International Best Practices for Assessing and Reducing the Environmental Impacts of High-Voltage Transmission Lines

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1. Introduction

1.1 Objectives and Road Map of this Paper

This paper discusses internationally-recognized best practices for assessing, avoiding, reducing, and mitigating the environmental impacts associated with the siting, construction, and operation of high-voltage electric power transmission lines and associated facilities such as substations and converter stations. It also discusses the environmental assessment and mitigation requirements of international financial institutions (IFIs), such as the World Bank and the Asian Development Bank (ADB), that are relevant to obtaining IFI financial and/or technical assistance (TA) for transmission projects.

Section 2 of this paper contains a brief discussion of the types of environmental impacts associated with transmission lines. Note that this discussion refers only to the impacts associated with transmission facilities themselves, not to the system-wide impacts and benefits resulting from the interconnection of previously separate grids. The latter issues are discussed in a separate paper, Von Hippel and Williams, Environmental Issues for Regional Power Systems in Northeast Asia, and in other papers prepared for this workshop.

Section 3 of this paper discusses widely-accepted approaches and methods for assessing and reducing transmission line impacts. **Section 4** discusses the environmental requirements relevant to transmission line projects set by the World Bank for Bank-funded initiatives, and **Section 5** discusses Asian Development Bank requirements for transmission facilities projects. **Section 6** describes the environmental assessment and mitigation dimensions of a recent transmission project in Asia that has received IFI support: the East China (Jiangsu) Transmission Project. **Section 7** concludes with observations on the relevance of past experience to the Northeast Asia grid interconnection project. References for this paper and for further study are provided in **Section 8**.

2. Types of Environmental Impacts Found in Transmission Projects

2.1 Characterization of Transmission Line Impacts

An extensive empirical knowledge base exists on the types of environmental impacts associated with electrical transmission projects. The literature includes such sources as project environmental impact assessments and reviews, academic journals, textbooks, electric utility operations manuals, and regulatory authority and international lender guidelines.[1] Much of the knowledge base on the environmental impacts of transmission rights-of-way is represented in the proceedings of an ongoing series of international meetings on the topic.[2] The most common categories of environmental impacts appearing in this literature are described briefly in the following paragraphs.

2.2 Land Use Changes

The construction and operation of transmission lines can lead to significant land use changes in the transmission rights-of-way and on the grounds of associated facilities. Many industrial, commercial, and residential uses are incompatible with the requirement to keep transmission rights-of-way clear of obstacles and structures, and for reasons of safety and public health. Agriculture can be affected, by the elimination of cropland, the temporary loss of crop production due to construction, and the incompatibility of certain crops and agricultural activities with transmission facilities. Transportation can be affected by the placement of transmission lines and towers near airports, roads, and waterways.

2.3 Forest Impacts

Transmission line construction and maintenance can lead to the permanent removal of woody vegetation and in some cases to the complete conversion of strips of forest ecosystem into bare

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[1] Two early surveys are Goodland, R., ed. 1973, Power Lines and the Environment. Millbrook, New York: Cary Ecosystem Center, and Asplundh Environmental Services, 1979, Right-of-Way Ecological Effects Bibliography. Report No. EPRIEA-1080. Willow Grove, Pennsylvania. For a representative list of impacts with which U.S. regulatory authorities are concerned, see, for example, United States Department of the Interior,1979, Environmental Criteria for Electric Transmission Systems. Document No. 001-0100074-3. Washington, D.C.: General Printing Office. A more recent example can be found in Public Service Commission of Wisconsin, Environmental Impacts of Electric Transmission Lines, PSC Publication #6010B, July 1998, available online at http://psc.wi.gov/consumer/brochure/document/electric/6010b.pdf.

[2] Seven meetings of the International Symposium on Environmental Concerns in Rights-of-Way Management have been held in the U.S. and Canada since 1976. The most recent was held in Calgary in 2000. See Seventh International Symposium on Environmental Concerns in Rights-of-Way Management, Elsevier Publications: New York. The proceedings of these meetings include several hundred peer-reviewed research papers on a wide spectrum of topics associated with environmental impacts and management of electric, gas, and transportation rights-of-way. The Eighth International Symposium on Environmental Concerns in Rights-of-Way Management will be held in New York in September 2004. This meeting could represent an opportunity for collegial knowledge-exchange on the Northeast Asia grid integration project. Further information can be found at http://www.right-of-way-env.com.

land or land covered by completely different vegetation communities. Fragmentation, pesticide use, and invasive plant species within the right-of-way can also affect surrounding forest areas.

2.4 Wetland and Riparian Impacts

Transmission line construction and maintenance can convert areas of wetland or riparian ecosystem outright, destroy or disturb plant and animal communities, and introduce invasive species. Soil compaction and soil erosion in wetlands and riparian areas can alter hydrology, changing the timing and magnitude of water and nutrient flows essential to ecosystem functions.

2.5 Hydrologic Changes

Transmission line construction can alter hydrology by compacting soil, removing plant cover, and altering existing drainages or creating new ones. Altered hydrology can affect aquatic, wetland, and riparian habitats and species, and can affect soil moisture and surface water availability in other kinds of ecosystems.

2.6 Soil Erosion

Transmission line construction can lead to soil erosion by removing vegetation cover, compacting soils, and cutting into banks. Erosion can reduce soil fertility and lead to siltation, which affects water quality and productivity in aquatic and wetland ecosystems.

2.7 Biodiversity Impacts

The construction and operation of transmission lines can affect biodiversity in many ways, including habitat conversion and fragmentation, changes in hydrology, soil compaction and erosion, pesticide use, introduced species, and hunting and harvesting enabled by rights-of-way and construction roads. Species in small, rare, sensitive, and otherwise critical habitats may be especially affected.

2.8 Wildlife Impacts

The wildlife impacts of transmission line construction and operation include bird electrocutions and collisions, changes in predator-prey relations in and along the edges of rights-of-way, destruction or alteration of wetland and aquatic environments, and increases in hunting and fishing enabled by rights-of-way and construction/maintenance roads.

2.9 Toxic and Water Pollution

Toxic pollution from transmission lines can result from pesticide use in rights-of-way, and from the leakage of PCBs from equipment that contains them. Water pollution can result from inadequate wastewater treatment for construction camps, workshops, and staff quarters.

2.10 Safety and Public Health

Transmission lines present a risk of electrocution to the public, by direct contact with high-voltage equipment and lines, and also by induced voltages, especially in the case of vehicles and farm machinery that transit beneath transmission lines. Humans and farm animals can also risk electrocution or nuisance shock when inadequate grounding at substations energizes metal

objects, such as stock tanks, outside substation grounds. Other safety threats include the collapse of transmission towers during storms.

2.11 Electromagnetic Fields (EMF)

The effects of power-line frequency electromagnetic fields (EMF) on humans are scientifically uncertain at this point, but some studies indicate that chronic exposure to relatively high-level EMFs from overhead high-voltage AC transmission lines (and other AC equipment) can lead to an increased incidence of adverse health effects, including childhood leukemia and miscarriage.[3]

2.12 Electromagnetic Interference (EMI)

Corona and induced electromagnetic fields from the operation of high voltage transmission lines can produce electromagnetic interference (EMI), or electrical noise, that affects the functioning of electronic and telecommunications equipment. "Jitter" in television screens and computer monitors can result from EMI.

2.13 Audible Noise

Corona from the operation of high voltage transmission lines can make audible noises, often described as "hissing," in the vicinity of the right-of-way. Transformers also produce noises often described as "humming," which are frequently audible outside substation borders. People often consider such noises to be a nuisance.

2.14 Resettlement

The need to clear land for transmission rights-of-way and associated facilities can result in the removal of people living in these locations, and their resettlement in new locations. Depending on conditions, resettlement can be socially and economically disruptive to the people affected, and ecologically damaging to the area in which they are resettled.

2.15 Indigenous Peoples

Transmission lines and associated facilities, and roads built for construction and access, can affect indigenous communities in a variety of ways, including removal and resettlement from ancestral homes, destruction or damage of important cultural sites, and the opening of previously remote areas to commerce and interactions with outsiders.

2.16 Economic Disruption

The construction and operation of transmission lines and associated facilities can affect local economies by disrupting agriculture, by producing or eliminating local jobs in construction or maintenance, and by affecting property values for reasons such as aesthetic changes, perceptions of hazard, and road access.

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[3] NIEHS EMF-RAPID Program Staff, Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields, NIH Publication No. 99-4493, National Institute of Environmental Health Sciences, 1999. http://www.niehs.nih.gov/emfrapid/html/EMF_DIR_RPT/Report_18f.htm

2.17 Cultural Sites

Transmission line construction can affect cultural sites such as areas of archaeological, historical, or religious significance. Burial sites and buried artifacts may be disturbed, especially when trenches are required for underground cables.

2.18 Aesthetic Impacts

Transmission lines and towers are unattractive to many people, especially when located near their homes or near scenic sites such as parks and river crossings.

3. Best Practices for Assessing and Reducing Environmental Impacts in Transmission Projects

3.1 Best Practices in Environmental Assessment

Internationally-recognized best practices for reducing the environmental impacts of transmission line construction and operation inevitably begin with the environmental assessment (EA) process and the preparation of written environmental impact studies. Altough the names and specific details associated with environmental assessment may differ in different countries and jurisdictions, there are common features that are widely considered to reflect current international best practices. These common features include those summarized in the subsections below (3.1.1 – 3.1.9).

3.1.1 Alternative Routings

- Alternative routings must be proposed for transmission rights-of-way, as well as alternative locations for substations and other transmission facilities. Detailed maps with topographic and land use information must be included in draft and final environmental studies.

3.1.2 Specific Design Features

- Proposed line designs used for environmental assessment purposes must include, for each section of each alternative route, the specific information essential to determining potential environmental impacts, including right-of-way width, pole type and height, and span lengths. Similar information is required for substations, converter stations, and switchyards.

3.1.3 Technical Alternatives

- Relevant technical alternatives under consideration – such as the possible use of DC transmission, and the possible use of underground cables to substitute for overhead lines – should be included where applicable in descriptions of alternative routings and designs.

3.1.4 Comparative Assessment

- Environmental assessment stresses the comparative assessment of the proposed alternative routings, line designs, and technical alternatives for a number of categories of environmental impact, such as those described in Section 2 above. The null option – namely, of not building the transmission line or related facilities at all – should also be included in the

comparison as a standard against which the project can be judged.

3.1.5 Social Impacts

- Social, cultural, and economic impacts on affected populations are included within the meaning and basic intent of the environmental assessment process.

3.1.6 Expert Assessment in the Field

- Environmental assessment of transmission projects must not be paper studies only. Empirical investigations of conditions and potential impacts in the field must be undertaken by appropriate experts, including as appropriate such professionals as engineers, ecologists, biologists, economists, and anthropologists.

3.1.7 Public Input

- The environmental assessment process must actively solicit public input, including that of affected communities and non-governmental organizations (NGOs). Public input is often linked to a multi-stage process in the preparation of environmental impact studies, in which draft studies containing descriptions of the proposed alternative routings and line designs are made available for public inspection, and meetings or other venues for soliciting input on these draft studies are provided.

3.1.8 Mitigation Plans

- After routings and design alternatives have been duly considered and decided upon, specific mitigation measures to reduce specific impacts identified in the environmental assessment must be concretely described in a mitigation plan. These measures should be based on international best practices as determined through due diligence by appropriate experts. The administrative and institutional arrangements for implementation of the mitigation plan should be clearly spelled out in the final environmental assessment report.

3.1.9 Monitoring

- Monitoring of environmental impacts, as measured against baselines established in the environmental assessment process, and of the ongoing implementation of mitigation plans, must be an integral part of the construction and ongoing operation of the transmission facilities.

3.2 Best Practices in Project Implementation

In addition to the general principles of Environmental Assessment described in the previous section (Section 3.1), there are also specific best-practice techniques employed in actual project implementation. Some of the most widely-recognized environmental best practices employed during the siting, design, construction, and operation phases of transmission projects are briefly described in the sections below. This list is general in nature; it goes without saying that the

selection of the most appropriate specific methods for an actual project is always dependent on the specific conditions unique to that project.[4]

3.2.1 Avoidance of Sensitive and High Value Areas

The siting of transmission facilities must seek to avoid to the maximum extent possible areas of high ecological, cultural, economic, and aesthetic value and sensitivity. When siting in such areas cannot be avoided altogether, the area of disruption should be minimized and the impacts mitigated.

3.2.2 Use of Existing Corridors

The use of existing utility and transportation corridors for transmission facilities is generally preferred over the construction of new corridors, as long as such use does not adversely affect the environment or the pre-existing infrastructure.

3.2.3 Detailed Environmental Mapping

Proposed transmission routings should be accompanied by detailed mapping of environmental and cultural resources along the entire route, based on data collected by appropriate experts conducting field investigations, remote sensing, and other reliable data sources. Examples of the types of data required include terrain and vegetation features, hydrologic features, the presence of sensitive or endangered species, migratory bird flyways, archaeological sites, indigenous villages, agricultural and industrial facilities, and seasonally sensitive data such as fire incidence, wildlife breeding, and fish spawning periods.

3.2.4 Integration of Environmental Data and Project Design

After environmental resources are mapped, they are often entered into GIS databases, in order to be more readily available for incorporation into decisions about transmission facility design,

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[4] John W. Goodrich-Mahoney, Electric Power Research Institute, "EPRI's Rights-of-Way Environmental Issues in Siting, Development and Management Research Program: Current and Future Directions", Edison Electric Institute Natural Resources Workshop 2003, http://www.eei.org/meetings/nonav_meeting_files/nonav_2003-03-30-km/. This workshop identified five top issues requiring ongoing research:

- The Degree to Which ROWs can Function as Ecological Corridors is Unknown
- The Degree to Which ROWs are a Fragmenting Force at the Regional, Landscape, and Watershed Scale is Unknown
- Specific Knowledge is Lacking on How to Control or Limit the Spread of Invasive species and the Chemicals Used on ROWs to Other Areas
- The Ramifications of Compliance with the Migratory Bird Treat Act are Unknown
- How can ROWs Function as Habitat for T&E Species Both on the ROW and as Part of a Larger Landscape

construction, and operation.[5] Integration of environmental data with project planning can be further facilitated by using transmission design tools such as PLSCADD (Power Line Systems - Computer Aided Design and Drafting), which are specifically designed to import and display GIS data.[6]

3.2.5 Land Restoration and Set-Asides

When sensitive habitats are affected by the construction of transmission facilities, two kinds of mitigation measures are often employed. (1) Wetlands, forests, and other sensitive habitats disturbed by construction are re-landscaped and replanted with native vegetation, and otherwise restored as nearly as possible to their original condition. (2) Lands in other locations with habitats similar to those affected by the transmission project are purchased by the utility, placed in public trust, and protected from future development.[7]

3.2.6 Resettlement Plans

When construction of transmission facilities entails resettlement of individuals who live on the proposed facility grounds, a formal assessment must be undertaken and all resettlement expenses and losses paid by the utility. Resettlement decisions and implementation must adhere strictly to due process of the relevant laws in each country, as well as to international treaties and the regulations of project financiers such as the World Bank.

3.2.7 Compensation Plans

Other economic losses to individuals due to transmission facilities—for example, lost agricultural production in the right-of-way during construction—must also be formally assessed and compensated. When environmental, community, and cultural impacts affect a community as a whole—for example, in the case of damage to waterways or fisheries—these impacts should also be formally assessed and payments made to appropriate public agencies or NGOs to compensate the community, restore lost amenities, and support research into long-term effects and management practices.[8]

3.2.8 Construction Practices in Sensitive Habitats

When the construction of transmission facilities in sensitive habitats cannot be avoided altogether, impacts can be minimized in a number of ways:

- Pre-construction surveys and post-construction monitoring.
- Use of underground cables instead of overhead lines (except where cable construction is more destructive than the impacts it would avoid)

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[5] George N. Guill and Gary A. Breece, Georgia Power Company Field Services, "Mapping species of concern on transmission rights-of-way using GIS techniques", Edison Electric Institute Natural Resources Workshop 2003, http://www.eei.org/meetings/nonav_meeting_files/nonav_2003-03-30-km/.

[6] On integration of GIS data with PLSCADD, see http://www.powline.com/products/pls_cadd.html.

[7] For an example in the U.S., see http://www.sierrapacific.com/news/features/948873600.html

[8] See Preferential Standards Task Force, www.sustainenergy.org.

- Widening span lengths to reduce the number of towers in sensitive habitats, or avoiding placing towers in sensitive locations such as rivers.
- Limiting construction to dry seasons or periods when the ground is completely frozen in order to minimize the effects of construction equipment on wet soils.
- Avoiding construction during periods in which essential natural processes such as wildlife breeding and fish spawning might be disturbed.
- Providing stringent control of erosion and sedimentation when vegetation is removed.
- Using helicopters for tower installation and other means of minimizing road-building in remote areas.
- Minimizing construction duration, noise, and use of explosives.
- Ensuring that construction equipment is properly cleaned to avoid accidental spreading of invasive species.
- Employing cultural experts in the project team to identify and protect valuable archaeological and cultural artifacts and sites encountered during construction.

3.2.9 Pest and Vegetation Management

Control of insects and vegetation in transmission rights-of-way should be conducted so as to minimize impacts on surrounding ecosystems. The techniques employed are generally referred to as Integrated Pest Management and Integrated Vegetation Management, and are adopted as appropriate to specific site conditions—for example, the terrain, vegetation type, and species present—along the entire right-of-way, as indicated by environmental mapping. IPM and IVM minimize the use of herbicides and pesticides in favor of practices such as replanting with native species, manual mowing and trimming, and maintaining populations of natural predators. Where herbicides and pesticides are used, they are precisely targeted and applied to minimize their spread into surrounding ecosystems.[9]

3.2.10 Wildlife Protection

Techniques for protecting wildlife in transmission rights-of-way and substations must adapted for specific local conditions. Some widespread methods include the following:

- Bird collisions can be avoided by siting of towers and lines away from avian flyways, based on environmental surveys.
- Traditional lethal methods of controlling wildlife to protect transmission facilities—for example, shooting or poisoning birds and small mammals to prevent them from shorting out equipment such as transformers and breakers—must be replaced by non-lethal methods. For birds these methods include air guns and propane exploders to frighten them away, and the

[9] See U.S. EPA IPM strategies at http://www.epa.gov/oppbppd1/PESP/strategies/2003/eei03.htm. Much of what is known about long-term vegetation management on electric transmission rights-of-way comes from the 50-year study by Bramble and Barnes, commenced in 1953. See Mike Neal, "Working with Natural Resource Groups to develop a National Standard for Vegetation Management" http://www.eei.org/meetings/nonav_meeting_files/nonav_2003-03-30-km/.

elimination of convenient nesting places on transmission towers.[10] For small mammals, these include such methods as squirrel guards, electric fences, and the use of predator scents.[11]

- Illegal hunting and fishing in transmission rights-of-way, by utility employees as well as by members of the public, must be strictly monitored and prevented. Limiting public access to rights-of-way, and minimizing the construction of roads into otherwise roadless areas, can also reduce illegal hunting.
- In some cases, transmission rights-of-way may be managed proactively for wildlife habitat restoration and the creation of wildlife corridors to connect protected areas and reserves.

3.2.11 EMF Reduction

Although the health effects of chronic exposure to EMFs from AC transmission lines remain scientifically uncertain, many utilities and regulatory authorities employ EMF reduction practices as a precautionary measure, usually within the limit of a few percent of overall project cost. Guidelines differ from country to country; in many places, utilities seek to keep annual average magnetic field intensities at the edge of the right-of-way below about 10 mG (milli-Gauss). This is usually accomplished by one or more of the following methods:[12]

- Use of DC transmission instead of AC transmission. DC transmission produces primarily static electric fields, and is therefore assumed to pose a minimal EMF-related human health concern.
- Use of underground cable, especially in populated areas.
- Raising conductor height above the ground, typically by increasing tower height.
- Reducing conductor spacing.
- Arranging phases so that fields tend to cancel.
- Increasing transmission voltage (since magnetic field intensities are a function of current, and increased voltage, all things being equal, will result in reduced current).
- Reducing loads (and therefore, currents).
- Increasing right-of-way widths or buffer zone widths, to move people further from transmission lines.

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[10] Gary Littauer, Avian Predators: Frightening Techniques for Reducing Bird Damage at Aquaculture Facilities, Publication 401, Southern Regional Aquaculture Center, 1990. http://aquanic.org/publicat/usda_rac/efs/srac/401fs.pdf

[11] See http://www.bentonpud.org/articles/Squirrels_0403.htm, http://www.crnweb.org/crnweb/news/DV/9/00/0000082.asp?uri=2085, http://www.critterguard.org/article_curbingcritters.htm

[12] Southern California Edison, EMF Design Guidelines for New Electrical Facilities, SCE EMF Education Center, 1994. (Not available online).

3.2.12 Aesthetic Improvement

Transmission tower aesthetics can be made more acceptable to many people by changes in tower material, height, or color. For conductors, sandblasted wires can be used to reduce the glare from reflected sunlight off of transmission wires. Underground cables can be used in especially sensitive scenic areas.

4. World Bank Environmental Guidelines for Transmission Projects

4.1 World Bank Environmental Policy

The World Bank made its first explicit recognition of environmental concerns when it created the position of Environmental Adviser in 1970. In the 1980s, facing increasing public criticism over the environmental and social consequences of its lending policies, the Bank adopted formal guidelines for environmental and social screening of projects. Particularly since the Rio "Earth Summit" in 1992, lending explicitly directed to environmental improvement has received increasing emphasis, and environmental and social "safeguard" policies are now systematically integrated into the review process for all forms of Bank assistance. The most recent codification of these policies came in 2001, when the World Bank Board endorsed an official Environment Strategy that named environmental protection, social cohesion, and economic growth as the three legs of the sustainable development tripod that support the Bank's core mission of alleviating poverty.[13]

4.2 World Bank Organization and Procedures Relevant to Transmission Projects

Under President James D. Wolfenson and the Board of Managing Directors, the World Bank is organized into regional and functional departments known as Vice-Presidential Units (VPUs). The six regional VPUs are highly autonomous, and each holds the ultimate responsibility for Bank lending that region. The current Vice-President for the East Asia and Pacific region is Jemal-ud-din Kassum. Within each VPU are country units (Country Departments and Country Offices) for the countries in the region, some of which are located at World Bank headquarters in Washington, D.C., and others in field offices in the countries themselves. These units are the principal interface between the Bank and the national governments of borrowing countries. Evaluation of proposals for Bank assistance is assigned to task teams selected from the country units.

In addition to regional VPUs, the Bank also has seven Network VPUs. The Bank's environmental work is led by the Environmentally and Socially Sustainable Development (ESSD) VPU, of which the current Vice-President is Ian Johnson. Within the Environment Division, the more than 100 staff members responsible for Environmental Assessment (EA) are coordinated by Jean Roger Mercier, Lead Environment Specialist. Regional Environment Sector Units, or RESUs, provide technical assistance to task teams evaluating project proposals. The

[13] World Bank, Making Sustainable Commitments: An Environment Strategy for the World Bank, Washington, D.C.: World Bank, 2001. http://lnweb18.worldbank.org/ESSD/envext.nsf/41ByDocName/EnvironmentStrategyEnvironmentStrategyDocument

RESU Director for East Asia and the Pacific is Maria Teresa Serra. Another Network VPU relevant to electric transmission projects is the Infrastructure VPU, which includes the energy sector. The Infrastructure Vice-President is Nemat Shafik. Within the Infrastructure VPU is the Energy and Mining Sector Board, chaired by Jarral Saghir. The Energy and Mining Sector Unit (EASEG) of the East Asia and Pacific Region is located at Bank headquarters and in field offices in China, Thailand, and Vietnam. The Acting Director of EASEG is M. Farhandi.

Several recent trends in Bank assistance policies are relevant to a possible East Asian grid interconnection project.

- Energy sector loans have decreased substantially, from about 25 percent of total lending throughout the 1970s and 1980s, to about 10 percent by 2000.[14]
- In 2001, the Bank established two explicit priorities for energy sector assistance: (1) power sector reform (2) provision of energy services to the poor.[15]
- Since about 2000, energy infrastructure loans to middle-income countries have been de-emphasized.
- Since about 2000, project lending in general has been de-emphasized relative to other forms of Bank assistance, including technical assistance (TA) and alternative financial instruments such as loan guarantees and risk insurance. The Bank now envisions its role more as a seed loan provider, technical advisor, and coordinator of public-private partnerships, than as a source of bulk finance.[16]
- The current EASEG portfolio includes 24 active projects with a net commitment value of US$4.0 billion. Of these, 5 are electricity transmission projects, with a commitment value of US$1.4 billion.

The procedures for obtaining Bank assistance depend on a number of variables, including the types of financial instruments or assistance sought, what organizations are involved on the borrower side, and the precise nature of the project. In general, the steps for completing the environmental component of loan applications includes the following steps, which are undertaken by a partnership of the borrower and the Bank's task team:

- Creation and approval of a Project Concept Document (PCD). "The PCD defines the rationale for a proposed investment operation and …serves as the basis for a Bank decision to assist a borrower with project preparation."
- Creation and approval of a Project Appraisal Document (PAD) "…which evolves from the PCD… and summarizes the task team's assessments of various aspects of the operation… The PAD serves as the basis for the Bank's appraisal."
- Creation and approval of a Project Implementation Plan (PIP), which "presents main project components, implementation plan, and arrangements for monitoring and evaluation."

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[14] World Bank Energy and Mining Sector Board, The World Bank Group's Energy Program: Poverty Reduction, Sustainability and Selectivity, 2001. http://www.worldbank.org/energy/pdfs/energybrochure.pdf

[15] Ibid.

[16] See "Infrastructure Action Plan" at http://www.worldbank.org/infrastructure/.

- Environmental Assessment (EA). This is the process by which environmental and social impacts are identified and avoided or mitigated.
- In some cases with significant potential environmental impacts, an Environmental Monitoring Plan (EMP) is required.

Specific guidance on Bank criteria and procedures, including those that apply to Environmental Assessment, are generally based on one of three kinds of internal Bank documents: Operational Policies (OPs), Bank Procedures (BPs), and Good Practices (GPs). These are found in The World Bank Operational Manual and in other Bank manuals and guides. Those most relevant to the East Asian grid interconnection project are discussed in the next section (Section 4.3).

4.3 World Bank Environmental Safeguard Policies Relevant to Transmission Projects

Within The World Bank Operational Manual, ten policies are identified as "Safeguard Policies," the purposes of which are to ensure that adverse environmental and social consequences of projects receiving Bank support are identified, minimized, and mitigated. The ESSD VPU is responsible for ensuring the application of the Safeguard Policies. The Safeguard Policies most relevant to environmental assessment of electric transmission projects are briefly described in the following sections of this paper (and cross-referenced to sections in the Manual).

4.3.1 OP& BP 4.01 Environmental Assessment

OP & BP 4.01 describe the Bank's Environmental Assessment policies and procedures, which form the umbrella for all Safeguard Policies. During initial screening, proposed projects are grouped into one of four categories with respect to potential environmental impact. These categories determine the extent and nature of the Environmental Assessment process for that project. Category A projects have the most extensive environmental impacts and require the most extensive EA (an example of a Category A project is a large power plant or hydroelectric dam). Category B projects have more limited impacts and require a more limited EA. Category C projects are deemed to have negligible environmental impacts and do not require an EA. Category FI (Financial Intermediary) projects also do not require an EA to be submitted to the Bank, but are still required to meet the EA requirements of the principal project financier and host country. Electric transmission projects usually fall into Category B. Borrowers—not the Bank—are responsible for retaining EA specialists to conduct the EA. The EA must ensure that the project meets the relevant environmental laws and regulations of the host country. The Bank task team, however, provides oversight to ensure that the EA is conducted properly and that Safeguard Policies are fulfilled.

4.3.2 OP& BP 4.04 Natural Habitats

The Bank does not support projects that involve any significant conversion or degradation of *critical* natural habitats, or conversion or degradation of any natural habitats whatsoever unless there are no feasible alternatives and a comprehensive analysis demonstrates that the overall project benefits substantially outweigh environmental costs. The Bank also expects the borrower to closely involve local communities and NGOs in evaluating, planning, implementing and monitoring projects involving natural habitats and protected natural areas.

4.3.3 OP & BP 4.09 Pest Management

The Bank supports pest management strategies that promote biological or environmental control and reduce reliance on chemical pesticides, though pesticide use is acceptable if justified within an IPM framework. Borrowers must address pest management in the project's environmental assessment. If the Bank considers the technical and regulatory capacity of the borrowing country to be inadequate with regard to pest management, the Bank and the borrower will work together to strengthen such capacity. The benefits of pesticide use must be commensurate with risks, as categorized in the World Health Organization's "Recommended Classification of Pesticides by Hazard" (Geneva: WHO 1994-95).

4.3.4 OP& BP 4.11 Cultural Property

The term "cultural property" refers to sites and artifacts of archeological, paleontological, historical, or religious value, and also to places possessing extraordinary natural aesthetic values (such as canyons and waterfalls). The Bank will not finance projects that significantly damage non-replicable cultural property, and damage to any cultural property must be justified by overall project benefits as demonstrated by comprehensive analysis. Although the management of cultural property is the responsibility of the borrowing country, when a proposed project poses risks to cultural property competent authorities in government agencies, universities, and NGOs must be included in project evaluation, planning, implementation, and monitoring.

4.3.5 OP & BP 4.12 Involuntary Resettlement

The policy on involuntary resettlement was the first Safeguard Policy adopted by the Bank, in 1980. "Involuntary resettlement" refers to the involuntary taking of land resulting in relocation, loss of shelter, loss of assets, or loss of means of livelihood. The Bank considers that involuntary resettlement frequently leads to severe long-term hardship, impoverishment, and environmental damage. It should be avoided if at all feasible, and alternative project designs that involve no involuntary resettlement should always be considered. When it is not feasible to avoid involuntary resettlement, displaced persons should be meaningfully involved in planning their resettlement, should be fairly compensated for their losses, and should share in the benefits of the project.

4.3.6 OP & BP 4.36 Forests

Much of OP 4.36 concerns commercial forestry practices that do not pertain to electric transmission processes. However, it also makes clear that the Bank will not support any projects that involve significant conversion or degradation of *critical* forest areas and *critical* natural habitats, or projects that contravene international environmental agreements on forests and habitats. The Bank may support projects that involve some conversion of non-critical forests or habitats if comprehensive analysis demonstrates that there are no feasible alternatives and that the overall benefits of the project outweigh the environmental costs.

4.3.7 OP & BP 7.36 Projects in Disputed Areas

Projects in internationally disputed areas are considered highly delicate by the Bank. However, the Bank may support a project in a disputed area if the claimants have no objection to the project; or if the Bank determines that there are special circumstances that warrant approval notwithstanding objections by some claimants. Issues involving disputed areas fall under the jurisdiction of the Bank's Legal Vice President.

4.4 World Bank Environmental Assessment Guidelines for Transmission Projects

The Environmental Assessment Source Book, last updated in1999, contains guidelines for conducting EA for projects of various kinds, along with recommendations regarding environmental "good practices." Chapter 10 of the Source Book deals with energy projects, and includes a section that deals specifically with electric transmission projects. Relevant passages are quoted in the sections below.

4.4.1 Potential Environmental Impacts

"Electric power transmission lines are linear facilities that will affect natural and sociocultural resources… In general, the environmental impacts to natural, social, and cultural resources increase with increasing line length… The magnitude and significance of the impacts increase as the voltage of the line increases… Clearing of vegetation from sites and ROWs [rights of way] and construction of access roads, tower pads, and substations are the primary sources of construction-related impacts ... Operation and maintenance of the transmission line involves chemical or mechanical control of vegetation in the ROW…"

4.4.2 Effects on Land Use

"Electric power transmission lines have the greatest impact on land resources…Although ROWs are generally not very wide, they can interfere with or fragment existing land uses along the ROW. Long transmission lines will affect more areas and result in more significant impacts… Transmission lines can open up more remote lands to human activities such as settlement, agriculture, hunting, recreation, etc. Construction of the ROW can result in the loss and fragmentation of habitat and vegetation along the ROW. These effects can be significant if natural areas, such as wetlands or wildlands are affected, or if the newly-accessible lands are the home of indigenous peoples."

4.4.3 Clearing and Control of Vegetation in Rights-of-Way

"A variety of techniques exist for clearing vegetation from the ROW and controlling the amount and type of new plant growth. From an environmental point of view, selective clearing using mechanical means or herbicides is preferable and should be evaluated in project EAs. Broadcast aerial spraying of herbicides should be avoided because it affords no selectivity, releases unnecessarily large amounts of chemicals into the environment, and because it is an imprecise application technique, may result in contamination of surface waters and terrestrial food chains, as well as elimination of desirable species and direct poisoning of wildlife."

4.4.4 Health and Safety Hazards

"Placement of low-slung lines or lines near human activity (e.g., highways, buildings) increases the risk for electrocutions. Technical guidelines for design ordinarily minimize this hazard. Towers and transmission lines can disrupt airplane flight paths in and near airports and endanger low-flying airplanes, especially those used in agricultural management activities. Electric power transmission lines create electromagnetic fields (EMFs)... The scientific community has not reached consensus on specific biological responses to EMF, but the evidence suggests that health hazards may exist…"

4.4.5 Induced Development

"Depending on their location, transmission lines may induce development in or bordering on ROWs or in lands made more accessible. In locales where the supply or housing is limited, cleared ROWs are often attractive sites for non-permitted housing, which in turn gives rise to other environmental impacts and overburdens local infrastructure and public services."

4.4.6 Project Alternatives

"The environmental assessment should include an analysis of reasonable alternatives to meet the ultimate project objective of the distribution of electricity to load centers. The analysis may lead to alternatives which are more sound from an environmental, sociocultural, and economic point of view than the originally proposed project. A number of alternatives need to be considered, including: taking no action to meet the needed capacity; alternative voltages; DC transmission lines (permitting narrower ROWs); alternative sources of electricity; construction of smaller power facilities closer to the loads as an alternative to bulk power transmission; energy and load management plans to reduce need for additional power; upgrading of existing facilities; alternative routes and substation sites; underground transmission lines; alternative methods of construction including costs and reliability ; alternative transmission tower design and materials (e.g., wooden poles, steel or aluminum structures, etc.); alternative maintenance techniques and road designs. One of the most important considerations is an evaluation of alternative routes and substations sites. Many of the environmental impacts resulting from electric power transmission lines can be avoided or minimized by careful ROW and substation site selection."

4.4.7 Management and Training

"Depending on the education and experience of the staff, training in the environmental management of electrical power transmission lines may be warranted…The training should be done as part of the environmental assessment phase of the project…staff workers must have an understanding of the rationale for the recommended mitigation and monitoring that they may be implementing. Local, regional, and national environmental agencies involved in the review and approval of the project may also need training to monitor and enforce compliance during the construction and operation of the project."

4.4.8 Monitoring

"The monitoring requirements for transmission lines will be dependent on the type of environmental resources involved and the degree to which they are affected. Monitoring construction activities may be required to assure that negative land use and/or ecological impacts

are avoided and proper mitigation measures are employed. Monitoring of these impacts will be short-term (e.g., weeks) and occur along the line as it is constructed. Monitoring may be especially critical at crossings of major water bodies or wetlands, near wildlands and cultural properties. The actual monitoring will be based on visual inspections of the materials being used, the construction practices, and mitigation measures. Monitoring of ROW maintenance activities is also to be required to assure proper vegetation control methods, to prevent invasion of exotic species, and to support decisions which take advantage of possible benefits to wildlife."

5. Asian Development Bank (ADB) Environmental Guidelines for Transmission Projects

5.1 ADB Environmental Policy

In 2002, the Asian Development Bank (ADB) underwent a major reorganization, and at the same time its Board of Directors approved a new comprehensive policy on environmental protection. Like the World Bank, the ADB now officially embraces environmental protection as a core component of economic development and a central focus of the ADB mission. The new policy specifies the organizational structures and procedures required to integrate environmental considerations more fully into all ADB assistance processes and to ensure that environmental assessment is treated as an ongoing process rather than a one-time affair.[17] The operational details of the new environment policy are spelled out in the 2003 versions of the ADB Environmental Assessment Guidelines and the ADB Operations Manual. Aspects of the AEB environment policy potentially relevant to transmission projects are described in the sections below.

5.2 ADB Organization

The Chairman of the Board and chief executive of the ADB is the President, currently Tadao Chino. The principal operating units of the ADB are the five regional departments. The East and Central Asia Department (ECRD) is headed by the Director General, currently M.E. Tusneem. Within each regional department is an Infrastructure Division, which oversees energy projects proposed for that region, including electricity transmission. The directorship of the ECRD Infrastructure Division is currently vacant. Under the regional departments are the country offices, which are the main interface between the ADB and member countries for project lending and other forms of assistance.

In 2002, a new organizational entity, the Regional and Sustainable Development Department (RSDD), was created as the unit principally responsible for developing new policies and overseeing compliance throughout the ADB, and also for promoting regional cooperation and coordination. Within the RSDD, the Environment and Social Safeguard Division (ESSD) was created for the purpose of ensuring that regional departments implement ADB safeguard policies on the environment, resettlement, and indigenous peoples.[18] ESSD is responsible for developing

[17] Asian Development Bank, Environment Policy R-Paper, 8 November 2002. http://www.adb.org/documents/policies/environment/default.asp?p=policies

[18] http://www.adb.org/Documents/Others/Reorganization_2002/reorg0300.asp

and disseminating best practices and environmental assessment guidelines to the regional departments. The RSDD Director General is currently Akira Seki. The directorship of ESSD is currently vacant.

ADB work relevant to electric transmission projects is also overseen internally by cross-cutting sectoral and thematic committees. The current chair of the Environment Committee is E. Ouano, and the current chair of the Energy Committee is Mukhtar Ahmed.

5.3 ADB Environmental Assessment Requirements for Transmission Projects

5.3.1 Project Categorization

The process and specifications for environmental assessment of projects proposed to ADB are specified in ADB Environmental Assessment Guidelines, issued in May 2003, and in the ADB Operations Manual, Section 20, issued in February 2003. The first step in environmental assessment for all proposed projects is categorization.[19] Projects are assigned to one of four categories (A, B, C, or FI), based on the project's potential for environmental impact. These categories are defined in the Operations Manual as follows:

- "Category A: Projects with potential to have significant adverse environmental impacts. An environmental impact assessment (EIA) is required to address significant impacts."
- "Category B: Projects judged to have some adverse environmental impacts, but of lesser degree or significance than those for category A projects. An initial environmental examination (IEE) is required to determine whether or not significant environmental impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report."
- "Category C: Projects unlikely to have adverse environmental impacts. No EIA or IEE is required, although environmental implications are still reviewed."
- "Category FI: Projects are classified as category FI if they involve a credit line through a financial intermediary or an equity investment in a financial intermediary. The financial intermediary must apply an environmental management system, unless all subprojects will result in insignificant impacts."

In general, power transmission projects are assigned to Category B. However, the assignment is not automatic. Environmental impact categories are assigned by the Chief Compliance Officer of the RSSD, based on two forms that must be submitted by the project proposers. One is the Environmental Categorization Form, which is used for all projects (see Appendix). The other is the Rapid Environmental Assessment (REA) Checklist, which is specific to different types of projects. The REA is prepared by the project proposer with the assistance of an environment specialist in the regional department.

There is a specific REA for Power Transmission projects (see Appendix). The intent of the checklist is to rapidly determine two aspects of the project: the ecological sensitivity of the

[19] Asian Development Bank, ADB Environmental Assessment Guidelines, Manila: ADB, 2003. http://www.adb.org/Documents/Guidelines/Environmental_Assessment/default.asp

geographical areas in which the project is to be sited, and the potential severity of the impacts. Areas of special concern in the REA include:

- cultural heritage sites
- protected areas
- mangroves
- wetlands
- estuarine areas

Impacts of special concern in the REA include:

- encroachment on precious ecosystems
- disfiguration of landscapes
- erosion and altered hydrology
- damage to marine habitats by submarine cables
- pollution, siltation, noise, and disease transmission from construction activities
- unwanted access to protected areas
- dislocation or resettlement of local population
- creation of social conflict or economic losses for local population
- hazards to human and ecosystem health from vegetation control activities

5.3.2 The Initial Environmental Examination (IEE)

Since most electricity transmission projects are Category B, they are required to prepare an Initial Environmental Examination (IEE) report. Areas of investigation and study methodologies are investigated during a scoping phase. The IEE process requires public participation, with a 120-day public notice period prior to public hearings. The IEE includes the following components:

- Collection of baseline information on biophysical, social and economic aspects of the project area.
- Prediction of the nature, extent, and magnitude of environmental changes likely to result from the proposed project, with appropriate quantitative detail.
- Technical, social, and institutional measures to be implemented as integral elements of the project to reduce its impact.
- Preparing the Environmental Monitoring Plan (EMP)—covering all phases of the project from pre-construction through decommissioning, clearly defining responsibilities for mitigation, monitoring, enforcement, and remedial actions. The EMP should have the following features:

· Realistic sampling program (temporal and spatial)

· Sampling methods relevant to source

- Collection of quality data
- Comparable new data with other relevant data used in environmental assessment
- Cost-effective data collection
- Quality control in measurement and analysis
- Innovations (for example, in tracing contaminants and in the use of automated stations)
- Appropriate databases
- Multidisciplinary data interpretation to provide useful information
- Reporting for internal management and external checks
- Allowance for, and response to, input from third parties
- Presentation in the public arena (external assessment)

Additional information relevant to transmission projects may be found in the following sections of the ADB Operations Manual:[20]

- OM Section 20: Environmental Considerations
- OM Section 28: Regional Cooperation
- OM Section 50: Involuntary Resettlement
- OM Section 53: Indigenous Peoples

6. Case Study: East China (Jiangsu) Transmission Project

6.1 Project Description

The East China Transmission Project is a 500 kV transmission project in Jiangsu Province, proposed to the World Bank in 1997. The project implementer was the East China Electric Power Group Corporation (ECEPGC). The main project components were the construction of 993 km of new 500 kV transmission lines, plus five new 500 kV / 220 kV substations with a total capacity of 4000 MVA. A principal goal of the project was to support the new privately funded 2100 MW Yancheng power plant in Shanxi by providing bulk power transfer capacity to load centers in southern Jiangsu. The proposal also sought technical assistance and capacity-building components in order to further the corporatization and commercialization of ECEPGC and carry out a detailed design and implementation of a regional power market to increase power trade in East China. In 1998 the World Bank approved an IBRD loan of US$250 million to the project, or 31 percent of the total project cost of US$800 million.[21]

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[20] Asian Development Bank, ADB Operations Manual, Manila: ADB, 2003. http://www.adb.org/Documents/Manuals/Operations/default.asp

[21] The World Bank, East Asia and Pacific Region, Energy and Mining Development Sector Unit, Project Appraisal Document on a Proposed Loan in the Amount Of US$250 Million to the People's Republic of China for an East China (Jiangsu) Power Transmission Project, Report No: 1720 1-CHA, March 2, 1998.

6.2 Environmental Assessment

The initial appraisal of the project by the East Asia and Pacific Region Energy and Mining Board in tandem with the project implementer found that the potential environmental issues included safety, noise and fire hazards from transformers, electromagnetic radiation, and leakage and contamination from transformer oil or PCB-containing equipment. To limit impacts, the project implementer proposed to adhere to internationally accepted design standards and to monitor compliance, including no use of PCBs. The implementer also proposed to plan tower placement to minimize impacts to farm fields and to use line routes that would avoid populated centers, especially schools and clinics.

Based on the initial appraisal, the project was assigned to environmental Category B. Although a full EIA was not required either by the Bank or the National Environmental Protection Agency of China, ECEPGC engaged the international engineering and environmental consulting firm Golder Associates, with headquarters in Denver, Colorado, to conduct a full EIA, in conjunction with the National Environmental Protection Research Institute (NEPRI) of the Ministry of Electric Power. The report was to be completed in time for the Bank's appraisal of the loan proposal.

Resettlement was another issue identified in the initial appraisal. It was determined that the preparation of a Resettlement Action Plan would be conducted in two stages. "From earlier work on projects where transmission investments have been required, it has been determined that a complete resettlement action plan (RAP) cannot realistically be completed before project negotiation. The nature of transmission projects are such that most of the detailed routing of the transmission line and sitting of transmission towers is done in stages once the project financing is fully secured and the detailed engineering commences… The first-stage RAP will specify the resettlement policies and regulations, institutional arrangements, implementation procedures for all resettlement actions that would be carried out under the project, and a preliminary census of affected population. The first RAP will be completed before the project preparation mission." The second stage RAP was to be produced following project approval.

The EIA was completed in May 1998, with an accompanying Environmental Management Plan (EMP). The completed document is 377 pages long. On review the Bank concluded that all environmental aspects were satisfactorily addressed in the EIA, and that the EMP was adequate to insure the "sustained integrity of the mitigation program."

The main environmental issues considered during preparation of the EMP included:

- Loss of agricultural output and increased burden on local infrastructure during construction of the project
- Electromagnetic field (EMF) impacts on human health
- noise (from corona discharge)
- water body crossings and proximity to wetlands
- traversal of transportation (road, rail, water) corridors

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http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/1999/07/22/000178830_98111703542922/Rendered/PDF/multi_page.pdf

- migratory bird paths
- loss of agricultural land
- waste discharges at substations.

The principal mitigation measures incorporated into the project design included:

- runoff management and road alignment during the construction phase
- appropriate routing of transmission lines and siting of substations, as well as proper design considerations (height, spacing, right-of-way) for transmission towers, and substation noise control

The EIA and EMP were found to have addressed all the concerns expressed by affected parties in a series of 30 public meetings on environmental aspects of the project.

When the original project was completed, an extension project was undertaken, with the principal goal of building two additional substations. The EIA for this project was conducted, with Bank approval, entirely by State Power Corporation Environmental Protection Research Institute (SPEPRI). The EIA for the project extension was completed in 2002.

7. Conclusion

7.1 Summary

This paper has described the main types of environmental impact encountered in electricity transmission projects, along with internationally accepted best practices for assessing, avoiding, reducing, and mitigating these impacts. It has also discussed World Bank and ADB environmental assessment procedures and guidelines relevant to transmission projects, and as a case study described the environmental assessment process for the East China (Jiangsu) Transmission Project, a project comparable in scale to the proposed NEA grid interconnection that received substantial funding from the World Bank.

7.2 Implications for NEA Grid Project

7.2.1 Key Environmental Issues

Potential environmental impacts of the Northeast Asia grid project will depend strongly on the routing and design of the project. Indeed, it is difficult to predict what the principal impacts will be until specific routing and design options are available for detailed analysis. Nonetheless, based on the tentative routing and proposals discussed to date, it seems likely that the following types of environmental impact will require particular scrutiny as the project proceeds:

- Land use changes, especially in the Russian Far East and the DPRK
- Resettlement
- Interactions with sensitive wildlife habitat, wilderness areas, and national parks in all participating countries, with special emphasis on the Tumen River region and the DMZ (the de-militarized zone between the ROK and DPRK).

7.2.2 Methods and Costs of Avoidance and Mitigation

Utility industry publications, government regulations, and IFI guidelines contain numerous "best practice" methods for the assessment, avoidance, reduction, and mitigation of environmental damage from transmission projects. Many of these are briefly discussed in Section 3 above. The methods applicable to specific projects vary according to the project siting and design. Based on current proposals for the NEA grid project, some of the methods that are likely to be important include:

- Early initiation of environmental assessment during the project planning process, including preliminary impact estimates and the involvement of suitable experts on potentially affected ecosystems and communities.
- Selection of transmission line routings that avoid sensitive habitat.
- Use of DC transmission.
- Co-siting of transmission lines along existing rights-of-way.
- Use of integrated pest/vegetation management methods.

The cost of environmental assessment and mitigation is highly depended on the kinds of impact involved and the methods employed. In the United States, reported costs of assessment and mitigation range from less than 1 percent up to about 20 percent of total project cost.[22] It goes without saying that conditions and costs associated with mitigating transmission line impacts in the U.S. may differ substantially from those in NEA region.

7.3 Implications for IFI Funding of NEA Grid Project

7.3.1 Challenges and Opportunities

In principle, NEA grid interconnection has an opportunity to elicit financial and technical support from IFIs and other multilateral organizations on environmental grounds. NEA grid interconnection is consistent with recent strategic decisions at both the World Bank and the ADB to emphasize the environment and regional development. Among the potentially environmentally attractive features of the NEA grid interconnection are:

- The prospects for decreased net emissions due to efficiency gains in an interconnected NEA grid.
- The prospects for decreased net construction, mining, and other polluting or environmentally disruptive activities due to interconnection.
- The prospect of enhanced regional environmental cooperation, beginning with the harmonization of different environmental management standards and procedures in the

[22] The higher end of the range is represented by a recent project in the western U.S., the Alturas Intertie Project. This project entailed the construction of about 200 miles of 345 kV AC line, plus several substations. According to the company, Sierra Pacific, "Of the $159 million budgeted for the power line project, approximately $27 million or 17 percent of the total went toward environmental studies and mitigation measures." http://www.sierrapacific.com/news/features/948873600.html

different NEA countries with regard to the assessment and mitigation of transmission line impacts.

- The prospect of enhanced regional accounting of environmental costs and externalities, beginning with the cooperative assessment of NEA grid interconnection environmental costs and benefits.
- The prospect of the creation of electricity market/trading institutions that integrate environmental concerns through market forces into network-wide planning and operation of the interconnected NEA grid.

At the same time there are a number of challenges to obtaining IFI support, many of which are not fundamentally environmental in nature, but which may complicate environmental analysis and mitigation. These include:

- The four participating countries – Russia, China, ROK, and DPRK – fall into quite different membership, geographical region, and income categories in both the World Bank and ADB. For example, the DPRK is not a member of either IFI, and would have to be accepted for membership prior to becoming eligible for project finance. As another example, China is in the East Asia and Pacific region of the World Bank, while Russia is in the Europe and Central Asia region. Since both the World Bank and ADB are organized to emphasize regional autonomy, these affiliations to different regions according to political geography—the actual location of the project entirely in East Asia notwithstanding—may present an institutional challenge.
- The World Bank has recently made an effort to redefine its role, moving away from being a source of bulk finance toward becoming a source of seed finance and technical expertise. It has also de-emphasized energy infrastructure lending to middle income countries. Whether this new orientation will hold is not yet certain, since several influential borrower countries, including China and India, have recently indicated their strong dissatisfaction with a move away from energy infrastructure lending. Nonetheless, the environment for energy infrastructure lending seems somewhat uncertain at present and may constitute a challenge.

7.3.2 Roadmap for Environmental Assessment Process

An environmental assessment along the general lines of that required by the World Bank, as described in Section 4 above, will be required by the participating governments to satisfy their own national environmental laws, whether or not IFI funding is actually sought. The general roadmap for environmental assessment includes the following steps:

- Early integration of environmental assessment into project design and discussions of project finance.
- Initial environmental scooping of preliminary project designs and categorization of potential impacts and scale/type of environmental assessment required.
- Commissioning of internationally certified environmental assessment teams including all necessary professional competencies.
- Conduct of environmental assessment, including involvement of affected communities and non-governmental organizations, with due notice of public meetings and comment periods.

- Creation of monitoring and oversight institutions, and hiring of necessary personnel, to ensure that mitigations are correctly conducted during project construction and operation.
- Conduct of a follow-up assessment, to demonstrate compliance and report project outcomes.

As a final note, the most substantial current challenge to the NEA grid project is probably not environmental, but rather institutional. The institutional form of ownership and governance of a possible NEA interconnection is still uncertain, as are the operating principles and trading rules. Clearly, these issues must be clarified in order for the project to move forward. Possibly, a sub-regional dialogue on the NEA interconnection, similar in form to the WB/ADB/ESCAP sponsored discussion of Greater Mekong Sub-Region electricity trading, may contribute to the design of a mutually satisfactory institutional arrangement. Such a sub-regional dialogue might also begin work on harmonization of environmental standards, procedures, and institutions that the NEA interconnection will require.[23]

[23] Enrique Crousillat, World Bank, "Developing International Power Markets in East Asia," Note No. 143 May 1998.

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ANNEX:
ILLUSTRATIVE DOCUMENTS

Table 1: Comparison of Alignments

Item	Alignment I	Alignment II	Alignment III
Length	400 km	393 km	402 km
Terrain	Hilly and plain	Hilly and plain	Hilly and plain
Environmental details			
Towns in alignment, nearby	Sundergarh, Belpahar, Raigarh	Sundergarh, Sambhalpur, Raipur, Belpahar, Raigarh	Birkera, Ghunghuti, Raigarh
No. of houses in right-of-way (ROW)	Some houses are expected in ROW	Negligible	Some houses are expected in ROW
Forest area (km)	31.5	14.22	22.5
Forest area (ha)	151.2	68.256	108.00
Type of flora	Sal, Bija, Asan, Mohu,Palas	Sal, Bija, Asan, Mohu,Palas	Sal, Bija, Asan, Mohu, Palas
Type of fauna	Jackal, fox, monkey	Jackal, fox, monkey	Jackal, fox, monkey
Endangered Species	None	None	None
Compensation cost (Rs in million)	5.0	2.0	4.5
Construction problem	Anticipated due to dense forest, poor access, as well as presence of some houses in the ROW.	All locations are accessible all year round.	Line passes through thickly populated area, and dense forests, and some tower locations are in uplands; access is difficult, and number of extra high voltage (EHV) crossings is great.
Operation and Maintenance (O&M) problems	O&M problem are comparatively greater due to involvement of more forest and difficult access.	O&M problems are comparatively less due to minimum involvement of forest, presence of access roads.	O&M problems are more due to difficult access and traversing populated area.
Overall remarks	Route is long in highly forested area due to ROW problems. The route is not feasible.	Most feasible due to minimum forest area to be affected, easier access to the route, minimum O&M problems, and no river crossing.	Technically not desirable due to ROW problems, more forest area affected, difficult access, more EHV line crossings, and Mahanadi river crossing twice.

Source: IEE of 400 kV double circuit Raipur-Rourkela Transmission Line, POWERGRID Corporation of India, Ltd., May 1998.

From ADB Summary Environmental Impact Assessment (SEIA) on India Power Transmission Improvement Project, http://www.adb.org/Documents/Environment/Ind/ind-powertrans.pdf

IMPACT MATRIX

Activity	Potential Impact	Significance	Duration	Mitigation
Potential Impacts due to Design and Location				
Resettlement	Social inequities	None	N/A	No resettlement required
Historical/cultural monuments	Loss of values	None	N/A	Avoided through appropriate siting
Encroachment into ecologically sensitive areas and forests	Loss of values	Minor	Short	Siting avoids ecologically sensitive areas; monitoring to prohibit illegal tree felling
Interference with utilities/traffic	Disruption of services	Insignificant	N/A	No major interference
Impairment of aesthetics	Loss of environmental beauty	Minor	Long	Lines sited along roads; alignment modified to avoid impairment of aesthetics near cultural site; lattice towers
Potential Impacts during Construction				
Uncontrolled erosion/silt runoff	Soil loss/downstream siltation	Minor	Short	Revegetate and stabilize soil around towers
Maintenance of rights of way	Health and ecological hazard	Insignificant	Long	Little or no use of herbicides
Nuisance to nearby properties	Losses in neighboring land uses/values	Minor	Short	Compensation for temporary use of land
Blockage of wildlife passage/hunting	Species impacts	Minor	Short	No blockage; strict enforcement of rules against firearms and wildlife trapping
Interference with drainage pattern	Flooding	Insignificant	N/A	No new roads to be constructed
Inadequate disposition of borrow sites	Loss of land values	None	N/A	No borrow pits
Land acquisition	Social inequities	Minor	Short	Compensation
Health and safety	Sickness/accidents	Minor	Short	Health and Safety Plan
Potential Impacts during Construction				
Land value changes and population movements	Social inequities	Moderate	Long	Monitoring program implemented and action taken if needed
Increase in affluent/poor income gap	Social imbalances	Minor	Long	Monitoring
Escape of polluting materials and fires	Damage to environment and property	Minor	Long	Appropriate equipment purchased; monitoring, Health and Safety Plan
Health and safety	Sickness/accidents	Minor	Short	Health and Safety Plan
Inadequate environmental monitoring and operations and maintenance skills	Damage to ecological and social values	Minor	Long	Training to be provided by EdL; monitoring by independent party

MONITORING MATRIX

Sector	Measures	Type	Period	Responsibility
Soil erosion and slope stability	Assess slope failure risks	Design		Contractor
	Monitor ground cover clearing	Monitoring	Construction	EdL
	Monitor wet season activities	Monitoring	Construction	EdL
	Control access track standard	Monitoring	Construction	EdL
	Monitor soil/slope stabilization	Monitoring	Construction	EdL
Hydrology	Review floodplain tower hydraulic assumptions	Design		Contractor
Land use	Land compensation	Compensation		District officer/EdL
	Survey crop productivity	Monitoring	Construction	MAF
	Cropland rehabilitation	Monitoring	Construction	MAF
	Structures relocation/replacement	Design	Construction	District officer/EdL
Forestry	Monitor tree clearing	Design	Construction	DFO,Vill. volunteer
	Monitor clearing for construction camp and vehicle storage	Monitoring	Construction	DFO,Vill. volunteer
Wildlife	Monitor burning activity	Monitoring	Operation	EdL
	Prohibit firearms/trapping			
Public health	Check workers health monitoring	Monitoring	Construction	MOH
	Monitor malaria control	Monitoring	Construction	MOH/IMPE
	Check construction camp sanitation	Monitoring	Construction	EdL/MOH
Indigenous peoples	Check implementation of social monitoring	Monitoring	Construction Operation	Locally-based NGO
Heritage cultural sites	Monitor archaeological sites/artifact discovery	Monitoring	Survey Construction	Contractor/MOIC
Environmental monitoring audits	Undertake third party environmental monitoring audits	Monitoring	Construction Operation	Locally-based NGO
Others	Monitor unexploded ordnance contaminated area	Monitoring	Construction Operation	EdL
	Record security incidents	Monitoring Operation	Construction Operation	Contractor / EdL

EdL = Electricité du Laos; MOH = Ministry of Health; MAF = Ministry of Agriculture and Forestry;
DFO = District Forestry Office; NGO = Nongovernmental Organization;
MOIC = Ministry of Information and Culture

Environmental Impact Matrix and Monitoring Matrix for ADB Summary Initial Environmental Examination (SIEE) for Lao PDR Power Transmission and Distribution Project. http://www.adb.org/Documents/Environment/lao-power-transmission.pdf

IMPACT MATRIX

Activity	Potential Impact	Significance	Duration	Mitigation
Potential Impacts due to Design and Location				
Resettlement	Social inequities	None	N/A	No resettlement required
Historical/cultural monuments	Loss of values	None	N/A	Avoided through appropriate siting
Encroachment into ecologically sensitive areas and forests	Loss of values	Minor	Short	Siting avoids ecologically sensitive areas; monitoring to prohibit illegal tree felling
Interference with utilities/traffic	Disruption of services	Insignificant	N/A	No major interference
Impairment of aesthetics	Loss of environmental beauty	Minor	Long	Lines sited along roads; alignment modified to avoid impairment of aesthetics near cultural site; lattice towers
Potential Impacts during Construction				
Uncontrolled erosion/silt runoff	Soil loss/downstream siltation	Minor	Short	Revegetate and stabilize soil around towers
Maintenance of rights of way	Health and ecological hazard	Insignificant	Long	Little or no use of herbicides
Nuisance to nearby properties	Losses in neighboring land uses/values	Minor	Short	Compensation for temporary use of land
Blockage of wildlife passage/hunting	Species impacts	Minor	Short	No blockage; strict enforcement of rules against firearms and wildlife trapping
Interference with drainage pattern	Flooding	Insignificant	N/A	No new roads to be constructed
Inadequate disposition of borrow sites	Loss of land values	None	N/A	No borrow pits
Land acquisition	Social inequities	Minor	Short	Compensation
Health and safety	Sickness/accidents	Minor	Short	Health and Safety Plan
Potential Impacts during Construction				
Land value changes and population movements	Social inequities	Moderate	Long	Monitoring program implemented and action taken if needed
Increase in affluent/poor income gap	Social imbalances	Minor	Long	Monitoring
Escape of polluting materials and fires	Damage to environment and property	Minor	Long	Appropriate equipment purchased; monitoring, Health and Safety Plan
Health and safety	Sickness/accidents	Minor	Short	Health and Safety Plan
Inadequate environmental monitoring and operations and maintenance skills	Damage to ecological and social values	Minor	Long	Training to be provided by EdL; monitoring by independent party

MONITORING MATRIX

Sector	Measures	Type	Period	Responsibility
Soil erosion and slope stability	Assess slope failure risks	Design		Contractor
	Monitor ground cover clearing	Monitoring	Construction	EdL
	Monitor wet season activities	Monitoring	Construction	EdL
	Control access track standard	Monitoring	Construction	EdL
	Monitor soil/slope stabilization	Monitoring	Construction	EdL
Hydrology	Review floodplain tower hydraulic assumptions	Design		Contractor
Land use	Land compensation	Compensation		District officer/EdL
	Survey crop productivity	Monitoring	Construction	MAF
	Cropland rehabilitation	Monitoring	Construction	MAF
	Structures relocation/replacement	Design	Construction	District officer/EdL
Forestry	Monitor tree clearing	Design	Construction	DFO,Vill. volunteer
	Monitor clearing for construction camp and vehicle storage	Monitoring	Construction	DFO,Vill. volunteer
Wildlife	Monitor burning activity	Monitoring	Operation	EdL
	Prohibit firearms/trapping			
Public health	Check workers health monitoring	Monitoring	Construction	MOH
	Monitor malaria control	Monitoring	Construction	MOH/IMPE
	Check construction camp sanitation	Monitoring	Construction	EdL/MOH
Indigenous peoples	Check implementation of social monitoring	Monitoring	Construction Operation	Locally-based NGO
Heritage cultural sites	Monitor archaeological sites/artifact discovery	Monitoring	Survey Construction	Contractor/MOIC
Environmental monitoring audits	Undertake third party environmental monitoring audits	Monitoring	Construction Operation	Locally-based NGO
Others	Monitor unexploded ordnance contaminated area	Monitoring	Construction Operation	EdL
	Record security incidents	Monitoring Operation	Construction Operation	Contractor / EdL

EdL = Electricité du Laos; MOH = Ministry of Health; MAF = Ministry of Agriculture and Forestry;
DFO = District Forestry Office; NGO = Nongovernmental Organization;
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Environmental Impact Matrix and Monitoring Matrix from ADB Summary Environmental Impact Assessment (SEIA) on India Power Transmission Improvement Project, http://www.adb.org/Documents/Environment/Ind/ind-powertrans.pdf

Rapid Environmental Assessment (REA) Checklist

POWER TRANSMISSION

Instructions:

- ☐ This checklist is to be prepared to support the environmental classification of a project. It is to be attached to the environmental categorization form that is to be prepared and submitted to the Chief Compliance Officer of the Regional and Sustainable Development Department.
- ☐ This checklist is to be completed with the assistance of an Environment Specialist in a Regional Department.
- ☐ This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB checklists and handbooks on (i) involuntary resettlement, (ii) indigenous peoples planning, (iii) poverty reduction, (iv) participation, and (v) gender and development.
- ☐ Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title:

Sector Division:

SCREENING QUESTIONS	Yes	No	REMARKS
A. Project Siting Is the Project area adjacent to or within any of the following environmentally sensitive areas?			
▪ Cultural heritage site	☐	☐	
▪ Protected Area	☐	☐	
▪ Wetland	☐	☐	
▪ Mangrove	☐	☐	
▪ Estuarine	☐	☐	
▪ Buffer zone of protected area	☐	☐	
▪ Special area for protecting biodiversity	☐	☐	
B. Potential Environmental Impacts Will the Project cause…			
▪ encroachment on historical/cultural areas, disfiguration of landscape and increased waste generation?	☐	☐	
▪ encroachment on precious ecosystem (e.g. sensitive or protected areas)?	☐	☐	

ADB Rapid Environmental Assessment checklist for power transmission projects, page one.
www.adb.org/Documents/Guidelines/Environmental_Assessment/REA_Power_Transmission.pdf

Power Transmission, page 2

SCREENING QUESTIONS	Yes	No	REMARKS
▪ alteration of surface water hydrology of waterways crossed by roads and resulting in increased sediment in streams affected by increased soil erosion at the construction site?	☐	☐	
▪ damage to sensitive coastal/marine habitats by construction of submarine cables?	☐	☐	
▪ deterioration of surface water quality due to silt runoff, sanitary wastes from worker-based camps and chemicals used in construction?	☐	☐	
▪ increased local air pollution due to rock crushing, cutting and filling?	☐	☐	
▪ chemical pollution resulting from chemical clearing of vegetation for construction site?	☐	☐	
▪ noise and vibration due to blasting and other civil works?	☐	☐	
▪ dislocation or involuntary resettlement of people	☐	☐	
▪ social conflicts relating to inconveniences in living conditions where construction interferes with pre-existing roads?	☐	☐	
▪ hazardous driving conditions where construction interferes with pre-existing roads?	☐	☐	
▪ poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases from workers to local populations?	☐	☐	
▪ creation of temporary breeding habitats for mosquito vectors of disease?	☐	☐	
▪ dislocation and compulsory resettlement of people living in right-of-way of the power transmission lines?	☐	☐	
▪ environmental disturbances associated with the maintenance of lines (e.g. routine control of vegetative height under the lines)?	☐	☐	
▪ facilitation of access to protected areas in case corridors traverse protected areas?	☐	☐	
▪ accident risks associated with maintenance of lines and related facilities?	☐	☐	
▪ health hazards due to electromagnetic fields, land subsidence, lowered groundwater table, and salinization?	☐	☐	
▪ disturbances (e.g. noise and chemical pollutants) if herbicides are used to control vegetative height?	☐	☐	

ADB Rapid Environmental Assessment checklist for power transmission projects, page two.
www.adb.org/Documents/Guidelines/Environmental_Assessment/REA_Power_Transmission.pdf

ENVIRONMENTAL CATEGORIZATION

A. Instructions:

(i) This form is to be completed by the Sector Division in the Regional Department and submitted to the Environment and Social Safeguard Division (RSES) for endorsement by RSES Director, and for approval by the Chief Compliance Officer (CCO) of the Regional and Sustainable Development Department.

(ii) The environment categorization of a project is a continuing process. If there is a change in the components or/and site of a project that may result in category change, the Sector Division should submit a new environmental categorization form for endorsement by RSES Director and approval by the CCO. The old form should be attached for reference.

B. Project Data: Project No. _____

Country/Project Title: _____ Date: _____

Department/ Division: _____ Processing Stage:_____

Lending Modality: [ ] Project Loan [ ] Program Loan [ ] Financial Intermediation
[ ] Sector Loan [ ] SDP Loan Loan or Equity Investment

Coverage: [ ] Country [ ] Subregional [ ] Inter-regional

C. Environment Category: [ ] New [ ] Recategorization --- Previous Category _____

☐ Category A
☐ Category B
☐ Category C
☐ Category FI

Additional information is needed for categorization and is to be gathered by the Mission Leader. In the interim, the project is classified as:

☐ Category A/B [ ] Environmental Specialist to participate in fact finding
☐ Category B/C

Comments:

_____
_____
_____

D. Documents attached: *The categorization will be considered incomplete if proper documentation is not attached.*

Basis for Categorization/ Recategorization:
[ ] REA Checklist
[√] Project and/or Site Description (must be attached)
[ ] Other:_____

Terms of Reference for EIA/IEE:
[ ] Key issues identified and attached
[ ] Under preparation and will be submitted on _____(date

Environmental Categorization Form/ RRE/30/04/03

ADB Environmental Impact categorization form, page one.
http://www.adb.org/Documents/Guidelines/Environmental_Assessment/Environmental_Categorization.pdf

ENVIRONMENTAL CATEGORIZATION

E. Basic Environmental Assessment Requirements

Please check one of category A, B, C or FI

[ ] Category A:
- Environmental Impact Assessment (EIA)
- Environmental Management Plan including a Budget
- Public Consultation (at least twice)
- Disclosure 120 days in advance of Board Consideration

[ ] Category B:
- Initial Environmental Examination (IEE)
- Public Consultation

[ ] *Check if the project is to be deemed environmentally sensitive (by CCO)*
- Environmental Management Plan including a Budget
- Disclosure 120 days in advance of Board Consideration

[ ] Category C:
- Review of Environmental Implications

[ ] Category FI:

If Category FI, please check one of the following

[ ] Equity Investment
- Environmental Management System

[ ] Credit Lines
- Environmental Management System - including Environmental Assessment and Review Procedures for Subprojects

[ ] Credit Lines where all subprojects will only have insignificant impacts
- Review of Environmental Implications

For program, sector, or sector development program loans, please check the applicable requirements

Program and Sector Development Program Loans
- [ ] Environmental Assessment of Policy Matrix

Sector Loans
- [ ] IEEs of Sample Subprojects
- [ ] Environmental Assessment and Review Procedures
- [ ] Environmental Assessment of Sector Impacts (recommended)

F. Signatures

Category Assigned by:	Endorsed by:
_____	_____
RD Mission Leader	Director, RSES
Date: _____	Date: _____
Endorsed by:	Approved by:
_____	_____
Director, Sector Division	Chief Compliance Officer
Date: _____	Date: _____

Environmental Categorization Form/ RRE/30/04/03

ADB Environmental Impact categorization form, page two.
http://www.adb.org/Documents/Guidelines/Environmental_Assessment/Environmental_Categorization.pdf