

Nuclear Energy in the Twentieth Century: New International Approaches

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Elisabetta Bini e Igor Londero

Nuclear Energy in History

Nuclear energy represents one of the most controversial issues in contemporary history and politics, and raises either vehement opposition or unconditional support. On the one hand, the use of nuclear technology in the bombing of Hiroshima and Nagasaki during the Second World War shaped postwar discussions about the use of nuclear power, while at the same time influencing the balance of power between the two superpowers and relations inside the Atlantic bloc and with Third World countries. On the other hand, the same technology that raised fears of a potential nuclear conflict – and therefore of a Third World War and of a total annihilation of mankind – also became the object of widespread beliefs in the possibility of producing an unlimited, clean and effi-

cient source of energy. This apparent contradiction between the hopes and fears of nuclear power was declined differently in different national contexts, but characterized most countries in the post-World War II period. For many, including Italy, the «nuclear euphoria» of the 1950s and 1960s was strongly linked to the lack of energy resources. For others, such as Third World countries, access to nuclear power became a way of overcoming the technological gap with the developed world, and establishing their place in the international arena. In all cases, debates about nuclear policies intersected in complex ways with wider discussions about modernization and international relations¹.

Over the last twenty years, scholars have devoted an increased attention to the study

¹ B. Heuser, *Nuclear Mentalities? Strategies and Beliefs in Britain, France and the FRG*, New York, Palgrave Macmillan, 1998; S.R. Weart, *The Rise of Nuclear Fear*, Cambridge, Harvard University Press, 2012.

of nuclear energy. They have examined not only its political and military aspects, but also its industrial, social, cultural and scientific implications. By accessing new archival sources and using new methodological tools, these studies represent one of the most original fields of research in contemporary history. They incorporate a variety of approaches coming from different disciplines, such as the history of science, science and technology studies, international relations, business history, literature and media studies, and the history of social movements, all areas that often lie at the intersection of national, international and global history².

The following essays analyze some of the main issues that have been at the center of historiographical debates about nuclear energy in the last two decades. While adopting different points of view, they all address topics and fields of study that usually remain separate, namely the relationship between civilian and military nuclear power, the importance of nuclear energy in shaping post-World War II forms of modernization and international cooperation, the role played by scientists, anti-nuclear movements, and cultural representations of nuclear power in influencing or challenging government policies and promoting a transnational public opinion.

The military dimension of nuclear power has been at the center of a vast historiogra-

phy. While studies initially focused on the use of the atomic bomb during the Second World War and its aftermath, more recently scholars have expanded the scope of their research and have examined the diplomatic and political implications of the Cuban crisis, the Non-Proliferation Treaty (NPT), and the Euromissiles crisis, and their effects on the Cold War. Thanks to the opening of new archives and to projects such as the Nuclear Proliferation International History Project (NPIHP), they have also highlighted the importance of moving beyond a Cold War framework of analysis to examine the importance nuclear arms had in shaping Third World policies during and after the end of bipolarism³.

The relationship between military and civilian nuclear power has been at the center of a growing and particularly path-breaking literature, which has highlighted the importance of nuclear energy in shaping new forms of international cooperation (e.g. through EURATOM, the International Atomic Energy Agency and the Atoms for Peace program), as well as forms of national identity⁴. Many of these studies have examined the relationship between research institutions, the business world and the state in what was a very specific and peculiar case of post-World War II modernization. As some scholars have started to point out, the history of civilian uses of nuclear energy should be understood as part of a

² See the rich bibliography included in the various essays published in this forum.

³ The Nuclear Proliferation International History Project website is particularly rich in terms of archival information: www.wilsoncenter.org/program/nuclear-proliferation-international-history-project.

⁴ See for example G. Skogmar, *The United States and the Nuclear Dimension of European Integration*, Basingstoke, Palgrave Macmillan, 2004; G. Hecht, *The Radiance of France: Nuclear Power and National Identity after World War II*, Cambridge, The MIT Press, 2009.

much wider history of industrialization, and should be related both to debates about specific energy policies and to the building of modern democracies. As Barbara Curli argues in her essay, the decline of nuclear power from the 1970s onwards was the result not only of nuclear accidents or of the emergence of anti-nuclear and environmental movements, but also of a more general critique of modernity and growth. While the «nuclear crisis» has characterized most Western European countries, it has only partially involved the developing world or Eastern Europe, whose specific historical experiences have been the object of a thriving scholarship⁵.

One of the most promising fields of research concerns the role scientists, especially physicists, have played in different national contexts and internationally. Most studies have challenged existing barriers between the humanities and the hard sciences, and have examined the many uses governments, industries and research institutions made of radioisotopes, in biology and medicine, and in the production of civilian nuclear energy. By intersecting various disciplines and methodologies, this

research has shown the complexity that characterized postwar research in nuclear physics and has shed new light on the importance of transnational forms of scientific cooperation, despite the existence of specifically national policies on nuclear power⁶. Indeed, since the Manhattan Project, Research & Development (R&D) in nuclear technology led to forms of international exchange across the Cold War divide and between the North and the South. As recent studies have pointed out, in Europe nuclear research shaped the emergence of a transnational technocratic elite in charge of building forms of European integration through EURATOM⁷.

Scientists, particularly physicists, have been at the forefront of debates about the political, economic and ethical implications of nuclear power since the Second World War. This was particularly clear in the case of the Italian *émigrés* involved in the Manhattan project, who faced the difficult decision of supporting the use of the atomic bomb against Japan. The growing forms of opposition against the military applications of nuclear power have been at the heart of numerous studies, which have highlighted

⁵ I. Hristov, *The Communist Nuclear Era: Bulgarian Atomic Community during the Cold War, 1944-1986*, Amsterdam, Amsterdam University Press, 2014; S. Schmid, *Producing Power: the Pre-Chernobyl History of the Soviet Nuclear Industry*, Cambridge, The MIT Press, 2015; E. Gheorghe, *Building Détente in Europe? East-West Trade and the Beginnings of Romania's Nuclear Programme, 1964-70*, «European Review of History», 2014, 2, pp. 235-253; G. Hecht, *Being Nuclear: Africans and the Global Uranium Trade*, Cambridge, The MIT Press, 2012.

⁶ A.N.H. Creager, *Life Atomic: A History of Radioisotopes in Science and Medicine*, Chicago, The University of Chicago Press, 2013; F. Cassata, *L'Italia intelligente. Adriano Buzzati-Traverso e il Laboratorio internazionale di genetica e biofisica (1962-69)*, Roma, Donzelli, 2013; G. Battimelli, M. De Maria, G. Paoloni, *L'Istituto Nazionale di Fisica Nucleare. Storia di una comunità di ricerca*, Roma-Bari, Laterza, 2001.

⁷ See in particular J. Krige, *Atoms for Peace, Scientific Internationalism, and Scientific Intelligence*, in J. Krige, J.H. Barth (eds.), *Global Knowledge Power: Science and Technology in International Affairs*, Chicago, University of Chicago Press, 2006, pp. 161-181; Id., N. Oreskes (eds.), *Science and Technology in the Global Cold War*, Cambridge, The MIT Press, 2014.

the important role played by scientists but also by women and youth, and by pacifist, Communist and federalist organizations, from the 1950s onwards⁸. Many of them have highlighted the ways in which disarmament and anti-nuclear movements intersected with the emergence of new forms of grassroots democracy, both nationally and transnationally, particularly after the Three Mile Island accident and in the context of the Euromissiles crisis. They have thus highlighted their importance in challenging Cold War nuclear policies and the persistence of bipolarism during the 1980s⁹. One aspect of nuclear power that has only recently become the object of scholarly attention is the study of the forms of communication and propaganda that were carried out in support of or against nuclear power. Recent publications have examined the ways in which different media portrayed nuclear issues at a time when nuclear power symbolized both the promise of unlimited growth (embodied by the Atomium, built for the 1958 Brussels World's Fair) and the threat of global annihilation. They have also analyzed how these representations intersected with wider changes in so-

ciety, with the spread of mass consumption and the emergence of a transnational public opinion¹⁰. This research is particularly relevant not only from a historical point of view, but also in terms of current debates about nuclear energy. Especially after the Chernobyl disaster of 1986 and the Fukushima accident of 2011, public discussions concerning civilian and even medical uses of nuclear power have often been couched in stark ideological terms, making it difficult to adopt a critical perspective¹¹. Studies about the communication of nuclear risks, safety, science and technology might contribute to a more informed debate, also in light of the recent «nuclear renaissance» which has characterized especially the developing world¹².

The richness of international research on the history of nuclear energy may also fuel new studies about Italy's nuclear experience, which has largely remained on the margins of this scholarship. Yet, the Italian case is defined by a series of distinctive traits that make its study particularly relevant. It was characterized by a strong tradition in nuclear physics, which paved the way for post-World War II research in

⁸ L. Clavarino, *Scienza e politica nell'era nucleare. La scelta pacifista di Edoardo Amaldi*, Roma, Carocci, 2014.

⁹ K. Zarleno, *Civilian Threat, the Suburban Citadel, and Atomic Age American Women*, «Signs», 1999, 4; L.S. Wittner, *Confronting the Bomb: A Short History of the World Disarmament Movement*, Stanford, Stanford University Press, 2009; A.M. Kirchhof, J.H. Meyer (eds.), *Global Protest against Nuclear Power. Transfer and Transnational Exchange in the 1970s and 1980s*, special issue of «Historical Social Research», 2014, 1.

¹⁰ One of the few works is D. van Lente (ed.), *The Nuclear Age in Popular Media: A Transnational History, 1945-1965*, New York, Palgrave Macmillan, 2012.

¹¹ M. Arndt, *Memories, Commemorations and Representations of Chernobyl*, special issue of «Anthropology of East Europe Review», 2012, 1; T. Kasperski, *The Chernobyl Nuclear Accident and Identity Strategies in Belarus*, in G. Mink, L. Neumayer (eds.), *History, Memory and Politics in Central and Eastern Europe: Memory Games*, New York, Palgrave Macmillan, 2013.

¹² X. Yi-chong (ed.), *Nuclear Energy Development in Asia: Problems and Prospects*, New York, Palgrave Macmillan, 2011.

nuclear technology, and it was one of the first countries to express interest in developing civilian nuclear energy. However, it was also one of the first European nations to abandon nuclear power, not only as a result of anti-nuclear and environmental movements, but also as the outcome of political decisions about Italy's energy

policies. In recent years, new research has been carried out and has led to several conferences, such as *Il nucleare in Italia nel secondo dopoguerra. Ricerca, cultura, politica*¹³ held in 2012, and *Italy's Nuclear Experience in an International and Comparative Perspective*¹⁴ held in 2014, but much remains to be done¹⁵.

Leopoldo Nuti

Le armi nucleari e la Guerra fredda

La ricerca storica sulle armi nucleari si è concentrata a lungo prevalentemente su due grandi temi: da un lato la costruzione della bomba e la decisione di impiegarla alla fine della Seconda guerra mondiale, dall'altro il ruolo avuto dalle armi nucleari nel corso della Guerra fredda. In questa breve rassegna cercherò innanzitutto di ricapitolare le conclusioni a cui è giunto il dibattito storico e teorico su quest'ultimo punto, per discutere poi i lavori di alcuni degli autori che in anni recenti hanno svolto le ricerche più innovative e interessanti su alcuni momenti specifici del confronto bipolare, e concludere infine con un accenno alle tendenze più attuali¹.

Le armi nucleari e il sistema internazionale

Il dibattito storiografico e politologico sulla rilevanza delle armi atomiche ha ruotato sostanzialmente intorno a tre interpretazioni contrapposte. Per la prima, che è quella prevalente, le armi nucleari non sono state solo una componente rilevante della Guerra fredda, ma una delle sue caratteristiche strutturali. Solo il loro enorme potere distruttivo, in altre parole, avrebbe reso impossibile lo scatenarsi di un nuovo conflitto mondiale tra le grandi potenze. Come ha argomentato a più riprese John Lewis Gaddis, è stata la progressiva presa

¹³ www.elettra.trieste.it/Ippolito/.

¹⁴ www.elettra.trieste.it/Conferences/2014/NuclearItaly/. E. Bini, I. Londero (eds.), *Nuclear Italy: An International History of Italian Nuclear Policies during the Cold War*, Trieste, EUT, 2016 (forthcoming).

¹⁵ The editors of this forum are part of the Nuclear Italy Research Group (NIRG), founded in 2014, which includes researchers from the Department of Humanities of the University of Trieste, Elettra Sincrotrone S.C.p.A. Trieste, the Political Science Department of the University of Roma Tre, the Machiavelli Center for Cold War Studies (Cima), the Physics Department and the Department for Documentary, Linguistic-Philological and Geographical Sciences of the University of Rome «La Sapienza» and the Department of Culture, Politics and Society of the University of Turin.

¹ La letteratura sulle armi nucleari è estremamente ampia e variegata. Per ovvi motivi di spazio, in questa rassegna non vengono prese in considerazione opere di natura generale quali quelle di McGeorge Bundy o Lawrence Freedman.

di coscienza di questa terribile capacità di infliggere devastazioni immani che ha reso le superpotenze sempre più riluttanti a correre rischi da cui potesse scaturire un conflitto. Con il passare del tempo, perciò, la parità strategica ha spinto Stati Uniti e Unione Sovietica ad accettare lo *status quo* uscito dalla Seconda guerra mondiale, rendendo così le armi nucleari un elemento cruciale per la stabilità del sistema internazionale – quella che Gaddis ha definito «la lunga pace»². A livello teorico, questa interpretazione è stata poi sviluppata ulteriormente da Ken Waltz, con il famoso argomento che le potenze dotate di armi nucleari tendono a diventare attori sempre più responsabili e razionali, fino a produrre il paradossale risultato che *more may be better*; più armi nucleari ci sono in giro e più stabile è il sistema internazionale³.

Diametralmente opposta è la tesi del politologo americano John Mueller, il quale sostiene che il mancato scoppio di una terza guerra mondiale non sia la conseguenza della rivoluzione strategica causata dalle armi nucleari, ma la conclusione logica di un processo di apprendimento collettivo innescato dai disastri provocati dalle due spaventose guerre mondiali del XX secolo. Nell'argomentazione di Mueller, la presenza delle armi nucleari non ha alterato questo processo in maniera significativa, e

una terza guerra mondiale non ci sarebbe comunque stata anche se le bombe atomiche non fossero mai state inventate. L'ossessione delle grandi potenze per il conseguimento di uno status nucleare, perciò, è stata del tutto inutile: le armi atomiche possono aver provocato scelte politiche irrazionali o aver distorto le priorità di spesa dei governi, ma alla fine non hanno inciso sull'evoluzione di fondo del sistema internazionale⁴.

Molto più diffusa rispetto alle tesi di Mueller, infine, è la tendenza che sottolinea sì la rilevanza delle armi nucleari, ma per giungere a conclusioni ben diverse da quelle di Gaddis o Waltz. Secondo questa prospettiva, infatti, le armi nucleari hanno avuto un impatto decisamente negativo sul confronto bipolare, ampliando le tensioni tra le superpotenze e innescando una corsa agli armamenti che a sua volta ha generato ulteriori frizioni e momenti di crisi. Inoltre il loro moltiplicarsi ha aumentato in maniera esponenziale la possibilità di incidenti o di un impiego non autorizzato, come ha sostenuto a livello teorico Scott Sagan sia nel suo studio *The Limits of Safety*, sia disputando apertamente le tesi di Waltz in un fortunato saggio divenuto un classico in cui i due autori criticano le rispettive posizioni, *The Spread of Nuclear Weapons*⁵. A livello storiografico, analoghe argomenta-

² J.L. Gaddis, *The United States and the End of the Cold War: Implications, Reconsiderations, Provocations*, New York, Oxford University Press, 1992, in particolare il cap. 5, *The Essential Relevance of Nuclear Weapons*.

³ K.N. Waltz, *The Spread of Nuclear Weapons: More May Be Better: Introduction*, «The Adelphi Papers», 171, 1981, p. 1.

⁴ J. Mueller, *The Essential Irrelevance of Nuclear Weapons: Stability in the Postwar World*, «International Security», 1988, 2.

⁵ S. Sagan, *The Limits of Safety. Organizations, Accidents and Nuclear Weapons*, Princeton, Princeton University Press, 1993.

zioni sono state portate avanti soprattutto negli studi pubblicati sulla crisi di Cuba a partire dagli anni Novanta⁶. Conclusioni simili sulla pericolosità della corsa agli armamenti sono state infine raggiunte dagli studi sulla cosiddetta *war scare* del 1983, che hanno sottolineato la gravità della spirale di tensioni innescatasi nei primi anni Ottanta e culminata nell'esercitazione dell'alleanza atlantica *Able Archer*: secondo alcuni autori, infatti, quell'esercitazione fu interpretata erroneamente dai sovietici come un possibile attacco preventivo⁷. Un fortunato saggio di Eric Schlosser pubblicato nel 2013, dall'ironico titolo *Command and Control*, ha ulteriormente sviluppato questi temi, portando alla luce una serie di rischiosi incidenti o di malfunzionamento dei sistemi d'arma che avrebbero potuto degenerare nell'uso non autorizzato di ordigni nucleari⁸.

L'impiego delle armi atomiche alla fine della Seconda guerra mondiale

La storia della costruzione della bomba nel corso del secondo conflitto mondiale e la decisione di sganciarla contro le città di Hiroshima e Nagasaki continuano ad attrarre l'attenzione degli studiosi e costituiscono il problema più studiato della storia dell'era nucleare, in un dibattito che sembra desti-

nato a non avere fine. Per oltre un decennio dopo la fine del conflitto, la scelta dell'amministrazione Truman fu interpretata quasi esclusivamente alla luce della dettagliata ricostruzione fornita da uno dei protagonisti, l'ex segretario della guerra Henry Stimson, in un suo celebre saggio pubblicato nel 1947 su «Harper's Magazine»: il presidente americano e i suoi collaboratori ritennero necessario utilizzare le armi atomiche contro il Giappone per mettere fine alla guerra il prima possibile⁹. Questa lettura degli avvenimenti, come è noto, fu contestata dalla pubblicazione del volume con cui Gar Alperovitz sostenne invece che la bomba non fu utilizzata per accelerare la fine del conflitto ma per costruire una posizione di forza nei confronti dell'Unione Sovietica, in vista di un dopoguerra che si preannunciava quanto mai complesso¹⁰. Da allora la controversia non si è mai spenta ed è andata ben oltre la dimensione accademica, fino a condizionare l'allestimento dell'esibizione preparata dall'Air and Space Museum di Washington per celebrare il quarantesimo anniversario della fine della Seconda guerra mondiale, nel 1995.

Il dibattito si è inoltre arricchito sia grazie a una serie di studi che hanno contribuito ulteriormente a definire la dialettica interna all'amministrazione Truman, come quelli di Barton Bernstein o Martin Sher-

⁶ La storiografia sulla crisi cubana è amplissima. Per un'analisi relativamente aggiornata, cfr. R. Fitzgerald, *Historians and the Cuban Missile Crisis: The Evidence-Interpretation Relationship as seen through Differing Interpretations of the Crisis Settlement*, «Irish Studies in International Affairs», 2007, 1.

⁷ The 1983 War Scare: «The Last Paroxysm» of the Cold War, in The National Security Archive, www.nsarchive.gwu.edu/NSAEBB/NSAEBB426/.

⁸ E. Schlosser, *Command and Control. Nuclear Weapons, the Damascus Accident, and the Illusion of Safety*, New York, Penguin Random House, 2013.

⁹ H.L. Stimson, *The Decision to Use the Atomic Bomb*, «Harper's Magazine», 1161, 1947, pp. 97-107.

¹⁰ G. Alperovitz, *Atomic Diplomacy: Hiroshima and Potsdam*, New York, Simon and Schuster, 1965.

win, sia grazie alla progressiva disponibilità di fonti archivistiche non americane, che hanno permesso di studiare da un lato la percezione giapponese dell'impiego della bomba e dall'altro l'influenza che il bombardamento delle città giapponesi può aver esercitato sulla politica estera sovietica¹¹. La straordinaria ricostruzione che David Holloway ha fatto del percorso scientifico e politico culminato con la costruzione del primo ordigno nucleare sovietico, infatti, mostra chiaramente la preoccupazione di Stalin nei confronti della nuova arma e la sua determinazione a non lasciarsi intimidire dall'egemonia nucleare degli Stati Uniti. Atteggiamento, questo, confermato anche dagli studi di Vojtech Mastny, che però sottolinea la limitata comprensione che Stalin aveva delle implicazioni militari della bomba atomica. Ancora più assertivi nel sottolineare l'importanza di questa sequenza di avvenimenti, infine, sono stati Campbell Craig and Sergey Radchenko, che nel loro volume attribuiscono alla decisione americana di utilizzare l'atomica un'importanza fondamentale nel progressivo irrigidimento delle posizioni delle superpotenze destinato a trasformarsi nella Guerra fredda¹².

Gli studi di Marc Trachtenberg

Un approccio particolarmente innovativo allo studio delle ripercussioni politiche

della bomba atomica nel periodo iniziale della Guerra fredda è stato inaugurato da Marc Trachtenberg nei suoi saggi *History and Strategy* e soprattutto *A Constructed Peace*. L'analisi di Trachtenberg è tutta incentrata sul nesso tra il ruolo crescente assegnato alle armi nucleari all'interno della strategia adottata dagli Stati Uniti e l'importanza attribuita dalla politica estera sovietica alla ricerca di una soluzione della questione tedesca. La scelta di affidare la sicurezza dell'alleanza atlantica alle armi nucleari, argomenta Trachtenberg, finì per creare per gli Stati Uniti un dilemma quasi insolubile, perché tra la fine degli anni Cinquanta e i primi anni Sessanta gli alleati europei furono spinti a chiedere una crescente condivisione dell'arsenale atomico americano. Gli Stati Uniti, sostiene Trachtenberg, si trovarono così a scegliere se rafforzare la Nato in funzione antisovietica, ampliando sempre di più le maglie del *nuclear sharing* all'interno dell'alleanza fino a condividere le loro armi anche con la Repubblica federale tedesca, o se trovare un compromesso con Mosca sulla base dell'accettazione dello *status quo* in Europa, sostanzialmente riconoscendo la divisione della Germania. Il passaggio dall'amministrazione di Dwight D. Eisenhower a quella di John F. Kennedy fu decisivo nell'orientare la strategia americana verso la seconda soluzione.

¹¹ B.J. Bernstein, *The American Bombing Reconsidered*, «Foreign Affairs», 74, 1995; K. Bird, M.J. Sherwin, *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer*, New York, A.A. Knopf, 2005¹; D. Holloway, *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939-1956*, New Haven, Yale University Press, 1994; T. Hasegawa, *Racing the Enemy: Stalin, Truman, and the Surrender of Japan*, Cambridge, Belknap Press of Harvard University Press, 2005.

¹² V. Mastny, *The Cold War and Soviet Insecurity: The Stalin Years*, New York, Oxford University Press, 1996; C. Craig, S. Radchenko, *The Atomic Bomb and the Origins of the Cold War*, New Haven, Yale University Press, 2008.

Come ha sottolineato anche Marilena Gala, la ricerca della distensione nel confronto bipolare si esplicò perciò innanzitutto nello sforzo di individuare forme di controllo degli armamenti che congelassero la diffusione sia orizzontale sia verticale delle armi nucleari¹⁵. Il Trattato per l'abolizione parziale degli esperimenti nucleari, sostiene Trachtenberg, fu in buona sostanza l'equivalente di quel trattato di pace sulla Germania che non si poteva ufficialmente firmare¹⁴. Sia Hope Harrison sia Timothy Naftali e Aleksandr Fursenko hanno poi analizzato questo stesso periodo dal punto di vista sovietico, sottolineando l'importanza che la questione tedesca aveva assunto per Chruscev, determinato a cercarne una soluzione a tutti i costi anche correndo rischi gravissimi come quelli provocati dallo schieramento dei propri missili nucleari a Cuba. La crisi cubana è stata perciò vista da un numero crescente di studiosi come un vero e proprio punto di svolta della Guerra fredda: fu il primo momento in cui le superpotenze si confrontarono avendo entrambe la capacità di lanciare un attacco nucleare devastante sul territorio dell'avversario (anche se gli Stati Uniti godevano ancora di una notevole superiorità nei confronti dei sovietici), e i rischi corsi durante quel drammatico confronto spinsero sia Ken-

nedy sia Chruscev ad adottare un comportamento più attento alla ricerca di forme di collaborazione per attenuare il pericolo di una guerra atomica¹⁵. Altri autori, come Frank Gavin o Hal Brands Jr., hanno poi sviluppato ulteriormente le intuizioni di Trachtenberg fino ad analizzare il trattato di non-proliferazione nucleare del 1968 come il vero punto di arrivo di questo processo, dimostrando come il Tnp costituisse il cardine della politica di distensione degli anni successivi¹⁶.

La crisi degli euromissili

Seguendo l'evoluzione più generale della storiografia sulla Guerra fredda, infine, anche la ricerca sulle armi nucleari si è progressivamente interessata alla fine del confronto bipolare, studiando sia vari aspetti della crisi degli euromissili durante l'intero decennio 1977-1987, sia lo straordinario dialogo sviluppatosi tra Ronald Reagan e Mikhail Gorbachev a partire soprattutto dal loro secondo incontro a Reykjavik, nel 1986. Proprio nella profonda sfiducia che entrambi nutrivano nei confronti delle armi atomiche, infatti, questi due improbabili interlocutori trovarono un terreno d'intesa che agevolò la loro progressiva collaborazione e rese possibile il trattato sull'abolizione delle forze nucleari di tea-

¹⁵ M. Gala, *Il paradosso nucleare. Il Limited Test Ban Treaty come primo passo verso la distensione*, Firenze, Polistampa, 2002.

¹⁴ M. Trachtenberg, *A Constructed Peace. The Making of the European Settlement, 1958-1963*, Princeton, Princeton University Press, 1999; Id., *History and Strategy*, Princeton, Princeton University Press, 1991.

¹⁵ A.A. Fursenko, T.J. Naftali, *Khrushchev's Cold War: The Inside Story of an American Adversary*, New York, Norton, 2006¹; Id., *One Hell of a Gamble: Khrushchev, Castro, and Kennedy, 1958-1964*, New York, Norton, 1997¹.

¹⁶ H. Brands, *Non-Proliferation and the Dynamics of the Middle Cold War: The Superpowers, the Mlf, and the Npt*, «Cold War History», 2007, 3; F.J. Gavin, *Nuclear Statecraft. History and Strategy in America's Atomic Age*, Ithaca, Cornell University Press, 2012.

tro nel dicembre 1987, una vera e propria pietra miliare nel cammino verso la fine dell'era bipolare.

Anche su questi temi la storiografia ha offerto peraltro una vasta gamma di interpretazioni divergenti: Vojtech Mastny, ad esempio, ha sostenuto che il processo di distensione e in particolare la conferenza di Helsinki avevano messo in movimento forze sociali e politiche all'interno del patto di Varsavia che stavano gradualmente ma rapidamente erodendo le basi dell'egemonia sovietica in Europa orientale. La fine della Guerra fredda, secondo la sua interpretazione, si sarebbe in realtà potuta verificare anche prima se la nuova corsa agli armamenti innescata dalla crisi degli euromissili non avesse reso possibile all'Urss di irrigidire il controllo sui propri alleati sfruttando le rinnovate tensioni con l'occidente, limitando così l'impatto della distensione e della Conference on Cooperation and Security in Europe (Csce) all'interno degli altri stati del blocco orientale. Altri studiosi, al contrario, hanno proposto una lettura diametralmente opposta della crisi, sostenendo che lo schieramento dei missili SS 20 da parte sovietica faceva parte di una strategia volta complessivamente a indebolire il legame tra gli Stati Uniti e i loro alleati europei occidentali per provocare la graduale erosione del rapporto transatlantico – il tanto temuto *decoupling*. L'inattesa durezza della reazione occidentale, tuttavia,

avrebbe costretto la leadership sovietica a prendere atto del sostanziale fallimento del suo tentativo e a rivedere gradualmente l'intera impostazione della propria politica. Una lettura, quest'ultima, che è stata proposta soprattutto da molti dei protagonisti di quelle vicende, che forse finiscono per attribuire al confronto sugli euromissili un'importanza anche superiore a quella che ebbe effettivamente¹⁷.

Nuove ipotesi di ricerca

Un percorso interessante ma ancora relativamente limitato è poi quello degli studi volti a indagare la mentalità di quanti sono stati chiamati a prendere decisioni relative allo sviluppo e al possibile impiego delle armi atomiche. Dopo i primi pionieristici studi di Fred Kaplan e Gregg Herken¹⁸ sugli ambienti in cui erano state formulate le grandi linee della strategia nucleare americana, quest'approccio cominciò a essere più compiutamente sviluppato da un punto di vista storico in un volume collettaneo, *Cold War Statesmen Confront the Bomb*, in cui vari autori cercavano appunto di analizzare in che modo le principali figure della Guerra fredda avessero affrontato il problema delle armi nucleari¹⁹. Beatrice Heuser ha arricchito il campo di indagine affrontando da un punto di vista politico e culturale il rapporto tra armi nucleari e identità nazionali, un tema che poi ha trovato un ulteriore sviluppo nel lavoro di Ga-

¹⁷ Una sintesi del dibattito sugli euromissili in L. Nuti, F. Bozo, M.P. Rey, B. Rother (eds.), *The Euromissiles Crisis and the End of the Cold War*, Princeton, Princeton University Press, 2015.

¹⁸ G. Herken, *Counsels of War*, New York, Knopf, 1985; F. Kaplan, *The Wizards of Armageddon*, Stanford, Stanford University Press, 1985.

¹⁹ J.L. Gaddis, P.H. Gordon, E.R. May, J. Rosenberg, *Cold War Statesmen Confront the Bomb. Nuclear Diplomacy since 1945*, Oxford, Oxford University Press, 1999.

brielle Hecht sull'importanza simbolica del nucleare civile in Francia²⁰.

A questi studi sull'importanza politica delle armi nucleari se ne sono aggiunti col tempo altri che cercano di estendere le ricerche all'esterno della dimensione puramente statuale, analizzando attori non governativi come i movimenti di massa, i singoli scienziati o le loro associazioni, senza però trascurare quale possa essere stata l'influenza di questi attori sulle scelte che i governi dovettero compiere²¹. Spencer Weart, infine, ha cominciato a esplorare la dimensione più propriamente culturale della percezione della minaccia della bomba²².

Infine uno dei campi dove la ricerca presenta ancora ampi margini di miglioramento riguarda lo studio dei programmi nucleari di quegli stati solo indirettamente collegati alla storia della Guerra fredda. Le ricerche sui programmi nucleari cinese, indiano, pakistano, sud-africano, israeliano, e nord-coreano, o sulle ambizioni e le tentazioni nucleari brasiliane, sud-coreane e iraniane, per non citare che i casi più importanti, presentano infatti delle differenze

metodologiche abbastanza significative con quelli relativi ai programmi delle principali potenze coinvolte nel confronto bipolare. Mentre gli studi sulla bomba israeliana, su quella sud-africana e sulle aspirazioni brasiliane nel corso degli ultimi anni hanno potuto beneficiare di una crescente documentazione archivistica, e sono quindi in qualche modo assimilabili da un punto di vista metodologico a quelli sulle principali potenze nucleari, nella maggior parte degli altri casi le ricostruzioni sono raramente basate su fonti primarie provenienti dagli archivi dello stato di cui si analizzano le scelte nucleari: lacuna, questa, a cui gli autori hanno cercato di sopperire soprattutto con il ricorso alla storia orale o alle informazioni reperibili negli archivi di altri stati²³. Si tratta comunque di un campo di studi in pieno sviluppo, i cui risultati mostrano chiaramente la necessità di uscire dal semplice paradigma interpretativo della Guerra fredda per poter comprendere fenomeni che trovano in realtà la loro causa anche in fattori locali o regionali. Quest'ultima considerazione, a sua volta si può ricollegare

²⁰ G. Hecht, *The Radiance of France. Nuclear Power and National Identity after World War II*, Cambridge, Mit Press, 2009; B. Heuser, *Nuclear Mentalities? Strategies and Beliefs in Britain, France, and the Frg*, Basingstoke, Macmillan Press, 1998. Sulle scelte nucleari britannica e francese, peraltro, esiste una solida storiografia, che non è possibile citare in dettaglio in questa sede.

²¹ L.S. Wittner, *The Struggle against the Bomb*, vol. I, *One World or None: A History of the World Nuclear Disarmament Movement through 1953*, Stanford, Stanford University Press, 1992; M. Evangelista, *Unarmed Forces. The Transnational Movement to End the Cold War*, Ithaca, Cornell University Press, 2002.

²² S.R. Weart, *The Rise of Nuclear Fear*, Cambridge, Harvard University Press, 2012.

²³ Un esempio di come si possa comunque offrire una ricostruzione eccellente aggirando molti di questi ostacoli è naturalmente lo studio di A. Cohen, *Israel and the Bomb*, New York, Columbia University Press, 1999. O quello di J.W. Lewis, X. Litai, *China Builds the Bomb*, Stanford, Stanford University Press, 1988. Sulla bomba sud-africana cfr. i numerosi articoli di A.M. Van Wyk, ad esempio: *Apartheid's Atomic Bomb: Cold War Perspectives*, «South African Historical Journal», 2010, 1. Sulle origini del programma brasiliano, C. Patti, *The Origins of the Brazilian Nuclear Programme, 1951-1955*, «Cold War History», 2014. Su India e Pakistan cfr. rispettivamente G. Perkovich, *India's Nuclear Bomb. The Impact on Global Proliferation*, Berkeley, University of California Press, 2002, e F. Kahn, *Eating Grass. The Making of the Pakistani Bomb*, Stanford, Stanford University Press, 2012.

all'opportunità di ripensare l'intero problema della diffusione delle armi nucleari, che tanta importanza ha rivestito e riveste

nel sistema internazionale post-bipolare, secondo categorie e periodizzazioni diverse da quelle del confronto Est-Ovest²⁴.

Barbara Curli

Nuclear Europe

Nuclear energy accounts for more than one quarter of the electricity generated in the European Union, whose nuclear park includes 131 power plants currently operating in 14 of the 28 member states and 89 permanently shutdown reactors. The build-up of nuclear power capacity has been a feature of Western postwar modernization – Western Europe and North America accounting together for 63% of current global nuclear capacity. Prospects of nuclear development, instead, concern mainly non-Western countries. Among the 65 reactors currently under construction, only 4 are in the EU and 5 in the United States, more than half in Asia (23 in China)¹. Notwithstanding periodic announcements of a nuclear «renaissance»², and the EU being the third largest energy consumer of the world (after the United States and China),

with all the implications it entails for its international relations³, the nuclear energy era seems to have come to a standstill in Europe, while other rapidly developing areas of the world have entered it.

This new nuclear geopolitics, and the resulting perception that Europe's «nuclear civilization» could now be read with some historical distance, may partly explain the current revival in European nuclear historiography. Present debates on the relaunching of Europe's infrastructures of growth and strategies of technological improvement to face international competition have aroused new interest in «infrastructural Europeanism» and modernization through scientific and technological collaboration, thus emphasizing the role of technological networks, transnational systems of knowledge and scientific expertise in the making of Eu-

²⁴ P.J. Bracken, *The Second Nuclear Age. Strategy, Danger, and the New Power Politics*, New York, Times Books, 2012. M. Krepon, *Better Safe Than Sorry: The Ironies of Living with the Bomb*, Stanford, Stanford University Press, 2009; R. Rhodes, *The Twilight of the Bombs: Recent Challenges, New Dangers, and the Prospects for a World without Nuclear Weapons*, New York, Knopf, 2010.

¹ Data are drawn from official statistics of the European Union (www.ec.europa.eu/energy) and of the World Nuclear Association (www.world-nuclear.org), which are continuously updated, both last accessed 3 May 2015.

² A.N. Stulberg, M. Fuhrmann (eds.), *The Nuclear Renaissance and International Security*, Stanford, Stanford University Press, 2013.

³ J. Roberts, *Energy Challenges for Europe*, in A. Wenger, R.W. Orttung, J. Perovic (eds.), *Energy and the Transformation of International Relations*, Oxford-New York, Oxford University Press for the Oxford Institute for Energy Studies, 2009.

rope in a long-term perspective⁴. The history of European scientific cooperation in the nuclear field is part of this more general framework⁵. Moreover, the EU emphasis on «energy transition» and different courses adopted by member states with regard to their nuclear future raise a number of questions about the historical roots of national paths of energy diversification and their relationship with European integration. Nuclear energy production and most activities connected to it (from uranium supply to safety measures) are still regulated within the framework of the 1957 Treaty establishing the European Atomic Energy Community (EURATOM), which enjoys a separate legal status under the governance of EU's institutions. Traditionally – though undeservedly – portrayed as the ugly duckling of European integration and as an institutional and political «failure», especially as compared to its more successful Rome twin, the European Economic Community, EURATOM bears in fact some specificities that resist traditional narratives of European integration and are related to the role played

by nuclear energy in the postwar political economy, both domestically and internationally. Atomic energy is the only realm of European scientific collaboration dealt with in a specific treaty⁶. While depicting «the emergence of a new structure and a potent source of funding and of legitimation for expensive fields of scientific research and technical development»⁷, EURATOM thus represents a new supranational dimension of the postwar European «scientific state». At the same time, the different outcomes of that experience, only partially investigated by historical research⁸, are to be related to the Cold War dynamics of European «big science» and to the difficult paths of cooperation in R&D-intensive industrial sectors underlying the contested evolution of European common research policies⁹. This raises in different ways the issue of national political priorities of growth, reiterating, as Krige and Barth put it, the «centrality of the nuclear» in the postwar emergence of science and technology as a political «affair of the state» and a key element in international affairs¹⁰.

⁴ F. Schipper, J. Schot, *Infrastructural Europeanism, or the Project of Building Europe on Infrastructures: an Introduction*, «History and Technology», 2011, 3; E. van der Vleuten, A. Kaijser (eds.), *Networking Europe. Transnational Infrastructures and the Shaping of Europe, 1850-2000*, Sagamore Beach, Science History Publications, 2006; J. Schot, T.J. Misa, R. Oldenziel (eds.), *Tensions of Europe: The Role of Technology in the Making of Europe*, Special issue, «History and Technology», 2005, 1.

⁵ J. Krige, L. Guzzetti (eds.), *History of European Scientific and Technological Cooperation*, Luxembourg, Oopec, 1997.

⁶ O. Hallonsten, *Continuity and Change in the Politics of European Scientific Collaboration*, «Journal of Contemporary European Research», 2012, 3.

⁷ J. Krige, *The Politics of European Scientific Cooperation*, in Id., D. Pestre (eds.), *Companion to Science in the Twentieth Century*, Amsterdam-Abingdon, Routledge, 2003², p. 897.

⁸ O. Pirotte, *Trente ans d'expérience Euratom. La naissance d'une Europe nucléaire*, Bruxelles, Bruylant, 1988; M.Dumoulin, P. Guillen, M.Vaïsse (eds.), *L'énergie nucléaire en Europe. Des origines à Euratom*, Berne, Peter Lang, 1994; G. Skogmar, *The United States and the Nuclear Dimension of European Integration*, New York, Palgrave Macmillan, 2004.

⁹ J. Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe*, Cambridge, The MIT Press, 2006.

¹⁰ J. Krige, K.H. Barth, *Introduction. Science, Technology and International Affairs*, «Osiris», 21, 2006, p. 2.

Nuclear States

As a sector traditionally associated with high investment costs, massive State intervention and «technocratic» cultures and values, nuclear energy has traditionally reflected – even typified – the changing nature of the postwar public hand. The bulk of research has underlined the political economy of the Western «atomic state», in its various national declinations. Whereas the French experience, as the epitome of nuclear «technopolitics», has traditionally attracted particular historiographical attention, other national case-studies have elaborated on the tensions within the bureaucratic and scientific estate and the public-private debate resulting in the politicization of technological choices, as also related to the dynamics of international cooperation and competition¹¹. In this comparative picture, the Italian case bears some peculiarities: internal atomic rivalries and clash between private and public, e.g. over the issue of nationalization of the energy sector in 1962, affected and afflicted the Italian nuclear power program

of the 1960s and were ultimately responsible for the early substantial abandonment of the nuclear option, well before its official end in the aftermath of the Chernobyl accident¹². More recent research can be inserted in this same historiographical framework. The private-public controversy in the launching of the German nuclear program of the 1950s reflected the relationship between government, business, and science, as one of the German-specific features of postwar modernization¹³. Divisions within the atomic community and the intense «politicization» – for both domestic and international reasons – of technological choices lay also at the origin of diverging current energy paths, e.g. in Sweden and Finland as compared to Germany¹⁴. Even the apparently monolithic Soviet nuclear state was as much affected by vested interests and different scientific cultures and technocratic visions as most of the West¹⁵, whereas the dialectics over nuclear energy could be used in Franco's Spain as a leverage for political manoeuvring and criticism¹⁶. In sum, if the postwar nuclear state

¹¹ G. Hecht, *The Radiance of France: Nuclear Power and National Identity after World War II*, Cambridge, MIT Press, 1998; J.A. Camilleri, *The State and Nuclear Power: Conflict and Control in the Western World*, Brighton, Harvester Press, 1984; J.M. Jasper, *Nuclear Politics. Energy and the State in the United States, Sweden and France*, Princeton, Princeton University Press, 1990; B. Balogh, *Chain Reaction. Expert Debate and Public Participation in American Commercial Nuclear Power, 1945-75*, Cambridge, Cambridge University Press, 1991.

¹² B. Curli, *Il progetto nucleare italiano, 1952-1964. Conversazioni con Felice Ippolito*, Soveria Mannelli, Rubbettino, 2000; M. Elli, *Atomi per l'Italia. La vicenda politica, industriale e tecnologica della centrale nucleare ENI di Latina 1956-1972*, Milano, Unicopli, 2011.

¹³ C. Carson, *Nuclear Energy Development in Postwar West Germany: Struggles over Cooperation in the Federal Republic's First Reactor Station*, «History and Technology», 2002, 3.

¹⁴ M. Fjæstad, *Why Did the Breeder Reactor Fail? Swedish and International Nuclear Development in a Cold War Context*, Cesis Electronic Working Paper Series, 186, August 2009; P. Hakkarainen, M. Fjæstad, *Diverging Nuclear Energy Paths: Swedish and Finnish Reactions to the «Energiewende»*, «Renewable Energy Law and Policy Review», 2012, 4.

¹⁵ S.D. Schmid, *Organizational Culture and Professional Identities in the Soviet Nuclear Power Industry*, «Osiris», 23, 2008.

¹⁶ L. Sánchez-Vázquez, A. Menéndez-Navarro, *Nuclear Energy in the Public Sphere: Anti-Nuclear Movements vs. Industrial Lobbies in Spain (1962-1979)*, «Minerva», 2015, 1.

somehow epitomizes the modern industrial state's ideology of growth and technological utopia, recent research on different national case studies has confirmed its more or less «troublesome life»¹⁷, as originating from within its distinctive political features rather than from the various external challenges posed – à la Touraine – to the modernity it embodied. It is not by chance that the nuclear energy state – starting from its French idealtypical version – is attracting new interest in the framework of a long due revision of the reality and rhetoric of the «trente glorieuses»¹⁸. The shift is towards a new focus on institutions and the nature of power in postwar European democracies. As Sezin Topçu writes:

Je souhaite mettre à distance les approches normatives qui ont célébré les récentes transformations entre science, expertise et militarisme, en sousestimant souvent la question du pouvoir des institutions, au profit d'une valorisation des compétences de la «société civile». Après une décennie de promotion de l'«impératif participatif» et de la «démocratie technique», ce livre plaide pour moins de naïveté et une vision plus forte de la démocratie

[...] pour remettre le pendule du côté du pouvoir des institutions¹⁹.

Similarly, the new «post-colonial atom» historiography sheds further light on the ideology of international institutions as emanating from the very features of the postwar Western state (e.g. its racial dimension)²⁰.

A Nuclear Social Turn?

The progressive exhaustion of the nuclear golden age of the 1950s and 1960s appears therefore a much more complex issue than that raised by the environmentalist challenge. Rather, the nuclear question mirrored larger political tensions within European societies, changing power structures and political regulation (e.g. the national/local dimension), and shifting boundaries of welfare and citizenship²¹. Thus the redefinition of the social limits to nuclear growth emerging in the 1970s drew both on national specificities and on transnational currents. As recently shown, such redefinition was certainly related to that season of grass-roots movements, but was at the

¹⁷ H. Nielsen, H. Knudsen, *The Troublesome Life of Peaceful Atoms in Denmark*, «History and Technology», 2010, 2.

¹⁸ G. Hecht, *L'empire nucléaire. Le silence des «Trente Glorieuses»*, and S. Topçu, *Atome, gloire et désenchantement. Résister à la France atomique avant 1968*, in C. Plessis, S. Topçu, C. Bonneuil (sous la direction de), *Une autre histoire des «Trente Glorieuses». Modernisation, contestation et pollutions dans la France d'après guerre*, Paris, La Découverte, 2013, pp. 159-188 and 189-209.

¹⁹ S. Topçu, *La France nucléaire. L'art de gouverner une technologie contestée*, Paris, Seuil, 2013, pp. 25 and 29.

²⁰ G. Hecht, *Being Nuclear: Africans and the Global Uranium Trade*, Cambridge, The MIT Press, 2012; Ead., *Negotiating Global Nuclearities: Apartheid, Decolonization, and the Cold War in the Making of the Iaea*, «Osiris», 21, 2006.

²¹ S.R. Weart, *The Rise of Nuclear Fear*, Cambridge, Harvard University Press, 2012; H. Herring, *From Energy Dreams to Nuclear Nightmares: Lessons from the Anti-Nuclear Power Movement in the 1970s*, Charlbury, Jon Carpenter, 2005.

same time the expression of a generational change in European elites and ruling classes formation²², involving changes in cultural attitudes to modern economic growth, and in visions of society and of Europe's role in international relations. The ways these societal trends contributed also to the transformation of European supranational institutions and their ideological approach to energy diversification is a question still to be investigated. However, the nuclear issue confirms itself as a privileged viewpoint from which to address more general questions about the transformation of power in postwar Europe²³.

At the same time, a broader definition of the social dimension of the nuclear question allows us to cross Cold War boundaries, as recent impressive studies, e.g. on US and Soviet «nuclear cities»²⁴, and on the East German Wismut uranium mining company²⁵, have highlighted. Both these studies deal with the so far neglected issue of work in the nuclear industry, showing to what extent the Cold War provided also a framework for social, gender and family

organization affecting people's life on both sides of the iron curtain. Work in the atomic industry is in fact a very promising field of historiographical inquiry, as the very few studies existing on the subject demonstrate, though mainly from a sociological and ethnoanthropological perspective²⁶. Different questions such as the imperatives of productivity in high capital intensive industries, the historical differentiation of jobs and professional expertise in advanced technologies and their gender dimension; security, health, «human error» in the functioning of complex systems; the management and organization of risky enterprises, all are questions that go well beyond the issue of «accident», which remains however the primary inevitable lens of analysis of an «atomic risk society». Not to mention its political-existential dimension, that so far only cinema or literature have been able to touch upon, in the attempt to depict what it is like to work «les yeux rivés sur le dosimètre»: «ce que chacun vient vendre c'est ça, vingt millisieverts, la dose maximale d'irradiation autorisée sur douze mois glissants»²⁷.

²² See the editors' introduction, A. Mignon Kirchhof, J.H. Meyer (eds.), *Global Protest against Nuclear Power. Transfer and Transnational Exchange in the 1970s and 1980s*, special issue, «Historical Social Research», 2014, 1.

²³ J.H. Meyer, *Challenging the Atomic Community: the European Environmental Bureau and the Europeanization of Anti-Nuclear Protest*, in W. Kaiser, J.H. Meyer (eds.), *Societal Actors in European Integration. Policy Building and Policy-Making, 1958-1992*, Houndmills, Palgrave Macmillan, 2013.

²⁴ K. Brown, *Plutopia. Nuclear Families, Atomic Cities, and the Great Soviet and American Plutonium Disasters*, Oxford, Oxford University Press, 2013.

²⁵ R. Boch, R. Karlsch (hrsg.), *Uranbergbau im Kalten Krieg: Die Wismut im sowjetischen Atomkomplex*, Berlin, Ch. Links Verlag, 2011.

²⁶ P. Fournier, *Travailler dans le nucléaire. Enquête au coeur d'un site à risque*, Paris, Armand Colin, 2012; C. Perin, *Shouldering Risks: the Culture of Control in the Nuclear Power Industry*, Princeton, Princeton University Press, 2005.

²⁷ E. Filhol, *La Centrale*, Paris, P.O.L., 2010, p. 16.

Il nucleare e la ricerca scientifica: la corrispondenza Fermi-Amaldi

«Caro Edoardo, [...] come vedrai dalla intestazione di questa lettera il mio indirizzo non è più a Chicago. In realtà è più di un anno che il mio lavoro si è trasferito su questa mesa del New Mexico [Los Alamos, *N.d.a.*] dove siamo circondati da montagne alte da 3 a 4.000 metri. [...] Dalla lettura dei giornali di qualche settimana fa avrai probabilmente capito a quale genere di lavoro ci siamo dedicati in questi ultimi anni». Con queste parole Enrico Fermi introduceva, in una lettera a Edoardo Amaldi del 28 agosto 1945¹, tre settimane dopo il bombardamento atomico su Hiroshima e Nagasaki, il racconto – dal suo punto di vista – del lavoro svolto dopo il trasferimento negli Stati Uniti: questo racconto prendeva avvio dalla progettazione e realizzazione della bomba atomica. «È stato un lavoro di notevole interesse scientifico – proseguiva Fermi – e l'aver contribuito a troncare una guerra che minacciava di tirar avanti per mesi o per anni è stato indubbiamente motivo di una certa soddisfazione. Noi tutti speriamo che l'uso futuro di queste nuove invenzioni sia su una base ragionevole e serva a qualche cosa di meglio che a rendere le relazioni internazionali ancora più difficili di quello che sono state fino ad ora». E poco dopo: «Ti interesserà sapere – scriveva ancora ad Amaldi – che verso la fine del

1942 abbiamo costruito a Chicago la prima macchina per produrre una reazione a catena con uranio e grafite. È diventato d'uso comune chiamare queste macchine “pile”. Dopo la prima pila sperimentale molte altre ne sono state costruite di grande potenza. Dal punto di vista della fisica, come ti puoi immaginare, queste pile rappresentano una ideale sorgente di neutroni che abbiamo usato tra l'altro per molte esperienze di fisica nucleare, e che probabilmente verranno usate ancora di più per questo scopo dopo che la guerra è finita».

La fine dell'«età dell'innocenza»

Si scrive spesso che la ricerca nucleare ha avuto origini militari, ma non è esattamente così. Già all'inizio dei suoi studi Fermi aveva parlato dell'enorme quantità di energia che teneva insieme il nucleo atomico, e aveva provato a immaginare quali effetti avrebbero potuto verificarsi quando si fosse trovato il modo di liberarla. «La relazione fra massa ed energia – aveva scritto nel 1923 – ci porta senz'altro a delle cifre grandiose. Per esempio se si riuscisse a mettere in libertà l'energia contenuta in un grammo di materia si otterrebbe un'energia maggiore di quella sviluppata in tre anni di lavoro ininterrotto da un motore di mille cavalli (inutili i commenti). Si dirà

¹ Pubblicata in E. Amaldi, *Da via Panisperna all'America*, a cura di G. Battimelli, M. De Maria, Roma, Editori Riuniti, 1997, pp. 158-160.

con ragione che non appare possibile, almeno in un prossimo avvenire, che si trovi il modo di mettere in libertà queste enormi quantità di energia, cosa del resto che non si può che augurarsi, perché l'esplosione di una così spaventosa quantità di energia avrebbe come primo effetto di ridurre in pezzi il fisico che avesse la disgrazia di trovare il modo di produrla². Certo l'autore di queste parole non immaginava che meno di vent'anni dopo sarebbe stato proprio lui quel fisico. Comunque, all'inizio le possibili applicazioni di queste ricerche furono viste soprattutto nel campo della medicina. La possibilità di sfruttare i processi nucleari per la produzione su scala macroscopica di energia, e quindi anche le potenzialità sul fronte degli usi militari del nucleare, si pose in modo acuto per gli addetti ai lavori (poche decine di persone sparse nei laboratori di una decina di paesi, fra cui l'Italia) solo dopo la scoperta della fissione. Ed è innegabile che soltanto questo tipo di interesse spinse i governi a finanziare in misura fino ad allora inimmaginabile esperienze e studi che in un altro contesto storico avrebbero probabilmente riscosso scarsa attenzione e impiegato molto più tempo a raggiungere i risultati che poi hanno raggiunto.

Questo interesse militare pose ben presto dei problemi ai protagonisti delle origini della ricerca nucleare. Dopo che le bombe nucleari furono effettivamente impiegate, e dopo che la loro esplosione ne mostrò al mondo il terrificante potenziale distruttivo, uno di quei protagonisti, Robert Oppenheimer,

ebbe a dire che la fisica atomica aveva «conosciuto il peccato». Bruno Rossi, un altro di loro, scriveva nelle sue memorie di essere giunto a Los Alamos nel luglio 1943 consapevole di assistere all'inizio della fine di quella «età dell'innocenza della fisica delle particelle» per la quale avrebbe mantenuto per tutta la vita «una persistente nostalgia». Ma racconta: «Ricordo chiaramente con che animo decisi di andare a Los Alamos. Speravo che il nostro lavoro avrebbe dimostrato l'impossibilità di fare la bomba, ma avevo anche concluso che se, viceversa, la cosa fosse risultata possibile, occorreva evitare a ogni costo che Hitler avesse la bomba prima di noi»³.

È interessante osservare come oggi, in un contesto storico e politico totalmente diverso, sia cambiata, almeno da questa parte dell'Atlantico, la percezione del senso di quelle scelte e del dramma che esse rappresentarono per chi dovette affrontarle. Edoardo Amaldi, che pure ha legato il suo nome a importanti iniziative in favore del disarmo, così rifletteva nelle sue memorie: «Io non mi sono trovato di fronte a questo drammatico dilemma, ma penso che, se mi ci fossi trovato, dopo profonde e sofferte considerazioni su qual fosse il mio dovere morale di uomo invitato a decidere se collaborare alla difesa delle democrazie [...] o rinchiudermi nella mia sfera privata, non facendo nulla per combattere la dittatura, avrei alla fine optato per la prima soluzione. Presa questa decisione iniziale non c'era più nulla da fare. La storia macina gli eventi in modo assai diverso da quanto an-

² E. Fermi, *Nota*, in appendice ad A. Kopff, *Fondamenti della relatività einsteiniana*, Milano, Hoepli, 1923.

³ G. Battimelli, M. De Maria, *Prefazione* a E. Amaldi, *Da via Panisperma all'America*, cit., p. 31.

che i più assennati e lungimiranti riescano a prevedere»⁴.

Un altro aspetto, meno drammatico ma altrettanto gravido di conseguenze nei decenni successivi, riguarda il segreto militare imposto sui risultati della ricerca. Ne scriveva ancora una volta Fermi ad Amaldi, il 24 gennaio 1946: «Ci sono, naturalmente, anche degli inconvenienti molto seri. Il più serio di tutti sono i segreti militari. A questo proposito si spera che una buona parte dei risultati scientifici che ancora sono tenuti segreti potrà prossimamente venir pubblicato, ma per il momento la cosa procede assai lentamente»⁵. Quanto profonda fosse questa limitazione dovette provarlo lo stesso Amaldi quando si recò negli Stati Uniti pochi mesi dopo, ed ebbe modo di rivedere Fermi. «Durante la visita che egli fece a casa di Fermi, che si trovava a Chicago – racconta il figlio Ugo – dopo qualche ora di scambio di informazioni sulla guerra da poco finita e sulla situazione della ricerca scientifica in Italia, quando si passò a parlare dei più recenti risultati scientifici, Amaldi percepì che Fermi diveniva sempre più reticente. Ben presto si rese conto che Fermi non poteva parlare, nemmeno al suo vecchio allievo e amico non più incontrato per tanti anni, perché costretto al segreto militare. Lo shock fu ancora più grande quando Fermi, uscendo per andare al laboratorio dell'università, dovette chiedergli di non accompagnarlo. A partire da questo piccolo ma significativo episodio, corroborato da molti altri fatti successivi, Amaldi si

oppose per tutta la vita alla ricerca militare e ai suoi possibili intrecci con la ricerca accademica [...]. La pubblicazione completa dei risultati, e addirittura la non brevettabilità delle ricadute applicative della ricerca furono scritte nella carta costitutiva del Cern»⁶.

I cambiamenti per effetto della guerra

La vicenda ormai nota del Progetto Manhattan, qualunque cosa si pensi delle sue implicazioni etico-politiche, ha comunque avuto conseguenze durature sull'organizzazione della ricerca scientifica nei decenni successivi, sulla comunità scientifica e sui suoi rapporti con la società in generale. Si può continuare a prenderne nota attraverso le lettere di Fermi, che sono straordinariamente lucide a questo riguardo. Innanzitutto egli fotografa la nuova posizione che la fisica ha raggiunto rispetto ad altri settori della scienza nella considerazione dell'opinione pubblica: «La situazione della fisica – scrive ancora ad Amaldi e Gian Carlo Wick nel gennaio 1946 – ha subito cambiamenti molto profondi per effetto della guerra. Alcuni sono per il meglio: ora che la gente si è convinta che con la fisica si possono fare le bombe atomiche tutti parlano con apparente indifferenza di cifre di vari milioni di dollari. Fa l'impressione che dal lato finanziario la maggiore difficoltà consista nell'immaginare abbastanza cose con cui spendere. D'altra parte ci aspettiamo che il numero degli studenti cresca conside-

⁴ *Ibidem*, p. 50.

⁵ *Ibidem*, p. 167.

⁶ *Ibidem*, p. 11.

revolmente, ma non sappiamo se la qualità migliorerà o peggiorerà»⁷. Il tema delle «gerarchie disciplinari», cioè della percezione dell'importanza relativa delle discipline da parte del pubblico in diversi contesti storico-culturali ed economici, è ben noto agli storici e ai sociologi della scienza, ed è ben noto come la fisica abbia goduto di un prestigio senza precedenti dalla metà degli anni Quaranta all'inizio degli anni Ottanta del Novecento. Questo tipo di fenomeni è spesso condizionato da eventi di natura politico-economica che influenzano le scelte della classe dirigente dei paesi avanzati, e determinano gli orientamenti dell'opinione pubblica. La fisica, anche questo è ben noto, nel corso degli anni Ottanta ha dovuto cedere il passo alle discipline biologiche e mediche. Ma finché la sua permanenza al vertice delle gerarchie disciplinari è durata, nell'opinione pubblica ha spesso regnato una sorta di confusione tra vari settori della fisica, e in particolare tra fisica nucleare e fisica delle particelle elementari.

L'altro aspetto che Fermi fotografa è quello della nascita di un nuovo modo di organizzare la ricerca scientifica. «Un altro inconveniente – scrive – è che una larga parte dell'opinione pubblica è convinta che i risultati della ricerca scientifica durante la guerra sono stati dovuti in buona parte alla super organizzazione del lavoro scientifico. E quindi ne concludono che una simile super organizzazione sia il miglior modo di

promuovere il progresso scientifico anche in tempo di pace. L'opinione corrente della maggioranza dei fisici è che questo sarebbe uno sbaglio. Ma naturalmente ci sono sempre i candidati al posto di super organizzatore che pensano diversamente. Inoltre molti fisici si sono messi a occuparsi più attivamente di politica che di scienza e passano il loro tempo a Washington in piacevoli conversari con senatori e *congressmen*»⁸.

Fermi scrive nel gennaio 1946, e nel 1947 verrà pubblicato il celebre rapporto *Science: the Endless Frontier*, che sarà alla base del dibattito sul futuro della politica scientifica americana: ne è autore Vannevar Bush, ossia l'uomo che ha guidato la ricerca americana in tempo di guerra⁹. Il Progetto Manhattan aveva occupato più di 130.000 persone ed era costato oltre due miliardi di dollari dell'epoca¹⁰. Nel corso del secondo dopoguerra tutti i paesi che si sono dotati di strutture per lo sviluppo del nucleare (anche l'Italia) hanno avuto in queste strutture un volano fondamentale per la crescita in campo scientifico ed economico. Non è solo la dimensione delle risorse impiegate a determinare i risultati: è necessario stabilire collegamenti efficaci tra discipline scientifiche non sempre facilmente comunicanti, e anche un rapporto con le competenze amministrative e politiche. Nel 1961 un fisico che aveva partecipato al Progetto Manhattan, Alvin Martin Weinberg, l'aveva battezzata «big science». La *big science* costituisce

⁷ *Ibidem*, p. 167.

⁸ *Ibidem*.

⁹ Ora tradotto in italiano: V. Bush, *Manifesto per la rinascita di una nazione. Scienza, la frontiera infinita*, Torino, Bollati Boringhieri, 2013.

¹⁰ Per questi ultimi dati e per alcune considerazioni generali si fa riferimento a M. Pivato, *Il miracolo scipato*, Roma, Donzelli, 2011, pp. 5-10, e alla bibliografia ivi citata.

tuttora la base organizzativa fondamentale del rapporto tra sviluppo e ricerca nei paesi più ricchi, e rappresenta il modello di riferimento per i paesi che competono nell'eco-

nomia della conoscenza. La *big science*, più di ogni altra cosa, è il contributo di maggior durata che la ricerca nucleare ha dato alla ricerca scientifica contemporanea.

Lawrence S. Wittner

Nuclear Disarmament Movements

Even as nuclear weapons were being secretly developed by the major powers during World War II, the issue of nuclear disarmament began to be discussed by individuals and small groups of scientists who were aware of nuclear programs¹. But it was not until the US atomic bombing of Japan, in August 1945, that the general public learned of nuclear weapons and of the immense danger they posed to the survival of world civilization. An enormous public furor ensued, leading to the rise of social movements demanding nuclear disarmament.

These movements conducted three particularly vigorous protest campaigns over the following decades. The first, led by scientists' organizations (such as the Federation of American Scientists), world federalist organizations (such as the World Movement for World Government), Japanese *hibakusha* (survivors of the atomic bombing), and pacifist groups (such as the International Fellowship of Reconciliation, the War Re-

sisters' International, and the Women's International League for Peace and Freedom) emerged shortly after the atomic bombing and continued at a high level of mobilization through the late 1940s. Emphasizing the danger of world destruction, these organizations often posed the alternatives as «One World or None». There was also a Communist-led component to the nuclear disarmament campaign, as typified by the activities of the World Peace Council, an organization that aligned itself with Soviet foreign policy.

The nuclear disarmament campaign faded from visibility in the early 1950s, but began to revive later in the decade around the issue of the development of the H-bomb (which was immensely more powerful than the atomic bomb) and, particularly, nuclear weapons testing. Albert Einstein and Bertrand Russell warned of a nuclear holocaust, while the Pugwash movement brought together scientists from both sides

¹ This historical account is based on the author's *Confronting the Bomb. A Short History of the World Nuclear Disarmament Movement*, Stanford, Stanford University Press, 2009, an abbreviated version of the author's trilogy: *One World or None. A History of the World Nuclear Disarmament Movement through 1953*, Stanford, Stanford University Press, 1993; *Resisting the Bomb. A History of the World Nuclear Disarmament Movement, 1954 to 1970*, Stanford, Stanford University Press, 1997; *Toward Nuclear Abolition. A History of the World Nuclear Disarmament Movement, 1971 to the Present*, Stanford, Stanford University Press, 2003.

of the «Iron Curtain» to discuss nuclear dangers. Explicitly «Ban the Bomb» groups sprang up, including Gensuikyo and Gensuikin (in Japan), the National Committee for a Sane Nuclear Policy and Women Strike for Peace (in the United States), the Campaign for Nuclear Disarmament (in Britain, Canada, Australia, and New Zealand), the Struggle Against Atomic Death (in West Germany), the Campaign Against Atomic Weapons (in Denmark and Sweden), and numerous other organizations around the world. Staging protest marches under the new nuclear disarmament symbol, distributing antinuclear literature, and pressing their governments for disarmament, they became some of the largest, most dynamic social movements of their time.

Although this second round of protest against nuclear weapons faded after the early 1960s, a new, more powerful antinuclear uprising emerged in the late 1970s and continued into the mid-1980s. As older nuclear disarmament groups began to revive and newer ones to appear, the West European movement coalesced into the European Nuclear Disarmament campaign, initially designed to halt the deployment of a new generation of Euromissiles-Cruise and Pershing II missiles from the United States and SS-20 missiles from the Soviet Union. Meanwhile, in the United States, a Nuclear Freeze campaign – designed to stop the nuclear arms race through a Soviet-American agreement to halt the testing, development, and deployment of nuclear weapons – brought together most US peace and disarmament groups in a common effort. In 1982, nearly a million Americans turned out for an antinuclear rally. Campaign for

Nuclear Disarmament (in Britain), church organizations and the Green Party (in West Germany), the Interchurch Peace Council (in the Netherlands), and comparable movements elsewhere in Western Europe grew into enormous movements with demonstrations of unprecedented size. In the Pacific, antinuclear groups staged the largest protest rallies in the history of Australia, Japan, and New Zealand, while other Pacific Island nations organized a Nuclear Free and Independent Pacific Movement. Even in the Communist nations of Eastern Europe, the Soviet Union, and China, independent nuclear disarmament groups arose and challenged official government policy.

On the international level, too, older groups (such as the Pugwash movement) renewed their efforts, while newer ones (such as International Physicians for the Prevention of Nuclear War) added their strength to the nuclear disarmament campaign. In the fall of 1983, an estimated five million people demonstrated against the nuclear arms race. During this round of protest, as during the preceding ones, opinion surveys around the world showed overwhelming public opposition to nuclear weapons and a desire for their abolition.

Only in the late 1980s did the mass movement begin to decline, and even then it left behind hundreds of organizations, smaller but committed, that have continued to agitate for nuclear disarmament.

Motivation

Examining these movements, scholars have differed about their motivation. Most scholars – including April Carter, David Cortright, David Meyer, Paul Wehr, Rich-

ard Taylor, Nigel Young, Martin Ceadel, Lawrence Wittner, Matthew Evangelista, and John Sandford² – have emphasized the movements' emergence and mobilization in connection with the most obvious signs of nuclear danger: the escalation of the nuclear arms race and government talk of nuclear war. Nevertheless, some writers argue that other factors are more significant, such as a desire to aid the Soviet Union or destroy Western defenses against Soviet aggression (Thomas Cynkin, Alexander Shtromas, and Armand Clesse)³, anti-Establishment views (Kim Salomon and Joyce Marie Mushaben)⁴, and, in Eastern Europe, an attempt

to restore civil society (Vladimir Tismaneanu, Catherine Fitzpatrick, and Janet Fleischman)⁵. Still other scholars – including Amy Swerdlow, Glenn Hook, Zsuzsa Hegedus, Nils Petter Gleditsch, and Robert English⁶ – though emphasizing the driving force of nuclear fear, have also called attention to other factors.

Weakness and Decline

The causes of the movements' weakness and decline provide other points of contention for scholars. Some writers – including Wehr, Martin Ceadel, and Gleditsch⁷ – stress internal factors, such as ill-

² A. Carter, *Peace Movements. International Protest and World Politics since 1945*, London, Longman, 1992, pp. 40-84 and 108-215; D. Cortright, *Peace Works. The Citizen's Role in Ending the Cold War*, Boulder, Westview Press, 1995; D.S. Meyer, *A Winter of Discontent. The Nuclear Freeze and American Politics*, New York, Praeger, 1990; P. Wehr, *Nuclear Pacifism as Collective Action*, «Journal of Peace Research», 1986, 2; R. Taylor, *Against the Bomb. The British Peace Movement, 1958-1965*, Oxford, Clarendon Press, 1988; Id., N. Young, *Britain and the International Peace Movement in the 1980s*, in Id. (eds.), *Campaigns for Peace. British Peace Movements in the Twentieth Century*, Manchester, Manchester University Press, 1987; M. Ceadel, *Britain's Nuclear Disarmers*, in W. Laqueur, R. Hunter (eds.), *European Peace Movements and the Future of the Western Alliance*, New Brunswick, Transaction Books, 1985; L.S. Wittner, *One World or None*, cit.; Id., *Resisting the Bomb*, cit.; Id., *Toward Nuclear Abolition*, cit.; M. Evangelista, *Unarmed Forces. The Transnational Movement to End the Cold War*, Ithaca, Cornell University Press, 1999; J. Sandford, *The Sword and the Ploughshare. Autonomous Peace Initiatives in East Germany*, London, Merlin Press/European Nuclear Disarmament, 1985.

³ T.M. Cynkin, *The British Antinuclear Movement: Precedents, Program, and Prospects*, in J.E. Dougherty, R.L. Plaltzgraft Jr. (eds.), *Shattering Europe's Defense Consensus. The Antinuclear Protest Movement and the Future of NATO*, Washington, Pergamon-Brassey's, 1985; A. Shtromas, *Pacifism and the Contemporary International Situation*; Id., *The Soviet Union and the Politics of Peace*, and A. Clesse, *The Peace Movements and the Future of West European Security*, in P. van den Dungen (ed.), *West European Pacifism and the Strategy for Peace*, London, Macmillan Press, 1985.

⁴ K. Salomon, *Fred i vår tid*, Malmö, Liber, 1985; J.M. Mushaben, *Reflections on the Institutionalization of Protest: The West German Peace Movements*, «Alternatives», 1984, 4.

⁵ V. Tismaneanu, *Unofficial Peace Activism in the Soviet Union and East-Central Europe*, in Id. (ed.), *In Search of Civil Society. Independent Peace Movements in the Soviet Bloc*, New York, Routledge, 1990; C. Fitzpatrick, J. Fleischman, *From Below. Independent Peace and Environmental Movements in Eastern Europe & the USSR*, New York, Helsinki Watch Committee, 1987.

⁶ A. Swerdlow, *Women Strike for Peace. Traditional Motherhood and Radical Politics in the 1960s*, Chicago, University of Chicago Press, 1993; G.D. Hook, *The Ban the Bomb Movement in Japan: Whither Alternative Security?*, «Social Alternatives», 1985, 2; Z. Hegedus, *The Challenge of the Peace Movement: Civilian Security and Civilian Emancipation*, «Alternatives», 1987, 2; N.P. Gleditsch, *The Rise and Decline of the New Peace Movements*, in K. Kodama, U. Vesa (eds.), *Towards a Comparative Analysis of Peace Movements*, Hants, Dartmouth Publishing, 1990; R. English, *Eastern Europe's Doves*, «Foreign Policy», Fall 1984.

⁷ P. Wehr, *Nuclear Pacifism as Collective Action*, cit.; M. Ceadel, *Britain's Nuclear Disarmers*, cit.; N.P. Gleditsch, *The Rise and Decline of the New Peace Movements*, cit.

defined leadership, the absence of unified goals, the unpopularity of some movement ideas (for example, unilateralism), and the inability of activists to sustain lengthy protest campaigns. Others – such as Ralph Summy, Carter, Swerdlow, Michael Krasner, and Andrew Rojecki⁸ – point to external factors, such as public identification of protest campaigns with Communism, the pressing nature of other peace issues, and the largely hostile mass communications media. Many more scholars, however – among them Thomas Rochon, Rob Kleidman, Taylor, Nicole Gnesotto, Meyer, Tony Chafer, Jolyon Howorth, and Wittner⁹ – see both internal and external factors in operation, especially co-optation.

Efficacy

Perhaps the most sharply disputed issue among scholars is that of efficacy. In their

accounts of the nuclear arms race, some writers – notably John Gaddis, Richard Rhodes, Gerard DeGroot, and Paul Lettow¹⁰ – barely notice nuclear disarmament campaigns and ignore their role in influencing government nuclear weapons policy. Instead, they contend that whatever shifts in policy that occurred resulted from the personal preferences of government officials.

Other scholars – including Mark Cioc, Jeffrey Boutwell, McGeorge Bundy, Krasner, Nikolaj Petersen, and Carter¹¹ – conclude that disarmament movements had some efficacy. This ranged from changing the climate of opinion, to extending the range of debate, to changing institutions, to affecting Soviet and Western negotiations over nuclear arms. Although Bundy views the Freeze campaign as a failure, he maintains that public pressure lay behind the

⁸ R. Summy, *The Australian Peace Council and the Anticommunist Milieu, 1949-1965*, in C. Chatfield, P. van den Dungen (eds.), *Peace Movements and Political Cultures*, Knoxville, University of Tennessee Press, 1988; A. Carter, *Peace Movements*, cit.; A. Swerdlow, *Women Strike for Peace*, cit.; M.A. Krasner, *The Political Influence of the New Danish Peace Movement, 1979-1986*, Aarhus, University of Aarhus, 1986, p. 17; A. Rojecki, *Silencing the Opposition. Antinuclear Movements and the Media in the Cold War*, Urbana, University of Illinois Press, 1999, pp. 101, 159, 177.

⁹ T.R. Rochon, *Mobilizing for Peace. The Antinuclear Movements in Western Europe*, Princeton, Princeton University Press, 1988; Id., R. Kleidman, *Dilemmas of Organization in Peace Campaigns*, in T.R. Rochon, D.S. Meyer (eds.), *Coalitions and Political Movements. The Lessons of the Nuclear Freeze*, Boulder, Lynne Rienner Publishers, 1997; R. Taylor, *Against the Bomb*, cit.; N. Gnesotto, *All Quiet on the French Front?* in W. Laqueur, R. Hunter (eds.), *European Peace Movements*, cit.; D.S. Meyer, *A Winter of Discontent*, cit.; T. Chafer, *Politics and the Perception of Risk: A Study of the Anti-Nuclear Movements in Britain and France*, «West European Politics», 1985, 1; J. Howorth, *France. The Politics of Peace*, London, European Nuclear Disarmament/Merlin Press, 1984; L.S. Wittner, *One World or None*, cit.; Id., *Resisting the Bomb*, cit.; Id., *Toward Nuclear Abolition*, cit.

¹⁰ J.L. Gaddis, *Strategies of Containment. A Critical Appraisal of American National Security Policy During the Cold War*, Oxford, Oxford University Press, 2005; R. Rhodes, *Dark Sun. The Making of the Hydrogen Bomb*, New York, Simon & Schuster, 1995; Id., *Arsenals of Folly. The Making of the Nuclear Arms Race*, New York, Alfred A. Knopf, 2007; G.J. DeGroot, *The Bomb. A Life*, Cambridge, MA, Harvard University Press, 2005; P. Lettow, *Ronald Reagan and His Quest to Abolish Nuclear Weapons*, New York, Random House, 2005.

¹¹ M. Cioc, *Pax Atomica. The Nuclear Defense Debate in West Germany During the Adenauer Era*, New York, Columbia University Press, 1988; J. Boutwell, *The German Nuclear Dilemma*, Ithaca, Cornell University Press, 1990; M. Bundy, *Danger and Survival*, New York, Random House, 1988; M.A. Krasner, *The Political Influence*, cit.; Id., N. Petersen, *Peace and Politics. The Danish Peace Movement and Its Impact on National Security Policy*, «Journal of Peace Research», 1986, 2; A. Carter, *Peace Movements*, cit., pp. 78-79 and 148-151.

Partial Test Ban Treaty of 1963 and the US government's unwillingness to use nuclear weapons in the Vietnam War¹². David Holloway, in his examination of Soviet nuclear weapons policy through the early 1980s, draws a distinction between the influence of nuclear disarmament movements in the West and their lack of influence in the East¹³.

Most scholars, however, maintain that nuclear disarmament movements played a central role in reshaping nuclear weapons policy. They include Swerdlow, Dee Garrison, Meyer, Kleidman, Jeffrey Knopf, Nina Tannenwald, and Vincent Auger (study-

ing the United States)¹⁴, Steve Breyman (studying West Germany and the United States)¹⁵, Niels Haagerup (studying the Nordic countries)¹⁶, Kevin Clements (studying New Zealand)¹⁷, English and Evangelista (studying the Soviet Union)¹⁸, and Cortright and Wittner (studying nations around the world)¹⁹. Drawing, in some cases, on massive documentary material and interviews, they argue that the movements constituted the key factor in discouraging governments from developing nuclear weapons, pushing governments toward nuclear arms control and disarmament agreements, and preventing nuclear war.

¹² M. Bundy, *Danger and Survival*, New York, Random House, 1988, pp. 460, 537, 582.

¹³ D. Holloway, *The Soviet Union and the Arms Race*, New Haven, Yale University Press, 1983, pp. 183-184.

¹⁴ A. Swerdlow, *Women Strike for Peace*, cit., p. 4; D. Garrison, *Bracing for Armageddon. Why Civil Defense Never Worked*, Oxford, Oxford University Press, 2006; D.S. Meyer, *A Winter of Discontent*, cit.; Id., R. Kleidman, *The Nuclear Freeze Movement in the United States*, «International Social Movement Research», 1991, 3; J.W. Knopf, *Domestic Society and International Cooperation. The Impact of Protest on U.S. Arms Control Policy*, Cambridge, Cambridge University Press, 1998; N. Tannenwald, *The Nuclear Taboo. The United States and the Non-Use of Nuclear Weapons Since 1945*, Cambridge, Cambridge University Press, 2007; V.A. Auger, *The Dynamics of Foreign Policy Analysis. The Carter Administration and the Neutron Bomb*, Lanham, Maryland, Rowman & Littlefield, 1996.

¹⁵ S. Breyman, *Why Movements Matter. The West German Peace Movement and U.S. Arms Control Policy*, Albany, State University of New York Press, 2001, pp. 227-277.

¹⁶ N.J. Haagerup, *The Nordic Peace Movements*, in W. Laqueur, R. Hunter (eds.), *European Peace Movements*, cit.

¹⁷ K. Clements, *Back from the Brink. The Creation of a Nuclear-Free New Zealand*, Wellington, Allen & Unwin/Port Nicholson Press, 1988.

¹⁸ R.D. English, *Russia and the Idea of the West. Gorbachev, Intellectuals, and the End of the Cold War*, New York, Columbia University Press, 2000; M. Evangelista, *Unarmed Forces*, cit.

¹⁹ D. Cortright, *Peace Works*, cit., p. 248; Id., *Peace. A History of Movements and Ideas*, Cambridge, Cambridge University Press, 2008, pp. 126-154; L.S. Wittner, *One World or None*, cit.; Id., *Resisting the Bomb*, cit.; Id., *Toward Nuclear Abolition*, cit.

Nuclear Power, Popular Culture and the Rise of «Global Consciousness»

In the last decades of the Eighteenth century, the German philosopher Immanuel Kant published two essays in which he argued that humans, in spite of their bad inclinations, were driven towards more rational relationships with one another by nature, «die grosse Künstlerin». By travelling and meeting people in distant lands, Kant argued, people are able to establish peaceful relations, which may be turned into law, so that eventually a «world constitution» may emerge. This would not happen automatically: conscious effort was needed, and barbarous practices like slavery had to be abolished¹. Although more cynical thinkers have often criticized Kant's argument, versions of it have kept recurring. We see it in the hopeful reactions to the coming of the

telegraph in the 1840s, in Marshall McLuhan's prophecy of a «global village» in the 1960s, and in the brief euphoria about the internet during the 1990s². Jürgen Habermas' seminal thesis about the emergence of a «public sphere» in the coffeehouses and journals of the Eighteenth century was directly borrowed from Kant, and is now incorporated into some sociological theories of globalization³. Recently, historians have joined this debate. Bruce Mazlish, for example, claims that «more and more people are becoming aware that they live on one planet, whose challenges and problems are global in nature»⁴. And Akira Iriye writes that «a global consciousness», «a genuine world community» has been emerging since the Nineteenth century⁵. The forces

¹ I. Kant, *Beantwortung der Frage: Was ist Aufklärung*, Königsberg, Friedrich Nicolovius, 1784, and especially Id., *Zum ewigen Frieden, ein philosophischer Entwurf*, Königsberg, Friedrich Nicolovius, 1795. Citation from the latter essay, as found in the Gutenberg Project, available at www.gutenberg.org/ebooks/46875.

² D.J. Czitrom, *Media and the American Mind. From Morse to McLuhan*, Chapel Hill, University of North Carolina Press, 1982; on the early internet J. Goldsmith, T. Wu, *Who Controls the Internet? Illusions of a Borderless World*, New York, Oxford University Press, 2006.

³ J. Habermas, *Strukturwandel der Öffentlichkeit*, Darmstadt und Neuwied, Luchterhand, 1962. Recent application to international relations: e.g. K. Nash (ed.), *Transnationalizing the Public Sphere*, Cambridge, Polity Press, 2014. For a good discussion of Habermas' work and contemporary relevance, see J.B. Thompson, *The Media and Modernity: A Social Theory of the Media*, Cambridge, Polity Press, 1995, pp. 69-75.

⁴ B. Mazlish, *Social Bonding, Globalization, and Humanity*, «New Global Studies», 2011, 3, p. 7. See also Id., *The Idea of Humanity in a Global Era*, New York, Palgrave Macmillan, 2009, appendix I, *The Question of Global Identity*, where he also quotes, on p. 119, skeptics of this idea; J. Keane, *Global publics: Civil Society, Journalism and Democracy across Borders*, in G. Budde, S. Conrad, O. Janz (hrsg.), *Transnationale Geschichte. Themen, Tendenzen und Theorien*, Göttingen, Vandenhoeck & Ruprecht, 2006.

⁵ A. Iriye, *Global Community: The Role of International Organizations in the Making of the Contemporary World*, Berkeley, University of California Press, 2002, pp. 8, 128 are examples of these firm claims. An excellent critical discussion of recent literature with this claim: S.S. Stroup, *Borders among Activists: International NGOs in the United States, Britain, and France*, Ithaca, Cornell University Press, 2012, pp. 5-11. A. Iriye, P. Saunier (eds.), *The Palgrave Dictionary of Transnational History*, New York, Palgrave Macmillan,

that bring this about are obvious: increased communication, travel and trade, and the appearance of problems of an unprecedented scale, such as environmental pollution and flows of refugees. But to connect such developments with global awareness is a huge claim that cries out for empirical testing.

In this essay, I will argue that the appearance of nuclear power in its military and peaceful forms stimulated the simultaneous emergence in many parts of the world of an awareness of problems on a global scale, and that a comparative study of the representation of nuclear power in popular media is a fruitful approach towards understanding this rising awareness. But first let us take a critical look at the concept of global consciousness and at empirical studies that attempt to demonstrate its emergence.

Was there a Rise in Global Awareness?

Concepts like awareness and consciousness, which are the core of Mazlish's and Iriye's claims, are problematical in historical enquiry, because they refer to mental processes, which leave no direct traces in the sources. Our sources record only *fragments* of the *expressed* thoughts and feel-

ings of the more educated part of humanity; about the rest we can only speculate. Second, in the tradition of Kant, historians who write about global consciousness tend to be uncritically hopeful about it⁶. A more sober-minded historian, Mark Mazower, writes:

There is still virtually no shared consciousness globally of common struggles or common achievements. Enormous groups – the poor in the Global South for instance – have no sense of forming a single community [...] Even today's most urgent global issues tend to be tackled regionally or nationally: the history of global warming or organised crime is a history of multiple actors, as often as not talking at cross-purposes⁷.

But this position also leaves a lot unexplained, for example the amazing rise of international citizens' organizations like Amnesty International and Greenpeace, which spurred thousands of people to action, and became well-known to millions world-wide, and the global impact of media like CNN and Western and non Western television soaps⁸. Although difficult to chart, it seems likely that, especially in the post-World War II decades, millions of people around the world developed something

2009 is a rich inventory of themes and bibliography. Reviews of transnational history include: A. Iriye, *Global and Transnational History: the Past, Present, and Future*, New York, Palgrave Macmillan, 2012; J.H. Meyer, *Transnationale Geschichte: eine Perspektive*, «Historische Mitteilungen der Ranke Gesellschaft», 26, 2013-2014.

⁶ See review of A. Iriye's *Global Community*, cit., by A. Sotomayor in «Development in Practice», 2003, 4.

⁷ M. Mazower, review of D. Cannadine, *The Undivided Past*, «Financial Times», 9 March 2013. See also M. Mazower, *No Enchanted Palace: The End of Empire and the Ideological Origins of the United Nations*, Princeton, Princeton University Press, 2010, p. 6.

⁸ A seminal work in this field, which has also influenced historians, was written by two political scientists: M.E. Keck, K. Sikkink, *Activists beyond Borders: Advocacy Networks in International Politics*, Ithaca, Cornell University Press, 1998. It is criticized by S.S. Stroup, *Borders among Activists*, cit.

like the awareness Mazlish and Iriye speak about. To get a better grip on this phenomenon, we need to focus on issues with a transnational impact, and ask how they were framed («named, interpreted, dramatized», to quote a brief definition⁹), how they travelled across borders, and by whom and how they were received¹⁰.

Nuclear Power and World Opinion

Nuclear power is a paradigmatic example of such an issue, and it was framed in global terms from the start. After the media had reported the bombing of Hiroshima and Nagasaki, it was scientists from the United States, Britain, Denmark, Hungary and other countries who explained the new phenomenon to a global public, and appealed to each and all to prevent further armament and a nuclear war. Most of them were veterans of the Manhattan Project, which had created the Bomb, and several had joined the project after fleeing Fascism in their home countries. Their rhetoric was in terms of «we», meaning humanity:

«we» are threatened by global destruction, if «we» don't get our priorities straight, and act against the madness¹¹. When, a few years later, the American government started a counter campaign under the banner of the «peaceful atom» it also addressed world opinion, and used similar framing. President Dwight D. Eisenhower, in his famous December 1953 speech to the United Nations General Assembly, called nuclear power «a great boon for the benefit of all mankind»¹². And Disney's brilliant «Our Friend the Atom», which also reached an international audience, said: «The magic power of atomic energy will soon work for the profit of all humanity. It will bring the gifts of technology to even the remotest parts»¹³.

In different ways, all these people assumed the existence of world opinion, addressed it, and thereby contributed to creating it. Political leaders and peace activists shared the view that the Cold War was to a large extent a battle for world public opinion¹⁴. When the American activist Norman Cousins tried to persuade Albert Schweitzer in

⁹ The concept of framing, which goes back to E. Goffman, *Frame Analysis: An Essay on the Organization of Experience*, Harmondsworth, Penguin, 1975, is much used in research about social movements, e.g. M.E. Keck, S. Sikkink, *Activists beyond Borders*, H. Nehring, *Politics of Security: British and West-German Protest Movements and the Early Cold War, 1945-1970*, Oxford, Oxford University Press, 2013, and B. Ziemann (ed.), *Peace Movements in Western Europe, Japan and the USA during the Cold War*, Essen, Klartext Verlag, 2007. I have summarized the definition by M.E. Keck, S. Sikkink, *Activists beyond Borders*, cit.

¹⁰ On reception see M. Hard, A. Jamison, *Hubris and Hybrids: A Cultural History of Technology and Science*, New York-London, Routledge, 2005, *Introduction*.

¹¹ D. Masters, K. Way (eds.), *One World or None: A Report to the Public on the Full Meaning of the Atomic Bomb*, New York, McGraw-Hill, 1946. The idea of a world government had been discussed earlier, for example by H.G. Wells, *The World Set Free: A History of Mankind*, London, Macmillan and Co., 1914, and W. Wilkie, *One World*, New York, Simon & Schuster, 1943. See P. Kennedy, *The Parliament of Man: the United Nations and the Quest for World Government*, London, Penguin, 2006, chapter 1.

¹² H.R. Ryan (ed.), *US Presidents as Orators: A Bio-Critical Sourcebook*, Westport, Greenwood Press, 1995, p. 197.

¹³ H. Haber, *The Walt Disney Story of Our Friend the Atom*, New York, Dell Publishing Group, 1956, p. 127.

¹⁴ K. Osgood, *Total Cold War: Eisenhower's Secret Propaganda Battle at Home and Abroad*, Lawrence, University Press of Kansas, 2006, chapters 5 and 6.

Lambaréné to give a radio speech in protest to nuclear testing in 1957, he told him that «he would have an almost universal audience for anything he might say». According to Cousins, Schweitzer replied that «an informed and determined world opinion could serve as a powerful force in bringing about enforceable agreements with respect to arms control»¹⁵. Governments feared the influence of scientists and doctors who criticized nuclear power, men like Albert Einstein, Bertrand Russell and Benjamin Spock, because of their tremendous international public status and appeal¹⁶. The global impact of these men was greatly amplified by the international peace movements that sprang up right after Hiroshima and Nagasaki. They turned thousands of citizens into activists, and with their publications and peace marches, especially in Western cities, reached millions. Their archives allow us to document this process of transnational mobilization in detail. Recent studies by Holger Nehring, Benjamin Ziemann and others have demonstrated that in spite of the obvious transnational character of the issue and the international rhetoric, national mentalities and political structures created strong differences between the movements in different countries and that

cooperation across borders was very limited and difficult: an international civil society or a global public did not come about as easily as some historians have thought. Studies about movements against nuclear energy in the 1970s and reactions to the 1986 Chernobyl disaster point in the same direction¹⁷.

The Atom in Popular Media

Together with six colleagues, I attempted a very different approach in *The Nuclear Age in Popular Media*, which came out in 2012¹⁸. Our goal was to compare representations of nuclear power (military and peaceful) in media that reached large audiences in eight countries: the United States, the Soviet Union, the two Germanies, Britain, the Netherlands, Japan, and India. We used illustrated magazines, such as *Life* and *Stern*, as our main source, because they were very widely read. And because they had a very similar format in all the countries we studied, they were eminently suitable for systematic comparison. In addition, we studied popular novels, comics, films and film reviews, and exhibitions.

Popular media can help us understand the rise of international awareness for three reasons. First, they create an environment

¹⁵ N. Cousins, *Dr. Albert Schweitzer of Lambaréné*, Westport, Greenwood Press, 1973, pp. 167-168.

¹⁶ A wonderful case study is L.S. Wittner, *Blacklisting Schweitzer*, «Bulletin of the Atomic Scientists», 1995, 3.

¹⁷ H. Nehring, *Politics of Security*, cit.; B. Ziemann (ed.), *Peace Movements*, cit.; K. Kalmbach, *Meanings of a Disaster. The Contested «Truth» about Chernobyl: British and French Chernobyl Debates and the Transnationality of Arguments and Actors*, PhD Thesis, European University Institute, Florence, 2014; J.H. Meyer, A. Mignon Kirchhof, *Global Protest against Nuclear Power: Transfer and Transnational Exchange in the 1970s and 1980s*, special issue of the «Historical Social Research», 2014, 1. Their skepticism is similar to that of S.S. Stroup, *Borders among Activists*, cit.

¹⁸ D. van Lente (ed.), *The Nuclear Age in Popular Media: A Transnational History, 1945-1965*, New York, Palgrave Macmillan, 2012. Elaboration of, and references for the following can be found in that book, especially in the conclusion.

in addition to the physical one in which people live. This media-environment contains images and stories about the world far away from home, so that even people who hardly travel all their lives are confronted with global issues¹⁹. Second, because popular media are usually commercial products, geared to the desires and fears of common people, they tell us much more about widespread thoughts and feelings than publications aimed at, or produced by, activists, politicians and intellectuals, the main actors in the studies discussed above. Especially popular fiction reveals the emotional undertow that is hard to discern in the more rationalist discourse of the well-educated. Finally, popular media include a lot of pictorial material, which is difficult to analyze, but offers rich new perspectives. With regard to photographs, Susan Sontag has argued that they invite, more than moving images and texts do, a long look and reflection, much like quotations or proverbs. Some pictures «lock stories in our minds», «encapsulate common ideas of significance and trigger predictable thoughts, feelings»²⁰. An example from our research are the terrible photographs of victims of the Hiroshima and Nagasaki bombings, which appeared in 1952 in the Japanese magazine «Asahigraph», and were soon copied in magazines elsewhere, such as «Life» and the Dutch «Panorama». Although written reports had appeared within months after these events, the photos must have reached a much larger public, and are likely to have locked images and feelings connected to

nuclear war more effectively into the minds of millions than any other medium could, especially when they were printed again later, e.g. on the occasion of commemorations of the event.

Our research has demonstrated the importance of the relation between military and peaceful uses, which are usually studied separately. «Life» magazine, for example, increased its coverage of peaceful applications as weapons became more destructive during the 1950s. In the official rhetoric in the West, the two were consistently represented as radical opposites. The peaceful atom would solve numerous problems, such as energy provision, medical diagnostics and the treatment of disease. Because of the widespread fear of fallout from nuclear tests, the authorities emphasized the absolute safety of peaceful applications. Illustrated magazines, however, undermined this message by reporting regularly on fallout from tests and, especially in West Germany and the Netherlands, on researchers, doctors and workers in the nuclear industries who had fallen ill by working with radioactive materials. Even articles that praised nuclear medicine contained illustrations showing doctors and nurses in heavy protective gear, emphasizing the dangers of radiation. Thus the official contrast between military and peaceful, dangerous and safe, was continually undermined by what was clearly the greatest fear in this period: that of radiation. And most commonly, the undermining was not done by argument or taking a political

¹⁹ J. Tomlinson, *Globalization and Culture*, Cambridge, Polity Press, 2008, p. 9; J. Keane, *Global Publics*, cit.

²⁰ S. Sontag, *Regarding the Pain of Others*, New York, Picador, 2003, pp. 21, 106; citation on p. 86.

stand, but by sensationalist reporting supported by creepy images – in other words, by playing on common fears. Our research therefore suggests that the peaceful atom-campaign was much less successful than is commonly thought, and that the increasing public distrust in science, scientists and high tech, which became apparent in Western countries in the 1960s and 1970s, did not appear suddenly, but developed slowly in the highly ambivalent public image of nuclear technology in the 1950s.

In Communist countries and in India, popular media presented a very different picture. Here the peaceful atom was practically national ideology. East German and Soviet magazines depicted atomic energy as one of the technologies that would carry their societies towards utopia, while the West was using the same technology for making weapons. Until 1965, the Soviet «Ogonyok» even ignored the country's own nuclear arsenal. In India, the «Illustrated Weekly of India» did occasionally mention the risks of nuclear tests, but emphasized the bright future nuclear technologies would bring. This may be explained by the fact that the Indian magazine, in contrast with the other magazines we studied, served only the literate minority (most of the population being illiterate). The Indian elites, which included nuclear physicists, saw nuclear power as a way to modernity

for the newly independent states, with their country setting the example. If doubts about technological progress emerged in India and Communist countries, they were consistently contradicted by popular media.

Popular media such as cheap books, newspapers, magazines, films, songs and comics, reflect widespread feelings and thoughts, and are very likely to have shaped them as well. They allow us to study how world events and issues appeared in the media-environments in which people lived – how such events and issues were captured in images, interpreted in reports, and projected into comic book stories and films. They document not only ideas and arguments, which have been emphasized by public sphere scholars in the tradition of Habermas, but also the emotions of the past. Thus we may reconstruct how the world appeared to people exposed to these popular media in different parts the world, how transnational (though not global) areas emerged in which similar issues were defined in similar ways, and how such images and stories were shaped by previous discussions and by local peculiarities²¹. The Twentieth century has produced an incredible amount of such popular media, a magnificent set of sources for comparative studies of popular opinion, which so far have hardly been explored.

²¹ J. Radkau, *Hiroshima und Asilomar. Die Inszenierung des Diskurses über die Gentechnik vor dem Hintergrund der Kernenergie-Kontroverse*, «Geschichte und Gesellschaft», 3, 1998; H. Nehring, *Politics of Security*, cit., Epilogue.

Nuclear Energy in the Developing World: Past, Present, and Future

As the discovery of nuclear fission converged with the outbreak of the Second World War, military uses of nuclear technology emerged more to the forefront than its peaceful or civilian uses. After a period of postwar information censorship and controls on technology and materials, following President Dwight D. Eisenhower's Atoms for Peace speech in December 1953, nuclear technology meant for civilian uses began to disseminate worldwide. While that led to the initiation of nuclear energy programs by several developing countries, it also led to concerns about the potential risks of the spread of nuclear weapons from possible misuses given the dual-use nature of this technology. However, given the fact that only nine countries have developed nuclear weapons so far out of 30 countries that possess operating nuclear power reactors, the threat of nuclear proliferation seems to be limited¹. Nuclear energy can play a significant role in helping countries attain energy security through producing electricity by cleaner means – an issue of high importance in today's era of climate change.

Yet, the nuclear industry has experienced stagnation since the 1980s, and forecasts made during the Cold War regarding its performance have rarely materialized. According to estimates made by the International Atomic Energy Agency (IAEA), while there will be zero growth in nuclear energy in the OECD countries in the period 2003-2030, the non-OECD countries will witness expansion in nuclear energy². In other words, the possibility of a nuclear renaissance is primarily dependent on non-OECD countries' adoption of nuclear energy³. Currently, nine developing countries have operational nuclear power reactors: Armenia, Argentina, Brazil, China, India, Iran, Mexico, Pakistan, and South Africa⁴. Although this number could increase, with countries like the United Arab Emirates, Saudi Arabia and Turkey expressing desire for civil nuclear expansion, only 7.5% of the world's reactors are located in developing countries (predominantly in China and India) that produce merely 4.3% of the world's nuclear-generated electricity⁵. This contribution explores the key issues concerning nuclear energy in developing

¹ *International Status and Prospects for Nuclear Power 2014. Report by the Director General*, GOV/INF/2014/13-GC(58)/INF/6, Vienna, International Atomic Energy Agency, 2014.

² J. Goldemberg, *Nuclear Energy in Developing Countries*, «Daedalus», 2009, 4.

³ In this paper, the term developing countries is used to refer to countries that are neither members of the OECD, nor a former Soviet republic or a Soviet satellite state.

⁴ IAEA Pris Database: www.iaea.org/PRIS/WorldStatistics/OperationalReactorsByCountry.aspx (last accessed: 5 May 2015).

⁵ J. Goldemberg, *Nuclear Energy in Developing Countries*, cit., p. 72.

countries, and the challenges to materialization of a nuclear energy renaissance. It is divided into four sections. The first section examines the economic growth and climate change-led arguments in favor of nuclear energy, while the second section discusses the proliferation risks from dual-use nuclear technology. The third section underlines the subsidized nature of the nuclear technological complex, while the fourth and final summarizes the conclusions.

Economic Growth and Climate Change

Homi J. Bhabha, the first chairman of the Atomic Energy Commission of India, believed that by allowing developing countries to produce vast amounts of electricity nuclear energy would materialize their aspirations for economic growth. His ideas, which were posthumously published in «Science» magazine, convinced the Indian Prime Minister Jawaharlal Nehru, and led India to begin exploring nuclear energy as early as 1946 – a year before independence⁶. China, unlike India, began the pursuit of nuclear technology for solely military purposes and developed civilian reactors later on.

Today, China has 27 operational power reactors and India has 21 such reactors, and they derive 2,39% and 3,53% of their electricity from nuclear energy respectively.

Brazil, Argentina and Pakistan each derive 2,86%, 4,05% and 4,34% of their electricity needs from nuclear power. Mexico and South Africa derive less than 7% of their electricity needs from nuclear energy. In other words, with the exception of Armenia, nuclear energy accounts for only a small contribution to the energy needs of most developing countries⁷. In 2008, fifty developing countries that do not have nuclear power expressed interest to the IAEA in building their first nuclear power plant⁸. Eight years hence, only the United Arab Emirates is close to this goal and currently has three reactors under construction⁹.

Concerns of climate change through global warming have led proponents of nuclear energy to canvass strongly in favor of the construction of power reactors worldwide, and of an increased dependence on nuclear energy. The low-carbon production of nuclear energy makes it a viable alternative to fossil fuels in the context of climate change. The rising demands for energy along with climate change concerns are what is driving the nuclear renaissance, according to the World Nuclear Association¹⁰. However, as the next two sections will demonstrate, the risks and costs of a civil nuclear expansion are quite high raising questions about their viability for developing countries.

⁶ H.J. Bhabha, *Science and the Problems of Development*, «Science», 3710, 1966.

⁷ All data obtained from IAEA Pris Database: www.iaea.org/PRIS/home.aspx (last accessed: 12 May, 2015).

⁸ J. Goldemberg, *Nuclear Energy in Developing Countries*, cit., p. 72.

⁹ IAEA Pris Database: www.iaea.org/PRIS/WorldStatistics/UnderConstructionReactorsByCountry.aspx (last accessed: 5 May, 2015)

¹⁰ *The Nuclear Renaissance*, World Nuclear Association website, January 2014, available at: www.world-nuclear.org/info/Current-and-Future-Generation/The-Nuclear-Renaissance/ (last accessed: 13 May, 2014).

Nuclear Proliferation, Safety and Security

Out of the nine developing countries that possess operating nuclear power reactors, three countries have confirmed nuclear weapons (China, India and Pakistan), one is accused of developing such weapons (Iran), two countries attempted to develop nuclear weapons in the past (Brazil and Argentina), and one possessed nuclear weapons but eventually dismantled them (South Africa). This makes the risks of nonproliferation a potential concern although possessing sensitive dual-use nuclear technology is a necessary but not sufficient condition for nuclear weapons development. Other factors like national security, domestic politics and prestige have important impact on nuclear proliferation by states¹¹. Although IAEA safeguards exist to prevent misuse of technology meant for peaceful purposes for military uses, concerns of nuclear proliferation remain with civil nuclear expansion¹².

With the 2011 Fukushima nuclear disaster in Japan, concerns of nuclear safety returned to the limelight, leading some West European countries like Germany, Switzerland and Italy to declare a phase out

of nuclear energy from their energy mix¹³. However, developing countries like India and China have been less pessimistic, and have moved ahead with plans for large-scale civil nuclear expansion¹⁴. India had witnessed massive protests against nuclear energy at Kudankulam but the government has remained determined to adhere to its plans to build several new reactors over the coming years¹⁵. Interestingly, this is not the case in another emerging economy with a long history of pursuing civil nuclear energy, Brazil. By 2013, the Latin American country seemed to be scaling down on nuclear energy and promote wind power instead¹⁶.

The Fukushima incident highlighted not only the impact of natural disasters on nuclear power plants, but also the importance of independent regulators and the pitfalls of probability risk assessments. A report released by the Fukushima Nuclear Accident Independent Investigation Commission in 2012, called it a preventable and manmade disaster and blamed the government-industry collusion for it. Moreover, the absence of a completely independent body to oversee the safety of nuclear reactors also emerged as a key flaw in the Japanese

¹¹ S.D. Sagan, *Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb*, «International Security», 1996-1997, 3.

¹² M. Fuhrmann, *Atomic Assistance: How «Atoms for Peace» Programs Cause Nuclear Insecurity*, Ithaca, Cornell University Press, 2012.

¹³ J. Shimkus, *Italy Joins Germany and Switzerland on Nuclear Power Ban*, Energy Digital website, 30 April 2011, available at www.energydigital.com/renewables/3037/Italy-Joins-Germany-and-Switzerland-on-Nuclear-Power-Ban (last accessed: 11 May, 2015).

¹⁴ H. Timmons, V. Bajaj, *Emerging Economies Move Ahead with Nuclear Plans*, «The New York Times», 14 March 2011.

¹⁵ *Anti-Kudankulam Activists Raise Protests to the Next Level*, «The Hindu», 20 October 2013.

¹⁶ B. Winter, *Brazil Cools on Nuclear Power Plans; Favors Wind*, Reuters website, 15 September 2013, available at www.reuters.com/article/2013/09/15/us-brazil-nuclear-idUSBRE98E06U20130915 (last accessed: 11 May, 2015).

case¹⁷. The Fukushima case also demonstrated the limitations of risk assessments, and the challenges to predicting massive accidents triggered by natural incidents like earthquakes and tsunamis¹⁸.

Although in India – a country at the forefront of the nuclear renaissance – initial efforts were made to make nuclear energy regulation independent, such attempts did not bear fruit. In 2011, a bill was set up to establish the Nuclear Safety Regulatory Authority as an independent body to replace the preexisting non-independent Atomic Energy Regulatory Board. However, the bill was never passed, leading the IAEA to criticize India for nuclear safety regulations¹⁹. Given the secrecy surrounding nuclear establishments in general, it makes changes harder to implement. Moreover, corruption and bureaucratic inertia being pervasive in developing countries, this makes nuclear energy more risk-prone in such countries. Another element that nuclear energy brings about is that of nuclear security, or the need to secure nuclear materials, radioactive substances and associated materials from theft, sabotage, illegal trafficking and other means of unauthorized access. In other words, nuclear substances – even if under IAEA safeguards – could fall prey to criminals and terrorists, and make their

way to potential proliferators or pose risks through dirty bombs²⁰. This further increases the costs of nuclear energy since adequate resources need to be invested in order to ensure good and safe custodianship of nuclear materials, which makes it quite challenging for developing countries. In other words, nuclear energy can increase insecurity through proliferation, pose extensive risks to human lives and property for safety reasons, and raise questions of good custodianship of nuclear materials and infrastructure. Moreover, this raises the political and economic costs for adopting nuclear energy, which is not the case with renewable sources of energy. For developing countries with high resource constraints, it is therefore not particularly cost-efficient.

Costs, Costs, Costs

Today, six countries derive more than 40% of their electricity needs from nuclear energy: France, Slovakia, Hungary, Ukraine, Belgium, and Sweden²¹. With the exception of Ukraine, all are OECD member-states, and hence of a higher GDP bracket than the developing countries of the world. In each of these states, the nuclear power is heavily subsidized, and a recent study has shown that the nuclear industry will con-

¹⁷ C.D. Ferguson, M. Jansson, *Regulating Japanese Nuclear Power in the Wake of the Fukushima Daichi Accident*, «Federation of American Scientists Issue Brief», May 2013.

¹⁸ M.V. Ramana, *Beyond our Imagination: Fukushima and the Problems of Assessing Risk*, Bulletin of the Atomic Scientists website, 20 April 2011, available at www.thebulletin.org/beyond-our-imagination-fukushima-and-problem-assessing-risk-0.

¹⁹ A. Sinha, *Iaea: Separate the Aerb from other Entities*, «The Indian Express», 28 March 2015.

²⁰ *Nuclear Terrorism: Threats, Risks and Vulnerabilities*, International Atomic Energy Agency website, available at www-ns.iaea.org/security/threats.asp?s=4 (last accessed: 11 May, 2015).

²¹ IAEA Pris Database: www.iaea.org/PRIS/WorldStatistics/NuclearShareofElectricityGeneration.aspx (last accessed: 11 May, 2015).

tinue to depend on state subsidies in order to remain competitive²². The question is thus, should developing countries invest in such an expensive enterprise that would cost their governments millions of taxpayer dollars in subsidies? It may not be the wisest of choices.

Additionally, nuclear reactors often face construction bottlenecks that lead to cost overruns²³. In India, for instance, an anti-nuclear movement in the Western state of Maharashtra has delayed construction of two European Pressurized Reactors (EPR) by the French nuclear company Areva²⁴. Furthermore, much has been written about nuclear waste management and the risks emanating from it if not conducted properly²⁵. In other words, the risks and costs emanating from nuclear power are high, making nuclear energy less viable, especially for developing countries.

To conclude, despite the risks and costs of nuclear energy, several emerging economies are deeply interested in exploring possibilities of building nuclear reactors. At the same time, companies like General Electric, Westinghouse and Areva, are scrambling for control of these new markets. China currently has 24 reactors under construction, while India has 6. While the two rising Asian economies are investing extensively in their domestic nuclear power production, they both have ambitions of becoming nuclear suppliers to other countries. Of course, this is truer in the Chinese case, while India's non-membership of the Nuclear Suppliers Group poses a structural stumbling block for nuclear exports for New Delhi²⁶. Developments over the coming years will confirm whether further civil nuclear expansion in developing countries will materialize or remain a pipedream.

²² D. Koplow, *Nuclear Power: Still Not Viable without Subsidies*, «The Union of Concerned Scientists», February 2011.

²³ T. Johnson, *Nuclear Power Expansion Challenges*, Council on Foreign Relations website, 18 March 2011, available at www.cfr.org/united-states/nuclear-power-expansion-challenges/p16886#p2 (last accessed: 12 May, 2015).

²⁴ *Work on Jaitapur, Koodankulam Might be Delayed: Department of Atomic Energy*, Dna website, 27th September 2011, available at www.dnaindia.com/mumbai/report-work-on-jaitapur-koodankulam-might-be-delayed-department-of-atomic-energy-1592149 (last accessed: 12 May, 2015).

²⁵ See F. von Hippel, *A Nuclear Waste Solution*, «The Los Angeles Times», 15 September 2009.

²⁶ *Russia and China Outgun the West in Civil Nuclear Exports*, «Financial Times», 20 February 2015.