Handbook of Environmental Impact Assessment

VOLUME 2

ENVIRONMENTAL IMPACT ASSESSMENT IN PRACTICE: IMPACT AND LIMITATIONS

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17: Environmental Impact Assessment for Energy Projects

THOMAS RUSSO

17.1 INTRODUCTION

Energy projects pose a number of significant challenges to the environmental impact assessment (EIA) practitioner, despite the fact that many assessments have been prepared over the years. When examining previous EIAs, the challenge for the practitioner in many cases is the difficulty of separating the utility of the EIA approach from controversies associated with the proposed project. Another challenge is sorting through the large volume of information available on all facets of EIA, from scoping to detailed methodologies. Indeed, the practitioner may conclude that one only has to follow the same series of steps that were used to prepare an adequate EIA on the previous project in his or her country or region. Nothing could be further from the truth. In fact, viewing EIA of energy projects as such is simply a 'prescription for failure' in the long run. The products of such EIA exercises are voluminous and burdensome documents that confuse and confound rather than assist decision makers, investors and affected people.

Conducting EIA on energy projects has become very complicated. Part of the complication arises as a result of more educated and knowledgeable groups of participants who have experienced first hand the results of poorly planned and executed energy projects (Abacos & Ortalano 1988; IUCN & World Bank 1997). These participants and their increased knowledge of EIA since the late 1960s are demanding more relevant EIAs and open and transparent regulatory structures to evaluate proposed energy projects and ensure sustainable energy development. Finally, we must add the fact that global competition and privatization of the electric and natural gas industries are proceeding at an unprecedented rate and that the private sector will play an increased role in global energy development (Roseman & Mahorta 1996; Kerber 1997).

EIA practitioners can draw on almost 30 years of experience in conducting EIA on energy sector projects. The problem in relying solely on past experience is that the world has changed dramatically in the last 5 years. These changes present new challenges to the EIA practitioner today and in the future. For this reason, the goal of this chapter is not merely to identify good practice, but to help the reader to begin to fundamentally rethink EIA and to seriously question EIA practices. The ultimate goal of such an exercise is to achieve dramatic improvements in analysis and decision-making that lead to significant protection, mitigation and enhancement of environmental and social resources. The chapter also raises the need for a new and, perhaps, to some, a radical redesign and approach to EIA and decision-making. The author's goal is not solely to present a new approach. Those readers who are looking for pragmatic approaches that have been successful in preparing EIAs around the world should not be disappointed. The chapter discusses characteristics of energy projects, fuel cycles and regulatory structures, as well as analysis of environmental impacts and mitigation. All of these factors affect what EIA approaches are appropriate in a given situation

In the author's opinion, there is no perfect EIA for an energy project, despite the efforts of some very intelligent people and organizations who have spent large amounts of time and money preparing institutional guidance and hundreds of

EIAs on a variety of projects. Hence, instead of seeking the 'ideal EIA', the author has identified specific aspects from a wide variety of EIAs that illustrate good practice. The hope is that, through such a patchwork, the EIA practitioner will be able to fashion an EIA process that captures the principles outlined in Volume 1, and prepare a good EIA that is useful for decision makers and managers over the life of the project.

The term 'decision maker', however, requires some definition, since it is used very broadly in this chapter. Certainly, individuals who have the responsibility to authorize the project are included in the definition. However, decision makers also include individuals and organizations who will design and implement environmental mitigation, as well as the project proponent and those responsible for the construction, operation and maintenance of the project throughout its life. In addition, governmental organizations, indigenous peoples, non-governmental organizations (NGOs) and lenders also are decision makers as they will decide whether to support or oppose the proposed project with capital and other resources. The above definition is consistent with the author's strong belief that energy projects require sufficient capital and resources over the life of a project. Hence, the EIA must not be forgotten once the decision on the project has been made, but should be an 'adaptive' document rather than 'final' (Burton *et al.* 1981; Quintero 1997). Indeed, a good EIA should set the stage for what needs to be accomplished to avoid and minimize environmental and social impacts over the life of the project (Lee & McCourt 1997).

17.2 TYPES OF ENERGY PROJECTS

The energy projects discussed here fall into two general categories: electrical energy, and energy transport and storage projects. The electrical energy projects include the familiar coal, natural gas and biomass-fired electric generating plants, as well as cogeneration plants. Others include hydropower, geothermal, wind, solar and fuel cells powered by hydrogen, natural gas or propane. Energy transport projects include electric transmission lines and natural gas and oil pipelines, as well as liquefied natural gas (LNG) terminals.

Table 17.1 Sustainability and energy projects (modified from Goodland 1993).

Best	
1 Solar	Renewable and sustainable
2 Photovoltaics	
3 Wind	
4 Tidal and waves	
5 Biomass (= alcohol)	
6 Efficiency and conservation	
7 Hydropower	Potentially sustainable
8 Fuel cells	
9 Geothermal	
10 Gas	Non-renewable and unsustainable
11 Coal	
12 Nuclear	
Worst	

Goodland (1993) ranked energy projects according to their potential impacts and sustainability and whether they are renewable resources (Table 17.1). While this categorization is useful to orientate us with respect to EIA globally, there are many variables that can change the rankings or make them entirely irrelevant. For example, countries in arid areas with rich sources of oil may develop natural-gas fired combined cycle or combustion turbine electric energy projects. From their perspective, this might appear feasible when the alternative may be to flare the gas at the well site. Also, the distribution of hydropower, wind, geothermal and biomass resource potential is generally distributed unequally.

Another aspect of energy projects that can help the EIA practitioner gain some insight on selecting alternatives and in carrying out an analysis is the net overall electric efficiencies and heat efficiencies of different power plant types (Fig. 17.1). Dehli (1997) points out that hydropower projects and fuel cells are the most efficient in converting mechanical and chemical energy, respectively, into electrical energy. Combustion turbines, however, are making great strides in this area, with some technologies capable of breaking the 60% thermal efficiency barrier (General Electric Corporation 1998).

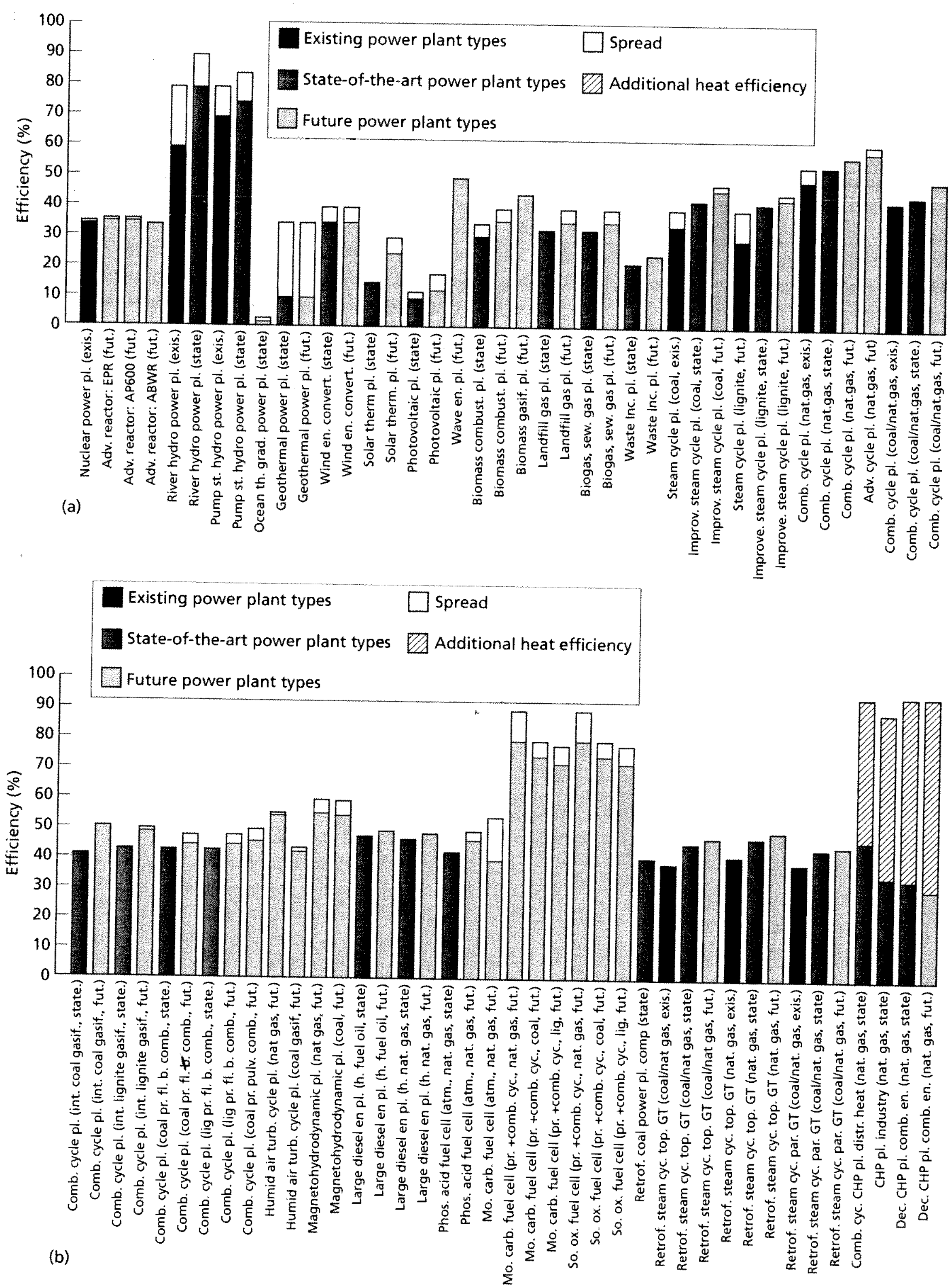

Fig. 17.1 Net overall electrical efficiences and additional heat efficiences of different power plant types (based on Dehli 1997).

The quality of fuel used in coal-fired electric energy projects can also spell the difference between severe air quality and water quality problems. For example, coal that has a high sulphur and ash content will not only release sulphur oxides (SO_x) into the atmosphere, but require washing prior to being used in a coal plant. Washing the coal and subsequent disposal of the ash may contaminate other land and water resources.

The EIA practitioner will be faced with a wide variety of energy production systems associated with electricity. While specific expertise in a given technology is not imperative, a thorough knowledge of the characteristics of the energy systems will generally assist the EIA practitioner in determining impacts and also determining whether an alternative energy system is reasonable (Edison Electric Institute 1984). General knowledge of the energy systems is imperative if the practitioner does not have an engineering background. An overview of the energy production systems associated with electricity shows how complex energy systems can be for coal (Table 17.2).

The EIA practitioner may think of energy projects as 'pure plays', that is, the project produces or transmits energy and these are the only other benefits or opportunities. This is not the case for every type of energy project. For example, some of the earliest hydropower projects constructed in the USA, Europe and Canada in the early 1900s began as pure play energy projects, but over the course of more than 50 years the projects now provide multiple benefits, such as flood control, irrigation, water supply, fish and wildlife habitat, cooling water for coal- and nuclear-fired energy projects and recreational use (American Society of Civil Engineers 1997). Other projects, like the Glen Canyon Project on the Colorado River, were

Table 17.2 Energy production systems associated with electricity (modified from International Atomic Energy Agency 1992).

Energy group	Energy source	Energy system
Fossil fuel	Coal	Direct coal combustion
		Pressurized fluidized bed combustion
		Atmospheric fluidized bed combustion
		Coal gasification
		MHD
	Oil	Direct oil combustion
	Natural gas	Gas steam boiler
		Gas turbine
		Fuel cell
	Peat	
	Oil shale	
	Tar sands	
Nuclear		PWR
		BWR
		Candu
		HTR
Renewables	Hydropower	Run of river
		Conventional storage
		Pumped storage
	Geothermal	Conventional binary
	Solar—photovoltaic	Central tower
	Solar—thermal	
	Wind	
	Biomass	Harvesting energy crops
	Waste incineration	

BWR, boiling-water reactor; HTR, high temperature reactor; MHD, magnetohydrodynamics; PWR, pressurized-water reactor.

constructed to provide irrigation benefits. The revenues from sale of hydroelectric power generation have been used to pay for these irrigation benefits (Palmer 1997). Cogeneration projects will also be encountered and should be viewed as viable alternatives when electric energy and LNG terminal projects are being contemplated for industrial users. Cogeneration projects use steam or hot water, the byproducts of an industrial process to produce electricity. Some energy projects are multipurpose from conception, but others may become multipurpose over time. While this complicates EIA for both practitioner and decision makers, it also challenges the analyst to develop mitigation programmes that increase benefits to participants that may arise over the life of projects.

Electric transmission line and natural gas/oil pipeline projects are not only distinguishable by the fundamental differences in the physics of electricity and natural gas/oil, but by the conduits that transmit them. For the most part, natural gas will flow from point A to point B with few problems associated with back flow or loop flows. The flow of electricity is similar in a linear system, but things change rapidly in an interconnected system. The electricity transmitted from a hypothetical power plant is indistinguishable from the electricity generated by other power plants. In other words, we do not have any idea where the power produced from our hypothetical power plant will end up (Pierce 1994). The relevance of the latter may not seem obvious at first glance, but is very important in defining what constitutes the proposed energy project. For example, if a geothermal project is being proposed and electric power will be transmitted into an existing 700 km long interconnected transmission system, should the EIA practitioner analyse the 700 km transmission line or a portion of the line? This question is addressed in greater detail in Section 17.4.5.

17.3 CHARACTERISTICS OF ENERGY PROJECTS

EIA practitioners need to focus on the complete life cycle of the energy facilities they are evaluating and specifically address strategically the fuel cycle associated with a proposed facility. Despite the different kinds of energy projects that the EIA practitioner will face, there are generally a number of characteristics that are common to all. As illustrated in Figs 17.2–17.4, these characteristics

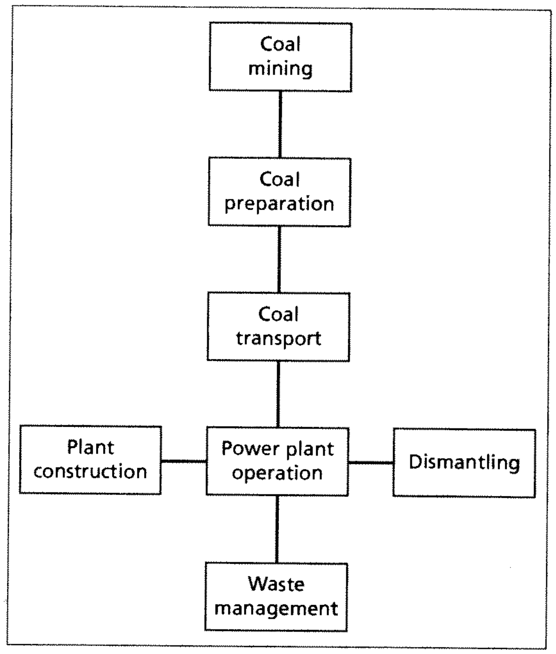

Fig. 17.2 The coal fuel cycle (based on International Atomic Energy Commission 1992).

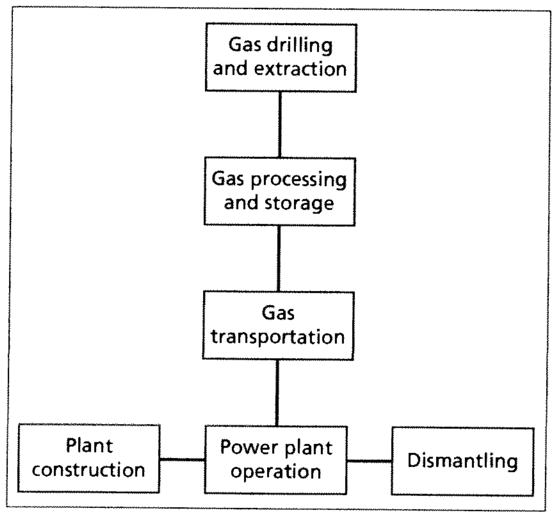

Fig. 17.3 The gas fuel cycle (based on International Atomic Energy Commission 1992).

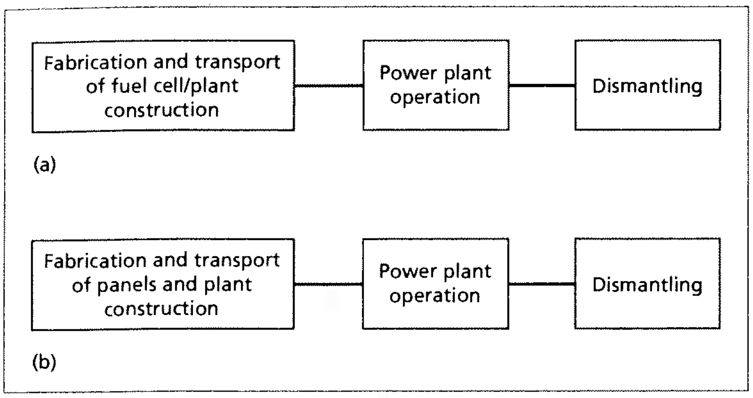

Fig. 17.4 The (a) photovoltaic and (b) solar (thermal) fuel cycle (based on: International Atomic Energy Agency 1992).

Table 17.3 Daily fuel use and emissions from typical 450 MW power station (source: Serchuk & Means 1997).

	Fuel used (t)	Energy efficiency (%)	Solid waste (t)	Waste heat (GWh)	SO_x emitted (t)	NO_x emitted (t)	CO_x emitted (t)
Conventional coal	3657.6	38.0	457.2	17	76.2	10.2–35.6	9144.0
Coal with 90% FGD	3708.4	37.5	599.4	17	8.1	10.2–35.6	9245.6
Conventional oil	2286.0	39.0	1.0	17	172.7	7.1–15.2	7620.0
Oil with 90% FGD	2316.5	38.5	304.8	17	17.3	7.1–15.2	7721.6
Conventional gas	2133.6	40.0	0.0	16	0.0	3.0–15.2	6096.0
Combined cycle gas	1778.0	48.0	0.0	13	0.0	2.0–10.2	4572.0

CO_x, carbon oxides; FDG, flue gas desulphurization; GWh, gigawatt hours; NO_x, nitrogen oxides; SO_x, sulphur oxides.

are: (i) extraction/harvesting/collection of the fuel; (ii) preparation of the fuel; (iii) transportation of the fuel to a power generating site or plant; (iv) plant construction; (v) plant operation; (vi) waste management; and (vii) decommissioning. These characteristics should dictate the types of analysis undertaken and specifically the mitigation to reduce or eliminate project impacts. Looking at various fuel cycles can help organize EIAs of various energy projects, as well as illustrating some of the important characteristics. In assessing various energy project proposals the pertinent fuel cycle should be factored into the analysis. Failure to do so will result in a biased analysis. For example, failure to consider the source of coal, its extraction and transportation and associated impacts on land and water may give the impression that the only significant impacts are on air quality. Even a brief discussion of whether the coal mining was deep-mine or surface would give decision makers an idea of impacts to land and water from the mining activities.

Another aspect of the fuel cycle that the EIA should focus on is the fuel characteristics. For fossil fuels, these include:

- caloric value;
- moisture content;
- ash content;
- sulphur content;
- carbon content;
- trace metals;
- impurities;
- tar content.

Knowledge of the quality of the fuel often provides additional insight into whether a higher quality might offset costly scrubbers or additional preparation and waste disposal activities associated with a poor quality fuel (Table 17.3). For example, a fuel with lower caloric value might be preferable to one with a higher sulphur content if

SO_x and acid rain were considerations. In addition, an entirely different fuel, such as natural gas, might be substituted in one of the generating units of the coal-fired electric project (Serchuk & Means 1997).

Most energy projects are long-lived assets. Once constructed, they are usually in place for at least 35 years and, for some such as hydropower projects, up to 100 years, assuming that they are adequately designed and maintained (American Society of Civil Engineers 1997). EIAs spend a great deal of time and effort focusing on the immediate construction related impacts on the environment and human environment. Few EIAs devote sufficient attention to the operational aspects of the projects, let alone mitigation measures to eliminate or reduce operational impacts. This is a great oversight given the fact that few countries have strong programmes to revisit energy projects periodically to ensure that their operations are conforming to current standards of environmental quality or the public interest. Coal plants and gas fired combustion turbines generally have a life expectancy of about 25–35 years, while hydropower projects generally can operate for at least 50 years or longer. Some hydropower projects in the USA have been operating for at least 75 years or more. Generally, at the end of their life cycles, most energy plants are either refurbished using the same fuel or with a fuel that has economic and/or environmental advantages. The same is true for hydropower projects, which, generally at the end of the first 50 years, have little or no debt service. Advances, which include computerized operating systems, increased efficiency and lower operating costs of new coal, gas and hydropower turbines and generators, ensure that most energy projects undergo refurbishment and substantial life extensions.

17.4 UNCOMMON ISSUES

The relevant issues associated with analysing the environmental impacts of energy projects can be divided into several categories: (i) regulatory structures; (ii) environmental and mitigation/enhancement analysis; (iii) implementation and compliance; (iv) project proposal definition; and (v) decommissioning. As will be apparent from the following discussion, there is considerable overlap between these categories. In keeping with the other chapters in this Part of the Handbook, these issues are discussed under the above categories and then areas of good practice in relation to site selection, scoping, baseline surveys, predication, evaluation, mitigation, monitoring and auditing are addressed.

17.4.1 Regulatory structures

Churchill (1992) and Russo (1994, 1995) advocate the need for a dispute resolution mechanism to deal with safety, health and environmental issues. Such a mechanism is needed irrespective of the kinds of environmental and energy laws and regulations in a country. The need for a dispute resolution mechanism in the form of an independent regulatory body, decision makers or a quasi-judicial body and the role of EIA are important considerations as projects become more complex and affect environmental and human resources (Hoecker 1992). Some projects, by their very nature, however, if sited properly can easily avoid or satisfactorily mitigate adverse environmental and social impacts. Energy transport and storage projects like natural gas and oil pipeline projects, as well as LNG terminals, fall into this category. However, in the case of large hydropower projects, the need for dispute resolution mechanisms increases exponentially.

All energy projects will be conceived, sited, analysed, constructed and operated according to a regulatory triad, based on politics, law and the market (Fig. 17.5). In countries like the USA, the regulatory scheme relies ultimately on rule of law or regulation. Disagreements over the adequacy of an EIA or procedural aspect of a siting process are ultimately decided by a government regulatory agency or the courts. Most of the energy projects developed in the USA, Canada and other western countries fall into this type of regulatory scheme either at the national or provincial/state level. Energy pipeline projects are usually conceived and processed rapidly with little or no problem. Hydropower projects and electric transmission line projects take much longer to site or authorize.

Many of the developing countries tend toward the right-hand side of the triad shown in Fig. 17.5,

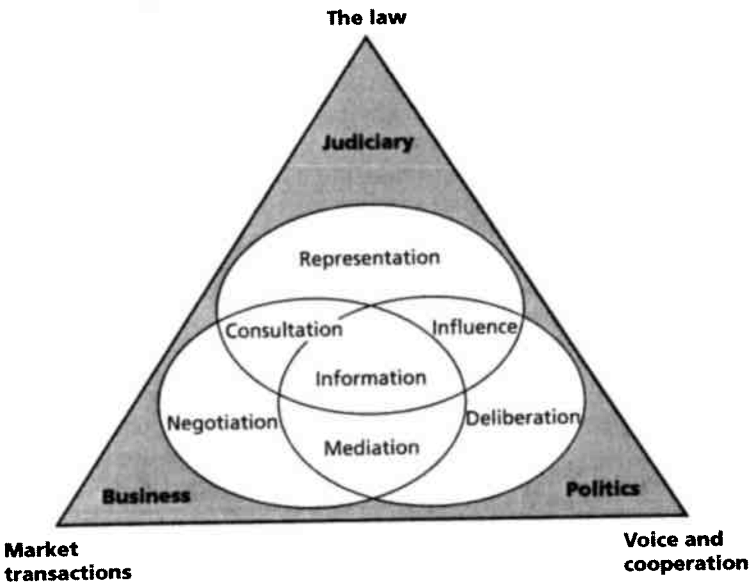

Fig. 17.5 The regulatory triad (based on Churchill 1992).

where politics is an important feature. Most of these energy projects are developed and operated by national governments or special ministries. Traditionally, energy and power ministries have had a great deal of political power, since electricity was, and still is, used as a social instrument. For example, electric power or water resources are made available at below market rates, etc. In this regulatory arena, influence, rather than facts or information, usually dictates the outcome (Fig. 17.5). Few countries, except for the UK and New Zealand, have embraced a regulatory structure that relies on the market. However, the USA, Canada and many other countries are beginning to privatize their electric and energy industries and promote competition through non-discriminatory open access to transmission systems and transparent energy tariffs on a real-time basis. Competition is also being enhanced by separating generating assets from transmission and distribution lines so that consumers know the relevant costs of each service.

The regulatory triad and the presence, absence and performance of the specific regulatory structures play a significant role in influencing how projects are conceived by developers and analysed in an EIA. The structure dictates to a large extent whether the EIA is just a 'paper' exercise or a document that will serve as a basis for sound decisions regarding project proposals and ultimately design, construction and operation. In a sense, the type of regulatory system in a country or region can prevent the open and transparent EIA and siting process that is desired. In reality, the project proponent or lead government ministry who prepares the EIA is a natural adversary of other participants, such as international and national environmental NGOs, indigenous peoples and other governmental organizations within a given country. This tension between participants is reflected in how the various groups align themselves in the regulatory triad (Fig. 17.6).

As more countries rely on the private sector to commercialize and finance energy projects, the length of time taken for the siting process and preparation of EIAs has become more important. Extensive delays in the overall process and perceived risks can cause shifts in capital away from certain classes of energy projects (Russo & von Stackelberg 1994). The best example of these phenomena is hydroelectric projects, whether they are small or mega-projects. The high risk and extensive time needed to site and prepare the EIAs of such hydro projects have shifted capital to non-renewable fossil-fuelled electric plants, which take much less time to site and are less

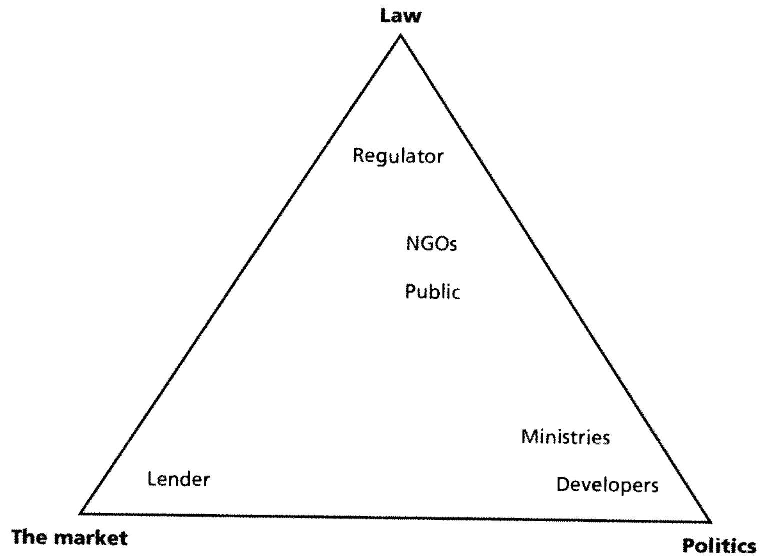

Fig. 17.6 How energy project participants normally align themselves in the regulatory triad. NGOs, non-governmental organizations.

controversial. The unfortunate fact here is that developers are willing to cope with the risks and uncertainty of higher future fuel prices rather than deal with the higher risks and controversy associated with environmental issues associated with hydro projects.

The extensive delays in siting large, complex projects are usually a result of the lack of, or an overly burdensome, dispute resolution mechanism in place for specific classes of energy projects. In the former case, the project proponents and participants are left to wage a 'war of words' with each other and wield political influence as a means of affecting outcomes. In the latter, the regulatory body may be too preoccupied with process and creating a record. Hence, because the regulatory body is risk adverse, the process becomes expensive and produces untimely decisions. Time is of critical importance to EIA also. When there are extensive delays in the preparation of the EIA, comments and recommendations from participants can grow stale, new laws or regulations may be developed, or the EIA team may not be able to stay together for the duration of a long siting process fraught with controversy. Senecal (1997) alluded to the psychological stress on EIA practitioners who were analysing the Three Gorges Hydroelectric Project in the People's Republic of China. He also indicated that the increasing demands for information made by project opponents were unrealistic and generally beyond the capabilities of the analysts. In such cases, the demands for scrutiny of every aspect of a project, no matter how insignificant, can affect the quality of the overall analysis and impede the development and implementation of necessary mitigation if such a project is authorized.

In terms of the regulatory triad, one might conclude that all one has to do is to move the developers and participants to the middle of the regulatory triad (Fig. 17.7). Whilst this is correct in general for certain types of projects, it does not mean that there should be a 'one size fits all' process for all types of energy projects. A comparison by the Federal Energy Regulatory Commission (FERC) (1994) of the regulation and siting of private sector sponsored natural gas pipelines and hydropower projects illustrates this point.

The most complex natural gas pipelines proposed in the USA are several hundred kilometres long. These pipelines cross state boundaries and multiple jurisdictions. Yet the siting process and preparation of an EIA take little more than one year to complete. In contrast, hydroelectric projects, irrespective of their size, take at least three times as long, even when the project is being relicensed or reauthorized. Here, the FERC is the

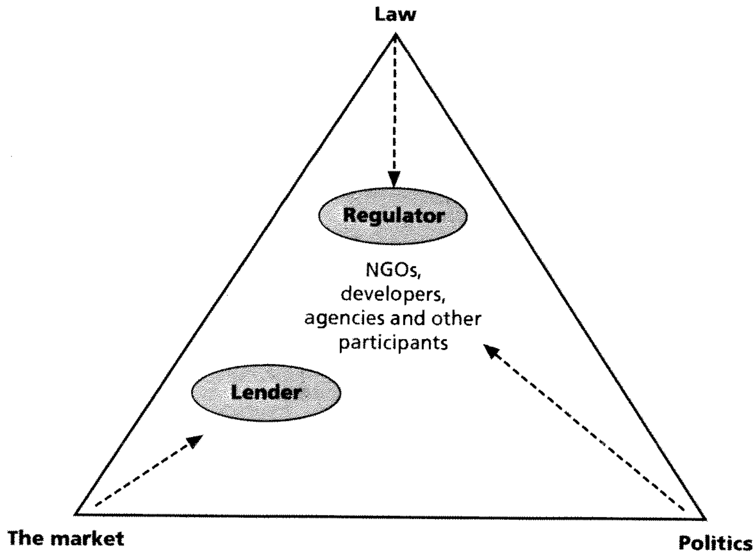

Fig. 17.7 An optimum alignment of energy project participants in the regulatory triad. NGOs, non-governmental organizations.

dispute resolution mechanism discussed above, so in general this does not account for the large differences in the siting and EIA processes. These differences are caused by the inherent nature of gas pipeline projects and hydropower projects, the regulations governing each, the efficiency of the regulatory process and the behaviour of the natural gas and hydropower industries. In both cases, FERC always seeks to avoid and mitigate environmental impacts. However, in the case of a gas pipeline, it is much easier. The EIA analyst can change the route of the pipeline to avoid a sensitive environmental area. Specifically, pipelines can avoid an adverse impact by going around it, under it or above it. At the same time, the economic viability of the pipeline project is seldom jeopardized by route changes or the above mitigation measures to parts of the route. This is not the case with hydropower projects. These projects follow the river and, while there are many mitigation options available, it is not as easy to avoid impacts and still maintain the viability of the project. Thus, gas pipeline projects may not require the same regulatory process as hydropower projects, although both types of projects benefit from moving toward the centre of the regulatory triad.

17.4.2 Collaborative environmental assessments and teams

In the case of hydropower and other types of complex and controversial energy projects, what is essentially needed is to move all the participants to the middle of the regulatory triad and to form a collaborative or cooperative team. Generally, the more complex and larger the project, or the greater the number of projects proposed in a region or country, the greater the need to form such a team. The team would ultimately prepare an EIA for decision makers and share responsibility for the design and mitigation needed to avoid and mitigate significant adverse effects on the human environment. Ideally, the team would prepare an EIA for a proposed project that could be supported by all or a majority of the participants. This EIA is termed a collaborative or cooperative environmental assessment (COEA).

The formation of a team and preparation of a COEA is the antithesis of a traditional project cycle. Under the latter, the project proponent prepares the EIA and the numbers of participants increase over time as the EIA is finalized and submitted for approval to a regulatory or funding body. Just the opposite usually occurs with the formation of a COEA team and, in some cases,

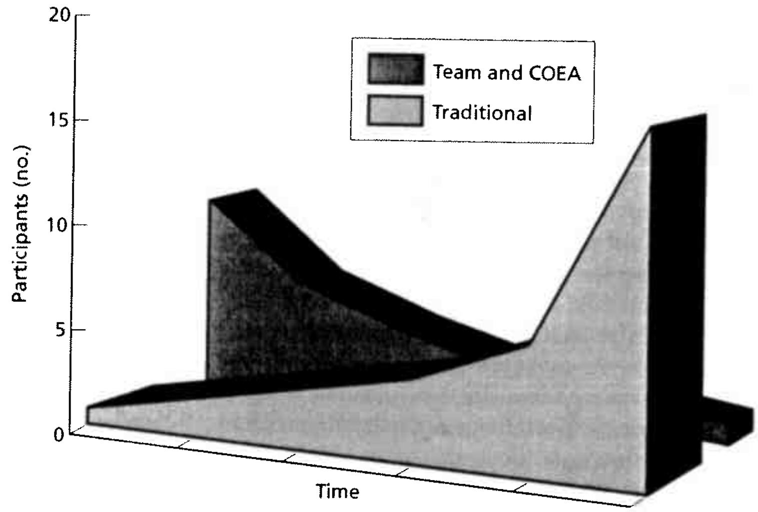

Fig. 17.8 A comparison of public participation over time with a traditional preparation of EIA and cooperative environmental assessment. COEA, cooperative environmental assessment.

smaller numbers of participants are involved, because NGOs and the public have greater confidence that issues will be satisfactorily addressed prior to submission for approval and/or funding.

A COEA is a reflection of the reality of sharing power and decision-making authority with participants. Such a process also imposes obligations on NGOs and indigenous people to pool resources and work towards solutions rather than to create impediments to the siting process. In some circumstances, proponents fund participation of NGOs and indigenous people as well. Without such commitments by project proponents and a majority of participants, the likelihood of a successful COEA is low. Such a process requires some degree of structure, which is provided by a third-party facilitator or regulatory body to oversee and to make certain that information is shared, that participants are allowed to explore non-traditional options with respect to mitigation and siting alternatives and that participants live up to their obligations. The regulator's or third-party facilitator's major duty is to serve as an information resource, bring an overview of successful mitigation strategies and creativity to the table and gain the commitment to ensure that the mitigation agreed to will be carried out as promised (Russo 1994; Russo & von Stackelberg 1994; Silliman & Russo 1997). Hence, the regulator or third-party facilitator must bring a great deal of 'people' and negotiating skills to the process. Because the goal of a COEA is to ensure that projects are sustainable and environmentally acceptable, the project proponent and participants may also wish to legitimize any agreements and conditions (New England Power Company 1997). These agreements or conditions would be reflected and evaluated in the COEA and made a part of the financial package and national or regional permit authorizing the project.

The critical difference between a COEA and an EIA prepared under a traditional siting process is that, under the former, the design is very preliminary and the proponent and participants are left to design the preferred project that should be developed (Fig. 17.8). Hence, a great deal of work goes into the COEA prior to formally filing it with the government entity and/or international lenders for approval. Once filed, the decision makers ensure that the proposal meets their respective requirements and that the financing is adequate to implement all aspects of the project, especially the mitigation measures and compliance features.

Giffen (1997) and Burkhart *et al.* (1997) provide a good explanation of the dynamics of collaborative arrangements as a means of resolving disputes and the preparation of COEAs for hydropower projects. Recently, the US FERC finalized regulations that promote the establishment of collaborative/cooperative teams and the preparation of COEAs (Federal Energy Regulatory Commission 1997b). There are about 30 COEAs being prepared by FERC hydropower licensees and other participants in the USA. Most of the COEAs are on hydropower projects that are being relicensed or reauthorized and which have been operating for a period between 30 and 50 years. The largest of such projects is the relicensing of the St Lawrence–Franklin Delano Roosevelt Project on the St Lawrence River, which constitutes the international border between the USA and Canada. A cooperative team, consisting of the project operator and 43 organizations, has prepared a scoping document which outlines what resources should be analysed in an EIA (Federal Energy Regulatory Commission and New York Department of Environmental Conservation 1997).

The success, and growing acceptance, of COEAs in the USA is due to a significant shift by participants toward the middle of the regulatory triad and away from the notion of the courts and administrative, trial type hearings as a means of resolving disputes. Market forces are also influencing COEAs as deregulation, and increased competition in, the electric industry accelerates. FERC's policy of encouraging settlements and discussions between environmental NGOs and the hydropower proponents has also borne results. In fact the relationship between FERC and its harshest critics, the Hydropower Relicensing Reform Coalition, consisting of American Rivers, the Audubon Society, Conservation Law Foundation, Trout Unlimited and others, has been improving as a result of FERC's encouragement and support of collaborative and cooperative processes. These changes have required fundamental changes in the behaviour of FERC, the hydropower industry and environmental NGOs from their traditional ways of doing business.

In the international arena, it also appears that there is finally some promising movement toward the centre of the regulatory triad on siting large dams. At a conference in Gland, Switzerland, in early April 1997, the World Conservation Union (IUCN) and the World Bank Group invited a diverse group of participants from around the world to explore whether they could work together in seeking resolution of highly controversial issues associated with large dams. To the surprise of the 37 workshop participants, who represented large dam construction and equipment companies, the private sector, consultants, environmental NGOs, indigenous people, government and international lenders, a consensus was made on how to proceed and on the breadth of issues to be investigated (IUCN & World Bank 1997). As a result, the participants agreed to form a World Commission on Large Dams to investigate experience and if and how large dams can contribute to sustainable development. These developments are a necessary prelude to COEAs and will have a beneficial impact on all hydropower projects, not only large dams.

17.4.3 Environmental and mitigation analysis

EIAs in the developed countries have historically gone to great lengths in analysing environmental impacts. Besides becoming encyclopaedic and taking too long to prepare, EIAs and associated methodologies are too mechanistic and, for the most part, inappropriate for most developing countries (Biswas 1993). Furthermore, their sheer size and complexity are at odds with the document needs of decision makers. If that is the case, then one has to wonder why so much emphasis is placed upon analysis of impacts when generic impacts for certain kinds of energy projects are well documented. In fact, these impacts are so well known for certain kinds of projects that many experts have designed criteria for avoiding them based on international, continental and regional bases (Ledec 1997; IUCN & World Bank 1997; Robinson *et al.* 1997). How is it that, with so much known about the environmental impacts of energy projects, so little effort is applied to analysing and outlining detailed mitigation measures, that are necessary to avoid or reduce adverse impacts? This is especially relevant given the fact that: (i) we have nearly 30 years of experience of doing EIAs on energy projects; (ii) energy projects are long lived assets; and (iii) the actual evidence shows that problematic energy projects do not have the necessary mitigation in place.

Given short timeframes and limited budgets, EIA practitioners would be well served by shifting the emphasis to mitigation instead of producing detailed impact analyses. EIA on the proposed and now abandoned Arun III Hydroelectric Project in Nepal is a case in point. The EIA consisted of volumes of impact analysis, but the information on mitigation measures and implementation was quite generic. Decision makers could take no assurance from the EIA that the proposed mitigation measures would reduce or eliminate the environmental or social impacts as stated.

Irrespective of whether or not the controversial Arun III Hydroelectric Project should have been approved, an alternative to the voluminous EIA and associated environmental reports would have been the development of a very detailed environmental mitigation plan for the project that would have covered not only its construction, but its operation for many years to come. Such a detailed plan would include specific mitigative measures and costs, including those for institutional strengthening, needed to ensure implementation and compliance.

In Canada and the USA, the development of environmental mitigation plans and their associated costs is becoming increasingly important. The development of such plans is in many cases the major ingredient in obtaining project approval and convincing participants that impacts will be reasonably dealt with. The greater reliance on environmental mitigation plans is part of a greater movement away from pure analysis or the notion of producing good paper. An example dealing with a large thermal power plant illustrates the point presented by Ahmad (1997).

The challenge to the EIA practitioner may be in selecting from amongst multiple mitigation measures with various costs. Of course, the relative importance and magnitude of the environmental and social resources will be a factor, together with the effectiveness of the measures and whether they can be implemented. As documented by Ahmad (1997), IUCN recommended a passive and much more cost-effective mitigation strategy for a coal-fired electric generating project in Pakistan. IUCN recognized that the willingness of the project proponent to accept certain measures was dictated by cost and also the institutional capacity of the Water and Power Development Authority (WAPDA) to implement and maintain mitigation measures. Given the facts and the emphasis of most developing country power operators to deal with power-related issues, there was greater likelihood that the scrubbers might not have been maintained properly and environmental conditions would have worsened over the life of the project. The selection of natural gas or a cleaner fuel was a better alternative.

In the USA, protection of fish migrating downstream of hydropower projects is commonplace. Hence, screening turbine intakes, spilling water and diverting fish to outlet structures are all typical fishery mitigation measures. Whilst screening intakes may seem appropriate at first sight, river systems with large quantities of organic matter may clog the screens. This may cause greater rates of impingement of fish on the screens if they are not cleaned adequately. Cada *et al.* (1997) have recognized the need for better measures to protect fish and are working on the design of a fish-friendly turbine, in which the survival of fish is enhanced compared with existing designs.

The EIA practitioner may also be faced with analysing mitigation measures that would restore wetlands and natural habitats. Caution should be exercised in this area unless there is a long-term commitment to restoration and the mitigation is well funded. Rather than attempting to restore wetlands in the vicinity of the proposed energy project, it might be more cost effective and beneficial to have the developer purchase wetland habitats and protect and manage these for the life of the project.

17.4.4 Implementation and compliance

Currently, the controversy and long delays associated with some kinds of energy project proposals are caused by the historically poor performance in constructing, operating and maintaining the projects already authorized and operating with respect to environmental and social concerns. One does not have to search very hard to find an energy project that does not have all of the required environmental and social mitigation measures promised in the EIA. Either the mitigation measures are not implemented at all, or they fall short of expectations because of poor performance, non-specificity, lack of technical expertise, insufficient budget or unanticipated impacts. Participants only have to experience this first hand or read about poor performance elsewhere for controversy and delays to envelop the siting and EIA process for entire segments of the energy sector. The relative performance of France's and Canada's nuclear power programmes compared to the poor performance of the nuclear power industry in the USA provides a striking example. Despite the threat of global warming and the limited number of economically feasible hydropower sites in the USA, the public is reluctant to embrace nuclear power. The reason is a lack of confidence in the regulatory process and the ability of the regulators to protect the public.

Internationally, there is a growing concern about the ability, or willingness, of energy project proponents to implement mitigation measures having obtained approval and the loan. There does not seem to be an effective and efficient mechanism to either ensure implementation of the mitigation plan or compliance with it, although this may be changing. Most electric utilities or power ministries in developing countries have poor institutional capacity in simply performing the day-to-day activities that ensure a healthy power sector organization. Asking the same organizations to implement environmental and social mitigation programmes successfully is very problematic. Clearly, the same long-term view and policy of strengthening the institutional capacity of energy sector organizations has to apply to the environmental performance. Many power sector organizations and international energy developers have recognized the need to consider and effectively deal with the environmental aspects of their projects (Russo & von Stackelberg 1994). Even the related irrigation agencies in some developing countries are beginning to recognize that investments in environmental capacity-building are the key to managing their infrastructure projects (Dames & Moore 1996; DuBois *et al.* 1997).

Many countries have regulatory structure and environmental laws to ensure that environmental controls are adhered to. In the USA, Canada, Europe and other developed countries, environmental protection agencies enforce air quality emission standards, water quality standards and waste disposal. Whilst these enforcement agencies deal with many of the most obvious environmental measures, most have no experience of dealing with relocation of people, indigenous issues, fishery passage and protection, minimum stream flows, cultural resources, wetlands, aesthetics and recreation. Whilst compliance with air and water quality standards is relatively straightforward, the success of other mitigation measures and plans is not as well defined. The responsibility for designing and implementing mitigation measures falls on the project proponent in most cases.

Ensuring that the mitigation is implemented according to the environmental management or mitigation plans falls on another regulatory body in most cases, and their are wide variations from country to country. For example, Canadian electricity regulation is at the provincial level, Scandinavian countries have national and local siting laws and regulations, whilst that in Japan is dictated by the Ministry of Industry and Trade, which promotes pollution control technology and encourages the 10 major Japanese utilities to do likewise. In Argentina, Brazil and Uruguay, there are ad hoc regulatory systems and much is left to the discretion of the state and federally run power producers. In contrast, Chile has considerable private sector participation which is regulated by the National Energy Commission (Gilbert *et al.* 1996).

In the USA, specific agencies that own and operate projects are responsible for implement-ing mitigation measures, which are a part of the agency budgets. The US Army Corps of Engineers and Bureau of Reclamation operate a large number of government-owned hydroelectric projects which fall into this category. The Department of Energy and the associated power administrations, such as Bonneville Power, Western Area, Tennessee Valley Authority and others, own and operate both extensive electric transmission lines and some hydropower and other power generating plants and bear the responsibility for implementing mitigation measures. The measures may include raptor-proofing transmission lines to prevent electrocution of birds of prey or burying portions of the line to avoid perceived impacts from electromagnetic fields and visual quality intrusions into a view shed.

Private sector energy projects in the USA are regulated by either the respective states or the federal government. Fossil-fuel generating facilities are regulated by the states, although federal air emission standards usually must be complied with. The FERC regulates all non-federal hydropower projects, LNG terminals and interstate natural gas and oil pipelines (Federal Energy Regulatory Commission 1994; Russo & Narins 1994). FERC has the authority by law and regulation to condition hydropower, natural gas pipeline and LNG terminal proposals so that they comply with a host of national environmental protection laws. FERC also has the power to ensure compliance through a system of fines and penalties, issuing orders to discontinue operations until compliance is achieved and revoking licences and pipeline certificates for non-compliance. In summary, one finds that the responsibility for mitigation always rests with the project proponent, subject to national laws and national and regulatory bodies, like FERC.

In the absence of well-developed legal and regulatory systems that can enforce mitigation or a philosophy of self regulation, the EIA practitioner should refocus efforts to build the needed institutional capacity to implement the mitigation over time. For large hydropower projects, such as the 2700 MW Yacyreta Project on the Paraña River in Argentina and Paraguay, Quintero (1997) makes a good case for institutionalizing the use of the EIA as an adaptive management tool, to counter the tendency to use EIAs only during the planning phase of projects and also to address environmental and social impacts not addressed in the EIA. Quintero (1997) and Lee and McCourt (1997) both advocate focusing on developing and financing an institutional strengthening package to implement an environmental management plan for both the Yacyreta Project and Lesotho Highlands Water Project in Africa for several years after the project is constructed.

One critical aspect of conducting EIAs on energy project proposals in most parts of the world is the notion that there is only one opportunity to do so, i.e. when the project is being proposed. In most countries, there is no legal provision to re-examine the project after a period of time, let alone make modifications to its operating regime. In many countries, permits or authorizations are indefinite or for the life of the project. In the USA, FERC-licensed hydropower projects must undergo an environmental review before a new licence can be reauthorized and also before changes to a project's operation are allowed. In a similar vein, water projects authorized by the US Bureau of Reclamation are also subject to environmental review when existing contracts expire and prior to signing new contracts. This makes sense, given the increase in our knowledge regarding environmental impacts and the mitigation needed to solve problems. In Canada, Hydro Quebec has instituted a form of environmental review and improvements when refurbishing some of their hydroelectric projects (P. Senecal, personal communication). This programme is entirely voluntary and is a good example of what a conscientious energy developer can accomplish. The EIA practitioner would be wise to try to stage needed mitigation over a period of the project's life, especially after debt service is reduced (Russo 1997).

17.4.5 The bigger picture—criteria for defining the project

What constitutes a proposed energy project and what to analyse in an EIA are common questions that must be dealt with. For example, is it appropriate to prepare an EIA of a an electric transmission line separately in conjunction with an EIA of a proposed electrical energy project, such as a hydropower or fossil-fuel electric generating plant? The answer depends upon a number of factors and is complicated by the physics of electricity as described earlier. In the USA, EIA practitioners at the FERC have made distinctions between primary transmission lines and those that are part of the interconnected system, when evaluating proposed or existing hydropower projects (Federal Energy Regulatory Commission 1993). FERC defines primary transmission lines as those necessary to evacuate the electricity from the power plant to the interconnected system. Therefore, if a new hydropower project were being evaluated, the construction of the 2.5 km of new transmission line between the powerhouse and the existing high voltage interconnected system would be evaluated in the EIA and be considered a part of the proposed project. The interconnected system, however, would not be evaluated. In some countries, the existing transmission system may be highly connected and there may be a tendency to evaluate the entire transmission line system, especially if it has not been subjected to an EIA before. This may not be appropriate, except to consider the route in the context of cumulative impacts. In other instances, primary transmission lines are quite long and will affect the viability of remote power stations. In this case, the primary transmission lines are part of the hydropower project and should be evaluated along with any new roads required to construct the transmission line or generating facilities. For example, multiple small hydro sites or a remote thermal station may be economically constrained not so much by the site-specific environmental and financial feasibility of the proposed power plants, but by the costs to transmit or evacuate the power to a user or the interconnected system.

Pires *et al.* (1993) provide a good overview of how extensive transmission lines in Brazil should be examined. In situations involving very long transmission lines, irrespective of whether they are primary or interconnected, the line may be a stand-alone project. In such cases, the potential impacts of the line, together with the institutional capacity to carry out an EIA, should be used to guide the decision. If the institutional capacity of the organization is not strong, it may be better to analyse the transmission line as a stand-alone project and focus the analysis on determining the environmentally preferable route. Analysing an extensive transmission line and associated power plants is good EIA practice, especially in addressing cumulative effects. The latter may be difficult to analyse and mitigate when separate documents are prepared on transmission line and power plant components.

Other aspects of newly proposed energy projects have to be considered also. For example, roads associated with the construction of the project and other facilities, such as switch yards, penstocks, natural gas pumping stations, etc. Generally, an EIA should assess those activities associated with constructing and operating energy generating facilities. Another aspect of defining a project is peculiar to hydropower projects. Most EIA practitioners will agree that a proposed hydropower dam and associated reservoir are certainly a part of the project to be analysed. We also have to factor in rights of way for penstocks, the tailwater areas immediately downstream from powerhouses and spillways and lands adjacent to the project reservoir. Historically, some hydropower projects in the USA have included a significant amount of land around reservoirs in FERC hydropower projects, while others have not. In some cases, there may be as many as 8000–10000 acres of land associated with a project. The inclusion of land in a project boundary is a regulatory decision, as part of the land is not subject to flooding from reservoir operations (Russo & Narins 1994). In the USA, land included in the project boundary has received a certain degree of protection from other activities, such as mining or timber harvesting, and is also managed for fish and wildlife protection. These activities are permitted only after receiving approval from the FERC, which usually prepares an EIA on larger, more complicated activities. In a sense, the inclusion of additional land adjacent to a reservoir has also served to ensure the integrity of the proposed hydropower project, by ensuring that land disturbing activities in the watershed do not cause excessive erosion, sedimentation and other adverse impacts that could jeopardize the financial feasibility of the project (Russo & von Stackelberg 1994).

17.4.6 Decommissioning and reauthorizing projects

As discussed previously, decommissioning is a part of the life cycle of many energy projects. Whilst, in theory, the EIA practitioner should consider this in a newly proposed energy project, one has to question the merits of analysing the impacts of an event that *may* materialize in 35–50 years, let alone committing resources toward such an activity. In practice, most EIAs do not analyse such impacts or provide even a general analysis. Some EIA analysts rely on other regulations and laws to deal with such a scenario in the distant future. For example, in the USA, the FERC and the Nuclear Regulatory Commission have regulations governing the decommissioning of natural gas pipelines, hydropower and nuclear power projects, respectively. EIAs are usually required before decommissioning such projects.

Decommissioning can also have various meanings depending upon the type of energy project. For example, with natural gas pipelines, it could mean totally removing the pumping stations and pipelines that are above ground and leaving the underground pipelines in place. With hydropower projects, decommissioning could mean removing the dam and all of the associated penstocks and transmission lines. It could also mean simply removing the generating equipment from the powerhouse and retaining the project dam and associated reservoirs. The latter situation is very prevalent on hydro projects that have been in existence for 30–50 years and have a large number of other activities associated with them. For example, hydro project reservoirs may be the source of water for irrigation, municipal and industrial purposes as well as for fish and wildlife. Towns and cities may develop adjacent to the reservoir to take advantage of dependable water supplies. Decommissioning can also take the form of a partial breaching of a dam. Thus, over time, riverine conditions would be established, but at less cost.

With respect to hydropower projects and dams, the most authoritative work on decommissioning is by the American Society of Civil Engineers (1997). This work was prepared by a working group of hydropower project operators, dam safety experts, environmental agencies and the major environmental NGOs in the USA This work uses a planning process that relies heavily on EIA to determine whether or not to decommission, how to do it and what mitigation measures are required. Recently, the FERC used an EIA to assess decommissioning and reauthorizing the Edwards Dam Project at the mouth of the Kennebec River in Maine. The final EIA supported FERC's decision to totally remove the project (Federal Energy Regulatory Commission 1997c).

The other factor that has to be dealt with in relation to older energy projects is reauthorization and/or refurbishment. Reauthorization of the project may come about as a result of regulatory requirements, such as the expiration of a permit, or an economic event, such as refurbishing generating units or increasing generating or transmission capacity to increase the life of the project. Advances in technology which increase efficiency, low interest rates, etc. may also make the refurbishment advantageous.

Prior to the time that an existing permit is about to expire or refurbishment is needed, an energy project operator could also propose to decommission or abandon the project. In these cases, an EIA would analyse the impacts and mitigation measures to reduce or avoid impacts. If the operator was interested in reauthorization and/or refurbishment, the project would be subjected to an environmental analysis on decommissioning and consideration of how the project could be operated differently to enhance environmental values. The scope of the decommissioning analysis is highly case specific. The key question on decommissioning is whether or not it is voluntary on the part of the project operator or is a reasonable alternative in an analysis that examines whether the project should be reauthorized and, if so, under what conditions.

The 'no action' option should be a relevant part of any EIA dealing with a decommissioning, reauthorization or refurbishment proposal. This may seem counterintuitive at first glance, especially with regard to decommissioning. However, retaining some project features may result in less environmental impact than their wholesale removal. An energy project should also be analysed from the perspective of its components and as a whole. Most important, the EIA must objectively examine environmental benefits and adverse effects of removing as well as retaining structures. Finally, the operation of the project should be evaluated, especially if certain features are retained. For example, there may be more environmental benefits in retaining the underground portions of a natural gas pipeline than the associated erosion and impacts to water quality involved with removing it. Hydropower projects are a special case, because people and multiple beneficial uses may develop within a reservoir and its watershed over a 30–50-year period. This is not the case for other energy projects. For example, a hydropower reservoir maintained and operated in an environmentally sensitive manner may promote benefits to fish and wildlife species and habitats associated with the reservoir and also benefits downstream as well. Hence, the beneficial environmental effects of removing a hydropower dam and restoring a river to its natural condition may not exceed the adverse impacts on existing beneficial uses associated with the project reservoir. Large and deep hydropower reservoirs are usually good sediment traps. The chemical quality of the bottom sediments generally reflects development in the river basin. Hence, heavy industrialization may result in hazardous materials in the bottom sediments, and removal of the dam may suspend and introduce toxins to the downstream portions of the watershed. There is no single answer as to whether or not removing certain facilities is warranted. Each hydropower project will be different and possess a different set of beneficial and adverse uses. The EIA must objectively analyse both the beneficial and adverse effects associated with the decommissioning proposal and the no action alternative and its components. As with any EIA of an energy project, the identification of mitigation necessary to support the proposal should be given a high priority.

17.4.7 Leveraging sustainable development

Reauthorizing energy projects may become more common as the private sector is called upon to construct and/or operate energy projects for limited terms, provided by build–own–operate (BOO) and build–own–operate–transfer (BOOT) schemes. Usually such schemes have terms of 25–35 years and some permits/licences for private sector ownership of an energy project are from 30 to 50 years. Reauthorizing projects provides an opportunity to re-evaluate an energy project's operation. It also allows the EIA analyst to call attention to changes in various societies, technological advances in energy generation and scientific advances in environmental science and mitigation and, importantly, to promote more sustainable energy projects. The idea of reauthorizing a project also recognizes the limitations of EIA to predict impacts over extensive periods of time and the fact that the environmental setting after 30–50 years may be very different as a result of the project. If energy projects are well maintained, life extensions are possible at considerably lower costs. More financial resources may also be available to fund environmental mitigation and thus operate the project in a more environmentally sustainable manner.

Russo (1997) advocated focusing attention on existing water projects as a means of leveraging sustainable development. This is especially relevant if existing hydropower or other energy projects are subject to reauthorization or renewal and EIA is required. The strategy is also relevant in countries where there is no regulatory requirement to reauthorize energy projects. The rationale behind this approach is not to limit the EIA's focus to proposed 'greenfield' energy projects, but to identify environmental mitigation measures from other projects in the region or watershed that will maximize environmental benefits within the constraints of the environmental mitigation budget. This approach is particularly relevant when the project operator owns multiple energy projects in a region or watershed, or water rights and natural resource concessions. For example, under normal circumstances an EIA practitioner's analysis may include what type of scrubber is required to reduce nitrogen oxide (NO_x) and SO_x emissions in a new coal-fired plant, whilst ignoring two other older coal-fired facilities in the same airshed owned by the company that have no scrubbers at all. In this situation, the EIA might focus on least-cost environmental mitigation that will provide the greatest environmental benefits to the entire airshed. All things being equal, this might include requiring minimally acceptable scrubbers on all three coal plants, rather than a state-of-the-art scrubber on the newest project, or substituting more environmentally friendly fuels on some or all of the existing and new coal-fired electrical generating units.

Existing hydropower projects offer an extraordinary sustainable development opportunity when examined in the context of a regulatory structure that requires reauthorization or refurbishment, as well as in the absence of such a structure. Many of the older hydro projects have altered watersheds significantly since they control downstream flow releases. These older projects are operated as a system with other hydropower projects in the watershed. Because of their relative age, many of these projects also have little or no debt after 30–50 years of operation. This fact, together with their ability to regulate whole or significant portions of river systems, makes them ideal candidates to effect mitigation that can produce significant environmental benefits. When such projects are examined in conjunction with other similar projects on the same river or river basin, the opportunities for identifying least cost environmental mitigation increase dramatically. This is because the universe of possibilities has gone beyond just a single project and the river basin and its environmental resources have become the unit of analysis. An example will illustrate the point. In the USA, 11 hydropower projects were subject to reauthorization and EIA. These projects were located in three distinct river basins and each project was characterized as a peaking project or base-load plant. By examining all 11 projects across the three river basins together, participants were able to identify parts of the river systems and projects that were very valuable from a power standpoint and those other projects where mitigation would do the most good and benefit environmental resources. As a result, four of the marginal peaking projects were operated as base-load plants, while the remainder continued to produce power as peaking projects. Significant environmental mitigation was identified at the marginal power sites.

17.5 EXAMPLES OF GOOD PRACTICE

In this section, attention is focused on examples of good EIA practice in relation to site selection, scoping, baseline surveys, prediction, evaluation, mitigation, monitoring and auditing, to the extent that these are available for energy projects. As stated earlier, few EIAs will excel in all of the areas. The author's intent here is to discuss a number of the most exciting examples and shed some light on why he believes they are steps in the right direction to making EIA more useful in the energy sector.

17.5.1 Site selection

The Navajo Transmission Line Project Environmental Impact Statement (EIS) is an excellent example of how to use EIA for site selection (USDOE Western Area Power Administration 1996). The EIS emphasizes site selection from numerous transmission route/corridor alternatives and mitigation through the selection of the most cost-effective route by avoiding significant environmental impacts. As part of the scoping, the analysts performed a rigorous regional corridor environmental feasibility study, which included a resource inventory, impact assessment and mitigation planning to select the environmentally preferred route. The study identified alternatives. Only then the EIA used to analyse these four alternative routes in detail and help select the final route.

This approach is very relevant not only to electric transmission line projects, but also to natural gas pipeline projects and other energy projects, where the possibility of multiple routes and alternatives can easily overcome one's technical and resource capabilities. The environmental feasibility study is certainly not as detailed as the EIA of the four alternative routes. Nevertheless, it narrows the field of alternatives in line with the objectives of scoping. As in this case, when done with the participation of different interests, a burdensome EIA can be avoided and resources devoted to identifying the best corridor or project alternatives. The approach is very interesting, because it seems to answer the fundamental question of many participants regarding how the proponent arrived at a decision on what project to actually propose and how that project was conceptualized. In this case, Diné Power Authority, representing the Navajo Indian Nation, used a scaled down form of EIA and the participants to help them identify and narrow project alternatives or concepts. They then used the EIS to make the final selection.

17.5.2 Scoping and baseline surveys

An excellent example of scoping and designing baseline surveys is the activities associated with the relicensing/reauthorization of the 912-MW, St

Lawrence–Franklin Delano Roosevelt Project Hydropower Project on the St Lawrence River, which is the international border of Canada and the USA. Scoping on this project consisted not merely of a few meetings and site visits, but included monthly meetings between the hydropower operator and 39 other organizations (60–70 individuals from the USA, Canada and the Mohawk Nation) over a 14-month period. The New York Power Authority (NYPA) with the assistance of FERC and the New York Department of Environmental Conservation (NYDEC), worked with all of the participants to prepare a Scoping Document, which defined the relevant issues, necessary studies to analyse impacts and specific mitigation that would meet some resource needs (Federal Energy Regulatory Commission & NYDEC 1997). The scoping process is noteworthy here, because it promoted ongoing dialogue amongst participants in special subcommittees and in the larger group. This type of process helps not only to structure the EIA, but also to focus on the necessary mitigation that would avoid or reduce impacts to environmental resources and make the project more environmentally sustainable (Russo 1997; Silliman & Russo 1997). Baseline studies were designed by NYPA and the participants' organizations, with special attention paid to the level of analysis and what specific information was needed to define an impact and the necessary mitigation to avoid or eliminate it. Because participants reviewed the study design plans, a staged approach was agreed to. For example, if initial study results shed sufficient information on the resource issue, there would be no need to complete the entire study.

17.5.3 Mitigation, monitoring and compliance

There are several excellent examples of how organizations have employed EIA to develop mitigation measures, along with monitoring and auditing. These examples include the Muzaffargarh Thermal Power Station, Pakistan, the Yacyreta Hydropower Project in Latin America and the Lesotho Highlands Project in Africa (Ahmad 1997; Lee & McCourt 1997; Quintero 1997). The case study of the Muzaffargarh Thermal Power Station in Pakistan is of interest, as it illustrates how mitigation can be approached by the EIA analyst when the entire fuel cycle is examined. In this case, IUCN focused on low-cost and practical solutions, which included alternative fuels, such as natural gas, instead of the usual expensive flue gas desulphurization system to reduce air pollution impacts. IUCN's approach had additional environmental benefits in that it caused the WAPDA in Pakistan to develop a computerized plant management and maintenance system and improve its solid waste management and gas emission monitoring at the Muzaffargarh Thermal Power Station. WAPDA has also started to implement these measures at some of its other plants. Hence, the mitigation proposed by IUCN has strengthened the institutional capacity of WAPDA, which will translate into less adverse environmental impacts in Pakistan's energy sector.

The 2700-MW Yacyreta Hydropower Project and associated navigation lock on the Paraña River in Paraguay and Argentina is an excellent example of how EIA can be used to strengthen the institutional capacity of a bi-national organization to deal with both expected and unexpected impacts from the operation of a large hydropower project. The situation at Yacyreta illustrates how EIA can fail to identify all impacts, especially if the project is large and controversial and environmental regulations are lacking. Despite this drawback, the use of the EIA as a basis and tool to deal effectively with unanticipated impacts is noteworthy. In the case of Yacryeta, the EIA did not predict that filling the reservoir would result in 'floating islands' or that highly oxygenated water flowing over the project spillway would cause nitrogen gas supersaturation and large fish kills. These two unanticipated impacts were dealt with successfully because the EIA on the project had focused on: (i) minimizing impacts through implementation of detailed mitigation plans; (ii) developing the institutional capacity in both Argentina and Paraguay to deal with unforseen environmental situations; and (iii) using the EIA as an adaptive tool rather than just the final document to advance project approval and financing.

The Lesotho Highlands Water Project (also discussed in Chapter 9, this volume) and the increased importance of the environmental management plan (ERM) and its successful implementation are a good example of a trend in EIA to focus more attention on mitigation plans. Detailed ERMs that are well thought out in terms of cost and scheduling bring an important aspect of energy projects to the attention of decision makers: that long-lived assets like hydropower projects will require extensive ERMs if impacts are to be mitigated satisfactorily. The costs of developing and implementing ERMs over an extensive period of time are legitimate project costs, that must be factored into the decision well before construction begins. The costs and the relative success of implementing the ERM is of concern to international lenders, because failure to do so can adversely affect the economic feasibility of the project and increase the risks (Russo & von Stackelberg 1994). Institutional strengthening is a major component of ERMs because well maintained hydropower projects are amongst the assets that last the longest and cannot be easily removed once constructed.

Good examples of EIA on natural gas pipelines and LNG storage facilities are the FERC's EISs on the Northern Border Project and the Eco Eléctrica LNG Import Terminal and Cogeneration Project. The EIA of the Norther Border Project (Federal Energy Regulatory Commission 1997a) analysed two competing applications to expand natural gas service to new and existing customers in the Midwest USA, primarily the Chicago, Illinois, area. Northern Border Pipeline Companies wanted to construct 628 km of new natural gas pipeline, eight new compressor stations, nine metering stations and 13 new communication towers. The competing proposal by Natural Gas Pipeline Company of America (Natural) called for 138 km of new gas pipeline, one new compression station and other associated facilities. The EIS evaluated a range of systems and route alternatives, route variations and compressor site alternatives. A preferred recommended natural gas pipeline project was the result of the analysis and included required environmental mitigation during construction and operation of the project, using guidelines outlined in FERC's *Natural Gas Pipeline Environmental Compliance Work Book* (Federal Energy Regulatory Commission 1996) and Hosmanek (1984).

The EIS on the Eco Eléctrica LNG Project is instructive because it illustrates what island nations or other countries may be faced with when natural resources are limited. In addition, the project configuration illustrates how a project can be developed to improve energy efficiency and develop other resources in a sustainable manner by looking at the entire fuel cycle. In the case of Eco Eléctrica, the major aspect of the proposal was the decision to try to satisfy the other development needs of Puerto Rico, such as demands for electricity and adequate water supplies. This was accomplished by using vaporized flue gases from the LNG plant as a fuel source to power a 461-MW electric cogeneration plant. These flue gases would have been flared if they were not used by the cogeneration plant. In turn, the surplus waste heat from the cogeneration facility was used to power a salt water desalinization plant capable of producing 15.1 million litres per day of fresh water needed for the LNG plant. Surplus water then would be sold for public use in Puerto Rico for other uses.

Both the FERC and the Puerto Rico Planning Board (1996) prepared the EIS, with English and Spanish versions being published. Both the FERC and the Board evaluated a variety of mitigative measures beyond that proposed by Eco Eléctrica, as well as site, facility layout and operational and energy alternatives. The EIS not only analysed the impacts of the terminal and project, but also LNG ships and the risks associated with LNG spills and the risks to marine life. Both the FERC and Board staff recommended additional studies and developed specific mitigation measures, which were made part of the certificate authorizing the construction and operation of the project.

The EIA of the 3100-km Bolivia–Brazil Gas Pipeline project is the basis for an extensive ERM which incorporates the concept of impact avoidance and compliance from construction, operation and maintenance. Many EIAs prepared on projects in developing countries, and particularly those funded by international lenders, like the World Bank, Inter-American Development Bank and the Corporación de Fomento, are committed to mitigation measures (see Chapter 6, this volume). Whilst this is a step in the right direction, few of the EIAs or ERMs discuss how this will be done and, more importantly, who will ensure compliance. The ERM on the Bolivia–Brazil Gas Pipeline Project answers both of these questions—only time will tell how things actually work out. Aside from the length of the pipeline, there is the fact that Enron Corporation, a global energy company, is participating in the project.

The ERM for the Bolivia–Brazil Gas Pipeline project will rely on three levels of review to accomplish the goals of environmental protection established for the project: (i) the construction contractor, (ii) the environmental monitoring contractor and (iii) a third-party environmental auditor. The construction contractor is responsible for conducting environmental inspection on their own work. The environmental monitoring contractor, independent from the construction contractor, will oversee all activities and report any non-compliance to the environmental project manager. The third-party environmental auditor, who will report directly to the international lenders, will audit all activities related to the environment, from field activities to the reporting activities of the environmental monitoring contractor. The ERM and a similar Indigenous Peoples Development Plan will provide guidance to the construction contractor, monitoring contractor and environmental auditor to ensure project compliance with all programmes (Dames & Moore 1997a, b).

The above compliance programme is interesting because it places environmental personnel and an independent audit function alongside the construction contractor to ensure compliance. As discussed earlier, the regulatory structure of a country does affect how EIA is performed and, in this case, has led to a compliance component that goes far beyond what has been the case previously. The reasons for the development of the strong compliance programme are: (i) the extensive length of the project and scale of impacts to large parts of Bolivia and Brazil; (ii) the participation of Enron Corporation, with its expertise in constructing and operating natural gas pipelines and familiarity with good practice and FERC compliance in the USA; and (iii) pressure on international lenders to take more responsibility for what happens after loans are approved.

Although the compliance programme is novel in many respects, the experience in South Africa on the Drakensberg Pumped Storage Project is also noteworthy. In the mid 1970s, the Department of Water Affairs formed the Drakensberg Environmental Committee, to determine the impact of the project and make recommendations on measures to exclude or reduce construction impacts on the environment. The Committee was also empowered to obtain assistance from environmental experts. The Committee conducted studies, made recommendations and implemented a number of mitigation measures to reduce or eliminate environmental impacts. Roberts and Erasmus (1982) indicated that the most important part of the Committee's work was the implementation of the recommendations. They found it crucial to obtain the cooperation of management and the design and site personnel. The Committee and management formed a special coordinating committee to work with the construction site personnel during the implementation phase.

The Drakensberg Pumped Storage Project and its activities are cited as good practice, because it illustrates that a complicated regulatory scheme is not required to design and implement environmental mitigation. Well-thought-out and simple mitigation plans which could be integrated with the design and construction team were the hallmark of success. The author believes that the ability of the Committee to work with the project proponents and integrate environmental components into the construction and operation of the project should not be overlooked.

The final example of good practice deals with the EIS on the relicensing of the Edwards Dam Project in Maine. This hydroelectric project, whilst controversial, illustrates good practice in analysing a decommissioning alternative which included total removal of all project facilities. The EIS included a thorough analysis of the costs and environmental effects of removing the dam, including those of resuspension of bottom sediments, and the beneficial and adverse environmental effects of decommissioning the project with refurbishment, adding additional generating capacity and constructing upstream fish passage facilities.

17.6 CONCLUSIONS

There is no single EIA on any energy project reviewed that scores high marks in all areas. The EIA practitioner must, in a sense, stop looking at the last EIA done in his or her own country or region and begin looking at other experiences in other countries. It is hoped that this chapter provides the beginning of that journey and hopefully a good step in the right direction. A number of the references cited here refer to further interesting EIAs. Practitioners need to be very creative and modify approaches to suit their countries and special situations.

Most energy projects are long-lived assets. Therefore, the EIA practitioner should devote more time and effort to the analysis of environmental mitigation measures that will avoid, reduce or compensate for unavoidable adverse effects well beyond the construction phase. The EIA practitioner needs to be cognizant of the regulatory structure in the country where the facility is to be sited. In the absence of a well-structured regulatory programme, mitigation measures should not be complicated or beyond the institutional capacity of the environmental organizations who will be implementing them. EIAs should be used as an adaptive management tool rather than a final document on the way to project approval. EIAs should serve as a basis for setting up a long-term environmental mitigation programme that is replete with capital and operating costs.

Privatization of the energy sector may be beneficial in some respects for EIA and the environment, as many energy companies from developing countries are more familiar with good siting and environmental practices than host country developers or the national governments. EIA practitioners must try to develop compliance mechanisms into ERMs. Also mitigation measures need to be recast in the light of when they will occur. In other words, the EIA practitioner must realistically indicate not only what is needed, but also when it is needed, given the 30–100-year lives of some energy projects.

Cooperation between energy project developers and EIA practitioners is crucial if one is to find least-cost mitigation measures that provide the greatest environmental benefits. The formation of collaborative and cooperative teams is an idea that should be explored during the design and implementation of an energy project. COEAs are an idea whose time may have come, as energy project proponents recognize the need to pool resources with participants and affected people to design and carry out projects that are sustainable. Settlements and agreements on how projects should be designed and operated can reduce a project's financial and environmental risks.

Finally, EIA practitioners should not overlook the rich assortment of energy projects that have also been developed over the last 50 years. While these projects may not be a part of the current proposal, they may be owned and operated by the same proponent. Hence, the opportunities to identify least-cost environmental mitigation might be more fruitful and the environmental benefits more significant.

Note: The views expressed in this chapter are those of the author and do not represent the official views and policies of the US Federal Energy Regulatory Commission.

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