Technical Memorandum

Description of Scenarios for Vietnam Prepared at the PoleStar Workshop 4-15 October 1999

Eric Kemp-Benedict, Ph.D.
with contributions from workshop participants

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S E I STOCKHOLM ENVIRONMENT INSTITUTE
Boston Center, Tellus Institute
11 Arlington Street, Boston, MA, 02116, USA

Phone: (617) 266 8090 | Fax: (617) 266 8303 | Email: info@seib.org | http://www.seib.org

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1 Introduction

This report describes a set of integrated scenarios prepared as part of a training workshop held in Hanoi, Vietnam, 4-15 October 1999. The workshop introduced the scenario-building approach and computer program of the Stockholm Environment Institute's (SEI) PoleStar system. It was held at the office of the National Environment Agency (NEA) project "Strengthening of the Environmental Management Authority Vietnam" (SEMA). The participants were drawn from a variety of backgrounds, including NEA staff and staff from several ministries and institutes within Vietnam.

The two-week workshop had two one-week phases. During the first phase, participants were introduced to the PoleStar scenario-building approach. This phase included an intensive introduction to the PoleStar software. Also, participants discussed sustainable development issues in Vietnam, with the discussions centering around a demonstration scenario prepared prior to the workshop by SEI.

During the second phase, participants developed integrated scenarios for Vietnam that covered a range of issues: economics; demographics; household electricity and water use; industrial energy consumption and pollution emissions; electricity generation; transportation energy demand and emissions; and land use. The base year for the scenarios is 1995, and scenarios were constructed for 2000, 2005 and 2010. The scenarios were informed by presentations by speakers from NEA and the Ministry of Planning and Investment (MPI). The participants also prepared summary notes and presentations on the scenarios they had constructed. One of the scenarios is a *Reference* scenario, in which population and economic growth proceeds according to government expectations, but no particular focus is given to environmental issues. The other, which was not completely implemented during the workshop. is a *Policy* scenario, in which more attention is paid to specific environmental issues.

This report will focus on the scenarios produced, drawing mainly on the summary notes and the presentations of the speakers and participants.[1] Through the efforts of the participants, data on current patterns should be accurate and up-to-date. Also, the scenarios should reflect plausible and desirable development paths. However, the amount of time available during the workshop did not allow for a thorough review of the scenarios produced. Consequently, these scenarios should be be viewed as provisional. They serve as a starting point for discussing possible development directions for Vietnam and for developing more refined scenario analysis, but should not be taken as definitive scenarios for the country.

2 The PoleStar System

In the face of an inherently unpredictable future, scenarios can help explore alternative development paths. Rather than attempting to predict a particular future, scenarios are

[1] When reviewing the scenarios after the workshop, the author noted some inconsistencies in the data, which seemed to arise from errors in entering or interpreting data. These have been changed for this report, and the changes are noted below. Also, some additional sources have been used to provide a broader context for the scenario discussion. These sources are referenced in the text.

stories of possible futures. By connecting activities that can be influenced by policy today to environmental and social problems that might not occur until decades into the future, they serve to bring potential future problems to bear on current decision making.

The purpose of the workshop was to introduce the PoleStar system, a software tool to aid the generation and evaluation of alternative development scenarios. PoleStar is both a comprehensive, flexible and easy-to-use accounting framework for mounting economic, resource and environmental information, as well as being a scenario-building tool for examining alternative development scenarios. PoleStar is applicable at national, regional and global scales. The user customizes data structures, modeling relationships, time horizons and spatial boundaries, all of which can be expanded or altered in the course of an analysis.

A PoleStar application generally begins with the current accounts, a snapshot of the current state of affairs. Next, scenarios are developed to explore alternative futures. Finally, environmental and resource pressures are computed and can be compared to user-defined sustainability criteria. Demographic and economic data and assumptions act as driving variables for the scenarios, providing a scale for the activity within the sectoral modules.

3 Current Patterns

3.1 Economy and Demography

In 1991 the Party adopted a 10-year strategy for economic growth (Thai, 1999). Prior to its inception economic growth had been slow, increasing about 3% during1989 and 1990. Following the adoption the plan, economic growth increased substantially, and has generally remained high. The economy grew by 8% in 1995 and by more than 9% in 1996 (Thai, 1999). However, recently growth has declined in the wake of the general economic crisis precipitated by the events of 1998. In 1998 the economy grew by only about 5% (Thai, 1999). The total economic output for Vietnam in 1995 was VND 288,918 billion (GSO, 1999).[2] By the year 2000, the GDP is expected to be VND 401,495 billion (Thai, 1999), reflecting an average annual increase of close to 7%.

Despite the considerable economic growth between 1991 and 1995, economic output per capita remains low. When converted into United States dollars at market exchange rates, incomes are about $1 per day. Even when adjusted for purchasing power, average GDP per capita is only about $5 a day (Thai, 1999). In international comparisons, this places Vietnam in the rank of the poorest countries. A major government goal is to move the country out of that bracket. In spite of low incomes, Vietnam ranks high in many human development measures. For example, life expectancy in 1995 was 66 years, compared to 62 on average for all developing countries and 51years on average for the least-developed countries, while the literacy rate is 93% (UNDP, 1998).

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[2] All currencies are expressed in 1998 Vietnam dong (VND). The 1995 value used in the scenario constructed during the workshop is corrected to 1998 values , using figures from Thai (1999) and GSO (1999).

The structure of the economy is shown in Table 1.[3] As shown in the table, over the short period of five years, between 1995 and 2000, industry's share in the total is expected to grow from 29% of the total to 34%, continuing the shift toward an industrial economy that has characterized growth in Vietnam since 1990.

Table 1. Economic Structure, 1995 and 2000

Sector	1995	2000
Industry	29%	34%
Agriculture	27%	25%
Services	44%	41%

Source: 1995 data from GSO (1999); 2000 figures from Thai (1999).

The population in 1995 was 74 million. Of this total, only about 20% lived in urban centers (GSO, 1999). A 1993 survey indicated that on average there were about 5 people per household (GSO, 1994). About 20% of the population lived in urban areas in 1995, similar to the share in 1990 (GSO, 1999).

3.2 Land, Forests and Agriculture

In recent years, due to the gradually increasing industrialization and modernization of the country, combined with a shift toward a market economy, Vietnam has clearly made progress. However, with a limited land area, the resultant increase in demand has created more pressure for land resources. Past mistakes in using and managing natural resources in general—and land resources in particular—have resulted in degradation. To ensure a sustainable use of land, leading to both socioeconomic and environmental benefits, the Government, both at local and central levels, plays an important management role.

The land-use distribution in 1995 is shown in Table 2. Historically, over the period 1943-1995, forest area in Vietnam declined from 14.3 million ha to 9.3 million ha, and forest loss continues today.

[3] The economic structure shown for 1995 is slightly different from that used during the workshop, to make them consistent value added used for the scenarios. The differences appear to be due to placing economic activities in different categories. In particular, Party activities are included here within the Service sector, which appears to be the same convention followed in Thai (1999). The differences between the two categorizations are at most 2% in any sector.

Table 2. Land-Use Distribution in 1995

Land use type	Area (ha)	Share (%)
Cultivated land	7,352,253	22
Grazing land	1,211,403	4
Built-up land	1,347,251	4
Natural forest	825,500	25
Artificial forest	1,047,700	3
Fallow land and bald hills	12,453,000	38
Other	1,489,219	5
Total	33,153,822	100

Note: Numbers may not add to total due to rounding.

In economic terms, agricultural output has increased regularly since 1989, by over 4% per year on average, contributing to the average income of farmers, which increased by over three times between 1990 and 1993 (SEMA, 1999a). Currently, Vietnam is a net exporter of rice, the most important food crop. In contrast, in 1989 the country was experiencing protracted famine. The pressure on agricultural land is high—in the Red River Delta region, agricultural land per capita is 500 m^2, the lowest average in the world (SEMA, 1999a).

3.3 Industry

Along with other sectors of the economy, industry has experienced high growth since 1990. Over the period 1983-1989 growth averaged 6.6% per year, while between 1991 and 1995 growth averaged 13.7% per year, exceeding the target for that period (SEMA, 1999b). In the wake of the general economic crisis following the events of 1997 growth fell below the target, but remained relatively high, still exceeding 10% per year. A transition to an industrial economy is a central feature of government development strategy (SEMA, 1999b).

Despite the impressive contributions industrial growth has made to overall economic growth and socioeconomic development, growth in the sector has been accompanied by increasing pollution (SEMA, 1999b). The rise in pollutant emissions seen in the past decade is unlikely to slow in the future, because of limited resources for investing in newer, cleaner technologies. State-owned enterprises , which are struggling to make the transition to a more market-oriented economy with limited resources and old equipment, still account for a large proportion of total industrial output (SEMA, 1999b). In 1995, state-owned enterprises contributed 50% to total gross industrial output, while non-state domestic enterprises contributed 25% and the foreign-invested sector the remaining 25% (GSO, 1999). The state-owned enterprises play an important social role in guaranteeing employment (Hy, 1999). The contrast between social and environmental impacts of state-owned enterprises highlights the importance of sustainable development perspective, which examines social and environmental goals together.

For this study, five industrial subsectors are identified: Metallurgy, Building Materials, Chemical-Fertilizer, Paper and a residual "Other" subsector. Most (around 78%) of the industrial value added is generated by the "Other" subsector, with Metallurgy and Paper products each contributing about 2% and the Building Materials and Chemical-Fertilizer industries each contributing about 9%.

3.4 Transportation

In 1995, for both passenger and freight transport, the major mode of transportation is by road. People traveled, on average, about 224 km, expressed as the average per capita passenger-km traveled during the year, while for goods a total of 30 billion tonne-km were hauled. For both passenger and freight traffic, about 40% was by road.

Government plans for future development include maintaining and upgrading the existing road infrastructure, as well as building new roads, including roads to link economically important areas to ports and harbors (SEMA, 1999b). There are also plans to upgrade and extend the transportation infrastructure in other modes as well—rail, marine and inland waterway. Aside from any impacts from increased vehicle use, these large-scale projects will have impacts on communities and the environment (SEMA, 1999b).

The existing fleet in all modes is essentially all petroleum-burning. As travel increases in the future it can be expected that air emissions, noise pollution and dust will rise along with it. In addition, petroleum requirements for transportation needs can be expected to increase.

3.5 Energy

The scenarios described in Section 4.6 of this report focus on the modern fuels required by a modernizing economy: electricity, petroleum, natural gas and coal, with a particular emphasis on electricity. Also, they focus on energy use for transportation and industrial production.[4] Vietnam has crude oil, coal and natural gas reserves. However, currently the natural gas reserves are relatively undeveloped. The major energy conversion sector in the country is the electricity generation sector. Essentially all of the crude oil that is produced is exported for processing in other countries, and petroleum is imported.

In 1995 electricity generation amounted to 53 PJ (15 billion kWh). Of this total, about 75% was supplied from hydroelectric sources, the remainder supplied by thermal power plants burning coal, petroleum products and natural gas. The major fuel consumed by thermal electric plants is coal, which contributes 78% of the total fuel consumed by thermal power plants. Nuclear sources are not expected to be developed until after 2015.

In the future, non-hydroelectric sources are expected to grow more rapidly than hydroelectric sources (SEMA, 1999b). Correspondingly, air emissions from combustion, and dust from coal-fired plants, are also expected to rise.

[4] Currently, most household energy use is biomass. For the households responding in the 1992-1993 Vietnam Living Standards Survey (GSO, 1994), the main sources of fuel were wood (54%); grass, leaves, agricultural residues and similar biomass sources (34%) and either coal or charcoal (9%). The remaining 3% was supplied by modern fuels (bottled gas, kerosene and electricity). These estimates are close to those reported by the Rural Wood Energy Development Program (RWEDP, 1999), which were based on statistics gathered by Vietnam's Institute of Energy. According to the same source, 80% of biomass consumption is accounted for in the household sector (RWEDP, 1999).

3.6 Water

In terms of total supply, Vietnam has abundant water resources. However, most of the flow is carried by the Mekong and Red Rivers, which originate outside the country. As a result, over half of Vietnam's water resources (60%) are supplied by cross-border flows (FAO, 1999). The future of water development in Vietnam is therefore dependent on water development in neighboring countries. For example, China has plans to build nine hydroelectric plants on the Mekong river, which will affect Vietnam as a downstream country (Thai, 1999). Furthermore, the water flow is not evenly distributed. Chronic water shortages in mountainous areas in the dry season is a concern and there is overpumping in some areas (SEMA, 1999a). A further problem is the contamination of existing water supplies by saline or brackish water.

In the scenarios, water withdrawals by households and industry are treated explicitly. Also, use of hydroelectricity is treated in the scenarios. As mentioned in Section 3.4, most electricity in Vietnam is generated by hydroelectric plants. While these do not add to withdrawals, the major role played by hydroelectric production emphasizes the importance of water resources to development. Agricultural water use, which in 1990 accounted for 87% of withdrawals (FAO, 1999), has not been treated explicitly in the scenarios. Instead, agricultural water use will be discussed qualitatively in this report.

Water pollution is a current problem that can be expected to intensify in the course of development. In rural areas ponds are used both as water sources and as waste repositories (SEMA, 1999a). Most industrial waste water is not treated before discharge into water bodies. Chemical and dye plants, as well as thermal power plants, are considered to pose the greatest risks (SEMA, 1999a).

4 Two Scenarios

4.1 Scenario Overview

Two scenarios were prepared by the workshop participants. One is a *Reference* scenario, in which population and economic growth proceeds according to government expectations, but no particular focus is given to environmental issues. The other is a *Policy* scenario, in which more attention is paid to specific environmental issues. In some sectors a *Policy* scenario was constructed explicitly to meet particular environmental goals. In other sectors the more rapid economic growth envisioned in the *Policy* scenario drives activity, in order to highlight the difficulties rapid growth might lead to, in the absence of focused environmental policy.

In addition to addressing environmental concerns, the *Policy* scenario focuses on social goals. Economic growth is higher, and poverty reduction more rapid. In order to achieve these aims, important policies identified by the workshop participants include:

- Give priority to develop main industries, with a special focus on the development of infrastructure and energy production to support economic development in an industrializing economy.
- Invest further in family planning.

- Invest in education to improve labor quality; open more vocational schools to train skilled labor and to transfer labor from agricultural production to industry.
- Give priority to poverty and hunger elimination.
- Bring new crop varieties into agriculture and make fallow land and bald hills agriculturally productive.

4.2 Economy and Demography

In general terms, government plans for the next two decades involve combining sustainable development with a socialist orientation (Thai, 1999). Consistent with this view, many recent government documents have emphasized the environment, especially as it is affected by industrialization (Hy, 1999). The 8th Party Congress resolved that in 2020 Vietnam will complete the industrialization process. However, this challenging goal may not be feasible. In 1990 the level of economic development was low, offering opportunities for rapid growth. But by 2000 the level is relatively high, and achieving similar growth rates will prove increasingly difficult (Thai, 1999).

Consistent with expectations of possible future growth, the *Reference* scenario assumes that the relatively rapid economic growth that Vietnam has experienced between 1990 and 2000 slows in the future, averaging about 7% per year between 1995 and 2010.[5] In the *Policy* scenario the economy grows more rapidly than in the *Reference* scenario, averaging about 8% per year over the course of the scenario. In order to achieve rapid growth in the future, the country plans to rely on advanced technology (Thai, 1999).

In both scenarios, population increases from 74 million in 1995 to 89 million in 2010, an average growth rate of 1.2% per year over the period (Thai, 1999).

4.3 Land, Forests and Agriculture

As the population grows in the scenario, requirements for agricultural land and the built environment increase. In addition, cropland continues to be degraded at rates consistent with historical patterns. Requirements for land to replace the degraded crop areas adds to the demand for new cropland. These expand at the expense of other types of land, including forest and bare hills that might otherwise be reforested.

In a long-term view, extending to 2015, beyond the end of the *Reference* scenario, land area would be distributed in the following way:

- More than a half the land (18 million ha) will be covered by plants with a clean environment and a sustainable ecosystem.
- Nearly 10 million ha of agricultural land (of which about 4 million ha will be for rice cultivation) will satisfy requirements for food security and industrial production, by

[5] Economic output (GDP) for the *Reference* scenario, and population growth in both scenarios, are taken from projections presented during the workshop by Prof. Thai of MPI. For the scenarios all GDP values are in constant 1998 Vietnamese Dong (VND).

meeting the food demand of the society and supplying enough raw material for processing.

- Nearly 3 million ha of land will be used for specific purposes to meet the demand for industrial, cultural, social and national security services.
- More than 3% of the total land area (1.1 million ha) will be used to build resident apartments which are basically urbanized to ensure a high quality living standard for all people.
- There will still remain 1.8 million ha of rivers, streams and bald rock mountains, some of which will be exploited for other purposes. The rest of this area will be left in its natural state for aesthetic and environmental purposes.

The *Reference* scenario should move toward this pattern. In the *Reference* scenario, requirements for built land per capita decrease by 11% over the course of the scenario, from 0.018 ha per capita in 1995 to 0.016 ha per capita by 2010. The decline in area per capita is accompanied by increasing urbanization, and is consistent with the observation that an urbanized population requires less land per capita than a primarily rural population (SEMA, 1999a). The rate of decline is slightly slower than the rate of population increase, leading to a gradual increase in the built environment, from 1.3 million ha to 1.4 million ha between 1995 and 2010. About 40% of the additional built environment expands into bare land or "other" land, while another 40% expands into agricultural land. The remaining 20% expands into existing forest.

For the purposes of this study, agricultural land requirements are assumed to increase at the same rate as population. A more complete analysis was considered too complex to undertake during the workshop. However, some insight into how agricultural land areas might change under the scenario assumptions can be gained from the following long-term goals identified by the participants:

- Food security (over 300kg rice equivalent / person / year)
- Population stabilization at a little over 100 million people

In 1995 paddy output was 25 million tonnes, or between 300 and 350 kg per capita, close to the minimum for food security (GSO, 1999). To maintain or raise that level, agricultural production must at least keep up with population growth. However, there is potential for reducing the amount of land required to produce the same agricultural product, either by increasing multiple cropping or by raising yields (SEMA, 1999a). On the one hand, if production were to exceed the minimum required for food security, then without any productivity improvements land area per capita would increase. On the other hand, if food production were maintained close to the minimum level for food security, and productivity were increased, then land area per capita would decrease. The assumption of constant agricultural land area per capita can be seen as a middle route between these two extremes. Agricultural land expands at the rate of about 113 kha/year, from 8.6 million ha to 10.3 million ha. As it expands, it pushes onto bare land and, to a lesser extent, forest land. The displaced bare land represents land that might have been reforested, so to some extent it reflects a loss of potential forest area.

There is assumed to be sufficient afforestation in the scenario that the total forest area increases, consistent with the long-term goal of reestablishing the country's forests. However, accomplishing this will be challenging in light of conversions of forest land and potential forest land to other uses.

4.4 Industry

As the economy grows in both scenarios, its structure shifts to reflect a greater degree of industrialization. In the *Reference* scenario the industrial share of GDP increases from 29% in 1995 to 41% by 2010. In the *Policy* scenario the increase is slightly faster, rising to 42% by 2010. Industrial value added therefore grows much faster than GDP, at 9% per year on average in the *Reference* scenario, and 11% per year on average in the *Policy* scenario. These rapid increases, taken by themselves, would imply similarly rapid increases in resource consumption and pollutant emissions in the industrial sector.

Within the industrial sector the structure changes as well. In both scenarios, the "Other" industrial subsectors gradually decline from 78% of total value added to 68%, while the Metallurgical, Building Materials, Chemical-Fertilizer and Paper subsectors gradually increase their share of total industrial output. Of the different subsectors, the Chemical-Fertilizer subsector is least energy-intensive, while the Metallurgical subsector is most energy-intensive.

4.5 Transportation

In both scenarios, travel needs, expressed as passenger-km per capita or tonne-km per billion VND, each increase. Passenger travel per capita increases by a factor of about two, while freight transport per unit GDP increases by a factor of about four. However, economic growth is much higher than population growth in the scenarios, leading to much higher increases in freight travel than in passenger travel.

The same energy efficiency improvements and vehicle shares are assumed in each scenario. In both scenarios there is some penetration of electric buses and trains, leading to lower petroleum requirements from within the sector.[6] Also, because of the importance of hydroelectric power in electricity production and the expansion of natural gas, emissions due to electric vehicles are lower than those of petroleum-burning vehicles.

Due to the much greater increase in freight transport than in passenger transport, energy requirements for freight increase much more quickly than do energy requirements for passenger transport. In the *Reference* scenario, energy requirements for passenger transport increase by 1.7 times between 1995 and 2010, while energy requirements for freight transport increase by 17 times over the same period. The difference between the scenarios is in the freight mode shares. Observing the greater importance of freight transport to future energy resource pressures in the *Reference* scenario, in the *Policy* scenario it is assumed that there is a shift from relatively energy-intensive road transport

[6] In the PoleStar application prepared during the workshop, energy intensities for electric vehicles were not entered, since they did not lead to emissions within the sector. For this report, to connect electricity demand to the electric generation sector, energy intensities for electric vehicles are assumed to be one-quarter the intensity of the corresponding petroleum-consuming vehicle.

to less energy-intensive water-borne transport. By 2010, water claims 50% of total freight transport, compared to 25% in the base year. Combined with the considerable expansion of freight transport this can be expected to place strong pressures on inland waterways and marine environments. As a result of the greater use of water transport in the *Policy* scenario, freight energy requirements are 8% less than in the *Reference* scenario.

4.6 Energy

As a result of rising petroleum and electricity demand for transportation and the growing energy demand for a variety of fuels in the industrial sector, energy requirements increase considerably over the course of the scenario. The discussion here will focus on electricity, the major energy conversion industry in the country.

In each scenario, a small amount of electricity is assumed to be exported, in addition to the requirements of the industrial and transport sectors. Exports in the scenarios amount to about 5% of total demand. As electricity demand—and, with it, electricity production—grows over the course of the scenario, the contribution from hydropower declines as a share of production, replaced mainly by natural gas. The contribution from hydropower drops from over 70% of the total to around 50% by the end of the scenario, while the contribution from natural gas rises from just 5% in 1995 to 30% by 2010. However, despite the declining importance of hydroelectricity as a share of production in the scenarios, growth in demand in the industrial and transportation sectors is sufficiently high that hydroelectric production increases by over 3 times over the course of the *Reference* scenario. If the number of households with electricity increases, as modern fuels gradually replace biomass in household energy consumption, then that demand would add further to the rising requirements for electricity.

Energy-related air emissions increase rapidly in the scenarios. In the Referencescenario, NOx emissions from industry and energy conversion increase by a factor of 4.0, and SO_x by emissions by a factor of 3.8, between 1995 and 2010. From the transport sector, CO_2 emissions increase by 7.6 times over the course of the *Reference* scenario, and by 7.0 times in the *Policy* scenario, despite a focus on reducing emissions from the transport sector. These increases suggest the need for strong policy action to avoid the impacts that accompany economic development, in order to protect the health of people and the environment.

4.7 Water

As a result of rising water requirements by households, industry and agriculture, pressures on water resources can be expected to increase in the future. As incomes rise, household water use per capita increases as well. As a result, even though population growth over the period 1995-2010 is fairly modest, water consumption rises rapidly. In both scenarios, household water withdrawals increase by 4% per year on average between 1995 and 2010. These increases imply pressures on water-delivery systems. Water withdrawals by industry rise at an even faster rate, at around 10% per year in each of the scenarios.

In the base year, non-agricultural water uses are relatively unimportant. However, agricultural withdrawals would not be expected to increase at the same rate of non-agricultural withdrawals. Non-agricultural withdrawals in the scenario increase by around 5 times. Currently about one-half the crop area is irrigated (SEMA, 1999a). Although this area may expand, and although application of irrigation water may increase with increased yields, the increases are unlikely to reach those in other sectors. As a consequence, agricultural withdrawals can be expected to claim a declining share of water withdrawals in coming decades.

5 Conclusions

The scenarios produced during the workshop provide a first look at some of the possible development paths Vietnam might pursue. The *Reference* scenario started with the expressed plans and goals of the government, and investigated some of the possible impacts on energy resources, air pollution, water requirements and land use. The purpose of the workshop was for training in the use of the PoleStar system software, and the scenarios are provisional. However, they suggest some potential future difficulties, if socioeconomic goals are not pursued together with environmental goals.

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