Nuclear Italy

An International History of Italian Nuclear Policies during the Cold War

edited by
Elisabetta Bini
and Igor Londero

with the collaboration of
Giulia Iannuzzi

EUT EDIZIONI UNIVERSITÀ DI TRIESTE

Contents

Abbreviations

AA/USP	Arquivo Álvaro Alberto, Centro Interunidade de História da Ciência, Universidade de São Paulo, São Paulo, Brasil
AAm	Archivio Amaldi, Dipartimento di Fisica, Università "La Sapienza", Roma, Italia
AAn	Archivio Andreotti, Istituto Luigi Sturzo, Roma, Italia
AAPD	Akten zur Auswärtigen Politik der Bundesrepublik Deutschland, Das Institut für Zeitgeschichte, Berlin, Germany
ABC	Academia Brasileira de Ciência
ACDA	Arms Control and Disarmament Agency
ACS	Archivio Centrale dello Stato, Roma, Italia
AEC	Atomic Energy Commission
AECL	Atomic Energy of Canada Ltd.
AEP	Archivio Enrico Persico, Dipartimento di Fisica, Università "La Sapienza", Roma, Italia
AGIP	Azienda Generale Italiana Petroli
AHCEA	Archives historiques du Commissariat à l'Energie Atomique, Fontenay-aux-Roses, France
AHMRE	Arquivo Histórico do Ministério das Relações Exteriores, Brasília, Brasil
AM	Archivio Aldo Moro
AMN	Ansaldo Meccanico Nucleare
APA	Ambasciata di Parigi
APDA	Atomic Power Development Associates
APNB	Arquivo Paulo Nogueira Batista, Centro de Pesquisa e Documentação sobre a História Contemporânea do Brasil, Fundação Getulio Vargas, Rio de Janeiro, Brazil
ASE	ENI Historical Archive, Pomezia (Roma), Italia
ASMAE	Archivio Storico Diplomatico del Ministero degli Affari Esteri, Roma, Italia
ASPR	Archivio Storico Presidenza della Repubblica, Roma, Italia
AUSSME	Archivio dell'Ufficio Storico dello Stato Maggiore dell'Esercito
BNFL	British Nuclear Fuel Limited
BWR	boiling water reactor
CAMEN	Centro per le Applicazioni Militari dell'Energia Nucleare

CBPF	Centro Brasileiro de Pesquisas Físicas
CBTN	Companhia Brasileira de Tecnologia Nuclear
CCFP	Consultative Committee on the Fusion Programme
CdG	Comité de gestion/Comitato di gestione
CEA	Commissariat à l'énergie atomique et aux énergies alternatives
CEP	Calcolatrice Elettronica Pisana
CERN	Centre Européen pour la Recherche Nucléaire
CFPF	Central Foreign Policy Files
CIA	Central Intelligence Agency
CIP	Campo Internazionale per la Pace
CIPE	Comitato Interministeriale per la Programmazione Economica
CIRENE	CISE Reattore a Nebbia
CIRTEN	Consorzio Interuniversitario per la Ricerca Tecnologica Nucleare
CISE	Centro Informazioni Studi ed Esperienze
CIT	Compact Ignition Tokamak
CN	Combustibili nucleari
CNEN	Comissão Nacional de Energia Nuclear
CNEN	Comitato Nazionale per l'Energia Nucleare
CNPq	Conselho Nacional de Pesquisa
CNR	Consiglio Nazionale delle Ricerche
CNRN	Comitato Nazionale per le Ricerche Nucleari
Coren	Combustibili per reattori nucleari
CPF	Comitato Politico di Fisica
DC	Democrazia Cristiana
DDF	Documents Diplomatiques Françaises
DFR	Douneray Fast Reactor
DGAP	Direzione Generale Affari Politici
DP	Democrazia Proletaria
DSSMD	Diario Storico di Stato Maggiore della Difesa
EC	European Community
EDC	European Defence Community
EDF	Électricité de France
EEC	European Economic Community
ELDO	European Launcher Development Organisation
ENEA	Comitato nazionale per la ricerca e lo sviluppo dell'Energia Nucleare e delle Energie Alternative
ENEL	Ente Nazionale per l'Energia Elettrica
ENI	Ente Nazionale Idrocarburi

ENSI	Energia Nucleare Sud Italia
EPR	Evolutionary Power Reactor
ESRO	European Space Research Organisation
Euratom	European Atomic Energy Community
EURODIF	European Gaseous Diffusion Uranium Enrichment Consortium
FBR	fast breeder reactor
FGCI	Federazione Giovanile Comunista Italiana
FIG	France, Italy, Germany
FN	Fabbricazioni Nucleari
FOIA	Freedom of Information Act
FOM	Fundamental Research on Matter, Institute for Plasma Physics, Nieuwegein
FORATOM	European Atomic Forum
FT	Frascati Tokamak
FTU	Frascati Tokamak Upgrade
GIAU	Gruppo Italiano Arricchimento Uranio
GLCM	ground launched cruise missiles
HAEU	Historical Archives of the European Union, European University Institute, San Domenico di Fiesole (Firenze), Italia
HC	Archives du Haut-Commissaire à l'énergie atomique
HLG	High Level Group
HWR	heavy water reactor
IAEA	International Atomic Energy Agency
IBRD	International Bank for Reconstruction and Development
ICBSA	Istituto Centrale per i Beni Sonori ed Audiovisivi, Roma, Italia
IFOR	International Fellowship of Reconciliation
IGNITOR	Ignited Torus
IMAC	International Meeting Against Cruise
INF	intermediate-range nuclear forces
INFCE	International Nuclear Fuel Cycle Evaluation
INFN	Istituto Nazionale di Fisica Nucleare
IPQ	Instituto de Pesquisa Química
IRI	Istituto per la Ricostruzione Industriale
IRIS	International Reactor Innovative and Secure
ISODARCO	International School on Disarmament and Research on Conflicts
ITER	International Thermonuclear Experimental Reactor
JCL	Jimmy Carter Library, Atlanta, Georgia, United States
JET	Joint European Torus
JRC	Joint Research Centre

LASL	Los Alamos Scientific Lab
LEU	low enriched uranium
LGI	Laboratorio Gas Ionizzati
LMFBR	liquid metal fast breeder reactor
LRTNF	long-range theatre nuclear forces
LTBT	Limited Test Ban Treaty
LWR	light water reactor
MDA	Ministero della Difesa-Aeronautica
MIR	Movimento internazionale per la Riconciliazione
MIT	Massachusetts Institute of Technology
NAC	North Atlantic Council
NARA	National Archives and Records Administration, Washington, DC, United States
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NBC	Nuclear Biological Chemical
NET	Next European Torus
NPG	Nuclear Planning Group
NPPC	Nuclear Power Plant Company
NPT	Non-Proliferation Treaty
NRC	Nuclear Regulatory Commission
NSC	National Security Council
NUCLEI	Nuclebrás Enriquecimento Isotópico
OECD	Organisation for Economic Co-operation and Development
OECE	Organisation for European Economic Co-operation
PCI	Partito Comunista Italiano
PDUP	Partito di Unità Proletaria
PEC	Prova Elementi di Combustibile
PEN	Piano Energetico Nazionale
PFR	Prototype Fast Reactor
PIE	Post Irradiation Examination
PNE	Peaceful Nuclear Explosion
PR	Partito Radicale
PRO	Progetto Reattore Organico
PSDI	Partito Social-Democratico Italiano
PSI	Partito Socialista Italiano
PUN	Progetto Unificato Nazionale
PUREX	Plutonium and Uranium Recovery by Extraction

PWR	pressurized water reactor
RAI	Radiotelevisione Italiana
RAPTUS	Rapido-Torio-Uranio-Sodio
RRPL	Ronald Reagan Presidential Library, Simi Valley, California, United States
RWE	Rheinisch-Westfälisches Elektrizitätswerk AG
SALT	Strategic Arms Limitation Talks
SCG	Special Consultative Group
SELNI	Società Elettronucleare Italiana
SENN	Società Elettronucleare Nazionale
SICA	Sicurezza Internazionale e Controllo degli Armamenti
SIMEA	Società Italiana Meridionale per l'Energia Atomica
SME	Società meridionale di elettricità
SNAP	Systems for Nuclear Auxiliary Power
SNR	sodium-cooled fast reactor
TNA	The National Archives, Kew, Richmond, Surrey, United Kingdom
TNF	theatre nuclear forces
UKAEA	United Kingdom Atomic Energy Authority
UKNA	United Kingdom National Archives
UNAEC	United Nations Atomic Energy Commission
UNIPEDE	Union internationale des Producteurs et Distributeurs d'Énergie Électrique
USAEC	United States Atomic Energy Commission
USG	Ufficio del Segretario Generale
USIA	United States Information Agency
USPID	Unione Scienziati per il Disarmo
WEU	Western European Union

Elisabetta Bini and Igor Londero

Introduction

This book examines the history of Italy's nuclear policies during the Cold War, by placing the Italian case in an international and comparative framework. It highlights the importance the international context had in shaping the country's specific experience, and analyzes the ways in which international politics and economics, technological and scientific exchanges, as well as social and cultural movements, influenced Italian nuclear policies, both civilian and military. All the essays published in this volume assume that the history of nuclear energy should be written by adopting an international perspective. The spread of nuclear knowledge (scientific, civilian, as well as military), and the implementation of nuclear policies, have a specific international dimension that should be taken into consideration, since no nuclear program has ever had a distinctly national character, and every country pursuing a nuclear policy has been, in one way or another, deeply influenced by the international context.

Looking at the history of Italian nuclear programs through the lens of international and comparative history allows for a new understanding of the specificities – and in some ways uniqueness – of Italy's nuclear experience. 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 applied nuclear physics, revolving around the so-called via Panisperna boys, who gathered around the charismatic figure of Enrico Fermi. While the group dispersed because of the racial laws introduced by the Fascist regime and, partly, because of the anti-Fascist activity of some of its members, the work carried out during the 1930s paved the way for post-World War II research in nuclear technology. It was immediately after the war that Italian scientists – including Edoardo Amaldi, the only member of the via Panisperna boys to have stayed in Italy – identified in applied scientific research a way to solve the country's secular social, political, economic and industrial problems, through the creation of a national committee for atomic energy.

During the 1950s, Italy was one of the first countries to express interest in developing civilian nuclear energy, taking advantage of the forms of assistance provided by the

United States through the Atoms for Peace program. In a context characterized by a lack of energy resources, politicians and industrialists alike embraced the idea that atomic power would offer the possibility of producing an unlimited, clean and efficient source of power. Through important figures such as Francesco Giordani – President of the Comitato Nazionale per l'Energia Nucleare (CNEN) – and Felice Ippolito – Secretary General of the Comitato Nazionale per le Ricerche Nucleari (CNRN, later renamed CNEN) –, Italy was at the vanguard of nuclear research and technology. The CNRN/CNEN directed all advanced research programs toward specific goals (like the building of the Frascati synchrotron and the first nuclear power plants), and advanced a specific vision of the role nuclear programs should have in promoting the country's modernization, through forms of state-led planning. It also served to develop an Italian scientific foreign policy, playing a leading role in establishing relations with the United States – the largest exporter of nuclear technology at the time – and participating in the building of a unified Europe through Euratom.

Despite the fact that in the mid-1960s Italy was one of the most advanced countries in terms of nuclear research, it was also one of the first nations to abandon nuclear power. Ippolito's indictment in the summer of 1963, and his subsequent imprisonment, were in many ways the result of a political decision about the modernization of Italy's economy, society and administration, which had deep consequences on the country's research policies and institutions, as well as on its long-term energy strategies. While much has been written about the so-called "Ippolito affair" and the decline of Italy's nuclear programs in the 1960s, we still know too little about how the Italian case differs from other European cases, and the ways in which Italian actors interacted with, and were influenced by, an international context characterized by debates about non-proliferation and by access to large quantities of cheap oil.

By placing the Italian case in a larger international and comparative framework, this volume draws on a growing literature about the history of nuclear policies during the twentieth century, which represents one of the most original fields of research in contemporary history. These studies use new methodological tools and 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, fields that often lie at the intersection of national, international and global history. With few important exceptions, the Italian case has remained on the margins of this scholarship, focusing on aspects of military power, or adopting a national perspective to the study of its subject matter. By using an interdisciplinary approach, this volume seeks to challenge existing barriers between the humanities and the hard sciences, thus contributing to the long-term debate about the "two cultures".

This book stems from a conference held in Trieste in November 2014, titled *Nuclear Italy. Storia internazionale del nucleare italiano* (Nuclear Italy. An International History of Italian Nuclear Policies), which drew together scholars from a range of different disciplines (history, physics, international relations, literature, and economics), all carrying out original research on the history of Italian nuclear policies. The conference was promoted and organized by Elettra Sincrotrone Trieste S.C.p.A. and the Humanities Department of the University of Trieste, alongside the Department of Political Sciences of the University of Roma Tre, and the Department of Documentary, Linguistic-Philological and Geographic Sciences of the University of Rome "La Sapienza". It was based on an international call for papers, and saw the presence of discussants selected from among the most important scholars in the field.

The 2014 conference built upon a previous one, organized by Elettra Sincrotrone Trieste S.C.p.A. and by the Graduate School of Humanities (SDiSU) of the University of Trieste in 2012, titled *Il nucleare in Italia nel secondo dopoguerra – ricerca, cultura, politica* (Nuclear Energy in Italy after World War II – Research, Culture, Politics). The conference examined Italy's nuclear experience by looking at the role played by Ippolito between the end of World War II and the mid-1960s. One of the results of the conference was the decision to create a research group working on the history of Italy's nuclear policies from a variety of different perspectives and through the lens of international history, which led to the establishment of the Nuclear Italy Research Group (Nireg).[1]

This volume is divided into four sections. The first section, "Civilian Uses of Nuclear Energy", examines Italy's use of nuclear energy for civilian purposes. The essays consider the country's relations with the United States and highlight the ways in which American policies such as the Marshall Plan, the Atoms for Peace program, and US military and corporate involvement in Western Europe, influenced Italian projects and strategies. They highlight 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, across the Atlantic and beyond. They analyze the role Italy had in shaping European nuclear policies, through forms of cooperation between Italian scientists and Euratom. These essays open up new venues of research on the importance scientific research had in promoting European integration, through men like Ippolito, who represents the prototype of a European technocrat involved in building a unified Europe. Despite the fact that many of Euratom's projects never saw the light, the agency gave life to a range of scientific programs that deserve to be studied, since they testify to the forms of international and European collaboration that characterized a whole era of nuclear research.

1 Nuclear Italy Research Group, https://niregblog.wordpress.com.

The second section, "Military Aspects of Nuclear Power", examines the importance the military dimension of nuclear policies had in shaping Italy's specific experience, particularly in the context of the signing of the Non-Proliferation Treaty (NPT) and the Euromissiles Crisis. By emphasizing the relationship between civilian and military uses of nuclear power, the essays in this section analyze the importance the nuclear arms race had in the creation of a "balance of terror", which kept international politics in checkmate for more than half a century. From the US policy of secrecy, to President Eisenhower's program Atoms for Peace, to the difficult compromises that led to the signing of the NPT, the question of nuclear arms dominated a whole era.

The third section, "Public Opinion and Anti-nuclear Movements", analyzes the different cultural and political meanings intellectuals, scientists and the media assigned to nuclear energy in Italy, at a time when nuclear power symbolized both the promise of unlimited growth and the threat of global annihilation. The essays examine the forms of communication that were carried out in support of or against nuclear energy, and how they intersected with wider changes in Italian society, symbolized by the spread of mass consumption, the emergence of a transnational public opinion, and new forms of grassroots democracy. They investigate the ways in which different groups critiqued and opposed the use of nuclear energy for military, civilian and research purposes. Compared to other countries, where anti-nuclear movements emerged during the 1950s and 1960s, in Italy they were initially a rather elitist initiative – albeit an influential one. It was only in the second half of the 1970s, and increasingly during the Euromissiles Crisis and the 1987 referendum, that they established themselves as a significant political force.

The fourth section, "The Role of Scientists and Scientific Research", examines the importance scientists and research institutes had in shaping Italy's nuclear experience. The essays focus on the relationship between scientists, the state, firms and society, and the specific contribution Italian researchers gave to the development of nuclear technologies. They show the complexity that characterized post-war research in nuclear physics, and the role scientists had in debates about the political, economic and ethical implications of nuclear power since World War II. These essays shed new light, and open up new questions, on the relationship between scientific research and ethical issues, which was so central in the thinking of scientists such as Albert Einstein and Robert Oppenheimer, but also Amaldi, reflecting on their responsibility in the context of the Manhattan Project. While the nuclear era led scientists to be increasingly influenced by large-scale industries and the state, it also brought about a new definition of the role they should have in society. Especially among those who were traumatized by the destructive power of the technology they had helped develop, scientists advanced the idea that they should be involved in public debates and assert their position. Investigating these aspects means

highlighting the delicate relationship between intellectuals and researchers on the one hand, and society on the other, a topic which is particularly crucial today.

Acknowledgments

The organization of the conference *Nuclear Italy. Storia internazionale del nucleare italiano* and the publication of this volume would not have been possible without the contribution of many institutions and individuals. Our greatest thanks goes to Carlo Rizzuto, former President of Elettra Sincrotrone Trieste S.C.p.A., who from the very beginning supported this project with enthusiasm, and encouraged us to think outside disciplinary boundaries. Without his constant input, this volume – and the conference and networking behind it – would not have been possible. We also wish to express our gratitude to Elisabetta Vezzosi for her generosity, and for believing that the work we as academics carry out in groups is far better than what we produce as single individuals.

We would like to thank Elettra Sincrotrone Trieste S.C.p.A. for providing generous funding for the conference and the volume, as well as the Humanities Department of the University of Trieste, the Department of Political Sciences of the University of Roma Tre, and the Department of Documentary, Linguistic-Philological and Geographic Sciences of the University of Rome "La Sapienza", for their financial support. The administrative staff of Elettra Sincrotrone Trieste S.C.p.A. and of the Humanities Department of the University of Trieste gave us important assistance before, during and after the conference, and we would like to thank in particular Roberto Pugliese, Roberta Saccon, and Gloria Norio.

Our thanks goes also to our colleagues who, at different stages, supported our efforts, in particular Guido Abbattista, and the chairs and discussants who came from close and far away: Giovanni Battimelli, Alain Beltran, Matthew Evangelista, Gianrossano Giannini, Georg Meyr, Benoît Pelopidas, and Claudio Tuniz. This volume would not see the light without the work of the scientific committee that initially selected the papers presented at the conference. Heartfelt thanks to Giovanni Battimelli, Leopoldo Nuti, Giovanni Paoloni, Carlo Rizzuto, and Elisabetta Vezzosi. And many thanks to Terrence Chamberlain for revising the English language of the essays published here.

Last, but certainly not least, we wish to express our deep gratitude to Giulia Iannuzzi for her invaluable contribution in organizing the conference and editing this volume in a superb way.

Part I - Civilian Uses of Nuclear Energy

Elisabetta Bini

Atoms for Peace (and War): US Forms of Influence on Italy's Civilian Nuclear Programs (1946-1964)*

This chapter analyzes the ways in which the United States influenced Italy's civilian nuclear policies between the end of World War II and the mid-1960s. Existing scholarship on the history of postwar US-Italian relations has largely overlooked this issue, with the important exception of studies about military uses of nuclear power.[1] Most research on the country's civilian nuclear energy programs has adopted a national perspective, and has focused on the differences and clashes between private firms and public agencies and research centers, or on the debates that accompanied the nationalization of the electric industry in the early 1960s.[2] Studies about Italy's energy policies, on the other hand, have mostly focused on oil and natural gas, and have examined the role the state-owned company Ente Nazionale Idrocarburi (ENI) had in reconstructing Italy after the Second World War and in challenging American interests in Italy and internationally.[3]

* This chapter is part of a research project carried out at the University of Trieste between 2014 and 2016 with the support of Elettra Sincrotrone Trieste S.C.p.A. It presents initial results of a study of American documents held at the National Archives and Records Administration in College Park (NARA), namely the papers of the State Department, the American Embassy in Rome, the Central Intelligence Agency (CIA), the Joint Committee on Atomic Energy, and the Atomic Energy Commission (USAEC). I wish to express my gratitude to Professors Carlo Rizzuto and Elisabetta Vezzosi for their support and for their comments on previous versions of this paper.

1 Leopoldo Nuti, *La sfida nucleare. La politica estera italiana e le armi atomiche* (Bologna: il Mulino, 2007).

2 Mario Silvestri, *Il costo della menzogna. Italia nucleare, 1945-1968* (Torino: Einaudi, 1968); Giovanni Paoloni, ed., *Energia, ambiente, innovazione: dal CNRN all'ENEA* (Roma-Bari: Laterza, 1992); Valerio Castronovo, ed., *Storia dell'industria elettrica in Italia*, vol.4, *Dal dopoguerra alla nazionalizzazione, 1945-1962* (Roma-Bari: Laterza, 1994); Giovanni Zanetti, ed., *Storia dell'industria elettrica in Italia*, vol. 5, *Gli sviluppi dell'Enel (1963-1990)* (Roma-Bari: Laterza, 1994); Barbara Curli, *Il progetto nucleare italiano (1952-1964). Conversazioni con Felice Ippolito* (Soveria Mannelli: Rubbettino, 2000); Giovanni Paoloni, *Il nucleare in Italia* (Roma: Enel, 2008).

3 Angelo Pressenda and Marcella Sarale, *L'ENI da Mattei a Cefis: la politica del petrolio tra mito e realtà* (Torino: Einaudi, 1978); Giulio Sapelli and Francesca Carnevali, *Uno sviluppo tra politica e strategia: ENI (1953-1985)* (Milano: FrancoAngeli, 1992); Daniele Pozzi, *Dai gatti selvaggi al cane a sei zampe. Tecnologia, conoscenza e organizzazione nell'Agip e nell'Eni di Enrico Mattei* (Venezia: Marsilio, 2009); Elisabetta Bini,

Until the mid-1950s, when the United States developed the Atoms for Peace program, the US administration remained quite suspicious about Italy's project to develop a civilian nuclear energy program. Both the State Department and the Atomic Energy Commission (USAEC) kept firmly under control Italy's efforts to extract uranium in the North of the country. Their greatest concern was that the Italian government might declare its uranium property of the state, like it had done with its hydrocarbon resources. Despite a series of requests from Italian scientists and industrial firms, the Marshall Plan did not provide any funds for the purchase of nuclear equipment.

In the context of the Atoms for Peace program, the United States gained increased influence over Italy's atomic energy plans. While Italian firms and research centers expressed immediate interest in the program, the State Department and the USAEC used American aid and technology to shape Italian nuclear policies, in particular the relationship between public and private actors and agencies. They tried to strengthen the position of private Italian industrial groups such as Edison and Fiat, and contain the state-led forms of economic development promoted by the Centro Nazionale per le Ricerche Nucleari (CNRN) and its director Francesco Giordani. Furthermore, as part of the bilateral agreement between the two countries, they offered enriched, rather than natural uranium, thus making Italy dependent on a technology controlled by the United States.

While existing studies about US-Italian relations in the nuclear energy field have argued that the US undermined Italy's nuclear project, this chapter contends that Italian policies were only partly defined by the United States.[4] Rather, they were the outcome of a domestic conflict between public agencies and private firms, which used US interest in the country's nuclear program to promote their own specific interests. Along with the instability that characterized Italian governments at the time, these tensions delayed the signing of bilateral agreements, and negatively affected Italy's atomic program. When, in 1960, the Italian Parliament finally passed an atomic energy bill and established the Centro Nazionale per l'Energia Nucleare (CNEN) as Italy's main institution devoted to the development of peaceful uses of nuclear energy, American and Italian firms and agencies engaged in new forms of cooperation. Especially after John F. Kennedy became President, and in the context of the creation of center-left governments, the US administration and the USAEC supported the expansion of Italy's nuclear policies and a greater

La potente benzina italiana. Guerra fredda e consumi di massa tra Italia, Stati Uniti e Terzo mondo (Roma: Carocci, 2013). For a general overview: Pier Angelo Toninelli, "Energy and the Puzzle of Italy's Economic Growth," *Journal of Modern Italian Studies* 1 (2010): 107-127.

4 See in particular Simone Turchetti, "A Most Active Customer: How the US Administration Helped the Italian Atomic Energy Project to 'De-Develop'", *Historical Studies in the Natural Sciences* 5 (2014): 470-502.

role of the state in promoting civilian nuclear energy programs. In the first half of the 1960s, the US provided most of Italy's research reactors, and trained a new generation of Italian scientists in the US, while American firms participated in building two of the country's three nuclear power plants. In 1962 the American government viewed favorably the creation of the Ente Nazionale per l'Energia Elettrica (ENEL), a public agency that centralized the production of electric energy.

In this framework, the decline of the Italian nuclear program in the early 1960s was more the result of domestic conflicts than of American forms of influence. Once ENEL was founded, it decided to rely on oil, rather than nuclear power, to fuel its electric plants. This decision was the outcome of a complex set of decisions: on the one hand, following the decrease in the price of crude oil on the international market, Standard Oil (N.J.) flooded the Italian market with oil from North Africa. This strategy was supported by American oil companies operating in Italy, by the Italian refining industry and by ENEL, and by the State Department, which considered it a way of reducing Italy's reliance on Soviet oil. On the other hand, the shift away from nuclear power was closely linked to the decline of the forms of economic planning promoted by center-left governments in the early 1960s, and to a series of conflicts inside and between Italy's main political parties. When, in 1963, Secretary General of CNEN Felice Ippolito was accused of mismanaging public funds and removed from his position, public investments in the Italian nuclear program decreased rapidly. The government embraced a more "minimalist" policy, which made Italy increasingly dependent on imported fossil fuels. In the context of the "Ippolito affair", various sectors of the US administration and of the USAEC adopted a critical stance. They pointed out that the decline of Italy's civilian nuclear program represented a potential threat to the country's modernization, as it undermined one of its most advanced scientific, technological and industrial sectors.

The Early Postwar Years

Until the mid-1950s, the US administration was wary of any effort on the part of Italian firms and research centers to develop an atomic program. While the 1946 McMahon Act (or Atomic Energy Act) limited access to nuclear information to countries that had been US wartime allies, the 1947 peace treaty forbade Italy from acquiring or developing nuclear weapons. Through the regular despatches the US Embassy in Rome sent to the State Department, and through direct contacts between the Special Assistant to the Secretary of State for Atomic Energy and the USAEC, the American administration kept a close eye on Italian atomic energy programs. It also drew on personal con-

tacts with Italian nuclear physicists working in the United States – such as Emilio Segrè and Federico Sensi – to receive reports on Italy's activities. In particular, it monitored the discovery of uranium mines in various parts of the country. Between the late 1940s and the early 1950s, it sent a representative of the Economic Cooperation Administration (ECA), along with several USAEC geologists, to carry out studies of uranium deposits in the area around the town of Cuneo, and asked private Italian firms to provide samples to be analyzed. Its aim was to control any sources that could be used by the United States for its own nuclear activities or in the framework of the Mutual Defense Assistance Program. The United States' greatest concern was that the Italian government might declare uranium a public property, as it had done with its hydrocarbon resources.[5]

Despite a series of requests from Italian scientists and industrial firms, the Marshall Plan did not provide any funds for the purchase of nuclear equipment. As a memorandum from the Office of the Under Secretary of State put it, "the Department considered it undesirable to establish as a precedent, purchase of nuclear research equipment with funds provided by the ECA".[6] The USAEC aimed at avoiding any association between ECA and atomic energy programs (also for public relations reasons). It decided not to include uranium among the strategic materials the United States might ask in exchange for American aid, so as not "to give to Communist propaganda such powerful corroboration of the claim that we were bargaining world economic health against perpetuation of an atomic monopoly for the United States".[7]

The US administration was not only worried about security, military and political issues, but aimed at influencing Italian (and, indeed, European) energy policies by assigning a crucial role to oil, as the main fuel of Europe's economic reconstruction. As David Painter has pointed out, "more than 10 per cent of the total aid extended under the Marshall Plan financed imports of dollar oil from US companies".[8] American aid created markets for US oil companies, and reconfigured Western Europe's energy pat-

5 Richard G. Hewlett and Francis Duncan, *Atomic Shield: A History of the United States Atomic Energy Commission (AEC)*, Vol. II, *From 1947 to 1952* (University Park: Pennsylvania State University Press, 1969); Nuti, *La sfida nucleare*, 21-31. NARA, General Records of the Department of State (hereafter RG 59), Decimal File, 1950-1954, box 5314; NARA, RG 59, Office of the Secretary (hereafter OS), Special Assistant to the Secretary of State for Atomic Energy & Outer Space (hereafter S/AE), General Records Relating to Atomic Energy Matters (hereafter GRAE), 1948-1952, box 80; NARA, RG 59, OS, S/AE, GRAE, 1948-1952, box 51.

6 NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 76.

7 Under Secretary of the Department of State to Mr. Lovett, November 14, 1947, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 76. John Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe* (Cambridge: The MIT Press, 2006); John Krige and Kai-Henrik Barth, eds., "Global Power Knowledge: Science and Technology in International Affairs," special issue of *Osiris* 21 (2006).

8 David S. Painter, "The Marshall Plan and Oil", *Cold War History* 2 (2009): 160; Timothy Mitchell, "Carbon Democracy," *Economy and Society* 3 (2009): 399-432.

terns and relations, marking a sharp decline of British and German coal.[9] Italy received over 143 million dollars in petroleum aid, which placed Italy third in the ranking of Marshall Plan aid recipients of petroleum products.[10]

The US administration and the USAEC became increasingly involved in Italian nuclear policies after the CNRN was founded in 1952 under the direction of Francesco Giordani. A long-time supporter of state-led forms of intervention in the economy, and former President of the public company Istituto per la Ricostruzione Industriale (IRI) in the 1930s, Giordani believed that atomic energy should allow Italy to overcome its chronic dependence on the import of energy resources, and that the state should have a crucial role to play in developing a public agency specifically devoted to this task. In the first half of the 1950s, the USAEC's main concern was that the CNRN might introduce, as John A. Hall, head of the Commission's Office of International Affairs put it, a "governmental policy concerning uranium, its domestic use and control and export", and undermine American efforts to control global uranium resources.[11]

As the CNRN started drafting a new law regulating the production and use of uranium, Special Assistant to the Secretary of State for Atomic Energy Gordon Arneson wrote to the US Embassy in Rome and encouraged Ambassador Clare Boothe Luce to meet with Prime Minister Giuseppe Pella. In December 1953, Luce handed over to Pella a memorandum asking the Italian government assurances that "any uranium produced could be freely exported to the United States", in line with the 1950 mutual defense agreement, and pointed out that "Italy might retain such quantities of uranium as would be required in the Italian atomic energy program".[12] In exchange, the US would provide financial and technical assistance in locating and extracting uranium, and train Italian personnel. The Italian government showed little interest in the offer and postponed any decision on the matter. While the political context was highly unstable, the Italian government voiced, as Arneson put it, "the usual nationalistic reasons for resisting foreign development of mineral resources".[13]

The Atoms for Peace Program

9 David S. Painter, *Oil and the American Century: The Political Economy of US Foreign Oil Policy, 1941-1954* (Baltimore: The Johns Hopkins University Press, 1986); Stephen J. Randall, *United States Foreign Oil Policy Since World War I: For Profits and Security* (Montreal: McGill-Queen's University Press, 2005).

10 Painter, "The Marshall Plan and Oil", 166.

11 John A. Hall to Gordon Arneson, August 21, 1952, NARA, RG 59, OS, S/AE, GRAE, 1948-1952, box 80. On Francesco Giordani: Valerio Castronovo, ed., *Storia dell'IRI. Vol.1. Dalle origini al dopoguerra, 1933-1948* (Roma-Bari: Laterza, 2012); Barbara Curli, "Francesco Giordani e l'autonomia energetica", in ANIMI, ed., *Radici storiche ed esperienza dell'intervento straordinario nel Mezzogiorno* (Roma: Bibliopolis, 1996), 213-225.

12 Memorandum, December 23, 1953, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 502.

13 Secret memorandum, October 13, 1954, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 502.

It was in this context that US President Dwight D. Eisenhower announced the Atoms for Peace program, with the aim of promoting peaceful uses of atomic energy throughout the world. With the approval of the Atomic Energy Act in 1954, private firms were allowed to obtain information about nuclear energy production, and exchange information with foreign countries. As a result, in the mid-1950s the United States signed a series of bilateral agreements with most Western European countries, including Italy. The accord was the outcome of a long series of discussions between Italian and American government representatives, industrialists and scientists, and set the terms for American forms of influence on Italy's atomic energy policies.[14]

Given the strength of the Communist Party, Italy was not "just another country". It was especially Luce who expressed concern for American plans to help Italy develop an atomic program. During a meeting held in Paris in February 1955 (a few months before the signing of the bilateral agreement) between Deputy to the Special Assistant to the Secretary of State for Atomic Energy, State Department representatives and US Ambassadors in Europe, Luce pointed out that "with one-third of the Italian population voting Communist, there was no possibility for sufficient security arrangements to make possible a US-Italian bilateral agreement under present interpretation of the security provisions of the Atomic Energy Act of 1954".[15] The problem was also Italian public opinion, since Italian Communist broadcasts "commented that President Eisenhower failed to say whether the US would support an immediate ban on atomic weapons", while left-wing papers argued that the program was a reaction to the Soviet acquisition of the atomic bomb.[16] At the sime time, Luce recognized the positive effects the Atoms for Peace program might have, and argued that, "knowledge of the possibilities of a United States-aided atomic energy program could have a great effect in influencing the next Italian elections",[17] while the Central Intelligence Agency (CIA) was convinced that the program would "bring political and psychological benefits to the US".[18]

Italy expressed immediate interest in the American program, and was one of the first countries to do so. The forms of international cooperation promised by the Atoms for Peace program seemed to offer new possibilities to a country that was desperate to de-

14 Richard G. Hewlett, *Atoms for Peace and War, 1953-1961: Eisenhower and the Atomic Energy Commission* (Berkeley: University of California Press, 1989); Ira Chernus, *Eisenhower's Atoms for Peace* (College Station: Texas A&M University Press, 2002); John Krige, "Atoms for Peace, Scientific Internationalism, and Scientific Intelligence," *Osiris* 1 (2006): 161-181.

15 NARA, RG 84, Records of the Foreign Service Posts of the Department of State, Italy, Rome Embassy, Records of Clare Boothe Luce (hereafter CBL), 1955-1957, box 4.

16 NSC Briefing, December 10, 1953, in NARA, CIA Records Search Tool (CREST).

17 NARA, RG 84, CBL, 1955-1957, box 4.

18 Memorandum for the Director of Central Intelligence, August 9, 1954, NARA, CREST.

velop autonomous forms of energy, but lacked the means and technology to do so. The CNRN pointed out that, "considering the scarce Italian availabilities of power and their prevailing high costs – the utilization of nuclear energy on an economical level would be reached in Italy sooner than in other Countries".[19] The CNRN wanted to receive 10 tons of heavy water, fissionable material, and a research reactor. Its aim was to obtain equipment and technology, while at the same time promoting an atomic energy policy that would be independent from the United States.[20]

Discussions about the bilateral agreement took place in Washington, DC, rather than in Rome. The US Embassy insisted that an American offer be made to Italian Ambassador Egidio Ortona rather than to the Italian government, "in order to prevent the possibility that Italians might tie up the approach … with our interest in uranium".[21] Ortona highlighted the interest the Italian government had in establishing forms of cooperation with the US, and argued that the CNRN wished to send a mission of atomic experts to the US in order to "pav[e] the way for the stipulation of a cooperation agreement".[22] He pushed the State Department to prepare a draft, so that Prime Minister Mario Scelba might sign it during his trip to the United States in March 1955. He also let the State Department know that Giordani and Edoardo Amaldi were "prepared to come to the US immediately to undertake the negotiation of a bilateral".[23] During his official visit to DC, Scelba was accompanied by Giordani who, along with Amaldi, Carlo Salvetti, Bruno Ferretti and Anna Baroni, represented the Italian government in the field of atomic energy.

Bilateral talks were immediately characterized by a growing American concern for the debate taking place in the Italian Parliament around the signing of an atomic energy bill. During Scelba's visit, Luce reported that the Italian government had approved a draft law assigning the state responsibility for the development of atomic energy in all its different phases. The bill – presented by Giordani and by Minister of Industry Bruno Villabruna, and submitted in February 1955 – promoted the idea that the state should have a direct role in prospecting for mines and using nuclear energy for industrial purposes, and that uranium should become a state property.[24] Luce heavily criticized the law,

19 NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 503.

20 Paoloni, *Energia, ambiente, innovazione*.

21 Interim Programs to Develop the Peaceful Uses of Atomic Energy, January 6, 1955, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 503.

22 Italian Embassy to Secretary of State, February 22, 1955, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 503.

23 Memorandum of Conversation, February 14, 1955, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 503.

24 Paoloni, *Energia, ambiente, innovazione*.

and Giordani's role in pushing the government to endorse it, and related the CNRN's proposal to the policies promoted by ENI and its President Enrico Mattei. Luce was particularly concerned about the Oil Law that was being discussed in Parliament, which hindered the activities of US private oil companies operating in Italy, by creating a monopoly over the exploration and extraction of hydrocarbons. The Ambassador went so far as arguing that "unconfirmed reports circulating to effect that law [on atomic energy] inspired by Enrico Mattei who plans absorb Natl Committee [CNRN] into framework of ENI".[25] She concluded that private companies might be better suited to carry out a program aimed at developing Italy's civilian atomic energy through bilateral relations with the United States, offering "concrete proof to long-claimed willingness Ital industry proceed with exploitation peaceful atom".[26] Luce's position was reinforced by General Electric representatives who, in a letter to the USAEC, argued that the Giordani-Villabruna bill would be "in contrast to that feature of the declared policy of the USA … that the development, use and control of atomic energy shall be directed so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise".[27]

The USAEC used Giordani's visit to point out that it would not support the atomic energy bill, and that its approval might have deep consequences on the possibility for Italy of obtaining US assistance. As the US Embassy in Rome put it, "the reports of the Italian Atomic Energy Delegation to Washington re US criteria in Atomic Energy Cooperation, has now caused the Council of Ministers to instruct the Ministry to withdraw its first draft and present another with the objectionable monopoly features eliminated".[28] While discussions in the Italian Parliament stalled, the United States and Italy signed a bilateral agreement, according to which the United States would provide heavy water, while Italy could buy up to 600 kg of enriched uranium from the USAEC and a research reactor similar to the one installed at the Argonne laboratory. By focusing on enriched rather than natural uranium, the USAEC aimed at making sure that, as Simone Turchetti has argued, "countries receiving supplies … would be continuously reliant upon US imports to run their nuclear programs".[29]

25 US Embassy in Rome, March 18, 1955, NARA, RG 84, CBL, 1955-1957, box 9.

26 NARA, RG 84, CBL, 1955-1957, box 9.

27 NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 502.

28 American Embassy Rome to Department of State, May 6, 1955, NARA, RG 84, CBL, 1955-1957, box 4819.

29 Turchetti, "A Most Active Customer", 480. See also John Krige, "The Peaceful Atom as Political Weapon: Euratom and American Foreign Policy in the Late 1950s", *Historical Studies in the Natural Sciences* 1 (2008), 5-44.

The agreement came into effect after the International Conference on the Peaceful Uses of Atomic Energy was held in Geneva in August 1955, during which Italian firms and agencies committed to developing an atomic program. Whereas Italian delegates proposed to build three nuclear plants and highlighted the presence of uranium resources in the northern parts of the country, the main private firms – Fiat, Montecatini, and Edison – expressed interest in purchasing reactors from the United States.[30] It was especially Edison, the biggest private Italian electric company, that took advantage of these debates to obtain material from the United States. In April 1955, Edison's CEO Giorgio Valerio sent a letter to the USAEC asking for its support in importing an American power reactor to Italy. He pointed out that, "Edison intends to increase further its steam generating capacity and it believes that the time has now come to turn to atomic energy using American equipment and engineering."[31] A few months later, he visited the United States, together with Mario Silvestri and the director of the company's thermal power stations, Franco Castelli, and started talks with Westinghouse to purchase a pressurized water reactor, which was supposed to be a duplicate of the one the American company was building for the Yankee Atomic Electric Company in Massachusetts. In December 1955, Edison founded the Società Elettronucleare Italiana (SELNI), with the aim of building a nuclear power plant in Trino Vercellese, near Turin.[32] The following year, Hall met with Vittorio Valletta, general manager of Fiat, to develop a joint program in the field of atomic energy and, in particular, build power reactors through the company Società Ricerche Impianti Nucleari (SORIN), with equipment provided by Westinghouse.[33]

In the second half of the 1950s, US-Italian relations in the field of atomic energy continued to be influenced by the debate about the atomic energy bill, which revolved around the relationship between public agencies and private firms. While Giordani received Segni's support for a bill reserving to the state the right to exploit materials needed to produce nuclear power, and giving it control over the industrial use of fissionable material, other Italian politicians advanced a different view of the country's atomic project. In 1956, Senators Giuseppe Caron and Stefano Perrier challenged the Giordani-Villabruna draft law by presenting another project, modeled on the 1954 US Atomic Energy Act, which would have allowed private industrial groups to develop atomic energy programs under government control.

30 American Embassy in Rome, August 12, 1955, NARA, RG 84, CBL, 1955-1957, box 9.

31 Giorgio Valerio to USAEC, April 14, 1955, NARA, RG 326, Records of the Atomic Energy Commission, Office of the Secretary, General Correspondence, 1951-1958, box 111.

32 Valerio Castronovo, *Il gioco delle parti. La nazionalizzazione dell'energia elettrica in Italia* (Milano: Rizzoli, 2012).

33 Atomic Energy Developments in Italy, February 7, 1957, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 503.

The debate stalled in Parliament and slowed down relations with the USAEC. Giordani traveled to the United States in January 1956 to close the deal and buy a research reactor to be placed at Ispra, near Milan. While in the United States, he met with Hall and asked for a revision of the bilateral agreement, in order to purchase a larger quantity of enriched uranium, as well as a power reactor. Just before Giordani left for the United States, Luce "suggested that if the Italians approach us for a power bilateral agreement, we should insist that they establish their own basic atomic energy law first".[34] Gerard Smith of the USAEC replied unofficially that the US government "would probably like to see the Italian atomic energy legislation prior to the completion of an agreement for cooperation in the power reactor field".[35]

The Italian Council of Ministers approved the bill in the Fall of 1956, shortly after Giordani resigned from his position and was replaced by Felice Ippolito, another strong supporter of a state-led nuclear program. In his remarks before the Council, Minister of Industry and Commerce Guido Cortese argued that, "The bill has taken into account the experience behind foreign legislation and that provided by the various international conferences. … Our law … is specifically designed to give to private enterprise sufficient guarantees and incentives to enable it to intervene with adequate investments in the mining phase as well as that of industrial utilization".[36] However, the proposal stalled in Parliament and was eventually withdrawn in 1958, at the end of the legislature. In the meantime, the CNRN proposed an interim law regulating the role the agency should have, and presented a new bill, creating the CNEN under the control of the Ministry of Industry and Commerce. It took another three years for the bill to be approved and come into effect.

While the US administration pushed the Italian government to pass a law that would be acceptable to the United States, it was the contrast between public agencies and private firms, and the lack of stable governments, that delayed the signing of bilateral agreements and negatively affected Italy's atomic program. When, in 1957, the Italian government asked the State Department to revise the bilateral agreement in order to import more fuel to operate the country's three reactors, the US Embassy pointed out that, "neither of two government groups now in the field, Agip Nucleare and Società Energica Nucleare (SEN) [*sic*], have been able to come up with concrete projects".[37] In

34 Memorandum for the file, January 10, 1956, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 502.

35 Italian Atomic Energy Development, January 17, 1956, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 503.

36 American Embassy Rome to Department of State, October 1, 1956, NARA, RG 84, CBL, 1955-1957, box 4819.

37 David Zellerbach to Secretary of State, May 17, 1957, NARA, RG 59, Central Decimal File (hereafter CDF), 1955-1959, box 2541.

such a context, "it is very difficult indeed to plan a coherent atomic energy program with no law or regulation on which to base it, and with authority and responsibility for the program dispersed and unclear".[38] According to the new agreement signed in 1957, Italy would receive 7,000 kg of enriched uranium over a twenty-year period, while the United States would supply enriched uranium for two power plants.

The contrast between public agencies and private firms led to a delay in Edison's plan to build a nuclear power plant in northern Italy using American technology. As Valerio put it, one of the main problems was that there was no "'agreement of cooperation' between the United States and Italian government, appropriate authorizations from the governmental agencies concerned, provision for supply of nuclear fuel". The main issue, though, was that Edison encountered countless problems in obtaining funding from the Export-Import Bank, despite the fact that the USAEC pressured banks to provide loans to private foreign companies.[39] It was especially the Italian government that undermined Edison's activities. In the winter of 1956-1957, Cortese – under pressure from Ippolito – turned down the company's request to receive a bill of exchange guarantee for the Export-Import Bank loan.[40] The controversy continued, and in 1959 the Minister of Industry had not yet approved the site of the SELNI reactor. A report sent to the State Department pointed out that,

> The Embassy understands that the Secretary General, Ippolito, of the CNRN has taken an interest in the matter. Ippolito is an outspoken opponent of private participation in nuclear power development, as in the SELNI project, and is a particular foe of the parent Milan Edison group. Ippolito's influence could quite possibly be brought to bear … to delay approval of the site chosen by SELNI. This could prevent private industry from becoming established in the nuclear power field, and this getting a foot in the door, before this question comes under examination in the legislative consideration of the proposed basic nuclear law.[41]

The Italian Ministry of Industry dragged its feet for years, refusing to issue an official permit to allow construction of the plant. The American Embassy explained the situation, stating that, "the Ministry has hesitated to authorize construction of the SELNI plant because the long standing controversy on whether private interests will be permit-

38 Report on Atomic Energy Developments in Italy, December 19, 1957, NARA, RG 84, CBL, 1955-1957, box 4819.

39 Edisonvolta purchases a large power reactor, December 20, 1956, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 502; Felice Ippolito and Folco Simen, *La questione energetica (dieci anni perduti 1963/1973)* (Milano: Feltrinelli, 1974).

40 Ippolito and Simen, *La questione energetica*, 28.

41 AmEmbassy to Department of State, April 6, 1960, NARA, RG 59, CDF, 1960-1963, box 2690.

ted to operate Italian nuclear power plants has not yet been resolved by Parliament."[42] The Embassy intervened through its Economic Counselor, who pressured the Italian government to take a clearer stance. It "assured Minister Colombo that the issue of public vs. private nuclear power was recognized as an internal Italian matter", but it also pointed out that "the Westinghouse company has already committed a considerable amount of money in work … and therefore is anxious to have the project authorized to go ahead regularly".[43]

In 1960, the Italian Parliament finally passed the atomic energy bill it had been debating since the mid-1950s. The law established the CNEN as Italy's main agency devoted to the development of peaceful uses of atomic energy. Placed under the control of the Ministry of Industry, CNEN promised to allow Italy to overcome its chronic lack of energy resources. In the early 1960s, it was one of the most advanced agencies in Western Europe, and set Italy among the most advanced countries – along with Japan – in the field of civilian nuclear energy.[44]

The American Embassy in Rome kept closely under control Italian discussions about the so-called Colombo Bill, which eventually led to the creation of CNEN, fearing that it might exclude private firms from operating in the field of nuclear energy. Once the bill was passed, the Embassy recognized that, "a major obstacle in the way of planning and carrying out a long range Italian national nuclear program was removed",[45] and that Italy could gain "a position of European, if not world, prestige and leadership in the nuclear field".[46] CNEN would encourage new forms of planning which, in the Embassy's view, "in the past ha[ve] been hampered by the fact that allocations were made on a year to year basis".[47] Thanks to this new institutional context, a series of agreements signed by American and Italian firms and agencies in the second half of the 1950s finally came into effect. These included building a nuclear power plant in the Southern town of Garigliano, which was based on an agreement between the state-owned Società Elettronucleare Nazionale (SENN) and General Electric and received funding from the World Bank; and operating Italy's first research reactor in Ispra, which was sold by the American Car and Foundry Company and was partly funded by the USAEC.[48] By 1961, the United States provided Italy with six research and training reactors, along with the

42 AmEmbassy to Secretary of State, January 29, 1961, NARA, RG 59, CDF, 1960-1963, box 2691.

43 AmEmbassy to Secretary of State, March 8, 1961, NARA, RG 59, CDF, 1960-1963, box 2691.

44 Ruggero De Leone and Cecilia Dau Novelli, "Dal Cnen all'Enea, 1960-1982," in Paoloni, *Energia, ambiente, innovazione*, 71-160; Silvio Labbate, *Il governo dell'energia. L'Italia dal petrolio al nucleare (1945-1975)* (Firenze: Le Monnier, 2010).

45 AmEmbassy to Department of State, May 6, 1961, NARA, RG 59, CDF, 1960-1963, box 2691.

46 AmEmbassy to Department of State, May 6, 1961, NARA, RG 59, CDF, 1960-1963, box 2691.

47 AmEmbassy to Department of State, October 18, 1960, NARA, RG 59, CDF, 1960-1963, box 2690.

48 Piero Isola, *Odissea Garigliano. Storie del nucleare in Italia* (Manziana: Vecchiarelli, 2004).

enriched uranium needed to fuel them. Among them, the Progetto Reattore Organico (PRO), which was the outcome of a close collaboration between AGIP Nucleare, Fiat, and Montecatini on the Italian side, and the Martin Marietta Corporation from Baltimore and Atomic International on the American side.[49]

The only exception remained the building of the SELNI nuclear power plant, which became the object of a heated political controversy in the context of the debate about the nationalization of Italy's electric industry. In 1962, SELNI and Westinghouse pushed the US administration to approve the shipment of the reactor needed to operate the plant. The State Department replied by asking CNEN for an official statement that the reactor was part of the US-Italian bilateral agreement. However, the Italian government refused to issue the statement considering how politically sensitive the matter was. A CNEN representative in Washington, DC, "advised that due to governmental crisis and likelihood of nationalization nuclear industry in 'opening to left' of new coalition no official Rome presently in position state SELNI authorized receive shipment."[50] The State Department concluded that "any implication of US interference in planned nationalization, nuclear power or SELNI reactor specifically must of course be avoided."[51]

The Nationalization of the Electric Industry

In November 1962, the Italian Parliament voted to create ENEL, which centralized the production of electric power. The law was part of a wider debate, carried out by the Italian Parliament between the second half of the 1950s and the early 1960s, about the need to create center-left governments, based on a coalition between the Christian Democratic Party (DC), the Italian Socialist Party (PSI) and the Italian Social-Democratic Party (PSDI). The establishment of ENEL was one of the conditions set by the PSI for supporting the creation of a center-left government.[52]

In the late 1950s, the US administration remained weary about socialists' participation in the Italian government. Its attitude changed after John Foster Dulles – a fierce anti-Communist – left his position as Secretary of State in 1958. However, the United

49 US Participation in Inauguration of Italy's First Nuclear Reactor, April 22, 1959, NARA, RG 84, CBL, 1955-1957, box 4819; Felice Ippolito to Wells, Director of International Affairs, USAEC, March 1960, NARA, RG 59, OS, S/AE, GRAE, 1948-1962, box 502. See also Paoloni, *Il nucleare in Italia*.

50 Department of State to AmEmbassy, February 23, 1962, NARA, RG 59, CDF, 1960-1963, box 2695.

51 Department of State to AmEmbassy, February 23, 1962, NARA, RG 59, CDF, 1960-1963, box 2695.

52 Labbate, *Il governo dell'energia*; Leopoldo Nuti, *Gli Stati Uniti e l'apertura a sinistra. Importanza e limiti della presenza americana in Italia* (Roma-Bari: Laterza, 1999); Valerio Castronovo and Giovanni Paoloni, eds., *I cinquant'anni di ENEL* (Roma-Bari: Laterza, 2013).

States still wanted to make sure that the new government would confirm Italy's membership in the Atlantic Alliance and avoid any form of neutralism. Prime Minister Amintore Fanfani's trip to the United States in June 1961 was, in this sense, crucial. Just before he left for Washington, DC, Charles Douglas Jackson, who had been Eisenhower's special assistant, sent a report to President John F. Kennedy, pointing out that the PSI was indeed breaking away from the Communists.[53]

While the nationalization of the Italian electric industry reminded many of the forms of economic nationalism carried out by ENI in the oil field, the US administration and the American Embassy recognized the political and economic importance of ENEL. As the Embassy put it, "the nationalization of electric power can be viewed as a defensible political compromise adopted in the hope of furthering long-range political objectives of major importance to the country. In this light, the purpose was to obtain support for a center-left government from socialists … who are loyal to democratic principles and therefore fundamentally opposed to communism, while being nothing worse than doctrinaire".[54] According to the US administration, the creation of ENEL was not so radical, since center-left governments did not intend to nationalize other sectors, private firms could continue to operate, and ENEL might have overall positive effects on the Italian economy, boosting the government's economic planning policies, particularly in the South. The United States' main concern was the proposal – advanced by ENI – to nationalize all energy sectors. Once ENEL was established, the US Embassy reported optimistically that, "the limitation of the proposed new agency to electric power production would seem to end the hopes of those who from time to time have proposed creation of a gigantic single state agency to control the whole energy sector", while at the same time limiting the possibility on the part of the CNEN of establishing full control over the Italian nuclear sector.[55]

ENEL, however, decided to rely on oil, rather than nuclear power, to fuel most of its electric plants. The decision was tied to economic and political reasons, and depended on a series of changes that characterized the national and international energy market. The most important one had to do with the declining price of crude oil, linked to the discovery of new fields in North Africa. Furthermore, in the early 1960s the United States' approach to Italian oil policies changed significantly. After ENI signed a series of treaties with the Soviet Union for the import of crude oil, the US administration and American oil companies intervened to stop Mattei's activities. In 1963, with the support of the State Department, ENI and Standard Oil (N.J.) signed an agreement,

53 Catronovo, *Il gioco delle parti*, 163.

54 AmEmbassy Rome to Department of State, October 1, 1963, in NARA, RG 84, Italy, US Embassy Rome, Classified General Records (hereafter CGR), 1946-1964, box 28.

55 AmEmbassy to Department of State, July 20, 1962, NARA, RG 59, CDF, 1960-1963, box 2695.

according to which the American oil company would provide ENI with crude oil and natural gas it extracted in Libya, in exchange for technical equipment. The treaty reduced Italy's dependence on Soviet oil and allowed Esso to find an outlet for its hydrocarbon resources.[56]

Thanks to these deals, Italy received large quantities of cheap oil, which it refined in its many plants, especially the ones located in Sicily. Part of the refined products was sent to other Western European countries, but what was left was used to fuel Italy's electric industry. The government's and ENEL's strategy was largely supported by American oil companies operating in Italy, as well as by ENI and the Italian refining industry.[57] ENEL's decision to rely on oil to fuel its electric plants led to a sharp decline of Italy's nuclear program, given that the agency reduced its investments in the nuclear sector and relied almost entirely on cheap oil rather than on a more diversified range of energy sources. As a result, despite the country's advances in the nuclear sector, by the second half of the 1960s only 5% of Italy's electricity came from nuclear power. This decision had long-term effects, since it made the Italian economy and industry largely dependent on imported oil and increasingly vulnerable to the changes of the international oil market, as was clear during the 1973 oil "shock".[58]

The "Ippolito Affair"

Italy's shift away from nuclear energy was also the result of political decisions. In the summer of 1963, Giuseppe Saragat, leader of the PSDI accused Ippolito of mismanaging public funds. After a long trial, Ippolito was removed from his position, leading to a decline of public investments in nuclear programs. The American Embassy in Rome reported widely on what it called the "Ippolito scandal" and the subsequent trial. When Saragat made his accusations, it highlighted how "Saragat's stand on question of nuclear power has distinct political connotation. Evidently prepared for him by experts in the field who oppose nuclear plants, his statements seem aimed at discrediting Felice Ippolito".[59] A week later, the Embassy confirmed its opinion that "Saragat's principal

56 Archivio Storico ENI (ASE), Fondo ENI, Presidenza, Raffaele Girotti, b. 76, f. 3369. On US reactions to the treaty between the Soviet Union and ENI: Elisabetta Bini, "A Challenge to Cold War Oil Politics? The US and Italy's Relations with the Soviet Union, 1958-1969", in Jeronim Perovic, ed., *Cold War Energy: A Transnational History of Soviet Oil and Gas* (London: Palgrave Macmillan, 2017): 201-230.

57 De Leone and Dau Novelli, "Dal Cnen all'Enea", 91-92.

58 AmEmbassy Rome to Department of State, February 1, 1963, NARA, RG 84, Italy, US Embassy Rome, CGR, 1946-1964, box 28. Elisabetta Bini, "A Transatlantic Shock: Italy's Energy Policies between the Mediterranean and the EEC, 1967-1974," *Historical Social Research*, 4 (2014): 145-164.

59 AmEmbassy in Rome to Ruepda, August 1963, NARA, RG 59, Central Foreign Policy File (here-

motives were political rather than economic, although he … has been concerned with large expenditures involved in building and operating nuclear power stations".[60] It immediately linked the accusations to the policies carried out by the center-left governments, and argued that,

> [Saragat] has raised question of type of center-left to be created … namely, whether it would be a center-left that would institute needed social and economic reforms with full respect for individual initiative and enterprise, or center-left of type sought by such left-wingers as Riccardo Lombardi and Ugo La Malfa, who advocate basic structural changes in economy.[61]

Saragat's support for the first option obviously meant undermining the reformist ethos that had characterized political discussions concerning the founding of ENEL and CNEN's programs.

US representatives immediately considered the political repercussions of the "Ippolito affair". While the CIA reported that "revelations of conflicts of interest in the government Nuclear Energy Committee are causing a political uproar that may complicate maneuvers this fall to form a new government",[62] the American Embassy pointed out that the Italian Communist Party (PCI) might take advantage of the situation, by taking sides with Ippolito and trying to broaden the investigations to various DC Ministers of Industry.[63] Furthermore, it argued that, "the government has handled the case very gingerly apparently because many important personalities had been subsidized by Ippolito [Lombardi and La Malfa in particular]".[64]

The Embassy initially pointed out that the "Ippolito 'scandal' is but one of several involving top government officials which have blown up Italy in past few years … [Ippolito] appears to [*sic*] deeply implicated to escape completely unscratched."[65] The Ambassador argued that, "The decision to arrest Ippolito would also seem to indicate the Government's determination to do something positive about the rash of economic and political scandals that have beset Italy in the past several years, and possibly enhance its public image at a time when popular support for its programs is so eagerly sought".[66]

---

after CFPF), 1963, POL, box 3951.

60 AmEmbassy in Rome to Ruepda, August 1963, NARA, RG 59, CFPF, 1963, POL, box 3951.

61 AmEmbassy in Rome to Ruepda, August 1963, NARA, RG 59, CFPF, 1963, POL, box 3951.

62 CIA, September 19, 1963, NARA, CREST.

63 AmEmbassy in Rome to Ruepda, September 1963, NARA, RG 59, CFPF, 1963, POL, box 3951.

64 AmEmbassy in Rome to Department of State, October 17, 1963, in NARA, CFPF, POL, box 3952.

65 AmEmbassy in Rome to Ruepda, August 1963, NARA, RG 59, CFPF, 1963, POL, box 3951.

66 AmEmbassy in Rome to Department of State, March 5, 1964, in NARA, CFPF, 1964-1966, Political & Defense, box 2366.

However, during the trial the Embassy changed its initial impression that "firm evidence has been uncovered against Ippolito", and pointed out that Ippolito "administered the agency, and its funds, in accordance with CNEN directives", and that, despite his "deplorable personal traits … his staff felt that he was accomplishing the desired objective of moving Italy ahead in the field of nuclear technology".[67] One year after the outbreak of the "Ippolito affair", the Embassy pointed out that one of the main results had been to waste "a year in the field of nuclear research and development", reduce "the country's stature and prestige in international nuclear agencies", and convince the public that nuclear power was too expensive for Italy.[68]

Conclusion

Between the end of World War II and the mid-1960s, Italy's civilian nuclear program was profoundly influenced by the Cold War and, in particular, by US policies and interests in Western Europe. Until the mid-1950s, the US administration and the US-AEC kept Italy's uranium resources under control, and did not provide any aid or funds for the purchase of nuclear equipment under the Marshall Plan. Once the Eisenhower administration introduced the Atoms for Peace program, the US used its bilateral agreements with Italy to shape the country's civilian nuclear program, by strengthening the role of private industrial groups and providing enriched, rather than natural uranium, thus making Italy dependent on a technology controlled by the US.

This chapter has argued that, rather than simply representing an imposition of American technology and industrial strategies, US policies interacted in complex ways with a variety of Italian actors, which offered their own interpretations of the meaning of civilian nuclear projects for the country's modernization. Until the early 1960s, when the Italian Parliament finally approved an atomic energy bill and created the CNEN, the US encountered many forms of resistance on the part of Italian politicians and institutions. These were tied to a specifically domestic struggle between public and private firms and research centers, revolving around the nationalization of the electric industry, which hampered the development of Italy's nuclear program. Once CNEN was established and the Italian government started supporting the idea that the development of a nuclear policy should be part and parcel of the forms of economic planning and modernization

67 AmEmbassy in Rome to Department of State, August 7, 1964, NARA, CFPF, 1964-1966, Political & Defense, box 2366.

68 AmEmbassy in Rome to Department of State, August 19, 1964, NARA, CFPF, 1964-1966, Political & Defense, box 2366.

promoted by the center-left coalitions, the US became actively involved in providing Italy with reactors, and training a new generation of Italian scientists and technocrats.

The link between the development of a civilian nuclear program and Italy's modernization came to a sudden halt in the early 1960s, after the creation of ENEL and in the aftermath of the "Ippolito affair". This chapter has shown that the decline of public investments in the nuclear sector was only partly the result of American forms of pressure. While US oil companies and the State Department pressured the Italian government and ENI to buy large quantities of cheap crude extracted in North Africa, thus reducing the country's dependence on Soviet petroleum, ENEL's resolution to rely on oil, rather than nuclear power, to fuel its electric plants, was a domestic choice. It resulted, once again, from a struggle between public and private firms and interests, and intersected with the decision, on the part of the Italian government, to marginalize the forms of economic planning and modernization that had characterized the late 1950s and early 1960s. In this framework, it should come as no surprise that the American Embassy, the US administration and the USAEC interpreted the "Ippolito affair" as putting an end to one of Italy's most advanced scientific, technological and industrial projects, and undermining Italy's international prestige.

Fabio Lavista

Political Uncertainty and Technological Development: The Controversial Case of AGIP Nucleare (1956-1962)

Investing in high-technology, capital-intensive sectors is risky, because revenues are delayed over time and because it is often very difficult to forecast the pattern of development of technological regimes,[1] especially if they are in their formative period, as was the nuclear energy sector during the 1950s. Moreover, investments' potential positive performance is strictly linked with the ability to acquire technical, as well as managerial and organizational, capabilities. Every effort to innovate in these sectors is, in fact, the result of a process of trial and error, a learning process in which gaining access to the knowledge structured or embodied in machinery is relevant, as is the ability to coordinate complex socio-technical systems.[2] As several scholars have argued, a successful innovation is often not a matter of invention, but mainly a matter of design, in the sense of devising efficient products or processes, given some cost constraints.[3] This is true for pure innovation, but also for the transfer of technology: in both cases, designing new technology is a risky activity, since technical uncertainty can rapidly translate into huge financial losses.

Regardless of the path followed to acquire knowledge and design efficient innovation processes, the implementation of a new technological regime is a costly and time-consuming activity, especially in cases in which the entire national innovation system is involved. In these cases, among which we can list the production of nuclear energy, the institutional framework is particularly relevant. Several scholars have highlighted the importance public policies have in fostering technological investments. These can ensure the presence of a stable institutional framework, which in turn allows for large

1 Franco Malerba and Luigi Orsenigo, "Technological Regimes and Sectoral Patterns of Innovative Activities", *Industrial and Corporate Change* 6, no. 1 (1997): 83-118.

2 Franco Malerba and Richard R. Nelson, eds., *Economic Development as a Learning Process: Variation across Sectoral Systems* (Cheltenham, UK-Northampton, MA: Edward Elgar, 2012), 1-20.

3 Richard R. Nelson, ed., *National Innovation Systems: A Comparative Analysis* (New York: Oxford University Press, 1993), 8-9.

investments, guaranteeing the amount of time needed to put into effect processes of knowledge acquisition and transfer. Reducing political uncertainty is very important, given that the lack of clear orientations deeply affects investments.[4] Since technological projects are not fully reversible, in the face of uncertainty protagonists become extremely cautious, and hold back on investments to such a degree that it seems possible to directly link political instability to the succession of cyclical investment fluctuations.[5]

Political certainty is always important for technological development, but different industrial sectors respond differently, in relation to the degree of complexity that characterizes them. The more an industrial sector's technology is complex, the more political stability is needed for its development. For instance, political certainty helps to explain the development of the electro-nuclear sector, because of the technology involved and the amount of investments needed to start a nuclear energy production plant. In this case, two other aspects have to be taken into consideration, which were particularly evident during the 1950s: the nuclear sector's dependence on international relations, and the relevance of state intervention. After World War II, for the majority of industrialized countries, the possibility of succeeding in the production of nuclear energy was radically linked to the import of technology and nuclear fuel from the United States and the United Kingdom.[6] Foreign policy was therefore crucial in determining the success or failure of technological innovation strategies. National industrial policies were equally important, given the degree of state intervention in the sector, both indirect – by means of regulation –, and direct – through state-owned enterprises.

This chapter examines the relationship between political uncertainty and technological development, through a study of the Italian electro-nuclear industry during the 1950s. It focuses in particular on the case of the Azienda Generale Italiana Petroli (AGIP) Nucleare, an electro-nuclear firm affiliated to the Ente Nazionale Idrocarburi (ENI), the main Italian oil public holding. The first paragraph discusses the role of state-owned enterprises and politics, and is followed by a brief analysis of the Italian government's electro-nuclear policy. The third and fourth paragraphs examine ENI's behavior in the energy sector, and give an account of the political difficulties the company faced both nationally and internationally. Finally, the chapter draws some conclu-

4 Alfred A. Marcus, "Policy Uncertainty and Technological Innovation", *The Academy of Management Review* 6, no. 3 (1981): 443-48.

5 Ben S. Bernanke, "Irreversibility, Uncertainty, and Cyclical Investment", *The Quarterly Journal of Economics* 98, no. 1 (1983): 85-106; Nick Bloom, Stephen Bond, and John Van Reenen, "Uncertainty and Investment Dynamics", *The Review of Economic Studies* 74, no. 2 (2007): 391-415.

6 Richard G. Hewlett and Jack M. Holl, *Atoms for Peace and War, 1953-1961: Eisenhower and the Atomic Energy Commission* (Berkeley: University of California Press, 1989); John Simpson, *The Independent Nuclear State: The United States, Britain, and the Military Atom* (New York: St. Martin's Press, 1983).

sions on the role political choice had in determining the success or failure of technological development processes.

State-Owned Enterprises and Technological Development

During the 1950s, countries that decided to enter the nuclear sector created public agencies devoted to research and development, and started funding national nuclear programs. In some cases, the state was directly involved in building nuclear plants; in other cases, private companies had greater freedom.[7] In Italy, the role of the state was particularly relevant: in 1952, the government founded the Comitato Nazionale per le Ricerche Nucleari (CNRN), a national agency aimed at carrying out research in the field of nuclear energy, while state-owned enterprises were involved in the construction of two of the three nuclear plants that were built in the 1950s.[8]

In this respect, it has to be considered that by definition state-owned enterprises do not pursue only their own specific interests, but have extra-enterprise aims that are external in origin, and are the result of political choices. Some of these are non-economic, social objectives, and a large part of them can be considered "macro-economic". The latter can affect several aspects of the national economy: its growth, the distribution of resources, specific budget policies, the balance of payments, the degree of the national industry's technological development, and the quality of the human capital employed.[9] State-owned firms' extra-enterprise purposes may not be so different from those of internal firms, but usually, given that the nature and timing of research and development programs are subject to government approval, they can turn out to be different from what the enterprise considers to be its aims. If, in theory, state-owned firms' pursuit of extra-enterprise targets can have positive effects on national industrial systems, and stimulate catch-up processes, in some circumstances it can also become a trap that in the long run prevents the pursuit of development programs.[10]

7 Joseph A. Camilleri, *The State and Nuclear Power: Conflict and Control in the Western World* (Seattle: University of Washington Press, 1984); Benjamin K. Sovacool and Scott V. Valentine, *The National Politics of Nuclear Power: Economics, Security and Governance* (London-New York: Routledge, 2012).

8 Giovanni Paoloni, "Gli esordi del nucleare", in *Storia dell'industria elettrica in Italia*, vol. 4, *Dal dopoguerra alla nazionalizzazione 1945-1962*, ed. Valerio Castronovo (Roma-Bari: Laterza, 1994), 383-407; Barbara Curli, *Il progetto nucleare italiano (1952-1964): Conversazioni con Felice Ippolito* (Soveria Mannelli: Rubbettino, 2000).

9 Venkata Vemuri Ramanadham, *The Economics of Public Enterprise* (London: Routledge, 1991), 72-97.

10 Daron Acemoglu, Philippe Aghion, and Fabrizio Zilibotti, "Distance to Frontier, Selection and Economic Growth", *Journal of European Economic Association* 4, no. 1 (2006): 37-74.

Some scholars have recently highlighted the role the state has played in promoting the expansion of many high-technology sectors, supporting basic research or funding expensive projects with a high risk of failure. The result of these policies has been the introduction of technologies subsequently adopted by private enterprises, both in capital-intensive sectors and in the production of mass consumer goods. In particular, these studies have underlined the importance mission-oriented funding and procurement have, along with the ability to bring together multiple protagonists, leading them toward shared objectives. According to these interpretations, the success of the entrepreneurial state lies in its ability to overcome market and policy uncertainty, in other words to reach a strong consensus on policies as such.[11]

The same scheme could be applied to state-owned enterprises. The design of widely shared strategies is, in fact, imperative to maintain an adequate level of funding and prevent the diversion of resources for political reasons. From this point of view, the development of Italian state-owned firms after World War II is illustrative: while they did not directly produce innovation, they were very effective in promoting the renewal of the managerial elite's technical knowledge and in importing technology. During the 1950s, huge public investment plans led to the modernization of entire industrial sectors. First, they led to the renewal of the steel industry,[12] and important changes were introduced in other strategic sectors as well, namely the mechanical, transport, and telecommunications industries.[13] In many cases, these policies did not lead to innovation in the narrow sense of the term, but by acquiring technology abroad the Italian industry underwent a process of modernization.[14] The existence of a widely shared vision of development, in terms of the pattern of technological innovation to follow, along with the international

11 Mariana Mazzucato, *The Entrepreneurial State: Debunking Public vs. Private Sector Myths* (London-New York: Anthem Press, 2014).

12 Gian Lupo Osti, *L'industria di Stato dall'ascesa al degrado. Trent'anni nel gruppo Finsider. Conversazioni con Ruggero Ranieri* (Bologna: il Mulino, 1993); Ruggero Ranieri, "Steel and State in Italy and the UK: The Public Sector of the Steel Industry in Comparative Perspective (1945-1956)", in *European Yearbook of Business History*, vol. 2 (Aldershot-Brookfield: Ashgate, 1999), 126-54.

13 Andrea Colli, "La grande stagione dell'IRI", in *Storia dell'IRI*, vol. 2, *Il "miracolo" economico e il ruolo dell'IRI*, ed. Franco Amatori (Roma-Bari: Laterza, 2013), 58-150; Sergio Mariotti, "Le telecomunicazioni: dal monopolio tecnologico ai mutamenti degli anni Ottanta e Novanta alla privatizzazione", in *Storia dell'IRI*, vol. 5, *Un gruppo singolare: settori, bilanci, presenza nell'economia italiana*, ed. Franco Russolillo (Roma-Bari: Laterza, 2015), 201-76.

14 Fabio Lavista and Ferruccio Ricciardi, "Le nuove funzioni d'impresa: formazione, comunicazione, ricerca e sviluppo", in *Storia dell'IRI*, vol. 2, *Il "miracolo" economico*, ed. Amatori, 313-72; Cristiano Antonelli, Federico Barbiellini Amidei, and Claudio Fassio, "L'IRI, la ricerca, lo sviluppo tecnologico, la crescita (1950-1994). Esternalità e governo della conoscenza", in *Storia dell'IRI*, vol. 5, *Un gruppo singolare*, ed. Russolillo, 839-918.

financial aid available through the Marshall Plan, allowed public companies to carry out their objectives.[15]

Given its characteristics (the technologies adopted, the strategic interests involved, the opportunity of having access to international forms of aid aimed at promoting its peaceful applications), the nuclear energy industry could have followed a similar path. In practice, though, its evolution was radically different, mainly because of the lack of definite public choices, in terms both of industrial and foreign policies. The following pages aim to demonstrate this hypothesis, through a study of ENI, which in the mid-1950s developed one of the most promising Italian electro-nuclear projects.

The Italian Government's Nuclear Policy during the 1950s

In the early 1950s, hydroelectric power plants provided almost 89 per cent of Italy's electricity. However, hydroelectric energy was close to exhaustion, given that 70 per cent of it had already been or was about to be exploited. One alternative would have been to extend the use of thermal power stations, but this would have meant an increased dependence on fuel imports.[16] In the first half of the 1950s, similar estimates and reasoning led the Italian government to consider developing nuclear energy. In 1946, the Centro Informazioni Studi ed Esperienze (CISE),[17] a private research center for the peaceful use of nuclear energy, had been created, with the aim of building a first power plant; in 1952, the Italian government established the aforementioned CNRN, with the task of supporting and coordinating – through research contracts – the activities of the CISE and of the Istituto Nazionale di Fisica Nucleare (INFN), an inter-university research institute founded in 1951, and promoting several other initiatives in the nuclear field.[18]

At first, the Italian government was reluctant to start a public debate on nuclear energy. The approval of the decree that led to the creation of the CNRN was mostly due to the pressure exerted on the executive by the community of physicists. A greater government and public involvement in this area became unavoidable after Dwight D. Eisenhower's December 1953 speech in front of the United Nations General Assembly,

15 Francesca Fauri, *Il Piano Marshall e l'Italia* (Bologna: il Mulino, 2010).

16 Gino Martinoli, "Previsioni sullo sviluppo delle Centrali Nucleari di potenza in Italia, in un quadro tecnico-industriale", paper presented at the annual FNAEM congress, Rome, February 26, 1959, 4-5, Fondazione CENSIS, Roma, Carte Martinoli, b. 7, fasc. 1.

17 CISE was established by some of the main Italian large-size enterprises active in the mechanical, chemical and electrical sectors: Azienda elettrica milanese, Cogne, Edison, Falck, Fiat, Montecatini, Pirelli, Sade, and Terni.

18 Paoloni, "Gli Esordi Del Nucleare", 381-89.

and the subsequent International Conference on the Peaceful Uses of Atomic Energy, held in Geneva in 1955, which initiated international financial and technical forms of cooperation in the nuclear field[19].

The political debate on nuclear energy, however, began at a very difficult juncture. In the mid-1950s, the crisis of the political alliance that had ruled Italy since 1947 reached its peak, and was followed by a long political negotiation, which sought to enlarge the ruling majority, built around the Democrazia Cristiana (DC). Negotiations lasted until the beginning of the 1960s and led to the inclusion into the government of the Partito Socialista Italiano (PSI), which in the previous decade had already promoted some major changes in Italy's economic policy. The struggle between the various factions of the DC led to the progressive abandoning of the forms of financial stabilization that had been followed since 1947, and to the approval of the first national economic planning policy. In January 1955, Christian Democrat Ezio Vanoni, who at the time was Finance Minister in Mario Scelba's government, presented a ten-year plan for employment and income growth.[20] As we will see, these new political orientations deeply influenced the nuclear debate. There is another element that has to be taken into consideration in analyzing the beginning of the Italian nuclear program: the proposal of nationalizing the entire energy sector. The idea of nationalizing the electrical industry for anti-monopolistic purposes had already been debated during the Fascist period. Immediately after World War II, it had received support from leftist parties and unions, and at the end of the 1950s it became a major political issue, given that the PSI considered it an unavoidable element to participate in an alliance with the DC.[21] Even before the establishment of the alliance between the PSI and the DC, the debate over the structure of the national energy industry was at the top of the political agenda. In particular, its reorganization was a programmatic point of Amintore Fanfani's second government (July 1, 1958 – February 15, 1959), an issue that, as we will see below, deeply influenced ENI's behavior.

At the beginning of the 1950s, there were two contestants in the Italian energy sector. First, private producers of energy, led by Edison, one of the founders of CISE, which entered the nuclear sector with the intention of thwarting the nationalization project or, at least, of minimizing the consequences of a political decision by meeting the country's

19 Hewlett and Holl, *Atoms for Peace and War*, 209-37.

20 Ezio Vanoni, *Discorsi sul programma di sviluppo economico* (Roma: Istituto poligrafico dello Stato, 1956); Vanoni, *La politica economica degli anni degasperiani. Scritti e discorsi politici ed economici*, ed. Piero Barucci (Firenze: Le Monnier, 1977); Bruno Bottiglieri, *La politica economica dell'Italia centrista 1948-1958* (Milano: Edizioni di Comunità, 1984), 197-328; Fabio Lavista, *La stagione della programmazione. Grandi imprese e Stato dal dopoguerra agli anni Settanta* (Bologna: il Mulino, 2010), 104-38.

21 Giorgio Mori, "La Nazionalizzazione in Italia: il dibattito politico-economico", in *La nazionalizzazione dell'energia elettrica. L'esperienza italiana e di altri paesi europei*, *Atti del Convegno internazionale di studi del 9-10 Novembre 1988 per Il XXV anniversario dell'istituzione dell'Enel* (Bari: Laterza, 1989), 91-115.

energy needs. Second, public enterprises working in the energy field, namely the firms of the Istituto per la Ricostruzione Industriale (IRI), controlled by the electric sub-holding Finelettrica, and the companies affiliated to ENI.

At first the Italian government, following the new planning policy introduced in the years 1954-1956, favored the cooperation among state-owned enterprises. An effort clearly testified by a meeting of the Committee of Ministers for the development of employment and income – the inter-ministerial body in charge of implementing the Vanoni Plan – held in Rome in October 1956. On that occasion, Prime Minister Antonio Segni, a Christian Democrat, who at that time was also President of the Committee, underlined "the need for Italy to start an industrial activity to produce nuclear energy". Giuseppe Medici (Ministry of the Treasury), Guido Cortese (Ministry of Industry and Commerce) and Emilio Colombo (Ministry of Agriculture and Forests) supported Segni's statement. All agreed that, given the advancement of research in the field of peaceful uses of nuclear energy in Western bloc countries, Italy should have kept itself updated. At the end of the meeting, the Committee decided that ENI – whose president, Enrico Mattei, had been invited in order to illustrate ENI's future investment plans – should have carried out the exploration and production of radioactive minerals, using one of its subsidiaries, Somiren. ENI would have drafted a new industrial plan to process radioactive materials, prepare nuclear fuel and regenerate nuclear fuel. Together with IRI, ENI would have been in charge of building a nuclear power plant in Southern Italy providing energy to Finelettrica, which in turn would have distributed and marketed electric power. In addition, the Committee authorized ENI to join Fiat and Montecatini – two private firms – in the construction of a second power plant in Northern Italy.[22]

The Italian government, therefore, decided to promote the growth of the nuclear sector in the context of the development policies started with the Vanoni Plan, assigning a key role to state-owned enterprises, which would have cooperated among each other and with private companies. In the following years, however, things took a different turn: the six years that elapsed between the 1956 meeting of the inter-ministerial committee and the 1962 approval by the Parliament of the nationalization of the electric industry – years in which the building of the first three Italian nuclear power plants was started – were characterized by a fierce political struggle. The political deal on nuclear energy was drafted in a context that favored contrasts not only between private and state-owned enterprises – respectively "victims" and beneficiaries of a possible nationalization –, but also between

22 Draft of the Comitato dei ministri per lo sviluppo dell'occupazione e del reddito nel quadriennio 1957-1960's meeting, Rome, October 11, 1956, Archivio Storico ENI, Pomezia (Roma) (hereafter ASE), ENI, BG.III.6, f. 1.

different public holdings, which started to pursue competitive development strategies in the nuclear field.

While political uncertainty influenced the decisions of the protagonists, two international elements should also be taken into consideration: first, the difficulties enterprises active in such an unknown and risky sector had to face in order to raise capital from international financial markets. Second, the international political and economic forms of pressure carried out in favor of different technological options. The United States and Great Britain fought for dominance in the field of nuclear reactors, and in the case of the United States, economic objectives went hand in hand with strategic needs tied to Cold War power politics.[23]

ENI's Strategy

Considering this context, it is interesting to follow the evolution of ENI's strategies, given that political uncertainty and the absence of a clear political will deeply influence the operations of this state-owned company. Its actions are in some ways paradigmatic of how the protagonists of the nuclear sector operated in that period. In fact, ENI decided to enter this new field mainly for extra-enterprise objectives and tried to leave as soon as the political framework changed, putting an end to its projects.

In order to understand this behavior, one has to keep in mind that in the mid-1950s ENI was in the midst of an intense growth phase. Once Mattei assured ENI control over the natural gas fields discovered in Northern Italy, he tried to increase the company's access to international oil sources. While it was struggling to control the nuclear sector, ENI signed two of its most controversial oil deals, namely an agreement with Reza Pahlavi of Iran and one with Gamal Abdel Nasser of Egypt.[24] As a result of this expansion strategy, ENI increased its financial commitment and experienced growing international tensions, especially with the United States, which accused the Italian company of challenging its interests in Italy, with the legal monopoly it established on natural gas resources in Northern Italy, and abroad. At an international level, the economic contrasts resulting from ENI's strategy, whose aim was to decrease oil prices, soon turned into political tensions, given that the company's agreements challenged consolidated

23 Robin Cowan, "Nuclear Power Reactors: A Study in Technological Lock-In", *The Journal of Economic History* 50, no. 3 (1990): 541-67.

24 Marcello Colitti, *Energia e sviluppo in Italia. La vicenda di Enrico Mattei* (Bari: De Donato, 1979); Daniele Pozzi, *Dai gatti selvaggi al cane a sei zampe. Tecnologia, conoscenza e organizzazione nell'Agip e nell'Eni di Enrico Mattei* (Venezia: Marsilio, 2009).

international balances, grounded on a static repartition of expenses, profits and roles between big international oil companies and producing countries.

Until that moment, ENI's national and international strategies were successful, thanks to Mattei's and his staff's political abilities and the support of Vanoni, to whom Mattei was closely tied, both politically and personally.[25] Vanoni's sudden death in February 1956 opened up a difficult political period for ENI, as its orientation became more and more dependent on the temporary alliances Mattei was able to establish. With Vanoni gone, Mattei's political points of reference were DC members Fanfani and Giovanni Gronchi, with their neo-Atlanticist foreign policy.[26] In this framework, ENI's nuclear strategy, which was intended to ensure Italy's energy independence, became a prerequisite for a more independent foreign policy.

This, however, is only part of the story, since Mattei half-heartedly decided to enter the nuclear sector. As we have seen, the initial input came from the Committee of Ministers in charge of carrying out the Vanoni Plan. Mattei was eager to comply with the Committee's solicitations, because in the same months the government was discussing a reorganization of the energy sector, which would have led to the creation of a new all-embracing public energy agency, the Ente unico per l'energia. By becoming involved in the nuclear sector, ENI would have been in a more favorable position than IRI, in case the project would have been approved. The Italian government started talking explicitly about this a few months before the 1958 political elections. As an internal ENI report noted, the plan was part of the DC's political agenda and of the agreement signed by the DC and the Partito Social-Democratico Italiano (PSDI), the two political parties that after the elections formed Fanfani's second government. The project was also mentioned in the keynote speech Fanfani gave to the Parliament, after he was appointed Prime Minister. The DC clearly stated in its electoral program that public energy holdings were crucial in achieving a balance between public and private enterprises, assuring the exploitation of national energy sources and promoting economic development. After the establishment in 1956 of the Ministero per le partecipazioni statali,[27] the government program became even more explicit: the document referred to the need for ENI and IRI of introducing a series of reforms, aimed at "obtain a clearer distribution of tasks

25 Fabio Lavista, *Analisi economica, politica estera e sviluppo. Giorgio Fuà, l'ufficio studi dell'Eni e la governance delle partecipazioni statali* (Bologna: il Mulino, 2016).

26 Anna Bedeschi Magrini, "Spunti revisionistici nella politica estera di Giovanni Gronchi presidente della Repubblica", in *L'Italia e la politica di potenza in Europa (1950-1960)*, ed. Ennio Di Nolfo, Romain H. Rainero, and Brunello Vigezzi (Milano: Marzorati, 1992), 59-73; Agostino Giovagnoli and Luciano Tosi, eds., *Amintore Fanfani e la politica estera italiana: atti del convegno di studi tenuto a Roma il 3 e 4 febbraio 2009* (Venezia: Marsilio, 2010).

27 Fabio Lavista, "Dallo statuto del 1948 alla programmazione economica nazionale", in *Storia dell'IRI*, vol. 2, *Il "miracolo" economico*, ed. Amatori, 523-61.

between the two holdings; establish a more efficient managerial control, in order to enhance their economic performances and guarantee a coherent development program, subordinate to central authorization mechanisms; organize state-owned enterprises in a new central bargaining agency; and, finally, allow some form of profit sharing, involving workers in decision processes". The agreement, which was clearly grounded on the primacy of politics, also included the possibility of merging all state-owned enterprises working in the research, production and distribution of energy into a new public holding. As ENI's report pointed out, Fanfani's keynote speech offered a deep insight into the project. It underlined the need to "distribute competencies and enterprises between ENI and IRI more efficiently", and merge their electric subsidiaries into a new holding, to which the two companies would have transferred their long-term concessions for the exploitation of energy sources and which would have used its profits to acquire new concessions.[28]

In the following months, the new holding was not created. The struggle inside the DC, stirred up by Fanfani's attempt to include the PSI in the government, led to the project's failure.[29] The nationalization of the energy sector would have been carried out only a few years later, under the first centre-left coalition government, in a profoundly different context and following a different procedure. For some time, though, it seemed possible that ENI could became the new holding as proposed by the DC's political program.

After the creation in the first half of the 1950s of Somiren – an enterprise active in nuclear fuel research –, and the founding in 1956 of AGIP Nucleare, placed under the supervision of Gino Martinoli, ENI started to hire and train new personnel; study the nuclear technologies available on the international market; and build – not by chance in 1958 – a first nuclear power plant in Latina (near Rome), after signing an agreement with the British Nuclear Power Plant Company (NPPC).[30] As we will see in the following paragraph, two aspects of this story are particularly interesting, as far as the relationships between political uncertainty and technological development is concerned. First, the fact that the survey on available technologies led ENI to draft a development plan that went far beyond the construction of a single power plant, a plan tailored for a public holding that was ready to manage the whole electric sector. The second interesting aspect is ENI's decision to opt for British technology, a decision that was grounded in the need to diversify nuclear technologies, given that the other Italian enterprises active in those years in the nuclear sector used US technology. Since British nuclear power plants

28 See *Appunti sulla costituzione di un Ente nazionale dell'energia*, 1958, ASE, ENI, BG.III.6, b. 2.

29 Giorgio Galli, *Storia della Democrazia Cristiana* (Bari: Laterza, 1978), 183-205.

30 Mauro Elli, *Atomi per l'Italia. La vicenda politica, industriale e tecnologica della centrale nucleare ENI di Latina 1956-1972* (Milano: Edizioni Unicopli, 2011).

were fueled by natural uranium, whereas American ones relied on enriched uranium, which could only be enriched by US enterprises, such a choice would have assured Italy a more independent future.[31]

Political Uncertainty, at Home and Abroad

The peculiar development of the Italian nuclear sector during the 1950s and the 1960s led to the building of three nuclear power plants, each designed following a different technology: thanks to a loan granted to it by the Export-Import Bank, Edison signed an agreement with Westinghouse to buy an enriched uranium reactor, moderated with pressurized water. IRI participated in the research project Energia Nucleare Sud Italia (ENSI), which was promoted by the CNRN and received funding from the International Bank for Reconstruction and Development (IBRD); the enterprise signed an agreement with General Electric to build a second enriched uranium reactor, moderated in this case with boiling water. Finally ENI, using its own financial resources, signed an agreement with NPPC in order to build a natural uranium reactor, graphite-moderated.[32]

The diversification of the nuclear industry was partly justified by the immaturity of the technology, given that it was impossible to know in advance which technological pattern the nuclear sector would have followed. However, this decision led to a scattering of resources and to an almost complete lack of synergies, with negative effects on the further developments of the field. Some protagonists have argued that this dispersion of resources was the outcome of a "feud" between the main actors of the Italian nuclear industry, who focused their efforts on gaining a favorable position in the case of a reorganization or nationalization of the industry.[33] The main responsibility for the development of the sector, though, was undoubtedly political.

The story of the Italian nuclear industry took place in a very unstable political environment, both nationally and internationally. In ENI's case, this uncertainty explains the choices – especially the technological ones – made by the public holding. If one considers the possible future developments of the sector, the agreement signed with NPPC was a rational choice, given that at the time Euratom was supporting research programs aimed

31 See internal report on different nuclear technologies written on the occasion of a Mattei's trip to Great Britain, May 1957, ASE, ENI, H.III.2, b. 35.

32 Paoloni, "Gli esordi del nucleare".

33 Mario Silvestri, *Il Costo della menzogna. Italia nucleare 1945-1968* (Torino: Einaudi, 1968); Colitti, *Energia e sviluppo in Italia*; Carlo D'Amicis and Mirella Fulvi, eds., *Conversando con Gino Martinoli* (Roma: Fondazione Adriano Olivetti, 1991); Curli, *Il progetto nucleare italiano*.

at evaluating the possibility of developing the gas/graphite technology.[34] However, the plan Martinoli drafted for AGIP Nucleare did not focus only on the use of this technology. In the same months in which it tried to reach an agreement with the British nuclear authorities, ENI tried to sign a similar cooperation agreement with the US firm Babcock & Wilcox. Its aim was to build a second nuclear reactor moderated with pressurized water, in compliance with the directives received in 1956 by the Committee of Ministers for employment and income.[35] The decision to focus only on British technology came later, between 1957 and 1958, and it was not the result – as some scholars have argued – of Mattei's hostility toward the United States, but rather of domestic and international political pressures.

Some telegrams sent by the US embassy in Rome to the State Department in May 1957 leave little doubt about the nature of these pressures. Two days after the resignation of Segni's government – the one that assigned IRI and ENI the task of building two nuclear power plants, one in the Northern and one in Southern Italy –, Ambassador James David Zellerbach informed the State Department that even before the government crisis, "efforts [had] been made [by Italian officials]: a) to convince Mattei that AGIP Nucleare [had] no business in the electric power field but should [have confined] activities to search for uranium, b) should Mattei and supporters [have insisted] on entering the power field to try to convince them to buy Calder-Hall type plants [the British nuclear power plant type]". Therefore, in 1957 there were several national interests that were putting pressure so that ENI would not have entered the nuclear sector or, at least, that it would not have entered it thanks to an agreement with the United States. The telegram stated that, "foreign and career officers and other interested ministers [believed] SEN [AGIP Nucleare's competitor, controlled by IRI and private enterprises] [was] the logical group to represent the State in this field". As a matter of fact "knowledge that AGIP-Nucleare could not [have obtained] a world bank loan [figured] heavily among the reasons for favoring SEN".[36] International ostracism against ENI undoubtedly favored IRI and private enterprises: just ten days later, Zellerbach confirmed that "both the foreign office and CNRN [were] opposing AGIP entrance (Mattei) in the nuclear energy field and the earlier report of SEN to the Babcock Wilcox project was the first step in this campaign".[37] The new government (May 19, 1957 – July 1, 1958),

34 See *Partecipazione dell'Euratom a reattori di potenza*, May 2, 1961, ASE, ENI, I.V.4, b. 280.

35 See *Osservazioni sul programma di sviluppo dell'energia nucleare*, Roma, March 8, 1957, ASE, ENI, H.III.5, b. 84.

36 See telegram by James David Zellerbach to State Department, May 17, 1957, National Archives and Records Administration, Washington, DC (hereafter NARA), General Records of the Department of State, Central Decimal File 1955-1959, b. 2541, f. 611.6597/1-3157, d. 611.6597/5-1757.

37 See telegram by James David Zellerbach to State Department, May 27, 1957, NARA, General Records of the Department of State, Central Decimal File 1955-1959, b. 2541, f. 611.6597/1-3157, d. 611.6597/5-1757.

largely controlled by the DC and placed under the direction of Adone Zoli, along with the CNRN, took advantage of the possibility of accessing international funding, and granted precedence to SEN in signing an agreement with a US corporation.

The strategy pursued by the US government is clearly explained in a third telegram that Zellerbach sent to the State Department two days later, while Mattei was in London to negotiate a deal with the British nuclear agency. Zellerbach hoped that Mattei's trip would be successful because: "1) Mattei would thereby [have removed] himself from contention over concrete US projects and thereby [have] immensely [simplified] the task of getting on with these projects, and 2) there was a reason to believe that [the Italian government] would [not have approved] 'any time soon' another ENI loan of magnitude necessary to finance the Calder-Hall project in which event Mattei would [have been] out on atomic power business where he belonged".[38] Therefore, after supporting the agreement between Edison and Westinghouse with the aim of limiting public intervention in the electric sector, the US government also supported the agreement that led to the ENSI project. This included IRI, but not ENI, and could be considered part of a well-established tradition of international aid granted by the IBRD to Southern Italy.[39] By doing so, the US government achieved several aims: it helped private electric enterprises, it offered its support to the development policies Italian governments had been promoting since the approval of the Vanoni Plan,[40] and it excluded ENI. For the Italian public holding, opting for British technology became the only feasible alternative.

The reasons behind the US government's hostility to ENI went beyond competition in the nuclear sector. However, the US strategy would have been less successful if the Italian government had had a clearer policy for the development of a national nuclear industry, as it had done in the oil field, where ENI was able to gain more leeway.[41] In this context, Mattei was forced to follow multiple strategies: a few months after the aforementioned political skirmishes, and after Zoli's government resigned and was substituted by Fanfani's second government, ENI's President came close to becoming chairman of the new Ente unico per l'energia. The crisis of Fanfani's government a few months later led to a temporary dismissal of the plans to reorganize the electric industry. In this context, it was clear that the plan promoted by Martinoli for AGIP Nucleare would be

38 See telegram from James David Zellerbach to State Department, May 29, 1957, NARA, General Records of the Department of State, Central Decimal File 1955-1959, b. 2541, f. 611.6597/1-3157, d. 611.6597/5-1757.

39 Leandra D'Antone, "Straordinarietà e stato ordinario", in *Storia del capitalismo italiano dal dopoguerra ad oggi*, ed. Fabrizio Barca (Roma: Donzelli, 1997), 579-625.

40 Barbara Curli, "Energia nucleare per il Mezzogiorno. L'Italia e la Banca Mondiale (1955-1959)", *Studi Storici* 37, no. 1 (1996): 317-51.

41 Pozzi, *Dai gatti selvaggi*, 307-458; Lavista, *Analisi economica*, see fourth chapter.

of little interest for Mattei, while oil would continue to be ENI's core business. This was a field that started registering a rapid increase in investments, just as ENI was entering into the nuclear sector. As a result, the company became unwilling to immobilize huge financial resources in the nuclear field.

ENI's growing indebtedness (see Figure 1) explains its progressive disengagement from nuclear energy, starting in 1959. The process began with the firing of Martinoli and the resizing of his development plan; it was followed by a suit against NPPC, aimed at reducing the cost of the Latina nuclear power plant, which had already started to be built; and by the attempt to sell the plant to IRI, even before the government made a decision on the nationalization of the energy sector.[42]

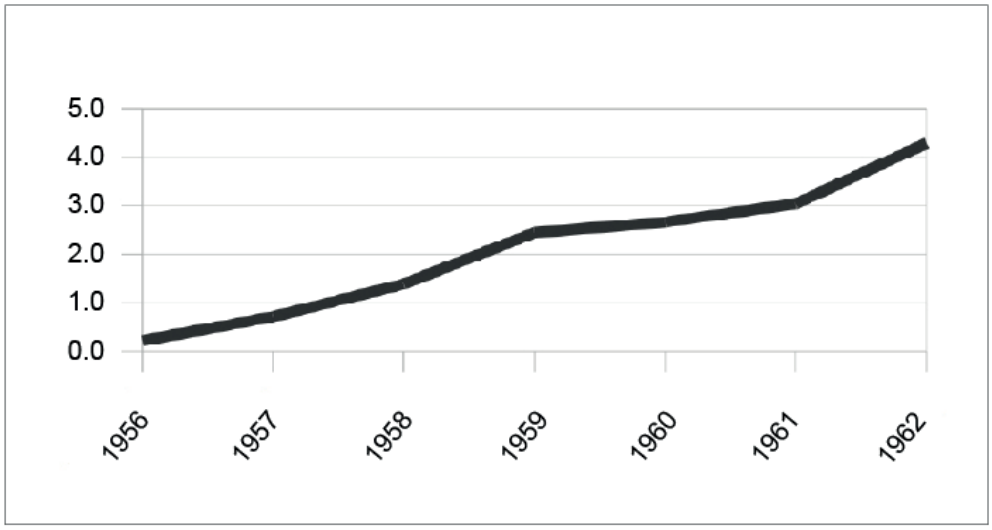

Figure 1: ENI's debt to net worth ratio, 1956-1962. Source: ENI's financial statements, various years.

Conclusion

Despite ENI's success in the building of the Latina nuclear power plant (in 1963 it was the first active plant in Italy), it soon became evident that the nuclear field could not become a priority for this public group. Given the political context described above, even other protagonists of the nuclear industry found it difficult to develop their policies.

42 Elli, *Atomi per l'Italia*, 75-95.

The turbulent international context, coupled with political uncertainty at a national level, deeply influenced the decision processes of both public and private enterprises. On the one hand, international forms of pressure affected their decisions concerning international partnerships and this, in turn, had important consequences on the technological evolution of the sector. On the other hand, uncertainty negatively influenced companies' levels of investment. Given that the Italian government did not offer any reassurance about its support for nuclear programs, enterprises active in the energy industry limited their efforts in the nuclear field. Even the Ente Nazionale per l'Energia Elettrica (ENEL), the energy agency created in 1962 with the nationalization of the energy sector, limited its investments in the nuclear field and decided to focus its efforts on managing the investments made by other firms during the 1950s.

Considering these developments, we can conclude that the evolution of the Italian nuclear sector during the 1950s confirms two initial assumptions: the success of public intervention rests on the ability to overcome not only market, but also political, uncertainties; this ability is one of the most important prerequisites for technological development.

Barbara Curli

Italy, Euratom and Early Research on Controlled Thermonuclear Fusion (1957-1962)*

ITER, the international controlled thermonuclear fusion project, is the world's largest fusion experiment and the most important European research project, apparently "one of the largest and most expensive science projects ever",[1] and also a very controversial one. The European Union (with Switzerland) participates for around 46 per cent of total costs and the other six partners (Japan, China, Korea, the Russian federation, India and the United States) for around 9 per cent each. The ITER device, "approximately three times as heavy as the Eiffel Tower", is a tokamak currently under construction at Cadarache, in the South of France.[2] Italian research and Italian industry extensively participate in the ITER project,[3] which is also intended as an industrial policy tool to support research and development in advanced technology on a European scale.[4] The

* Although this research is at a very preliminary stage, I wish to thank the people and institutions that greatly contributed to its beginning: Aldo Pizzuto, Head of Unità tecnica fusione of ENEA, Centro Ricerche di Frascati, and his associates, Vincenzo Vitale and Giulia Bartolomei, for their collaboration and warm hospitality in Frascati; Gianni Battimelli, for his friendly guidance in the Archives of the Department of Physics of "La Sapienza" University, Rome; Franca Magistrelli, Carlo Bernardini and Romano Toschi for their helpful insights into the early phases of the Frascati project; Odile Frossard and Sophie Delmas at the Archives historiques du Commissariat à l'énergie atomique, Fontenay-aux-Roses, France; and John Krige for kindly sharing his unpublished work on nuclear fusion.

1 W. Patrick McCray, "'Globalization with Hardware': ITER's Fusion of Technology, Policy, and Politics", *History and Technology* 26, no. 4 (December 2010): 283-312.

2 Fusion for Energy, *Annual Report 2014*, http://www.fusionforenergy.europa.eu/mediacorner/annualreport.aspx, last accessed April 19, 2016.

3 Aldo Pizzuto, "La partecipazione italiana al programma internazionale per la fusione", *Italian ITER Business Forum*, Milan, June 26, 2014, http://www.iibf2014.enea.it/, last accessed April 19, 2016; Paolo Acunzo, "La partecipazione delle industrie italiane al progetto ITER/Fusion for Energy", paper presented at the conference *ITER: un'opportunità per le aziende piemontesi*, Turin, November 16, 2015**,** http://www.confindustria.piemonte.it/convegni-ed-eventi/2444-iter-un-opportunita-per-le-aziende-piemontesi-torino-16-novembre-2015, last accessed April 19, 2016.

4 European Commission, Directorate general for Research, Fusion Energy Research, *Fusion and Industry together for the Future* (Luxembourg: Office for Official Publications of the European Communities, 2009).

Frascati Tokamak Upgrade (FTU), one of the seven tokamaks currently operating in Europe, which developed from a first generation prototype, the Frascati Tokamak (FT), set in operation in 1977, is located in the Frascati National Laboratories of the Comitato Nazionale per la ricerca e lo sviluppo dell'Energia Nucleare e delle Energie Alternative (ENEA), the national agency for new technology and energy. Italian industry (e.g. Ansaldo) also has a long tradition of presence in nuclear fusion and industrial application.[5]

Both European collaboration in controlled thermonuclear fusion research and Italian involvement in this field have in fact a long history, which goes back to the early days of the European Community, but has been underexplored so far. This chapter is intended as a preliminary contribution to the historical reconstruction of the early steps of European cooperation in nuclear fusion, with particular emphasis on Italian participation.[6] This chapter is part of a larger research project on the history of European research in nuclear fusion: here, we will limit ourselves to outlining the historical background leading to the first association contract between Euratom and the Comitato Nazionale per le Ricerche Nucleari (CNRN), then Comitato Nazionale per l'Energia Nucleare (CNEN), to support the early Italian effort in the field.

The History of Controlled Thermonuclear Fusion: Some Methodological Remarks

Historiography on fusion is still scarce, and mainly concerns the American case.[7] Limited access to archives, on nuclear energy in general, and on nuclear fusion in particular, partly explains the difficulties to be encountered in any scholarly reconstruction of fusion history. Most available literature deals with fusion either in the framework of future energy prospects,[8] or is limited to popular science books,[9] even to futurology.[10]

5 ENEA, *1960-2010: 50 anni di ricerca sulla fusione in Italia*, ed. Paola Batistoni (Frascati: ENEA-Edizioni Scientifiche, 2010).

6 We adopt here "fusion" as a simplified term for "controlled thermonuclear fusion", which would be the correct expression.

7 Joan Lisa Bromberg, *Fusion: Science, Politics, and the Invention of a New Energy Source* (Cambridge, MA: MIT Press, 1982).

8 *Fusion*, ch. 12, in Richard Muller, *Energy for Future Presidents: The Science behind the Headlines* (London: Norton, 2012), 199-218.

9 Garry McCracken and Peter E. Stott, *Fusion: The Energy of the Universe* (Oxford: Elsevier, 2005, 2nd ed. 2013); Charles Seife, *Sun in a Bottle: The Strange History of Fusion and the Science of Wishful Thinking* (New York: Viking, 2008); Robin Herman, *Fusion: The Search for Endless Energy* (Cambridge: Cambridge University Press, 1990).

10 Michio Kaku, *Physics of the Future: How Science Will Shape Human Destiny and Our Daily Lives by the Year 2100* (New York: Doubleday, 2011).

A series of books written by experts and protagonists are rich and informative, though they rarely escape some rhetorical, even lyrical, tone, related to the symbolic nature of fusion energy.[11] Apart from obvious questions arising from current events (the ITER project), which in themselves would indeed justify intellectual curiosity on the historical background of European fusion, there are several additional reasons for a historical research on the subject.

The first concerns the specificity of the European experience. Research on thermonuclear fusion had military origins (fusion being the principle on which the H bomb is based) and early ideas developed in American and British laboratories during and immediately after World War II. Research was then boosted in the early 1950s as a consequence of the announcement of the first Soviet atomic bomb in 1949, soon setting up a competition between the United States, the United Kingdom and the Soviet Union on which one would be the first nation to achieve nuclear fusion.

In Europe, where no single country would be able to carry out alone an effort in the field, research on nuclear fusion developed from the very beginning in the Community framework of Euratom. All national research evolved under Euratom's heading: in this respect, nuclear fusion is probably the only example of a truly "common" European policy and of a sector almost completely *euratomisé*, to use Jules Guéron's expression. This does not mean that there are no national programs. The Europeanization of techno-scientific research is not to be seen in contrast to national interests, but rather as also the pursuit "of one's interest by other means", that is, by Europeanizing all or part of national efforts.[12]

The history of fusion may indeed contribute to improve our understanding of Euratom's historical experience: usually (though undeservedly) portrayed as a "failure" in the history of European integration – especially if compared to its more successful Rome twin, the European Economic Community (EEC) – Euratom is in fact a still relatively underexplored subject, in particular with regard to the ways its activities were redefined as a consequence of the merger of the executives in 1967.[13] To write a history of fusion is

11 T. Kenneth Fowler, *The Fusion Quest* (Baltimore: Johns Hopkins University Press, 1997); Paul-Henri Rebut, *L'énergie des étoiles. La fusion nucléaire contrôlée* (Paris: Odile Jacob, 1999); Paul Reuss, *L'épopée de l'énergie nucléaire. Une histoire scientifique et industrielle* (Paris: EDP Sciences, 2007); Guy Laval, *L'énergie bleue. Histoire de la fusion nucléaire* (Paris: Odile Jacob, 2007).

12 John Krige, "The Politics of European Scientific Cooperation", in *Companion to Science in the Twentieth Century*, ed. John Krige and Dominique Pestre (1997, Amsterdam-Abingdon: Routledge, 2003), 897-919, quote 900.

13 Olivier Pirotte, *Trente ans d'expérience Euratom. La naissance d'une Europe nucléaire* (Bruxelles: Bruylant, 1988); Michel Dumoulin, Pierre Guillen, and Maurice Vaïsse, sous la direction de, *L'énergie nucléaire en Europe. Des origines à Euratom. Actes des journées d'études de Louvain-la-Neuve, des 18 et 19 novembre 1991* (Berne: Peter Lang, 1994); Gunnar Skogmar, *The United States and the Nuclear Dimension of European Integration* (Houndmills, Basingstoke, Hampshire-New York: Palgrave Macmillan, 2004).

thus to also write a history of the ways Euratom has been transformed overtime, and to look at the political, economic, and cultural dynamics underlying the "Europeanization" of scientific and technological collaboration.[14] As John Krige wrote, Euratom represented a new level of the postwar relationship between the state and *big science* in Western Europe, and its history depicts "the emergence of a new structure and a potent source of funding and of legitimation for expensive fields of scientific research and technical development". Krige lists nuclear fusion (referring to JET, the Joint European Torus) among the seven main fields of techno-scientific cooperation "to be situated at the heart of the process of European economic and political integration".[15]

Euratom's experience in controlled thermonuclear fusion should however also be assessed within the larger context of the role of *big science* in postwar international institutionalism. Euratom is a regional framework, whose activity is constantly in relation to other multilateral institutions in charge of nuclear energy development and control. The fusion experience is thus another example of hybridization and intersection among multiple international institutional levels – European Organization for Nuclear Research (CERN), Organisation for European Economic Co-operation (OECE), International Atomic Energy Agency (IAEA) etc. – and is also related to the important role played by the international Geneva conferences on the pacific uses of atomic energy (in particular that of 1958), and in the specific case of fusion by the international conferences on Fusion and Plasma Theory. Although constantly interacting, however, each of these levels retains its own specificity, both politically and institutionally (as in the case of early cooperation between Euratom and CERN on nuclear fusion, as subsequently analyzed).

Fusion, moreover, played a peculiar role in the technological and scientific Cold War. Although a highly "politicized" sector, though unlikely to yield economic or strategic-military-industrial returns if not in the very long term, research on fusion turned out to be particularly suited to "science diplomacy" practices and to be used as a foreign policy tool across the iron curtain. This role was somehow eased by the undisputed Soviet leadership in the field. According to the Report released in 1966 by the US Atomic Energy Commission (USAEC) on the status of fusion research in the world, as far as manpower involved in the sector the Soviet Union "leads the world": "their effort is twice the US effort. In plasma theory the Soviets are preeminent and at this time their effort in theory is about four times the US effort. In number and variety of major experimental devices the Soviets also lead the world".[16] As will be seen in the next paragraph, starting from the

14 Luca Guzzetti, *A Brief History of European Union Research Policy* (Luxembourg: European Commission, Directorate-General XII Science, Research, Development, 1995).

15 Krige, "The Politics", 897.

16 USAEC, *AEC and Action Paper on Controlled Thermonuclear Research*, June 1966, III-32, http://fire.pppl.gov/US_AEC_Fusion_Policy_1966.pdf, last accessed April 19, 2016.

decision to declassify information announced by the major nuclear powers (the United States, the United Kingdom and the Soviet Union) at the II Geneva conference in 1958, fusion was indeed a scientific field always bearing a "symbolic" value of collaboration which at times helped to cross the rigid logic of the Cold War divide, thereby setting up a long tradition of Euro-Soviet-American cooperation lasting to some extent until today. There is therefore an evident political dimension in the history of fusion that may have affected in different ways decision-making on national and international projects and gone beyond purely scientific considerations.

As a matter of fact, when looking at the history of nuclear fusion one is struck by the continuous exchange among European, American and Soviet laboratories already in the late 1950s and onward. A further element of interest in studying nuclear fusion in a historical perspective is thus to trace the development of a truly transnational (even across the iron curtain) epistemic community of scientists, technicians, technocrats, managers, promoters of science and of techno-scientific policies. At the national level, given the relevant involvement of the state in financing and control, fusion soon appeared as yet another very politicized field of scientific research, subject to bureaucratic management and rivalries, while at the same time "wedded to an ethic of progress and excellence".[17] At the European level, fusion raises a number of additional methodological questions, e.g. whether it is possible to detect a specificity, that is, whether Euratom's regional institutional dimension might have contributed to some peculiar form of "identity" of the European fusion community. The historical experience of the fusion community is thus to be assessed as a contribution to both the social history of nuclear energy, and the history of European integration.[18]

Given the high cost of investment, fusion research developed as a typically public-financed sector, both at a national and at a European level. A study of European fusion history may thus help us to deepen our understanding of the political decision-making processes leading to the investment in research and development on a Community scale and of the rhetoric supporting the development of a 'European public hand' in strategic sectors. In particular, it may help to assess the role of an emerging "fonction publique européenne" in techno-scientific cooperation. In the case of fusion, for example, one should acknowledge the fundamental role played by Donato Palumbo (1921-2011),

17 Steven Goldberg, "Controlling Basic Science: The Case of Nuclear Fusion", *Georgetown Law Journal* 68 (1979-80): 683-725, see 700.

18 Edgar Grande and Anke Peschke, "Transnational Cooperation and Policy Networks in European Science Policy-Making", *Research Policy* 28 (1999): 43-61; Olof Hallonsten, "Continuity and Change in the Politics of European Scientific Collaboration", *Journal of Contemporary European Research* 8, no. 3 (2012): 300-19; Laurence Jourdain, *Recherche scientifique et construction européenne. Enjeux et usages nationaux d'une politique communautaire* (Paris: L'Harmattan, 1995).

an Italian physicist and "a fusion visionary",[19] who from 1958 was in charge of the European Fusion Programme and for many years was its head and key figure. He carried out with unanimously recognized competence and dedication the *contrats d'association*, a new formula whereby Euratom would finance, develop, coordinate and supervise national fusion programs. When Palumbo retired in 1986, 13 contracts were in operation. Both archival documentation and oral sources confirm the key coordinating and stimulating role played by Palumbo,[20] who would himself confess "my total dedication to the European Fusion Programme throughout my 28 years in Brussels".[21]

Finally, a study of fusion is a study of the role played historically by Italian research in the nuclear field and on Italy's position in European techno-scientific cooperation and integration. It provides a further viewpoint from which to explore the relationship between Italy and Euratom, and – more broadly – to assess the patterns of Italian techno-scientific modernization, and its limits.[22] It is also a contribution to a still relatively little known aspect in the history of relations between Italy and France in the nuclear field.

Euratom and the Origins of the European Research Programme on Controlled Thermonuclear Fusion

The possibility of producing energy using the fusion of the isotopes of hydrogen had been first discussed during the war by scientists engaged in the Manhattan Project, and pursued early on in the United Kingdom by George Thompson, professor of physics at the Imperial College in London, and Moses Blackman, who in 1946 produced the first classified patented scheme to confine a plasma using a "pinch effect". To their effort was added that of Peter Thonemann, an Australian physicist working in Oxford, and of James Tuck, a British physicist who participated in the Manhattan Project, and after the war would be called back to Los Alamos to join the team assembled by Edward Teller to launch the program for a hydrogen bomb. The UK Atomic Energy Authority (UKAEA), and the British top nuclear establishment, in particular Sir John Cockroft and Lord Cherwell, thus became convinced that a British program on nuclear fusion

19 Jean Jacquinot, "Donato Palumbo (1921-2011), a Fusion Visionary", *ITER Newsline* 201 (December 2001), http://www.iter.org/newsline/201/977, last accessed April 19, 2016.

20 Harry Bruhns, "In Ricordo di Donato Palumbo (1921-2011)", *Il Nuovo Saggiatore* http://static.sif.it/SIF/resources/public/files/ricordo/palumbo.pdf, last accessed April 19, 2016.

21 Donato Palumbo, "The Work of the European Commission in Promoting Fusion Research in Europe", *Plasma Physics and Controlled Fusion* 29 (1987): 1465-73.

22 Barbara Curli, "L'esperienza dell'Euratom e l'Italia. Storiografia e prospettive di ricerca", in *L'Italia nella costruzione europea. Un bilancio storico (1957-2007)*, ed. Pietro Craveri and Antonio Varsori (Milano: FrancoAngeli, 2009), 211-29.

was needed, as it was indeed launched in 1951, to be developed in the Culham and Harwell laboratories.[23]

The US program was officially launched in 1951 as a classified program, the so-called Sherwood Project, financed and supervised by the USAEC, and carried out in four laboratories: Princeton (directed by Lyman Spitzer Jr.); the Los Alamos Scientific Lab (LASL), directed by James L. Tuck; the Livermore branch of the University of California's Radiation Lab, directed by Herbert York and Richard F. Post; and the Thermonuclear Group of the Oak Ridge National Laboratory; in addition to research carried out in several US universities.[24] Generous funding by the USAEC, which in the mid-1960s provided 23 million dollars out of a total national fusion budget of 40 million dollars (Defense providing an additional 10 and NASA another 5),[25] was intended to support nuclear fusion research, "because of its potential social benefits, and of its close association with the hydrogen bomb project", and in order to maintain "American leadership in nuclear technologies to ensure that the nation had a sound platform in both civilian and military applications".[26] Research on nuclear fusion was thus from the very beginning characterized by the "intermingling of science and politics".[27]

By the mid-1950s, then, although still strictly classified, fusion research was very much at the forefront of the international nuclear discourse and of Cold War techno-scientific and prestige competition, and very well embodying the optimistic ideology of those "années folles"– as Bernard Goldschmidt defined them – of nuclear fervor.[28]

Moreover, the origin of the European Fusion Programme should be assessed in the framework of the international competition between the United States, the United Kingdom and the Soviet Union, and in view of the International Conference on the Peaceful Uses of Atomic Energy held in Geneva in September 1958, where important announcements about nuclear fusion were anticipated. Already in April 1956, during a visit to England by Nikita Khrushchev – the first visit to the West by a Soviet leader – the Soviet physicist Igor Kurchatov (the father of the Soviet atomic bomb, and, with Andrei Sacharov, of the Soviet H bomb), who was a member of Khrushchev's delega-

23 On the British program see also R. S. Pease, "The UK Fusion Programme", *Plasma Physics and Controlled Fusion* 29 (1987): 1439-47.

24 On the origins of the US controlled thermonuclear fusion program see Bromberg, *Fusion*; Stephen O. Dean, "Historical Perspective on the United States Fusion Program", paper presented at American Nuclear Society 16th Topical Meeting on the Technology of Fusion Energy, Madison, WI, September 14-16, 2004, http://fire.pppl.gov/Dean_US_fusion_TOFE_2004.pdf, last accessed April 19, 2016.

25 USAEC, *AEC and Action Paper.*

26 John Krige, "The First Twenty Years of Nuclear Fusion Research", unpublished manuscript.

27 Bromberg, *Fusion*, 2.

28 Bertrand Goldschmidt, *L'aventure atomique. Ses aspects politiques et techniques* (Paris: Fayard, 1962).

tion, gave a very open and in-depth speech at Harwell on questions related to fusion.[29] The speech anticipated the declassification of information related to fusion, which was announced by the United States, the United Kingdom and the Soviet Union at the 1958 Geneva conference. It was evident that such a decision was intended to use international scientific cooperation also as a foreign policy and détente tool.[30]

All these features contributed to the insertion of nuclear fusion among the priorities set by the Treaty establishing the European Atomic Energy Community (Euratom), signed on March 25, 1957. During the negotiations leading to the Treaty, fusion had already been defined "une tache de première urgence".[31] It was listed in Annexe I of the Treaty as a field of research to be carried out by the Commission according to article 4 of the Treaty. Under the heading *Physics applied to nuclear energy,* point e) foresaw "the study of fusion, with particular reference to the behaviour of an ionized plasma under the action of electromagnetic forces and to the thermodynamics of extremely high temperatures".

In order to outline the strategic actions of the new Community, on September 11, 1957 Euratom's Comité intérimaire entrusted a group of experts with the task of establishing a first research program. The group of experts met for the first time in Paris on December 3, 1957 (Amaldi and Felice Ippolito were the Italian members).[32] On that occasion a *Note* presented by the French Delegation was adopted as a basis for discussion. According to the *Note*, which had been prepared by the French Commissariat à l'énérgie atomique (CEA), "le mandat donné au groupe d'experts qui se réunit le 3 décembre 1957 est d'étudier les possibilités d'entreprendre certains travaux préparatoires à l'exécution du programme de recherches d'Euratom. Il semble que l'on puisse, dans ce cadre, examiner les questions suivantes, en vue de s'adresser à la future Commission les recommandations appropriées". Among the priorities listed by the *Note*, were high flux reactors, research prototypes, and nuclear fusion. The aim would be to outline a kind of inventory of activities under way in member countries at that time, in each of these three fields, while waiting for the operational start up of the joint research centre (JRC): "Les premiers travaux de ces groupes d'études devraient permettre de passer commande d'études à faire sous contrat que le Centre commun ne peut espérer faire

29 Igor V. Kurchatov, "The Possibility of Producing Thermonuclear Reactions in a Gaseous Discharge", speech given at Harwell, April 25, 1956, published in *Nucleonics*, June 1956, http://fire.pppl.gov/kurchatov_1956.pdf, last accessed April 19, 2016.

30 United Nations, *Peaceful Uses of Atomic Energy: Fifty Years of Magnetic Confinement Fusion Research, 1958-2008* (Vienna: IAEA, 2008).

31 Groupe de l'Euratom, Rapport du Groupe ad hoc, *Programme et Budget de Recherche*, 3 Janvier 1957, Archivio Edoardo Amaldi, archivio del Dipartimento di Fisica, Università "La Sapienza", Roma (hereafter AAm), sezione Dipartimento di Fisica (hereafter SADF), 175, 2, 1.

32 On Amaldi and Ippolito see forward.

lui-même avant un certain temps". The reason for the insertion of fusion among these priorities was mainly political: according to the French *Note*, "Il convient de se hâter sur les travaux sur la fusion car Américains, Anglais et Russes ont annoncé que ce sera un des principaux sujets de la Conférence de Genève".[33]

Declassification then opened up a new phase in fusion research history and favored the start of the European program within the Euratom framework. No single European country at the time was able to carry out an exclusively national effort, thus there was no competition between a national and a European program, nor questions related to industrial applications (as in the case of fission); and a common program would allow to relieve the costs of research that no single member country would be able to bear individually, in particular in a field still at a very preliminary stage and with very long-term expected experimental results. Fusion seemed thus an ideal field of European co-operation, and one that would strengthen Europe's techno-scientific "identity", rooted in the golden age of faith in the capability of science and technology to orient unlimited progress and social change.[34]

The Group of Experts' Report accepted almost entirely the content of the French *Note* and proposed that the Commission adopted the three above-mentioned fields (high flux reactors, research prototypes, and nuclear fusion), as the first programs to be pursued by Euratom, in addition to the establishment of the JRC. In relation to fusion, the Report underlined:

> la fusion nucléaire constitue le type même de recherche à long terme où un travail en commun est particulièrement souhaitable. Les experts ont été unanymes à reconnaître l'urgence d'une action commune dans ce domaine ou anglo-saxons et russes ont consenti d'importants investissements et semblent attendre des résultats positifs. Les travaux de ce troisième Groupe devraient permettre de confier des contrats de recherche à des laboratoires, publics ou privés, sans attendre la constitution du Centre.[35]

33 *Note de la Délégation française sur les activités de recherche d'Euratom*, Paris le 28 novembre 1957, Archives historiques du Commissariat à l'Energie Atomique, Fontenay-aux-Roses, France (hereafter AHCEA), Archives du Haut-Commissaire à l'énergie atomique (hereafter HC), F5.17.11.

34 On these cultural, discursive features of Euratom's early history, see Barbara Curli, "Nuclear Europe: Technoscientific Modernity and European Integration in the Discourse on Euratom", in *Discourses and Counter-Discourses on Europe: From the Enlightenment to the European Union*, ed. Manuela Ceretta and Barbara Curli (London: Routledge, 2016, forthcoming).

35 Comité intérimaire pour le Marché commun et l'Euratom, *Rapport du Groupe de la Recherche nucléaire*, 4 décembre 1957, AHCEA, HC, F5.17.11.

The Euratom-CERN Joint Work Study Group, 1958-1959

Almost simultaneously, an attempt was made to establish a Euratom-CERN Joint Work Study Group for Fusion Research. The initiative apparently came from François De Rose, the man responsible for Atomic questions at the Quai d'Orsay, who had been the French representative at the IAEA and just appointed (1958) President of the CERN Council. De Rose had approached the President of the Euratom Commission Louis Armand and the director of Research and Education Jules Guéron, again in view of the Geneva conference.[36] On May 31, 1958 a first meeting between Guéron, Cornelis J. Bakker, the director-general of CERN, and John B. Adams, director of the protosynchroton division of CERN, laid the following terms of reference for the agenda of the Joint Study Group:

> to note and evaluate plasma physics research programmes aimed at fusion at present being conducted or planned in Europe and in other countries; to consider and make suggestions for coordinated European fusion programmes; to consider and make suggestions of the means by which such programmes could be carried out either by existing national research centres or by the creation of a European centre; to consider and estimate other research programmes that could be undertaken by small centres and university departments; to consider and make suggestions for the training of suitable staff for the above programmes in universities and other centres.[37]

During the meeting it was agreed that members of the Group "should be European scientists engaged in fusion research work who could be considered as experts in this field and whose advice is particularly valuable to the study group's work". The Italian scientists invited were Bruno Brunelli and Enrico Persico. Euratom would contribute two thirds of the estimated expenses, and CERN one third. Euratom's contribution would however not exceed 75,000 Sw. Frs for 1958.[38]

Participation in the Joint Study Group was inserted in Euratom's first Research Program laid down on June 19, 1958, as complementary to the strengthening of fusion research in national centers: "cependant, le sujet est si neuf que l'on doit aider plusieurs équipes, même petites et modestement outillées, et qu'il convient d'encourager des recherches annexes. Il y a donc lieu de prévoir, avant même la fin de l'étude CERN-Eurat-

36 Krige, "The First Twenty Years".

37 Euratom-CERN Joint Study for Fusion Research, *Minutes of Meeting held at CERN to discuss the possibility of setting up a joint study group to consider European fusion research programmes*, June 2, 1958, AAm, SADF, 190, 1, 1.

38 Euratom-CERN Joint Study for Fusion Research, *Minutes of Meeting*, June 2, 1958, AAm, SADF.

om, d'assez important contrats avec un ou deux centres puissants, et de plus nombreux contrats d'études auxiliaires".[39]

This line was confirmed by Euratom's Technical and Scientific Committee, chaired by Amaldi, during a meeting when Francis Perrin, member of the Committee and Haut Commissaire of the French CEA, "souligne l'importance de la fusion contrôlée et les espoirs qu'elle suscite, mais insiste sur les difficultés techniques et économiques auxquelles on se heurte aujourd'hui. Il estime qu'il y a là un objectif intéressant, quoique lointain, pour lequel Euratom pourrait être chef de file".[40]

The joint Euratom-CERN project would soon, however, meet the opposition of some members of CERN that were not members of Euratom. In addition to Great Britain, which at the time was the most advanced European country in nuclear fusion, tied to the United States by a series of nuclear special relationship agreements, the project met the opposition of Switzerland and Sweden, two neutral countries particularly sensitive to questions which might worry public opinion. Nuclear fusion could be related in the public mind to the H bomb and this raised also worries about the image of CERN, especially in that early start-up phase. CERN explicitly excluded any research which could bear any commercial or military return. Some members of CERN thus resented the project "as an unacceptable redefinition of CERN's identity".[41]

Finally, in June 1958 the CERN Council rejected the proposal of a joint CERN-Euratom study group. The failure of this initiative showed the difficulties in combining the efforts of two very different organizations with respect to membership, aims and structures.

At the same June 1958 meeting, the Council of CERN decided instead to set up its own Study Group to which representatives from European and other countries working in the field should be invited, and whose task would be to evaluate the research programs at present in progress or in preparation.[42]

In July 1958 Bakker informed Guéron that

> unfortunately, the objections to our joint proposal raised by some of our CERN Member States, who are not members of Euratom, were still maintained. The Council noted with appreciation the offer of Euratom to co-operate in an evaluation of plasma physics research programmes, but finally decided that, for the time being, CERN should conduct its own study. However, CERN proposes to invite

39 Euratom, la Commission, Division Recherche n° 95, *Programme de recherches*, Bruxelles, 19 juin 1958, AAm, SADF, 190, 1, 1.

40 Euratom, la Commission, Comité scientifique et technique, *Projet de compte-rendu de la réunion du 7 juillet 1958*, Bruxelles, 18 juillet 1958, AAm, SADF, 190, 1, 1.

41 Krige, "The First Twenty Years", 30.

42 European Organisation for Nuclear Research, *Annual Report 1958* (Geneva: CERN, 1959).

> Euratom and other organizations which might show an interest in the matter to send observers to the study group.[43]

The CERN Study Group held three meetings. In the letter of invitation to Persico to join the Group, Adams explained that the purpose of the first meeting was "to establish a list of the research programmes in the USA, USSR and Europe, the state of the work and the results obtained".[44] All European laboratories working in the field of fusion research, as well as CERN, Euratom and the OECE, were asked to send representatives.

The first meeting was held on September 25-26, 1958, shortly after the Atoms for Peace conference in Geneva. Nearly all the members of the Study Group had taken part themselves in the conference, and the meeting was devoted to "trying to assimilate the information released" at the conference.[45]

During the second meeting on December 11-12, 1958 various papers and reports were discussed, on specific research and experiments carried out in the members' laboratories, and a comparison was made with the work being undertaken in the United States and the Soviet Union. "The Study Group, having this time more or less assimilated the vast amount of published literature in the field of fusion research and having reviewed, in the light of this knowledge, their own fusion programmes" were able to begin to discuss the general problem of fusion work in Europe.

The aim of the third meeting, held on March 5 and 6, 1959, was to prepare a final report to be submitted to the CERN Council and to "define the nature of the work to be done in the near future". According to the report,

> the fundamental physics, on which all devices and projects depend, has proved to be much more intractable than was originally estimated. It is therefore clear that the major task before anyone in fusion work in the near future is to accelerate the understanding of the physics of plasma. However, such a conclusion does not imply that large scale experimental work should be abandoned, nor does it mean a slowing down of fusion activities. A properly balanced programme must allow for the study of fusion problems, theoretical, experimental and technological, on as broad a front as is economically possible …. A European fusion programme should aim at encouraging this diverse activity at all levels and by whatever means that are appropriate.

---

43 Letter by Cornelis J. Bakker, Director-General of CERN to Jules Guéron, July 3, 1958, AAm, SADF, 175, 2, 2.

44 Letter by John B. Adams to Enrico Persico, "CERN Study Group on Fusion Problems", July 31, 1958, Archivio Enrico Persico, Dipartimento di Fisica, Università "La Sapienza", Roma (hereafter AEP), 16/73.

45 An account of the three meetings is in the Final Report, see *European Fusion Research: Report of the CERN Study Group on Fusion Problems*, 2nd draft, March 24, 1959, AEP, 16/73, from where subsequent quotes are taken.

A comparison was then made between the European effort (the largest laboratories in Britain, France and Germany) and the US effort in terms of scientific staff (210 versus 288) and operating costs (6.7 million dollars versus 28.7). Although the number of staff was comparable, costs were "but a small fraction of those of the USA".

However, the report continued, "the staffing problem in fusion research is not fundamentally different from the problem of finding staff for the other branches of physics. There is undoubtedly a serious shortage of physicists in Europe, and plasma physics and fusion research can only take a fraction of these people". Education and training should be supported in European universities, and the "exchange of staff working on fusion problems between the various laboratories" encouraged. "Now that there are no longer any questions of security or classification in fusion work, the problem is only one of arranging that European staff can move freely between the laboratories", as it was "already an established tradition" in several laboratories and "an accepted way of life in high energy physics".

The study group also considered the possibility of establishing a "European" laboratory for fusion problems, not meant to replace the national laboratories, but "in addition to those already existing". The several pros and cons were weighed and it was concluded that for the time being, "unless it can be demonstrated that a European laboratory is needed in order to build larger facilities than can be built by national groups, the many other advantages of such a centre may prove insufficient to overcome the difficulties in its creation and maintenance". The matter was therefore left for a later review.

Euratom, however, was playing a new role in the European research scenario, and its relation to CERN needed to be assessed,

> The part being played by Euratom in the fusion work was discussed by the Study Group. Euratom represents six of the twelve member states of CERN and unfortunately does not contain the most currently active member state in the work of fusion, namely Britain. The policy of Euratom on fusion is to encourage the growth of large centres in its member states by placing contracts for fusion work. … Their general policy, therefore, is to concentrate the fusion work in order to counteract the dispersion tendency.

The system was similar to the American one. However, whereas in the United States the AEC formed "a backbone to the whole venture", in Europe this raised the question of supervising fusion activities, as there was "no such common organization although the large national centers can be compared with the AEC laboratories in the States".

The Report of the Study Group was presented at the thirteenth session of the CERN Council in May 1959. It recommended against the establishment of a common European fusion research laboratory, but proposed the continuation of a loose association for

information and the exchange of ideas. The CERN Council approved this report and agreed that CERN for the time being should sponsor the Study Group until the end of the year, a period which was subsequently extended at the December session until the end of 1960.[46] The Group, under the continuous stimulus of Adams, would continue to hold scientific meetings until 1964 in several places and laboratories, widely attended by the European fusion community of the time.

The Euratom-CEA Association Contract

In September 1958, probably also as a consequence of the failure of the joint CERN-Euratom undertaking, the Euratom Commission put Palumbo in charge of the launching of a Community fusion program. Palumbo was well aware of the difficulties that a common fusion facility would raise (as it had been discussed on a more general European level during the CERN meetings), even if established in the new JRC in the process of being instituted. Rather, as anticipated also by Euratom's Scientific and Technical Committee, it was thought preferable to set up a network of contracts of association between Euratom and the national centers that were dealing with fusion research: the Community would coordinate and supervise the financial and scientific effort in the field. As Palumbo himself later recollected, "we should try to provoke collaboration within the six Member States, based on mutual confidence and co-responsibility", "In the course of this, I encountered some considerable difficulties and even hostility, not only from within the Commission but also from some of the potential partners. However, a Coherent European Fusion Programme was finally constituted".[47]

The new network of contracts of association would constitute the framework within which all fusion research in Europe would be developed, and would remain so for many years. The structure was partly modeled on that of the Sherwood Project, where the Sherwood Committee financed and coordinated research in American fusion laboratories.[48]

On December 23, 1959 the Commission met the representatives of the national nuclear authorities of the member states, with Palumbo and Guéron, in order to set the priorities of the new Community and outline the first five-year plan. During the meet-

46 European Organisation for Nuclear Research, *Annual Report 1959* (Geneva: CERN, 1960).
47 Palumbo, "The Work".
48 Bromberg, *Fusion*.

ing the importance of fusion was restated, and the first association contract on nuclear fusion signed with the French CEA was announced.[49]

The contract was located in Fontenay-aux-Roses (FAR) and was managed by a Comité de gestion (CdG), that met every three months and was made up of two representatives of Euratom (Palumbo and Ellerkmann, while Guéron attended the first meetings); two representatives of the CEA (Jacques Yvon, director of the Physique et Piles atomiques section of the CEA, and Jean-Pierre Goure), and Georges Vendryes, chief of the Département de Recherche Physique of the CEA, who was named chief of the Groupe de recherche of the association.[50] The chairman of the CdG was alternatively (on a yearly basis) either Palumbo or Yvon. The initial budget (350 million [old] francs) was 75 per cent at Euratom's expense and 25 per cent CEA. In 1959 there were 61 personnel involved in the contract (including 2 women); in 1961 the number had already increased to 150, one third of whom were Euratom employees.

Early activities were mainly devoted to an exchange of researchers with other laboratories, in particular in the United States and in the United Kingdom. Furthermore, in 1959, during the first negotiations for British entry in the Community, the United Kingdom-Euratom agreement was signed, which foresaw cooperation in nuclear fusion.[51] Fusion soon became an important part of the CEA activities at FAR, and very quickly developed to the extent that a complete reorganization was carried out in 1962, also involving a change in the terms of the contract with Euratom (participation became Euratom 54 per cent, CEA 46 per cent). The Service de phisique of the CEA Centre of Saclay was also included in the contract, with regard to studies on plasma behavior that could be related to controlled fusion.[52] In 1962 there were 127 personnel (including 6 women) – 84 from CEA and 43 from Euratom.

49 Commission Euratom, *Compte rendu sommaire de la réunion du 15 décembre 1959 à Val Duchesse*, AHCEA, HC, F5.17.11. Italy was represented by Ippolito, Forcella and Naschi of CNEN, France by Perrin, Goldschmidt and Yvon of the Cea; for Germany Wolfgang Filkelnburg and Dietmar Fuchs.

50 The Groupe de recherche included a Service de recherches sur la fusion, whose Chef de Service was Hubert and his alternate Prévot. Hubert would then become director at the Direction Recherche et Enseignement of Euratom. On this early French fusion community see Anatole Abragam, *De la physique avant toute chose* (Paris: Odile Jacob, 1987).

51 Mauro Elli, *Politica estera ed ingegneria nucleare. I rapporti del Regno Unito con l'Euratom (1957-1963)* (Milano: Unicopli Editore, 2007).

52 On fusion research carried out by the CEA in those early years see M. Trocheris, "Controlled Thermonuclear Fusion Research Conducted by the French Commissariat à l'energie atomique", in *Peaceful Uses of Atomic Energy*. Proceedings of the fourth international conference, United Nations-IAEA, Geneva, September 6-16, 1971, vol. 7; Trocheris, "The History and Future of the French Fusion Programme", *Plasma Physics and Controlled Fusion* 29 (1987): 1425-27.

The Laboratorio Gas Ionizzati and Early Italian Research on Nuclear Fusion

The launching of research on fusion in Italy can be dated back to May 1957 when Persico, professor in the Department of Physics of the University of Rome and one of Enrico Fermi's "ragazzi di via Panisperna", created a research group on ionized gasses bringing together some researchers (Bruno Brunelli, Franca Magistrelli, Alberto De Angelis) already active in research on sources of radio frequency ions at the Istituto di Fisica superiore. In June 1957, Persico and Amaldi[53] attended the international congress on ionized gasses in Venice, where they exchanged views and information on plasma and high temperature production. Immediately after the congress, and again in September 1957, Bruno Brunelli visited several laboratories abroad (namely, the Imperial College in London, Saclay, CERN, Amsterdam, the Clarendon Laboratory in Oxford, and Aachen),[54] while Persico and Amaldi were making contacts with eminent scientists in the field of fusion research. They organized exchanges and seminars in Rome, inviting, among others, Franco Rasetti, who was in the United States at Johns Hopkins University, and came to Rome in 1959 for a series of seminars on plasma spectroscopy; and George Linhart, from CERN, who gave a series of seminars on plasma physics, then edited by Franca Magistrelli and Ugo Ascoli. On September 20, 1957 Ippolito, Secretary General of CNRN, asked for a first draft budget and anticipated an amount of 10 million lire to provide the group with a more institutional framework.[55]

On October 18, 1957 the formal decree was signed that established the Laboratorio Gas Ionizzati (LGI), which consisted of a theoretical and an experimental group.[56]

53 One the most distinguished Italian scientists, Edoardo Amaldi came from the group of "ragazzi di via Panisperna" led by Enrico Fermi. The main figure behind the reconstruction of postwar Italian physics, he was director of the Department of Physics in Rome, President from 1960 to 1965 of the Istituto Nazionale di Fisica Nucleare and member of the Board of CNRN, then CNEN. He served as chairman of Euratom's Scientific and Technical Committee and as secretary general of CERN from 1952 to 1955. On Amaldi, see Carlo Rubbia, *Edoardo Amaldi. Scientific Stateman* (Geneva: CERN, 1991), http://cds.cern.ch/record/228364/files/CERN-91-09.pdf, last accessed April 19, 2016; Fernando Ferroni, ed., *The Legacy of Edoardo Amaldi in Science and Society*, Atti del Convegno (Bologna: Società italiana di fisica, 2010); Lodovica Clavarino, *Scienza e politica nell'era nucleare. La scelta pacifista di Edoardo Amaldi* (Roma: Carocci, 2014).

54 Bruno Brunelli, *Relazione sulle visite ai laboratori stranieri di ricerca sui plasmi ad alta temperatura*, n.d., AEP, 15/72.

55 On this early phase see also Luisa Bonolis and Franca Magistrelli, "La nascita e gli sviluppi della ricerca sui plasma e sulla fusione nucleare in Italia", *Analysis* 3-4 (2010): 27-44; Bruno Brunelli, "The History and Future of the Italian Fusion Programme", *Plasma Physics and Controlled Fusion* 29 (1987): 1429-38, and on the general background of Italian research in physics at the time, Claudio Villi, *La fisica nucleare fondamentale in Italia* (Padova: Cleup, 1976).

56 CNRN, Laboratori Gas ionizzati, *Resoconti organizzativi e scientifici*, n.d. (but December 1957), AAm, SADF, 198, 1, 4. The group was composed of Persico and Amaldi as scientific supervisors, Brunelli, Magistrelli, Ascoli, De Angelis, Segre, and A. Bernardini (lab technician).

In January 1958 a preliminary five-year research plan was outlined, with an estimated budget of 550 million lire.[57]

In 1960 the LGI, under the direction of Brunelli, was moved to Frascati, where the Laboratori Nazionali had just been constructed in order to host the Electrosincrotron. In 1960 CNRN changed its name to Comitato Nazionale per l'Energia Nucleare (CNEN). Its active and dynamic Secretary-General Ippolito provided the necessary financial and "political" support for the LGI's early steps, as yet another tile in the framework of the Italian nuclear program, that was intended as a project of modernization of national scientific research and nuclear industrial application.[58] As Brunelli himself recalled, "fortunately, in those years we had Felice Ippolito, who very quickly met our demands".[59] The LGI was subsequently joined by John Allen, from Harwell, and George Linhart, Charles Maisonnier and Heinz Knopfel, from CERN.

The launching of the Italian fusion program was also embedded in the optimistic climate following the Geneva Conference of 1958, as seen above. A long Report by Felice Ippolito on the conclusions reached by the conference and on the Italian position is worth dwelling upon. Is also worth remembering that at the Geneva conference Italy presented a joint study with the World Bank – the Energia Nucleare Sud Italia (ENSI) Project – for the construction of a nuclear plant in Southern Italy, which would become the Garigliano nuclear power plant, and which put Italy in all the international media regarding nuclear developments.[60] The Italian participation, although limited, had given a qualified and "favorable impression", showing that Italy, "although a late-comer, intends to make up for lost time".[61] Although mainly devoted to the prospects of nuclear fission, the Conference had been dominated by the declassification of information on nuclear fusion:

> Noteworthy results have been reached in this field by the United States, England, and the USSR, and by some minor countries, like France. During the sessions the

57 CNRN, *Programma di ricerche sul plasma*, Com RF/04/58, January 1958, AAm, SADF, 198, 1, 4.

58 On the launching of the Italian nuclear project in the second half of the 1950s and the role of Felice Ippolito, see Barbara Curli, *Il progetto nucleare italiano, 1952-1964. Conversazioni con Felice Ippolito* (Soveria Mannelli: Rubbettino, 2000).

59 See the interviews with Bruno Brunelli and Sergio Segre in *Energia, ambiente, innovazione, dal Cnrn all'Enea*, ed. Giovanni Paoloni (Roma-Bari: Laterza, 1992), 246-47. In this same volume see also Claudio Cigognetti, "I laboratori nazionali di Frascati, 1957-1982", 209-18. On this early phase see also Fernando Amman and Romano Toschi, "I Laboratori Nazionali di Frascati del Comitato Nazionale Ricerche Nucleari", *Ingegneria nucleare* II, no. 4 (1959): 175-85.

60 On the Ensi Project see Barbara Curli, "Energia nucleare per il Mezzogiorno. L'Italia e la Banca Mondiale, 1955-1959", *Studi Storici* 37, no. 1 (1996): 317-51.

61 *Relazione preliminare sulla II Conferenza di Ginevra sugli usi pacifici dell'energia nucleare*, settembre 1958 (unsigned, but written from Geneva by Felice Ippolito), AAm, SADF, 160, 2, from where subsequent quotes are taken.

> programs that the major powers intended to pursue in this research field have been discussed, which was particularly useful for specialists in other countries in order to coordinate programs and avoid duplication and waste of manpower and means.

However, it was evident that "practical industrial applications [are] still very far ahead and even the first step, that is, to produce a controlled fusion in a laboratory, [is] far away". Great powers devoted "enormous means" to fusion, but "the most eminent scientists attending the Conference agreed that these studies are still at a 'university stage'". And this was probably the reason why the Russian delegates had been so "open" on the issue, but very tight on all other matters (nuclear plants, uranium and thorium supplies on Soviet territory, etc.).

The Association Contract CNEN-Euratom

The association contract between the LGI and Euratom (Contratto di ricerca Euratom-CNRN [then CNEN]-Laboratorio Gas Ionizzati) was signed in January 1960. It originated as a sub-contract of the CEA contract, until 1962, when the CEA withdrew and the Italian contract became independent. Documentation shows that the idea of associating the LGI to the French contract may have been first put forward by Brunelli, who in a letter to Persico wrote: "I have told Hubert and Palumbo about the sub-contract …. They suggested that we should advance a formal request, that will be read at the next Comité de gestion to be held in early September".[62] The issue was then followed up by Amaldi with Guéron in Brussels. Guéron guaranteed that Palumbo and Vendryes were taking care of it.[63]

The first meeting of the association was held in July 1960 in Rome at the Physics Department. The Comitato di gestione (CdG) of the Italian contract was constituted by Amaldi, President of the Istituto Nazionale di Fisica Nucleare, as representative of CNRN (that in August 1960 would become CNEN, where Amaldi was a member of the Board); Palumbo as representative of Euratom; and Brunelli, as chief of the Research Group. Until 1962 a representative of the CEA would take part in the meetings: it was alternatively Michel Trocheris, of the Service de Physique théorique and chief of the Controlled fusion Department at the CEA, and Vendryes.

Even after 1962, when the CEA withdrew from the association, either Trocheris or Vendryes continued to attend the meetings in Frascati, and Brunelli those at Fontenay-aux-Roses. At times Giovanni Naschi, director of the Segreteria tecnica of CNEN, and

62 Letter from Bruno Brunelli to Enrico Persico, August 24, 1959, AEP, 15/72.

63 Letter from Jules Guéron to Edoardo Amaldi, September 16, 1959, AEP, 7/20.

in charge of its financial management, was present at the meetings. In 1965 Amaldi left the CdG because of other obligations, and was substituted by Sebastiano Sciuti.[64]

The Guidelines (*Regolamento*) of the CdG were modeled on the French one. The financial effort of the Italian contract was distributed as follows: Euratom 60 per cent, CNEN 40 per cent, for a total amount of around 270 million lire for 1963.

The Group was made up of 57 people. The group's only woman, Franca Magistrelli, remembers those years as "the most intense and productive years of my professional life".[65] Brunelli recalls "the great enthusiasm" of that period.[66]

In this early phase, research in Frascati developed along two main directions: the so-called Program A (directed by John Allen, originally from Harwell, then in Frascati as Euratom's employee) on "Cariddi", the "Hot Ice" experiment, etc.; and Program B (directed by Linhart) on MIRAPI (MInimum RAdius PInch) and MAFIN (MAgnetic Field INtensification, whose implementation required the construction of the Colleferro bunker).

Great importance was attributed to training and education, as particularly endorsed by Amaldi, and to developing ties with the University of Rome and other Italian universities, e.g. through the creation of graduate fellowships. A new generation of fusion experts would develop through a continuous exchange with laboratories abroad, in Europe, the United States and the Soviet Union. New figures were created in the Euratom framework, such as the *stagiaire qualifié d'Euratom*, who was allowed to train in European laboratories. The CdG also dealt with the organization of meetings and conferences; decisions on papers to be submitted to international conferences, etc. By the mid 1960s, a European fusion community had been established, in particular thanks to Euratom's financial effort and Palumbo's coordinating role.

After the first two years of operation (the association contract was originally intended to last for two years and six months), a CNEN internal document made a first assessment of the status of research on fusion in Italy and of the relationship with Euratom. Euratom had appreciated the work carried out by LGI and had proposed not only the renewal of the association as from July 1, 1962, but also the strengthening of the program, for a total amount of 3 billion lire on a three year period, of which 40 per cent at the expense of CNEN.[67]

---

64 Reconstruction of the activity of the CdG is based on the Minutes of Meetings, in Archivi Enea Frascati, Contratto di ricerca Euratom-CNRN (Laboratorio Gas Ionizzati), poi Contratto di ricerca Euratom-CNEN (Laboratorio Gas Ionizzati), *Comitato di gestione, 1960-1968*.

65 On Franca Magistrellli, see "Franca Magistrelli", in *Maestri e allievi della fisica italiana nel Novecento*, ed. Luisa Bonolis (Pavia: Goliardica Pavese, 2008), 307-32, quote 318.

66 Brunelli, "The History", 1430.

67 CNEN, *Contratto di associazione CNEN-Euratom nel campo della fusione nucleare controllata*, GEN/24/62, ottobre 1962, AAm, SADF, 260.

Conclusion

The second phase of the association contract – that we are not dealing with here – would soon face a series of difficulties and shortcomings, related to the progressive bureaucratization of Euratom and its early "crisis", that would reflect itself in the drastic financial cut to the Community's second five-year plan, and to the crisis of the JRC at Ispra.[68] Cuts to the fusion program would be a direct consequence of these general changes (although they were less relevant than those affecting fission), before a wider reorientation of Euratom's activities took place as a consequence of the Merger of the executives in 1967. This would somehow affect all fusion programs in the various centers where association contracts were in operation – in addition to Fontenay-aux-Roses and Frascati, in the meantime Euratom had supported the launching of fusion programs in the German centers of Garching (the Max Planck Institut für Plasma Physik, where a contract had been signed with Euratom in 1961), and Jülich (in 1962); the Dutch centre of Fundamental Research on Matter (FOM, 1962) and the Belgian Ecole Royale Militaire in Brussels (1969).

Within this general framework, in the second half of the 1960s several difficulties would also affect national nuclear programs, including fusion programs, because of general economic and monetary troubles, the reconsideration of national fission programs (e.g. the French shift to light water reactors); and social and political unrest in 1968. In the Italian case, in particular, the crisis of the Frascati centre took place within the framework of the more general crisis of the Italian nuclear program, as a consequence of the "caso Ippolito" and the demise of CNEN;[69] and as a consequence of the events of 1968 and the resulting political and trade union unrest, which practically crippled activities in the Frascati Centre.[70]

This situation would soon require a re-launching of the European fusion program as a whole, which would only take place following the "tokamak revolution" announced at the Third Conference on Plasma Physics and Controlled Nuclear Fusion held at Novosibirsk in 1968, when Soviet scientists reported about the superiority of the toroidal configuration for magnetic confinement. A new phase of European fusion history would then be set into motion.

---

68 On the crisis of Euratom and the difficult launching pf the second five-year plan, see Felice Ippolito, *Un progetto incompiuto. La ricerca comune europea, 1958-1988* (Bari: Dedalo, 1989).

69 On the "caso Ippolito", Curli, *Il progetto nucleare*; Curli, "Il caso Ippolito", in *Scienziati d'Italia. 150 anni di ricerca e innovazione*, ed. Marco Cattaneo (Torino: Codice Edizioni, 2011), 83-100.

70 On this critical passage at the Frascati Centre, see Giovanni Battimelli, ed., *L'Istituto Nazionale di Fisica Nucleare. Storia di una comunità di ricerca* (Roma: Laterza, 2002).

Mauro Elli

Italy in the European Fusion Programme during the 1980s: A Preliminary Overview

Even a cursory look at the existing literature on the European Fusion Programme (EFP) identifies two main recurrent themes: the creation of the Joint European Torus (JET) as a joint undertaking, and the related leading role of the long-lasting Director of the Fusion Programme in Brussels, Italian physicist Donato Palumbo.[1] The main thrust of these writings consists in tracing the success of JET back to early attempts at setting up a European program in controlled thermonuclear fusion by "networking" several scientific activities in national laboratories and universities, with a view to coalescing them into a coherent ensemble. This approach puts a premium on the hardly surprising political squabbles between member-states over the siting of JET, while it leaves comparably in the shadow the scientific "networking" as such, so that the latter is proposed somewhat as a mere precondition for the big device – the latter being intended both as a defining moment and the end of the story.

When it is investigated, this "pre-history" of JET is in no way juxtaposed – or, even less, opposed – to the joint undertaking; rather, it is often described as the successful outcome of a clever and unswerving work by a theoretical physicist turned science manager and "Eurocrat", i.e. Palumbo.[2] Most accounts prize his scientific authority and diplomatic skills, his vision for the future, and his pertinacity. In the same way, they recognize that the cornerstones of the EFP were a result of his own conceptions: networking via contracts of association and Euratom financial participation, the preferential support scheme in the 1971-1975 program, which pushed European laboratories to converge toward studies in toroidal plasma confinement; the special mobility scheme

1 Danis Willson, *A European Experiment: The Launching of the JET Project* (Bristol: Hilger, 1981); E. N. Shaw, *Europe's Experiment in Fusion: The JET Joint Undertaking* (Amsterdam: North Holland, 1990); Shaw, "Joint European Torus", *History of European Scientific and Technological Cooperation*, eds. John Krige and Luca Guzzetti (Luxembourg: Official Publications of the EC, 1997), 165-78.

2 Donato Palumbo, "Some Considerations on Closed Configurations of Magnetohydrostatic Equilibrium", *Il Nuovo Cimento* B 53 (1968): 507-11.

for scientific personnel; the creation of consultative committees to assure the overall coherence of European efforts and avoid redundancies.[3] In many respects, such accounts reflect Palumbo's own recollections of the Fusion Programme's history, as he made them public on a number of occasions.[4]

Such approach, which is comprehensively adopted even by a recent essay,[5] though it maintains a different focus and deals with a wider timespan, gives rise to two types of shortcomings: first, it has a leaning to look back to the past from the mid-1980s point of view, encompassing the following period in the realm of "consequences"; second, it focuses on Palumbo as a Commission senior official while leaving in the background the contribution of Italy to the Fusion Programme, and the role played by other Italian scientists and engineers in a number of capacities. This is still odder if one considers that in the 1980s Italy developed new sizable projects, which led her effort to be second only to the French and German ones under different headings.[6]

This chapter addresses the "presence" of Italy in the EFP during the 1980s focusing on the support for new Italian initiatives against the background of growing difficulties in raising the necessary funding for fusion in the context of the European Framework Program (FP).

The Background

By the end of the 1970s, with the creation of JET as a joint enterprise, and a growing orientation of the Programme toward fusion as a long-term energy source, the need was felt to adopt new structures for orientation, coordination, and control of activities.

3 Umberto Finzi, "Palumbo Donato", in *Dizionario biografico degli italiani* 80 (2014), www.treccani.it, *ad vocem*; *Commemoration for the Life and Work of Donato Palumbo*, JET, November 21, 2011, Abingdon, United Kingdom; Harry Bruhns, "In Ricordo di Donato Palumbo (1921-2011)", *Il Nuovo Saggiatore*, http://static.sif.it/SIF/resources/public/files/ricordo/palumbo.pdf, last accessed February 18, 2016; Interview with Paolo Maria Fasella, July 31, 1998, Historical Archives of the European Union, European University Institute, San Domenico di Fiesole (Firenze), Italy (hereafter HAEU), INT585, 7.

4 Donato Palumbo, "The European Fusion Programme", in *Industry's Role in the Development of Fusion Power: Papers Delivered at the AIF Conference on Industry's Role in the Development of Fusion Power* (New York: AIF, 1981); Palumbo, "Nature and Prospects of the EURATOM Fusion Programme", *Philosophical Transactions of the Royal Society of London: Series A, Mathematical and Physical Sciences* 322 (1987): 199-211; Palumbo, "Setting JET on Track", presentation for the 25th Anniversary of JET, Culham, May 20, 2004; Palumbo, "The Work of the European Commission in Promoting Fusion Research in Europe", *Plasma Physics and Controlled Fusion* 29 (1987): 1465-73.

5 Patrick McCray, "'Globalization with hardware': ITER's Fusion of Technology, Policy, and Politics", *History and Technology* 26 (2010): 283-312.

6 Expenditures by the fusion associations in 1987, HUAE, ITER 9.

While JET would retain its own organization and each association would continue to be managed by a steering committee including representatives of the Commission, the overall overseeing structure of the Fusion Programme needed reform. After the Council's decision of December 26, 1980, the Consultative Committee on Fusion, the Liaison Group and the Committee of Directors were dissolved and replaced by a single Consultative Committee on the Fusion Programme (CCFP). The structure and guidelines of the CCFP were similar to the JET Council's, while its membership consisted of three representatives of the Commission, two members appointed by JET and for each member-state – as well as for the associate countries, i.e. Sweden and Switzerland – three representatives appointed by each national government. Every national delegation would include both a member coming from a State department and one from the scientific community. In the case of Italy, the three members were selected respectively by the Comitato nazionale per la ricerca e lo sviluppo dell'Energia Nucleare e delle Energie Alternative (ENEA), the Consiglio Nazionale delle Ricerche (CNR) and the Ministry for Scientific Research.[7]

The CCFP had the task of watching over ongoing activities, defining priority actions (subject to preferential support by the Community), and selectivity applying criteria in the definition of new activities. These criteria hinged on the "reactor relevance" of the proposed activity, namely ensuring a focus on tokamaks and a growing attention for the technological aspects of research and development compared to fundamental research in plasma physics. The tokamak (*toroidalnaya kamera magnitnaya katushka*, or "toroidal chamber and magnetic coil") is a magnetic confinement system originally developed in the Soviet Union, which, by the late 1960s, had become the frontrunner in fusion research by achieving a high plasma performance.[8] Central to this process of re-orientation was the definition of conceptual parameters for the Next European Torus (NET), ideally an engineering testing reactor linking JET to a future prototype reactor called DEMO.[9]

In the face of increasing expenses for devices and instrumentation, and to assure maximum continuity, it was agreed that after the first three years a new five-year research program would be implemented, overlapping the last two years of the previous one. This provision gave rise to an almost continuous process of scientific reappraisal and financial negotiation, which allows to sketch some basic features of the EFP during the 1980s. The decade opened with a very substantial budget of 750 millions European Currency Unit (MioECU) for the five-year program 1979-1983, leading to the launch of several mid-

7 "Communication from the Commission to the Council concerning the creation of a "Consultative Committee of the Fusion Programme", COM (79) 771 final, December 19, 1979 and CCFP first meeting, January 8, 1981, HUAE, ITER 1.

8 John Wesson, *Tokamaks* (Oxford: Clarendon, 2004), 15-23.

9 CCFP second meeting, March 9-10, 1981 and CCFP fourth meeting, April 7, 1981, HUAE, ITER 1.

sized experiments in support of or collateral to JET.[10] The entity of the effort was such that by 1982 it drove Palumbo to voice his concern and to propose a period of reflection.[11]

A measure of consolidation occurred already in the years 1982-1986,[12] but cuts were even heavier in the period 1985-1989, with the original proposition (790 MioECU) reduced by 100 MioECU. Though the allocation of funds for the years 1985-1986 allowed for the continuation of activities, a revision of the program became necessary for the post-1986 period. At this time Palumbo expressed his disappointment for the level of support the Commission's proposals had received from national governments once presented to the Council:[13] with fusion bound to be included in the FP – and oil prices heading to full-fledged counter-shock – the Fusion Programme was coming under careful scrutiny.[14]

The budget for the years 1987-1991 was caught up in the battle unleashed by the British determination to curb the projected second FP, which was eventually scaled down from 7.7 billions European Currency Unit (BioECU) to 5.4 BioECU.[15] This was a very delicate moment for the EFP, as the original budget estimate was increased by the preoccupation of strengthening NET and technology-related activities while international cooperation on the ITER project was taking shape. Though a measure of delay was unavoidable, fusion as a FP2 sub-action held out reasonably well, passing from an original request for 1005 MioECU to 985 MioECU, with the latter eventually being cut by 30 MioECU.[16]

The Presence of Italy

Against this background, Italy was able to reinforce its participation in the EFP by applying for preferential support (i.e. 45 per cent of funding from the Community) for two different projects, the Reverse Field Experiment (RFX) and the Frascati Tokamak

10 Note à la Commission, n.d., HAEU, ITER 1.

11 CCFP tenth meeting, June 22-23 1982, HAEU, ITER 2.

12 CCFP third meeting, April 7, 1981 and CCFP seventh meeting, October 15, 1981, HAEU, ITER 1; CCFP ninth meeting, April 2, 1982, HAEU, ITER 2.

13 CCFP twenty-first meeting, October 24, 1985 and Draft communication of the Commission to the Council on the Fusion Programme, n.d., HAEU, ITER 5.

14 "The scientific and technical strategy of the Community", COM (85) 140 final, April 9, 1985, HAEU, ITER 5.

15 Ingo Rollwagen, "Progress in Europe by Integrated Research Policy: Development and Challenges", *EU Monitor*, April 28, 2005: 16, http://www.dbresearch.com/PROD/DBR_INTERNET_EN-PROD/PROD0000000000186906.pdf, last accessed February 18, 2016.

16 CCFP twenty-fifth meeting, February 6-7, 1986 and CCFP twenty-seventh meeting, June 19, 1986, HAEU, ITER 6; CCFP thirtieth meeting, April 29, 1987, HAEU, ITER 7; CCFP thirty-fifth meeting, October 26-27, 1988, HAEU, ITER 8.

Upgrade (FTU), respectively in March and June 1981.[17] Studies of the reverse field pinch family – basically a plasma column carrying current that produces magnetic forces that constrict the column, producing higher plasma densities, and in which the stabilizing toroidal magnetic field reverses on the outside of the torus – had been encouraged at Culham, Los Alamos and Padua by the intrinsically high Ohmic heating power of these devices and by the theoretical work of John Brian Taylor on the relaxation of plasma toward the natural state of lowest energy.[18] In explaining the experimental results obtained in the ZETA device at Culham, Taylor had produced a theory of the self-organization of the magnetic field where the plasma rapidly accesses to minimum-energy states (relaxation), which are the preferred state of the system, by controlling a few global parameters. This opened questions of how and why relaxation occurs.[19] Considering relaxation as a benign process, reverse field pinches were promising from a reactor point of view, since they offered a relatively high ratio of kinetic plasma pressure and magnetic field pressure (by and large an indicator of economic efficiency) and the expected possibility of reaching thermonuclear ignition without additional heating.[20]

In Padua, work on ionized gases started in the late 1950s on the initiative of the Institute of Electric Engineering directed by Giovanni Someda, with the support of the Institute of Physics under Antonio Rostagni.[21] In the 1970s research in toroidal devices and the pinch effect produced promising results in the context of an association between Euratom and the CNR, so that in 1979 the quiescent regime found on ZETA some twenty-five years earlier was reproduced for the first time. This gave rise to a new wave of research projects on the reverse field pinch; among them RFX, originally proposed by Culham as a 1 MA machine and then upgraded to 2 MA by the end of the 1970s, which had been envisaged as a tripartite venture in which Culham, Padua and Los Alamos would participate.[22]

In September 1981, cuts in the British fusion budget and the fact that JET was located at Culham led the United Kingdom Atomic Energy Authority (UKAEA) to

17 CCFP second meeting, March 9-10, 1981 and CCFP fifth meeting, June 26, 1981, HAEU, ITER 1.

18 John Brian Taylor, "Relaxation of Toroidal Plasma and Generation of Reverse Magnetic Fields", *Physical Review Letters* 33 (1974): 1139-41.

19 Sergio Ortolani and Dalton Schnack, *Magnetohydrodynamics of Plasma Relaxation* (Singapore: World Scientific Publishing, 1993), 1-14.

20 Cornelius Marius Braams and Peter E. Stott, *Nuclear Fusion: Half a Century of Magnetic Confinement Fusion Research* (Bristol: Institute of Physics Publishing, 2002), 92-97.

21 For a brief review of early fusion research in Padua see Consorzio RFX, *Fisica e ingegneria della fusione: la ricerca verso una nuova fonte di energia* (Vigorovea: Graficamontaggi, 2007). On Someda and Antonio Rostagni, see Lorenzo Maranesi, *Giovanni Someda e il suo tempo* (Venezia: Ist. veneto di scienze, lettere e arti, 2004); Milla Baldo Ceolin, *Antonio Rostagni* (Padova: Società cooperativa tipografica, 1991).

22 Braams and Stott, *Nuclear Fusion*, 99-101.

inform the Commission that it was not in the position to keep RFX in its program. The American interest too failed to materialize. The Italian delegation to the CCFP, however, was able to express the willingness of the CNR to put in the money and build RFX in Padua. On April 2, 1982 physicist Piero Caldirola assured CNR funding to realize RFX, provided that the project received preferential support from the Commission as originally envisaged.[23]

In the meantime, the CCFP was discussing the proposal for preferential support for FTU put forward by the Laboratorio Gas Ionizzati (LGI) at Frascati. Back in the 1970s, in the wake of general interest by the scientific community for tokamaks, the LGI had established contacts with a group of physicists and engineers working at MIT. Among them, by the late 1960s, Bruno Coppi had developed the idea of producing high-temperature plasma with a compact tokamak with a small major radius, so that Ohmic heating per volume would increase and the temperature would rise. At MIT he had become acquainted with the Francis Bitter National Magnet Laboratory, a centre for the fabrication of exceptionally high field magnets, and its leading magnet designer, Bruce Montgomery. In addition to a small radius, now Coppi imagined a device with a formidable toroidal field called ALCATOR (i.e. high field torus), which by 1974 was achieving resounding success. As a consequence of contacts with MIT, the Frascati laboratory opted for a compact machine of small dimensions having a strong magnetic field, though tempered by the need of having plasma dimensions that were not so small as to disperse the power. This was the Frascati Tokamak, of which FTU was presented as an upgrade.[24]

FTU was criticized at the CCFP meeting of July 15, 1981. François Prévot, head of the CEA Fusion Department, expressed concern on the application of ALCATOR scaling laws (an empirical scaling criterion for calculating energy confinement time according to results in ALCATOR experiments) and, more generally, for a technology which combined high temperatures, high densities and high wall loading. Friedrich Wagner, who was working at Garching on the high-confinement regime for plasma,[25] questioned the NET relevance of FTU and its chance of reaching ignition without additional heating.[26]

---

23 Arnold Allen to Donato Palumbo, September 15, 1981, HAEU, ITER 1; CCFP ninth meeting, April 2, 1982, HAEU, ITER 2.

24 Joan Bromberg, *Fusion: Science, Politics, and the Invention of a New Energy Source* (Cambridge: The MIT Press, 1982), 162-64, 230-31; Paola Batistoni, ed., *1960-2010: cinquant'anni di ricerca sulla fusione in Italia* (Roma: ENEA, 2010): 38-41, http://www.fusione.enea.it/EVENTS/eventifiles/50esimo/50anni-fusione.pdf, last accessed February 18, 2016; Kenneth Fawler, *The Fusion Quest* (Baltimore: John Hopkins University Press, 1997), 180.

25 Friedrich Wagner et al. "Regime of Improved Confinement and High Beta in Neutral-Beam-Heated Divertor Discharges of the ASDEX Tokamak", *Physical Review Letters* 49 (1982): 1408-12.

26 CCFP sixth meeting, July, 15, 1981, HAEU, ITER 1.

By the time the CCFP Programme Committee agreed in recommending preferential support for FTU, in January 1982 Palumbo announced that CNEN had sent a new proposal for preferential support in the form of a preliminary draft conceptual design for a high-field, compact tokamak called Ignited Torus (IGNITOR). Indeed, while ALCATOR represented a relatively inexpensive way to study tokamaks in a university environment, at the International School of Fusion Reactor Technology held at Erice, Sicily, in September 1976 Coppi had proposed developing a new line of compact devices as a parallel program to large tokamaks like JET to reach plasma ignition.[27]

The IGNITOR proposal, however, was not really welcomed by the CCFP, which refused to call in American experts to appraise it. After a long discussion, in June 1982 the CCFP requested a position from Etienne Davignon, then vice President of the Commission with responsibility for industrial, energy and research matters, who appointed a special panel chaired by famous British scientist John Adams to assess the scientific and technical interest of IGNITOR for fusion research, as well as the soundness of the project. On the same occasion, both the French and the Germans expressed a negative attitude toward the building of RFX at Padua – with the Germans insisting that RFX had to be seen in connection with IGNITOR.[28] This connection might have disruptive effects both at a European level and in Italy, where the fusion association was being reorganized so that ENEA would take over CNR fusion activities, notably RFX. The Adams Panel reported to Davignon on December 23, 1982, casting both lights and shadows. IGNITOR could be a complementary, low-cost experiment, but the apparatus was considered as potentially dangerous.[29]

Meanwhile, the CCFP agreed on preferential support for RFX by majority vote – not unanimously as would be expected after a positive technical appraisal (and, indeed, as was the case for the other 'alternative line', i.e. the German stellarator Wendelstein 7-AS).[30] European funding for RFX and, most likely, for FTU made the uneasy coexistence with IGNITOR a reason for perturbation in Italy. On the one hand, the two Italian associations with Euratom were being merged under ENEA, the latter being the statutory organization responsible for nuclear energy and other alternative sources, so that RFX (a CNR project) was to fall under the ENEA umbrella. On the other hand, the Ministry for Scientific Research (the parent department of the CNR) insisted on

27 Bruno Coppi, "Compact Experiments for α-Particle Heating", in *Tokamak Reactors for Breakeven: A Critical Study of the Near-Term Fusion Reactor Program*, ed. Heinz Knoepfel (Oxford: Pergamon, 1978), 303-26.

28 CCFP eight meeting, January 7-8, 1982 and CCFP tenth meeting, June 22-23, 1982, HAEU, ITER 2.

29 John Adams to Etienne Davignon, December 23, 1982, HAEU, ITER 3.

30 CCFP eleventh meeting October 20, 1982, HAEU, ITER 2.

the relevance of fusion research (and RFX, in particular) in connection with the Project "Energetics II" (Progetto Finalizzato Energetica II). The latter was a big research and development exercise organized by the CNR in the context of the Piano Nazionale di Ricerca per l'Energia; ENEA would take part on equal footing with its steering committee. On December 22, 1982, the Comitato Interministeriale per la Programmazione Economica (CIPE) approved the start of "Energetics II", but it recommended a comprehensive appraisal of Italian fusion activities in order to define national priorities for action in the field – with special attention to costs and possibilities of European cooperation such as RFX.[31]

Such an appraisal, in fact, was tantamount to holding in abeyance RFX for the time being. Rumors spread that the Italian Government would not support the project anymore. At the CCFP meeting of February 1983, Cees Braams, director of the Institute for Plasma Physics in Nieuwegein (FOM) and "founding father" of Dutch research on nuclear fusion, asked the Italian delegation to comment and Caldirola, hinting at the relationship between RFX and "Energetics II", stated that the position of the CNR had not changed. On the same occasion, FTU received preferential support status and Romano Toschi, the Italian representative from Frascati, definitely stated that IGNITOR did not feature in the fusion association program of ENEA.[32]

These facts seem to point to the possibility that it was IGNITOR, as a latecomer project without any immediate prospect of European funding, which sent shockwaves through the Italian party and put into question the future of RFX. The hypothesis is reinforced by the fact that ENEA was apparently unwilling to put forward a formal proposal regarding IGNITOR, a precondition for any further action by the CCFP. Indeed, this was particularly surprising at a moment when IGNITOR and a tritium handling laboratory figured as favorite items to fill the large gap left at the JRC by the cancellation of Super-SARA – a light-water reactor safety research project abandoned amid chronic delays, escalating costs, and allegations that Italian entities had got too large a share of research contracts.[33]

By June 1983, the Italian authorities confirmed the validity of RFX, but they refrained from giving the green light to the project still pending a decision on funding. At the CCFP meeting of June 15-16, Giorgio Rostagni (Antonio's son and disciple of Giovanni Someda), who had taken over from Caldirola in view of the sensitivity of the RFX situation, tried to reassure his colleagues by pointing out that the delay was due to changes in the Italian government, but the project had passed all stages of verifica-

31 CIPE, delibera n. 107, December 22, 1982; *Progetto finalizzato energetica 2. Studio di fattibilità* (Roma: CNR, 1982).

32 CCFP thirteenth meeting, February 9-10, 1983, HAEU, ITER 3.

33 CCFP fourteenth meeting, April 19, 1983, HAEU, ITER 3.

tion except for the final decision. Undeterred, the CCFP passed a resolution that was actually an ultimatum: if Italy did not make up its mind by the meeting scheduled for October 19-20, 1983, then the CCFP would conclude that RFX did not have the support of the Italian association.[34]

After the general election and the formation of the first Craxi government in August 1983, just a few days before the CCFP deadline the Ministry of Industry and the Ministry for Scientific Research proposed including RFX in the program of ENEA. On October 19, CIPE authorized the necessary funds, but it also recommended that ENEA start a feasibility study of IGNITOR drawing on the existing documentation.[35] The following day, Rostagni was able to take part in the second day of the CCFP meeting after the news had been communicated from Rome directly to commissioner Davignon. On that occasion, the CCFP further noted the merging of the ENEA and CNR contracts and that the financing of RFX would be assured under the single ENEA contract of association.[36]

Subsequently, the troubled life of RFX went relatively smoothly. Even though the collaboration with American and Japanese laboratories, as originally envisaged, did not materialize, the project succeeded in covering a 7.5 MioECU gap through European funds, notwithstanding the constraints to Fusion Programme budgets in the mid 1980s.[37] The RFX construction phase was substantially completed by 1991 and the experimental phase began in 1992.[38] Nowadays the Consorzio RFX is the site where the prototype of one of the plasma heating systems for ITER is being built in cooperation with India and Japan.[39]

FTU started operating in 1989, with a reduced toroidal field compared to the earlier Frascati tokamak (from 10T to 8T), in order to allow openings in the vacuum chamber necessary for the installation of all the radio frequency power coupling structures foreseen. Indeed, unlike IGNITOR (in which Ohmic heating was expected to play a major role), the new high field tokamak at Frascati was developed as a test-bed to study plasma heating and non-inductive current drive[40] efficiency in high density plasmas by equip-

34 CCFP fifteenth meeting, June 15-16, 1983, HAEU, ITER 3.

35 CIPE, delibera n. 93, October 19, 1983.

36 CCFP seventeenth meeting, October 19-20, 1983, HAEU, ITER 3.

37 CCFP twenty-eighth meeting, October 29-30, 1986, HAEU, ITER 6.

38 Giorgio Rostagni, "RFX: An Expected Step in RFP Research", *Fusion Engineering and Design* 25 (1995): 301-13.

39 Sabina Griffith, "Signature Seals Future of Neutral Beam Test Facility", *ITER Newsline*, November 5, 2010.

40 On the interest in maintaining a tokamak current indefinitely by a combination of the electric current self-generated inside the plasma and various mechanisms for non-inductive external current drive, see Braams and Stott, *Nuclear Fusion*, 187.

ping it with three different radio frequency heating systems.[41] Some difficulties occurred in mid-1985 through a combination of budget cuts to the Fusion Programme in general and raising estimates for the installation of a lower hybrid device, i.e. one of the three most successful schemes for radio frequency heating.[42] As Roberto Andreani (director of the ENEA fusion division at Frascati) explained, earlier Italian estimates had been approximate, notably because the potential supplier of gyrotrons had not been able to quote a firm price. Now asked for a revision of the financial ceiling agreed for the heating scheme, the CCFP agreed by majority vote with the provision that ENEA verified the practicability of the heating method via a pre-experiment in the Frascati Tokamak with electromagnetic power at the highest end of the frequency range.[43] One should not make too much of these dynamics, however, as it was in the logic of the CCFP to criticize actions proposed for preferential support in order to assure both the overall coherence of the Fusion Programme and a spend-wise approach to research. Accordingly, in October 1988, the CCFP awarded preferential support both to an ion Bernstein wave experiment,[44] i.e. the use of a hot plasma wave to carry the radio frequency power to heat the tokamak reactor core, and to high density Electron Cyclotron Resonance Heating tests[45] on FTU, provided that ENEA could demonstrate the availability of a gyrotron of advanced design in a time consistent with the proposed timescale pursuant to the technical suggestions received.[46]

As far as IGNITOR was concerned, in 1984 Coppi made a direct approach to Davignon, and on July 12 a special meeting recognized the substantial changes introduced in the original proposal, so that it was agreed that the CCFP would reconsider the project. In October 1984, the Committee questioned Coppi extensively, in particular on the possible position of IGNITOR in the European strategy and whether it was aimed at more than attaining ignited plasma. Coppi admitted that not too much attention had been given to burn stabilization and that, once the physics of the machine had been proven, another core should be built for material testing. At the end, the CCFP, though recognizing the importance of experimental studies of burning plasmas, did not formulate an opinion, nor took any further steps. IGNITOR should be seen in connection with the present US interest in physics machines for the study of burning plasmas, the CCFP concluded, so that it might be played as a possible way of strengthening international collaboration.[47]

41 Batistoni, *1960-2010*, 72-82.
42 Wesson, *Tokamaks*, 261-62, 286-90.
43 CCFP twenty-second meeting, May 23-24, 1985, HAEU, ITER 5.
44 See Braams and Stott, *Nuclear Fusion*, 187.
45 See Wesson, *Tokamaks*, 290-99.
46 CCFP thirty-fifth meeting, October 26-27, 1988, HAEU, ITER 8.
47 CCFP twentieth meeting, October 17-18, 1984, HAEU, ITER 4.

Indeed, Coppi's idea inspired Princeton, with strong backing from the director of the Magnetic Confinement Program in the US Department of Energy, to propose the Compact Ignition Tokamak (CIT) specifically to study the physics of burning plasmas. CIT soon captured the enthusiasm of American fusion scientists, concentrated on advancing toward ignition, even though few if any regarded CIT design as a direct path to a reactor. But CIT's physical dimensions grew dramatically – reflecting the difficulty of building a high-field tokamak with engineering structures that left enough space for a plasma – and the project was abandoned in 1990 among fears that it would not ignite.[48]

On October 15, 1986, the Italian Minister for Scientific Research, Luigi Granelli, directly addressed the vice President of the European Commission, Karl-Heinz Narjes, proposing the inclusion of IGNITOR in the much-discussed program for 1987-1991. After stressing the American interest in this kind of device, Granelli re-launched the idea of siting IGNITOR at Ispra – this time as a joint undertaking. Under this condition, the Italian government would be ready to assume a substantial financial commitment to the project. A couple of weeks later, the Commission – with the support of the Italian delegation – proposed putting the IGNITOR design phase within the activities of the Euratom-ENEA association, thereby granting a support in the order of 2-4 MioECU, which would be included in the financial ceiling of the contract of association for the period 1987-1991. Meanwhile, it would be possible to explore bilaterally with Italy ways and means for the construction of IGNITOR. However, the CCFP's reaction was very cold. Expressing their concern at launching such an initiative before reaching a possible understanding with the United States, some delegations questioned the compatibility of the project with the ongoing construction of RFX and FTU by ENEA. On a more general note, the CCFP pointed out the difficulty of including IGNITOR in the Community strategy, as it was based on big tokamaks with a growing focus on technology and engineering.[49]

The matter, however, remained quiescent for more than two years. The Italian delegation presented the official proposal for priority support only in February 1989. The CCFP reacted once again by voicing the usual misgivings: what would IGNITOR bring to the European Programme? Would it really ignite and what contribution would a transiently ignited device give to the study of burning plasmas? Francis Troyon, director of the Plasma Physics Research Center at the École Polytechnique Fédérale of Lausanne and discoverer of a relationship that expresses the limit in pressure that cannot be

48 Braams and Stott, *Nuclear Fusion*, 228; Fawler, *The Fusion Quest*, 181.

49 Luigi Granelli to Karl-Heinz Narjes, October 15, 1986, and CCFP twenty-eight meeting, October 29-30, 1986, HAEU, ITER 6.

exceeded in a plasma,[50] raised a number of technical points concerning the interconnectedness of physics and technical solutions for such a compact device like IGNITOR. He pointed out the damaging psychological consequences that could arise if, after all, IGNITOR did not ignite. Robert Aymar, then head of the CEA fusion department, requested that IGNITOR's position be considered in direct relation to the US intention of proceeding with CIT – by then on the eve of being cancelled. The CCFT concluded that the proposal should be examined in depth and as diligently as possible,[51] but IGNITOR would never receive Euratom support.

Conclusion

Even from this very restricted investigation, the relevance of Italy to the EFP is considerable, both quantitatively and qualitatively. Italy was able to take advantage of the substantial fusion budget of the early 1980s and successfully defended its major projects, not so much in a logic of "just return", but by conceiving and deeply connecting them to the mainstream of the fusion community. One notable exception is IGNITOR, which has long since remained a subject of heated controversy in the scientific community and, of course, politically.

More research is needed on the political aspects, focusing on the feedback/relationship between scientists and science managers on the one hand and government/EC officials on the other. Far from representing a mere context, this link might be a way to test the consistency of Italy's European policy, maybe discovering a realm in which the country could be ambitious without any risk of marginality.[52] There is a preliminary proviso, however: is this matter really relevant for the understanding of contemporary Italian history? If one cursorily examines references on the country's history in the 1980s, the provisional answer would be negative.[53]

50 François Troyon et al., "MHD-Limits to Plasma Confinement", paper presented to the XI European Conference on Controlled Fusion and Plasma Physisc, Aachan, September 1983, ed. December 1983, http://infoscience.epfl.ch/record/120771/files/lrp_231_83_hq.pdf, last accessed February 18, 2016.

51 CCFP thirty-sixth meeting, February 2-3, 1989, HAEU, ITER 9.

52 See Marinella Neri Gualdesi, "L'Italia e l'Europa negli anni ottanta: tra ambizione e marginalità", in *L'Italia nella costruzione europea. Un bilancio storico (1957-2007)*, ed. Pietro Craveri and Antonio Versori (Milano: FrancoAngeli, 2009), 79-108.

53 See, for example, Silvio Pons, Adriano Roccucci and Federico Romero, *L'Italia contemporanea dagli anni Ottanta a oggi*, 3 vols. (Roma: Carocci, 2014); Marco Gervasoni, *Storia d'Italia degli anni Ottanta: quando eravamo moderni* (Venezia: Marsilio, 2010); Antonio Varsori, *La cenerentola d'Europa? L'Italia e l'integrazione europea dal 1947 a oggi* (Soveria Mannelli: Rubbettino, 2010); Simona Colarizi, ed., *Gli anni Ottanta come storia* (Soveria Mannelli: Rubbettino, 2004); Ennio Di Nolfo, ed., *La politica estera italiana negli anni Ottanta* (Manduria: Lacaita, 2003).

While it is understandable that historical analysis have focused on traditional political and diplomatic dynamics and, as one scholar noted, the attention to the role of scientists in Italian society has been intermittent,[54] this relative lack of attention is somewhat strange. Be it an effect of the traditional Italian difficulty in considering natural sciences as part of "culture"[55] or a manifestation of conflicting views on the possible role of scientific research in Italy,[56] historians should reflect on the relevancy of a subject like fusion research, not simply as an exercise in international or transnational history, but as a significant contribution to the understanding of contemporary Italy and her relations with the rest of the world.

54 Giuliana Gemelli, "Gli scienziati", in *Le élites nella storia dell'Italia unita*, ed. Guido Melis (Napoli: Cuen, 2003), 213-39.

55 Antonio Ruberti, "Riflessioni sul sistema della ricerca dopo il 1945", in *Ricerca e istituzioni scientifiche in Italia,* ed. Raffaella Simili (Roma: Laterza, 1998), 213-30.

56 Giovanni Paoloni, "Lo sviluppo scientifico italiano nell'ultimo sessantennio: due modelli a confronto", *Meridiana* 54 (2005): 39-61.