necessity or benefits of the roads chosen. As stated earlier, vested interests and the middle class will not easily release the current situation, but through repetitive awareness understanding can be created, which leads to belief and ultimately to (willingness to) change, the so-called Four Levels of Change (Occupational Safety and Health Organization 2004).

6.10. Scenario-Specific Strategies

Due to their structural difference, each scenario requires its own specific set of strategies. Table 6.1 lists these scenario-specific strategies. The relative importance of a particular strategy among the scenarios is indicated by the amount of checkmarks. The ranking is based on information obtained from the interviews and literature. The strategies are by no means rigid but are guidelines that can help to anticipate future developments, or when a scenario suddenly becomes reality (through wild cards).

The argument for these strategies is as follows:

- Decentralizing energy supply not only results in a higher energy efficiency, since energy will be transported over much shorter distances (Lovins 1976), and the fact that less reserve generating capacity is required, but also creates a situation where sudden impacts (e.g. extreme weather events) on the energy distribution network only affect a relatively small area and thereby minimizes the risk for a total blackout (Scheer 2005, Wagner 2009);

- In the case of severe impacts due to environmental degradation, water security (in other words, availability, affordability and reliability) might be mitigated, thereby jeopardizing energy security. In this case a shift must be made from energy sources that require significant amounts of water, such as hydro power, bio-fuels and fossil fuels, to energy sources like wind and solar power;

- When the contextual environment emits strong signals that future energy availability might be mitigated, policies should focus on developing industries
that do not require significant energy inputs, like the service industry, rather than energy intensive industries like the mining sector. In the case where the environmental degradation makes the interior almost impossible to inhabit, the notable exception regarding the service industry is the eco-tourism sector;

- When energy is abundant (due to the exit of large energy consumers), all efforts must be put into place to maximize the value added per energy unit by promoting investment in downstream activities (even when domestic oil reserves are depleted, this can be achieved by importing oil and using existing oil production and refining infrastructure). Since materialization of these activities can take years and even decades, it might be opted in the case of already developed renewable energy sources to export generated energy;

- When energy is scarce, an option is to import energy through interconnections with neighboring countries or construct conventional or nuclear plants (but which can take 10 to 15 years from decision making to operationalization);

- Developing energy sources in the interior can provide a solution for the living areas in the coastal zone that are threatened by the rising sea levels. It will also promote further decentralization of energy sources;

- Electrification of the transportation sector is a phenomenon that is catching more momentum in both developed and developing countries. The main reason for this is not only the fact that electric vehicles are cleaner and more energy-efficient, but also because the main infrastructure to power these vehicles is already in place, viz. the ordinary electricity grid (Romm 2005, International Energy Agency 2009c). Utility companies also benefit from this phenomenon since it enables them to utilize their capacity, which is otherwise left unused in low-demand periods, like for instance during the night, when people use less electricity and therefore could charge their vehicles (Electric Power Research Institute 2009);

- According to the energy systems ranking done by the Stanford University in 2009, first and second generation bio-fuels may be renewable, but are not always sustainable, irrespective of the bio-fuel crop used (Jacobson and Delucchi 2009). The main reason behind this is the soil exhaustion, water usage, deforestation,
particulate emission, life cycle efficiency, and influence on surrounding eco- and agricultural systems that are involved in the production of bio-fuels. One notable exception might be fuels obtained from the cultivation of algae (also known as third generation bio-fuels), which are able to produce bio-diesel or bio-hydrogen, since these are expected to cause much less negative impacts like first and second generation bio-fuels;

- In certain scenarios it might be attractive to promote investments in the renewable energy systems industry, not only because it will provide employment, but also because it will lower the dependency on foreign energy systems suppliers while creating a local technological base. In the case of renewable and sustainable technologies, like wind, hydro and solar energy, this is easier to establish than conventional energy systems, since the latter are technologically more complex and capital-intensive, therefore have a steeper learning and adoption curve (Scheer 2005, Wagner 2009, Lund 2010).
### Table 6.1: Scenario-specific strategies

#### 6.11. Leading Indicators

The following indicators relating to each of the scenario dimensions hint towards which end that particular dimensions is heading (Naipal 2009, Kruyt, van Vuuren, de Vries and Groenenberg 2009, Schipper, Unander, Murtishaw and Ting 2001), and therefore towards which scenario the present is evolving:
Impact by Environmental Degradation

- Temperature patterns;
- Precipitation patterns;
- River current velocities;
- Wind velocities
- Change in seasonal animal behavior;
- Rate of domestic and global deforestation;
- Flooding of the interior;
- Sea level rise;
- Rate of global carbon emissions;
- The share of renewable energy sources in global energy supply.

Exit / Entrance of Large Energy Consumers

- Shift in global commodity demand;
- Domestic and global economic growth;
- Commodity prices;
- Domestic and global resource estimates;
- Commodity reserves to production ratio;
- Import dependence;
- Political stability;
- Willingness to pay for energy-related goods and services;
- Growth of the share of small and medium enterprises in the Surinamese economy;
- Technological advances;
- Energy intensity of the Surinamese population and the small and medium businesses;
- Fuel intensity;
- Domestic and global sales of vehicles that run on alternative fuels;
- Shift in values regarding energy usage.

6.12. Robustness Analysis

The table below provides an overview of the current strategies and the proposed (general and scenario-specific) strategies under each scenario. Each strategy is evaluated regarding its merit in that particular scenario with regard to energy security. This is done by assigning a plus-, zero- or minus-sign, respectively indicating a positive, neutral or negative effect on energy security. This comparison of strategy sets under each scenario is known as Robustness Analysis (Taylor 1999).

As is clearly evident, the current set of strategies do not held well in each of the scenarios, save the intention to start an energy institute (though nothing substantial has been materialized yet). The main reason behind this is the fact that these strategies were formulated with only one singular future in mind, which was created using forecasting techniques departing from a present which was (and still is) characterized by a fairly stable and acceptable level of energy security and not taking into account any future critical uncertainties.

On the other hand, the proposed general strategies hold well in each of the scenarios. Furthermore, some scenario-specific strategies have such a positive impact that they even hold well in other scenarios.
### Scenarios

<table>
<thead>
<tr>
<th>Scenario Dimension 1:</th>
<th>I (Prometheus’ Eagle)</th>
<th>II (Sisyphus’ Labor)</th>
<th>III (Ixion’s Wheel)</th>
<th>IV (Tantalus’ Torment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Severe Impacts of Environmental Degradation</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>B: Minor Impacts of Environmental Degradation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C: Exit of Large Energy Consumers</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>D: Entrance of Large Energy Consumers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Strategies

#### Current Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidizing electricity price in a non-transparent way</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Producing ethanol from sugar cane</td>
<td>−</td>
<td>+</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Create an energy institute</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Expand thermal capacity</td>
<td>−</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

#### Proposed General Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decentralize energy supply</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Promote investment in renewable energy</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>Promote energy efficiency and energy savings</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Increase tariff, with a transparent subsidy policy</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Create an energy institute</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Formulate proper legislation for the energy sector</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Assess domestic energy resources and plan using scenario planning methodology</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

#### Scenario-specific Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus on industries that are not energy intensive</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Build new conventional and nuclear plants</td>
<td>−</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Create a regional transmission and distribution network</td>
<td>−</td>
<td>+</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>Promote investment / invest in renewable energy in rural areas</td>
<td>−</td>
<td>+</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>Electrify the transportation sector</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

*Table 6.2: Robustness Analysis of the current and proposed strategies*
Part IV: Concluding Remarks

This part of the thesis concludes with a discussion of the conclusions and recommendations that stem forth from this research. Since this project has not only focused on the results, but has also spent a lot of attention on the scenario planning methodology, both the used methodology (deductive-based scenario planning), and the results of its use, namely the scenarios and strategies, will be placed under close scrutiny.

The recommendations provide indications for follow-up actions that need to be taken as a result from this research project.
7. Conclusions and Recommendations

7.1. Conclusions

7.1.1 Scenario Planning

The following conclusions can be drawn with regard to the used methodology:

- Literature points to many instances where uncertainty has been dealt with through the use of (a form of) scenario planning. After having performed a general assessment of the energy sector (electricity, transportation fuels and Liquefied Petroleum Gas used for cooking), a quick glance at the current status immediately indicates that the sector has to deal with several uncertainties, both domestic and global, which can be expected to become more severe in the future. Scenario planning is therefore one of the most important tools for strategizing in this sector in Suriname;

- Scenario planning has various approaches, namely the inductive, deductive and incremental method. The deductive method is preferred over the other methods since it the most analytical method, which is a relevant advantage since the scenario planning methodology is explorative and qualitative in nature and therefore leaves a lot of room for subjective influences. Though it is impossible to cancel these influences completely, the analytical characteristic of the deductive method provides some sort of a counterweight against these subjective influences;

- The deductive method can be executed in two ways, namely by using the scenario-matrix or the event tree. From these two possibilities, the scenario-matrix appears to be the superior one, since its nature provides the ability to produce challenging scenarios, which were not imagined or thought of before, by simply taking the scenario dimension to its opposite extremes;

- Another method is the morphological analysis method (commonly used in the form of a software program) which enables the user to create scenarios by simply providing variables regarding the subject matter as input. However, this method delivers too much scenarios to manage for most common problems and it does not trigger the user to look for driving forces behind easy to perceive parameters.
7.1.2. Scenarios and Strategies to 2050

The following conclusions can be drawn with regard to the created scenarios and formulated strategies:

- Contemporary energy security in Suriname can be considered as to be acceptable, but one has to take into account that this is the result of a number of windfalls: high levels in the van Blommenstein reservoir, high commodity prices for gold and oil which in turn provided the Government high enough revenues to subsidize electricity. However, demand is rising, lake levels are dropping, oil prices are low resulting in lower revenues for the Government, and the call for electrification of the interior is becoming louder. Furthermore, the windfalls have actually acted as a Resource Curse, since the Government did not use the advantages to structurally improve energy security. Rather, approaches to improve security have been piecemeal, inconsistent and on an ad-hoc basis;

- The interviews and some of the literature on the energy sector in developing countries all point to the quality and capacity of the Government to formulate a vision, strategy and policy as the greatest uncertainty regarding energy security. In the case of Suriname, where the power sector constitutes a relative large portion of the total energy sector and the majority of the energy is obtained from domestic sources (the Brokopondo Hydro Power Plant), it can be even stated that the by far largest uncertainty is domestic-bound rather than foreign or global;

- Taking the role of the Government out of the picture, the interview results all point towards the same critical uncertainties, which implies that the derived scenario logic regarding energy security in Suriname is the optimum of all possible combinations of driving factors. The derived scenarios are therefore relevant for the Surinamese energy sector;

- Each of the created scenarios place Suriname for some serious challenges. These challenges not only confine themselves to the energy sector but penetrate all aspects of life, not only because of the fact that energy is one of the base components for all social and economic activity, but also because of the fact that Suriname has a relatively high energy intensity;
- The strategies set out in this report have all two things in common. First, on a lot of different fields (e.g. energy efficiency, power sector reform, electrification of the interior) initial stages of development have hardly been achieved. This implies that a lot of work is still ahead which will require not only huge amounts of “hard” input such as equipment and capital, but also “soft” input such as research and education. Second, these strategies can only be put into effect successfully after having informed and communicated with the population, having held public hearings, set up awareness campaigns, etc. It is a fact that a developing country as Suriname requires relative more efforts on this front since only a relative small portion of the population is well-educated;

- As explained in the previous point, the contemporary situation in the Surinamese situation conveys various fields that are still in initial stages of development. This is reflected in the strategies which often are bend on introducing new models, behavior, methods etc., rather than improving or modifying them as is usually the case in Now Developed Countries. This implies that Suriname still needs to conquer the most difficult hurdles before it can pick up momentum for further optimization of its energy security. It is assumed that this is the case for most developing countries;

- Due to the vast difference in social, environmental, economic and infrastructural characteristics between the interior and the coastal zone, one can not escape the fact that different sets of strategies and policies need to be developed and applied for these two regions.

7.2. Recommendations

7.2.1. Scenario Planning

With regard to the scenario planning methodology the following is recommended:

- Small states like Suriname require a tool for decision making that deals with uncertainty, since these countries are extra vulnerable for uncertain, random and / or sudden external forces. Though it has been used in a handful of situations, it is recommended that efforts are out in place to disseminate the methodology within the
public and private sector. Courses and exercises in scenario planning must be provided in institutes that provide higher education, and scenarios must be created for different sectors, like the health, educational, mining, manufacturing sector. This will not only enhance co-operation and communication with various stakeholders, it will also provide better understanding of subject matters, and thus the driving forces in the contextual environment that shape the future. The scenario can be used to:

1. Set the strategic direction and prepare a rough timetable of events;
2. Be more perceptive of the environment when trying to identify towards which scenario the present is evolving, and anticipate new insights and innovations;
3. Accelerate collaborative learning by providing insight in the environment during the scenario building process;
4. Test existing strategies by challenging assumptions upon which they are built;
5. Rehearse the actions that need to be taken in different environments;
6. Describe goals that need to be achieved (so-called normative scenarios).

- There are currently a number of large-scale projects in the planning, exploration or execution phase (infrastructural construction, housing projects, and gold, bauxite and oil exploration and exploitation). It is strongly advised to test these projects against various scenarios in order to determine under which scenario those projects will (not) be viable. With the use of limit values of leading indicators, decision makers can then determine in advance whether a project needs to be shelved or a project can be taken out of the drawer, thus preventing wasting financial resources or missing opportunities;

- The time required to take the interviews was quite substantial. This can be greatly reduced by conducting scenario planning exercises in a workshop setting, since the typical workshop takes about two days (of course this depends on the number and diversity of the participants and the subject matter). This not only saves time, but synergetic advantages will result in better group conversations and thus better driving factors, scenarios and strategies (van der Heijden 2005);
- The interview results clearly showed that respondents, who were not directly / indirectly involved with the subject matter, were providing more challenging answers, in particular their depictions of scenarios. This has probably to do with the fact that, since they are not directly / indirectly involved with the subject matter, they are not confined by paradigms and their experiences enables them to look at the subject matter from different perspectives. This is of the utmost importance for scenario planning and something that must be considered carefully when executing such an exercise, in particular in a workshop setting, where people usually invite subject matter experts.

7.2.2. Scenarios and Strategies to 2050

With regard to the created scenarios and strategies for energy security in Suriname to 2050 the following is recommended:

- The scenarios can be elaborated with numerical representations of the leading indicators and some other important parameters. An tool that enables this is a software called Long range Energy Alternative Planning (LEAP) System (Heaps 2008) which is frequently used in scenario exercises (Ghanadan and Koomey 2005, Wang and Watson 2008). The advantage of this is that people will be able to relate better with the scenarios since the depictions of the future seem more concrete and lively. This can benefit the quality of the formulated strategy;

- In order to prevent the creation of normative scenarios, the quality / capacity of the Government was not chosen as one of the scenario dimensions even though it emerged as the most uncertain high impact driving force. These normative scenarios would have been less challenging than the ones developed, since the driving forces chosen in this exercise were not always explicitly mentioned in the interviews or even in literature while they are very relevant to the Surinamese situation. Also adding to the challenging characteristic of the developed scenarios is the fact that the strategies developed require follow-up action by the Government and the driving forces chosen can not directly be influenced by the Government.
However, this does not take the quality and capacity of the Government out of the equation to achieve or maintain an acceptable level of energy security. Capacity needs to be built within the Government (which implies that the educational sector must be upgraded to deliver the required products, see section 8.8) in order to develop a long-term vision, elaborate on the advised strategies and implementation and monitoring of policies. This implies that issues regarding energy security should be taken out of the political context and decisions must be made on rational grounds;

- The Government should initiate various forms of two-way communication with various actors in society by means of debates, public hearings, workshops, education and training programs and awareness sessions to inform about and warn for the tough times ahead. The scenarios can help delivering these messages, in particular since they depict plausible and probable futures. These forms of two-way communication are required to run through all the four levels of change: awareness, understanding, belief and change (see figure 7.1). Only when these stages have been achieved, far-reaching decisions (e.g. car pooling, increase of tariffs and taxes on fuel inefficiency) will be accepted by society and can they be deployed successfully;

- Since the contextual environment is dynamic and therefore subject to continuous change, scenarios need to be reviewed and updated every 4 – 5 years by conducting a new scenario exercise / workshop;

- The formulated strategies in this research need to be followed up on by communicating them (as explained earlier) and creating SMART policies that need to be deployed, monitored and adjusted where necessary (in other words walking through the PDCA-cycle). This road from strategy to implementation and continuous adjustment or improvement requires sufficient qualified resources. Though the education system needs to be altered to produce deliverables that are up to this task, the Government can make a sound start by using domestic and foreign expertise, even though they are not employed by a government agency. It is however an important requisite, that politicians need to demonstrate willingness to take the energy security issue out of the political context and to have decisions taken by technocrats;
In order to guarantee the sustainable follow-up on action plans that are derived from energy strategies and policies, even after a change of Government, policy makers need to make sure that scenarios, strategies and policies have been communicated with the public, and that the strategies (including scenario-specific strategies) and even the recurring scenario exercises must be embedded in a so-called Energy Act. This will make it difficult to stray away from the strategic road and it will guarantee the periodical adjustment / improvement of scenarios and strategies;

Of all the strategies explained, the setup of an energy institute is by far the most important, because of the important functions, roles and responsibilities of such an institute. Such an institute will actually be able to trigger a jump-start to a more sustainable future, since it operates autonomously, clusters knowledge and responsibilities that are currently dispersed over various governmental departments (therefore benefiting from synergy advantages), institutes and private companies, monitors and scans the environment and executes short-, middle- and long-term plans.

Figure 7.1: Four Levels of Change (Occupational Safety and Health Organization 2004)
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Appendices
Appendix A

Energy Security in Suriname

Local newspaper articles

Other references:


Appendix B

Scenario Planning

Forums
- Global Business Network
- Shell Scenarios
- World Future Society
- The Futurist

Journals
- Long Range Planning
- Journal for Management and Organizational Studies
- Planning Theory
- Journal of Management

Magazines:
- Wired. Scenario’s: the Future of the Future

Other References


Klinec, I. 2004. Strategic Thinking in the Information Age and the Art of Scenario Designing. The First Prague Workshop On Futures Studies Methodology, September 16-18, Institute for Forecasting, Slovak Academy of SciencesCharles University, Prague


Appendix C

Driving Forces for Energy Security in Suriname

Energy Scenarios
- United States
- Ireland
- United Kingdom
- Energy Technology Perspectives
- International Energy Agency
- California

Other References


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Ramsay, W. C. 2006b. *The key challenges to energy security*. Presentation by the Trade Union Advisory Committee to the OECD, s.l.


Appendix D

Key Actors in Suriname’s Energy Sector

- Suralco, LLC:                          - General Manager (P. de Wit)
  - Power Manager (R. Liems)

- N.V. EBS:                              - General Manager (G. Lau)

- Staatsolie N.V.:                       - General Manager (M. Waaldijk)

- Staatsolie Power Company Suriname N.V.: - General Manager (E. Fränkel)

- Ministry of Natural Resources:         - Director (J. Abdul)

- University of Suriname representatives: - R. Mohan
  - S. Naipal

- Consultants:                          - L. Boksteen
  - V. S. Ajodhia (KEMA)
  - D. Ferrier (CESWO)

- Representatives of the tourism sector - M. Panday

- Representatives of the agricultural sector -

- IAMGOLD                              - General Manager (R. Adams)

- Newmont Mining                       - Suriname representative (A. Brandon)
Appendix E

Conceiving Energy Strategies

Energy Strategies
- Arizona
- Russia
- New Zealand

Journals:
- Bulletin of Science, Technology and Society
- Energy Economics
- Energy Policy
- Urban Studies
- Energy for Sustainable Development
- International Journal of Energy Sector Management

Magazines:
- Energy Magazine

Other references:


Martina, S. 2006. *Van kritiek naar energiek, Curaçao een voorbeeld voor Suriname?*. Presentation held at the University of Suriname, Paramaribo


Appendix F

The Services Industry in Suriname

The services industry in Suriname is primarily made up of the following components (Algemeen Bureau voor de Statistiek, 2004):

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade</td>
<td>20.19%</td>
</tr>
<tr>
<td>Hotels &amp; Restaurants</td>
<td>3.88%</td>
</tr>
<tr>
<td>Transport</td>
<td>17.36%</td>
</tr>
<tr>
<td>Financial Services</td>
<td>13.56%</td>
</tr>
<tr>
<td>Commercial Activities</td>
<td>14.33%</td>
</tr>
</tbody>
</table>

_Table F.1: Main constituents of the services industry_
Appendix G

Suriname’s Energy Resources
Figure G.1: Potential sites for micro hydro power in Suriname (Naipal 2007)
Appendix H

Brief Background on Interviewees

Dino Toussaint (interviewed 16 September 2009) is the director of I-N-I Environment, Health and Safety consultancy, a Dutch firm that is operating in Suriname for more than 3 years, and is currently undertaking a number of projects in diverse industries in Suriname.

Amrish Premchand (interviewed 17 September 2009) is the Operations Engineer / Supervisor at the N.V. Energiebedrijven Suriname (EBS) for a couple of years.

Martin Panday (interviewed 18 September 2009) has international experience in the tourism sector, and has for instance worked for a couple years at the Foundation of Tourism Suriname. He frequently writes for newspapers and magazines regarding various topics, and is currently advisor for the NIKOS consulting firm regarding Tourism & Wellbeing in the twinning-facility project.

Derryck Ferrier (interviewed 21 September 2009) is the director of the Center for Economic and Social Scientific Research (CESWO). Since the 1970s he has been thinking about the difficulties surrounding the energy supply after the depletion of conventional hydrocarbons. He is also the representative in Suriname for the so-called Initiative for the Integration of Infrastructure in South America (IIRSA).

Rudi Liems (interviewed 22 September 2009) has worked for 35 years for the Suriname Aluminum Company (Suralco) LLC. There he assumed various positions with the Central Engineering, Smelting and Power House departments. At the end of his career he was the Power Manager in charge of the Thermal Plant and the Afobaka Hydro Plant. He is currently Engineering and Maintenance Manager at the Staatsolie Maatschappij Suriname N.V. (SOM) and is Chairman of the Board of Directors at Amazon Conservation Team.
Albert del Prado (interviewed 23 September 2009) has been a staff worker at the Ministry of Natural Resources, on the sub-department of Hydro Works (Bureau voor Waterkrachtwerken). In the beginning of the 1980s he built the micro hydro power station at Poeketie (in the interior). After his career with the Government, he joined Staatsolie Maatschappij Suriname N.V. where he worked for 9 years. He now acts as a consultant and has for example installed the first wind turbine in Suriname at Galibi.

Roy de Rooy (interviewed 24 September 2009) is a retired member of the executive team of N.V. EBS. He has an engineering background and has 30 years of experience at N.V. EBS.

Ravic Nijbroek (interviewed 25 September 2009) is a PhD-student at the University of Florida and is researching the impacts of climate change on Suriname. He has worked for the Inter-American Development Bank office in Suriname, and now works for Conservation International Suriname.

Miguel Antonius (interviewed 27 September 2009) has an electrical engineering background who lectures at the PolyTechnic College and the University of Suriname.

Professor Siewnath Naipal (interviewed 28 September 2009) is a lecturer at the University of Suriname and does research in the field of coastal zone management, climate change and micro hydro power.

Sam McNair (interviewed 29 September 2009) is a world-renowned expert in equipment reliability and affiliated areas such as change management, performance management, machinery health, life cycle analysis etc. He has experience in a number of industries such as the nuclear, consulting, ethanol and agriculture industry. He is a frequent contributor to a number of journals. In his role as a consultant, he has visited numerous countries all over the world. He currently works for the US-based consulting firm Life Cycle Engineering, for which he has frequently visited Suriname within the timeframe of a little over 18 months.
Lothar Boksteen (interviewed 29 September 2009) has a civil engineering background. He is a former manager at the NV EBS and the chairman of the now defunct Jaikreek Phedra project (a hydro power project). He has been the Minister of Labor and Health and the Minister of Public works. He acts currently as a consultant for the Water Company of Suriname and is chairman of the Central Main Polling Station. He was a member of the Energy Advice Committee, and counterpart for the Government of Suriname for studies done by third parties for the diversion of the Tapanahoni River. Currently, he is one of the main advocates for the execution of a feasibility study for the Tapajai project.

Ruben Yang (interviewed 2 October 2009) was formerly employed by the Suriname Aluminum Company LLC, a subsidiary of Alcoa, where he worked as an electrical engineer at the Power House for 13 years. He also worked at Staatsolie Maatschappij Suriname N.V. as lead engineer for 3 years. After departure from Suriname he functioned as lecturer at the energy laboratory in Curacao. He has been the chairman of the Energy Advice Committee of the Ministry of Natural Resources in Suriname and is currently the director of the trading firm Mitra.

George Orie (interviewed 5 October 2009) is the former head editor of the newspaper De Ware Tijd and de Bouw- en Woonkrant. He is currently the head editor of the magazine Sabaku, for which he has written a couple of articles on issues regarding energy, such as supply, prices, infrastructure and Staatsolie Maatschappij Suriname N.V.

Michael Kopinsky (interviewed 6 October 2009) has 8 years of experience at the N.V. EBS, after which he was 16 years director of the trading and installation firm Elgawa. He is currently chairman of the Granrki Hydro Project Foundation and director of Sustainable Technical Solutions (SUTESO). At the moment, Mr. Kopinsky is responsible for writing action plans to implement the recommendations provided in the report “Suriname Power Sector Assessment and Options for its Modernization” (KEMA 2008a, 2008b, 2008c).
Jainul Abdul (interviewed 6 October 2009) is the Permanent Secretary for Energy, Mining and Water supply at the Ministry of Natural Resources and holds this position for 25 years now.

Orlando dos Ramos (interviewed 6 October 2009) is the managing director of Consulting Partners N.V., a firm that deals with mechanical and electrical installations. He is also chairman of the Suriname Business Forum, and was a member of the Energy Advice Committee of the Ministry of Natural Resources. He is also one of the contributors to the report “Suriname Power Sector Assessment and Options for its Modernization” (KEMA 2008a, 2008b, 2008c).

Viren Ajodhia (interviewed 6 October 2009) is a consultant in the field of energy tariffs. Through the German consulting firm KEMA he has advised many governments, state-owned and private companies in the energy sector all over the world. He is one of the main authors of the report “Suriname Power Sector Assessment and Options for its Modernization” (KEMA 2008a, 2008b, 2008c).

Eddy Jharap (interviewed 10 October 2009) is the founder of the state-owned Staatsolie Maatschappij Suriname N.V. After he quit his job as the head of the Mining Service (a governmental body) he was tasked with the goal of exploring and exploiting hydrocarbons. This led to the birth of the state-owned company in 1980 where he remained managing director for 25 years. During his career he incorporated more downstream activities in the portfolio of the company, such as a refinery, bunkering services, marine fuel supply and a power plant. He is currently a member of the board at the Institute of Graduate Studies and Research of the University of Suriname.

Dennis Wip (interviewed 13 October 2009) has a background in physics, and is one of the principal lecturers at the University of Suriname. He has done various types of research in the field of energy.
**Rudolf Elias (interviewed 16 October 2009)** was part of the executive team at Ballast Nedam Suriname (infrastructural construction) and BHP-Billiton Maatschappij Suriname (mining) and is since recently the Deputy Director New Business at the Staatsolie Maatschappij Suriname N.V. In his new role he is involved with exploring the possibilities to start the production of ethanol in Suriname and involved with Staatsolie’s newly appointed role by the Government to act as an agent to deal with Suralco LLC to have the Tapajai project realized.

**Peter de Wit (interviewed 4 December 2009)** has worked for Royal Dutch Shell and BHP-Billiton, and currently works for Alcoa. His career at Alcoa took him to the Spanish refinery at San Ciprian, after which he came to Suriname, where, after having assumed various positions, he currently holds the position of General Manager at Suralco. In this position, he is responsible for the refinery, mining (which was recently taken over from BHP-Billiton) and power generation divisions.
Appendix I

Summary of Interview Results

Below is a summary of the answers by all respondents to each of the questions.

1. Which aspects (within the Government, within Suriname, and within the global context) do you deem crucial with regard to their impact on Suriname’s energy security (availability, affordability, reliability) to 2050?

Government
- Corruption;
- Management capacity;
- Taking decisions based on political motives;
- Strategy and policy;
- Building relationships with neighbors;

Domestic Factors
- The extent to which Suriname is a consumption or production society;
- Discovery of new hydrocarbon reserves;
- Peak investments;
- (Ethnicity-based) Conflict;
- Demand;
- Deforestation in the interior;
- Depletion of natural resources;
- Energy awareness;
- Migration towards the coastal zone;
- Compatibility of the Surinamese education sector with domestic (and regional) challenges;
Foreign / Global Factors
- Oil price;
- World economy;
- Conflicts that can destabilize the world economy;
- Technological breakthroughs;
- Climate change.

2. Which aspects that have a significant impact on Suriname’s energy security to 2050 would you classify under the category of so-called “Predetermined Elements”, i.e. aspects with a relative certainty regarding their future developments?

- Population increase;
- Growth of Suriname’s GDP;
- Increasing energy intensity;
- Suriname has sufficient renewable energy resources.

3. Which aspects that have a significant impact on Suriname’s energy security to 2050 would you classify under the category of so-called “Critical Uncertainties”, i.e. aspects which are very uncertain with regard to their future evolution or timing thereof?

- Technological breakthroughs;
- Impact by climate change;
- Impact by domestic deforestation;
- Peak investments;
- The kind of regime that will be in command after an election;
- Governmental decisions;
- Depletion of natural resources in Suriname;
- Discovery of hydrocarbon reserves;
- Oil price behavior;
- World economy;
- Domestic conflict.
4. **Could you give a description of how a positive yet plausible scenario regarding Suriname’s energy security in 2050 would look like, and could you describe the important events that have led to that scenario?**

The majority of the respondents draw a positive scenario that is made up of positive global developments, such as negligible negative impact of climate change, no turmoil that jeopardizes fuel supply etc., and positive local developments such as the realization of renewable energy sources, such as hydro power, through the actions of a sound Government with a clear strategy and policy, which is actively communicated with the population.

5. **Could you give a description of how a negative yet plausible scenario regarding Suriname’s energy security in 2050 would look like, and could you describe the important events that have led to that scenario?**

Suriname will resemble some of the poorer places in Africa. There will be frequent black outs due to poor maintenance and investments in the generation, transmission and distribution of electricity. This leads to great social costs since materials, production and leisure are lost, resulting in conflict between various groups. The main cause for this is the structural lack of effective investments in the energy sector, since the Government did for years on end not act in a proactive way by means of the execution of a long-term strategy and policy. Furthermore, energy supply is diminished since climate changed has affected bio-fuel crop yield and water resources required for hydro power.

6. **Could you indicate which so-called “Early Warning Signals” might help us in assessing towards which energy scenario Suriname is heading?**

- Dynamism of the economy, given in by the level of knowledge, poverty, investments etc.;
- Energy demand;
- Number of black outs;
- Climate change indicators;
- Oil price behavior;
- Demographic trends;
- Health of the world economy;
- Capacity building of the Government, enabling sound decision making while switching from a short-term reactive mode to a long-term proactive mode.

7. If today you were being charged with taking decisions regarding energy security, which decisions you would take within the coming months or years that could / will have a long-term impact on energy security?

- Invest in alternative energy;
- Build management capacity, for instance by installing an autonomous entity responsible for energy management;
- Liberalizing the energy sector;
- Create energy awareness;
- Increase utility tariffs to reach market levels;
- Install an autonomous institute responsible for energy management;
- Change the education system to match the domestic challenges.