

St Antony's International Review

The Politics of Nuclear Technology in the Twenty-first Century

VOLUME 4, NUMBER 2, FEBRUARY 2009

Notes on Contributors	2
Editorial Introduction: The Politics of Nuclear Technology in the Twenty-first Century Martin Bayly and Robert Nelson	3
The Concept of 'Tailored Deterrence' in the 'Second Nuclear Age' John Baylis	8
Illicit Nuclear Procurement Networks and Nuclear Proliferation: Challenges for Intelligence, Detection, and Interdiction Jack Boureston and James A. Russell	24
Kazakhstan's 'Nuclear Renaissance' Togzhan Kassenova	51
Japan's Nuclear Option: A Debate Revisited Yuki Tatsumi	75
Climate Change, Energy Security, and Nuclear Power Milan Ilnyckyj	92
Review Essay: Perkovich and Acton, <i>Abolishing Nuclear Weapons</i> Elbridge Colby	113
A Response to Elbridge Colby James M. Acton and George Perkovich	120
Book Reviews	124

Notes on Contributors

James M. Acton is an associate in the Nonproliferation Program at the Carnegie Endowment for International Peace and former lecturer at the Centre for Science and Security Studies in the Department of War Studies at King's College London.

John Baylis is Professor of Politics and International Relations at Swansea University.

Jack Boureston is a researcher at the Center for Contemporary Conflict in the Department of National Security Affairs at the Naval Postgraduate School.

Elbridge Colby served in the Office of the Director of National Intelligence, on the Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, and with the Department of State.

Milan Ilnyckyj received his MPhil in International Relations in 2007 from the University of Oxford and now works in Ottawa.

Togzhan Kassenova is a research associate at the Center for International Trade and Security, University of Georgia.

George Perkovich is Vice President for Studies and Director of the Nonproliferation Program at the Carnegie Endowment for International Peace.

James A. Russell is Senior Lecturer in the Department of National Security Affairs at the Naval Postgraduate School.

Yuki Tatsumi is Senior Associate of the East Asia Program at the Henry L. Stimson Center.

Editorial Introduction: The Politics of Nuclear Technology in the Twenty-first Century

3

MARTIN BAYLY AND ROBERT NELSON

The Frisch-Peierls memorandum of March 1940 must rank as one of the most significant historical documents of the twentieth century for students of international relations. Otto Frisch and Rudolph Peierls, two refugee scientists fleeing the German Nazi regime, arrived in Britain in 1940 and set about alerting the British government to the imminent danger of nuclear technology. Using their knowledge of the activities of German scientists, the memorandum warned the British government that Germany sought to construct a nuclear device – the only logical deterrence to which, they argued, would be a British nuclear weapon. The enormity of what the two scientists were proposing was not lost on them, for the brief memorandum discussed not only the scientific feasibility of the device, but also the strategic and ethical dimensions to the existence of such a weapon in the hands of governments.¹ Their prescient warning serves as a foreword to debates that continued during the cold war period and have remained relevant in our post-cold war era. The Frisch-Peierls memorandum set in motion events that would come to define the strategic balance of the contemporary era.

With the end of the cold war, the threat of global nuclear conflict initially appeared to fade. Since then, however, the number of states that possess nuclear weapons, or are suspected of pursuing them, has increased. Among the security challenges posed by this proliferation is the risk of non-state actors, such as terrorist groups, acquiring such weapons. But strategic concerns form only part of the role of nuclear technology in international politics, as the technology and knowledge required for military uses of nuclear technology have filtered through to civilian life, creating an abundant alternative energy resource. The use of nuclear power as part of broader strategies for promoting economic development and managing climate change has received much greater attention in recent years. These new challenges, and the often conflicting policy-making priorities they entail, call into question the roles and capabilities of existing political institutions and agreements, both domestically and internationally. In light of these problems, *St Antony's International Review (STAIR)* invited researchers and policy experts

Martin Bayly and Robert Nelson, 'Editorial Introduction: The Politics of Nuclear Technology in the Twenty-first Century,' *STAIR* 4:2 (2009): 3-7.

to submit articles exploring different aspects of 'The Politics of Nuclear Technology in the Twenty-first Century.' A sense of historical context informs the questions addressed below, allowing the reader to identify continuities and changes across many aspects of the politics of nuclear technology, from the Second World War to the war on terror. The articles selected for this issue fall into three broad and overlapping sets of themes and questions, involving strategy, identity, and energy.

Strategy

The new nuclear age challenges traditional concepts of deterrence and their role in strategy and policy. How have deterrence strategy and nuclear proliferation changed in the twenty-first century? John Baylis, a leading expert on nuclear strategy in the United Kingdom, examines the evolution of American nuclear deterrence strategy from the cold war to the post-cold war era. Baylis endeavors to identify aspects of continuity and change in strategic doctrine and deterrence policy, in order to determine what is distinctive about the nature of the contemporary challenges nuclear weapons pose to international security, and the deterrence concepts used to address them. Do cold war concepts 'still hold good,' Baylis asks, in the changing strategic landscape of the twenty-first century?² Baylis traces key concepts in nuclear strategy, from 'massive retaliation' and 'mutually assured destruction' in the early cold war period, to the emergence of the post-cold war concept of 'tailored deterrence,' with its implications for preemption, the changing role of non-state actors, non-proliferation, and attempts to diminish or abolish nuclear arsenals.

What role do transnational actors play in the new nuclear age? The potential for terrorist groups to acquire nuclear materials – independently of, or in collaboration with, states – has introduced new uncertainties and challenges into security studies. Jack Boureston and James Russell of the US Naval Postgraduate School address the role of illicit procurement networks in historical and contemporary nuclear proliferation. The origins of clandestine nuclear procurement can be traced to the 1940s, with early efforts to obtain the information, people, materials, and technology necessary to build an atomic weapon. Nuclear espionage and theft continue the long-established practice of stealing military-related industrial secrets, made more complex and difficult to combat in today's globalizing and interdependent world. Their article investigates the development of the nuclear black market, focusing on the illicit procurement networks of four different states – Pakistan, Iraq, Iran, and North Korea – and their quest to build a nuclear weapon in circumven-

tion of international export control regimes. In each case, they report, procurement networks began in affiliation with the state, and in some cases became increasingly autonomous. Examining the A. Q. Khan network and others, they surmise that multinational corporations, as well as non-governmental and quasi-governmental organizations represent more complex structures that operate across borders and on a global scale – to trade, legally and illegally, in the materials and knowledge of nuclear technology. Procurement networks are staying ahead of export controls, they warn, by altering their tactics, by learning new techniques, and by finding ways to exploit legitimate trade practices.

Identity

Debates within countries over the desirability of acquiring and using nuclear technology and weapons are often linked to questions of national identity. These concerns can involve party politics, constitutionality, issues of historical memory, and competing definitions of the national interest. How do these issues affect policy decisions? Yuki Tatsumi of the Stimson Center examines the constitutional, political, and psychological dimensions of evolving debates in Japan over nuclear policy. She revisits the foundational principles of Japanese security policy after the Second World War – especially the ‘Yoshida Doctrine,’ which emphasized the primacy of non-military means for ensuring Japan’s safety – and addresses trends in public opinion, perceptions of the credibility of the US-Japan alliance and the US ‘nuclear umbrella,’ and Japan’s image of its role in world politics. Debates continue to surround Article 9 of Japan’s constitution, which renounces the use of force as an instrument of Japanese foreign policy, and the legislative framework in which nuclear technology is used only for peaceful purposes. Tatsumi classifies ideological currents in Japanese politics in order to clarify the landscape of the nuclear debate, and identifies the key factors that explain Japan’s continued unwillingness to develop nuclear weapons.

Energy

The spread of nuclear technology is not only of concern to the developed world; much of the world’s uranium deposits are located in the developing world, and these countries are often suggested as locations for waste disposal. How do these issues shape economic development strategies in developing countries? Can nuclear power be a useful tool in the fight against climate change, or are the risks too great? Two main

factors have revived interest in nuclear power as a source of energy: high hydrocarbon prices and concerns about climate change. Nuclear power has become a divisive issue among those hoping to achieve a low-carbon global economy. Milan Ilnyckyj, an Oxford graduate, considers the advantages and disadvantages of nuclear power as a mechanism for reducing greenhouse gas emissions and for improving energy security. He gives special consideration to such issues as lifecycle emissions, radioactive wastes, and electrical grids. Ilnyckyj believes energy security and climate change objectives can be met simultaneously, and addresses options for producing energy from non-hydrocarbon sources. Nuclear power can be an attractive choice: compared to renewable options such as solar energy, a nuclear plant can produce more than one hundred times as much power on the same plot of land.³ But risks must be considered as well, including the danger of accidents, proliferation, and the uncertain sustainability of nuclear power. Nuclear facilities can be expensive and slow to construct, and some argue that the goals sought by nuclear advocates can be achieved more rapidly and at lower cost through other means. Governments will have to find a balance between optimizing cost and managing risk.

Growing energy demand worldwide, along with climate concerns, are pushing many governments to consider nuclear energy. There are country- and region-specific factors that must be considered when weighing the nuclear energy option. Togzhan Kassenova of the University of Georgia examines the challenges and advantages of the 'nuclear renaissance' in Kazakhstan. Kazakhstan is an interesting case, as it is in the midst of weighing nuclear energy options in both domestic and international contexts – by introducing indigenous nuclear energy to meet the country's energy demand, and by striving to be a key player in the international uranium, nuclear fuel, and power reactor markets. Kazakhstan's nuclear past is relevant to its nuclear future in several ways: being included in Soviet nuclear weapons programs meant important infrastructure was left in place after the Soviet Union collapsed; environmental and human consequences of nuclear testing led to public opposition to nuclearization; and Kazakhstan's denuclearization policy in the early 1990s earned the country strong non-proliferation credibility. Existing nuclear infrastructure and a strong non-proliferation record make it a potential candidate for an international nuclear 'fuel bank.' What impact will Kazakhstan's plans in the nuclear energy sphere have on non-proliferation and export controls? Kassenova addresses the risks involved, including proliferation concerns associated with the nuclear fuel cycle, along with environmental concerns and regional geopolitical instability.

In addition to full-length articles, this edition of *STAIR* features an expert debate on the controversial and complicated question of nuclear abolition. In their recent Adelphi Paper for the International Institute for Strategic Studies, *Abolishing Nuclear Weapons*, James M. Acton and George Perkovich lay out the conditions necessary for the abolition of nuclear weapons, and steps that could be taken to achieve that ambitious and elusive goal.⁴ How could the project of nuclear abolition begin, and how could it be completed? What obstacles would be faced, and what risks would be involved? Elbridge Colby, who served on the Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, reviews their proposals, and the authors have responded to Colby's critique.

Through the articles that follow – revolving around themes of strategy, identity, and energy – the *STAIR* editors hope to make a contribution to ongoing debates over the politics of nuclear technology in our age. ■

Notes

¹ See Lorna Arnold, *Britain and the H-bomb* (Basingstoke: Palgrave, 2001). The editors are grateful to Lorna Arnold OBE for her assistance with this edition of *STAIR*.

² See John Baylis, 'The Concept of "Tailored Deterrence" in the "Second Nuclear Age,"' *STAIR* 4:2 (2009): 8-23.

³ See Milan Ilnyckyj, 'Climate Change, Energy Security, and Nuclear Power,' *STAIR* 4:2 (2009): 92-112.

⁴ James M. Acton and George Perkovich, *Abolishing Nuclear Weapons*, Adelphi Paper 396 (London: International Institute for Strategic Studies, 2008).

The Concept of ‘Tailored Deterrence’ in the ‘Second Nuclear Age’

JOHN BAYLIS

This article looks at one of the key concepts behind American thinking about nuclear weapons in the post-cold war period. It begins with a discussion of the main features of cold war thinking about nuclear deterrence and considers the debate about whether deterrence worked during the cold war. It then focuses on the key features of the post-cold war nuclear age and looks at some of the main characteristics of what has been called the ‘second nuclear age.’ Attention is then given to contemporary United States thinking about the role of nuclear weapons and the development of the concept of ‘tailored deterrence.’ Finally, the article considers the debate about whether there is anything different about this concept and cold war ideas about strategic nuclear deterrence and concludes by considering what challenges ‘tailored deterrence’ poses for international security today.

The role of nuclear weapons in national and international security was the focus of significant intellectual debate during the cold war from which emerged many strategic concepts, such as deterrence and arms control. With the end of the cold war, interest in nuclear weapons declined. Nuclear weapons continued to exist but at lower numbers, and initially little intellectual effort went into their continuing role in world politics. More recently, however, with growing concerns about the proliferation of weapons of mass destruction and the fear that non-state actors might acquire such weapons, a new debate has begun about what has been called ‘the second nuclear age,’ and whether cold war concepts still hold true in the changed geo-strategic world of the twenty-first century.

This article begins with a discussion of deterrence during the cold war before going on to consider the characteristics of the ‘second nuclear age’ and the emergence of the concept of ‘tailored deterrence.’ Attention is then focused on the question of whether there is anything different about this concept and cold war ideas about strategic nuclear deterrence. The article concludes with a discussion of the challenges that ‘tailored deterrence’ poses for international security today.

It soon became clear to western statesmen after the nuclear bombs were dropped on Hiroshima and Nagasaki that the only probable use for this 'absolute weapon,' as Bernard Brodie called it, was to deter major wars from breaking out.¹ This belief became central in the development of the 'massive retaliation' strategy by the United States during the 1950s. Any level of war with the Soviet Union was to be prevented through the threat of annihilation. It soon became clear, however, that the credibility of this threat would decline with the Soviet development of nuclear weapons and especially, after Sputnik in October 1957, with its ability to respond in kind against the US homeland. Indeed, 'massive retaliation' came to be seen not only as lacking in credibility but also as increasingly dangerous because it encouraged one side to get in its attack first.

As a result, thinking about deterrence evolved in the 1960s, with a growing emphasis on what became known as 'mutual assured destruction.' Writers like Herman Kahn, Thomas Schelling, and Albert Wohlstetter were highly critical of 'massive retaliation' and argued that the development of invulnerable, second strike capabilities would help to stabilize the deterrent relationship.² This critique evolved under Secretary of Defence, Robert McNamara, into a doctrine that involved a continuation of the search for unilateral advantage but also implicitly recognised that strategic stability depended on similar superpower capabilities. If both sides knew that they could not destroy or disarm the other without suffering a devastating response, there would be no incentive to strike first. Much of the strategic debate in the United States in late 1960s and 1970s centred on the question of whether it was best to target Soviet cities ('countervalue' targeting) or Soviet military forces ('counterforce' targeting). In practice, both capabilities were developed as the US built up a force of over 12,000 warheads by the 1980s on its land-based missiles (ICBMs), submarine-launched missiles (SLBMs), and heavy bombers. Increasingly, however, the US developed a 'countervailing strategy,' which emphasized threats against Soviet war-making capabilities. This reflected a perception of the 'mind set' of Soviet leaders on what was most likely to deter them should a conflict arise. In turn, this view of Soviet strategic culture led to a further evolution of US strategy during the Reagan era, which emphasized an ability not only to 'countervail' but also to 'prevail' should a nuclear war break out.

This 'prevailing nuclear strategy' reflected the view that if the Soviet Union believed the United States was preparing to fight and win a nuclear war it would be effectively deterred because this was part of its

own strategic nuclear planning. The problem with this strategy by both superpowers was that each needed more and more nuclear weapons in order to try to 'prevail,' which seemed to promise an arms race, with all of the dangers involved, that effectively would have no end. By the end of the cold war the dangers of this approach were increasingly becoming recognized, even by the superpowers themselves.

There was also considerable debate at the end of the cold war about whether deterrence had actually kept the peace for the past forty years. Walton and Gray have argued that:

There ... are a great many continuing controversies concerning the reliability of deterrence during the Cold War. To claim that deterrence theory was proven to have worked 'as advertised' because there was no US-Soviet military conflict, much less a nuclear war, is to assume a causal relationship which may or may not have existed. Certainly, the United States attempted to deter Soviet military aggression, but whether American deterrence actually prevented war between the two powers is unknown and, ultimately, unknowable. History, unlike a laboratory experiment, cannot be repeated, and we have no 'control Cold War' to compare to the real Cold War.³

Along with a growing concern to downgrade the salience of nuclear weapons, this questioning and uncertainty of the reliability of deterrence became an important and continuing debate in international politics in the post-cold war period.

The 'Second Nuclear Age'

With the cold war over in the early 1990s, there was a general consensus in the west and Russia that in the future much lower numbers of nuclear weapons would be needed. As part of the 1991 Strategic Arms Reduction Treaty (START), both agreed to reduce the size of their nuclear arsenals to around six thousand warheads each. Both also agreed to stop directly targeting each other. In this sense, the world appeared to be a much safer place than it was during the cold war. At the same time, however, nuclear weapons continued to exist and concerns about proliferation increasingly created new anxieties. In May 1998, India and Pakistan conducted nuclear weapons tests, and military confrontation between the two South Asian states in 2002 led many to believe that nuclear weapons would be used for the first time since 1945. The fact that war was avoided helped to revive interest in nuclear deterrence ideas but it also led to increased concerns that the deterrence relationship between the two states was fragile and posed serious dangers. Neither seemed to

have a clear doctrine of deterrence and there was an absence of a mutual understanding of how nuclear stability might be maintained.⁴

The Indian and Pakistani tests put increasing pressure on the Non-Proliferation Treaty (NPT), which, despite its limitations, had helped to constrain nuclear proliferation during the cold war period. The NPT was further undermined by North Korean and Iranian nuclear programmes assisted by the activities of the A.Q. Khan network.⁵ Following the attacks on the Twin Towers and the Pentagon on September 11, 2001, there was also a growing fear that terrorist groups might also seek to acquire nuclear weapons and, if acquired, might well use them. These events helped to distinguish the new era from the old. The bipolar 'first nuclear age' was characterized by massive nuclear conflagration. The 'second nuclear age' is characterized by a broader variety of nuclear states and potential nuclear actors, which may pose an even greater possibility of nuclear weapons being used.⁶ Concerns have arisen that many of the proliferating states are not models of good international citizenship and that some leaders, especially of terrorist groups, may be undeterrable. This, in turn, has raised even more questions about whether nuclear deterrence has a role to play in this new era of world politics.

For those who believe that nuclear deterrence was not only unreliable during the 'first nuclear age' but also very dangerous, there are even fewer reasons to see utility in nuclear weapons in the post-cold war period. According to this view, attempts by the existing nuclear powers to maintain their nuclear capabilities undermine the NPT and encourage further nuclear proliferation. Such weapons are also viewed as being of little, if any, value in dealing with the new, increased danger of international terrorism.

At the end of the cold war, however, despite a recognition that the numbers of nuclear weapons needed to be significantly reduced, the existing nuclear powers continued to see strategic utility in maintaining such weapons, if only as a hedge against renewed strategic threats in a world that was increasingly uncertain. The difficulty was to find a clear conceptual basis to guide strategic nuclear policy. This can be seen especially in the United States as policy-makers sought to establish a conceptual basis for their present and future nuclear capabilities.

Deterrence in Post-Cold War American Strategic Thinking

Despite the end of the cold war, the belief remained amongst officials that deterrence should continue to be an important part of American national security policy. In his Annual Report to Congress in 1995, Secretary of Defence William Perry emphasized, 'Concepts of deterrence ... continue to be central to the US nuclear posture. Thus, the United States will continue to threaten retaliation, including nuclear retaliation, to deter aggression against the United States, US forces and allies.'⁷

Although the Clinton administration accepted that the security environment had changed 'radically' and that there were 'growing threats from a number of emerging adversaries,' concern existed that Russia still had the potential to pose a threat in the future. This meant that, although the range of targets within the Single Integrated Operational Plan (SIOP) was reduced, 'the basic tenets' of US nuclear strategy remained untouched.

Change began to occur, however, in 1997 when the Clinton administration decided to move away from the 'prevailing nuclear strategy' of its predecessor, to one of deterrence with lower numbers of nuclear weapons. US strategy still planned for a range of attacks from limited responses with a few nuclear weapons to much larger attacks using thousands of weapons. Also, contingency plans still existed to attack a range of military targets, nuclear forces, and civilian leadership sites in Russia. At the same time, however, SIOP was 'evolving to a collection of far more differentiated retaliatory choices, tailored to a threat environment of greater nuance and complexity.'⁸ The Clinton administration believed that greater flexibility was needed if US deterrence was to remain credible in the new strategic environment that was emerging.

The Emergence of the Concept of 'Tailored Deterrence'

These initial ideas about 'tailored deterrence' under the Clinton Administration further evolved during the Bush administration. At the same time, there was a determination to move further away from the cold war ideas about 'strategic nuclear deterrence' which, still characterized US nuclear strategy under Clinton. According to Keith Payne, who was Assistant Secretary of Defence during the 2001 Nuclear Posture Review:

Deterrence threats based on the generally high nuclear yields of the cold war arsenal may not appear credible, given the excessive civilian destruction likely to occur ... Clearly, some reasonable and much needed steps to better align us deterrence policy to the realities of the new era include broadening us deterrent threat options ... seeking an understanding of the opponents intentions and the flexibility to tailor deterrence to specific requirements of foe, time and place.⁹

An important part of 'tailored deterrence,' according to US defence officials, was the need to understand the strategic culture or 'mindset' of a potential opponent. According to Ryan Henry, the Principal Deputy Secretary of Defence for Policy, for deterrence in the twenty-first century to work, it was important for the US to have 'the means to determine what assets an adversary holds dear and wants to protect; an ability to identify which military tools can be used to threaten those assets, and an effective means of communicating to adversaries that the military can target their most important assets and destroy them.'¹⁰ As Payne has noted on another occasion, tailoring deterrence to deal with emerging threats involves an understanding of 'the specific opponent's mind-set and behavioural style, and the different ways opponents can perceive and respond to our deterrence threats.'¹¹

This focus on tailoring deterrence to meet different 'mindsets,' as we have seen, was not new. It was a concept that was the subject of considerable debate in the later stages of the cold war.¹² Even then, however, critics pointed out the difficulties of discovering and operationalizing the concept in relation to the Soviet Union. Trying to do this in the new strategic environment posed even greater challenges for US strategists. Given the perceived diversity of threats, 'tailored deterrence' implies that different operational plans have to be developed to meet very different conflict situations. In order to do this, it is reported that the SIOP of the cold war era has been replaced with OPLAN (operations plan) 8044, designed to include a much wider range of contingencies and potential adversaries than in the past. Defence chiefs have pointed out that the US war plan has changed from 'a single large, integrated plan to a family of plans applicable to a wider range of scenarios.'¹³ The purpose, as General Richard B. Myers, Chairman of the Joint Chiefs of Staff, pointed out in 2001, is designed to provide the president with 'more flexible options to assure allies, and dissuade, deter and if necessary, defeat adversaries in a wider range of contingencies.' Basing these plans on a wide range of very different strategic cultures, however, poses major difficulties.

The challenge is highlighted by the fact that this 'family of plans' has been developed to deal with three main types of contingencies.¹⁴ These include: (1) immediate contingencies, involving 'well-recognized, cur-

rent dangers, including WMD attacks on US forces or allies in the Middle East or Asia'; (2) potential contingencies, which involve 'plausible, but not immediate dangers' (this could take the form of new military coalitions or the re-emergence of a 'hostile peer competitor,' like Russia) and; (3) unexpected contingencies, in terms of 'sudden and unpredicted security challenges,' which might include 'sudden regime change' leading to an existing nuclear arsenal being transferred to the control of a hostile leadership (this might happen in places like Pakistan).¹⁵

Once again, contingency planning of this kind poses significant problems for US defence planners. Although planning for 'immediate' and 'potential' contingencies is reasonably straightforward, preparations for 'unexpected' contingencies are much more difficult. This has given rise to what has been called 'adaptive planning,' which is designed to allow the US to respond 'almost instantaneously to new requirements.' To do this, US Strategic Command (STRATCOM), which is responsible for developing US operational plans, 'employs modern computing techniques and streamlined processes to significantly improve ... planning capability for rapid, flexible crisis response.'¹⁶ Such adaptive planning would appear to invoke preparations to 'react promptly with little or no warning, at the start of a conflict, either to pre-empt the adversary's use of weapons of mass destruction or to undermine the adversary's ability to prosecute the conflict on its own terms.' Such pre-emptive plans raise important questions which will be returned to later.

One of the main purposes of developing the idea of 'tailored deterrence' was to try to provide a coherent conceptual basis for the continuing role of nuclear weapons in American strategic planning. In particular, the concept is designed to provide a basis for force planning requirements. Following the 2002 Strategic Offensive Reductions Treaty (SORT or 'the Moscow Treaty'), the United States planned to further reduce the size of its nuclear arsenal to 1,700-2,200 'operationally deployed warheads' by the end of 2012. The Bush administration initially went out of its way to argue that this force was not configured by the need to counter a threat from Russia. For a time, it appeared that the focus of US nuclear doctrine was an emerging threat from 'rogue states' or terrorist organizations rather than Russia. By 2007, however, government officials were arguing that 'the future direction that any number of states might take, including some established nuclear powers with aggressive nuclear force modernization programmes, could have a dramatic effect on US security and the security of our allies.'¹⁷ It was clear that Russia and China were seen by the Bush administration as states that had 'aggressive nuclear force modernization programmes' and therefore might

need to be specifically deterred.¹⁸ Thus, 'tailored deterrence' had to take account not only of a variety of emerging adversaries with limited capabilities but also of significant and well-established nuclear powers with much larger and more sophisticated capabilities. This has raised significant questions about whether the number and types of weapons the US plans to deploy in the period up to 2012 (and beyond) are appropriate for the tasks which the 'tailored deterrence' strategy requires to be effective. Before we look at this, and other questions that the pursuit of a 'tailored deterrence' strategy raises, we turn to the question of whether this new strategy is fundamentally different from US strategy during the cold war.

'Tailored Deterrence' Compared

There seems little doubt that the numbers of nuclear weapons and the wide range of targeting options have changed quite dramatically since the end of the cold war. At the same time, as a Congressional Research Service report by Amy Woolf made clear in October 2001:

There are similarities between 'tailored deterrence' and Cold War deterrence strategy. For example, both are based on the precept that it is necessary to know what your adversary values and to maintain the weapons and attack plans needed to target those valued assets. During the Cold War, the United States developed a number of attack plans that were tailored to address the values, interests, and capabilities of its primary adversary, and some smaller plans to address threats from other adversaries such as China and the Warsaw Pact nations. Just as US war plans evolved during the Cold War to accommodate changes in weapons capabilities and threat assessments, the Administration's supporters believe that tailored deterrence will allow for similar, ongoing modifications to US war plans.¹⁹

This view is supported by the fact that the idea of 'tailored deterrence' has evolved from the Clinton to the Bush administration and considerable attention has been given to 'adaptive planning' for a number of years. This said, as Woolf goes on to argue, contemporary 'tailored deterrence' involves a longer list of potential adversaries compared with cold war strategic deterrence. In the new security environment which prevails, US nuclear planners perceive 'multiple potential opponents, sources of conflict and unprecedented challenges.' Woolf's conclusion is that the change from strategic deterrence to 'tailored deterrence' is less of a change in 'how to deter' than in 'whom to deter.'²⁰ While this may be so, 'tailored deterrence' creates new and challenging problems for defence planners.

Despite the evolution of US nuclear strategy during the cold war, and changing views about the requirements of deterrence, a basic understanding between the United States and the Soviet Union emerged on 'the rules of the game.' There was also a good system of communication between them to discuss crisis situations as they arose. Deterrence during the cold war presumed that both sides were aware of the threats and possible responses. With multiple potential opponents this may no longer be the case. With the exception of a renewed US-Russian cold war, the long term development of a 'deterrent understanding' between the US and other opponents is unlikely to be present and arrangements like the 'hot line' are almost certain to be absent. This is likely to affect the credibility of the deterrent threat as well as crisis management arrangements with all of the inherent dangers involved.

This problem is compounded by the difficulty of understanding a range of very different strategic cultures which tailored deterrence requires. It was difficult enough for American planners to understand Soviet strategic culture (and vice versa) during the cold war. How much more difficult is it for contemporary US strategists to understand the 'mindsets' of North Korea, Iran, or Al Qaeda, should they acquire nuclear or other mass destruction capabilities?

An awareness of this difficulty appears, at least in part, to be behind two significant developments in contemporary US nuclear planning. First, there has been considerable interest in developing a range of capabilities, some nuclear, some conventional, to attack mobile or fleeting targets. This involves improving the ability of American forces to attack promptly, accurately, or even pre-emptively, at the beginning of a conflict. This seems to be behind what the Pentagon has described as 'the prompt global strike' mission. A Department of Defence paper entitled 'Deterrence Operations: Joint Operating Concepts' highlights the ability to destroy 'targets otherwise invulnerable to conventional attack, e.g. hard and deeply buried facilities, "location uncertainty" targets, etc.'²¹ This requires the development of deep penetration weapons which might be used preemptively against states developing nuclear, or other mass destruction, capabilities.

This new (or renewed) emphasis on preemption is designed mainly to help deter 'emerging threats' but it raises important questions for international security. Does the US possess the kind of highly accurate intelligence that such attacks would require? Given intelligence failures in Iraq, there must be some doubts about this. There are also dangers

either that the adversary may feel pressured to act even more quickly, before the United States launched its pre-emptive attack, or that such attacks might have destabilizing and unpredictable global economic consequences, especially if oil-producing states, like Iran, were targeted. This might in turn undermine the credibility of such threats.

A second difficulty arises from the determination to develop missile defence systems and to deploy them in the former Warsaw Pact countries of Poland and the Czech Republic. It is argued by US planners that such deployments will help to protect US forces and allies from attacks by 'rogue' nuclear powers in the Middle East. In line with cold war thinking, such deployments have been seen by Russia, however, as highly provocative and have caused then-President Vladimir Putin (now Prime Minister) to withdraw from the Conventional Forces in Europe (CFE) arms control agreement which helped to end the cold war and put a heightened emphasis on Russian nuclear capabilities.²² As Keir Lieber and Daryl Press predicted, these developments associated with pre-emption and defensive systems also appear to have played a part in encouraging the modernization of Russian nuclear forces and the establishment of a new strategic partnership between Russia and China.²³

Since the collapse of the Soviet Union, Russia has given particular emphasis to nuclear weapons in its defence policy. With the deterioration of its conventional forces and the technological gap that has increasingly opened up as a result of improvements in US conventional capabilities, Russian planners have stressed the importance of maintaining nuclear weapons for deterrent reasons. Initially, this increased reliance on nuclear weapons was part of a rather vague doctrine which focused on deterring a 'large scale nuclear attack against Russia and its allies.' In the 2000 National Security Concept, however, Russian nuclear strategy began to emphasize not only deterrence against large-scale attacks but also the ability to fight more limited nuclear conflicts. According to Nikolai Sokov, 'the 2000 concept allowed for the use of nuclear weapons as a deterrent to small-scale wars that do not necessarily threaten Russia's existence and sovereignty.' The new mission implies that Russia needs to plan for limited use of nuclear weapons in contrast to the all-out nuclear strike in response to a massive attack. This represented 'a qualitatively new stage' in Russian nuclear doctrine.²⁴ Further changes were added in 2003 when the Ministry of Defence in Moscow announced that it could 'no longer completely rule out preventive use of force if demanded by the interests of Russia or its alliance commitments.' This reflected, in part, growing concerns about the proliferation of weapons of mass destruction. It also reflected, however, growing concerns about US reluctance to abide by cold war arms control agreements, its development of

small nuclear munitions, Ballistic Missile Defence (BMD) deployments in Poland and Czech Republic, and the growing 'technological gap' at the conventional level. By 2007, as relations with the west deteriorated, President Putin was emphasizing the need to raise 'the combat readiness of Russian strategic nuclear forces' as a more explicit deterrent against the US.²⁵ This reflected anxieties that a new arms race might be underway.

Another challenge for the US concept of 'tailored deterrence' arises from critics who argue that far from enhancing deterrence, attempts to provide a flexible range of nuclear capabilities will make their use more likely. The combination of improved smart conventional capabilities and a new range of low-yield nuclear weapons, so it is argued, will blur the distinction between conventional and nuclear forces. The result is likely to be a greater willingness to cross the nuclear threshold, if US officials believe that the consequences of doing so will not lead to catastrophic consequences associated with an escalation of the conflict to higher levels. Russian officials, in particular, have expressed their concerns about this 'lowering of the nuclear threshold' and have indicated that this would 'trigger a revision of the existing [Russian] guidance on the employment of nuclear weapons.'²⁶

Whether the threat to use such low-yield weapons is now more credible as a deterrent than it was during the cold war is a matter of considerable contemporary debate. Opponents of 'tailored deterrence' argue that such a threat is not credible given the 'disproportionate and unacceptable collateral damage and severe political fallout' that would result. Supporters of 'tailored deterrence' argue, in contrast, that because the United States would be unlikely to suffer a direct attack itself, such threats to use low-yield nuclear weapons are much more credible in the contemporary strategic environment than they were during the cold war.

Apart from the debate about credibility, two further challenges are evident in the contemporary strategic debate on 'tailored deterrence.' The first concerns the size of the US force required to deter the different possible threats that are envisaged. Some have argued that there is an apparent disconnect between the concept of 'tailored deterrence' and the size of the planned US nuclear arsenal. According to this view, 'if the goal is simply to be able to threaten small numbers of targets in large numbers of countries, then a much smaller force than the 2,200 weapons planned may be sufficient.'²⁷ On the other hand, given the increasing concern of the US administration with established nuclear powers, like Russia and China, it may be that a force of this size is not sufficient. For those who remain wedded to the view that the US would require a coun-

tervailing strategy against a combination of established nuclear powers, the present size of the force might be regarded as insufficient. In contrast, for those who support a more 'existential' view of deterrence, the present numbers might be enough. The problem would seem to be that the uncertainty in US relations with Russia and China prevents the formulation of a clear deterrent doctrine which encompasses them. 'Tailored deterrence' as a concept reflects, but does not resolve, this uncertainty.

Another strategic challenge posed by 'tailored deterrence' concerns the implications for US non-proliferation policies. There is a widespread consensus that the greatest threat to US, and indeed international, security in general arises from the proliferation of nuclear weapons to an increasing number of states and even to terrorist organizations like Al Qaeda. There is a continuing debate, however, over whether the determination of the United States (and other western nuclear powers) to continue to maintain, and even to develop further, its nuclear capabilities contributes to further proliferation or helps to deal with its inevitable consequences.

Critics of 'tailored deterrence' argue that the US perception that nuclear weapons have continuing utility leads other states, especially those opposed to American values and strategic objectives, to try to develop their own nuclear capabilities. It may be that for countries like North Korea and Iran, the lesson learned from recent conflicts is that the US is less likely to intervene in their affairs if they possess nuclear weapons. Just as US planners see nuclear weapons as having utility for deterrence, many other states are likely to come to a similar conclusion in dealing not only with the US, but also with other regional threats to their security.²⁸

In contrast, supporters of 'tailored deterrence' tend to argue that proliferation is likely to continue irrespective of US policies. Most states acquire nuclear weapons for reasons associated with specific regional rivalries, and US nuclear forces are usually largely irrelevant in such situations. Government officials also stress the value of providing a range of nuclear forces in providing 'extended deterrence' to those allies who might seek nuclear capabilities themselves if US protection was not available. In this sense, 'tailored deterrence' helps to stem rather than to encourage proliferation. The ultimate realist argument put forward by US strategists, however, is that given the limitations of the non-proliferation treaty and the kind of strategic environment that prevails, US national security interests require the possession of a wide range of nuclear weapons as well as BMD deployments against what appears to be a greater risk of the use of nuclear weapons in the twenty-first century.

There is also a view that a more forceful counter-proliferation response is necessary.²⁹

Both arguments seem to have some validity, but there is clearly some tension between them. It follows from this that, for those interested, the difficult task of trying to balance deterrence policies with non-proliferation policies, the key contemporary debate is 'whether, or how, the size, structure, and role of the US nuclear arsenal can affect the emergence of, or deterrence of, nuclear threats in other nations.'³⁰

Conclusion

There can be little doubt that many states believe that nuclear weapons continue to have utility in the contemporary world. Indeed the salience of nuclear weapons seems once again to be rising. The existing nuclear powers seem determined to retain their nuclear capabilities and new nuclear states are emerging. It also seems likely that terrorist groups will continue to seek to acquire some form of nuclear capability and other weapons of mass destruction to further their own particular aims and interests. What has been largely missing in Western strategic thought since the end of the cold war is the kind of coherent doctrine relating to the role of these weapons, which, controversial as it was, prevailed during the cold war era. Either nuclear states have said very little about how they perceive nuclear weapons to fit into their broader national security strategy or they have tended to argue, rather vaguely, that in an uncertain world nuclear weapons provide a 'hedge' against the emergence of potential adversaries. The one exception to this has been in the United States, which tends to have a more open public debate about nuclear questions than many other countries. Although the debate has lacked the sophistication and variety of the 'golden age' debates of the late 1950s and early 1960s, there has nevertheless been an attempt by both the Clinton and Bush administrations to modify cold war deterrence thinking to the changing post-cold war strategic environment. This evolution of post-cold war US strategic thinking is likely to continue under President Barack Obama.

It has been argued that 'tailored deterrence' has given a degree of conceptual unity and clarity to the strategic debate which has taken place, and continues to take place, in the United States. It would be wrong to infer from this, however, that a consensus has finally developed around this concept, despite support for it from elements within the Democratic and Republican parties. As during the cold war, a significant debate rages about the requirements and implications of pursuing such a strategy.

Different views exist about such things as whether it provides effective guidelines for the size and structure of US nuclear forces; whether it provides credibility given the variety of the threats it is designed to deal with; about whether the trend towards pre-emption might be dangerous and destabilizing; whether it helps to blur the distinction between modern conventional weapons and low-yield nuclear weapons which might undermine the traditional 'nuclear taboo;' and whether it helps to prevent the proliferation of weapons of mass destruction or encourages more states and groups to acquire them. There are also concerns about its impact on Russia and China and the possibilities of a new arms race, especially as Russia recovers its confidence and international stature. A number of very high level defence and foreign policy officials on both sides of the Atlantic have also recently gone on record arguing for a new initiative to reinvigorate multilateral arms control with an aim to achieve a nuclear-free world in the future.³¹ During the 2008 US presidential election campaign, the then-Senator Obama went out of his way to emphasize the importance of the NPT and his determination, if elected, to improve the working of the treaty. While emphasizing his support for a strong deterrent as long as nuclear weapons existed, he also indicated that an Obama administration would 'make the goal of eliminating all nuclear weapons a central element' in US nuclear policy.³² Whether this will translate into a fundamentally new approach to US nuclear strategy, however, remains to be seen. ■

Notes

¹ Bernard Brodie, *The Absolute Weapon: Atomic Power and World Order* (New York: Harcourt Brace, 1946).

² See Herman Kahn, *On Thermonuclear War* (Princeton: Princeton University Press, 1960); Thomas C. Schelling, *Arms and Influence* (New Haven: Yale University Press, 1966); Albert Wohlstetter, 'The Delicate Balance of Terror,' *Foreign Affairs* 32:2 (1959).

³ C. Dale Walton and Colin S. Gray, 'The Second Nuclear Age: Nuclear Weapons in the Twenty-first Century,' in *Strategy in the Contemporary World*, ed. John Baylis, James Wirtz, Colin S. Gray, and Eliot Cohen (Oxford: Oxford University Press, 2007), 214.

⁴ See Michael Quinlan, 'India-Pakistan Deterrence Revisited,' *Survival* 47:3 (2005).

⁵ See Gordon Corera, *Shopping for Bombs: Nuclear Proliferation, Global Insecurity, and the Rise and Fall of the A.Q. Khan Network* (Oxford: Oxford University Press, 2006).

⁶ For a more detailed discussion of the concept of the 'second nuclear age,' see Walton and Gray, 'The Second Nuclear Age.'

⁷ US Department of Defence, *Annual Report to the President and Congress*, by Secretary of Defence William Perry (Washington D.C.: US Department of Defence, 1995), 84.

⁸ General George L. Butler, US Air Force, Commander in Chief, US Strategic Command, 'Renaming the Single Integrated Operational Plan,' Memorandum to the Chairman of the Joint Chiefs of Staff, September 2, 1992. Cited in Hans M. Kristensen, 'U.S. Strategic War Planning After 9/11,' *The Non-proliferation Review* 14:2 (2007): 373-390, 379.

⁹ Keith Payne, 'Letter to the Editor,' *Defence News*, March 15, 2004.

¹⁰ Jason Sherman, 'Henry: Quadrennial Review Will Advance "Tailored Deterrence" Concept,' *Inside the Pentagon* 21:50 (2005).

¹¹ Keith B. Payne, testimony before the US Congress House Armed Services Committee, Subcommittee on Strategic Forces, hearing on United States Nuclear Weapons Policy, July 18, 2007.

¹² See Colin S. Gray, 'National Style in Strategy: The American Example,' *International Security* 6:2 (1981).

¹³ Written posture statement of General Richard B. Myers, Chairman of the Joint Chiefs of Staff, to the US Senate Committee on Appropriations, Subcommittee on Defence, April, 2005. Emphasis added.

¹⁴ Ibid.

¹⁵ See US Department of Defence, *Annual Report to the President and Congress*, by Secretary of Defence Donald H. Rumsfeld (Washington D.C.: US Department of Defence, 2002), 88.

¹⁶ US Senate, Committee on Armed Services, statement of Admiral James O. Ellis, Commander in Chief of Strategic Command, February 14, 2002. Cited in Amy Woolf, 'Nuclear Weapons in US National Security Policy: Past, Present, and Prospects,' *CRS Report to Congress*, October 29, 2007, 17.

¹⁷ US Secretary of Energy, Secretary of Defence, and Secretary of State, 'National Security and Nuclear Weapons: Maintaining Deterrence in the 21st Century,' (statement by the Secretary of Energy, Secretary of Defence, and Secretary of State, July 2007).

¹⁸ For a different view of Chinese nuclear policy see Jeffrey Lewis, *The Minimum Means of Reprisal: China's Search for Security in the Nuclear Age* (Cambridge, M.A.: MIT Press, 2007).

¹⁹ Woolf, 'Nuclear Weapons in US National Security Policy,' 17.

²⁰ Ibid.

²¹ US Department of Defence, *Deterrence Operations: Joint Operating Concept*, Version 2.0 (Washington, D.C.: Department of Defence, 2006), 39 (available online at <http://www.dtic.mil/futurejointwarfare/concepts/do-joc-v20.doc>).

²² Tony Halpin, 'Putin rattles nuclear sabre at NATO,' *The Times*, November 21, 2007.

²³ See Keir A. Lieber and Daryl G. Press, 'The End of MAD? The Nuclear Dimension of US Primacy,' *International Security* 30:4 (2006); and the correspondence section of *International Security* 31:3 (2006/7). See also Nikolai Sokov, 'Russia's Nuclear Doctrine,' Nuclear Threat Initiative, August 2004, <http://www.nti.org/e-research/e3-55a.html> (accessed January 18, 2009).

²⁴ Sokov, 'Russia's Nuclear Doctrine.'

²⁵ Halpin, 'Putin rattles nuclear sabre at NATO.'

²⁶ Sokov, 'Russia's Nuclear Doctrine.'

²⁷ Woolf, 'Nuclear Weapons in US National Security Policy.'

²⁸ See Hans M. Kristensen, 'U.S. Strategic War Planning After 9/11,' and Derek Smith, *Detering America: Rogue States and the Proliferation of Weapons of Mass Destruction* (Cambridge: Cambridge University Press, 2006).

²⁹ See John Baylis and Mark Smith, 'The Control of Weapons of Mass Destruction,' in *Strategy in the Contemporary World*, ed. John Baylis, James J. Wirtz, Colin S. Gray, Eliot Cohen (Oxford: Oxford University Press, 2007).

³⁰ Woolf, 'Nuclear Weapons in US National Security Policy.'

³¹ See Douglas Hurd, Malcolm Rifkind, David Owen, and George Robertson, 'Start Worrying and Learn to Ditch the Bomb,' *The Times*, June 30, 2008. A similar view was expressed by George Shultz, Henry Kissinger, William Perry, and Sam Nunn in *The Wall Street Journal*, January 4, 2007. See also George Perkovich and James M. Acton, *Abolishing Nuclear Weapons*, Adelphi Paper 396 (London: International Institute for Strategic Studies, 2008). See Review Essay of the paper in this issue of *STAIR*.

³² Cited in Alexander Mooney, 'Obama Says Time to Rid World of Nuclear Weapons,' CNNPolitics.com, July 16, 2008, <http://edition.cnn.com/2008/POLITICS/07/16/obama.speech/index.html> (accessed January 19, 2009).

Illicit Nuclear Procurement Networks and Nuclear Proliferation: Challenges for Intelligence, Detection, and Interdiction

JACK BOURESTON AND JAMES A. RUSSELL

None of today's nine nuclear weapons states achieved their status without the assistance from people, information, equipment and/or sensitive technology that came from somewhere else. In a relatively small number of cases, transfers from one state to another happened between established political allies that shared strategic objectives. However, many of these programmes undeniably depended upon stolen knowledge and illicitly acquired materials. However much the international community wants to forget about this sordid history, the stealing of nuclear secrets has provided a regrettable but irrefutable foundation for all states seeking to build nuclear weapons.¹ This was the case at the dawn of the nuclear era, and it remains the case today.

To be sure, nuclear espionage and theft constitute just one component of a long-established international practice: stealing military-related industrial secrets - a thriving practice that remains alive and well in today's globalizing and interdependent world. In 2007, the South Korean National Intelligence Service reported that over \$100 billion in technology had been stolen and illegally exported in the previous three years. Much of the stolen technology found its way to China.² The practice of stealing nuclear secrets has long been part of this tradition. The underworld of clandestine nuclear procurement began in the 1940s, with US and Soviet spies scouring the globe to obtain the information, people, materials, and technology necessary to build the bomb. The espionage activities of Klaus Fuchs, the Rosenbergs, and a team of Soviet spies working under cover on the Manhattan Project significantly speeded up the Soviet Union's nuclear programme.³ More recently, China is believed to have accelerated its nuclear weapons programme courtesy of stolen US plans and technology. Many believe that China's systematic, state-directed programme of industrial espionage is ongoing.⁴ In 1999, Congressional researchers declared that China's next generation of nuclear weapons would almost certainly integrate stolen US design information.⁵

Despite the international community's best efforts to administer export control regimes to control the illicit spread of the most dangerous

Jack Boureston and James A. Russell, 'Illicit Nuclear Procurement Networks and Nuclear Proliferation: Challenges Intelligence, Detection, and Interdiction,' *STAIR* 4:2 (2009): 24-50.

technologies, consumer and suppliers alike continue to find new ways of avoiding detection. Practices honed by spies of an earlier era continue today with national authorities, quasi-governmental organizations, front companies, wayward corporate entities, and well-placed individuals helping would-be proliferators acquire technologies and materials around the world.

This paper investigates the nuclear black market of the modern era, focusing on the illicit procurement networks of four different states in their quest to build a nuclear weapon in circumvention of international export control regimes. While today's illicit procurement networks, extending from states like Iran and North Korea, are not fundamentally that different from the illicit procurement network created by the Soviet Union in the 1940s, today's increasingly interconnected world offers new avenues and opportunities for complex illicit procurement networks. If the world remains committed to controlling the spread of nuclear weapons as called for under the Nuclear Non-Proliferation Treaty, then it must keep pace with the efforts of today's suppliers and consumers as they construct illicit procurement networks. The objective of this paper is to draw attention to four illicit procurement networks from the modern era, comparing factors in these cases as a way to illustrate their similarities and differences that, in turn, can offer some general yet instructive lessons. These lessons provide a guide to the international community, and can help it in taking the necessary steps to detect future illicit networks through the collection of intelligence, thus facilitating national-level and internationally-administered efforts to interdict, and shutdown, the networks.

Terminology and Theory

What constitutes a nuclear black market? Mark Fitzpatrick, a former US non-proliferation official defined it as: 'the trade in nuclear-related technologies, components or materials that is pursued for non-peaceful purposes and most often by secretive means.'⁶ It might be more accurate to describe this phenomenon as a 'grey' market, since some transactions may not be explicitly illegal, but still may take advantage of loopholes in national export regulations.

How are black markets formed and how do they operate? In their paper on proliferation rings, Braun and Chyba focused on the exchange of nuclear weapons-related and missile technologies among several developing countries. The authors called these 'second-tier proliferation networks,' consisting of such countries such as Iran, Libya, Malaysia,

Pakistan, South Africa, Turkey, and others.⁷ The authors stated that 'proliferation ring members' support one another either directly at the state-to-state level or indirectly through once-removed private sector supplier networks. Their research found that 'rings' of clandestine exchanges of technologies sprang up between and among the network participants.⁸ A prime example provided by the authors is that of North Korea's barter with Pakistan for missile-for-enrichment technologies. They called this exchange a 'benchmark event in the global proliferation enterprise.'

Alexander Montgomery borrowed from research on social network structures to explain that there are basically three procurement network structures: rings or circles, stars, and cliques. According to Montgomery, circles are formed with connections between each node; stars have a central hub that connects to each node; cliques are networks where all nodes are directly connected to each other. Montgomery contends that all networks so far have been star structures, with the state acting as the hub, and any future nuclear network will likely adopt the star structure in part because nuclear proliferation has greater tacit knowledge requirements.⁹

In his research on procurement networks, Bruno Gruselle noted that the controlling factors that shape the appearance of networks remain the same worldwide, even if the individual situations of network actors vary.¹⁰ Gruselle concluded that state demand has always been the driving force for proliferation, but the structure of the networks designed to satisfy the demand is new. According to Gruselle, network structures have been made possible by three factors: (1) increased trade flow and tools to manage trade have made it possible for networks to conceal themselves in ways that are difficult to monitor; (2) the fact that various goods used for WMD development are also used for civilian purposes makes it easier for networks to hide the true intent for purchases; (3) the appearance of suppliers that are capable and willing to transfer materials and technologies contributes to the development of networks.¹¹

The above literature focuses mainly on demand as the driving factor for the development of network structures. James Russell argued in 2006 that distinctions between the supply and demand aspects of weapons proliferation would become increasingly blurred in future proliferation networks.¹² He posited that non-state actors would assume more important roles in illicit procurement networks, providing proliferation market 'substructure' to function in the supply and demand sides of the market.¹³ Looking at phenomena such as the Khan Network and other procurement networks, we surmise that multinational corporations, non-governmental and quasi-governmental organizations, and transnational social movements all represent examples of ever more numerous

organizational structures that operate across borders and on a global scale, therefore requiring further scrutiny by the international community. Non-state proliferation market substructures include at least one of three characteristics: (1) they deal in legitimate trade in dual-use items that can be diverted to develop WMD; (2) as front companies and subsidiaries of state-run organizations, they can operate outside national borders and circumvent export controls; and (3) they service demand of violent non-state actors that seek weapons (possibly both conventional and unconventional).

Case Studies

Pakistan

In 1974, after India tested its 'peaceful nuclear explosion,' Pakistan assembled a group under the Pakistan Atomic Energy Commission (PAEC) to build a nuclear weapon. Recognizing that it was deficient in various technologies, the PAEC established a multi-layered procurement network to acquire nuclear related equipment and technologies. It contracted with foreign companies to obtain facilities, equipment, and know-how, and used their embassies abroad as bases for procurement missions; cooperated with allies to obtain goods; used front companies to procure items; used multiple intermediaries; falsified export control documents; and made use of personal connections to seek out and purchase essential nuclear materials. In what is now the most publicized case on nuclear networks, A.Q. Khan, a Pakistani national, was instrumental in developing an elaborate network of buyers and sellers that helped not only Pakistan develop its nuclear programme, but also Iran, Libya, and North Korea. He achieved all this while living and working in the Netherlands in the early 1970s.¹⁴ Pakistan employed various strategies to evade international detection and controls, including purchasing individual components such as centrifuge pre-forms rather than complete assemblies; hiding critical components on long lists of useless materials; paying exaggerated prices to entice suppliers to overlook export license requirements; buying samples and the means to reproduce them; purchasing raw materials and machines to refine them; establishing trans-shipment routes; cooperating with friendly countries such as China, Libya, and North Korea; and enlisting members of the Pakistani diaspora worldwide.¹⁵

Pakistani buyers frequently traveled abroad to meet with relevant companies (or their representatives) to obtain goods, services, and knowledge necessary to build a nuclear weapons programme. These buy-

ers courted organizations that might have been politically sympathetic to helping Pakistan in its quest, or simply interested in selling goods to a willing buyer at mark-up prices. In early 1975, Sulfikar Ahmed Butt, thought to be the PAEC's chief nuclear buyer, befriended Rudolf Ortmayr, a manager at the West German firm Nukleartechnik GmbH (NTG), and presented him with a comprehensive wish list of items necessary for PAEC's programme.¹⁶ NTG produced various nuclear components, including technology in nuclear medicine, heavy-ion research, heavy water production, nuclear fuel fabrication, nuclear contamination, and vacuum technology.¹⁷ Under Ortmayr, NTG provided Pakistan with much needed items and contacted other companies on behalf of the PAEC for goods it could not provide. In 1985, NTG sold and exported a tritium recovery facility to Pakistan, calling it a heavy water purifier on licensing paperwork to elude export control regulations. The PAEC also developed a close relationship with scientists at the Karlsruhe Nuclear Research Center (KFK), located in Karlsruhe, Germany. In the 1980s, ninety per cent of KFK was owned by the West German Government. While avoiding the attention of the authorities, KFK's scientists were therefore able to transfer items such as mass spectrometer components, train Pakistani scientists, and invite some Pakistani scientists to visit the KFK facilities. As KFK was a government sponsored facility, it did not operate under the same export constraints as other companies. Despite German foreign ministry officials passing on US intelligence reports alleging illegal transfers of materials to Pakistan, Economics Ministry officials allowed exports to continue.¹⁸

Pakistan's procurement efforts extended to North America. From 1977 to 1980, a Canadian citizen of Pakistani origin, Abdul Aziz Khan, visited Pakistan to work with A.Q. Khan. In 1980, Abdul Aziz Khan returned to Canada, and with the help of two associates began obtaining high-frequency inverters - electrical components that are used in uranium centrifuges (devices used to enrich uranium for either nuclear reactor cores or nuclear weapons cores). Operating out of two small stores, Aziz Khan and his friends purchased the inverters, repackaged them, and made nine shipments to the Kahuta Research Laboratory (KRL) in Pakistan. They were later caught and convicted for making illegal exports. In 1981, US officials seized a package of zirconium at Kennedy Airport that was to be shipped to Dr Sarfras Mir, a retired Pakistani army colonel, who operated the front company S. J. Enterprises. The package had been labeled as mountaineering equipment.¹⁹

Since uncovering Libya and Iran's nuclear activities, western intelligence agencies have been busy disassembling the Khan international nuclear procurement network. Although headed by A. Q. Khan in Paki-

stan, the network relied on intermediaries in Austria, Dubai, Germany, Japan, Malaysia, the Netherlands, Singapore, South Africa, Switzerland, Turkey, the US, the UK, and possibly other places. It was made up of Khan's past schoolmates, colleagues, and contacts. Some examples include Gotthard Lerch, once a high level manager at Leybold-Heraeus and friend of Khan's; Buhary Seyed Abu Tahir (BSA Tahir), owner of SMB Computers and a contact made while Khan was maintaining the KRL; Gerhard Wisser, friend of Lerch's and supplier of South Africa's nuclear programme; Johan Meyer, manager of Tradefin Engineering and contact of Wisser's; and Hank Slebos, a school mate of Khan's in the Netherlands. The loose connections in this network underscore the importance of social networks as a basis for developing and operating a procurement network. Khan's network was used to procure, manufacture, or otherwise supply needed items. Khan established trans-shipping points in Turkey and Dubai, and manufacturing operations in South Africa and Malaysia. Firms in Japan and Singapore also contributed high-tech equipment to the network.²⁰ According to Grusselle, 'The A. Q. Khan Company appears to have always operated on the principle of a direct initial contact between the network leader and his customers. Once contacts had been made and main principles had been defined, Khan appears to have left his main associates responsible for operational implementation.'²¹

Iraq

After the 1981 bombing of its Osirak reactor, Iraq established a sophisticated procurement network to obtain the technologies necessary for its nuclear programme. In the 1980s, the Ministry of Industry and Military Industrialization (MIMI), coordinated with Iraq's commercial, diplomatic, and intelligence services to establish front companies, use intelligence services, use embassies, and find ways to evade the export controls of other nations. Their efforts mimicked many of the techniques successfully developed by Pakistan.

In the 1980s, Iraq used its embassy personnel to help it identify willing sellers of equipment needed for its programme. In one important case, Ali Abdul Muttalib, commercial attaché at the Iraqi embassy in Bonn, Germany, identified companies that could be useful to fill item requests. He also learned how to elude European export controls by describing equipment in such a way that would facilitate approval of licenses.²² Muttalib also facilitated buying missions from Iraqi delegations. In 1987, for instance, Khadhir Hamza led a delegation to Germany to locate needed equipment such as highly enriched uranium (HEU) processing equipment and high speed measuring equipment to help Iraq

develop high explosive lenses. Muttalib identified relevant companies including Leybold and Degussa, and introduced Hamza to Werner Sonntag, a representative of the Neuero and Inwako companies. The Iraqis gave Sonntag a long list of explosive test equipment and the technologies necessary for designing a facility to conduct explosive testing. Hamza and Sonntag are known to have had extensive contracts with Iraq.²³ Inwako provided other equipment, including ring magnets to stabilize centrifuge rotors and helped Britain's Swift-Levick to transfer magnets to Iraq. Inwako helped Iraq upgrade its SCUD-B missile systems.²⁴

Iraq used experts in countries such as Germany to help them obtain needed materials for their nuclear programme. For instance, Karl Heinz Schaab, ex-MAN Technologien AG employee helped to provide centrifuge rotors to Iraq. MAN was a principle consulting company to the URENCO uranium enrichment consortium, supplying that company with carbon-fiber rotors for its more advanced uranium centrifuges. Schaab left MAN New Technology because he felt that they did not promote him fairly. He subsequently established his own small firm. During that time he was often without projects and therefore took every opportunity to work, including taking on jobs that were beneath his ability with the rationale that he'd gain more appropriate contracts in the future. In the mid-1980s, Dietrich Hinze and Bruno Stemmler - also a former MAN employee who had dealings with the Iraqis in the past - introduced Schaab to their Iraqi contacts for possible work. Schaab and his colleagues may also have worked together on projects in Brazil. Schaab trusted and admired Stemmler and therefore did not question the Iraqis' stated purpose of their requests. Although Schaab was technically adept as an engineer, he was not experienced as a businessman. This reportedly made him more susceptible to Iraqi influences. The Iraqis treated Schaab with the respect and kindness that he felt he deserved. On two occasions, Schaab and his colleagues made shipments to Iraq. The first occurred in 1989, when Schaab shipped a small number of rotor samples. In 1990, Schaab shipped twenty complete rotors. Schaab manufactured the rotors himself using an S-glass fiber supplied by the Japanese firm Toray and a filament winding machine, then sent to a firm in Austria. Apparently both shipments went to the Austrian firm which then shipped the rotors on to Iraq.²⁵ According to sources, Schaab was a centrifuge expert and therefore had the technical know-how to assist the Iraqis to set-up a centrifuge programme for uranium enrichment. Schaab also sold classified MAN-blueprints of a sub-critical centrifuge for forty thousand dollars to the Iraqis, along with thirty-six carbon fiber rotors during a meeting in Kaufbeuren. The Iraqis may have exported the rotors through diplomatic channels to conceal their transport. In

total, Schaab sold the Iraqis equipment and items for the total amount of approximately one million dollars. He also provided technical assistance to the Iraqis, such as installing a prototype test-rotor in a Baghdad laboratory.²⁶ Iraqi agents often found companies such as Schaab's that were small and needed infusions of capital for their operations.²⁷

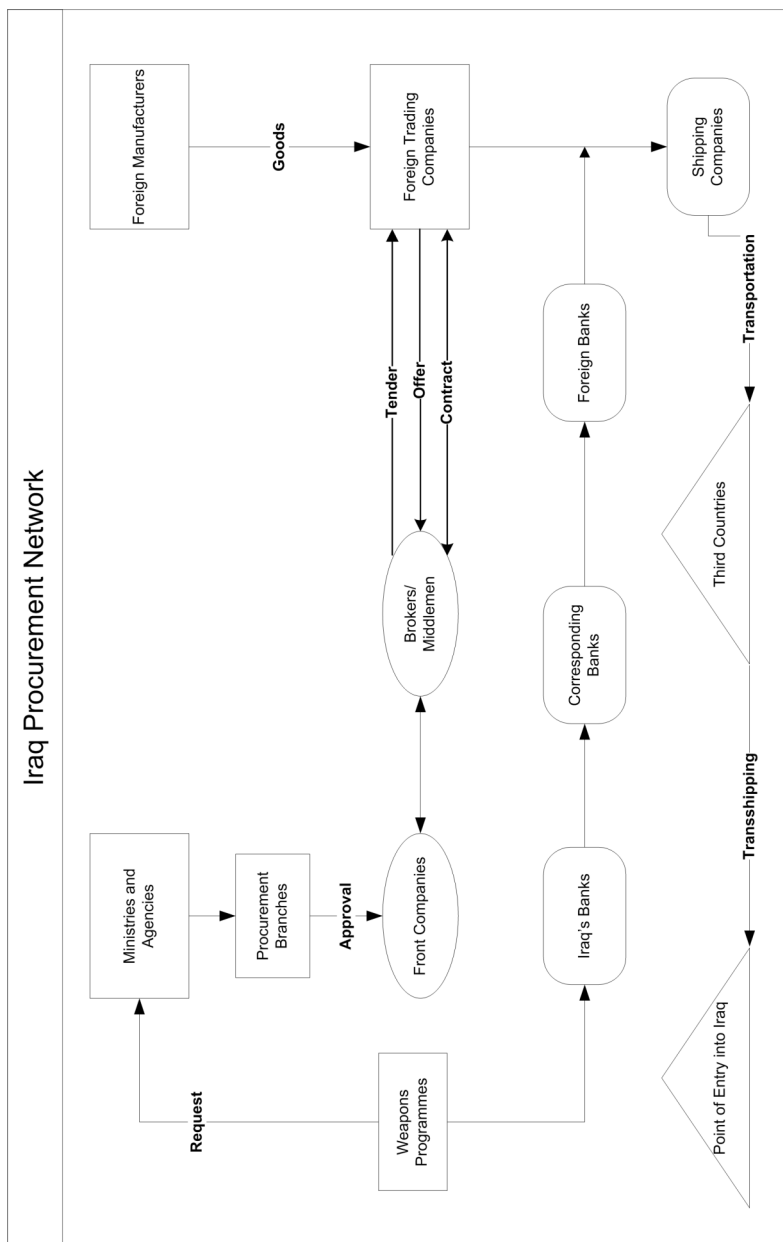
As a part of its network Iraq established a series of front companies to procure items and disguise their final destination and end-use. MIMI set-up the Al-Arabi Trading Company and Nassr General Establishment to procure materials for Iraq's conventional and unconventional weapon programmes, and Iraq's nuclear establishment directed other front companies such as the Industrial Projects Company (IPC) to purchase components for Iraq's centrifuge programme.²⁸ The Iraqis also used these companies to purchase or buy controlling stocks in other companies to procure needed items and other business benefits. For instance, in 1987, Al-Arabi secretly purchased a fifty per cent stake of the German Firm H + H Metalform GmbH.

Co-founder of H+H, Dietrich Hinze was an engineer who worked for over twenty years in the tool making and mechanical engineering firm Leifeld and Co. in Germany. In the early 1980s, Hinze decided to set up his own business, together with his partner Hütten, who was once the sales manager at Leifeld. Together, in 1983, they founded the company H+H Metalform. The name of the new firm, H+H, stood for *Herstellung und Handel* in German or 'production and trade' in English. One of the main activities of H+H was the production and sale of vertical-flow-forming machines, developed by Mr. Hinze. Flow-forming machines have both military and civilian applications. They can be used to produce steel tubes for ammunition and missile casings, as well as centrifuge rotors for uranium enrichment but can also be used to produce industrial gas-cylinders and pressure cookers.

In April 1987 H+H was contacted by the London-based company, Meed International, which belonged to an industrial network responsible for procuring military equipment, especially in the field of rocket technology for Iraq. Meed's parent company was the Nassr Establishment for Mechanical Industry Ltd., located in Taji, Iraq. During contract negotiations between Hinze and the Nassr Establishment, it soon became clear that Nassr wanted to produce artillery with diameters of 122-262 mm. The Iraqis needed flow-forming equipment for this and other purposes although these were never openly stated. Hinze was in Baghdad several times to supervise the installation of his machines and other equipment. He gave further assistance in technical problems regarding the production of flow forming parts that later turned out to be items for the Scud missile. Altogether, the contract was subsequently concluded for the sup-

ply of nine flow-forming machines (each worth between \$1-2 million). To produce their machines, the young company H+H needed additional capital. The banks approached by Mr. Hinze refused to give credit because the company could not offer sufficient security. Therefore they had no option but to accept an offer from the Iraqis to acquire a fifty per cent stake in H+H. This is how another subsidiary of Nassr, Al-Arabien Co Ltd., came to have a share holding in H+H. From 1987 through 1990, H+H Metalform supplied machines tools and equipment for the production of rockets and ballistic missiles worth altogether around twenty-five million dollars. In nearly all cases, export permits were issued by Germany's Federal Office for Trade and Industry (BAW). Part of this is due to H+H declarations that the machines were to be for civilian purposes, like producing gas-cylinders, hydraulic-cylinders, lamp-posts, etc. However, these were covers to escape suspicion and gain export licenses. Iraq's contracts with H+H included provisions for machines, equipment, and technical assistance. In addition, H+H provided Iraq with contacts to other firms who cooperated because of their long-standing relationship with H+H Metalform.²⁹

Iraqi intelligence services also established front companies to procure needed items. Some of these companies operated subsidiaries in other countries such as Jordan to facilitate the procurement and shipment to end-users in Iraq. For example, the Iraqi Al-Eman group organized material flows through Jordan to Iraq, often labeling the contents of packages and end-users in such a way as to quell suspicions of illegal activity. According to the Iraq Survey Group's final report, the Sattam Hamid Farhan al-Gaaod company established the Al-Eman Commercial Investment group in the 1990s and Sattam Hamid had a special relationship with the Agricultural Supplies Committee of the Ministry of Agriculture (MoA). From 1990 to 2003, Al-Eman shipped approximately one container a month through Jordan to Iraq via the Iraqi Embassy in Jordan. For Instance, in 1995, Al-Eman purchased a kit of reagents worth five thousand dollars from the Swiss firm Elisa for an organization named AL-IBAA, a special unit in the Iraqi MoA. AL-IBAA was connected to Saddam, had a special research facility and was granted an unlimited budget. AL-IBAA was able to obtain any equipment and support within Iraq that it needed and paid cash for all its orders.³⁰ A diagram of Iraq's procurement network is described below.

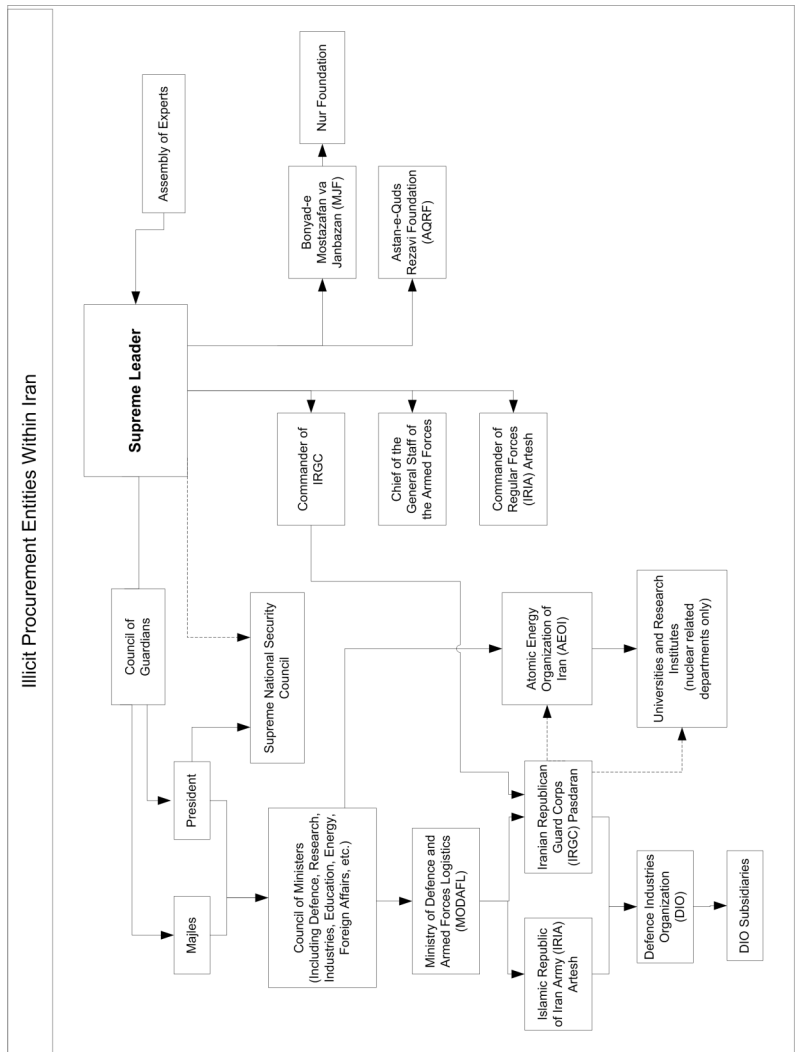


Source: Mark Fitzpatrick, ed., *Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks – A Net Assessment* (London: International Institute for Strategic Studies, 2007).

Since the 1980s, Iran has acquired nuclear-related materials and equipment, designs, and assistance from a multitude of entities in countries including China, France, Germany, Japan, the Netherlands, Pakistan, Russia, Switzerland, and the United States. The type of equipment obtained ranges from high-strength aluminum and steel, electron beam welders, balancing machines, vacuum pumps, computer-numerically controlled (CNC) machine tools, and flow-forming machines, to whole centrifuges and uranium conversion plants.³¹ Iran developed its model for procurement in a similar fashion to those of Pakistan and Iraq. Commonalities include the use of persons in national embassies to make contacts, use of front companies and falsified end-user certificates to conceal end users, and the use of middlemen to contact willing suppliers, to obtain the required equipment and assistance.

In 1987, Iran became the Khan network's second client after Pakistan when it purchased a set of centrifuge blueprints and sample pieces of obsolete equipment from the Pakistani programme. It also purchased a nuclear weapon design blueprint which was thought to be based on an early Chinese model, but may also have been a more modern Chinese design. Khan may have provided a number of other items to Iran, including nuclear weapon designs and a number of studies including some on the manufacture of uranium hemispheres. In the late 1990s Dr Khan provided North Korean nuclear experts with up to twenty discarded centrifuges, sets of drawings, technical data, and a quantity of uranium hexafluoride (UF₆). All items are useful for uranium enrichment research.³² Khan's last known customer was Libya. Khan and his network provided a long list of items and information including: twenty pre-assembled L-1 centrifuges and components for an additional two hundred L-1 centrifuges; ten thousand L-2 machines and supporting equipment, including feed stations, product and tails withdrawal stations, vacuum equipment, cascade piping, drive systems, and other miscellaneous equipment. Khan's procurement network helped to manufacture and ship the components and equipment from entities in different countries. In addition, the network provided Libya with technical assistance and design information on a conversion and fuel fabrication laboratory (referred to as Project 702); a post-irradiation examination facility, designed for the receipt and disassembly of pressurized water reactor (PWR) spent fuel assemblies (Project 307); a radiochemical separation laboratory, consisting of a pilot scale Purex reprocessing plant designed for processing approximately 1100 kg of uranium per year of PWR spent fuel and recovering

approximately 10 kg of plutonium per year (Project 701); and a high level liquid waste vitrification plant that is designed for solidifying high level waste from the reprocessing plant (Project 303). Lastly, the Khan network provided Libya with design information for the fabrication of a nuclear explosive device, including information related to high enriched uranium re-conversion, casting and machining, and the testing of nuclear weapons components. Much of the sensitive information coming



Source: author research

from the network existed in electronic form, enabling easier use and dissemination. This includes information that relates to uranium centrifuge enrichment and, more disturbingly, information that relates to nuclear weapon design.³³

Iran's procurement network appears to be controlled by the top tiers of government. The President appoints the cabinet, called the Council of Ministers, and the appointees must be confirmed by the legislature, the Majlis. Included in the Council of Ministers are the Ministry of Defense and Armed Forces Logistics (MODAFL), the Ministry of Energy, and the Ministry of Education and Research. These ministries serve as three conduits for procurement and administration of Iran's WMD programmes. The diagram of Iran's procurement structure is above.

MODAFL controls both the Artesh, the regular military and the Pasdaran — also known as the Iranian Revolutionary Guard Corps (IRGC).³⁴ The IRGC initially had an independent command structure after its creation in 1979. Following the end of the Iran-Iraq War, the Iranian government sought to modernize and professionalize the IRGC and the regular military under MODAFL.³⁵ At this time, the industrial and procurement organizations of both militaries were combined into the Defense Industries Organization (DIO), the organization which supplies both MODAFL and the IRGC. DIO is staffed by, and linked to, both the Artesh and the IRGC. However, most directors of IO and the MODAFL were IRGC officers.³⁶ MODAFL, DIO, and subsidiaries have been listed in UNSC Resolution 1737, US State Department sanctions lists, and Japanese METI sanctions lists for involvement in the nuclear and ballistic missile programmes source.³⁷ The IRGC uses Iran's Defense Industrial Organization (DIO) and its subsidiaries, some universities, and the 'bonyads' (see below) to attempt to acquire dual-use nuclear technology in countries such as Japan and Germany. The IRGC maintains links to each leg of this network. The DIO is normally directed by an IRGC commander, for example, former DIO director and current Minister of Defense and Armed Forces Logistics (MODAFL) Brig. General Mostafa Muhammad Najjar.³⁸

Outside of formal state control, and believed to answer only to the Supreme Leader, is a network of NGOs known as 'bonyads.' These organizations possess an independent authority beyond the reach of elected officials and other parts of the government.³⁹ They publish no accounts, are tax exempt, and have special relationships to state power.⁴⁰ Operationally, bonyads are special cooperative corporations that are responsible for a large segment of the Iranian economy, and they manage groups of companies with offices within Iran and around the world.

Some bonyads have alleged links to proliferation activities, including the Mostazafan va Janzaban Foundation (MJF), the Nur foundation, the Astan-e-Qods Rezavi Foundation (AQRF), and the Imam Reza Holy Shrine.⁴¹ Cases against MJF, AQRF, and Nur Foundation originate from the German Intelligence Service (BND) and NCRI, respectively. The MJF, AQRF, and the Nur foundation are staffed with former IRGC commanders. Mohsen Rafiqdust, a founding member of the IRGC and former its former commanding officer, was director of MJF from 1989-98 and director of Nur from 1999 to the present day.⁴² In 1997, the weekly Germany magazine *Stern* reported that a BND investigation was underway to determine if the MJF was a conduit to procure materials useful for WMD production. According to the report, at the time the MJF was headed by the former head of the IRGCC, Mohamed Rafighdost. *Stern* quoted a German Government report confirming that MJF had created 'fake' companies to act as intermediaries to purchase goods related to the production of WMD.⁴³ According to the BND report, 'DIO couriers carry parcels full of microelectronics components and files out of the office in Duesseldorf in the evening and take them to the Iranian Embassy in Bonn.'⁴⁴ In 2000, a BND report noted that the MJF makes illegal purchases through dealers and dummy companies in Dubai and ships them back to Iran.⁴⁵ Noted examples are the Alborz, Aliaf P.P. Azar, Tizro Trading Company, Yusaf Universal Import-Export Est, and Company 209.⁴⁶ MJF may also operate in the US According to a 2007 *Wall Street Journal* report, 'a group calling itself the Mostazafan Foundation of New York took control of a Manhattan office tower built in the 1970s by the deposed Shah.'⁴⁷ The group later changed its name to *The New York Foundation* and maintained majority control of the building.

The Imam Reza Holy Shrine also has links to Iran's WMD programme, albeit only tangentially. The shrine's custodian is Ayatollah Abbas Vaez Tabassi, cell mate to the Supreme Leader Ayatollah Ali Khamenei prior to the Iranian Revolution. Tabassi's son, Nasser Vaez Tabassi owns and operates Al-Makasseb, a multimillion dollar company based in Dubai.⁴⁸ Al-Makasseb was financed by Bank Melli, Iran's largest financial institution, which has 3500 branch offices worldwide.

Like Iraq, Iran invested in foreign companies to fulfill its procurement needs. For instance, in 1987 Iran invested in the Rio Tinto-Zinc mining company in Namibia.⁴⁹ In 1996, Iran may have purchased the German machine-tool manufacturer Sket Magdeburg.⁵⁰

As noted earlier, both the IRGC and Atomic Energy Organization of Iran have used various Iranian universities as procurement fronts for Iran's nuclear programme. In 1991, the Sharif University of Technology in Tehran ordered centrifuge components from the Austrian firm

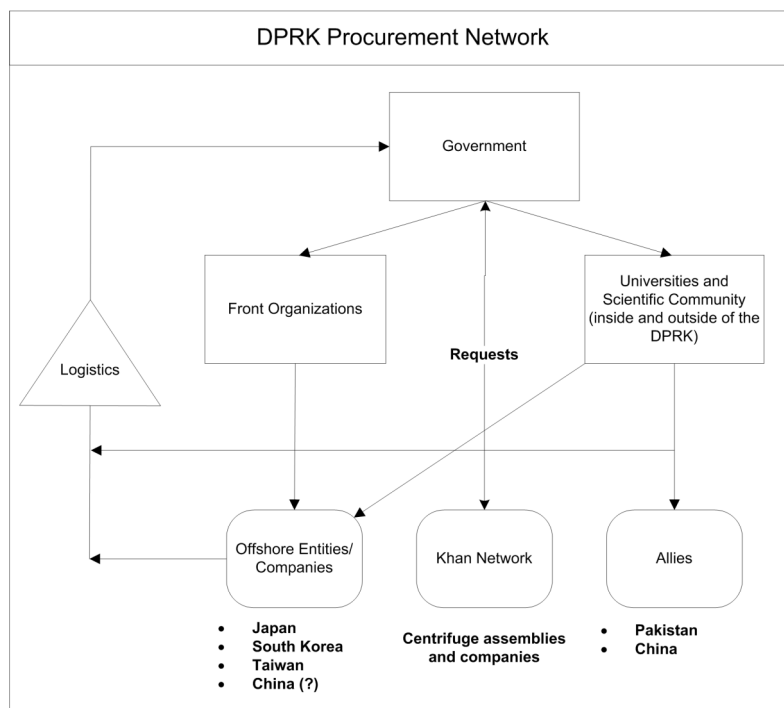
Tribacher.⁵¹ That same year, Sharif also ordered ring magnets from Thyssen, a German machining company and sought to purchase vacuum pumps from Leybold. Another German firm, Karl Shenck of Darmstadt transferred Sharif a balancing machine.⁵² In 1993, AGIE and Charmilles Technologies sold Sharif electronic discharge machinery that can be used to produce nuclear fuel production equipment and gas centrifuge components.⁵³ In 2003, the Australian firm GBC Scientific Equipment attempted to deliver a mass spectrometer (used to evaluate the enrichment of uranium) to Amir Kabir University of Technology. In 2002, GBC had exported a mass spectrometer to the Centre for Agriculture and Medicine at Karaj. The equipment was used to measure uranium isotope enrichment levels.⁵⁴

North Korea

The Democratic People's Republic of Korea (DPRK) established its illicit nuclear procurement networks as far back as the 1970s, developing a system of using expatriates and agents traveling around the world to acquire the necessary items to support their nuclear programme. North Korea was also aided by its allies in Russia, China, and Pakistan in obtaining goods and services.

In the late 1980s, A. Q. Khan offered centrifuge technology to the North Koreans, with major shipments occurring in the late 1990s. Those shipments may have coincided with the provisions of the agreed framework which mandated the halting of any reprocessing activities.⁵⁵ In 1997, Khan may have also provided the North Koreans with the same shopping list that he did the Iranians in 1987. That list helped the North target willing companies and stay below the radar of foreign authorities. Between 1999 and 2000, Khan provided North Korean engineers with up to twenty P-1 centrifuges and technical advice on the operation of centrifuges.⁵⁶ Since the late 1990s North Korea has been working to develop its uranium enrichment programme. The North's procurement agents used Khan's list of nuclear suppliers to help them obtain related equipment. For instance, the Japanese company Mitutoyo is known to have transferred goods to Scomi International, as part of an order from the Khan network, to Iran, Libya, and North Korea. Mitutoyo is a privately-owned company that makes three-dimensional precision measuring machines.⁵⁷ These machines can be used to help produce the rotors needed for a centrifuge-based uranium enrichment programme. In each case of transfer, Mitutoyo is known to have eluded export controls by falsely stating that overseas subsidiaries were the final destination.⁵⁸ In the case of transfers to Iran, the company sold the machines to a locally based

Iranian trading company, Seian trading company, which is thought to be an Iranian front company to help Iran purchase equipment for its own nuclear programme.⁵⁹



Source: author research

For many years, agents of the DPRK tapped into Japan's North Korean population and industrial base to obtain the materials they need for its WMD programmes.⁶⁰ In 1946, North Korean scientists living in Japan established an association in the Kanto area of Japan. Over the years, the association underwent several changes and in 1985 it merged with other organizations to form the Kyako or Korean Association of Science and Technology (KAST). According to some media reports, KAST is under the direct control of the external relations division of the Korean Workers Party in Pyongyang.⁶¹ The group is comprised of approximately 1,200 members, some of whom work in fields such as physics and engineering, and have periodically visited North Korea.⁶² KAST operates twelve branches all over Japan and manages a number of Japanese corporations. These include the Daiei Machinery Corporation (later renamed the Diastar Corporation) and the Shinei Shouji Corporation. Members work in a number of other research institutes, national universities, and

corporations that could be helpful in WMD development.⁶³ Illicit equipment transfers have been traced back to those companies. For instance, in 1993, Daiei arranged for the export of measurement equipment to North Korea. In 1994 Japanese authorities discovered that a KAST related company had transferred a jet mill machine – equipment used to grind materials finely – to North Korea.⁶⁴ Another organization, the Kim Man-Yu Science Foundation, established with the objective of assisting North Korean scientists in Japan, may have helped Korean scientists living in Japan both to obtain goods and nuclear know-how and then send it back to North Korea.⁶⁵ The structure of the DPRK procurement network is described above.

North Korea established and operated a viable logistical system between itself and Japan to transport items home without raising suspicions. Specifically, the North Korean ferry, *Man Gyong Bong*, that runs between North Korea and Japan was used to ship items home. According to news reports, before the Taepo-Dong-1's first test launch in 1997, missile components were regularly exported from Japan to North Korea.⁶⁶ In 2003, the Tokyo Vacuum Corporation, a vacuum pump maker, and an export agent, Nakano Corp., transported vacuum pumps to North Korea via a Taipei company.⁶⁷ According to press reports, the pumps could be used in uranium enrichment processes. However, there seems to be some confusion regarding their specific use.⁶⁸ In another example, between August 2006 and August 2007, the Taipei company, Hua Yueh International, made as many as fourteen shipments of Japanese dual-use components (including stainless steel pipes, computer software and computer numerical controlled machine tools) to North Korea. The company reportedly mislabeled the point of destination as 'China.'⁶⁹

For decades, North and South Korea have held scientific and educational exchanges in the hope that they would engender better relations between the two countries. These exchanges also facilitated transfers of goods and assistance. For instance, the Korea Mining and Development Corporation (KOMID) assisted North Korea in its missile proliferation efforts.⁷⁰ According to a BBC report in 2004, the Horkos Corp. in Fukuyama mislabeled tools that can be modified to produce centrifuge rotors and sent them to South Korea. Investigators suspect that the ultimate destination of the tools was North Korea.⁷¹

North Korea procurement agents are also known to be targeting European companies to fulfill its requirements. For instance, in 2002, North Korean experts made an effort to procure 22 metres of 6061-T6-grade aluminum pipes from the Optonic GmbH in Germany.⁷² North Korea also imported 2600 aluminum tubes from Russia.⁷³ In addition to targeting European companies, North Korean diplomats may have re-

cruited South Korean intellectuals living in Germany for clandestine procurement activities. In October 2003, South Korean sociologist Chong Ty-yul was arrested for engaging in an organized anti-government and anti-democratic movement in Germany since the 1970s.⁷⁴

Network Commonalities

In each of these cases there are some common procurement practices. Each network started out affiliated with and organized by the state, but in some cases they are semi-autonomous in nature. In each case the network used embassies located in industrial centers around the world as bases for making purchases and shipping materials home. They also created fronts such as phony companies, education institutions, and non-profit organizations to conceal procurement activities, and they established offshore logistics and financial centers to move acquired technologies and pay for them.

In some cases, procurement network substructures have emerged as semi-independent bodies that may function as third tier supplier networks depending on their intentions and motivations. These third tier networks include quasi- or non-governmental organizations, military organizations, state-owned companies, and nonprofit or religious organizations. Again, Khan may have been the most flagrant example, but other examples may include the IRGC and bonyads in Iran or even KAST in Japan. Each was set up by the state with specific purposes and given functions that required that they establish a procurement network structure, with a high level of autonomy. These entities could help other countries or other allies develop WMDs if it was to their advantage to do so. In the case of the IRGC for instance, if it seemed advantageous for them to provide WMD to a non-state actor — a terrorist or military group in Iraq, Lebanon, or elsewhere — to defeat Iran's enemies, then this could be achieved with or without the knowledge of the head of state, given their somewhat autonomous nature, and control of WMD facilities.

Companies such as Mitutoyo may also provide products to groups that it knows are aiding suspected proliferators, but in this case, it may be to increase company's profits.

New Nuclear Suppliers?

As nations have developed their procurement efforts and perfected the methods of evading export controls, some have emerged as future nuclear suppliers. A case in point is the revelation that North Korean enti-

ties have contracted with Syrian officials to help Syria build a nuclear programme. Although the details are not well known, there is evidence that North Korean engineers were building a nuclear reactor similar to the twenty to twenty-five megawatt thermal reactor in Al-Kibar outside of the city of Al-Tibnah.⁷⁵ To support its contract with the Syrians, North Korea employed one of its own procurement agents to travel abroad and purchase needed items. According to a recent *Washington Post* report, western intelligence has been tracking the activities of the North Korean company, Namchongang Trading Group (NCG). According to the *Post's* report, NCG employees have traveled to several European countries such as Germany to purchase an array of items including electric timers, steel pipes, vacuum pumps, transformers, and aluminum pipes cut to precise dimensions. These items were purchased and shipped to NCG's branch office in Beijing, then sent on to the Al-Kibar site. According to David Albright, 'because it's a branch office in China, NCG can buy equipment from suppliers throughout the world, even in Europe and possibly the United States, particularly if the companies have subsidiaries in China.'⁷⁶ China is a nuclear-armed state, meaning some export regulations are different. Additionally, as Albright indicates, if items were being purchased in China, but by a branch office in China, then it may not attract the attention of the authorities. Like North Korea, China has good relations with Syria.

This is not a new phenomenon. During the cold war, states in the western and eastern blocs benefited from the technological developments of their allies. Now that it is confirmed that North Korean entities have been assisting Syria, it is distressing to think that other countries could also receive North Korean assistance. Iran has similarly offered to help its allies (or potential allies) with nuclear technologies, and some countries that are just looking to join an expanding nuclear market, such as Brazil and Argentina, may also be future illicit conduits. Perhaps even more disconcerting is the whole set of substructures such as the IRGC, KAST, and the myriad front companies, that could, given sufficient motivation (be it financial or political) act on their own to supply would be proliferators.

Challenges for Intelligence and Detection

Given that we know what items are necessary to build nuclear programmes, and we know the common methods that networks use to acquire these items, what can be done to curtail the development of future networks? The underlying remedy to chronic illicit nuclear transactions

is developing more transparency and greater control over the export of nuclear-related and dual-use materials. More intelligence collection, information sharing, and policing are needed. By monitoring information sources and focusing on the common elements found among procurement networks, we can detect sales (and attempted sales) of relevant items. More export-related information is needed. As intelligence agencies and other government agencies collect information about possible illicit transactions, regulatory bodies and police organizations need to be given this information to help them stop these transactions. More collection and analysis of industry information, business transactions, dubious business enquiries, and suspicious bid offers is needed. And more sharing of information is needed between nations and international bodies such as the International Atomic Energy Agency (IAEA). Within the IAEA, the Trade and Technology Analysis unit (TTA) is asking member states to provide information about enquiries for potential purchases of goods and services. TTA hopes to get any information on communications to learn who is interested in purchases and what they are interested in acquiring. This information can help detect third party activity that can then be stopped.

National agencies could also share information of suspicious foreign enquiries with industries who, in turn, could alert their constituents to illicit activities. More work needs to be done to make companies aware of illicit network activities, holding companies more responsible for ensuring that their employees are not transferring nuclear related goods illicitly. David Albright called companies the first line of defense and perhaps the most important line of defense.⁷⁷ Commercial entities need to be made more aware of the dangers of buyers attempting to buy their goods while concealing the end-use or purpose for the purchase.

Conclusion

As nations continue to develop nuclear programmes and established suppliers look for ways to compete against others to increase profits, they will look for new methods to evade export controls and transfer goods under the radar. Clearly the most dangerous materials being trafficked today are those that are related to nuclear programmes. Although in the past the press had reported on illicit procurement activities, their significance was not realized until authorities acted to break up the Khan network.⁷⁸ The proliferation activities of Pakistan, Iran, Iraq, and North Korea illustrate the problem faced today by the international community: procurement networks are staying ahead of export controls by altering

their tactics, learning new and more evasive techniques and finding ways to exploit legitimate trade practices to acquire sensitive materials. While control regimes may have successfully slowed the first and second tier of proliferation networks, there is actually a third tier of networks - a 'substructure' that is comprised of a variety of semi-autonomous groups that can service the demand size of today's nuclear black market.⁷⁹

The challenge for intelligence agencies, and international and national regulatory bodies, is to continue to investigate questionable activities and to find new tools to interdict any transactions which may result. Looking for indicators such as frequent buying missions to industrial countries, suspicious contacts and organizations operating out of embassies, scientific exchanges and other doubtful alliances among allied nations, and nationals living overseas shipping materials to their home country, investigators can identify and analyze the existence of new and existing procurement networks. This information then needs to be shared with industries and companies that produce sensitive items to make them more aware of illicit procurement efforts and thereby enable them to ward off illicit attempts to buy their products. These and other more innovative measures are needed to help enable the international community to stifle nuclear procurement activities, thereby slowing the spread of nuclear weapons. ■

Notes

¹ A history recently summarized in William Broad, 'Hidden Travels of the Atomic Bomb,' *New York Times*, December 8, 2008, <http://www.nytimes.com/2008/12/09/science/09bomb.html?ref=science> (accessed January 18, 2008).

² Kim Sue-young, 'Industrial Espionage Haunts Korea,' *Korea Times*, June 11, 2007, <http://www.koreatimes.co.kr/www/news/special/2008/09/180-4524.html>.

³ As grippingly retold in Richard Rhodes, *Dark Sun: The Making of the Hydrogen Bomb* (New York: Touchstone, 1996).

⁴ James Kitfield, 'Espionage, the Sequel,' *Air Force Magazine* 90:3 (2007).

⁵ US House of Representatives Select Committee, *us National Security and Military/Commercial Concerns with the People's Republic of China*, 105th Cong., 2d Sess., 1999, H. Rep. 105-851, <http://www.house.gov/coxreport/cont/gncont.html> (accessed January 18, 2009); also see Peter Grier, 'China Problem,' *Air Force Magazine* 82:8 (1999).

⁶ Mark Fitzpatrick, 'Understanding Clandestine Nuclear Procurement Networks' (lecture given at the International Atomic Energy Agency 2007 Scientific Forum, Session 4: Safeguards and Nuclear Verification, Vienna, September 19, 2007).

⁷ Chaim Braun and Christopher Chyba, 'Proliferation Rings: New Challenges to the Nuclear Non-Proliferation Regime,' *International Security* 29:2 (2004): 5-49.

⁸ Ibid.

⁹ Alexander H. Montgomery, 'Ring in Proliferation,' *International Security* 30:2 (2005): 153-187; Alexander H. Montgomery, 'Proliferation Networks in Theory and Practice,' in *Globalization and WMD Proliferation: Terrorism, Transnational Networks, and International Security*, ed. James A. Russell and James S. Wirtz (New York: Routledge, 2008), 28-39.

¹⁰ Bruno Gruselle, *Proliferation Networks and Financing* (Paris: Fondation pour la Recherche Stratégique, 2007), <http://www.frstrategie.org/barreFRS/publications/rd/RD-20070303-eng.pdf>. (accessed January 19, 2009).

¹¹ Ibid.

¹² James A. Russell, 'Peering into the Abyss: Non-State Actors and the 2016 Proliferation Environment,' *Nonproliferation Review* 13:3 (2006): 645-657.

¹³ Ibid.

¹⁴ David Albright and Corey Hinderstein, 'The A.Q. Khan Illicit Nuclear Trade Network and Implications for Non-Proliferation Efforts,' in *Globalization and WMD Proliferation*, ed. James A. Russell and James S. Wirtz (New York: Routledge, 2008), 49-62.

¹⁵ Mark Fitzpatrick, ed., *Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks – A Net Assessment* (London: International Institute for Strategic Studies, 2007).

¹⁶ See *Der Spiegel*, February 20, 1989.

¹⁷ Mark Hibbs, 'German Prosecutors Cite Illegal Exports to Pakistan, India, and South Africa,' *Nuclear Fuel*, December 26, 1988.

¹⁸ Ibid.

¹⁹ Leonard S. Spector, *The New Nuclear Nations* (New York: Random House, 1985), chap. 2, <http://www.acamedia.info/politics/nonproliferation/spectorNN85/chapters-2-3.htm> (accessed January 19, 2009).

²⁰ For example, an investigation is underway in Japan to determine if an unnamed company's sale of a uranium conversion facility to Libya is in violation of Japan's export control laws. Although not handled by middlemen, the transaction report-

edly involved other countries, as the packing material originated from outside Japan. 'Did Japan Know About Libya Nukes?', *CBS News*, February 20, 2004.

²¹ Gruselle, *Proliferation Networks and Financing*.

²² Institute for Science and International Security, 'Illicit Procurement Infrastructure,' <http://www.exportcontrols.org/print/domestic.html> (accessed January 19, 2009).

²³ Ibid.

²⁴ 'Iraq's Silent Allies In Its Quest For The Bomb,' *Businessweek*, January 14, 1991, <http://www.businessweek.com/archives/1991/b319537.arc.htm> (accessed January 19, 2009).

²⁵ Mark Hibbs, 'German Expert Wanted by Authorities for Giving Iraqi Carbon Centrifuge Rotors,' *Nuclear Fuel*, November 9, 1992.

²⁶ Michael Rietz, 'Dual-use Exports, or a Twilight Business Versus Systemic Failures of Export Controls' (talk delivered at a luncheon sponsored by the Institute for Science and International Security, Washington, DC, December 10, 1999), <http://www.isis-online.org/publications/iraq/talkwashforweb.html> (accessed January 19, 2009).

²⁷ Ibid.

²⁸ Mark Fitzpatrick, 'Nuclear Black Markets: Other Countries and Other Networks,' in *Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks – A Net Assessment*, ed. Mark Fitzpatrick (London: International Institute for Strategic Studies, 2007), chap. 2.

²⁹ Mahdi Obeidi and Kurt Pitzer, *The Bomb in My Garden: The Secrets of Saddam's Nuclear Mastermind* (New Jersey: John Wiley, 2004), 113.

³⁰ Iraq Survey Group, *Final Report: Executing Illicit Procurement in Iraq: Ministries, Commissions, and Front Companies* (Washington, D.C.: Central Intelligence Agency, 2004), <http://www.globalsecurity.org/wmd/library/report/2004/isg-final-report/isg-final-report—vol1—rfp-03.htm> (accessed January 19, 2009).

³¹ David Albright and Corey Hinderstein, 'The Centrifuge Connection,' *Bulletin of the Atomic Scientists* 60:2 (2004): 61-66.

³² 'Re-imposition of Sanctions Feared,' *Dawn*, February 5, 2004. Cited in Mark Fitzpatrick, ed., *Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks – A Net Assessment* (London: International Institute for Strategic Studies, 2007), 72.

³³ International Atomic Energy Agency Board of Governors, *Implementation of the NPT Safeguards Agreement in the Socialist People's Libyan Arab Jamahiriya*, IAEA Doc. GOV/2008/39, September 12, 2008, 3-9.

³⁴ 'Iran's Missile Industry, US Missile Development Firms with Iranian Links,' FBIS Document FTS19980605000876, June 5, 1998.

³⁵ 'Iran's Military Strength Said to Rest on "Terrorism," Nonconventional Arms,' *Middle East Review of International Affairs*, March 1, 2002, OSC document GMP20010330000137.

³⁶ 'Biography of Iranian Defense Minister Brig-Gen Mostafa Mohammed Najjar,' BBC Monitoring, November 7, 2005, <http://www.monitor.bbc.co.uk/>; 'Open-Source Research on Nuclear Doctrine and Strategy, Command and Control, and Delivery Systems in Israel and Iran,' Library of Congress, December 2005.

³⁷ United Nations Security Council Resolution 1737, December 23, 2006, <http://daccessdds.un.org/doc/UNDOC/GEN/No6/681/42/PDF/No668142.pdf?OpenElement> (accessed January 19, 2009).

³⁸ 'Biography of Iranian Defense Minister Brig-Gen Mostafa Mohammed Najjar,' BBC Monitoring, November 7, 2005, <http://www.monitor.bbc.co.uk/>; 'Open-Source Research on Nuclear Doctrine and Strategy, Command and Control, and Delivery Systems in Israel and Iran,' Library of Congress, December 2005.

³⁹ Andrew Higgins, 'Inside Iran's Holy Money Machine,' *Wall Street Journal*, June 2, 2007.

⁴⁰ Ibid.

⁴¹ 'Biography of Iranian Defense Minister Brig-Gen Mostafa Mohammed Najjar,' BBC Monitoring, November 7, 2005, <http://www.monitor.bbc.co.uk/>; 'Open-Source Research on Nuclear Doctrine and Strategy, Command and Control, and Delivery Systems in Israel and Iran,' Library of Congress, December 2005.

⁴² 'Profile: Iran's Nur Foundation Allegedly Bribes Reformers,' *OSC Feature*, October 24, 2006, OSC document FEA20061024029100.

⁴³ Karl Guenther Barth and Joerg Schmitt, 'Hot Goods for the Mullahs,' *Stern*, September 11, 1997, 182-184, OSC document FTS19970911000422.

⁴⁴ Ibid.

⁴⁵ 'German Report Notes Iran's Nuclear Arms Efforts,' *Frankfurter Rundschau*, OSC document EUP20000305000169; also noted in Andrew Higgins, 'Inside Iran's Holy Money Machine,' *Wall Street Journal*, June 2, 2007.

⁴⁶ 'Dubai is a Growing Diversion Risk, Germany Officials Say,' *The Risk Report* 2:4 (1996), www.wisconsinproject.org/countries/dubai/divrisk.html (accessed January

19, 2009). According to the *Wisconsin Project on Nuclear Arms Control*, MJF manages over 400 companies and factories. See Iran Watch, 'Iranian Entity: Bonyad e-Mostazafan Foundation,' <http://www.iranwatch.org/suspect/records/bonyad-e-mostazafan-foundation.html> (accessed January 19, 2009).

⁴⁷ Higgins, 'Inside Iran's Holy Money Machine.'

⁴⁸ Mehdi Khalaji, 'Iran's Revolutionary Guards Corp, Inc.,' The Washington Institute for Near East Policy, August 17, 2007, <http://www.washingtoninstitute.org/templateC05.php?CID=2649> (accessed January 19, 2009).

⁴⁹ Martin Bailey and Shyam Bhatia, 'Namibia uranium may fuel Iran's A-Bomb,' *The Observer*, May 17, 1987.

⁵⁰ Andrew Koch and Jeanette Wolf, *Appendix: Selected Iranian Nuclear Imports* (Monterrey, CA: Center for Non-Proliferation Studies, 1998), <http://cns.miis.edu/pubs/reports/pdfs/iranrpt.pdf> (accessed January 19, 2009)

⁵¹ Albright and Hinderstein, 'The Centrifuge Connection.'

⁵² Andrew Koch and Jeanette Wolf, *Iran's Nuclear Facilities: A Profile* (Monterrey, CA: Center for Non-Proliferation Studies, 1998), <http://cns.miis.edu/pubs/reports/pdfs/iranrpt.pdf> (accessed January 19, 2009).

⁵³ Koch and Wolf, *Iran's Nuclear Facilities: A Profile*, Appendix.

⁵⁴ Iran Watch, 'Supplier: GBC Scientific Equipment Pty Ltd,' <http://www.iranwatch.org/search/view—record.asp?sc=suppliers&id=124> (accessed January 19, 2009).

⁵⁵ Gordon Corera, *Shopping for Bombs: Nuclear Proliferation, Global Insecurity, and the Rise and Fall of the A.Q. Khan Network* (Oxford: Oxford University Press, 2006), 91, 92.

⁵⁶ Ibid, 93.

⁵⁷ 'Mitutoyo Tied to Iran, North Nuclear Quests,' *The Japan Times*, September 2, 2006.

⁵⁸ Ibid.

⁵⁹ Martin Fackler, 'Japanese Company Suspected of Selling Nuclear Equipment to Iran,' *The New York Times*, August 29, 2006. Note: This trading company may also go under the name 'Seishin Enterprise Co.' It was raided in 2003 for illicitly exporting a Jetmill industrial-grade grinder to Iran. Source: Keiichi Takagi and Hiroshi Kawase, 'Japan in Trouble! Part One: The Hidden Enemy,' *Sankei Shimbun*, July 21, 2007, OSC document JPP20070721023001.

⁶⁰ Katsuhisa Furukawa, 'Japanese Perspectives on Regional Proliferation' (presentation given at a conference on 'Over-the-Horizon Proliferation: Challenges for

Interdiction and Counter-Proliferation Policy,' Monterey, CA, June 18-20, 2007), <http://www.ccc.nps.navy.mil/si/2007/Aug/russellAug07.asp> (accessed January 19, 2009).

⁶¹ 'Japanese Police Find S&T Association Under Direct Control of North Korea's WPK,' *Tokyo Sankei Shimbun*, November 18, 2006, OSC document JPP20061120014001.

⁶² 'OSC Analysis: Association of Korean Scientists in Japan Reportedly Involved in Proliferation to DPRK,' OSC, OSC document FEA20060131018507; 'Photographic Record of Pro-Pyongyang Koreans in Japan Supporting DPRK, 2002,' OSC document, May 2006, OSC Doc Id. KPP20060518300003.

⁶³ Ibid.

⁶⁴ Katsuhisa Furukawa, 'Japanese Authorities Target Illicit North Korean Technology Procurement,' *WMD Insights* 20 (2007): 23-29.

⁶⁵ 'Weekly Details Investigation into Japanese Expert's Alleged Assistance to DPRK Nuclear Program,' *OSC Feature*, June 1, 2006, OSC document FEA20060601023696.

⁶⁶ 'Japan to Impose Stricter Sanctions Against North Korea,' *Mainichi Interactive*, September 14, 2006; Keiichi Takagi and Hiroshi Kawase, 'Japan in Trouble! Part One: The Hidden Enemy.'

⁶⁷ 'Illegal Pump Exports to DPRK Reflect Wider Problem,' *The Daily Yomiuri*, June 12, 2008, OSC document JPP2008612969142. This revelation came about after the IAEA visited the Yongbyon plant during verification activities earlier this year.

⁶⁸ Jeffrey Lewis, 'Japanese Pump at Yongbyon,' *Arms Control Wonk*, June 13, 2008.

⁶⁹ 'North Korea Acquiring Banned Japanese Products Through Taiwan as Procurement Base,' *Sankei Shimbun*, August 25, 2007, OSC document JPP20070828026004.

⁷⁰ 'ROK's Yonhap: US Imposes Missile Sanctions on DPRK Government,' *Yonhap*, September 2007, OSC document KPP2007092697.

⁷¹ 'Japan Raid Over "Nuclear Exports,"' *BBC News*, July 31, 2008, <http://news.bbc.co.uk/go/pr/fr/-/2/hi/asia-pacific/7534798.stm> (accessed January 18, 2009).

⁷² Mark Hibbs and Shahid-ur Rehman, 'U-235 Contamination Found on Russian Aluminum Imported by DPRK,' *Nuclear Fuel*, July 14, 2008, 12; 'North Korea Attempted to Procure German-Made Precision Equipment,' *Konfidensharu*, July 23, 2008, OSC document JPP20080723045001.

⁷³ Ibid.

⁷⁴ 'North Korea Attempted to Procure German-Made Precision Equipment,' *Konfidensharu*, July 23, 2008, OSC document JPP20080723045001.

⁷⁵ See David Albright and Paul Brannan, *The Al Kibar Reactor: Extraordinary Camouflage, Troubling Implications* (Washington, DC: Institute for Science and International Security, 2008), <http://www.isis-online.org/publications/syria/SyriaReactorReport—12May2008.pdf> (accessed January 19, 2009).

⁷⁶ Robin Wright and Joby Warrick, 'Purchases Linked N. Korean to Syria,' *Washington Post*, May 11, 2008, p. A18, <http://www.washingtonpost.com/wp-dyn/content/article/2008/05/10/AR2008051002810—pf.html> (accessed January 19, 2009).

⁷⁷ Statement made by David Albright at the 2007 Carnegie International Nonproliferation Conference, Washington, DC, June 26, 2007.

⁷⁸ Christopher Clary, 'A.Q. Khan, Proliferation Networks, and the Nuclear Slippery Slope,' in *Proliferation of Weapons of Mass Destruction in the Middle East*, ed. James A. Russell (New York: Palgrave, 2006), 93-114; Albright and Hinderstein, 'The A.Q. Khan Illicit Nuclear Trade Network,' 50-62.

⁷⁹ As argued by Russell, 'Peering into the Abyss.'

TOGZHAN KASSENOVA¹

Growing energy demand world-wide coupled with concerns about climate change are pushing many governments to consider either introducing nuclear energy to their countries' energy mix or increasing its existing share. A renewed interest in nuclear energy calls for a careful examination of the challenges and advantages of a 'nuclear renaissance.'² While there are some universal pros and cons of building nuclear power plants and producing nuclear energy, there are also country- and region-specific factors that have to be taken into consideration by each country deciding about a nuclear energy option.

Kazakhstan provides an interesting case study of the global 'nuclear renaissance' since it is about to participate in it both domestically (by introducing indigenous nuclear energy to meet the country's energy demand) and internationally (by striving to be one of the key players on the international uranium, nuclear fuel, and power reactors market).

This paper considers the pros and cons of Kazakhstan's nuclear energy push. It presents all major aspects of the country's nuclear plans for the future and makes an attempt to assess potential advantages and challenges associated with these plans. However, before considering Kazakhstan's nuclear future, a glimpse into its nuclear past is necessary. This helps to highlight an already existing nuclear infrastructure and to put current nuclear plans into the context of Kazakhstan's overall nuclear non-proliferation policy.

The Nuclear Past: The Soviet Nuclear Weapons Heritage

Kazakhstan could have become the fourth-largest nuclear power in the world if the country had decided to keep the nuclear weapons left on its territory when the Soviet Union crumbled. The nuclear inheritance was impressive: 1,410 strategic nuclear warheads, one of the world's largest nuclear testing sites at Semipalatinsk, nuclear weapons facilities, heavy bombers, and strategic anti-missile defence system components.

The decision to dispose of nuclear weapons was not an easy one to take or to implement. Complex political, economic, technical, and environmental factors had to be carefully considered before proceeding with denuclearization. There were several important questions that had to be

Togzhan Kassenova, 'Kazakhstan's "Nuclear Renaissance,"' *STAIR* 4:2 (2009): 51-74.

addressed by Kazakhstan's decision-makers. First of all, the young country had to ensure that its national security would not be undermined once it became nuclear-free. Even though it was clear that nuclear weapons could not have any tactical purpose in any potential conflicts in the post-Soviet space and beyond its immediate borders, they did provide some sort of security leverage for Kazakhstan. Second, for a new state which was coming out of the Soviet collapse and undergoing a severe economic crisis, the question of where to find resources for an expensive process of dismantlement was not a trivial one. Third, for a country that had already suffered severely as a result of nuclear testing conducted on its territory, it was extremely important to avoid any technological disasters connected with the denuclearization process. All the above being considered, Kazakhstan was treading carefully.

Complex negotiations about security assurances from nuclear weapon states (to be extended to Kazakhstan in case of its denuclearization) and on financial assistance with dismantlement (mostly coming from the United States) have resulted in Kazakhstan's decision to give up nuclear weapons and to join the Nuclear Non-Proliferation Treaty (NPT) as a non-nuclear state in 1993.

Kazakhstan's nuclear past is relevant to its nuclear future in several ways. First, being a part of the Soviet nuclear weapons programme meant that important components of a nuclear infrastructure have been put in place (nuclear facilities, a developed uranium mining industry, scientific and technological expertise). Second, the enormous environmental and human consequences of nuclear testing led to extremely strong public and civil society opposition to anything nuclear. Third, the way the leadership dealt with the nuclear weapons on its territory (dismantling and removing them) in the early 1990s earned Kazakhstan strong non-proliferation credibility in the eyes of the international community. It has provided some leverage and a foundation for its burgeoning role as a key player in the peaceful development of nuclear energy. Finally, two of the factors above – existing nuclear infrastructure and a strong non-proliferation record – make Kazakhstan a potential candidate as a site for an international 'fuel bank.'³

Having acted on its nuclear past, Kazakhstan has now to deal with its nuclear future. Once again, it is crucial for the country to consider all factors and decide whether participation in the 'nuclear renaissance' will present more benefits or disadvantages.

Kazakhstan's nuclear past has been crucial to how the country's population sees its nuclear future. The first attempt by the government and the nuclear industry to push for indigenous nuclear energy was not successful (a plan was drafted in 1998 and announced in 2002).⁴ Plans to build a new nuclear power plant at Lake Balkhash were met with vehement opposition from the public, environmental groups, and anti-nuclear groups. The major reasons for public distaste with anything nuclear were the environmental and health consequences of the Soviet nuclear testing programme at Semipalatinsk, where more than 450 nuclear tests were conducted, as well as memories of the disastrous Chernobyl tragedy (1986) and Three Mile Island accident (1972). In addition to all this, there was also strong lobbying from the coal industry. A decision was taken to build a coal-fueled power plant instead.

Despite abundant energy resources, Kazakhstan imports electricity in the southern part of the country, as the country's northern generating units are connected to a separate transmission grid (due to the unified Soviet grid). Initial proposals for developing nuclear energy suggested Lake Balkhash in the southern region as a site for a nuclear power plant partly due to these reasons.

However, there has recently not only been a comeback of nuclear energy plans but also a clear signal from the government that it is determined to proceed with building the first nuclear power plant in Kazakhstan since independence. It is planned that the construction of the nuclear power plant on the shore of the Caspian Sea in Aktau will begin in 2012-2013 and that the plant will become operational in 2015-2016.⁵ Existing infrastructure associated with the BN-350 reactor explains the choice of the site. The country's only reactor, BN-350 (a fast breeder reactor), was built during the Soviet time and operated in Aktau (on the eastern shore of the Caspian Sea) from 1972 to 1999.

The new plant will have a capacity to generate 600 megawatts. It will host two, first-of-their-kind VBER-300 reactor units.⁶ These medium-size reactors will be built by a joint Russian-Kazakh enterprise, Atomnye Stantsii (Nuclear Power Plants), using a design similar to Russian naval reactors. The feasibility study for the new plant is scheduled to be completed in 2009. After an initial announcement in February 2008 of the plans to build a nuclear power plant in Aktau, Kazakh president Nazarbayev once again confirmed the government's intentions in September 2008. He noted that it will not be possible 'to rely on gas

for long.⁷ Since no feasibility study has been completed, the only available cost estimates were made for the proposed, but unrealized, nuclear power plant at Lake Balkhash. The cost at the time was estimated by Kazakh experts to be around two billion dollars.

The Kazakh government reasons that introduction of nuclear energy is absolutely necessary to meet a projected growth in electricity demand. Currently, about seventy per cent of Kazakhstan's electricity is produced from coal, forty per cent from hydroelectric, ten per cent from gas, and fifty per cent from oil. Nuclear energy is expected to free up natural gas resources for export.⁸ Proponents of nuclear energy (e.g., the head of Kazatomprom Mukhtar Dzhakishev) point out that introducing nuclear energy to the energy mix will also help to reduce carbon emissions.⁹

It appears that the nuclear power plant in Aktau might be the first of many plants. The country's National Nuclear Centre, which conducts research on peaceful uses of nuclear energy, has proposed building twenty low-capacity nuclear plants (fifty to one-hundred megawatts each) to provide energy to small Kazakh towns. These are only tentative proposals with no firm plans.

Participating in the Global 'Nuclear Renaissance'

Kazakhstan's nuclear ambitions are not limited to building nuclear power plants at home. Even more ambitious plans are associated with Kazakhstan's growing role in the global nuclear market. The three major dimensions of its participation are: mining and export of natural uranium; export of nuclear fuel; and building and export of small- and medium-size nuclear reactors.

Kazakhstan's nuclear plans are to be carried out by the state-owned company Kazatomprom, which has a monopoly on all uranium mining and nuclear-fuel related activities. Kazatomprom was established in 1997 when Kazakhstan's uranium industry was in a state of disarray. A combination of factors, including the economic crisis in the aftermath of the Soviet collapse, disruption of all links between the former Soviet republics, Russia's decision not to buy any natural uranium from Kazakhstan in the early 1990s, as well as restrictions on uranium imports to the US from the USSR introduced during the Soviet era, all contributed to the bankruptcy of the uranium mining and production enterprise. The new management team that arrived with the establishment of Kazatomprom was led by an entrepreneurial manager, Mukhtar Dzhakishev. Within a rather short span of time the uranium industry started its climb back from crisis, and Kazatomprom is now the fourth-largest uranium pro-

Uranium Mining and Export

Currently Kazakhstan is the world's third-largest uranium producer after Canada and Australia. At 1.5 million tonnes, it holds roughly nineteen per cent of the world's uranium reserves.¹¹ More than fifty per cent of Kazakh reserves are suitable for extraction by in-situ leaching (a cheaper and environmentally friendlier method relative to extracting uranium from open pits or deep shaft mines).¹²

Kazatomprom is gradually expanding uranium production to new mines (e.g., the introduction of sixteen new mines in southern Kazakhstan).¹³ In 2007, the company produced 6,637 tonnes.¹⁴ In 2008, Kazatomprom plans to produce over nineteen tonnes of uranium, more than twelve-thousand tonnes in 2009, and then fifteen-thousand tonnes annually from 2010 onwards.¹⁵ If Kazatomprom's plans are realized and if the market conditions remain favourable, according to the company's own calculations, next year Kazakhstan will overtake its next strongest competitors – Canada and Australia – and become the world's largest uranium producer. External analysts are slightly more moderate in their estimations and predict that Kazakhstan will be the world's second-largest uranium producer by 2011.¹⁶ Kazatomprom already announced that the country is gearing up to produce 18,700 tonnes of uranium annually by 2015 and twenty-seven thousand tonnes by 2025.¹⁷

There has been a rapid expansion of foreign investment in the development of uranium mines. Kazatomprom reached cooperation agreements and set up a number of joint ventures with companies from Russia, Canada, France, China, and Japan. Cooperation with the international partners has especially intensified in the last couple of years. In most recent months, Kazatomprom reached a deal with the French multinational company Areva that will result in the companies' joint venture (JV) KATCO doubling uranium output to 4,000 tonnes per year until 2039, to be sold by Areva.¹⁸ Areva holds fifty-one per cent of KATCO's shares, while Kazatomprom owns forty-nine per cent. Its major uranium mine, Moinkum, is situated in southern Kazakhstan.¹⁹

The Kazakh-Canadian JV Inkai (sixty per cent of shares – Cameco; forty per cent – Kazatomprom) is developing a mine of the same name, also in southern Kazakhstan. Having begun in 2008, commercial production of uranium from the Inkai mine is expected to reach a capacity of two-thousand tonnes of uranium per year by 2010.²⁰ The trilateral JV

Zarechnoe was set up by Kazatomprom (49.33 per cent of shares), Russia's Tekhnabexport (49.33 per cent) Atomredmetzoloto (0.67 per cent), and Kyrgyzstan's Kara-Baltiiskii Mining Combine (0.67 per cent). The JV is developing an eponymous mine that has 30,700 tonnes of uranium reserves.²¹ It is projected that JV Zarechnoye will reach an annual production capacity of one-thousand tonnes of uranium by 2011. Another Kazakh-Russian JV, Akbastau, is expected to reach its capacity of three-thousand tonnes of uranium per year by 2018 (Akbastau will develop the Budyonnovskoe field, which has 280,000 tonnes of uranium).²²

Nuclear Fuel Cycle/Export

Moving from exporting natural uranium and producing fuel pellets only, Kazakhstan is making strides to produce and export a finished product – nuclear fuel. Exporting value-added nuclear fuel is considerably more economical and has an even more significant political and strategic value than export of raw materials. While a part of the Soviet Union, Kazakhstan had some components of the nuclear fuel cycle on its territory. Currently, mining and milling of uranium into yellowcake (partially refined uranium ore) are carried out in Kazakhstan; the yellowcake is then transported to Russia for conversion into uranium hexafluoride gas (UF₆) and uranium enrichment. The next stage of producing fuel pellets is also carried out in Kazakhstan while the final nuclear fuel product – fuel assemblies – is produced in Russia.

In what Kazatomprom's competitors refer to as 'neat moves',²³ the company has been gradually finding international partners to establish almost all stages of the nuclear fuel cycle within the country. In 2007, Kazatomprom reached an agreement with Canada's Cameco to establish the JV Ulba Conversion LLP (Kazatomprom holds fifty-one per cent shares; Cameco – forty-nine per cent). The new joint venture will build a conversion plant on the site of the Ulba Metallurgical plant²⁴ in eastern Kazakhstan that will produce up to twelve-thousand tonnes of uranium hexafluoride gas (UF₆) per year, which is about seventeen per cent of the world's conversion capacity.²⁵ The feasibility study for the facility is expected to be completed in 2009.²⁶ If this industrial project is set up, it could be a real breakthrough in the current commercial conversion capacity of the world: at this time, only Canada, China, France, Russia, the UK, and the US offer these services.

The only stage of the nuclear fuel cycle that will continue to be carried out abroad (in Russia) is uranium enrichment. Enrichment of uranium for nuclear fuel production is considered to be sensitive because

the same technology can be used to enrich uranium for use in nuclear weapons. Even though all countries party to the NPT have a legitimate right to the use of nuclear energy for peaceful purposes, various efforts are currently being undertaken to discourage states from pursuing indigenous enrichment facilities. As discussed below, several international initiatives are underway to offer countries with no enrichment technology access to enriched products and nuclear fuel in order to dissuade them from developing an enrichment capability.

To provide for its enrichment needs, Kazatomprom formed a joint venture with Russia's Tekhnabexport in 2006. The Kazakh-Russian joint venture established on a parity basis will build a new enrichment facility in Angarsk, Russia, the site of an existing enrichment facility. By 2013 the new plant will have a capacity of five million separative work units (SWU)²⁷ annually or about 757,863 kilograms of low-enriched uranium.²⁸ Sensitive uranium enrichment technology will not be available to Kazakhstan and will be a technological 'black box' for Kazatomprom, meaning it will not have access to technology *per se* but will, at the same time, benefit from enriching uranium at this facility, adding to the value of the country's exports. Kazakhstan will have priority in buying SWU from the Angarsk plant, while Russia will have priority access to six thousand tonnes of Kazakh natural uranium per year – enough to cover Russia's current nuclear power plants plus two new planned reactors.²⁹

Kazakhstan already has fuel pellet production capabilities at the Ulba plant in Ust-Kamenogorsk but currently only produces fuel pellets for Soviet-design reactors. Kazatomprom has begun the process of getting certification for producing fuel pellets for the other type of reactors.

The final stage of the nuclear fuel cycle – producing fuel assemblies out of fuel rods – will also be carried out in Kazakhstan in the near future. Based on recent Kazatomprom agreements with France's Areva, a fuel assembly plant will be built at the Ulba Metallurgical plant. The annual capacity of the new facility will be 1,200 tonnes. (The agreements were expected to be finalized in September 2008).³⁰

An extremely important development took place in October 2007 when Kazatomprom paid \$540 million to acquire ten per cent of Westinghouse Electric from Japan's Toshiba.³¹ Westinghouse is one of the world's largest suppliers of nuclear power reactors. By acquiring a share in this nuclear technology company Kazakhstan gained direct access to the world's nuclear energy market. In return, Toshiba received access to Kazakh natural uranium. Kazatomprom now is not limited to Soviet-type reactor technologies but also has access to Western reactor technologies. Additional international agreements on cooperation in the

nuclear field have been reached with Chinese, South Korean, and Japanese companies.

The last two years clearly demonstrate that Kazakhstan's Kazatomprom is seeking to diversify its pool of partners and move away from having Russia as the only choice for nuclear-related projects. Russia now has to compete with other countries for access to Kazakhstan's natural uranium and deals in the nuclear energy field. Nonetheless, Russia remains one of the key partners for Kazakhstan, critically important due to the enrichment facilities on which Kazakhstan relies.

Nuclear Reactor Exports

Closely connected both to the plans to develop nuclear energy domestically and with asserting a more important role in the global nuclear energy market are plans to build and export nuclear reactors. As mentioned above, together with Russia, Kazakhstan plans to build two reactor units for Kazakhstan's first nuclear power plant at Aktau. The plans do not end there.

After building a reactor for Kazakhstan's domestic use, the Kazakh-Russian enterprise is set to continue building this new type of medium-sized reactor for export to third-party countries. It is expected that it will be in high demand since the world's nuclear companies are currently offering reactors of high capacity (one-thousand megawatts and more), which are a good choice for countries with large energy demand and well-developed energy infrastructure. At the same time, there are numerous developing countries that are not densely populated and have less-developed electricity networks that would be better served by small-size reactors.³²

International Atomic Energy Agency (IAEA) Director General Mohamed El-Baradei has noted that most major vendors have failed to offer such reactors, which are believed to be more appropriate for countries new to nuclear energy. El-Baradei has mentioned that Jordan, Thailand, and Ghana are interested in reactors of one-hundred to four-hundred megawatt capacities.³³ Kazakhstan believes that other Central Asian countries will also be interested in buying such new reactor technologies.³⁴ These are proposed ideas with no firm plans made.

Apart from purely commercial projects, Kazakhstan is participating in international nuclear initiatives of political significance. As noted earlier, many in the international community are currently thinking of ways to discourage countries from developing indigenous uranium enrichment capabilities due to nuclear proliferation concerns. There are several major proposals that differ in specifics but that are similar in principle. Countries should be assured that even without having their own enrichment capacities they will have access to the enrichment process and to nuclear fuel.

In this respect, two initiatives deserve special attention as the most advanced in terms of being closer to implementation. The first is the establishment of the International Uranium Enrichment Center (IUEC) in Angarsk, Russia. The IUEC was founded by Russia (ninety per cent stake) and Kazakhstan (ten per cent stake). The initial share distribution has been changing, with Russia's stake being reduced, as new countries become partners. Armenia joined as a third partner in February 2008, taking ten per cent of Russia's share, and Ukraine is expected to join and take another ten per cent from Russia's current share.³⁵ The IUEC is planned as an international enrichment facility under the IAEA's scrutiny. Russian authorities recently announced their expectation to obtain all required licenses for the IUEC by the end of 2008.³⁶ It is expected that the IUEC will make use of Russia's existing enrichment facilities in Angarsk.³⁷ Kazatomprom's president Dzhakishev referred to his company's participation in the IUEC as 'more political' than commercial, based on Kazakhstan's determination to support Russia's initiative to internationalize sensitive parts of the fuel cycle.³⁸ In this context, Kazakhstan can be seen not only as a commercial player on the nuclear energy market but also as a political one.

The second initiative that recently received a boost and may be realized is the Nuclear Threat Initiative (NTI)/IAEA international 'fuel bank.' Similar to Russia's proposal for the IUEC in Angarsk, a 'fuel bank' will ensure fuel supplies to countries that meet basic non-proliferation requirements. A private non-governmental organization working to reduce nuclear threats world-wide, NTI pledged fifty-million dollars towards establishing a 'fuel bank' contingent on other contributors providing a total of one-hundred million dollars in cash or in kind within two years (by September 2008).³⁹

As of August 2008, Norway had pledged five million dollars, the United States fifty-million dollars, and the United Arab Emirates ten-million dollars.⁴⁰ NTI recently moved the original deadline of September 2008 for another year. There remains only fifteen million dollar in pledges to be made before NTI will act on its own commitment, which will mean that the international 'fuel bank' idea will move beyond the discussion stage.

Laura Holgate, NTI Vice-President for Russia/Newly Independent States programmes, has suggested that Kazakhstan could become a site for such a 'bank' because of its nuclear infrastructure, strong non-proliferation record, and large Muslim population, making Kazakhstan perhaps a more appealing host from the perspective of non-Western countries.⁴¹

In addition to the two more advanced initiatives, a separate US-led initiative with a similar aim is the Global Nuclear Energy Partnership (GNEP) proposed by President George W. Bush in 2006.⁴² Similar to the IUEC and the NTI/IAEA fuel bank ideas, GNEP is designed to find ways to prevent the spread of sensitive technologies. Countries with developed nuclear infrastructures will provide nuclear fuel cycle services (fresh fuel and spent fuel reprocessing) to nations who agree to use nuclear energy for power generation only.⁴³ Among the twenty-one states that signed the GNEP Statement of Principles accord are five nuclear powers (US, UK, China, France, Russia) and sixteen countries with developed nuclear fuel cycle infrastructure, among them Kazakhstan.

Kazakhstan's Nuclear Renaissance: Pros and Cons

What impact will Kazakhstan's plans in the nuclear energy sphere have on non-proliferation and export control? This is the question that has to be carefully considered by Kazakh decision-makers before the country takes a leap into a 'nuclear renaissance.' Careful consideration has to be given to all potential negative impacts of increasing uranium mining and export, developing nuclear energy at home, nuclear fuel production and export, and construction and export of nuclear reactors.

There are two levels of potential challenges associated with the above. At one level, we should consider the immediate and direct proliferation and export control risks and threats of each specific activity. At another level, the broader context of the regional security environment should be taken into account.

Uranium mining and associated waste entail only a limited proliferation risk. Natural uranium or waste accumulated as a result of uranium

mining cannot be used in a nuclear weapon. It is possible, though, to use both natural uranium and radioactive waste in an unsophisticated radiological dispersal device ('dirty bomb'). Since the material is only weakly radioactive, such a device would pose little or no harm to human health but there could be psychological reactions to its detonation. This leads to the conclusion that plans to increase uranium production in Kazakhstan do not significantly increase associated proliferation risks; however, a limited potential threat exists that would-be terrorists or entrepreneurial elements in search of financial gain might be interested in both natural uranium and radioactive waste.

Developing nuclear energy at home by building a nuclear power plant in Aktau, and plans to produce nuclear fuel for domestic consumption and export abroad should also be analyzed from the point of view of non-proliferation. Experts acknowledge that a proliferation risk comes from nuclear fuel cycle technologies and not from the reactors themselves.⁴⁴ The reactors and related sites, however, pose a nuclear terrorism risk: an attack or sabotage of such a facility by a terrorist or militant group. The sensitive part of nuclear fuel cycle technologies involves uranium enrichment during the process of fuel production and plutonium reprocessing from spent nuclear fuel (after the fuel was used in a nuclear reactor).

As noted, uranium enrichment technologies for peaceful nuclear energy are sensitive because they can also be used to produce highly enriched uranium (HEU) suitable for nuclear weapons. Spent fuel presents a proliferation risk because plutonium that might be recovered from it during reprocessing can be used in a nuclear weapon. US nuclear non-proliferation expert Charles Ferguson points out that as long as nuclear energy programmes 'remain peaceful, do not produce weapon-usable highly enriched uranium and do not separate or reprocess plutonium from spent fuel, there is little cause for concern that these programmes could provide nuclear-explosive material for terrorists.'⁴⁵

As of now, Kazakhstan has not announced any plans to introduce enrichment facilities within the country (with all the enrichment being carried out in Russia). At the same time, states do have a right to perform research and development and to use peaceful nuclear energy in accordance with Article IV of the NPT. Kazakhstan is mentioned among countries which noted that while enrichment technology is not something they need today, they will not give up on their rights to peaceful nuclear energy.⁴⁶ With respect to the issue of reprocessing spent fuel, at this point there are no reasons to assume that Kazakhstan would attempt to reprocess spent fuel with an aim of obtaining plutonium for a state-run weapons programme.

This should provide some assurance to the world community. A decision not to introduce enrichment technologies domestically indicates that the Kazakh government is not considering any nuclear weapons-related programme. It would be safe to assume that its nuclear energy and nuclear fuel production plans are clearly led by economic interests and energy supply calculations. This contrasts with, for example, Iran, a country whose peaceful nuclear energy plans are doubted by the international community due to the seemingly unpractical choice of pursuing enrichment at home when it is not economically viable. In this respect, particular risks associated with enrichment technology are minimized in Kazakhstan's case because it outsources its enrichment needs, currently to Russia, and possibly in the future, to other countries with well-developed nuclear infrastructures.

The spent fuel issue, however, is trickier. Even though there is reason to be confident that the Kazakh government would not attempt to use spent fuel for any weapons-related needs due to Kazakhstan's laudable non-proliferation record and voluntary denuclearization, there is a lack of clarity concerning what will happen with spent fuel in future. Currently there are no firm plans concerning spent fuel that will be generated by domestic nuclear power plants. Kazakhstan already has approximately 300 tonnes of spent fuel accumulated by the BN-350 fast breeder reactor at Aktau. After the reactor was decommissioned, its spent fuel was put in special casks and placed in temporary storage at the reactor site. It is planned that by 2009-2011 it will be moved to the Baikal-1 site, the former nuclear testing polygon of Semipalatinsk. There is already a storage facility for encapsulated radiation sources at the site, and plans call for the construction of a long-term spent fuel storage facility for the BN-350 fuel. Baikal-1 is under the auspices of the Nuclear Energy Institute of Kazakhstan's National Nuclear Centre (NNC). NNC officials indicate that by the time spent fuel from new nuclear reactors has accumulated, the problem of long-term storage of spent fuel and radioactive materials will be solved. Whether the spent fuel will remain in Kazakhstan or be sent back to Russia will depend on the type of nuclear reactors to be constructed (i.e. whether they are of Russian or foreign design).

Nuclear terrorism is a risk connected with any nuclear facility, and this risk applies to nuclear power plants and spent fuel pools or other sites of storage for radioactive waste. The safety of nuclear power plants is also a serious issue; there is a common concern that threat assessments about reactor safety might not always be adequately comprehensive. Another problem is that attempts to increase physical protection through redundancy (by introducing more guards, for example) can add to proliferation risks, as it means there are more 'insiders' at such a site. It is

harder to assess and monitor personnel reliability with more individuals involved.⁴⁷

It is notable that Kazakh authorities realize that it is necessary to ensure strict supervision of nuclear energy development. It was recently announced by the Kazakh Prime Minister Karim Massimov that a special state agency for nuclear energy supervision will be established. The Kazakh Energy and Mineral Resources Minister Sauat Mynbayev also noted that creating an independent nuclear commission is in line with the IAEA qualification requirements for nuclear energy development.⁴⁸

Kazakhstan's International Non-Proliferation Commitments and National Export Control Legislation

Kazakhstan joined the NPT as a non-nuclear state in 1993. The country has been a party to the Nuclear Suppliers Group (NSG) since 2002. The NSG is an ad hoc arrangement of forty-five nations aiming to ensure that the nuclear trade for peaceful purposes does not contribute to the proliferation of nuclear weapons or other nuclear explosive devices. All member states adhere to NSG guidelines covering transfers of nuclear items, such as 'nuclear material, nuclear reactors and equipment, non-nuclear material for reactors, plant and equipment for the reprocessing, enrichment and conversion of nuclear material and for fuel fabrication and heavy water production, and associated technologies,'⁴⁹ as well as transfers of nuclear-related dual-use equipment, materials, and technology.⁵⁰

The country signed a safeguards agreement with the IAEA in 1994, as well as the IAEA's Additional Protocol in 2004. Adherence to the Additional Protocol subjects all of Kazakhstan's nuclear facilities to stringent IAEA oversight, including comprehensive declarations, reporting, and site-access obligations. Kazakhstan is at the forefront of material protection, control and accounting (MPC&A) monitoring of the Central Asian states (with the most dramatic improvements being made at Kazatomprom's Ulba plant).

On a regional level, Kazakhstan is a signatory of a treaty establishing a nuclear-weapon-free zone in Central Asia (CANWFZ). The treaty was signed in 2006 by Kazakhstan and its four Central Asian neighbours (Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan). The treaty prohibits Kazakhstan from possessing or attempting to possess nuclear weapons and from assisting or encouraging other nations to acquire them. Together with the NPT, NSG, and IAEA obligations, the CANWFZ treaty adds an additional layer of responsibility on Kazakhstan to ensure

that it does not contribute to proliferation. The country's enthusiasm and support for the above agreements and for the Central Asian Nuclear-Weapon-Free Zone clearly indicate that it is extremely unlikely that Kazakhstan will use its know-how to pursue nuclear weapons or to help other countries to develop them.

It is quite safe to assume that Kazakhstan will not intentionally contribute to proliferation of nuclear technologies and materials. The country's record in adherence to non-proliferation standards and values is exemplary. However, a potential threat lies in unintentional proliferation risks associated with the country's activities in the nuclear field. In this respect, national export control, legislative regulations, and all of the 'on the ground' procedures related to the use of nuclear energy and nuclear exports become of paramount importance.

The major components of governmental control in the nuclear export area consist of three elements: accounting, export and import controls, and physical protection.⁵¹ The accounting system is implemented on two levels: at the regulatory level through the Kazakhstan Atomic Energy Committee (KAEC), the country's key regulating authority in the nuclear field; and at the operational level of facilities. KAEC collects reports from the facilities and prepares reports for the IAEA; keeps supporting documentation; maintains a database of related exports and imports; and maintains a database of nuclear material inventories. Individual facilities register and process information from key measurement points and maintain a database of nuclear material accounting.⁵² As mentioned previously, all of Kazakhstan's nuclear facilities are under IAEA safeguards and are subject to IAEA inspections.

Export controls are carried out in accordance with the Law on Export Control. The law was first adopted in 1996, but it was later amended and re-adopted in 2007. It lists nuclear and special non-nuclear materials, related equipment, technologies, dual-use technologies, and related services as items falling under export control regulations. All the above items require licenses for export and import. The law includes a so-called 'catch-all' provision which prohibits export-import operations involving any products or services that might contribute to WMD and WMD delivery systems production. The law obliges exporters to apply for a license for products or services (even if they are not listed among controlled items requiring a license) in those cases when they were informed by export control authorities that such products or services might be used for WMD or WMD delivery systems production or if the exporters themselves suspect this *might* be the case.⁵³ Since 2000, Kazakhstan has maintained export control lists based on the EU model lists.⁵⁴ The

licenses are issued by the Ministry of Industry and Trade. A special State Commission on Export Control was established in 2000.

Among important provisions of the Law on Use of Nuclear Energy (adopted in 1997, amended in 2004) are articles on accounting and control of nuclear material, and on export and import of nuclear energy related products and services in accordance with national legislation and international treaty obligations. The law also explicitly and categorically prohibits any activities on the territory of the country which involve using nuclear energy for purposes of developing, producing, testing, storing, or proliferation of weapons of mass destruction.⁵⁵

There are also additional governmental decrees on export control in general and on uranium exports in particular. The export control rules and regulations are enforced by the Criminal Code (2003). Article 243 of the Criminal Code provides that illegal export of technologies, information, or services that can contribute to WMD and WMD delivery systems production are to be punished with a fine or by a prison sentence of three to seven years.⁵⁶ The Customs Code regulates customs control with a special emphasis being placed on detection of unauthorized transfer of radioactive, nuclear and other sensitive materials.

It is clear that Kazakhstan's government aims to further improve export controls and invest in developing the export control system. However, even officials admit that there is a wide array of problems connected with insufficient funding of export control programmes including a lack of qualified specialists, a lack of specialized equipment for customs and border authorities, and a need to strengthen law enforcement mechanisms.⁵⁷

Political and Regional Factors

Corruption remains a serious problem for Kazakhstan as a factor that undermines the rule of law. Despite the fact that there is no evidence that the Kazakh nuclear industry is corrupt, the threat remains that corrupt officials could undermine the country's non-proliferation policies by making lucrative side deals with unreliable business entities. Kazatomprom's monopoly on uranium and nuclear fuel exports minimizes such threats since any wrongdoing could be traced through the country's export control system, through the requirements for obtaining licenses for export, and through the Nuclear Suppliers Group obligations. And, if corrupt officials or criminal groups wanted to smuggle nuclear material out of the country, they would need a whole chain of other corrupt individuals to ease the process.

The general political instability of the region – the ever-present risk of regime collapse both in Kazakhstan and in the neighbouring republics which could contribute to instability within Kazakhstan – also represents an inherent risk. The major threat is that nuclear safeguards and export control could be undermined during a socio-economic or political crisis.

If the issue of Kazakhstan's 'nuclear renaissance' is considered in the context of the regional security environment, the potential challenges become even more profound. Kazakhstan's geopolitical position is unfavourable. The country is situated in an unstable region, bordering the weak countries of Central Asia and a war-torn Afghanistan. The established drug-trafficking routes from Afghanistan via Central Asia and onwards to Europe and beyond could potentially be used for smuggling radioactive material. As highlighted before, natural uranium and associated radioactive waste pose a limited immediate proliferation risk. However, such material can be appealing to potential terrorists willing to construct a crude 'dirty bomb,' the use of which could cause significant public panic.

Environmental and Public Health Issues

Environmental and public health concerns were the main reason that initial plans for building a nuclear power plant in Kazakhstan were shelved. Due to the tragic legacy of nuclear testing at Semipalatinsk and the nuclear power plant accident in Chernobyl, Kazakhstan's population was extremely averse to the government's idea of developing nuclear energy. The anti-nuclear civil society movement and environmental groups got the upper hand in the initial debate on whether to build a nuclear plant at Lake Balkhash.

However, as several years have passed and memories of the Chernobyl and Soviet testing faded, the government renewed its push for domestic nuclear energy. This time around the opposition from civil society, although present, has not been sufficient to reverse nuclear plans. And it is clear that the government has made a firm decision to proceed.

There are three distinct environmental and public health issues that should be considered. First of all, the environmental impact of nuclear plant construction and operation: while it is correctly noted that nuclear energy is a significantly 'cleaner' source of energy compared to traditional energy sources, the environmental impact of the nuclear power plant construction should be integrated into calculations of the overall environmental impact. Greenhouse gas emissions can be reduced if less

fossil fuels are used in power generation. However, environmental groups argue that greater environmental benefit will result from investing in energy efficiency and renewable generation rather than the construction of nuclear reactors.⁵⁸

The second source of concern relates to radioactive waste and the management of spent fuel. Kazakhstan has already accumulated immense amounts of radioactive waste from Soviet-era uranium production (in 2001 Kazatomprom's Dzhakishev noted that 223 million tonnes of radioactive waste associated with Soviet-period uranium mining were already present on the territory of Kazakhstan).⁵⁹ The current increase in uranium mining will no doubt put additional pressure on the government and Kazatomprom to find an efficient method of dealing with uranium waste.⁶⁰ In 2001, Kazatomprom developed a scheme where revenue generated from importing foreign radioactive waste would be used to fund the disposal of Kazakh waste.⁶¹ The country's environmental groups and the public severely opposed the proposal, and it never went ahead. After joining the Central Asian nuclear-weapon-free zone, Kazakhstan committed itself to not importing foreign radioactive waste. This means that the country has to find independent ways of dealing with its own radioactive waste.

Spent nuclear fuel also represents an environmental and public health concern. Once the uranium pellets in nuclear fuel assemblies are no longer efficient for producing electricity, they are removed from the reactor and have to be stored or disposed of. Spent fuel contains highly radioactive elements with some elements remaining radioactive for years, and some for millions of years. Scientists agree that the best way to dispose of spent fuel is to bury it underground. There is not a single underground depository for spent fuel disposal in the world (the United States plans to build a repository at Yucca Mountain). The above ground spent fuel depositories are considered to be safe for temporary storage only but not suitable for the tens of thousands of years during which the waste is hazardous.⁶² Kazakhstan does not even have an above ground repository for permanent storage yet.

Kazakhstan is a state party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The Convention is aimed at achieving and maintaining a high level of safety in spent fuel and radioactive waste management.

Nuclear Energy in Kazakhstan's Economy and Energy Security

An entry into a global nuclear fuel market has obvious benefits for Kazakhstan's push into high technologies sectors. The uranium field is already one of the Kazakhstan's most competitive industries. Increased uranium exports can reduce Kazakhstan's dependence on oil as a major export commodity. Advancement in nuclear fuel production can have a positive spin-off effect on related industries and scientific and technological development. Moving away from exporting natural uranium to more advanced nuclear fuel exports will be of an even greater financial value.

Proponents of nuclear energy in Kazakhstan point out that the diversification of energy sources will ensure sustainable economic development and will strengthen the country's energy security. Abundant uranium resources are seen as one of the key reasons that Kazakhstan should proceed with introducing nuclear power to its energy mix. According to calculations cited in a Ministry of Energy and Mineral Resources report, uranium resources can make up for forty-six per cent of the energy mix (as fuel), with coal for thirty-four per cent, oil less than nine per cent, natural gas about six per cent, and bitumen about four per cent.⁶³

At the same time, it should be noted that Kazakhstan's electricity grid of over twenty-five thousand kilometres of power lines suffers significant losses during transmission and distribution (approximately twelve per cent of it is wasted) and losses in generated heat range between seventeen to thirty per cent due to inefficiency (e.g. due to insufficient insulation of heat pipelines).⁶⁴ Robust energy efficiency and energy-saving policies can make a significant difference to energy needs and reduce the justification for introducing nuclear power into the energy mix.

More importantly, nuclear energy, if considered, should be seen as a part of the solution, not the only one. There is significant potential in alternative energy sources. It is estimated that wind energy potential is approximately 1.8 trillion kWh per year and solar energy has a potential of 2.5 billion kWh per year. An additional thirty-five billion kWh of power and forty-four million Gcal of heat can be produced from biogas and biofuel (from biomass residues). Currently alternative energy sources account for only 0.02 per cent of the total consumption in Kazakhstan.⁶⁵ The country's hydroelectric potential is also currently underutilized: the estimated potential ranges from 27 to 170 billion kWh per year (currently hydropower provides ten to fourteen per cent of electricity consumed).⁶⁶

Kazakhstan's 'nuclear renaissance' seems to be a mixed blessing. On the one hand, there are benefits of the country's nuclear energy ambitions. On the other, there are a number of questions that raise concern and, at a minimum, require careful consideration on the part of Kazakh decision-makers and its nuclear industry prior to full-scale implementation of nuclear plans.

The positive impact of Kazakhstan's plans in the nuclear field can be summed up as the following. Extraordinary uranium resources can be put to good use for the nation's benefit. Uranium and nuclear fuel exports can be a strong economic force. By adopting, developing and employing the latest technologies, the nuclear industry will be driving scientific and industrial growth. Introduction of nuclear energy can provide a welcome additional component to the country's energy mix and help meet growing energy demands. More importantly, the strong position of Kazakhstan on the commercial nuclear fuel market and participation in multilateral nuclear fuel provision schemes ('fuel bank' ideas) will strengthen the country's political and strategic role in the region and the world at large.

At the same time, the following issues should be a matter of concern. First, there are certain proliferation risks connected with the nuclear fuel cycle. In Kazakhstan's case, one of the unanswered questions is the future of spent fuel. Second, environmental concerns are not unfounded and need to be integrated into overall nuclear policy-making. Third, the regional geopolitical situation in Central Asia creates a far from perfect environment for developing nuclear energy and dealing with proliferation-sensitive matters. Importantly, no feasibility has yet been completed on the nuclear power plant in Aktau. Until a comprehensive analysis is made, the economic feasibility of the Aktau nuclear energy plant will continue to be doubted. And finally, it appears that stronger policies at least be designed for energy efficiency and energy-saving before or coupled with plans to proceed with the development of nuclear power.

Kazakhstan's laudable non-proliferation standing and voluntary de-nuclearization give the country a lot of credibility, and the country's peaceful nuclear energy intentions are not doubted by the international community. However, Kazakhstan bears responsibility not only for its own policy choices but also for ensuring that in no indirect way does it contribute to proliferation of sensitive material or technologies. In this respect, a serious obligation is to make sure that ambitious plans in the uranium and nuclear fuel field will not undermine the non-proliferation

regime. Expansion of the nuclear sector will require additional resources to ensure this obligation is met. Domestically, both the government and the nuclear industry owe it to the population that the advertised benefits of nuclear energy, growing uranium exports, and expansion of nuclear fuel cycle services indeed outweigh potential environmental, public health, and proliferation risks. Before Kazakhstan makes a leap into the nuclear future, it should carefully consider whether it is ready for it. ■

Notes

¹ The author is grateful to Cristina Astrid Hansell and Emmanuel Pizzo for their comments on the earlier draft.

² Opinions on whether a ‘nuclear renaissance’ is already underway, imminent or not, vary. Without going into a debate on whether a global ‘nuclear renaissance’ is indeed imminent, the article considers Kazakhstan’s stance on domestic nuclear energy development and nuclear fuel production for export.

³ The ‘fuel bank’ idea is being promoted in the belief that if nuclear fuel is readily available to all countries on equal basis, the incentives for new countries to develop indigenous nuclear fuel cycles and associated sensitive technologies will be minimized (discussed in more detail later in the text).

⁴ ‘Kazakhstan Rejects Plan to Build Balkhash Nuclear Power Plant,’ Interfax-Kazakhstan, September 26, 2000; FBIS Document CEP20000926000321.

⁵ ‘Rosatom to Build Nuke Plant in Kazakhstan in 2012-2016,’ Prime-Tass English-Language Business Newswire, July 22, 2008.

⁶ World Nuclear News, ‘Nuclear Power Plans for Kazakhstan Firm Up,’ November 22, 2007, <http://www.world-nuclear-news.org/newNuclear/Nuclear—power—plans—for—Kazakhstan—firm—up—221107.shtml> (accessed August 26, 2008).

⁷ ‘Nazarbayev Confirmed Plans to Build Kazakhstan’s First Nuclear Power Plant,’ *Kazakhstan Mining Weekly*, September 29, 2008.

⁸ Dmitrii Verhoturov, ‘Novaya AES na meste staroi,’ *Expert-Kazakhstan*, July 9-15, 2007 (in Russian).

⁹ Clare Nuttal, ‘Analysis: Kazatomprom Aims for Top Nuclear Spot,’ Silk Road Intelligencer, August 22, 2008, <http://silkroadintelligencer.com/2008/08/22/kazatomprom-aims-for-top-nuclear-spot> (accessed October 27, 2008).

¹⁰ World Nuclear Association, 'World Uranium Mining,' <http://www.world-nuclear.org/info/inf23.html> (accessed August 24, 2008).

¹¹ Kazatomprom, 'Deposits of Kazakhstan,' <http://www.kazatomprom.kz/cgi-bin/index.cgi?p26&version=en> (accessed August 24, 2008).

¹² Kazatomprom, 'ISL Method,' <http://www.kazatomprom.kz/cgi-bin/index.cgi?p27&version=en> (accessed August 24, 2008).

¹³ Ann MacLachlan, 'Kazatomprom Sets Goals Higher for U Production, Pursues Nuclear Cycle,' *Nuclear Fuel*, September 10, 2007.

¹⁴ Kazatomprom, 'Uranium Production in Kazakhstan in 2007,' <http://www.kazatomprom.kz/15000/?nc7&version=en> (accessed August 24, 2008).

¹⁵ World Nuclear Association, 'World Uranium Mining.'

¹⁶ Goldman Sachs JBWere, 'Uranium Market Outlook,' <http://www.nupowerresources.com.au/Portals/0/Documents/GolldmanSachsJBWere-UraniumMar07.pdf> (accessed August 5, 2008).

¹⁷ Kazatomprom, 'Uranium Production in Kazakhstan in 2007.'

¹⁸ Kazatomprom, 'Areva and Kazatomprom Sign a Strategic Agreement in the Front End of the Nuclear Cycle,' <http://www.kazatomprom.kz/cgi-bin/index.cgi?nc225&version=en> (accessed August 17, 2008).

¹⁹ Kazatomprom, 'JV KATCO,' <http://www.kazatomprom.kz/cgi-bin/index.cgi?p44&version=en> (accessed August 15, 2008); 'Russian-Kazakh Uranium JV to Reach Projected Capacity in 2011,' Prime-Tass English-language Business Newswire, September 18, 2008.

²⁰ 'Cameco and Kazatomprom Progress Toward Conversion Plant,' *Market News Publishing*, June 3, 2008.

²¹ Kazatomprom, 'JV Zarechnoe,' <http://www.kazatomprom.kz/cgi-bin/index.cgi?p45&version=en> (accessed August 20, 2008).

²² 'Russian-Kazakh Uranium JV to Reach Projected Capacity in 2011,' Prime-Tass English-language Business Newswire, September 18, 2008.

²³ Elliot Blair Smith, 'Kazakh Salesman Aims to Be Rockefeller of Uranium,' April 22, 2008, *Bloomberg News*, <http://www.bloomberg.com/apps/news?pid=20601072&refer=energy&sid=a4CHUvmGEUI4> (accessed August 23, 2008).

²⁴ Established in 1949, the Ulba Metallurgical plant was known only by its code name Mailbox 10 until 1967. It was established in 1949. It produced low-enriched uranium fuel pellets used in half of the fuel fabricated for Soviet-designed reactors. At Ulba, Highly Enriched Uranium (HEU) fuel for the secret Soviet Alfa submarine

programmeme was produced and the plant participated in the development of fuel for nuclear-powered submarines. NTI, 'Nuclear Facilities: Ulba Metallurgical Plant,' <http://nti.org/e—research/profiles/Kazakhstan/Nuclear/facilities—ulba.html> (accessed August 27, 2008).

²⁵ Kazatomprom, press release, June 10, 2008, <http://www.kazatomprom.kz/cgi-bin/index.cgi?nc226&version=en> (accessed August 13, 2008).

²⁶ Kazatomprom, 'Areva and Kazatomprom Sign a Strategic Agreement in the Front End of the Nuclear Cycle.'

²⁷ SWU is a measure of the work expended during an enrichment process.

²⁸ Interview with Masha Katsva, Ux Consulting analyst, April 24, 2008.

²⁹ MacLachlan, 'Kazatomprom Sets Goals Higher for U Production.'

³⁰ 'Areva, Kazatomprom to Set Up Uranium, Fuel JVs,' *Reuters*, June 11, 2008.

³¹ Nariman Gizitdinov, 'Toshiba, Seeking Uranium, Sells 10 per cent of Westinghouse to Kazakhs,' *Bloomberg News*, August 13, 2007.

³² Dmitrii Verhoturov and Tulkin Tashimov, 'Vertikal Kazatomproma,' *Expert-Kazakhstan*, 32, September 3-9, 2007, 20 (in Russian).

³³ 'Kazatomprom Poised to Close Westinghouse Deal,' *Nucleonics Week*, September 11, 2007.

³⁴ Verhoturov, 'Novaya AES na meste staroi.'

³⁵ Anya Loukianova, 'The International Uranium Enrichment Center at Angarsk: A Step Towards Assured Fuel Supply?,' NTI Issue Brief, November 2008, <http://www.nti.org/e—research/e3—93.html> (accessed November 27, 2008).

³⁶ 'International Uranium Enrichment Center May Get Licenses by Year-End 2008,' *SKRIN Market & Corporate News*, October 1, 2008.

³⁷ Anton Khlopkov, 'Angarskii proekt: obogaschenie vs. rasprostranenie,' *Index Bezopasnosti* 2:14 (2008): 47 (in Russian).

³⁸ 'Kazatomprom Sets Goals Higher for U Production, Pursues Nuclear Cycle,' *Nuclear Fuel*, September 10, 2007, 5.

³⁹ 'NTI in Action: Creating an International Nuclear Fuel Bank,' NTI, <http://www.nti.org/b—aboutnti/b7—fuel—bank.html> (accessed August 17, 2008).

⁴⁰ NTI Global Security Newswire, <http://www.nti.org/d—newswire/issues/W—2008—8—8.html>, August 8, 2008 (accessed August 8, 2008).

⁴¹ David Horner, 'Fuel-Bank Moving in Congress as IAEA Board Meeting Nears,' *Nuclear Fuel*, May 21, 2007.

⁴² Opinions vary on GNEP's advantages and disadvantages and its future remains unclear.

⁴³ Global Nuclear Energy Partnership, <http://www.gnep.energy.gov/gnepProgram.html> (accessed August 13, 2008).

⁴⁴ Charles Ferguson, presentation at Carnegie International Nonproliferation conference, June 26, 2007, Washington DC.

⁴⁵ Ibid.

⁴⁶ Fred McGoldrick, Testimony Before the Senate Foreign Relations Committee, July 31, 2007, 8, <http://www.carnegieendowment.org/static/npp/reports/mcgoldrick-7-31-07.pdf> (accessed January 18, 2009).

⁴⁷ Scott Sagan, 'The Problem of Redundancy Problem: Why More Nuclear Security Forces May Produce Less Nuclear Security,' *Risk Analysis* 24:4 (2004): 935-946.

⁴⁸ 'Kazakhstan Plans to Tighten Nuclear Energy Supervision,' *Russia and CIS Investment Weekly*, September 19, 2008.

⁴⁹ 'Trigger' List, INFCIRC/254, <http://www.nuclearsuppliersgroup.org/testo—guide.htm> (accessed August 12, 2008).

⁵⁰ Nuclear Suppliers Group, <http://www.nuclearsuppliersgroup.org/testo—guide.htm> (accessed August 12, 2008).

⁵¹ As defined by Gulnara Yeligbayeva, 'Nuclear Material Protection, Control, and Accounting in Kazakhstan' (presentation at the Implementation of UNSCR 1540 in Central Asia and the Caucasus seminar, Almaty, October 9-10, 2006).

⁵² Yeligbayeva, 'The System of Nuclear Material Control of Kazakhstan.'

⁵³ Law on Export Control of the Republic of Kazakhstan, Article 8.

⁵⁴ Export control lists include commodities and technologies that require a license from a government before they can be exported. The EU control list represents a unified list of items appearing on the control lists of four multilateral regimes (the Missile Technology Control Regime, the Australia Group, the Wassenaar Arrangement, and the Nuclear Suppliers Group).

⁵⁵ Law on Nuclear Energy Use of the Republic of Kazakhstan, Article 3.

⁵⁶ Criminal Code of the Republic of Kazakhstan, Article 243.

⁵⁷ Murat Tashibayev, presentation at the Implementation of UNSCR 1540 in Central Asia and the Caucasus seminar, October 9-10, 2006, Almaty, Kazakhstan.

⁵⁸ Mary Beth Dunham Nikitin, Jill Marie Parillo, Sharon Squassoni, Anthony Andrews, and Mark Holt, 'Managing the Nuclear Fuel Cycle: Policy Implications of Expanding Global Access to Nuclear Power,' *CRS Report to Congress*, November 1, 2007, 6.

⁵⁹ Mukhtar Dzhakishev, 'Radiological Situation on the Territory of Kazakhstan,' Almaty, 2001, <http://www.nti.org/images/Dzhakishev%20report.pdf> (accessed October 22, 2008).

⁶⁰ Kazatomprom does indicate that in-situ leaching method of uranium mining results in a considerably lower level of radioactive waste (5 per cent instead of 100 per cent if a traditional method is used).

⁶¹ For details see Margarita Sevcik, 'Kazakhstan's Proposal to Initiate Commercial Imports of Radioactive Waste,' NTI Issue Brief, January 2003, <http://www.nti.org/e—research/e3—22a.html> (accessed August 19, 2008).

⁶² 'What Are Spent Nuclear Fuel and High-Level Radioactive Waste?,' Office of Civilian Radioactive Waste Management, US Department of Energy, <http://www.ocrwm.doe.gov/factsheets/doeymp0338.shtml> (accessed August 10, 2008).

⁶³ 'O vozmozhnostyah stroitel'stva AES v Respublike Kazakhstan,' Ministry of Energy and Mineral Resources, 2008 (in Russian).

⁶⁴ Developing Kazakhstan's Energy Strategy, Oppenheimer Technical Assistance Consultants (project funded by the UK FCO/Global Opportunities Fund), working paper, June 2005, Almaty, Kazakhstan.

⁶⁵ International Institute for Sustainable Development, *Clean Energy Investment in the Former Soviet Union (Ukraine and Kazakhstan): The Domestic Context*, August 2008, 33.

⁶⁶ *Ibid*, 39.

YUKI TATSUMI

In the last several years, there has been a renewed interest in how Japan is thinking about its nuclear option. In particular, the interest was fueled by the reported statements by senior Japanese politicians that seemed to suggest that Japan, in the face of North Korea becoming a de facto nuclear power, should revisit its postwar non-nuclear principle. Some observers outside Japan have even made comments that suggest Japan should reconsider its non-nuclear policy.¹

However, hastening to conclude that Japan is on the path to abandon its decades-long non-nuclear policy overlooks the political, emotional, and other complexities that remain in Japan before the government in Tokyo can seriously entertain the option of becoming a nuclear-armed state. It is important, therefore, that any discussion regarding Japan's nuclear option carefully examines the principles of its postwar security policy, the trend in public opinion; threat perception by the Japanese people; perception of the credibility of the US-Japan alliance; and Japan's national image held by the Japanese public. This article attempts to shed some light on the recent developments in Japan that surround the debate over Japan's nuclear option. The article first examines Japan's postwar security policy principles and the role that Japan's non-nuclear policy has played up to the present. Secondly, it focuses on the evolving debate over Japan's nuclear option since the 1990s. The article then discusses the key variables that could affect Japan's future decision toward its nuclear option.

The Role of a Non-Nuclear Policy in Japan's National Security Policy during the Cold War

Since its defeat in 1945, Japan's national strategy has been anchored in the 'Yoshida Doctrine.' This doctrine was significantly shaped by the postwar condition of Japan in 1945 which included an American occupation until 1951, economic destitution, and public distrust of Japan's military. Named after Prime Minister Shigeru Yoshida, who led Japan between May 1946 to May 1947, and again from October 1948 through December 1954, the doctrine emphasized non-military means of ensuring Japan's safety. While Japan rearmed after the United States strongly

Yuki Tatsumi, 'Japan's Nuclear Option: A Debate Revisted,' *STAIR* 4:2 (2009): 75-91

demanding it to do so in the wake of the Korean War, it chose to arm itself only with the capability that was minimally required to maintain public order and defend its borders from external aggression until US forces could come to its aid.²

Based on the Yoshida Doctrine, Japan's national security policy rested on three core principles: the minimal role of its military power, reliance on the bilateral alliance with the United States for its security, and efforts to achieve its security through other means of national power.

Having experienced a military defeat that was blamed on an abuse of power by a select number of military leaders, little (or no) use of military power in the conduct of national policy was considered desirable. This is most clearly seen in Article 9 of the Japanese constitution which prohibits Japan from possessing armed forces. Constitutionally speaking, the Japan Self-Defence Forces (JSDF), while treated as armed forces abroad, is not considered a military. Unlike a regular military, its personnel do not have the status of soldiers or military officers. Rather, they are considered to be civil servants, like diplomats, policemen, and other government employees and their role has been more akin to the National Guard in the United States.

Denying itself armed forces, Japan looked to the outside world for the source of its security. Initially, it expected the United Nations to provide the foundation for peace and security in the post-World War II world. When it became clear that this expectation would not be met because of the outbreak of the cold war, Japan turned to the United States to ensure its national security. It benefited the United States in two ways to enter into an arrangement under which it provided Japan security in exchange for allowing a large US force presence to be maintained on its soil: 1) it prevented Japan from reemerging as a military power; and 2) it allowed the United States to position its forces in proximity of the communist People's Republic of China and the Soviet Union.

The original Security Treaty between Japan and the United States of America, signed in 1951, makes clear Japan's expectations of the United States. The treaty stated that a disarmed Japan could request that the United States station some of its forces in Japan in order to protect it from external aggression. The original treaty also allowed the United States to use its military stationed in Japan to maintain peace and stability in the Far East, as well as to respond to attempts to disrupt Japan's domestic order.³ Even after Japan signed the Treaty of Mutual Cooperation and Security with the United States in 1960, Japan's military role in the alliance continued to be limited to the national defence.⁴

Where does Japan's nuclear policy fit in this picture? Japan's decision to adopt a non-nuclear policy is not only a reflection of its overall

approach to national security. It is also a part of Japan's postwar identity as a peace state (*heiwa kokka*).⁵ Japan's experiences of Hiroshima and Nagasaki in August 1945 provide an important emotional foundation for Japan's non-nuclear posture. When the Japanese fishing boat Daigo Fukuryu Maru was exposed to the hydrogen bomb test conducted by the United States in the Bikini Atoll in 1954, the national sentiment towards the non-nuclear option was strengthened.⁶

Through a series of policy and legislative decisions as well as a commitment to international treaty obligation made from the 1950s through the 1970s, the Japanese government created a framework in which its decision of not acquiring nuclear weapons was safeguarded. With the 1955 Nuclear Power Basic Law (*Genshi-ryoku Kihon-ho*), the Japanese government first declared its intention to use nuclear energy only for 'peaceful purposes.'⁷ In 1967, the Japanese Diet adopted the 'Three Non-Nuclear Principles,' which declared that Japan would not produce, possess, or allow the introduction of nuclear weapons onto Japanese soil. In 1968, Prime Minister Eisaku Sato declared the 'Four Nuclear Policies' in his address to the Diet, which included:

- (1) promotion of the peaceful use of nuclear energy;
- (2) efforts in global nuclear disarmament;
- (3) reliance on US extended deterrence; and
- (4) support for the Three Non-Nuclear Principles.⁸

Together, these laws, the Diet resolution and the declaratory policy formed the paradigm in which Japan can only use nuclear power for peaceful purposes.

Furthermore, Japan's commitment to a non-nuclear policy was also demonstrated by its signing of a series of international treaties and agreements that support nuclear non-proliferation. Japan was one of the first states to become a member of the International Atomic Energy Agency (IAEA), which was established in 1957; this resulted in regular IAEA inspections of its nuclear power plants and reprocessing facilities. Its commitment to the peaceful use of nuclear power was also reaffirmed when Japan signed the Agreement between Japan and the United States regarding the Non-Military Use of Nuclear Power in February 1968.⁹ Finally, its ratification of the Nuclear Non-Proliferation Treaty (NPT) in 1976 (Japan signed the treaty in 1970) solidified Japan's non-nuclear posture. Since then, nuclear disarmament has been one of the key elements of Japanese foreign policy.¹⁰

While upholding its commitment to non-nuclear posture, however, the Japanese government did not completely rule out the development

and possession of nuclear weapons as an option, either. For instance, the Japanese government argued in 1978 that the Japanese constitution did not prohibit the possession of nuclear weapons so long as it is considered what is 'minimally necessary' to defend Japan. The Japanese government reiterated this argument again in 1982.¹¹ Furthermore, during the 1960s and 1970s, Japanese leaders have made this quite clear to their American counterparts on various occasions. Shortly after China conducted its first nuclear test in 1964, Prime Minister Eisaku Sato told US President Lyndon Johnson that if China becomes a nuclear power, Japan should also consider acquiring nuclear weapons.¹²

It should be noted that Sato was one of few political leaders in Japan who seriously explored Japan's nuclear option. While he advocated the Four Nuclear Policies while serving as the prime minister, he also assigned the Study Group of Democracy—a non-profit organization that was closely connected with the Cabinet Intelligence and Research Office (CIRO)—to conduct the research entitled 'Basic Study on Japan's Nuclear Policy' (*Nihon no Kaku Seisaku ni kansuru Kiso-teki Kenkyu*). Conducted between 1968-1970, the study produced two reports—one on Japan's technological and financial capacity to produce nuclear weapons (completed in September 1968) and the other on the policy implications should the Japanese government decide to acquire nuclear capability (completed in January 1970).¹³

After carefully assessing Japan's technological capacity to produce nuclear weapons (including Japan's capability in developing launch vehicles at that time), the September 1968 Study Group report concluded that:

- (1) it is feasible for Japan to acquire a capacity to produce a very limited number of nuclear weapons from a purely technological standpoint;
- (2) however, given anticipated strong opposition from the public, the restriction in reprocessing the plutonium based on IAEA regulations that Japan was already subject to, the restrictions in financial and other resources, and the challenges for Japan to develop other technologies required to develop nuclear forces (i.e. precision guidance system), it will be extremely difficult for Japan to develop the capability to acquire nuclear force.¹⁴

The January 1970 Study Group Report examined the challenges Japan was expected to face if it should choose to acquire an independent nuclear capability. Analyzing several external factors including the trajectory of Chinese nuclear forces, the choice made by France to maintain a

limited nuclear capability, and the vulnerability of Japan to devastating nuclear weapon attacks (i.e. concentration of its population and critical industries in a limited number of urban areas), the report concluded that:

- (1) Japan has to be mindful that, with only a limited nuclear weapon capability, it may face retaliatory nuclear attacks, to which it remains highly vulnerable.
- (2) Japan's decision to become a nuclear weapon state can provoke serious suspicion not only in China but also in the United States and its West European allies of Japan's intentions, which can lead to Japan's international isolation.
- (3) Therefore, becoming a nuclear weapon state will not improve Japan's national security. Although acquiring nuclear forces can heighten the national sense of pride in a short-term, it will harm Japan's place in the international community in the end.¹⁵

During the cold war period, therefore, the Japanese government institutionalized a non-nuclear policy that was supported by a legal framework consisting of declaratory domestic policy statements, and participation in the international nuclear non-proliferation regime. While national consensus against nuclear weapons might have helped Japanese leaders to explain why Japan would not go nuclear, their decision was neither a mere reflection of the public's emotional reaction to Hiroshima and Nagasaki nor a naïve hope for peace in a nuclear-free world. Rather, their decision was based on the careful cost-benefit calculation of what would help Japan maintain its security, as seen in the Basic Study of Nuclear Policy that was undertaken during the Sato cabinet.¹⁶

To be sure, there was a lingering question of whether the third principle of the Three Non-Nuclear Principles—not allowing the introduction of nuclear arsenal to its sovereign space (*mochikomasezu*)—was compromised when US naval vessels considered to be armed with nuclear arsenals visited Japan. The Japanese government continued to claim that the Three Non-Nuclear Principles were not compromised. It argued that the visit of US naval vessels, if they were nuclear-armed, would be the subject of 'pre-consultation' under the Article X of the Mutual Security Treaty: in the absence of US request for such a pre-consultation, the government in Tokyo would assume that they were not armed with nuclear arsenals. While it is improbable in reality that nuclear-armed US vessels would unload its nuclear arsenals prior to its visit to Japan, the Japanese government nonetheless publicly claimed that it upheld the non-nuclear policy.

Regardless of how the policy debate unfolded within the Japanese government and the intellectuals that the Japanese government consulted, emotional reaction against nuclear weapons obscured the debate elsewhere in Japan. Substantive debate on Japan's security policy option became a social taboo because the notion of rearmament was negatively associated with pre-World War II militarism. Similarly, there was no serious public discussion on Japan's nuclear options during much of the cold war.¹⁷

A Nuclear Debate in Japan: Its Post-Cold War Evolution

As discussed in the previous section, there was very little public discourse on Japan's nuclear option. Classification of ideological currents in Japan on its security policy provided by Rust Deming and Richard J. Samuels are useful in examining the landscape of nuclear debate in Japan. Their analyses indicate that Japan's security policy debate, including its nuclear option, can be divided into the following four groups:

- (1) Alliance Nationalist: seeks Japan's national prestige through the build-up of its military power; advocates that Japan's future security policy should remain centered on the US-Japan Security Treaty; they emphasize that the boundaries of US-Japan defense cooperation should be steadily expanded, both in areas around Japan and globally; believes that Japan can best maximize its interests through close association with the United States.
- (2) Middle-Power Internationalist: advocates that Japan seek its prestige primarily through its non-military means; wants to see defence policy increasingly oriented toward cooperation under a UN or other multinational or regional framework; advocates reassuring the international community that Japan is not becoming an independent military power.
- (3) Neo-autonomist nationalist: argues that Japan needs more independent security policy; implicitly argues that Japan must keep an open mind toward acquiring nuclear weapons.
- (4) Pacifist: believes that Japan should secure its place in the international community by pursuing unarmed neutrality by the virtue of its economic prosperity; differs from nationalists in their fundamental distrust of military power as a means of protecting national interest.¹⁸

If there was any debate on Japan's nuclear option, it was between the neo-autonomist nationalists and the pacifists. The former included the conservative members in the ruling Liberal Democratic Party (LDP) as well as the journalists and other intellectuals who hold revisionist view of Japan's pre-World War II history. They advocated that Japan, when necessary, should consider acquiring nuclear weapon capability because it would never achieve true independence while depending on a US nuclear umbrella. Pacifists (including those in the Japan Communist Party and Social Democratic Party of Japan) argued that Japan would be able to maintain its security ultimately by abandoning its bilateral alliance with the United States and seeking unarmed neutrality. The alliance nationalists and the middle-power internationalists did not show as sharp of a difference as they would after 2001; appropriately called 'moderates' during the cold war, they advocated that Japan limit its role in security affairs and rely more heavily on the alliance with the US. Although they were the greatest in numbers and were generally opposed to Japan becoming a nuclear weapon state, they were not active participants in the debate during the cold war.

After the cold war, the debate over Japan's nuclear option began to change. Developments in Asia in the 1990s sparked discussion on Japan's nuclear option among Japanese political and intellectual leaders. For instance, the 1995 underground nuclear test by China and the 1998 nuclear tests by India and Pakistan were interpreted as a sign of the failure of Japan's postwar nuclear non-proliferation diplomacy. The absence of any considerable negative impact on these countries after their nuclear tests greatly shook Japan's faith in its non-nuclear posture.¹⁹ Further, the crisis over the North Korean withdrawal from the NPT, which brought the Korean Peninsula dangerously close to a second Korean War, alarmed Japan; the two countries with which it had the poorest relations—China and North Korea—now possessed nuclear weapons. Finally, the 1998 Taepodong missile launch by North Korea reaffirmed that the nuclear and missile threat posed to Japan by North Korea is a clear and present danger. It prompted many Japanese political leaders to advocate Japan investing in measures to defend the country from such threats. Japan materialized its sense of urgency in defending itself from missile and nuclear threats by acquiring a reconnaissance satellite and introducing a ballistic missile defense system jointly developed with the United States.

Despite these regional and international developments, Japanese public discourse continued to caution against Japan going nuclear. Prominent scholars and journalists in Japan across the ideological spectrum, while acknowledging the increased security threat emanating from East Asia, did not propose that Japan reconsider its non-nuclear posture. For

instance, the well-known conservative political scientist Terumasa Nakanishi argued that, while recognizing that Japan would likely find itself surrounded by nuclear states (China, Russia, and North Korea), Japan becoming a nonaligned independent nuclear power was improbable, as Tokyo would not be able to ensure sufficient deterrent capability on its own. He argued that the Japanese government could only overcome very strong public sentiment against such a policy decision in the wake of a cataclysmic event.²⁰ On the other end of the spectrum, Kumao Kaneko, a former diplomat, argued in 1996 that Japan should intensify its effort in nuclear disarmament diplomacy, pushing for a 'nuclear weapon free zone.'²¹ Yoichi Funabashi, a journalist known for his internationalist perspectives, also proposed that Japan embark on a 'rejuvenated' nuclear policy, pursuing more actively nuclear disarmament.²²

Further, the social 'taboo' against openly discussing Japan's nuclear option remained strong in Japan. Politicians who hinted that Japan might consider developing a nuclear capability faced intense criticism—even dismissal from their senior governmental positions. In 1999, for instance, the parliamentary vice minister of defence, Shingo Nishimura, expressed his view in an interview that in light of the developments in East Asia, Japan might have to study the option of possessing nuclear weapons. When the interview was published on October 19 and prime minister Obuchi fired Nishimura the next day.²³

The debate over Japan's nuclear option resurfaced in 2002. What first appeared as sporadic statements by political leaders—including the comments by Ichiro Ozawa—became a series of statements by Japan's political leaders on the possibility of Japan acquiring nuclear weapons. After North Korea's admittance to its violation of the terms of the 1994 Agreed Framework and development of its nuclear capability, the political and social 'taboo' in Japan against public discourse over its nuclear option softened. As the Six-Party Talks with North Korea continued to make little progress in convincing Pyongyang to dismantle its nuclear program, more people began to publicly discuss what Japan should do if North Korea became a full-fledged nuclear-armed state. Pyongyang's missile test in July 2006 and nuclear tests in October 2006 sparked the debate on Japan's nuclear option in political, journalistic, and in academic circles in a way that was unfathomable a decade before.

There are three major differences between the current debates in Japan and the debates that took place during the cold war. The first difference is the much higher degree of tolerance afforded to those who entertain the idea of Japan going nuclear. For instance, in 2002, when then Chief Cabinet Secretary Yasuo Fukuda commented that 'if international tension is intensified, some citizens might even argue that Japan

should possess nuclear weapons,' he was not removed from his post.²⁴ Further, in the immediate aftermath of North Korea's nuclear tests in October 2006, Shoichi Nakagawa, while serving as the Chairman of Policy Affairs Research Council of the ruling Liberal Democratic Party of Japan (LDP), openly suggested that Japan should seriously consider whether the nuclear option would be in Japan's interest. Despite a great deal of media criticism, he was not forced to resign his position.²⁵ Following Nakagawa's statement, then foreign minister Taro Aso argued that it would be important for Japan to discuss all options, including the possession of nuclear weapons. He further rejected the notion that a nuclear debate is somehow taboo, arguing that 'Japan is a free country that does not control people's opinions. ... I do not align myself with the thought that you somehow have to control what people think and say.' Again, despite severe criticism by mass media as 'inappropriate,' Aso was neither fired nor forced to resign.²⁶

The second difference is that the debate has grown more reasoned. Although the most recent debate over Japan's nuclear option is certainly spearheaded primarily by those who can be categorized as 'neo-autonomists,' their arguments have grown more pragmatic. For instance, many of them, unlike during the cold war, do not support the notion that Japan abandons its alliance with the United States and remilitarize to become a non-aligned country equipped with a full range of offensive capabilities including nuclear weapons. Rather, they propose a distinct set of options for Japan. For instance, Masato Ushio, a conservative journalist who specializes in military affairs, suggests that Japan, while maintaining a strong alliance with the United States, gradually abandon the Three Non-Nuclear Principles. He proposes that Japan do so by first revising the principle of not allowing the introduction of nuclear weapons and thereby permitting the United States to deploy its nuclear weapons in Japan.²⁷ Kan Ito, a Washington-based political analyst, advocates Japan acquire a nuclear deterrence capability that is minimally required for Japan to defend itself, but he concurrently rejects the idea of Japan becoming a major military power.²⁸ Even Shoichi Nakagawa, who has often been criticized for his extremely conservative views of security issues and his revisionist views of history, proposes that Japan debate its nuclear option with a premise that it never engages itself in a war of aggression; that is, Japan's acquisition of nuclear weapons must be examined from the perspective of whether pursuing such a capability as a means of self-defence is reasonable.²⁹

Thirdly, the moderates now participate in the debate—'normal nationalists (alliance nationalists)' and 'middle-power internationalists.' For instance, Toshiyuki Shikata, a retired Japan Ground Self-Force Of-

ficie officer who is known for his strong support of the US-Japan alliance and a greater security role for Japan in that alliance, supports a robust discussion of nuclear weapons. While opposing the idea that it acquire an independent nuclear capability, Shikata advocates that Japan engage more actively in its alliance relationship with the United States to ensure its credibility under the US nuclear umbrella.³⁰ Satoshi Morimoto, a leading pro-alliance security policy expert in Japan, also argues that the acquisition of nuclear capability does not serve Japan's interests, based on the negative impact it would have on relations with the United States, the damage it will have on Japan's international reputation, and strong anti-military sentiment held among Japanese nuclear power engineers. Nevertheless, he argues, Japan needs to have a more thorough debate over its nuclear option, both inside and outside of the government.³¹

For its part, the United States, historically wary of any pro-nuclear tendencies in Japan, seems to be expressing less discomfort when witnessing this debate. American observers used to describe the prospect of Japan going nuclear as something that would be 'most worrisome' for US interest in East Asia.³² However, as the nuclear threat from North Korea grows, there is a growing acknowledgement among US policymakers of Japan's sense of insecurity. Some American observers have now begun to call for a US-Japan dialogue on nuclear issues as a means for the United States to reassure Japan of the efficacy of Washington's nuclear umbrella, and also to help the Japanese carry out a rational assessment of whether acquiring nuclear weapons will be in its interest.³³

Despite all of these changes, it is unlikely that Japan will decide to abandon its non-nuclear posture in the short to medium term. Observers in Japan agree that North Korea's nuclear problem and its growing missile capability helped break the nuclear taboo. However, they also agree that Japan, especially policy-makers in the government, has no serious intention of pursuing a nuclear option.³⁴ Pointing to factors such as a resilient anti-nuclear public sentiment, the costs of going nuclear, and the lack of the needed materials and technology to build a nuclear weapon, they determine that Japan 'is not willing, interested, or able to become a nuclear power.'³⁵ Some also point to the lack of will in Japan to increase the defense budget in the aftermath of North Korean nuclear tests as a clear demonstration of Japan's disinterest in responding militarily to the North Korean threat.³⁶

Now that the taboo against discussing the nuclear option has been broken, the world can expect to witness Japan continue its nuclear debate. Of course, how the North Korean nuclear issue is settled will have a considerable impact on Japan's sense of security (or insecurity) because Japan is the country against which North Korea will most likely use its nuclear weapons against. In observing these nuclear debates, there are three key factors that make it unlikely that Japan will decide to become a nuclear weapon state.

First, public opinion continues to act as a considerable restraint on government policy. Despite the heightened sense of security in the face of nuclear and missile threats from North Korea, the Japanese public remains strongly opposed to Japan pursuing its own nuclear weapon capability. From the 1960s on, various poll results have consistently demonstrated the Japanese public's unwillingness to see Japan acquire nuclear weapons. The polls taken by Yomiuri Shimbun in 1969, 1978, and 1981, for instance, have shown that an overwhelming majority of the poll participants has answered 'no' when asked whether Japan should possess nuclear weapons.³⁷ More recently, the opinion poll on disarmament and nonproliferation diplomacy conducted by the Ministry of Foreign Affairs in early 2008 indicates that the vast majority of the survey respondents (73.5 per cent) think that Japan should exercise leadership in the area of disarmament and nonproliferation.³⁸ Such a consistency in public opinion suggests that it will be politically difficult for Japanese leaders to convince its people that acquisition of nuclear weapons is in the nation's best interest.

Secondly, there is insufficient strategic rationale for Japan to go nuclear. Almost three decades after the Basic Study of Nuclear Policy commissioned by then Prime Minister Eisaku Sato, the Japan Defence Agency quietly undertook another study for Japan's nuclearization between 1994-1995. The study yielded conclusions is similar to the 1968-70 private study commissioned by Sato. That is, the 1994-95 study concluded that Japan would not benefit by seeking to become a nuclear weapon state for the following reasons:

- (1) If Japan chooses to become a nuclear weapon state, it is likely to cause considerable damage to the US-Japan alliance because it will undermine the US security guarantee as stipulated by the provision-
ing of a nuclear umbrella.

- (2) A nuclear Japan will accelerate the discrediting (and even the disintegration) of the global nonproliferation regime that is centered on the NPT.
- (3) Japan, if it chooses to become a nuclear weapon state, must withdraw from the NPT. Such an action is likely to cause a vastly negative impact on Japan's international reputation.
- (4) Strong public resistance in Japan is anticipated.
- (5) Financial costs of building and sustaining the infrastructure for Japan's independent nuclear capability is far greater than what the Japanese government can afford to accept.³⁹

In other words, the cost-benefit calculation that decoded against Japan seeking its own nuclear capability in the 1960s still remains valid today.

However, while the probability of Japan changing its nuclear policy is low, potential changes in the US-Japan relations should caution us before we entirely discount the possibility of a nuclear Japan in the future. Despite the changes in its security environment, Japan's confidence in the US commitment to defend Japan remains meaningful. The two countries have been making efforts to maintain the credibility of deterrence against the missile threats against Japan by strengthening the bilateral cooperation in ballistic missile defence (BMD).

US observers, however, are concerned that Japan's confidence in the US is slowly eroding. They acknowledge that the recent changes in the US approach toward North Korea in the Six-Party Talks have frustrated Japan. Some in Japan have expressed feelings of betrayal by the US, particularly in light of its perceived failure to push to resolve the abduction issue with North Korea.⁴⁰ US observers have taken notice that even those who argue that Japan should center its security policy on maintaining a strong alliance with the United States refer to the nuclear policy option as a way to deal with a breakdown in US-Japanese relations. Moreover, the civilian nuclear agreement between the United States and India resulted in a further loss of confidence because it signals that the United States is not interested in upholding the global nonproliferation regime in which Japan has invested a great deal of energy and resources. Alarmed by these recent developments, some US observers have been strongly advocating a serious bilateral dialogue on Japan's security concerns, including nuclear questions, in order to alleviate Tokyo's sense of insecurity.⁴¹ Whether US efforts are enough to alleviate Tokyo's concerns remains to be seen.

This article examines Japan's non-nuclear policy during the cold war, the evolution of its debate in the post-cold war era, and the key factors to be considered when observing Japan's nuclear debate in the future. Those who are concerned about the recent developments of the nuclear debate within Japan suggest that breaking the nuclear taboo could bring 'a nuclear-armed Japan' within the range of realistic security policy options for future Japan.⁴²

Should such concerns be realized and Japan become a nuclear state, it will have a grave impact on the regional and global security environment. Within East Asia alone, it will heighten already high tensions between Japan, China, and South Korea. China, already in the process of developing a credible nuclear force, will be sure to continue its military build-up. South Korea, which declined the option to develop nuclear weapon at the face of strong US pressure against such a program, may also be enticed to reconsider its decision. In short, East Asia may become the only region in the world in which all major regional powers are nuclear states.

Further, the international nuclear non-proliferation regime will also be deeply affected by Japan's decision to become a nuclear armed state. Throughout the post-World War II period, Japan served as an example of a country that relinquished the option of becoming a nuclear state while technologically capable to do so, and still evolved into one of the world's major powers. Should Japan decide to become a nuclear state, it must first withdraw from the NPT. Japan's withdrawal from NPT alone will gravely impact the global nonproliferation regime. Further, it may prompt other countries that have followed Japan in their relinquishment of nuclear capability to reconsider their decision as well. Consequently, the world may witness a rapid proliferation of nuclear states.

The observations made in this article do not suggest such an outcome. Although Japan is most likely to debate its nuclear option more openly compared to the cold war era, the evidence thus far suggests that the overwhelming majority in Japan remains opposed to pursuing an independent nuclear arms capability.

One unknown factor, however, is the level of Tokyo's confidence in the US-Japan alliance as a lynchpin of its own security. As reviewed in the article, the only factor that will drive Japan to seriously consider the acquisition of nuclear weapons is Tokyo's loss of confidence in US commitment to the defence of Japan. In light of recent developments in the Six-Party Talks—Japan continues to be marginalized in the talks and

its people feel that the United States sacrificed the meaningful progress on abduction issues for its eagerness to reach an agreement with Pyongyang—there has been a growing suspicion on whether Washington takes Japan's security concerns seriously. Although the net effect of US-Japan policy divergence over North Korea on Japanese confidence in the United States remains an open question, it merits close attention by those who assess the probability of Japan shedding its postwar non-nuclear policy. The evolution of the policy dialogue between the two allies on nuclear issues deserves close attention, as it could have a direct impact on Tokyo's confidence in Washington's commitment to defend Japan from external threats.

As the only country that has been the victim of an atomic bomb, to go, or not to go nuclear is a serious question for Japan — one that can fundamentally impact its postwar national identity. However, the recent developments in its security environment have urged Japan to discuss nuclear question in a new manner. With Japan's confidence in the US-Japan alliance remaining unclear, observers of Japan are advised to pay close attention to this facet of the debate. ■

Notes

¹ Charles Krauthammer, 'World War II Is Over,' *The Washington Post*, October 20, 2006; David Frum, 'Mutually Assured Disruption,' *New York Times*, October 10, 2006.

² Christopher W. Hughes, *Japan's Security Agenda: Military, Economic & Environmental Dimensions* (Boulder and London: Lynne Rienner Publishers, 2004), 122-123.

³ *Nihon-koku to America Gasshu-koku no Aida no Anzen Hosho Jouyaku* (The Security Treaty Between Japan and the United States of America), signed September 8, 1951, <http://www.ioc.u-tokyo.ac.jp/fllworldjpn/documents/texts/docs/19510908.T2J.html> (accessed August 5, 2008).

⁴ While Article Five of the treaty obligates the US military to respond when an armed attack against Japanese territory takes place, the JSDF does not have a treaty obligation to reciprocate when an armed attack against the US occurs. See *Nihon-koku to America Gasshu-koku tono aida no Sougo Kyoryoku oyobi Anzen Hosho ni kansuru Jouyaku* (The Treaty of Mutual Cooperation and Security Between Japan and the United States of America), signed January 19, 1960, <http://www.mofa.go.jp/mofaj/area/usa/hosho/jyoyaku.html> (accessed August 3, 2008).

⁵ Mike M. Mochizuki, 'Japan Tests the Nuclear Taboo,' *Nonproliferation Review* 14:2 (2007): 306.

⁶ Nobumasa Akiyama, 'The Socio-Political Roots of Japan's Non-Nuclear Posture,' in *Japan's Nuclear Option*, ed. Benjamin L. Self and Jeffrey W. Thompson (Washington, DC: The Henry L. Stimson Center, 2003), 64-66.

⁷ *Genshi-ryoku Kihon-ho* (Nuclear Power Basic Law), Article Two, <http://law.e-gov.go.jp/htmldata/S30/S30HO186.html> (accessed February 3, 2008).

⁸ Kurt M. Campbell and Tsuyoshi Sunohara, 'Japan,' in *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices*, ed. Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss (Washington, DC: The Brookings Institution, 2004), 219-223.

⁹ The agreement was revised as the new Agreement between Japan and the United States regarding the Cooperation in Peaceful Use of Nuclear Power in 1989, <http://www.anzenkakuho.mext.go.jp/lawlist/pdf/s630702-05.pdf> (accessed August 20, 2008).

¹⁰ Ministry of Foreign Affairs of Japan, *Heisei 20-nen Nihon no Gunshuku Fukakusan Gaiko* (Japan's Disarmament and Nonproliferation Diplomacy 2008) (Tokyo: Ministry of Foreign Affairs of Japan, 2008), 30-89.

¹¹ Statement by Hideo Sanada, Director of Cabinet Legislative Bureau at the Budget Committee of the House of Councillors, March 11, 1978; Statement by Reiji Tsunoda, Director of Cabinet Legislative Bureau at the Budget Committee of the House of Councillors, April 5, 1982. Extracted from *Heisei 19-nendo Ban Bouei Handbook* (Handbook for Defense 2007) (Tokyo: Asagumo Shimbun-sha, 2007), 603-605.

¹² Kenneth B. Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose* (New York: Public Affairs, 2007), 251.

¹³ The two Study Group reports were never released in their entirety to the public. A summary, however, was reported by *Asahi Shimbun* on November 13, 1994. For the quotes of the summary of the two Study Group Reports reported in *Asahi Shimbun*, see <http://homepage.mac.com/ehara-gen/jealous-gay/nuclear-armament.html> (accessed December 8, 2008).

¹⁴ *Asahi Shimbun*, November 13, 1994, <http://homepage.mac.com/ehara-gen/jealous-gay/nuclear-armament.html> (accessed December 8, 2008).

¹⁵ *Ibid.*

¹⁶ Akiyama, 'The Socio-Political Roots,' 64.

¹⁷ *Ibid.*, 69-78.

¹⁸ Rust M. Deming, 'Japan's Constitution and Defense Policy: Entering a New Era?', Strategic Forum No. 213 (Institute for National Strategic Studies, National Defense University, 2004), <http://www.ndu.edu/inss/strforum/SF213/SF213-Final.pdf>

(accessed December 8, 2008); Richard J. Samuels, 'Security Japan: The Current Discourse,' *Journal of Japanese Studies* 33:1 (2007).

¹⁹ Yoichi Funabashi, 'Tokyo's Depression Diplomacy,' *Foreign Affairs* 77:6 (1998), 30.

²⁰ Fred Ikle and Terumasa Nakanishi, 'Japan's Grand Strategy,' *Foreign Affairs* 69:3 (1990), 89-91.

²¹ Kumao Kaneko, 'Japan Needs no Umbrella,' *The Bulletin of the Atomic Scientists*, (March/April 1996): 46-51.

²² Funabashi, 'Tokyo's Depression Diplomacy,' 35.

²³ Andrew L. Oros, 'Godzilla's Return: The New Nuclear Politics in Insecure Japan,' in *Japan's Nuclear Option*, 50-51.

²⁴ Yomiuri Shinbun, June 1 and June 3, 2002.

²⁵ For instance, Nihon Keizai Shimbun criticized his statement as 'unwise.'

²⁶ Asahi Shimbun, October 20, 2006; Nakagawa Shoichi, 'Jiritsu shita Kokka no Kaku-busou Rongi (Nuclear Debate of an Independent Nation),' *Voice* (December 2006), 46-51.

²⁷ Masato Ushio, 'San Gensoku wa Dankai-teki Haiki-wo (Three Principles to be Relinquished Gradually),' *Will* (January 2007), 77-79.

²⁸ Kan Ito, 'Jikoku no Bouei ni Sekinin wo Moteru Atarimae no Kuni-ni (Toward a Normal Country that Can Be Responsible For Its Own Security),' in *Nihon Kakubusou no Ron-ten* (Points of Debate in Japan's Nuclear Option) (Tokyo: PHP Kenkyusho, 2006), 189-251.

²⁹ Shoichi, 'Jiritsu', 48.

³⁰ See, for instance, Toshiyuki Shikata, 'Gunjiteki Tsu-ru kara Seijiteki Tsu-ru he (From A Military to A Political Tool),' *Will* (January 2007), 38-45.

³¹ Satoshi Morimoto, *Nihon Bouei Saiko-ron* (Japan's Defense Revisited) (Tokyo: Kairyu-sha, 2008), 266-278.

³² See, for example, Ted Carpenter, 'It's Time to Revise US-Japan Security Relationship,' *USA Today Magazine* 125:2620 (1997).

³³ See, for instance, Brad Glosserman, 'Nuclear Basic for the Alliance,' *PacNet Newsletter* No. 21 (April 7, 2007).

³⁴ Hajime Izumi and Katsuhisa Furukawa, 'Not Going Nuclear: Japan's Response to North Korea's Nuclear Test,' *Arms Control Today* (July 2007), <http://www.armscontrol.org/act/2007-06/CoverStory.asp> (accessed July 30, 2008).

³⁵ Mataka Kamiya, 'Nuclear Japan: Oxymoron or Coming Soon?,' *The Washington Quarterly* 26:1 (2002-3): 63-75.

³⁶ Izumi and Furukawa, 'Not Going Nuclear.'

³⁷ Kamiya, 'Nuclear Japan,' 66.

³⁸ Ministry of Foreign Affairs of Japan, *Gunshuku Fukakusan Gaikou ni Kansur Ishiki Chosa* (Opinion Poll on Disarmament and Nonproliferation Diplomacy), outcome released in March 2008, <http://www.mofa.go.jp/mofaj/gaiko/chosa/i-chosa.html> (accessed August 1, 2008).

³⁹ Llewelyn Hughes, 'Why Japan Will Not Go Nuclear (Yet),' *International Security* 31:4 (2007): 67-96.

⁴⁰ Ichiro Ozawa, President of the Democratic Party of Japan (DPJ), for instance, commented that the United States did not have Japan's interest at heart when Washington made an initial announcement that it would de-list North Korea from the State Department list of terrorism-sponsoring states.

⁴¹ Brad Glosserman, 'Japan peers into the abyss,' *PacNet Newsletter* No. 20 (March 20, 2008).

⁴² See, for instance, Howard French, 'Taboo Against Nuclear Arms Is Being Challenged in Japan,' *New York Times*, June 9, 2002; Robin Lim, 'Worried by China and North Korea: So much for Japan's nuclear taboo,' *International Herald Tribune*, June 13, 2002.

Climate Change, Energy Security, and Nuclear Power

MILAN ILNYCKYJ

Two factors have resuscitated interest in nuclear power throughout the developed world: high hydrocarbon prices and concerns about climate change. This paper considers the advantages and disadvantages of nuclear power as a mechanism for achieving climate change mitigation and energy security objectives. It also highlights some of the methodological problems faced by governments trying to decide which energy technologies to support in the future, including uncertainties about the comparative economics of nuclear power and other low-carbon options, particularly renewables. Special consideration is given to issues including lifecycle emissions, radioactive wastes, the proliferation of nuclear weapons, water and fuel availability issues, and the relationship between forms of electrical generation and the character and functioning of the electrical grid.

This paper does not seek to provide a final qualitative judgement of the relative merits of nuclear power and renewables, nor the relative validities of some of the most contested arguments for and against them. Rather, it seeks to summarize the state of the debate and some of the key contested elements within it.

Nuclear power is a more divisive issue than any other amongst those who are concerned with climate change and with driving the push towards a low-carbon global society. Advocates of a nuclear revival consider support for nuclear energy to be a badge proving genuine concern about climate change.¹ Those who disagree assert both that nuclear power has unacceptable problems associated with it and that climate change can be managed without the need to build more nuclear capacity. Adjudicating between the two positions is extremely difficult. Doing so requires assessing both the advantages and difficulties associated with nuclear power and those associated with the best available alternatives; it requires projections about what kind of technology will scale up in what ways, as well as controversial economic arguments about subsidies. The debate about nuclear energy and energy security is similar in many ways - although the areas in which they differ will be discussed below. In both cases, the kind of unbiased empirical data necessary to make an informed choice does not seem to be available. While this examination

Milan Ilnyckyj, 'Climate Change, Energy Security, and Nuclear Power,' *STAIR* 4:2 (2009): 92-112.

will largely focus on the intersection between climate change and nuclear power, energy security issues are raised throughout.

Arguably, the problem of climate change is dramatically more important than that of energy security, although that may not be the case for politicians who must face voters with an increasingly acute concern about energy prices and availability. The worst possible outcome for states that fail to secure energy supplies concurrent with their domestic needs is a contraction in the quantity of energy-intensive work that can be done. By contrast, the worst possible outcome from climate change is a situation in which natural carbon sinks become self-amplifying net sources of carbon, producing a runaway climate change effect ultimately leading to a world very hostile to human life. The prior existence of such inhospitable climates, as documented in paleoclimatic records, demonstrates that climatic forcings of a certain type and magnitude can be amplified into massive shifts in the climate system.² Even non-runaway climate change outcomes could prove devastating for the global economy as well as international peace and security, particularly if large-scale reductions in water availability or major agricultural impacts emerge on regional or continental scales.

Thankfully, it seems plausible that energy security and climate change objectives can be met simultaneously. Various options for producing energy from non-hydrocarbon sources offer up that possibility. The most probable clash between these objectives relates to coal: an amply available hydrocarbon towards which states — including China and the United States — might be driven to turn more sharply in response to greater uncertainty about energy imports. Coal for electricity, and liquefied coal for transport, holds the promise of reduced hydrocarbon imports. At the same time, continued use of coal threatens to seriously worsen climatic outcomes. Whether nuclear power or some other option proves to be the preferred mechanism for reconciling society's energy needs with the planet's limited capacity to absorb human impacts, avoiding the consequences associated with releasing the carbon in the world's coal reserves into the atmosphere must be a crucial objective for humanity. Because coal reserves are much larger than oil reserves, and because more carbon dioxide is produced for each unit of energy when burning coal, the climatic consequences of burning all of the world's coal would be far greater than those of burning all of the world's oil. That carbon must be kept in the ground or — if it proves effective and economically viable — temporarily extracted and then permanently re-buried, using Carbon Capture and Storage (CCS) technology.

This paper will concentrate on nuclear fission and renewables as possible sources of future electricity production. The latter category in-

cludes hydroelectric, wind, concentrating solar and solar photovoltaic, biomass, tidal, wave, and geothermal energy: all forms of energy with unlimited fuel supplies and no emissions aside from those required for construction. The possibility of continuing to use hydrocarbon fuels in conjunction with carbon capture and storage technology will not be considered extensively. While many governments and firms have expressed their confidence in CCS technology, it has not been demonstrated in a commercial power plant. Furthermore, the difficulties associated with the development and deployment of global CCS infrastructure are likely to be considerable. Former Assistant Secretary of the US Department of Energy Joseph Romm has estimated the physical requirements of producing one 'stabilization wedge' of emissions reductions using CCS. The concept of such wedges for climate change mitigation originated with the work of Stephen Pacala and Robert Socolow.³ Each wedge represents a policy or technology that reduces emissions below business-as-usual levels, reaching a rate of one gigatonne of annual reductions by 2050. Due to that process of ramping up, each wedge represents twenty-five gigatonnes of avoided emissions before 2050. Romm estimates that producing one wedge of emissions reductions using CCS would require physical infrastructure equivalent to all that being presently employed globally to extract oil from the ground.⁴ Given the enormous expense and the decades of construction that have gone into that infrastructure, physical limitations seem to be a realistic reason to limit estimates for the medium-term contribution of CCS, although others dispute this position. This is not to say that CCS will play no role in the energy mix of the future, but rather to somewhat temper expectations of how quickly and comprehensively it could be deployed, and identify it as not being a major subject of this analysis.

The Case for Nuclear

Some of the most outspoken advocates for rapid and comprehensive action on climate change are also big supporters of nuclear power. They see it as a low-carbon way to provide large amounts of electricity to national grids, as well as an important 'wedge' in the drive towards stabilizing global concentrations of greenhouse gases. Examples of such supporters include climatic scientist James Hanson and biologist James Lovelock. Political support for nuclear energy exists for several reasons: among them, concerns about maintaining secure access to energy and with low-carbon energy production. Views on nuclear energy as a long-term option differ among supporters. Whereas some see nuclear power

as a desirable option indefinitely, others see it as a temporary bridge serving as a deeply flawed stop-gap until superior energy options are more fully developed and deployed. Given the long timelines associated with power plant planning, construction, and deployment, errors made in the choice of generating options will have an impact for many decades.

Nuclear energy is a low-carbon way to produce electricity. Even when lifecycle emissions are considered – including energy use in locating, mining, milling, enriching, and disposing of spent uranium – nuclear energy has strong potential as a climate-friendly option. The Canadian experience provides a good example. The Pembina Institute estimates that the total emissions for Canada's nuclear sector (including twenty-three reactors at seven power stations) are between 468,000 and 594,000 tonnes of carbon dioxide per year.⁵ That is about 0.07 per cent of Canada's total emissions for the year in which the estimate was made (2006). In 2005, Canada's nuclear industry produced eighty-five terawatt hours of electricity, approximately eleven per cent of Canada's total energy use.⁶ By comparison, one five-hundred megawatt coal-fired power plant produces about three million tonnes of carbon dioxide. That is equivalent to about 0.4 per cent of Canada's installed electrical capacity, and about 0.4 per cent of Canada's 2006 emissions. The Pembina Institute estimates consider the greenhouse gas emissions associated with the construction and decommissioning of nuclear power stations, as well as those associated with fuel production and disposal. The Intergovernmental Panel on Climate Change (IPCC) estimates that if all the world's existing nuclear generating stations were coal plants, 2.2 billion tonnes of additional CO₂ per year would be entering the atmosphere. When lifetime emissions are taken into account, arguments that nuclear energy is nearly as bad as energy from fossil fuel are thus not credible. Nuclear energy has a genuine capability to produce low-carbon electricity.

The power output from nuclear plants is large and relatively consistent. Barring maintenance shutdowns, they are capable of maintaining large and steady flows into the electrical grid.⁷ This stands in particular contrast to individual renewable generating sites, where power output varies with wind intensity, incoming solar radiation, and so forth. A relatively predictable output means that nuclear stations do not require as much 'peak' generation capacity on standby. That being said, inevitable shutdowns for refuelling and maintenance mean that nuclear energy cannot claim to be entirely consistent, or wholly without the need for backup capacity that can serve the grid during times of disruption. These disruptions are, however, more rare and often more predictable than those associated with intermittent renewable technologies, such as wind

power. Nuclear power also has an advantage in terms of the amount of land required to produce a certain amount of electricity. Compared to renewable options like solar, a nuclear plant can produce more than one hundred times as much power on the same plot of land.

The economically viable supply of nuclear fuel in the medium-term seems adequate for present purposes. Furthermore, the most significant uranium producers globally are Canada and Australia: states likely to be stable suppliers, in contrast with some of the volatile regimes exporting hydrocarbon fuels. Certainly, states such as the US, France, and Japan would prefer to be able to secure long-term contracts for access to fuel from rich and stable democracies, as opposed to facing the need to buy fuel at volatile prices from states facing both significant internal and regional security challenges. Theoretically, it may become commercially viable in the future to use thorium for fuel in fission reactors,⁸ or to extract uranium from novel sources such as phosphates or seawater. Another possibility is that fuel reprocessing or so-called 'breeder' reactors will be developed to the point of commercial viability. If so, fuel availability for nuclear reactors might be extended quite considerably.⁹ While it would still not be accurate to refer to nuclear fission as a renewable source of energy, the provision of additional fuel and extension of its viability would generate a greater span of time in which technological progress could occur on other fronts. In so doing, nuclear energy could act as a significant bridge between an economy largely powered on carbon-intensive, increasingly costly and depleted fossil fuels, and one that relies upon energy extracted from inexhaustible sources.

Part of the case for nuclear also lies in the rebuttals of some of the charges against it. For instance, when it comes to the emission of toxic and radioactive substances into the environment, coal-fired electrical generation seems to be worse than nuclear power.¹⁰ Additionally, while nuclear accidents are far more sensational than those associated with other forms of electrical generation, they have been arguably less severe in reality than in the popular imagination. Even Chernobyl, a name that has become synonymous with all the dangers of nuclear energy, is estimated by the World Health Organization to have killed fifty-six people directly with four thousand expected extra cancer deaths among the six-hundred thousand most exposed people. Three-hundred thousand people were also permanently relocated.¹¹ By comparison, the WHO estimates that 2.4 million people per year die as the result of air pollution. By reducing deaths associated with toxic smokestack emissions (not to mention those associated with climate change), nuclear power might actually save lives, even when inevitable small and medium-scale accidents are taken into account. While challenging methodological and ethical

questions accompany any such comparisons, it must be acknowledged that there are serious risks and health consequences associated with the conventional alternatives to nuclear energy, as well as with nuclear power itself.

The Seriousness of Climate Change

The need to massively reduce global greenhouse gas emissions is clear and urgent. According to the Fourth Assessment Report of the IPCC, stabilizing the atmospheric concentration of greenhouse gasses at a level consistent with the European Union's target of less than 2°C of global temperature change requires massive reductions. Even at 2°C of change, the IPCC predicts wide-ranging and serious impacts.¹² Stabilizing concentrations means cutting emissions of all greenhouse gasses to a level where net absorption by sinks equals net global production. The level at which stabilization occurs determines what level of warming will occur. Two different stabilization scenarios offer a glimpse of the relationship between stabilization concentration, temperature change, and difficulty of implementation:

Stabilization at 450 Parts Per Million (PPM) of Carbon Dioxide Equivalent:

According to the IPCC, stabilization between 445 and 490 PPM would likely produce temperature increases of between 2.0°C and 2.4°C by 2100. Stabilizing at 450 PPM would require that global emissions peak by 2010 and fall by seven per cent per year thereafter, falling to seventy per cent below 2005 values by 2050. A study by Malte Meinshausen uses IPCC estimates about the relationship between stabilization and temperature change to estimate that there is a risk of between twenty-six per cent and seventy-eight per cent (mean forty-eight per cent) that mean global temperature change will exceed two degrees under this scenario.¹³

Stabilization at 550 PPM:

According to the IPCC, stabilization between 535 and 590 PPM would likely produce temperature increases of between 2.8°C and 3.2°C by 2100. This would require emissions to peak between 2016 and 2026, then fall at a rate of one to three per cent per year, reaching levels twenty-five per cent below 2006 levels by 2050. The Meinshausen study

projects a risk of between sixty-eight per cent and ninety-nine per cent that the two degree target will be exceeded, with a mean estimate of eighty-five per cent.

Another way to consider the problem is to decide upon a maximum level of acceptable temperature rise. By using that figure and estimates of the sensitivity of the climate to carbon dioxide, it is possible to determine how many carbon emissions humanity can produce while not exceeding the temperature threshold. Taking the 2.0°C target for temperature change adopted by the European Union, and using the climatic sensitivities at the upper and lower bound of the probable range determined by the IPCC, the total quantity of carbon dioxide that humanity can emit between the present day and the point where global society is carbon neutral is estimated between 484 and 661 billion tonnes of carbon – a figure that includes all emissions from both developed and developing states.¹⁴ Annual emissions of carbon are already ten billion tonnes per year (thirty-six billion tonnes of carbon dioxide) and increasing at around 3.5 per cent per year, despite the significant increase in fossil fuel prices. Given the definition of probability used by the IPCC, the 661 billion tonne figure only corresponds to a sixty-six per cent chance of avoiding a temperature increase of over 2.0°C, and it must be recalled that the emergence of strong positive feedback loops could boost climatic sensitivity well outside this range. Indeed, scientists including James Hansen have argued that stabilization below 350PPM is necessary to avoid dangerous anthropogenic climate change.

According to the *The Economics of Climate Change: The Stern Review*, a business-as-usual scenario in which emissions continue to increase at the present rate would likely result in 2.0°C to 3.0°C degrees of warming by 2050 and concentrations well over 1000 PPM by 2100, with probable temperature increases of more than 5.0°C.¹⁵ To put this in context, the temperature difference between the world at present and that prevailing during prior ice ages was between 3.5°C and 5.0°C.¹⁶ The higher the stabilization concentration, the greater the risk of runaway climate change, in which positive feedback loops such as losing reflective sea ice and the release of methane from melting permafrost reinforce the anthropogenic warming trend. Positive feedback loops of sufficient magnitude would overwhelm the capacity of carbon sinks, turning the planet into a net emitter of greenhouse gasses, even in the absence of human activity. In such a situation, humanity would be left with two options: waiting for the climate to reach a new equilibrium (which could be very hostile) through the combination of biological and geological effects, or actively trying to manipulate the climate system. Such ‘geoengineering’ possibili-

ties carry the grave risk of unintended consequences, even if they did prove effective at helping to stabilize temperatures.

All of this strengthens the case for re-examining nuclear energy: a technology that was essentially rejected as too risky and expensive in the period before climate change was a serious and well-understood concern. Stabilizing atmospheric concentrations of greenhouse gasses at a level that avoids dangerous interference in the climate system requires the rapid deployment of known low-carbon energy technologies. Aside from large-scale hydroelectricity, nuclear energy is the most significant such technology widely deployed today. That said, appropriately evaluating nuclear energy in a warming world requires objective and comprehensive consideration of its disadvantages, as well as alternative means for achieving the same outcomes. All this requires the balancing of many different kinds of risks: those directly associated with different forms of energy production, as well as those associated with health, environmental, economic, and geopolitical consequences arising from energy choices.

The Problems with Nuclear

Most of the major problems of nuclear energy are well known. They include the danger of accidents or the intentional targeting of nuclear stations by malicious actors. There are also issues of uranium mining and enrichment and the disposal of waste. Other arguments against nuclear energy include expense, the disputed need for major public subsidies, water usage, and deployment timelines. Geopolitical concerns include the dangers of nuclear proliferation. Finally, there is the reality that nuclear power plants do use a non-renewable resource as fuel, raising questions about how long reliance upon them can successfully delay the need for truly renewable options. Not all the problems associated with nuclear power differentiate it from all other options – for instance, fossil fuel power plants also require water for cooling. That said, each of these issues needs to be considered when assessing the costs and benefits of nuclear power.

One concerning aspect of using nuclear power is the possibility of catastrophic accidents. As etched into the public consciousness by the accidents at Chernobyl and Three Mile Island, it is possible for nuclear generating stations to go from billion dollar assets to major liabilities in minutes. The reality of this danger is underscored by the liability guarantees extended to nuclear firms in Canada and the United States. In Canada, the Nuclear Liability Act requires that nuclear generators purchase

insurance for damages up to seventy-five million dollars. The responsibility to pay claims exceeding seventy-five million dollars then rests with the federal government. There is no legal limit on the size of such claims. Suppliers of equipment for nuclear power generation are exempt from liability in the event of an accident. Given the possibility that a nuclear accident could cause far more than seventy-five million dollars in damages, significant financial risk is being transferred from private operators to taxpayers. In the United States, the Price-Anderson Nuclear Industries Indemnity Act limits the liability of private operators to ten billion, beyond which responsibility transfers to the federal government. Private firms are apparently unwilling to tolerate the full potential costs involved in an accident at their facilities, and the willingness of national governments to accept the transfer of risk must be seen as a significant implicit subsidy to the industry. The political risks associated with an accident are also substantial. A major shift towards new nuclear construction could be derailed in response to a major accident somewhere in the world. Wherever the probable rate of failure is non-zero and wherever some possible failure outcomes are catastrophic, the danger of such an outcome will continue to haunt the nuclear industry.

As with the extraction and processing of fossil fuels, the front end of the nuclear fuel cycle involves significant environmental impacts, including the toxic products of mining and the greenhouse gas emissions associated with exploration, mining, milling, enrichment, and transport. Many sites around the world have become seriously contaminated as the result of nuclear materials being handled there. The Hanford Site, used in the early period of nuclear technology in the United States, is probably the most contaminated site in the entire country, with millions of gallons of high-level waste present and large but uncertain associated future cleanup costs. While higher standards now exist in developed states, radioactive contamination of land and water must continue be borne in mind as costs associated with the use of nuclear energy. So too must the energy costs associated with fuel processing be counted against the total energy output of the nuclear industry. That is particularly important in circumstances where high-carbon power sources are used to power extraction and enrichment equipment. While the enrichment of fuel certainly generates net energy, energy use associated with producing uranium fuel can diminish the low-carbon qualifications of nuclear power.¹⁷

At present, the great majority of nuclear waste from commercial reactors is stored in either cooling ponds or dry storage casks. From both an environmental and a public support standpoint, the generation of nuclear waste is one of the largest drawbacks of nuclear fission as a

power source. Just as the emission of greenhouse gasses threatens future generations with harmful ecological outcomes, the production of nuclear wastes at all stages in the fuel cycle presents risks to those alive in the present and to those who will be alive in the future, across a span of time not generally considered by human beings. Wastes like Plutonium-239 remain highly dangerous for tens of millennia: a span roughly equivalent to the total historical record of human civilizations.¹⁸ Furthermore, while most states using nuclear power have declared an intention of creating geological repositories for wastes, no state has such a facility in operation.¹⁹ The decades-long story of the planned Yucca Mountain repository in the United States demonstrates some of the practical, political, and legal challenges to establishing such facilities in democratic societies. Dry cask storage is not an acceptable long-term option, as suggested by its Canada Nuclear Safety Commission categorization as 'a short-term management technique.'²⁰ When dealing with wastes dangerous for millennia, it cannot be assumed that regular maintenance and inspection will continue. Storage systems must be 'passively safe': able to contain the wastes they store for the full duration of their dangerous lives, without the need for active intervention from human beings. To date, no such facilities exist. Their successful development and commercial operation is a pre-requisite of the responsible expanded use of nuclear power. In an ideal world, passively safe storage facilities for waste would be established before, not after, the reactors that will eventually fill them.

Nuclear power has also been widely criticized for receiving high levels of governmental subsidies, both implicit (as with liability legislation) and explicit (as with direct support for new facilities). Estimates of the total subsidies provided to the nuclear industry in the United States alone range up to one-hundred billion dollars, though the early conflation of nuclear energy and nuclear weapons programmes makes precise estimation challenging.²¹ This leads to two major questions: firstly, why is it that the nuclear industry has been in subsidized operation for over fifty years but has not yet overcome the need for public support? Secondly, what proportion of the costs associated with new facilities will actually be borne by taxpayers, rather than the firms hoping to profit from them? The purpose of government subsidy is to correct for externalities in the market – situations where individually rational profit-maximizing actors will not make socially optimal choices. Given the negative externalities associated with nuclear power (waste, risks, etc.), justification for ongoing subsidy requires very strong evidence that nuclear energy produces substantially fewer externalities than alternatives, and that the absence of subsidy would lead to outcomes that are more adverse to a degree larger than the cost of the subsidies themselves. The effective comparison

of costs per unit of energy between nuclear power and other options requires a clearer understanding of all the subsidies and externalities involved with each.²²

Nuclear proliferation is a major geopolitical concern in several regions. States with hostile neighbours watch nervously whenever nuclear facilities of any kind are constructed. Furthermore, there can never be a complete separation between equipment, personnel, materials, and knowledge used for civilian nuclear power generation and the same things used for weapons development. All else being equal, a state in possession of reactors, fuel, and scientists will be able to produce an atomic bomb significantly more easily than one lacking these ingredients; this is especially true given the consensus that the most difficult aspect of acquiring a crude but functional fission device is the acquisition of bomb-grade uranium or plutonium. States that have either developed or sought to develop nuclear weapons using expertise (and possibly materials or equipment) diverted from civilian programs include Israel, South Africa, Pakistan, North Korea, Iraq, and possibly Iran. While the construction of new nuclear reactors in states that already have nuclear weapons probably does not contribute to proliferation risks, their more widespread dissemination in states with few or no bombs may well encourage regional rivals to consider moving towards nuclearization. The more volatile a particular region becomes – and the more acute the security concerns different states develop about one another become – the more likely various actors will seek to convert civilian into military nuclear capability.

One somewhat less obvious consequence that arises from the military connections of nuclear power is the degree to which secrecy impedes public scrutiny above and beyond the opacity of the figures available for other industries. Given that nuclear operators will always be presented with serious questions of security – as will the governments that license them – the nuclear industry has a unique opportunity to evade public and journalistic scrutiny through the assertion that secrets must be kept for security purposes. In Israel, for example, publicly available information about the storage of radioactive wastes is extremely limited. Such limitations frustrate attempts to discover the actual fiscal and environmental costs associated with the nuclear industry. This, along with the unwillingness of governments to provide too much public information on an issue as controversial and unpopular as nuclear energy, reduces the depth and meaningfulness of debates about nuclear energy. This makes it especially challenging to answer questions about the total levels of subsidy directed to the nuclear industry, as well as to determine what

proportion of those subsidies supported civilian electricity generation technologies and facilities.

One of the most probable and worrisome consequences of climate change is changes in regional water availability. Decreased water quantity and increased temperature both pose challenges for nuclear facilities, since they use very large quantities of water for cooling.²³ The IPCC projects that future precipitation is likely to be more sporadic, increasing in total quantity in high-latitude regions while subtropical zones dry out. Loss of winter snowpack leads to diminished summer river flow, while changes in precipitation patterns and evaporation will likewise alter the quantity and timing of water availability in different regions. Areas that have not faced significant water stress in the past may find themselves doing so, while areas that had previously faced moderate stress might find themselves in extreme conditions. Already, there are precedents of nuclear power plants that needed to be shut down due to high ambient water temperatures or low water flow. For example, in summer 2007, the generating station at Browns Ferry, Alabama had to be shut down because cooling water from the Tennessee River was too hot to use.²⁴ Particularly in areas like the Southern United States and Australia, uncertainty about future water availability could constrain the additional deployment of nuclear stations. Deployment in spite of such concerns could lead to additional shutdowns of the kind already seen, depriving the grid of power and the plants of usefulness.

At any point in time, the world's economically accessible supply of uranium depends upon several factors: the extent and quality of known reserves; available extraction and processing technologies; and the market price of uranium. In the medium-term, the last of these is arguably the most important, since higher costs should spur exploration and technological development. That said, it is possible that future supplies of uranium will prove insufficient to maintain low prices in the absence of commercial breeding of nuclear fuel; this is particularly true in the event that large amounts of new nuclear capacity is constructed. While nuclear supporters argue that future fuel constraints will be eliminated through technological advances, it is not currently clear whether such technologies will ever be viable and, if they are viable, when they will be available, at what cost, and with what level of government support. However, fuel costs are a comparatively small fraction of the total expense of building and operating nuclear plants. As such, the economics of doing so successfully is less dependent on fuel prices than for fossil-fuel fired thermal plants.

Enumerating the points against nuclear power does not, however, resolve the question of how to address climate change and energy secu-

urity concerns. One prominent opponent of nuclear energy is the British journalist George Monbiot. Arguably, however, the approach he describes in his thought-provoking book *Heat: How to Stop the Planet from Burning* demonstrates the great difficulty of achieving climate change goals while discontinuing the use of nuclear power.²⁵ If restrictions as harsh as those he describes are necessary to achieve energy security and a stable climate, without using nuclear energy, the support of governments and private citizens for such an approach may be weak. While his plan also includes far more aggressive total emission reduction targets than have been seriously considered by any state thus far, the difficulty of reaching them and the extent of lifestyle changes required to meet them are partly indicative of extra cuts required elsewhere by virtue of foregoing nuclear.²⁶ Arguably, nuclear power could also provide a kind of safety net, in the event that other kinds of emission reductions do not emerge as rapidly or forcefully as expected. Of course, this would require that these other measures are implemented just as energetically alongside nuclear construction as they would have been in its absence.

The Positive Case Against Nuclear

There are those who argue emphatically that the goals sought by nuclear advocates can be achieved more rapidly and at a lower cost through other means. Conservation can reduce total energy usage, efficiency can be improved, and funds that would have been used to subsidize nuclear power can be directed toward more rapidly-deployable renewable generating options such as wind and concentrating solar power. A prominent advocate of this view is Joseph Romm, whose analysis of carbon capture and storage (CCS) is mentioned above. He argues that not only can renewable sources of energy be used to mitigate climate change and bolster energy security, but that they can do this in ways that fundamentally and beneficially alter the energy basis of the world economy.

The falling price per watt of solar capacity suggests that renewable power could become cost-competitive with traditional generation options in the near-to-medium term, even when externalities like greenhouse gas emissions are not considered. According to *The Economist*, the price of solar cells has fallen from nearly twenty dollars per watt during the early 1980s to under five-dollars per watt in 2005.²⁷ Organizations including Google's RE < C initiative are seeking explicitly to produce renewable generation options that are economically as well as environmentally superior to coal power.²⁸ So long as one of the most major objections to renewable power is the high capital costs, the extended and ongoing trends

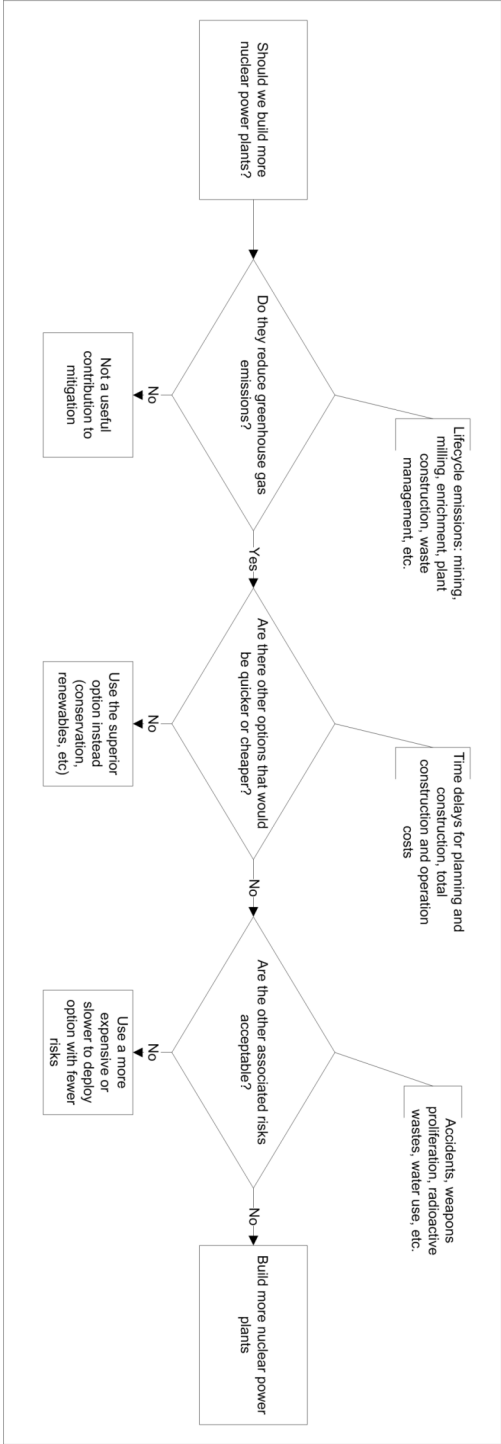
towards commercial viability are evidence that renewable power can rise to the challenge, potentially while receiving far less substantial subsidies than the nuclear and fossil fuel industries. States that implement carbon pricing policies, thus internalizing the climatic externalities associated with fossil fuel use, will further improve the relative economic appeal of renewable power, while generating more socially optimal outcomes (since externalities previously imposed upon powerless third parties will be constrained).

The arguably more transparent economics of renewables is a significant advantage over nuclear, at least from the perspective of those evaluating the two options. While there have certainly been subsidies granted for the development and deployment of renewable generation technologies, these are relatively transparent and well quantified. Because of secondary impacts and risks, the subsidies for renewables can be considered more justified than those granted to the nuclear industry. Whereas nuclear power plants produce significant externalities in the form of waste and accident risk, neither is a significant factor in relation to renewables. Of course, other issues exist with renewable options, such as land use, harm to birds and bats, and the disruption of river flow by dams. The use of renewables for electricity generation does have a stronger claim to 'infant industry' status than nuclear power, which is no newcomer to the business of large-scale electrical generation. Electricity has been commercially generated using nuclear fission since 1956. Nuclear fission also provides eleven per cent of Canada's electricity, nineteen per cent in the United Kingdom, thirty per cent in Japan, and eighty-eight per cent in France. It is neither a newcomer nor a small player, unlike many renewable options, such as wave, tidal, and ocean thermal power systems.

Arguably, renewable technologies have the capacity to be more rapidly deployed than nuclear technologies. Whereas a small number of firms have the heavy manufacturing equipment and expertise required to build nuclear reactors, the technology and capital required to produce various types of renewable power systems is more widely distributed. Whereas nuclear generating stations are massive, capital intensive, and slow to construct, renewable generation options have the potential to be more nimble and responsive to local conditions. This may prove especially advantageous in rapidly developing states like India and China. Renewable sources of energy also have the potential to form the backbone of a genuinely sustainable society: that is, one that would be capable of perpetuating itself indefinitely, given the limitations imposed by the finite nature of the planet.

Whereas nuclear plants would basically serve the same role as coal plants in the grid – single, large producers – renewable generation op-

Nuclear Power as a Climate Change Mitigation Option



tions have a varying level of output. Indeed, balancing the variable input from renewables would require far more energy storage and integrated energy transmission capacity than a nuclear-based alternative. The potential of renewables to provide the equivalent of baseload electrical capacity is therefore coupled with the development of a more efficient and intelligent electrical grid. Using high voltage direct current (HVDC) power lines makes it feasible to transport electricity long distances: connecting solar facilities in the American southwest to major cities, or others in North Africa to Europe. The more effective integration of electrical grids holds the promise of more closely equalizing energy prices: removing price differentials and situations where electricity is used wastefully in areas rich in generating capacity but poor in export capacity. An enhanced grid would also allow for more effective load balancing. Wind and solar power plants with outputs that peak at different times could be integrated to smooth output. They could also be combined with renewable options like hydroelectric and biomass plants capable of altering their output in real time. This approach – already being implemented in Germany's pilot Kombikraftwerk project – could lead to a grid where most capacity comes from renewables, with energy storage systems and perhaps some hydrocarbon-powered 'peaker' plants to deal with demand surges.

Demand management could also enhance the relative appeal of renewable sources of power. For instance, the transition towards a large number of electric battery vehicles operating in urban environments could create an enormous new reserve pool of energy. At times when renewable output exceeded demand, vehicles could be selectively charged. Likewise, at times when demand exceeded production, vehicle batteries could be partially drained to compensate. A smart electrical grid capable of managing such operations could also time and scale the operation of heating and cooling, energy intensive industrial processes, and other sources of demand so as to shift energy consumption from times of peak usage to those of peak availability. A renewably-backed smart grid could also improve efficiency in some areas through decentralization.

A transition to an electricity generation system based on renewable sources would both facilitate and require the development of significant new capacity in energy storage and transmission. While these would not be required in a scenario where coal and gas generation are simply supplanted by nuclear, their development may nonetheless be justified by the avoidance of many of the problems associated with nuclear fission, as well as the new opportunities a more flexible and distributed electricity generation system could provide.

Compelling arguments exist in favour of nuclear power, as well as against it and in favour of alternative options. The challenge presented to those wishing to select the best option is to weigh these arguments against one another, under conditions of uncertainty about what some key elements of the situation in the future will be. A number of possible outcomes could arise from the nuclear debate and subsequent choices. It is not clear at this point whether nuclear power or renewables would actually be the more expensive option in the long term. It is unlikely that a clear-cut answer to this question is possible, given the different weightings that could be given to factors like land and water use, the risk of accidents, and so on. Furthermore, given the path dependencies involved, it may not be knowable after the fact either. Regardless of which option is actually more costly, a number of possible outcomes could arise from the policy debate about nuclear energy and renewables:

- The expensive option is chosen and it works - achieving the desired outcomes for climate change and energy security.
- The cheaper option is chosen and it works.
- The cheaper option is chosen and it fails to adequately reduce emissions or enhance energy security.
- The expensive option is chosen and it fails.

The possible negative outcomes are therefore either (a) having spent too much money to achieve an outcome or (b) having chosen an unsuccessful strategy. (a) is not entirely separate from (b), since costs will likely influence the rate of deployment. It is also theoretically possible to succeed in either climate change or energy security, but not both. For instance, a strategy could be adopted that eventually requires severe cuts in energy usage, because the technology to provide the energy in a low-carbon manner does not emerge viably.²⁹ Alternatively, the failure to produce effective low-carbon technologies may drive states towards the continued heavy use of climatically unacceptable options like coal for energy generation, and possibly even transport fuels. Another interpretation is to consider 'try both approaches' to be the expensive option and 'choose one or the other' to be the less costly alternative. In this scenario, the same tradeoffs apply, although there is a higher overall possibility of finding at least one viable option, as well as a higher overall possibility of wasting money on unsuccessful or unacceptable approaches. Compounding the problem of absent knowledge is the problem of

impossible knowledge. When a major choice is made (implicitly or explicitly) about the direction to be taken, opportunities to learn about the outcomes of alternative choices are constrained. For instance, humanity might act aggressively to prevent dangerous climate change, achieve stabilization, and later doubt whether so aggressive an approach was actually required. Conversely, rejecting opportunities to create a low-carbon global economy might lead to very harmful climatic outcomes, but still leave uncertainty about whether any feasible action could have made a difference. Given the singular nature of the planet, genuine experimentation is impossible. As a result of that, and of the wide-reaching and potentially catastrophic character of climate change, policymakers must choose under conditions of considerable risk and uncertainty.

Perhaps the mechanism through which the best balance between risk management and cost optimization can be struck is a combination of experimentation and scrutiny. Differing political outcomes in various jurisdictions are likely to produce experiments of both kinds in the medium-term, with some states opting for a nuclear strategy and others seeking to achieve similar goals by other means.³⁰ The independent and rigorous evaluation of the costs, successes, and failures of each approach could provide invaluable guidance for the next round of decision-making. While security concerns must obviously be borne in mind, they must be addressed in a way that does not obscure the success or failure of new nuclear stations as commercial, civilian endeavours. By adopting both approaches, it may be possible to avoid prematurely closing off promising routes to emission reductions, while also not following blind alleys for too long. This is an approach that necessarily carries risks – most significantly, of wasting time in which a more effective strategy could have been deployed, as well as creating additional nuclear waste and proliferation problems. At the same time, it is arguably the approach that produces the best possibility of successfully shifting to a low-carbon society rapidly enough to avoid catastrophic climatic impacts. Given that no global coordination exists on energy choices, it seems inevitable that the experiment will be carried out. It will be incumbent upon those with the intention of tackling climate change to effectively assess the strength of arguments for and against nuclear energy on the basis of progressively accumulating data and experience. ■

¹ For example see Mark Lynas, 'Why greens must learn to love nuclear power,' *New Statesman*, September 18, 2008, <http://www.newstatesman.com/environment/2008/09/nuclear-power-lynas-reactors> (accessed December 31, 2008).

² The IPCC glossary defines external forcing as 'a forcing agent outside the climate system causing a change in the climate system. Volcanic eruptions, solar variations and anthropogenic changes in the composition of the atmosphere and land use change are external forcings.' Intergovernmental Panel on Climate Change, 'Glossary of Terms used in the IPCC Fourth Assessment Report,' <http://www.ipcc.ch/glossary/index.htm> (accessed January 5, 2009).

³ Stephen Pacala and Robert Socolow, 'Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies,' *Science* 305:5686 (2004): 968-972. Available online at <http://www.sciencemag.org/cgi/content/full/305/5686/968?ijkey=Y58LjdWjMPsw&keytype=ref&siteid=sci> (accessed December 31, 2008).

⁴ Joseph Romm, *Hell and High Water: Global Warming - the Solution and the Politics and What We Should Do* (New York: William Morrow, 2007).

⁵ Mark Winfield, Alison Jamison, Rich Wong and Paulina Czajkowski, 'Nuclear Power in Canada: An Examination of Risks, Impacts, and Sustainability,' December 2006, <http://pubs.pembina.org/reports/Nuclear—web.pdf> (accessed December 31, 2008).

⁶ See International Atomic Energy Agency, 'Nuclear Energy Country Profiles: Canada,' <http://www.nea.fr/html/general/profiles/canada.html> (accessed September 11, 2008).

⁷ Next generation reactor designs are intended to further increase both output and reliability. For a discussion of next generation design possibilities, see Declan Butler, 'Nuclear power's new dawn,' *Nature* 429 (2004): 238-240. Available online at <http://www.nature.com/nature/journal/v429/n6989/full/429238a.html> (accessed December 31, 2008).

⁸ Experimental usage of thorium fuel has been undertaken in the Molten-Salt Reactor Experiment at the Oak Ridge National Laboratory in the United States. Though the project was discontinued in 1976, many sources identify thorium as a possible alternative fuel for nuclear fission reactors in a situation where uranium becomes scarce and expensive.

⁹ For a discussion of the potential longevity of the Earth's uranium supplies, see David MacKay, 'Nuclear?', *Sustainable Energy – Without the Hot Air*, 2008. <http://www.withouthotair.com> (accessed December 31, 2008).

¹⁰ See Mara Hvistendahl, 'Coal Ash Is More Radioactive than Nuclear Waste,' *Scientific American*, December 13, 2007. Available online at <http://www.sciam.com/article.cfm?id=coal-ash-is-more-radioactive-than-nuclear-waste> (accessed December 31, 2008).

¹¹ World Health Organization, 'Estimated deaths & DALYs attributable to selected environmental risk factors,' 2002, <http://www.who.int/entity/quantifying-ehimpacts/countryprofilesebd.xls> (accessed December 31, 2008). See also Mark Peplow, 'Counting the dead,' *Nature* 440 (2006): 982-983. Available online at <http://www.nature.com/nature/journal/v440/n7087/full/440982a.html> (accessed December 31, 2008).

¹² Intergovernmental Panel on Climate Change, 'Fourth Assessment Report: Climate Change 2007,' <http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4-syr.pdf> (accessed December 31, 2008).

¹³ Malte Meinshausen, 'On the Risk of Overshooting 2°C,' Scientific Symposium 'Avoiding Dangerous Climate Change,' 2005, <http://www.stabilisation2005.com/14-Malte-Meinshausen.pdf> (accessed December 31, 2008).

¹⁴ Weaver, *Keeping Our Cool: Canada in a Warming World* (London: Penguin Books, 2008), 250.

¹⁵ Nicholas Stern, *The Economics of Climate Change: The Stern Review*, October 2006. <http://www.hm-treasury.gov.uk/sternreview-index.htm> (accessed December 31, 2008).

¹⁶ Andrew Weaver, *Keeping Our Cool: Canada in a Warming World*, 208.

¹⁷ See: Nate Hagens, 'The Energy Return of Nuclear Power,' *The Oil Drum*, April 22, 2008. <http://www.theoil drum.com/node/3877> (accessed December 31, 2008).

¹⁸ That said, Andrew Weaver and others have pointed out that the long-lived character of carbon dioxide in the atmosphere, combined with the lags in the climate system, make greenhouse gasses a comparable kind of long-term threat. See also Nature Reports Climate Change, 'Carbon is forever,' November 20, 2008, <http://www.nature.com/climate/2008/0812/full/climate.2008.122.html> (accessed December 31, 2008).

¹⁹ Facilities for the storage of low-level wastes do exist, such as the Waste Isolation Pilot Plant in the United States. See Geoff Brumfiel, 'Nuclear waste: Chernobyl and the future: Forward planning,' *Nature* 440 (2006): 987-989. Available online at <http://www.nature.com/nature/journal/v440/n7087/full/440987a.html> (accessed January 2, 2008).

²⁰ Atomic Energy of Canada Limited, *The concept for disposal of Canada's nuclear fuel waste: proposed for long-term protection of human health and the natural environment* (Manitoba: AECL Research, 1994).

²¹ Some argue that public support for the nuclear industry has not been out of line with support for other forms of electrical generation. For instance, in a 2008 report for The Nuclear Energy Institute, it was estimated that total subsidies to the American nuclear industry were \$65 billion, when regulation, research and development,

government services, and disbursements were taken into account. The same document concludes that total subsidies to renewable sources were \$45 billion exclusive of hydroelectric and geothermal power, and \$132 billion with those included. See Management Information Services, Inc., 'Analysis of Federal Expenditures for Energy Development,' September 2008, <http://www.nei.org/filefolder/Bezdek-Report.pdf> (accessed December 31, 2008). For another discussion of subsidies, see Jim Giles, 'Nuclear power: Chernobyl and the future: when the price is right,' *Nature* 440 (2006): 984-986. Available online at <http://www.nature.com/nature/journal/v440/n7087/full/440984a.html> (accessed December 31, 2008).

²² For a more detailed discussion of some of the economic issues associated with nuclear power, see 'The shape of things to come?', *The Economist*, July 7, 2005. Available online at <http://www.economist.com/displaystory.cfm?story-id=4149623> (accessed December 31, 2008).

²³ The Palo Verde Nuclear Generating Station in the United States is the only nuclear power plant not located beside a large body of water used for cooling. Instead, it uses treated sewage from nearby residential areas to disperse surplus heat. For more information on potential water availability limitations for nuclear power plants, see Joseph Romm, 'The Self Limiting Future of Nuclear Power,' June 2008. <http://www.americanprogressaction.org/issues/2008/pdf/nuclear-report.pdf> (accessed December 31, 2008).

²⁴ Kent Faulk, 'Reactor shut down at Browns Ferry Nuclear Plant,' *The Birmingham News*, August 9, 2008. Available online at <http://www.al.com/news/birmingham-news/index.ssf?/base/news/1218269761142400.xml&coll=2> (accessed December 31, 2008).

²⁵ George Monbiot, *Heat: How to Stop the Planet from Burning* (New York: Random House, 2006).

²⁶ Like many others, Monbiot also assumes that carbon capture and storage (CCS) will emerge as an effective and economically viable option. It remains to be seen whether CCS can be deployed as cheaply, effectively, and rapidly as proponents suggest.

²⁷ 'Another Silicon Valley?', *The Economist*, June 19, 2008. Available online at <http://www.economist.com/specialreports/displaystory.cfm?story-id=11565636> (accessed December 31, 2008).

²⁸ See 'Google's Goal: Renewable Energy Cheaper than Coal,' November 27, 2008. <http://www.google.com/intl/en/press/pressrel/20071127-green.html> (accessed December 31, 2008).

²⁹ For instance, if nuclear power is rejected but the land and materials for renewable generation do not prove to be sufficiently available to provide the level of electrical power that would sustain or expand current levels of global prosperity.

³⁰ Still others are likely to deploy carbon capture and storage in combination with fossil-fuel fired plants, allowing the evaluation of both optimistic and skeptic claims about the viability of that technology.

George Perkovich and James M. Acton.
Abolishing Nuclear Weapons.

Adelphi Paper No. 396, London: International Institute for Strategic
Studies, 2008, 130 pp.
ISBN: 9780415465830

ELBRIDGE COLBY

George Perkovich and James Acton have performed a service by forthrightly laying out the general conditions and steps that would need to precede nuclear abolition. Much of the discussion on whether and how to 'get to zero' avoids this kind of practical road-mapping, instead preferring to dwell on the dire necessity of the effort or on recommendations for early moves in that direction.¹

The book begins by stating its objective of seeking to encourage a goal-oriented conversation on the abolition of nuclear arms. (7) It assumes that the effort should be tried and seeks to work out how it could be done. (10) It then marches through the political conditions that would need to be established in order to increase the chances of getting rid of nuclear weapons (Chapter One), moves to problems of verification (Chapter Two), discusses the challenges posed by civil nuclear energy in a nuclear weapons-free world (Chapter Three), tries to confront the problem of enforcement once such an objective has been achieved (Chapter Four), and discusses the problems associated with hedging and managing nuclear knowledge after getting to zero (Chapter Five). By sketching out the requirements necessary to achieve a nuclear-free world (or something approximating it), Perkovich and Acton help open a new front, so to speak, in the debate: instead of talking entirely in generalities, now we can see what a plausible case would look like for how to 'get to zero' and can argue about that, too.

In so doing, they unintentionally provide another service. That is, to affirm the anti-abolitionist position by showing just how unrealistic and, even more pointedly, unappealing, getting to and living in a world without nuclear weapons would be. As their monograph shows, and occasionally even admits, (12, 83) such a project would involve the states of

the world exposing themselves to enormously increased risk at the cost of their national autonomy and flexibility in a profoundly doubtful and perpetually unstable endeavor. And all this in exchange for – well, the argument for why all this would be ventured is never advanced with the vigor commensurate with the call's demands.

The authors are ambitious. They state early that nuclear disarmament would not be feasible unless the most dangerous global flashpoint issues were resolved, including Taiwan, Kashmir, Palestine, and the Russian near-abroad, *inter alia*. (Chapter One) They further note that key regions of the world would have to continue to shelter under the United States' extended deterrence commitments, even as US conventional dominance would have to be reigned in 'by international law as understood by other major powers in determining whether, when, and how to use military force'. (25) Despite this loss of discretion, the US would simultaneously have to build up its conventional capabilities to meet these commitments in order to replace the loss in potency from removal of its nuclear forces. (30-31) Russia, China, Japan, Europe, India, Pakistan, and the other important powers would need to be satisfied that they would be protected against aggression or coercion from any of the others. (24-32) The Iranian and North Korean nuclear programs would have to be stopped. (36-37) And so on. These are not modest demands.

But the authors' point is more systematic and ambitious than a series of disjointed proposals, and is made more explicit later, in the context of enforcement: for nuclear disarmament to progress, among the great powers there would need to be 'significant reconciliation of their interests and approaches to regional and global security.' (90) This is because nuclear weapons are uniquely central to the world's security system due to their unparalleled destructiveness and consequent value as instruments of deterrence, a value the authors concede. (87) Nuclear weapons have played central and irreplaceable roles in deterring aggression, most notably against the Soviet threat (both conventional and nuclear) against western Europe and elsewhere, but also in the US-China, India-Pakistan and, more indirectly, Israeli-Arab contexts. Nuclear weapons continue to play a vital role in assuring at least thirty allies in Europe and Asia of US security commitments and, more importantly, provide a nearly unshakable backstop against future strategic and technological developments. Getting rid of nuclear weapons would, therefore, involve forfeiting the most effective known instruments of deterrence, instruments that have been correlated with – and, in all likelihood, were the principal cause of – sixty years without major great power war.²

As the authors recognize, such a forfeiture could only take place if the need for such deterrence no longer obtained; in other words, that

potentially dangerous interstate competition and disagreement no longer existed. Such a world is implausible (and perhaps impossible) if states are to retain the substantial autonomy they enjoy today. This forfeiture would require the important states of the world to find reasons and ways to cease acting in a fundamentally independent manner with respect to the management and resolution of their differences. Since conventional arms simply cannot provide the same effectiveness as deterrents, nuclear-armed states and those they shelter would have to see the decision to disarm as responsible and sustainable, a prospect only likely in a world in which states no longer fear that other states or non-state actors will exploit this vulnerability.

It would perhaps be too flippant to dismiss this as hopelessly implausible, but it is more than that. For if the proposal is offered with any seriousness of purpose, it is also a call for radical change in global governance. This is most clearly stated in the authors' discussion of the problem of enforcement in a nuclear-limited or nuclear-free world. Acknowledging that states would be intensely interested in enforcing the rules and in preventing cheating and breakout, the authors blithely state that 'it would be necessary to develop punishments that could deter states from breaching their obligations and deny states the benefits of any violation' and 'there must be decision-making avenues and procedures that enjoy international legitimacy and that would work in a manner timely and robust enough to deter or eliminate threats.' (84) This has a bloodless tone, and their suggestions – that the Five Permanent Members of the UN Security Council or a separate body of the nuclear eight take responsibility – seem only a marginal shift from current practice. But make no mistake. What they are talking about is a revolutionary shift in global governance: essentially the creation of a sovereign-like entity to manage international security relations. For if this entity were to be capable of assuring states that it could detect and, if necessary, punish a violator rapidly and effectively, it would clearly need to be a very different beast than the UN Security Council which, in comparison, is positively feckless. Indeed, the authors recognize that the power to make war in pursuit of these duties would be a necessary component of this entity's charter – and not only to make war, but to make it with such effectiveness as to satisfy other states that the nuclear-free world would be protected. (94) Yet if such an entity were to be effective, it could not reasonably confine itself to limited strikes, which even minor countries like Libya (1986), Sudan (1998) and Afghanistan (1998) could withstand. It would need to be able to prevent breakouts, withstand challenges if necessary and defeat recalcitrant powers. It would thus need to monitor states' most sensitive defence activities, have the strength to outmatch

any challenge, and bear the authority to act quickly, effectively and decisively – to be ‘exceptionally reliable.’ (83)

This means that even though the authors reject ‘automatic’ enforcement (which is meaningless anyway – who gets to decide what ‘automatic’ means?) the implication is to vest decision-making authority – a kind of sovereignty – with the entity. It would have the power to make decisions about states’ central security dispositions and actions and to act on those decisions – otherwise it would not provide the margin of safety other states would demand. Nor would the entity’s powers be confined to the merely technical sphere. States obtain and retain nuclear weapons for fundamentally political reasons, generally because of their security situation and, occasionally, for reasons of prestige. As the authors note, for a nuclear-free world to be sustainable, political disputes such as those over Taiwan and Kashmir would not only have to be resolved but also continuously managed. New conflicts would have to be addressed and prevented from reaching the point at which nuclear weapons would become an appealing tool. Thus political motivations would need to be an inherent part of the entity’s writ as well. Of course, these responsibilities might be shared with another entity like the Security Council. But the underlying point is that international political disputes of any severity would need to be disposed of at the international level. Thus an international entity or entities would have the power to make decisions about countries’ core security issues and to take effective actions based on those decisions.

In other words, to get to a reliably nuclear-free world, there would need to be a sovereign or nearly-sovereign international power to manage international security affairs. This would be an even greater necessity if the proposal to arm this international entity with a nuclear force were enacted. (100-101) Given that such a system is irreconcilable with the continuation of the independence of truly sovereign states, even when, as now, ensconced in numerous multilateral arrangements, it can be concluded that a nuclear-free world does, after all, demand a revolutionary change in the global political order. Perkovich and Acton approach their task coolly, with a moderate detachment, yet their conclusion inadvertently confirms that the most radical partisans of disarmament are right, after all: the goal of abolition requires something approximating world government.

Needless to say, such a prospect seems neither plausible nor particularly appealing. Which leads to the question: why, again, are we trying to do this? The authors state that their ‘ultimate reason’ is to try to ‘reduce the danger of sudden mass annihilation.’ (110) But opponents of abolition share that goal – they just think that retaining nuclear weapons

is more likely to prevent that unfortunate outcome. The real rationale seems to be something else, referred to by the authors as 'the principle of global nuclear equity.' (103) They hold to 'the basic principle that a nuclear order cannot be maintained and strengthened over time on the basis of inequity.' (10) Here is the real nub of the disagreement. Perkovich and Acton appear to think that nuclear proliferation and, eventually, use cannot be averted without all states being treated basically alike with respect to their nuclear capabilities. (10) This argument seems to be both plausible and to have moral power. But is it correct?

It seems pretty clear that it is not.³ First, is 'equity' really so important to states (and non-state actors)? Despite the clamour from some states, the historical record would certainly indicate that it is not. The very structure of today's international system not only accepts inequity, but positively relies on it. The UN Security Council, composed of the postwar world's 'Big Five', is vested by the UN Charter with 'primary responsibility for the maintenance of international peace and security.'⁴ On a more practical level, the cold war saw many countries such as Japan alongside Germany and other NATO powers appear content to allow the US to take a leading role in deterring Communist aggression; in fact, the allies appeared adamant that the US should not be treated alike, as this might encourage its withdrawal to its traditional insular posture. Going further back, periods of peace and stability were characterized by stark inequities in power: the pax Britannica, imperial Rome, China's role as the Middle Kingdom. More 'equal' periods – early modern or late nineteenth century Europe, for instance – have been far more violent.

Furthermore, the world is much more 'equitable' in nuclear terms than it initially appears. First, there are eight (or, counting North Korea, nine) nuclear weapons states. Second, most of the world's big economies essentially 'have' nuclear weapons: they are covered by a credible US nuclear-backed security commitment. In Europe, the non-nuclear allies in NATO have direct input into nuclear planning through established mechanisms within the alliance; some non-nuclear NATO allies are actually capable of delivering nuclear weapons themselves through 'dual-capable aircraft.'⁵ US allies in Europe and Asia thus enjoy the benefits of nuclear weapons even though they do not 'own' them. Third, many of the other big economies enjoy conventional commitments from countries (particularly the US) ultimately capable of resorting to nuclear use if necessary: Saudi Arabia, the Gulf States and several Southeast Asian nations would fall into this category. Fourth, many important states are 'lesser included' cases within 'protected' regions: Ireland, Switzerland, Sweden and Austria are 'free riders' on NATO's security structure. Fifth, the countries of Latin America, the South Pacific and, to a lesser extent,

Africa are in a security environment dominated by external powers effectively overseeing the security situation; furthermore, the countries of these regions are committed to nuclear weapons free zone pacts (the Treaty of Tlatelolco, the Treaty of Rarotonga and the signed but inoperative Treaty of Pelindaba). This leaves just a few 'anxiously unincorporated' states – Iran, North Korea, and Syria in particular – outside of existing nuclear or nuclear-enabled security arrangements.

This system - malleable, responsive, and realistic - seems to have worked exceedingly well. Not only has nuclear war been averted over the last sixty years, but so, too, in a break with the entire history of humanity, has conventional war among major powers. But, as Churchill observed, this cold peace is ultimately the 'sturdy child of terror.' Perkovich and Acton, in harmony with Henry Kissinger, George Shultz and a host of others, are skeptical that it is so 'sturdy.' Many others – and probably the authors, too – also recoil at the second part of Churchill's advice, better defined as promoting the threat of disproportionate and overwhelming retaliation designed to render any aggression irrational in itself, as opposed to merely 'terror.'

But Perkovich and Acton have shown what getting to and living in a world without nuclear weapons would probably look like: one nervously overseen and dominated by a sovereign entity (or entities). Achieving a world without nuclear weapons would entail sacrificing national political autonomy and, in large part, independence, because a world of free and separate states must always exist with the possibility of serious conflict, and that tension is incompatible with laying down the most effective instruments of deterrence. All good things do not go together, and this monograph shows us the stupendous costs we would incur to rid ourselves of nuclear arms (assuming, almost certainly wrongly, that it is possible). To those who believe we are perpetually only a minute away from the midnight of nuclear darkness, such a tradeoff may be, if not appealing, simply a necessity. To those who value the independence of nations, or who see world government as a recipe for gross inefficiency and unresponsiveness, if not tyranny, and who can bear the tension of a cold peace, the abolition project is to be resisted. This is also the case for those who believe such a venture to be hopelessly unrealistic and unconscionably risky, and for those who reject it for a host of other reasons. Competition and tension are inherently part of human interaction, and so success is never final. The most we can hope for then, is a cold peace based on making major aggression of any kind positively irrational. In an imperfect world, that's a lot. ■

¹ For the author's view on the inadvisability of the goal of nuclear abolition, see Elbridge Colby, 'Nuclear Abolition: A Dangerous Illusion,' *Orbis* (Summer 2008): 424-433.

² Contrary to the authors' claim, nuclear weapons are thus not like chemical or biological weapons, which have been at least nominally banned, because finding 'other means [...] to perform their functions' is vastly more difficult – if not impossible – with nuclear weapons than with other weapons' (11). In fact, the reason chemical and biological weapons have been 'banned' is precisely because they could be so easily substituted.

³ For a further elaboration of this point, see Colby, 'Nuclear Abolition,' 431-432.

⁴ Charter of the United Nations, Article 24.

⁵ 'NATO Handbook: NATO's Nuclear Force's in the New Security Environment,' <http://www.nato.int/docu/handbook/2001/hb0206.htm> (accessed January 18, 2008).

JAMES M. ACTON AND GEORGE PERKOVICH

We hoped that our Adelphi Paper might provoke exactly the kind of debate in which we are now engaged. For too long, those opposed to the project of abolishing nuclear weapons did not think it worth committing their arguments to paper. We therefore welcome Elbridge Colby's response. Our disagreement with him centres on two questions: why bother to pursue abolition at all? And, would 'world government' be necessary to ensure security in a world free of nuclear weapons?

We believe, as Colby correctly identifies, that in the long run it will be impossible to prevent proliferation without a serious commitment to disarmament. There is a broad consensus that the non-proliferation regime is, at best, in need of a serious overhaul and, at worst, in the process of collapsing. To this end, the United States and its friends have tried to enact new rules to prevent the spread of sensitive nuclear technology, argued for tougher sanctions on Iran and North Korea, advocated the strengthening of International Atomic Energy Agency (IAEA) safeguards and sought clarification of the conditions under which a state can withdraw from the Non-Proliferation Treaty (NPT). These efforts have met with little success because a large number of non-nuclear weapon states - the vast majority of which are in compliance with their non-proliferation obligations - have declined to support them.

We posit in our Adelphi Paper that this lack of cooperation stems, in large part, from the failure of the nuclear-weapon states to live up to their obligation to work in good faith toward disarmament. In response, Colby first asks whether states really care about equity before arguing that, actually, because of extended deterrence the world is largely equitable anyway. This argument would find little traction in, say, Argentina, Brazil or South Africa - three leading non-nuclear weapon states whose support is vital to strengthening the non-proliferation regime. Each had a nuclear weapons programme - South Africa actually had the bomb - but decided to abandon it and join the Non-Proliferation Treaty. They, along with Egypt, Indonesia and several other 'middle powers,' increasingly feel they were mistaken to go along with the decision in 1995 to extend the NPT indefinitely because the nuclear weapon states display little serious intention to live up to disarmament pledges. It would be strained to suggest that these middle powers which increasingly resist new non-proliferation initiatives 'enjoy the benefits of nuclear weapons'

in the same way that Japan, Turkey or South Korea (and, of course, the nuclear-armed states themselves) do.

By abandoning nuclear weapons programmes, these states gave up more than the ability to deter. They deprived themselves of the status and political power that derive from nuclear weapons today. This self-abnegation looks increasingly self-impairing as the nuclear weapon states agree to extend special treatment to nuclear-armed India, for instance. Security obstacles to nuclear abolition are real, as we discuss extensively, but Colby is blind to the political hazard of allowing nuclear weapons to be sources of prestige. Only a commitment to abolition can devalue the political currency of nuclear weapons and thereby keep other states from trying to acquire their own.

To be clear: progress on disarmament is not necessary to justify the value of a strengthened non-proliferation regime, but, as a practical matter, diplomats are finding that it is necessary to achieve it. Christopher A. Ford, for instance, who served as the US special representative for nuclear non-proliferation during the Bush administration recently stated:

Clearly, in my view, they [non-proliferation and disarmament] are connected to the degree that there are those out there who will be more easily enticed into collaborative, cooperative work against would-be proliferators to the extent that they perceive there to be some hope of real movement on disarmament. It is safe to say, I think, that it has been harder as a matter of non-proliferation compliance diplomacy to elicit cooperative effort because there is this sort of leitmotif out there in certain circles that, in effect, the N5 [the five recognized nuclear-weapon states] don't really deserve our help in controlling proliferation because they're not doing what they ought to do. On any number of different levels I will fight that view on its merits; but silly or otherwise it's widely held; counterproductive and dangerous or otherwise it is widely held.¹

As we say in the Adelphi Paper, the desirability of working in good faith towards the abolition of nuclear weapons does not necessarily make the end achievable. A central purpose of disarmament is to enhance global security. To this end, improved 'global governance' would be necessary for the safe elimination of nuclear weapons, as Colby correctly emphasizes. But that is not the same thing as 'global government.' A 'sovereign-like entity' with 'the power to make decisions about states' central security dispositions' is his creation, not ours. He frequently uses the pronoun 'it,' in reference to global government, as if we had invoked it. Yet, we envisioned no such thing.

A world free of nuclear weapons could only depend for stability and security on the alignment of interests between key states, not on the

deus ex machina of world government. Enforcing an abolition agreement would require a legitimate forum for states to decide collectively upon the response to breakout, but it would be the states themselves, not Colby's 'entity,' that marshaled the means to confront a violator. The efficacy of this process would depend on states regarding non-proliferation as a supreme priority (which they do not today) and acting accordingly, not on a solution being imposed on them from above.

States would also have to believe that they could protect their vital interests without nuclear weapons. Again, this would require not a 'sovereign-like entity' but, in Harald Müller's words, a 'great power concert.'² In such a model of international relations, states recognize that their security and prosperity is best served by respecting one another's core interests. It is a model that emphasizes dialogue and diplomacy. States do not need to eschew the use of force entirely but they do need to refrain from unilateral or unauthorized military interventions.

We certainly do not want to downplay the daunting challenge of reshaping international relations in this way. There is complete agreement between Colby and ourselves that one prerequisite would be to solve (or permanently stabilize) those territorial disputes that stimulate proliferation of nuclear weapons and threats to use them. However, we do not regard the aim as utopian. South America, for example (as Colby himself points out), is a continental nuclear weapon free zone. States there could produce nuclear weapons, but they have chosen instead to secure themselves without them, and without nuclear deterrence being extended by external powers.

Our Adelphi Paper argues that a minimum condition necessary to eliminate nuclear weapons from other continents and regions is strategic cooperation between the US, Russia, and China. These states would have to remove the threats that make nuclear weapons attractive to themselves and to others that have legitimately acquired them. For instance, concerns about the evolution of China's nuclear arsenal leads India (and hence Pakistan) to seek the means to augment fissile material production and keep open the option to conduct nuclear tests. Russia does not now contemplate reducing its nuclear arsenals to the low hundreds due to concerns about US conventional military power, ballistic missile defenses, and overall American strategic intentions - concerns that China also shares. Similarly, worries about Russian and Chinese intentions towards American allies make nuclear deterrence an attractive option for the US. Moreover, without strategic understanding amongst these three permanent members of the UN Security Council, the Council is unlikely to reliably enforce non-proliferation rules. This problem can be seen in the failure to halt Iran's nuclear programme, which in turn makes nu-

clear disarmament in the Middle East a more distant prospect. To summarize, most of the problems that make the abolition of nuclear weapons unfeasible today stem from the current divergence of US, Russian, and Chinese interests.

Several points contrary to Colby's discourse arise from this analysis. First, global government is irrelevant: the real challenge is for the three big nuclear weapon competitors to reorder their security relations in ways that could end their reliance on nuclear weapons, and then to build on their convergence to induce the other nuclear-armed states to follow suit.

Second, if these states move in this direction, they will not surrender national sovereignty, as Colby suggests. Rather, they will be making sovereign decisions to reassure each other and their neighbors that they will respect each other's territorial integrity and will only deploy military assets in non-threatening ways. This can be formalized in arms control and disarmament agreements, with the sort of verification and enforcement procedures we indicate. Such procedures may assign functions to international bodies - such as the International Atomic Energy Agency - but this is hardly revolutionary practice in international politics.

Finally, contrary to Colby's allusions, we do not predict that the many states whose cooperation would be necessary to make nuclear abolition feasible will actually take the necessary steps (although we urge them to do so). We merely try to identify some of those steps and invite serious international analysis and debate. We find nothing to fear in such debate, not least because we believe that states will not take the many sequential actions required to abolish nuclear weapons if they do not gain security along the way. ■

Notes

¹ Christopher A. Ford, 'Deterrence to (and Through) "Zero": Challenges of Disarmament and Proliferation' (speech to the Woodrow Wilson Center for International Scholars, Washington DC, 14 November 2008), <http://www.wilsoncenter.org/index.cfm?fuseaction=events.event—summary&event—id=487660> (accessed January 19, 2009).

² Harald Müller, 'The Importance of Framework Conditions,' in *Abolishing Nuclear Weapons: A Debate*, ed. George Perkovich and James M. Acton (Washington, DC: Carnegie Endowment for International Peace, forthcoming).

Daniel Pope. *Nuclear Implosions: The Rise and Fall of the Washington Public Power Supply System*.

Cambridge: Cambridge University Press, 2008. 282 pp. £55/\$85 (hbk). ISBN: 9780521402538

RAFAEL HEFFRON (Judge Business School and Trinity Hall, University of Cambridge)

New civil nuclear power is currently being advocated by governments across the United States and the European Union. This can be attributed to nuclear energy having been reframed as a solution in reducing carbon dioxide emissions. In *Nuclear Implosions: The Rise and Fall of the Washington Public Power Supply System*, Daniel Pope provides a timely, extensive and retrospective analysis of a previous push for the expansion of civil nuclear power in Washington State in the US. In essence, the author provides a detailed historical example of possible dangers and pitfalls associated with the provision of new nuclear power for the electricity market. The case revolves around the rush for nuclear energy as an energy source by a public agency in Washington State. The historical account is developed over six chapters. This before a concluding seventh, that delivers an analysis of the conditions of the current energy market in Washington and the lessons to be learned from the historical overview which apply to local, national and international communities.

The first two chapters chronologically detail how Washington state progressed to a situation where it committed to build five large nuclear power plants in the 1960s and 1970s. The Pacific Northwest region held the view that economic growth and electrical supply were positively and intrinsically linked. In the middle of the twentieth century, once hydro-power capacity was maximised, nuclear energy became an option. For this purpose a consortium of local public utility companies formed an alliance to create the Washington Public Supply System.

How the Washington Public Supply System began its implosion is detailed in chapters three and four. The author explains how conditions for five nuclear reactors were unfulfilled and only one plant was completed, and became operational. The root of the difficulties lay with the financial strains that arose because of the later plants' failure to secure the necessary financial guarantees. The situation was not helped by

problems arising with electrical demand, costs, and completion dates falling far short of their estimated values. The author cites theories from organisational and management studies, and states that the elements of implosion for nuclear power projects are also prevalent in other types of construction, transport, and infrastructure projects.

The resulting implosion is outlined in chapters five and six, and at the forefront of this were continuous financial and legal battles for all stakeholders concerned. One legal action by bondholders even prompted reform in the bond market. Of significance was the overall implication of the failure which resulted in the questioning of the capability of the legal system to resolve the issue of responsibility in cases of such complexity and magnitude. An underlying premise is that in comparison to oil or even gas, nuclear power has too much risk associated with it; a result of its high initial financial costs and potential for extreme environmental disaster.

The concluding chapter analyses the current state of the Washington state energy supply market while also deliberating upon the lessons learnt as a result of the crisis. Of particular concern to the author is the question whether the environment, energy supply and security, and economic concerns can be balanced in energy policy. The merit of Pope's research lies in this question. The effect of not achieving a balanced energy policy is demonstrated in the earlier chapters. For a person at any level involved in, or contributing to, energy policy this book presents an insight into an important episode in the history of nuclear energy. An undertone that runs through the last chapter suggests that nuclear energy policy that has not yet comprehensively dealt with the financial, technological, legal and, public concerns involved in new nuclear power projects risks peril. This book tells a cautionary tale for anyone contemplating a series of nuclear power plants in the twenty-first century. ■

David Elliot ed. *Nuclear or Not? Does Nuclear Power Have a Place in a Sustainable Energy Future?*

Basingstoke: Palgrave MacMillan, 2007. 257 pp. £56 (hbk).

ISBN: 9780230507647

DAYFDD ELIS (Worcester College, University of Oxford)

The early years of this decade were bleak for the British nuclear industry. In 2003, with electricity prices low and the massive government bailout of British Energy fresh in the mind, a Government White Paper seemed to sum up neatly the prospects for a new era of nuclear generation in the United Kingdom, describing the economic case as ‘unattractive’ and noting that the question of dealing with waste was still unresolved.

The tide was soon to turn, however, as rising natural gas prices and concerns about delivering on ambitious greenhouse gas emission targets came to feature more prominently in the Government’s thinking. In 2006, a mere three years after all but writing off the nuclear option, the Government conducted another review of the energy policy. The unambiguous conclusion was that atomic energy did have a role to play in Britain’s energy future after all. In the memorable words of Tony Blair, nuclear was ‘back on the agenda with a vengeance.’

With the nuclear debate well and truly re-opened, this would seem to be a propitious time for the publication of a book outlining the current state of the debate over nuclear power in the United Kingdom. *Nuclear or Not* seeks to do so by presenting a collection of essays from fourteen writers drawn from universities and from the nuclear industry.

The volume succeeds in capturing both the breadth and depth of this complex debate. It opens with a primer in nuclear fission technology and a history of the arguments about its use in the UK. Then two contrasting chapters consider how the discussion ought to be structured before proceeding to the substance of the contemporary cases for and against new nuclear.

As with any complex policy problem, framing the nuclear question carefully and consistently is critical. It is to the editor’s credit, then, that this is treated explicitly and early on. In the first essay, Gregg Butler and Grace McGlynn plead for a debate that is not framed as a search for an ideal form of electricity generation. All technologies have advantages and disadvantages, they argue, and our goal should be to find a mix of technologies that represents the best possible trade-off between risk and reward. The second essay, by Paul Allen, couches the debate in very

different terms. He argues that we must break the deadlock between nuclear and renewables by choosing, once and for all, which technology will take us to a low-carbon future.

Allen writes passionately, but does not convince intellectually, particularly when read next to Butler and McGlynn. He does not seek to justify, either conceptually or empirically his central premise: that there is a deadlock between nuclear power and renewables. Similarly, he does not justify the (self-devised) framework that he uses to compare the two technologies. Butler and McGlynn's approach of comparing overall costs and benefits of different options may raise several practical problems, but it is at least ethically well-rooted in utilitarianism.

After the two essays framing the debate, the volume proceeds to consider whether renewables and nuclear are complementary or competing technologies, again by means of two essays that reach very different conclusions.

Finally, the volume considers the main substantive issues of the debate: health risks, radioactive waste, the threat of terrorism, and cost. It also offers three perspectives on nuclear energy around the world in order to tackle the issues beyond the British context. All these contributions are well-informed, and interestingly each writer (with one exception) concludes that nuclear is not an option that the United Kingdom should pursue.

On first reading, this seems to amount to a strong and well-informed case against new nuclear builds. It is difficult, however, to avoid the suspicion that the negative answer most authors give to the question is due at least in part to an incomplete analysis of exactly the kind that Butler and McGlynn counsel against. This is perhaps a predictable result of in-depth treatment of some of the negative aspects of nuclear without a similarly-detailed analysis of other technologies.

Wisely, the editor adopts a more neutral line in his closing chapter, suggesting that nuclear may have a useful role to play despite its drawbacks. It is questionable whether a book that focuses on a single technology can make a balanced and holistic analysis of our energy options. Despite this, *Nuclear or Not* succeeds in offering an informative and well-articulated perspective on a debate that is certainly not over just yet. ■

Constance Perin. *Shouldering Risks: The Culture of Control in the Nuclear Power Industry.*

Oxford: Princeton University Press, 2007. 379 pp. £19.95 (pbk).
ISBN: 978069112774

MALCOLM JOYCE (Lancaster University)

Constance Perin's *Shouldering Risks: The Culture of Control in the Nuclear Power Industry* presents an enormously thorough argument on the complexities of human behaviour in response to both anticipated and unexpected events in the high-hazard industry that is today's nuclear power sector in the United States. Perin's text is very timely, hitting the desks of academics, technologists and psychologists at a time when much of the industrialised world is seriously considering a return to mainstream nuclear electricity production, via a proposition of several new reactor designs. Most of these reactor systems have been designed, in part, to alleviate anxieties associated with vulnerabilities of active safety systems by incorporating a variety of passive safety features into the new plant, to use fewer components and to occupy a smaller site footprint. Given that all this is technically feasible, since new plant are now in build, what do we know of the complex interaction of humans with these new designs, and moreover, what scope is there for error? This is the subtext of Perin's book and also an emphasis of its conclusion, based on an analysis of several events from the existing US nuclear power fleet.

Perin selects four real scenarios for consideration by the reader, each sufficiently technologically-dependent to have generated significant cause for thought within the specific nuclear plant communities associated with them. At the same time the events are also mutually complementary and are representative of the spectrum of possibilities that can face a plant operating team. This is unlikely to be a text that non-technologists will feel the need to discard as a result of overwhelming technological jargon as Perin has achieved an excellent compromise between the need for technical context and the non-technical premise of this text. Interestingly, what appeals most to the technologist on reading this book, in my opinion, is the unusual and welcome snapshot that Perin has established of the culture of engineers and technologists in the nuclear industry. Far from being full of jargon, the reader is left informed of the priorities and values of the highly-skilled and committed people that run these

complex high-hazard systems. For aspiring engineers in particular, this readily-available context, supported by extensive transcripts of numerous interviews with scientists and engineers at the front line in real plants, summarizes the routine, high-value decision making culture that some would argue is the essence of twenty-first century engineering with complex systems.

That is not to say that this is a trivial book to read – there is an enormous amount of cited detail whilst, conversely, the necessary technical background will be too superficial for some tastes. In particular, the summaries of the Three Mile Island and Chernobyl accidents early in the text opt for ‘root cause’ descriptions that not only belie the complexity and extensive research that these events have attracted, but also perhaps contradicts Perin’s warning reference to ‘folk theories’ in her conclusion. It is also important to appreciate in reading this text that, despite the nuclear industry’s global community and its desire to share information across national boundaries, this text is almost entirely a perspective from the United States and is nuclear-centric. There are thus important caveats in extrapolating the conclusions to a broader global context or to other high-hazard industries. For example, the incipient naval culture that Perin describes early in the book is not so apparent in the UK, due to significant differences in plant design and the origin of many nuclear engineers being in conventional power production. Furthermore, the ‘insular nature of many departments [in nuclear training]’ is not so in Europe, I would argue, with many engineers pursuing extensive courses in the societal responsibilities of technology and human performance. A broader global, cross-sector analysis of the type Perin presents in *Shouldering Risks* would be even more fascinating. ■

Michael Levi. *On Nuclear Terrorism*.

London: Harvard University Press, 2007. 210 pp. £18.00 (hbk).
ISBN: 9780674026490

DAVID ZARNETT (St Antony's College, University of Oxford)

In this sober and well-reasoned analysis, Michael Levi delves deep into the simultaneously exaggerated and underestimated threat of nuclear terrorism. The strength of this book is in the balance he draws between relevance for experts and policymakers on one hand, and comprehensibility for laymen on the other. Levi's central argument is that an effective defence system must be multifaceted and integrated, utilizing a creative rather than 'worst-case scenario' strategic approach, and accepting of the fact that absolute security is a chimera.

The spectre of nuclear terrorism in a post-9/11 world has created a sense of nostalgia for cold war stability. Yet the most intriguing aspect of Levi's analysis informs us that such nostalgia may not be warranted. Levi convincingly challenges the commonly held view that the odds are stacked against the security services who must succeed every time while the terrorists only have to succeed once. The author argues that this view should be flipped around. Instead of focusing on the dynamic between the terrorist group and the defence system from plot to plot, we should focus on this dynamic within single plots. Doing so results in Levi's remarkably more optimistic assessment that 'terrorists must succeed at every stage, but the defence needs to succeed only once.'

Thus, terrorists face considerable challenges in perpetrating a successful nuclear strike. When a terrorist group dodges one level of defence, they incur costs that increase their chances of detection at a later stage. For example, to acquire nuclear material, a terrorist organization may wish to avoid detection by foregoing one large purchase and instead making a series of smaller purchases. In doing so, the terrorists may evade detection, but they also increase their risk of falling prey to a sting operation or being a victim of fraud, as al-Qaeda was in 1993. If a terrorist is able to gather sufficient material and evade detection, the next set of obstacles is in assembling the weapon. Nuclear materials, especially uranium metal, are volatile and susceptible to spontaneous combustion. An explosion or fire may expose the plot to the authorities as it did to a Manila-based group in 1995, which was plotting to take down US airliners across the Pacific. In addition to accidents, the quality of the materials used also creates complications. These challenges can be overcome

by technical expertise but it is here that the terrorist group is faced with what may be its most serious trade-off: seeking technical expertise from those outside the group may increase the risks of detection but limiting expertise to within the group may increase the risks of technical failure.

This slim but dense volume ranges widely across a complex topic. Perhaps its key contribution lies in its detailed study of the trouble terrorist groups must go through if they decide to 'go nuclear.' While cold war-style deterrence is ineffective against non-state nuclear terrorists, reading this book will at least make them think twice. ■



Climate Change: Preparations for a Low-Carbon Future Call for Papers

Abstracts due April 30, 2009

Papers due August 31, 2009

Climate change has become an inescapable issue in national and international policy arenas. The scientific evidence for anthropogenic climate change has become increasingly clear and suggests the need for very significant and far-reaching changes across many spheres of economic, social, and political activity, both in terms of reducing emissions levels and adapting physical and social infrastructures to cope with future changes in climatic patterns and human environments. Yet, despite growing scientific consensus, the pace of addressing this challenge has varied considerably across policy-making areas, societies, and sites of governance. The *St Antony's International Review (STAIR)* seeks to examine the policy responses which are taking place across the full spectrum of global social and economic life, and invites academics, emerging scholars, and policy experts to submit abstracts of papers that explore one or more of the following topics related to preparations for a low-carbon future.

Framing the Issue

The way in which climate change discourse has been framed (in terms of a debate regarding the prioritization of mitigation versus adaptation, or whether commitments should be voluntary or legally binding) has implications for what action needs to be taken and by whom, and how present and future costs and benefits are distributed. How does construction of climate change as an issue vary across different policy areas? Is a shared understanding of the challenges posed by climate change necessary for effective action?

Rethinking Existing Policy

The twin challenges of mitigation and adaptation are posing new and far-reaching questions for policy-making across subjects as wide-ranging as international development, food, migration, health, forestry, international trade, technology, and intellectual property policy. How are different policy-making spheres addressing the issue of climate change? Does the incorporation of a climate dimension in sectoral policy debates

represent a genuine shift, or is it a form of 'green-washing' or 'cheap talk'?

Actors and Sites of Governance

A wide range of actors and sites of political action have emerged in response to the drive to address climate change, spanning the public and private sectors, as well as the global, regional, national, and sub-national levels. Which actors and forums have been privileged in this process, and with what consequences? Which elements of the problem are amenable to solution at local or national level, and which require truly global responses? Are existing institutions fit for the challenge, do the 'rules of the game' need to be changed, or is there a need for entirely new institutions?

Societal Attitudes Towards Consumption

Values and attitudes towards consumption and the environment are crucial to how climate change, and efforts to tackle it, will unfold. Are pressures from societal actors forcing shifts in policy-making, or are governments taking a lead in promoting low-carbon modes of production and consumption? Are some governments running too far ahead of the preferences of their electorates? Who should be responsible for encouraging such a transition, and by what means?

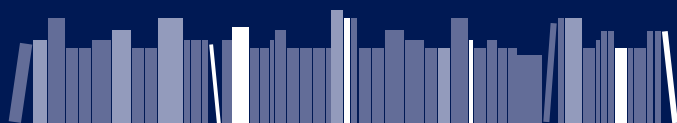
In conjunction with this general call for papers, *STAIR* also seeks to publish book reviews of works that adhere to the advertised theme of the issue.

Notes for contributors are available at www.stair-journal.org
Contact: info@stair-journal.org

BLACKWELL

THE LARGEST SELECTION OF
INTERNATIONAL
RELATIONS
BOOKS IN OXFORD

VISIT OUR POLITICAL
& REGIONAL STUDIES
DEPARTMENT TO BROWSE OUR STOCK



RESERVE ONLINE, COLLECT INSTORE

Blackwell are delighted to support St. Antony's International Review

Contact us:
Blackwell
48-51 Broad Street
Oxford OX1 3BQ
Tel: 01865 333661
Email: politics.ox@blackwell.co.uk

www.blackwell.co.uk

COME & SEE
US IN THE
NORRINGTON
ROOM

BLACKWELL

THE KNOWLEDGE RETAILER