Energy security in a developing world

Kuik, O.J.; Bastos Lima, M.G.; Gupta, J.

published in
Wiley Interdisciplinary Reviews. Climate Change
2011

DOI (link to publisher)
10.1002/wcc.118

document version
Publisher's PDF, also known as Version of record

Focus Article

Energy security in a developing world

Onno J. Kuik,* Mairon Bastos Lima and Joyeeta Gupta

Energy security, a fuzzy concept, has traditionally been used to justify state control over energy and a reluctance to deal with energy issues at global level. However, over time, the concept is acquiring different meanings that are applicable at different levels of governance. Many of the elements of the new definitions also imply a number of inherent contradictions. Against this background, this article explores the dimensions of energy security with a special focus on the developing world. It argues that (1) within developing countries (DCs), energy security implies both access to modern energy services by the poorest as well as access by the rapidly developing industrial, services, and urban sectors. Lack of adequate resources has implied trade-offs in terms of who gets access and in terms of taking into account the social and ecological consequences of specific energy sources. Furthermore, (2) the growing DCs' need for energy is impacted by industrialized country perceptions of the various dimensions of energy security—recognizing the need for access to the poorest; industrialized countries are increasingly implicitly questioning the right of DCs to use fossil fuels because of its implications for climate change; or to build large dams because of ecological and social security concerns or expand nuclear energy because of its potential security implications. The development of reliable, continuous, affordable, and environmentally sound provision of energy services combined with a focus on energy efficiency and conservation is the only way of alleviating the various multi-level dimensions of energy security. *WIREs Clim Change* 2011 2 627–634 DOI: 10.1002/wcc.118

INTRODUCTION

Energy security is an evolving concept. Following the significance of reliable access to energy during the two world wars, energy security was used to justify a nationalistic approach to energy and attempts to internationalize the scope of energy security were preempted. Energy security was seen as an integral element of national security, with oil as its primary focus.[1] Energy security became a hot topic after the oil crises of the 1970s. In response, the industrialized countries created an energy security system based on cooperation, coordination, monitoring, and strategic stockpiling.[1] Today, energy security is evolving rapidly to imply a more complex, multi-faceted concept.

The multi-faceted nature can be seen from a 2001 energy report of the U.S. administration which tried to summarize the issue in its title 'Reliable, Affordable and Environmentally Sound'. Despite the fact that the issue seems intuitively clear, an accepted analytical and unambiguous definition of energy security seems to be lacking.[2] Other refer to the four R's of energy security as: review (availability and situation), reduce (conserve), replace (shift to other sources), and restrict (new demands).[3] One analyst called energy security as 'one of the most overused and misunderstood concepts in the energy debate'.[4] Another analyst noted that most definitions are primarily self-serving and ideologically laden, from those who promote free trade, free market, and small government to those who promote the opposite.[5] Energy security has been used as an argument to justify a range of often inconsistent decisions.[6] A possible explanation of the 'fuzziness' of the concept may be related to the fact that different dimensions of the concept may (sometimes) be contradictory. Some of these contradictions are further explored in this article, but with a specific focus on energy security issues in relation to the developing world.

*Correspondence to: onno.kuik@ivm.vu.nl
IVM, VU University, Amsterdam, The Netherlands
DOI: 10.1002/wcc.118

The transition to the multi-faceted nature has certain features. First, the focus has shifted from oil alone to more energy sources, initially to gas and LNG (that are also internationally traded), but eventually also to the supply of electricity, which is in many respects a more domestic concern. Second, energy security is no longer only related to national security concerns but is also related to human security issues which focus on the affordability and availability of energy to the poorest people—a key issue for the developing world that is also perceived as a global concern as evident from their inclusion in the Millennium Development Goals.[7] Third, energy security has become linked to environmental security issues and sustainable energy sources have become the focus of policy. The recent British Petroleum oil leak of the U.S. coast in May 2010 has brought these issues once more to the fore. Fourth, energy and environmental security concerns have merged in the call for demand-side management and energy efficiency.[8,9] The threats to energy security have therefore also diversified, with respect to geography, technology, agents, institutions, and possibly solutions.

Most papers on energy security focus on the perspectives and positions of the developed or industrialized countries (IC).[6,10,11] In contrast, this article examines what energy security implies to developing countries (DCs) and what it implies to these countries in the context of their relationship with the industrialized world. The concept of energy security changes as the context of the discussion changes. Within the context of DCs, energy security has two key faces—-first, the provision of energy access to the poorest in rural and peri-urban areas and second, the continued access to energy by the industrial, service, and urban sectors. However, there are a number of challenges that DCs face in the domestic context (see *Energy Security in DCs—Issues and Trade-offs*). At the same time, the DCs' use and exploitation of energy resources has complex implications for global security, global energy security, and global environmental security (see *Energy Security in a DC–IC Context: Issues and Trade-offs*). Global governance on energy issues is struggling to cope with these issues (see *Global Energy Security Governance: Competing Rhetoric and Fragmentation*). These are the different dimensions that are explored further in this article. Last section concludes the article with its final considerations.

ENERGY SECURITY IN DCs—ISSUES AND TRADE-OFFS

In many parts of the world, access to modern energy services is poor, irregular, or unreliable.[12] The poverty, development, and energy security discussion has two dimensions to it. First, at national level, DC governments see a direct link between increased access to energy services and economic development. This is not only evident in the scientific literature but also in the policy and negotiating positions taken by these countries in the international climate negotiations. This often translates into increased access for the industrial, services, and urban sectors. For example, the Indian industry and services sector has faced a major shortage in energy supply to meet the needs of its industrial sector and this has been a major incentive for increasing energy supply.[13]

The other dimension is the access of the poor and marginalized to modern energy services. Currently, 2.6 billion people worldwide rely on traditional biomass such as dung, charcoal, or fuelwood as their primary source of energy, and it is estimated that 1.6 billion people lack access to electricity, the large majority of them in DCs.[14] The provision of improved energy services has been deemed essential for increasing food security, health, education, living standards, as well as to foster economic development.[12,15,16] The United Nations Development Program (UNDP) recognizes that 'none of the Millennium Development Goals (MDGs) can be met without major improvement in the quality and quantity of energy services in DCs'.[7] The development of productive activities, health and educational facilities, gender equity, and environmental sustainability all depend on having clean and efficient modern energy services, as Table 1 details below.

However, the twin challenges in DCs are subject to three types of trade-offs. First, the lack of adequate resources in these countries leads to trade-offs in making priorities with regard to where and for whom energy services should be provided. Progress so far has been highly uneven both in terms of geography and of urban–rural parity. While China, Latin America, and much of the Asia-Pacific region have succeeded in increasing the percentage of their population served with modern energy, in Sub-Saharan Africa and South Asia population growth has largely outpaced those advances.[17] This is a trend which has persisted since at least the early 1970s.[18] At the same time, most of those who gained access to modern energy through the last decades live in urban areas; four of the five persons without such access today are rural dwellers.[19] Rural areas are much harder to reach with usually centralized power grids, and high start-up costs coupled with fewer economic returns due to low population densities and the consumptive rather than productive nature of the

TABLE 1 | Energy and the Millennium Development Goals (MDGs)

MDG	Role of Energy
Eradicate extreme poverty and hunger	Development of agriculture, industry, commerce, and services; lighting for work after daylight[16,17]
	Food cooking, processing, and conservation (e.g., refrigeration)[16,17]
Achieve universal primary education	Heating, electricity, and information and communication technologies in schools[16,17]
	Energy access to attract teachers to poorer, particularly rural areas[17]
	Lighting for evening classes and home study[16,17]
	Freeing children, especially girls, from the need to collect biomass (e.g., wood) for fuel and allow them to use that time for studying[16,17]
Promote gender equality and empower women	Freeing women from the need to collect biomass, from the hazards of indoor air pollution due to traditional fuel use and providing more efficient stoves and other household equipment, allowing women to save their time and effort for education, social participation, or economic opportunities[15–17]
Reduce child mortality	Reduction of child disease and mortality from exposure to indoor air pollution or from drinking non-boiled water[16,17]
Improve maternal health	Power for health clinics and lighting during nighttime deliveries[1]
Combat HIV/AIDS, malaria, and other diseases	Lighting, refrigeration, and sterilization for the provision of health services[16]
	Communication, through radio and television, of information on hygiene, health promotion, and disease prevention[16,17]
Ensure environmental sustainability	Sustainability depends on clean energy systems which mitigate climate change and pollution and avoid damage on land, forests, or water resources[16,17]
Develop a global partnership for development	Energy has been part of the World Summit on Sustainable Development's call for partnerships among governments, non-state actors, and international organizations[16]

use which lead these areas to be frequently excluded from large-scale energy infrastructure programs.[18,20] Even when energy becomes available, it often remains expensive and demands a large share of the rural poor's income, so affordability too becomes an issue.[18,21]

Second, the lack of adequate resources leads to trade-offs regarding environmental sustainability. Most DCs (and some industrialized) find renewable sources of energy relatively expensive and focus on fossil fuels instead. Access to modern technologies has not always been easy and older and less environmentally friendly technologies are cheaper and more affordable.

Third, liberalization of the energy markets and lean national governance frameworks tend to favor high return energy investments over energy for consumptive uses of the poorest. On the one hand, the liberalization process itself focuses on profit maximization. While in the 1950s oil ownership was concentrated in the hands of a few companies, in both developed countries and DCs, power companies and infrastructure tended to be state-owned and centrally organized. A trend to liberalize the power sector was evident in the latter half of the 20th

century and since the early 1990s DCs were put under pressure to liberalize their markets.[22] In many DCs, there was also increasing dissatisfaction with the low service quality, non-collection rates, high network losses, poor service coverage, and the increasing drain on public finances.[23] Barnes and Toman[24] point out that in the early 1990s, the average electricity tariff in DCs was about 4 cents per kWh, whereas generation costs was about 10 cents per kWh. Such subsidies, they argue, left many utilities economically crippled, unable to finance any quality improvements of their services or extensions to rural areas. The combination of domestic dissatisfaction and pressure from the development banks and aid agencies led to electricity sector reform and liberalization. One of the major opportunities lies in the attraction of private capital to finance badly needed investments in energy infrastructure. For India alone, it has been estimated that it would need $665 billion over 30 years to finance the necessary expansion and modernization of its electricity sector.[25] Various climate change mechanisms (such as the Clean Development Mechanism and the Global Environmental Facility) and also other international funding mechanisms could possibly fund a part of these capital requirements.[13]

Jamasb et al.[22] reviewed econometric studies on the performance of these reforms in DCs. The reforms took many forms in different countries, some more and some less successful. There is some limited evidence that reforms have increased operating efficiency and improved access to urban customers. But Jamasb et al.[22] also concluded that the reforms did not pass on efficiency gains to customers and have not improved access to rural customers.

On the other hand, perhaps the hardest challenge is political, 'the poverty of power', for decision-making is often dominated by elite groups who may benefit from current conditions, while those who actually lack basic services have little or no voice in the political processes that determine their lives (Ref 26, p. 29). If current trends persist, however, *more* people are expected to rely on traditional biomass in the next decades, with grim consequences on health, development, and the environment.[17]

ENERGY SECURITY IN A DC–IC CONTEXT: ISSUES AND TRADE-OFFS

The use of energy in one part of the world is, however, no longer a local issue but a global issue because of three key global concerns it raises. First, increasing access to fossil fuel resources by the DCs raises the issue of resource depletion.[2] Furthermore, the concentration of energy resources in specific parts of the globe (e.g., Middle East) has energy security implications.[11]

Second, access to certain types of fuel raises challenges on security grounds. Gas pipes passing through certain DCs raise the fear of terrorist blasts; nuclear plants raise the risk of theft of enriched uranium and nuclear proliferation.

Third, the use of certain types of energy has localized to globalized environmental and social consequences that create a global concern. For example, large dams are seen as problematic by the World Commission on Dams[27] and their report has been extensively used to dissuade DC governments from developing such dams. This has impacted on DC decisions. However, the legitimacy of the World Commission on Dams has also been called into question.[28,29] At the other end of the scale and possibly the most important and urgent issue today is the issue of the impacts of fossil fuel use on global climate change and this raises the question of who has the right to emit greenhouse gases—the developed or the developing?[2] While in the early days of the climate negotiations, the implicit contract between developed and developing as adopted into the United Nations Framework Convention on Climate Change was that the developed countries would reduce their rate of growth of emissions to make room for the economic growth and, hence, emissions of DCs—the leadership paradigm.[13] In 1986, the UN High Commission on Human Rights adopted the Declaration on the Right to Development (1986)[a] which recognized finally the right of the DCs to develop. However, by 1997, it became evident that reducing emissions in the USA would not be easy[30] and this ultimately led to USA's withdrawal from the Kyoto Protocol in 2002. This slowed down the motivation of the remaining developed countries to increase the rate of reduction of their greenhouse gas emissions, and as early as 1997 the USA was calling on the key DCs to participate meaningfully in the regime—the conditional leadership paradigm. The continuing reluctance of the USA to substantially reduce its emissions of greenhouse gases and the increased pressure on the developing world have led to a stalemate. In January 2010, following the failure of the Copenhagen Conference to yield significant results, the key DCs have made some conditional commitments to try and reduce the rate of growth of their emissions. Most of these emissions are associated with the use of fossil fuels (although some are also associated with animal husbandry) and since many of these countries have large supplies of domestic fossil fuel they wish to exploit these first before importing

expensive foreign fuels that may imply a drain on their foreign exchange reserves. The USA and some six other countries have also set up the Asia-Pacific Partnership on Clean Development which focuses on using clean fossil fuel technologies as a way to address this stalemate; but for NGOs and academics this is seen more as a diversionary measure than as a serious effort to drastically address the conflict between national energy security concerns and global environmental security concerns.[31]

GLOBAL ENERGY SECURITY GOVERNANCE: COMPETING RHETORIC AND FRAGMENTATION

Global energy governance is highly diffuse: there are a range of activities by governmental actors, hybrid bodies, and treaties that are of relevance. There is no common forum focusing on resolving conflicts between countries and in dealing with the multiple dimensions of the energy security issue.

There is only one dedicated agency for atomic energy—the International Atomic Energy Agency (IAEA) established in 1957. However, there are several UN agencies that work on various dimensions of energy. As and when problems emerged, *ad hoc* solutions were envisaged. For example, the problem of large dams led to the establishment of the World Commission on Dams. The UN Commission on Sustainable Development has occasionally dealt with energy issues. In 2003, a decision was taken by the UN to set up a collaborative body and in 2004, UN Energy was created to help unite UN agencies working on energy issues. They focus on four areas—contribution to energy discussion, policy coherence and operational cooperation, information and knowledge management, and cooperation with non-UN partners, but the level of work conducted is quite limited. UN Energy has at present 20 members including FAO, IAEA, the World Bank, and others. The bottom line is that at UN level there is no clear policy framework for managing energy issues. Even the European Union has been unable to come up with a coherent European energy security strategy.[10]

Aid agencies and development banks have made policy on investing in energy infrastructure and this has been influential. Their own policies backed by financial assistance have had a critical influence on the nature of developments in the energy infrastructure and governance sector in key DCs. Many of these agencies have promoted liberalization of the energy sector in the developing world. They also have mechanisms in place pushing for promoting energy access for the poorest through channeling official development assistance funds in this direction.[12] Export credit agencies are also providing assistance in the area of energy but have often promoted fossil fuel technology exports.

There is a dearth of global declarations on energy and policy statements. The Millennium Development Goals aimed to prioritize energy access of the poorest. Multilateral energy agreements are limited to the Energy Charter and the agreements of the International Energy Agency. Some 1400 bilateral and plurilateral agreements on energy have been made between countries. However, the proliferation of these agreements does not provide any clear governing framework on how local to global energy security dimensions can be taken into account. In the meanwhile agreements made in specific areas have impact on global energy decisions. For example, the discussions within the Climate Change negotiations focus considerably on the nature of energy resources and its Clean Development Mechanism also aims to promote modern energy technologies in the developing world.

Essentially, the market runs energy governance. Ongoing market reforms in electricity markets have changed the role and position of governments in these markets. The role has changed from a monopoly supplier to a network player alongside private parties and stakeholders. More competition, improved technologies, and the traditional problems with centralized power grids have created opportunities for decentralized energy systems based on renewable energies to address issues of local energy scarcity and security. Governments have to weigh-off the costs and benefits of this alternative approach to the traditional approach of power grid extension on a case-by-case basis. They should also probably consider ways to alleviate financial constraints with regard to up-front investment costs of such decentralized options, and to examine and test new management and business models at the local level.

In the governance vacuum that has emerged in the field, the G-8 stepped in and developed a plan of action on Global Energy Security through increasing transparency, predictability, and stability of global energy markets; improving the investment climate in the energy sector; enhancing energy efficiency and energy saving; diversifying the energy mix; ensuring physical security of critical energy infrastructure; reducing energy poverty; and addressing climate change and sustainable development. The G-8 is thus actively promoting energy governance at least at rhetorical level, and there are now increasing calls for global governance on energy.[9,32,33]

The bottom line is that energy governance is an area where national security interests are more explicitly prioritized over global issues, and the nature of the explicit recognition of these interests has implied that countries are unwilling to promote and support a comprehensive global governance framework on energy. The diffuse and competing results of the different governance frameworks provide countries with the space to promote some common interests, while still maintaining the sovereign rights to do as they please in the energy arena in the domestic context. In the meanwhile, energy governance has been overtaken by climate change governance—while the latter is temporarily facing implementation challenges, if certain impacts become evident and have tragic consequences, this will probably be the arena where the issue of what kinds of energy should be invested in will be debated in the coming years.

The main challenge at the global level is threefold. First, will countries that see energy security most dominantly within the national security framework be willing to scale the issue to a global level? Second, given the significant role of energy in national income, will countries be able to rise above the short-term economic interests embedded in energy politics and trade, to come to consensus about which energy issues should be prioritized and which energy sources should be phased out and which not? Third, given the vast differences in contextual policies at local, provincial, and national levels, how can a system of global energy governance develop instruments that can eventually apply to all countries? To some extent, global governance on energy is already taking place. What remains to be seen is whether these different forms of international cooperation are able to focus more on sustainable energy issues than on the transfer of older and unsustainable technologies.

CONCLUSION

This article has reviewed the recent literature to focus on the nature of energy security issues facing DCs. Energy security is commonly understood as a supply of energy that is reliable, affordable, and environmentally sound. However, reliable and environmentally sound supplies may not always be affordable and this has led to many trade-offs in decisions focusing on energy supply. In a historical perspective, the notion of energy security has broadened in a number of dimensions: from concern about oil to a broad array of energy resources, from concern within a national perspective to local and global perspectives, and from a narrow economic perspective to a sustainability perspective.

This article concludes that energy security in relation to the developing world can be examined in terms of domestic issues and extra-territorial issues—the relations with the developed world. Within the domestic context energy security has two faces—the priority of meeting the needs of the poorest—mostly consumptive uses; and the priority of meeting the needs of the industrial, services and urban sectors—mostly profit making sectors. However, lack of resources has led to policies that make trade-offs between these two priorities and ignore the environmental consequences of energy infrastructure. At the same time, the lack of resources has led to deregulation, on the one hand, and liberalization on the other hand—and these forces have somehow accelerated these trade-offs.

It further concludes that with the rapid rate of industrialization in many of these countries, there is a new dimension to the energy security problem in the context of DC–IC relationships. First, the growing demand for fossil fuels raises the fear of accelerated resource depletion. Second, large dams are generally seen as passé, given modern knowledge about the social and ecological consequences of these and hence support for these dams is diminishing. Third, the rise of nuclear power and the challenge of climate change have made DC access to increased energy closely linked to global security issues. However, this IC–DC relationship takes on different dimensions in different issue areas. In large dams, the issue is biodiversity loss and social concerns; in nuclear, it is safety and the risks of terrorist access to enriched uranium; in the case of climate change, its a question of emission rights.

Globally, energy security issues have been receiving more and more attention. The challenges of fossil fuel depletion and its implications for development, the dependence on foreign energy and the correlated implications for depletion of foreign exchange resources (especially for the poor countries), the rise of energy geopolitics in the aftermath of the resurgence of terrorism at the global scale, the growing issue of access to energy of the poorest people, and the issue of meeting energy demands of the fast developing economies and the implications for climate change call for a more comprehensive understanding of global energy security issues.

The traditional approach to energy security provides a very narrow framework for policy processes, especially in light of the major environmental, social, political context in which energy operates. Such a realization has occurred in other fields, as in water management—where there has been a shift

toward integrated water resources management—and in climate change, where there has been a shift toward mainstreaming climate change into development.[34,35] However, similar shifts are not yet observable in the energy field, although this may be forthcoming.[36] The rise in information about the role of renewables, about energy as a service industry, and so forth also push in the direction of greater integration between energy and other fields.

Further research in the area of energy security could try to address some of the gaps recognized here, from the local to the global level. The emerging global energy governance, for example, is yet a very much uncharted territory, where institutional interactions, arrangements, and design still need further study. What is emerging is that security calls for diversity of dependence[37] and energy efficiency and conservation on the other hand.

NOTE

[a] A/RES/41/128, December 4, 1986.

REFERENCES

1. Yergin D. Ensuring energy security. *Foreign Affairs* 2006, 85:69–82.
2. Kruyt B, van Vuuren DP, de Vries HJM, Groenenberg H. Indicators for energy security. *Energy Policy* 2009, 37:2166–2181.
3. Hughes L. The four 'R's of energy security. *Energy Policy* 2009, 37:2459–2461.
4. Helm D. Energy policy: security of supply, sustainability and competition. *Energy Policy* 2002, 30:173–184.
5. Alhajji AF. What is energy security? Definitions and concepts. Middle East Economic Survey, L (45), 2007.
6. Löschel A, Moslener U, Rübbelke DTG. Energy security—concepts and indicators. *Energy Policy* 2010, 38:1607–1608.
7. UNDP. Energy for sustainable development: overview. United Nations Development Programme. Available at: http://www.undp.org/energy/. (Accessed May 29, 2009).
8. Egenhofer C, Gialoglou K, Luciani G, Boots M, Scheepers M, Costantini V, Gracceva F, Markandya A, Vicini G. Market-based options for security of energy supply. FEEM Working Paper, 2004.
9. Gupta J, Ivanova A. Global energy efficiency governance in the context of climate politics. *Energy Efficiency* 2009, 2:339–352.
10. Umbach F. Global energy security and the Implications for the EU. *Energy Policy* 2010, 38:1229–1240.
11. Lefèvre N. Measuring the energy security implications of fossil fuel resource concentration. *Energy policy* 2010, 38:1635–1644.
12. Modi V, McDade S, Lallement D, Saghir J. *Energy Services for the Millennium Development Goals*. New York: Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project, and World Bank; 2005.
13. Gupta J, van Asselt H, Kuik O, Evans C. Exogenous promotion of sustainable electricity options in India: opportunities and challenges. *Energy and Environment* 2007, 18:403–420.
14. Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Synthesis*. Washington DC: Island Press; 2005.
15. Rehfuess E. *Fuel for Life: Household Energy and Health*. Geneva: World Health Organization; 2006.
16. UN-Energy. The energy challenge for achieving the Millennium Development goals. United Nations 2005. Available at: http://esa.un.org/un-energy/. (Accessed May 29, 2009).
17. UNDP. *Human Development Report 2007/2008*. New York: United Nations Development Programme; 2008.
18. World Bank. *Rural Energy and Development for Two Billion People*. Washington, DC: World Bank; 1996.
19. IEA. *World Energy Outlook 2004*. Paris: Organisation for Economic Co-operation and Development (OECD); 2004.
20. Practical Action. Energy poverty: the hidden energy crisis. Available at: http://practicalaction.org/docs/advocacy/energy_poverty_hidden_crisis.pdf. (Accessed July 16, 2009).
21. Silva D, Nakata T. Multi-objective assessment of rural electrification in remote areas with poverty considerations. *Energy Policy* 2009, 37:3096–3108.
22. Jamasb T, Mota R, Newberry D, Pollitt M. Electricity sector reform in developing countries: a survey of empirical evidence on determinants and performance. World Bank Policy Research Working Paper, 2005.
23. Joskow PL. Electricity sectors in transition. *The Energy Journal* 1998, 19:25–52.
24. Barnes DF, Toman MA. Energy, equity, and economic development. In: Lopéz R, Toman MA, eds. *Economic Development and Environmental Sustainability*. Oxford: Oxford University Press; 2006, 245–272.
25. IEA. *Electricity in India. Providing Power to the Millions*. Paris: International Energy Agency/Organisation for Economic Co-operation and Development; 2002.
26. UN ESCAP (United Nations Economic and Social Commission for Asia and the Pacific), United Nations

Development Programme (UNDP), and Asian Development Bank (ADB). *Access of Basic Services for the Poor: the Importance of Good Governance*. Bangkok: UN ESCAP; 2007.

27. World Commission on Dams. *Dams and Development: A New Framework for Decision-making, The Report of the World Commission on Dams*. London: Earthscan Publishing; 2000.
28. Scheumann W. How global norms for dams reach decision-makers. In: Scheumann W, Neubert S, Kipping M, eds. *Water Politics and Development Cooperation: Local Power Plays and Global Governance*. Dordrecht: Springer; 2008, 55–80.
29. Dingwerth K. The democratic legitimacy of public private rule making: what can we learn from the World Commission on Dams. *Global Governance* 11:65–83.
30. Byrd Hagel Resolution 1997, US Senate Resolution 98 on Global Warming. Congressional Record, October 3, 1997; Senate, pp S10308–S10311. Available from Congressional Records online at: http://www.gpo.gov. (Accessed July 16, 2009).
31. Karlsson-Vinkhuyzen SI, van Asselt H. Introduction: exploring and explaining the Asia-Pacific Partnership on clean development and climate, International Environmental Agreements: Politics. *Law and Economics* 2009, 9:195–211.
32. Lesage D, van de Graaf T, Westphal K. The G8's role in global energy governance since the 2005 Gleneagles Summit. *Global Governance* 2009, 15:259–277.
33. Goldthau A, Witte JM. "Back to the future or forward to the past?" Strengthening markets and rules of effective global energy governance. *International Affairs* 2009, 85:373–390.
34. Dellapenna J, Gupta J. Toward global law on water. *Global Governance* 2008, 14:437–453.
35. Gupta J, van de Grijp N. *Mainstreaming Climate Change in Development Cooperation: Theory, Practice and Implications*. Cambridge: Cambridge University Press; 2010.
36. Edmonds JA, Wise MA, Dooley JJ, Kim SH, Smith SJ, Runci PJ, Clarke LE, Malone EL, Stokes GM. Global energy technology strategy: addressing climate change. Global Energy Technology Programme, USA; 2007.
37. Stirling A. Multi-criteria diversity analysis: a novel heuristic framework for appraising energy portfolios. *Energy Policy* 2010, 38:1622–1634.

