3 Nuclear Waste Governance in Italy: Between Participation Rhetoric and Regionalism

Maria Rosaria Di Nucci and Andrea Prontera

3.1 Introduction[1]

Over the last 65 years nuclear power in Italy has been characterised by cyclical stop and go activities. Starting with the pioneer phase in the 1950s, and engaging at the beginning of the 1960s in various technological developments, Italy has witnessed a discontinuous nuclear research strategy, as well as incoherent technology and industrial policies to promote this "modern" source of energy. Following the Chernobyl accident in 1986, the debate on nuclear power led to a 1987

[1] Parts of this article draw heavily on the previous work of one of the authors. See, Di Nucci (2015). M.R. Di Nucci drafted the text at the Research Center for Sustainability (Forschungszentrum für Nachhaltigkeit, FFN) Freie Universität Berlin, as part of the TRANSENS-project "Transdisciplinary research on the management of high-level radioactive waste in Germany" (transens.de). TRANSENS is a collaborative project funded by the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection and the "*Niedersächsisches Vorab*" of the Volkswagen Foundation by the Ministry of Science and Culture of Lower Saxony (FK 02E11849C).

M. R. Di Nucci (✉)
Freie Universität Berlin, Forschungszentrum Für Nachhaltigkeit (FFN), Berlin, Germany
e-mail: dinucci@zedat.fu-berlin.de

A. Prontera
Department of Political Science, Communication and International Relations, University of Macerata, Macerata, Italy
e-mail: andrea.prontera@unimc.it

M. Arentsen and R. van Est (eds.), *The Future of Radioactive Waste Governance*, Energiepolitik und Klimaschutz. Energy Policy and Climate Protection,
https://doi.org/10.1007/978-3-658-40496-3_3

referendum and the definitive shut-down in 1990 of all four country's nuclear power plants (NPPs). After attempts to revive the nuclear option, a second referendum three months after the Fukushima disaster in March 2011 led to the withdrawal of all Italian nuclear ambitions. However, nuclear waste stemming from the four permanently shut down NPPs, various research reactors, and reprocessing and fuel fabrication facilities represents a pressing problem.

Nuclear waste governance in Italy is characterised by complex, intertwined relationships and interaction between political-territorial levels from the national, through the regional to the local. The jurisdiction and responsibilities for nuclear waste are centralised; the governance of radioactive waste is shaped by a large number of national institutional actors and a limited number of regional and non-institutional actors, and has been characterised until recently by non-transparent top-down decisions.

The mandatory implementation at the national level of the *Council Directive* 2011/70/*Euratom* (European Council, 2011) put pressure on decision-makers. One of the major challenges was to initiate an inclusive process for a suitable site for nuclear waste on the basis of socio-technical and scientific criteria. Plans for the construction of a repository stayed strictly locked in the drawers of the nuclear waste operator SOGIN (Società Gestione Impianti Nucleari) for over five years. These plans envisaged the construction of a central surface repository and a technology park for the storage of both very low level (VLLW) and low-level waste (LLW) as well temporarily for intermediate-level waste (ILW) and high-level waste (HLW). However, the siting selection has been in a stalemate situation for a decade.

Recently, after a long period of incoherent stop and go, local opposition to the plans and a subsequent deadlock, the mandatory search for a national site is taking shape. The national map of potentially suitable areas was released in January 2021. The site search process should lead to the location of a site, which should house 78,000 cubic metres of VLLW and LLW, as well as temporarily 17,000 cubic metres of HLW. The latter should be stored for a maximum of 50 to 100 years and then placed in a repository for deep geological disposal (DGD), about which nothing has yet been revealed.

In this chapter, we identify the issues that dominate the governance debate on the storage and management of the Italian nuclear waste. Our analysis focuses on four domains: politics and administration; laws and regulations; science and technology, civil society, and on the interrelations between the domains. Special emphasis is laid on public participation and the involvement of local authorities, local communities and civil society in the site search procedures and planning. We look at the dynamics of the institutional actors, in particular the involved

Ministries, the regulatory authority (Ispettorato Nazionale per la Sicurezza Nucleare e la Radioprotezione, ISIN) and operator SOGIN and their interaction with civil society. They are all challenged to adopt a procedure on the basis of socio-technical criteria, which incorporates inclusive and decentralised forms of decision-making and interaction among players and stakeholders at all levels of (risk) governance. The process is therefore expected to be cumbersome and will require a new and more democratic approach to nuclear waste management. Such an approach will not be easy to implement in a country like Italy, which is characterised by scarce trust in public institutions and a long legacy of top-down decision-making.

This chapter is structured as follows. In Sect. 3.2, we describe the evolution of the Italian waste management strategy. We provide a brief historical background and key facts on the Italian nuclear programme and illustrate recent developments that have led to the current concept for the national repository. In Sect. 3.3, we consider the political, institutional and legislative domains of Italian nuclear waste governance. In Sect. 3.4, we investigate the scientific and technological domain. Then, in Sect. 3.5, we focus on the societal domain and its interactions with the previous ones. In particular, we look at these interactions with regard to the ongoing, more participatory siting policy, for which we provide a first assessment. Finally, in the Conclusion (Sect. 3.6), we ask what we can learn from the interaction between the different domains (how are science and politics integrated, how is civil society engaged in governance, etc.) and try to delineate what is unique about the Italian case. We suggest that nuclear waste governance in the country is affected by a vicious circle of (low) trust that is difficult to break despite the changing participation approach.

3.2 Evolution of the Waste Management Strategy

3.2.1 Brief Historical Background[2]

Italy had a pioneering role in the early development of nuclear power in the 1950s. Nuclear energy was seen as the answer to the lack of domestic fossil resources. In the 1960s, following the nationalisation of the electricity sector and the establishment of the national electricity monopolist ENEL (Ente Nazionale

[2] The facts referred to in this section are based on Di Nucci (2009, 2015).

Energia Elettrica), and due to cheap oil prices and powerful petroleum lobbies, the nuclear option was no longer pursued (Di Nucci, 2009). As a reaction to the oil crises of 1973 and 1979 there was a renaissance of nuclear power, and two massive nuclear development programmes were planned (Di Nucci, 2009). Nevertheless, the share of nuclear power remained marginal. Following the Chernobyl disaster in 1986, there was first a moratorium on nuclear plans, followed by a referendum in 1987, and finally a phase-out of all NPPs in 1990.

In the mid-1990s, ENEL abandoned fuel reprocessing in its own pilot facilities and opted for reprocessing abroad, and for an interim dry storage of the remaining spent fuel from its nuclear plants. Spent fuel from the British technology Magnox reactor in Latina was shipped to Sellafield in the UK for reprocessing, whilst used fuel from the other three Italian NPPs was sent for reprocessing in La Hague (France). Following reprocessing, vitrified waste will be returned to Italy.

In spite of the unambiguous results of the referendum in 1987, the debate on the nuclear option was revived in 2008 by the pro-nuclear centre-right Berlusconi government, which introduced a package of nuclear rulings and by-laws including measures to simplify the licensing of siting and construction. New legislation (Law 99/2009) was passed in July 2009, and envisaged six months to select sites for new NPPs.[3] However, this triggered a civic and institutional opposition. The regions with potentially suitable sites for new NPPs (Basilicata, Emilia-Romagna, Latium, Liguria, Molise, Marche, Calabria, Tuscany and Umbria) appealed against Law 99/2009, which they considered unconstitutional. In June 2010, the Italian Constitutional Court rejected the joint appeal by the regional governments, but the national government had to approve a new legislation on nuclear sites, in order to adjust to the decision of the Constitutional Court. Further, organised protest arose as members of the new Nuclear Regulatory Agency were named directly by the government in November 2010, without Parliament's approval. In December 2010, a joint meeting of the Parliamentary Commissions for Environment and for Industry rejected one of the nominations, halting the Berlusconi government's plans. In the aftermath of the Fukushima disaster in 2011, the initiative "Vote Yes to stop nuclear power", started by over 60 associations, promoted a referendum to repeal a number of the new laws introduced to pave the way for

[3] In the same year ENEL and Electricité de France (EdF) launched the joint venture Sviluppo Nucleare Italia to build at least four 1,650 MWe reactors deploying the EPWR (European Pressurised Water Reactor) technology of Areva.

new NPPs.[4] This referendum, held on 12–13 June 2011, reached a 55% voter turnout.[5] About 94% of respondents voted against restarting nuclear energy programmes. This confirmed the results of the Chernobyl referendum, showing that the majority of Italian citizens are against nuclear power.

3.2.2 The Current Dimension of the Waste Problem

Almost all the waste generated by the operation of nuclear installations is stored at the sites of origin. In addition, radioactive waste produced by R&D activities and medical and industrial uses is preliminarily stored in specific facilities. Most of this waste has been stored in untreated form, and dismantling activities, treatment and/or conditioning are on-going at NPPs and fuel cycle facilities. Concerning management of spent fuel, Italy decided to reprocess abroad. Following the stop of all nuclear power activities, the shipments of spent fuel for reprocessing terminated; the last shipment to the UK took place in 2005.

The Technical Guide 26, issued in 1987 by the former national environmental and safety agency ANPA (ANPA, 1987), subdivides waste into: Category I: very low-level waste (VLLW); Category II: low or intermediate-level waste (LILW) and Category III: long-lived and/or high-level waste (LLW/HLW). Radioactive waste of differing levels is being temporarily stored in at least 20 sites scattered throughout Italy (NEA/OECD, 2013; World Nuclear News, 2021).

Most of the radioactive waste derives from the operation of the NPPs and nuclear installations. Further radioactive waste stems from decommissioning activities, and the return of ILW and HLW from reprocessing of spent nuclear fuel abroad. The national inventory of radioactive waste, updated until 31 December 2020 by the regulator ISIN, indicates that there are approximately 31,751 cubic meters of radioactive waste, of which 14,000 cubic meters are VLLW, 12,500 cubic meters is LLW and 3000 cubic meters is ILW (ISIN, 2020, 2021a; SOGIN 2021c). To these volumes one needs to add the HLW returning after reprocessing abroad, and the medium-level radioactive waste expected from the dismantling of decommissioned nuclear plants (ENEA, n. d.). According to ISIN estimates, the waste returning in the next few years from reprocessing in UK and

[4] The questions posed in the referendum concerned the abrogation of about 70 regulatory and legislative measures established since 2008 in order to enable the construction of new NPPs.

[5] In Italy, legislative referenda require a turnout of over 50% of all eligible voters.

France will amount to approximately 35 cubic meters of HLW and approximately 48 cubic meters of ILW (See Table 3.1).

It has been estimated that the national repository will host 78,000 cubic meters of VLLW and LLW. Of this volume, approximately 33,000 cubic meters have already been produced, whilst the rest is expected to be produced in the future from the operation and decommissioning of NPPs, and from nuclear research facilities, nuclear medicine and industry. In addition, the national repository will also include a high activity storage complex for the temporary storage of approximately 17,000 cubic metres of IHLW. A part of this (approximately 400 cubic meters), consists of residues from fuel reprocessing carried out abroad and non-reprocessable fuel. SOGIN manages approximately 15,000 cubic meters stemming from the four NPPs and five nuclear facilities (Bosco Marengo, Casaccia, Ispra I, Saluggia and Rotondella). Additionally, NUCLECO,[6] stores temporarily 8138 cubic metres of radioactive waste in the Casaccia facilities (Deposito Nazionale, 2020). The major nuclear facilities and their locations are illustrated in Fig. 3.1.

3.2.3 Early Attempts to Develop a Waste Disposal Concept

In recent decades several attempts were made to develop and implement a radioactive waste disposal concept. In 1996, the national energy agency (ENEA) established a "Task Force for a National Site for a Radioactive Waste Repository" tasked with undertaking the conceptual and system projects and site prospection, selecting suitable sites and preparing the preliminary safety report. In 1999, the government launched a strategy for the complete decommissioning of nuclear facilities by 2020. The underlying precondition for this was the construction of a LILW repository to be used also for the temporary storage of HLW (see Di Nucci, 2015).

The Minister of Industry's timeline disclosed in December 1999 envisaged treatment and conditioning of waste from NPPs in on-site storage within ten years, with the perspective of a successive transport to a national waste repository; site selection and construction of a national repository for LILW within ten years, and decommissioning of NPPs and other nuclear facilities within 20 years.

[6] NUCLECO is a company belonging to the SOGIN group and acts as the operator for the collection, treatment, conditioning and temporary storage of radioactive waste and sources from nuclear medicine and scientific and technological research activities.

Table 3.1 Volume of radioactive waste according to category in 2020 and expected volume of returned waste (in m^3)

Waste category	International classification	Source	Volume in 2020 (m^3) (ISIN inventory)	(m^3) Estimated Volume*	Art of waste disposal
Category I	Very short -lived waste (VSLLW)	Industry, medical and research establishments	1,241.91		Controlled discharge
	Very low level waste (VLLW)	Industry, medical and research establishments	14,618.28	78,000	Long term surface storage in the national repository
Category II	Low level waste (LLW)	Fuel cycle facilities; NPPs, research reactors; decommissioning	12,700.07		
Category III	Intermediate Level waste (ILW)	NPPs, nuclear facilities, research reactors	3,141. 83	17,000	Temporary storage in the national repository waiting for emplacement in a DGD
	ILW	Reprocessing of spent fuel, vitrified ILW returning from Areva	47.6	*of which* 400 m^3 reprocessed fuel	
	High Level waste (HLW)	Vitrified HLW returning from BNFL	19	and non reprocessable fuel	
	HLW	Vitrified HLW returning from Areva	15.4		

**SOGIN estimates reported in Deposito* Nazionale (2020) *(*https://www.depositonazionale.it/consultazione-pubblica/progetto-preliminare/pagine/stima-dei-rifiuti.aspx*)*

(*Source:* Compiled and adapted from Di Nucci (2015), ISIN (2021) and SOGIN (2021c). Estimates until 2020)

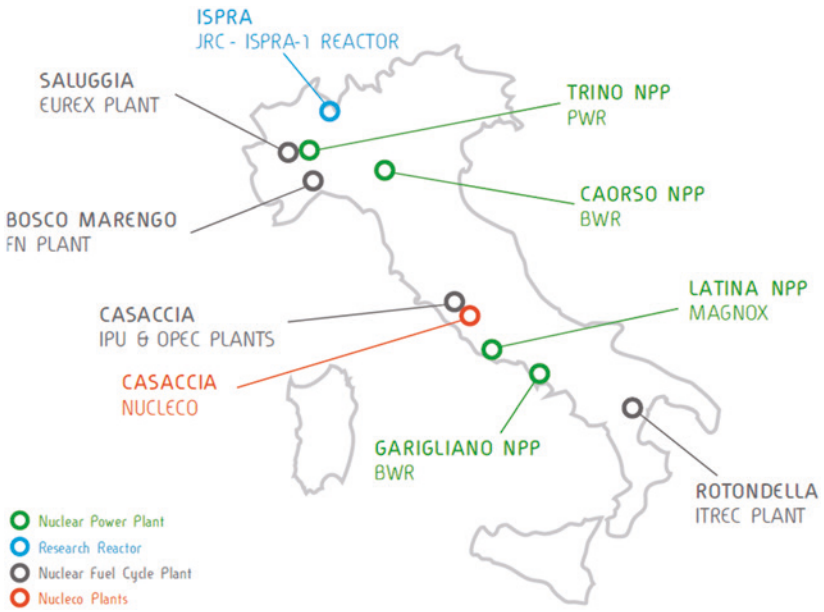

Fig. 3.1 Location of nuclear facilities where waste is temporarily stored. (Source: SOGIN (2020))

In 1999, an agreement between the government, regions and autonomous provinces was signed to define and initiate measures to promote the safe management of radioactive waste. In the framework of this agreement a working group was set up with the aim of preparing a document encompassing technical options and participatory procedures for the local population. The document was approved in January 2002 by the Conferenza Stato-Regioni—the body for horizontal coordination between the national government and regions (SOGIN, 2003, p. 24).

In 2001, the "Task Force Site" submitted to the environmental agency ANPA (later renamed ISPRA), which was acting as interim regulatory authority, a first draft of the conceptual and system projects designed for a repository for LLW, with the aim of starting a preliminary evaluation and testing the acceptability of directives and methodologies for the safety analysis. In 2002, the "Task Force

Site" also considered the near surface option. Following the selection criteria, around 33 areas for a surface facility were identified. (Di Nucci, 2015). However, in the end, the siting process failed in the wake of increasing local opposition (see Section 3.5).

3.2.4 Recent Developments and Design of the National Repository

The current disposal concept—as stated in the *Legislative Decree* 31/2010—focuses on a waste storage solution. It specifies the construction of a central repository as a surface structure (with reversibility and retrievability options) to store approximately 78,000 m^3 of VLL and LLW, as well as approximately 17,000 m^3 of HLW (Deposito Nazionale 2020). For the latter, a deep geological disposal (DGD) is considered necessary, and therefore high activity waste will be stored only temporarily (50–100 years) in a special area of the repository, and will then be permanently transferred to a DGD (Deposito nazionale n.d).

The decision for a centralised surface repository was based on the assumption that transferring the waste into a central structure could guarantee maximum safety for people and the environment, and could allow for the complete restoration of environmental systems, optimising time and costs and eliminating the need for temporary storage sites (Di Nucci, 2015).

The concept for a national repository also includes a technology park with a centre for R&D and innovation in the field of decommissioning and radioactive waste management on-site. The dedicated official portal on the repository explains the design of the facility. The repository will extend over 150 hectares, of which 40 hectares are foreseen for the technology park. The conditioned encased solid waste (or solidifying liquid waste, in cement or glass) is to be sealed inside steel drums filled with cementite. The drums will be sealed in reinforced concrete boxes, and all the boxes will be placed in a large cement aboveground tank which will be covered with a layer of soil and turf. These tanks will be sealed for 300 years. The total investment for the construction of the national repository and technology park is estimated to reach 900 M € (but could rise to 1.5 Bn € with related works), and will be financed through the electricity bill (the so-called A2RIM tariff component), which already covers the costs of dismantling nuclear plants (www.depositonazionale.it).

3.3 Nuclear Waste Politics, Administration and Legislation

3.3.1 Institutional Framework and Main Actors

Italy has a rather complex organisation and institutional setting. At the national level, a number of ministries share responsibilities in the nuclear waste area. We focus on the major institution with competence for regulations and for issuing the operating licence for nuclear and radioactive facilities. The Ministry of Ecological Transition, established in 2021, is responsible (under the technical advice of ISPRA) for assessing and inspecting nuclear facilities and activities involving the use of radiation sources, for technical recommendations and legally binding requirements. Moreover, its Department of Ecological Transition and Green Investments—DG for Waste, performs functions to ensure protection of the soil, air and water. Two further key institutional actors are: the Regulator ISIN and the Operator SOGIN. The former is the independent nuclear safety authority in charge of the regulation and control of nuclear installations safety and radiation protection.

The operator is responsible for decommissioning NPPs and fuel cycle plants and the disposal of LLW/ILW as well as the temporary storage of HLW. Other actors are the regional administrations where the sites are located, the Parliament, the national Regulatory Authority for Energy, Networks and the Environment (ARERA), and ISPRA. Additionally, there are consulting bodies such as the Conferenza Stato-Regioni in charge of discussing issues where competence is shared between central and regional governments. Under the Italian constitution, the opinion of this body is non-binding, but it represents a clear political message for the central government.

3.3.2 The Long Road to the Establishment of an Independent Regulator

Art. 5.2 of the Nuclear Safety Directive (Council Directive 2009/71/Euratom of 25 June 2009) requires European Union Member States to establish and maintain a competent regulatory authority functionally separated from any organisation associated with "[..] the promotion or exploitation of nuclear energy or radioactive material; the production of electricity using isotopes; the management of spent fuel and radioactive waste". The fact that such activities in Italy were for long time under the jurisdiction of the Ministry of Economic Development (an

actor traditionally closely connected with the nuclear industry) has been considered as a very critical issue (Di Nucci, 2015).

Indeed, the execution of regulatory and safety functions in Italy has a troubled history characterised by a continuing change of agencies. It started in 1964 with the creation of Comitato Nazionale per l'Energia Nucleare (CNEN) as regulatory agency using safety criteria from the UK and USA, and later was taken over by the Nuclear Safety and Health Protection Directorate, a department of the National Energy Agency ENEA (ENEA-DISP) (WNA 2021).[7] In line with Law 99/2009, a new Agency for Nuclear Safety (ASN, Agenzia per la Sicurezza Nucleare) was to be established with staff from ISPRA and ENEA-DISP. Following the cancellation of the ASN through Legislative Decree 201/2011, its functions were temporarily assigned to ISPRA, which de facto acted as the national nuclear safety authority.

ISPRA, established in 2008 as a governmental institute with administrative and financial autonomy under the supervision of the then Ministry of Environment, was in charge of the control and supervision of nuclear facilities and radiation protection. ISPRA's authorisation was required for detailed designs of any structure, system and component relevant to safety in any nuclear plant. Within ISPRA, the duties of the regulatory body were carried out by the Nuclear, Technological and Industrial Risk Department.

Legislative Decree No. 45 of 2014 finally provided for the establishment of a national independent nuclear regulatory authority responsible for nuclear safety and radiation protection, in accordance with the Directives 2009/71/Euratom and 2011/70/ Euratom (European Council, 2011). However, the Italian regulatory authority (ISIN) only began to operate in August 2018. ISIN is a technical body governed by public law and enjoys operational and administrative autonomy. It is responsible for the regulation and supervision (by inspection) of nuclear installations in matters of nuclear safety and radiation protection.

The bodies of ISIN are the Director, the Council (composed of three experts, one of whom has organisational coordination functions within ISIN) and the Board of Auditors. Both the Director and the Council are appointed by decree of the President of the Republic, after deliberation of the Council of Ministers. The Inspectorate took up all the functions concerning nuclear safety and

[7] In 1994, the responsibility for safety and licensing was transferred to ANPA, National Agency for Environment Protection and Technical Services (renamed APAT in 2002, and later in 2009, ISPRA).

radiation protection that over the course of decades had been attributed by the national legislation to several different agencies. The structure of ISIN is made up of about 65 units with proven expertise in the specific areas covered by the regulator, and stem mostly from staff of ISPRA's Nuclear, Technological and Industrial Risk Department, and other public administrations and research bodies.

ISIN is responsible for the authorisation processes and the technical assessments, control and supervision of the nuclear installations, including research reactors, plants and activities related to the management of radioactive waste and spent nuclear fuel, protection of nuclear materials and installations, use of ionizing radiation sources (www.isinucleare.it). Moreover, the remit of ISIN includes the issue of technical guides in matters of transport and certifications of radioactive materials.

3.3.3 Operator/Implementer

There is a long history of industrial interdependencies leading to the birth of the state-owned nuclear waste management and disposal company SOGIN. SOGIN started operating in 2001, but became a group in 2004 after the acquisition of a 60% stake in NUCLECO SpA, the operator responsible for collecting and conditioning as well as for the temporary storage of radioactive waste from nuclear medicine and R&D activities. Apart from management and decommissioning of NPPs, spent fuel and nuclear materials, SOGIN is also in charge of designing, constructing and operating the national repository for LILW and the interim storage for HLW. SOGIN operates according to the strategic guidelines of the Italian government. Authorisations are granted by the Ministry of Ecological Transition, on the basis of the technical advice of ISIN.

The company is financially solid and has approximately 1,150 employees.[8] At the end of the 2020 financial year, there has been an increase in the volume of decommissioning activities that grew from 48.3 M € in 2019 to 72.5 M € in 2020 (SOGIN, 2021a).

[8] In the past, due to its non-transparent management, its personnel recruiting practices, consulting services abroad and high expenses, SOGIN has been the object of various parliamentary interrogations, and has also been criticised by the Court of Auditors (Corte dei Conti) as well as by the Energy Regulatory Authority. See Rovai (2009) and Di Nucci (2015).

3.3.4 The Legal Framework

There is a high number of laws and rulings (mostly decrees) regulating nuclear activities and radioactive waste.[9] A milestone is *Law 282/2005*, promulgated for the Italian ratification of IAEA's "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management". Further major references are the *Legislative Decree 230/95* (implementation of various Euratom directives) later integrated and modified by the *Legislative Decree 241/2000*, as well as the *Legislative Decree 314/2003*, modified and converted in *Law 368/2003*, as well as *Law 239/2004*. Other important legal and normative references are Law *99/2009*, and the *Legislative Decree 31/2010*, with their subsequent amendments.

Legislative Decree 31/2010 ("Discipline of the storage systems for radioactive fuel and waste as well as economic benefits […]") belongs to the primary nuclear legislation. In the case of nuclear waste, this decree regulates steps and scheduling of the siting procedures of the national repository, including also public consultations. Art. 22 provides built-in provisions related to the funding of the decommissioning activities and compensation measures for the municipalities hosting nuclear facilities. Art. 4 states that construction and management of nuclear facilities are activities of state interest, are subject to a single authorisation upon request of the operator and are granted (in terms of *Legislative Decree 66/2010*)— and subsequent to a consultation with the Ministry of Defence and the respective region of the site in accordance with the "Unified Conference" (Conferenza Unificata)[10]— by decree of the Ministry of Economic Development in agreement with the Ministries of Environment, Infrastructures and Transportation. The response of the region is mandatory, but not binding, and is to be delivered within 90 days after the request for authorisation. Should there be no reaction after this time, the Conferenza Unificata will examine the matter. This Legislative Decree assigned to SOGIN the task of implementing the storage

[9] It would be an enticing task to list with references all relevant legislation. We therefore refer to the website of the Italian Parliament (http://www.parlamento.it), 'Laws' section,where it is possible to consult the laws, decree-laws and legislative decrees approved since the 13th Legislature (9 May 1996).

[10] The "Unified Conference" is a governance body consisting of a state-region conference, state-municipalities and autonomous bodies' conference, i.e. regions, provinces, municipalities, etc. Its aims are to enhance cooperation between the state activities and other bodies' and examine issues of common interest.

concept and made it also responsible for construction and operation of the national repository. Finally, it provides—along with Law 241/1990 and the Directive of the Presidency of the Council of Ministries 2/2017—the framework for the participation process that is organised around a 'National Seminar'. This process is open to all parties identified on the basis of the provisions of Art. 27, and to all those who participate in the public consultation by submitting comments and technical proposals, which should be made available on a dedicated website.

As anticipated, *Legislative Decree* 45/2014 that implemented the Euratom directive 2011/70 (European Council, 2011), provided for the establishment of the regulator ISIN. A joint Ministerial Decree (by the Ministry of Economic Development and the Ministry of Environment) of 7 August 2015, then implemented other Euratom directives providing for a renewed classification of nuclear waste. The legislative framework was subsequently upgraded with Legislative Decree 137/2017 and Legislative Decree 101/2020, which also improved the role of the new regulator.

3.4 The Science & Technology Domain

Italy has a long tradition in nuclear research, which dates back to the pioneering work of Enrico Fermi in the 1930s. This legacy is still reflected in the Italian research community and institutions. The dynamics between science, technology and society have been evolving over recent decades. On the one hand, policymakers manifested an increased need for scientific advice (science-policy interface). On the other hand, science continuously interacts with society. In his analysis of the risk society, Beck (1986) pointed out the importance of the inclusion of different expertise and forms of knowledge for gaining new insights.

Due to the many unanswered questions about nuclear waste disposal, multidisciplinary expert knowledge is required as a productive source for making the best possible decisions in balancing risk technologies with societal interests and concerns. Since the 1970s, opposition to the Italian nuclear programme has also been animated by an important part of the scientific community that developed contacts with environmental movements and NGOs (Baracca, 2008).

After the abandonment of the nuclear programme, the Italian nuclear research community has maintained a niche role. This role has occasionally expanded in conjunction with the re-launch of the nuclear option in the political agenda, especially under the centre-right government of Berlusconi in the late 2000s. However, the simple fact that Italy no longer has a nuclear power programme in place has favoured the separation between civil society and the niche of the nuclear

research community. Moreover, the public debate on nuclear waste is no longer influenced by the debate on the role of nuclear power in the country's energy mix. On the one hand, this situation has simplified the debate on nuclear waste management. On the other hand, however, the lack of a nuclear power programme has reduced the visibility and salience of the nuclear waste issue for Italian public opinion at large, with the exception of the local communities directly affected by the site location process.

The research community involved with nuclear waste includes various universities and research institutes as well as dedicated agencies. Theoretical nuclear research is performed by laboratories belonging to Consiglio Nazionale delle Ricerche (CNR) and Istituto Nazionale di Fisica Nucleare (INFN). All of the INFN's research activities are undertaken within a framework of international cooperation, in close collaboration with Italian universities. The leading agency for applied nuclear research is ENEA, which performs dedicated nuclear research, and manages research centres at Casaccia (Latium), Bologna, and Brasimone (Emilia Romagna).[11]

Research and emerging technologies in the field of decommissioning and waste management are carried out by SOGIN alone, as well as in cooperation with universities and research centres. They all participate in cooperative projects on nuclear safety, waste management and decommissioning within the framework of the Euratom Research and Training Programme. SOGIN participates in a number of European projects. Additionally, there is a number of international cooperation projects running within programmes and schemes of the OECD/NEA and the IAEA.

The scientific community is involved in nuclear waste management in different ways. First, experts from governmental agencies lay down the technical normative framework on the matter. The *Technical Guide 26* (ANPA, 1987), provides waste classification as well as the technical requirements. The *Technical Guide no. 29*, issued in 2014 by ISPRA defines the criteria for the location of a surface disposal facility for LLW and ILW. It identifies 15 exclusion criteria including: volcanic and seismic activities, geomorphological and hydraulic risk, altitude above 700 m, distance from the coast line within 5 km, unsuitable distance from residential areas, distance from motorways, suburban roads and railway lines, proximity to industrial activities, airports and military facilities, hydrology and

[11] For an account of the Italian nuclear R&D organisations and cooperation activities, see IAEA (2021).

hydro-resources; importance of biodiversity. Among the investigation criteria are the presence of secondary volcanic and tectonic activities, presence of erosion phenomena, weather and climatic conditions, soil and groundwater conditions, hydrogeological parameters, natural habitat, availability of transport infrastructures, presence of strategically important infrastructures, etc. (ISPRA, 2014).

A proposal for the *Technical Guide no. 32*, 'Safety and Radiation Protection Criteria for Engineered Surface Disposal Facilities of Radioactive Waste', has been published on the ISIN website and was subject to consultation with the public and interested companies, bodies and organisations for a period of 60 days. The criteria stipulate that the site qualification, design, construction, operation, closure and post-closure of disposal facilities must be planned and conducted in accordance with criteria that guarantee the safety and radiation protection of members of the public and workers, as well as the protection of the environment in the vicinity of the installation (ISIN, 2021c).

In addition, experts from the research community are involved in the decision-making and the participatory process for site location. This involvement exposes the interactions between science and society.

3.5 The Societal Domain and Its Interactions with the Political-Administrative and Scientific Domains

3.5.1 Italian Society and Nuclear Energy: An Evolving Relation

Italian citizens have twice manifested their opposition to nuclear energy through referendums. The relation between Italian society and nuclear energy, however, is more complex than these results suggest. The outcomes of the 1987 and 2011 referendums have been strongly influenced by international negative events, namely the Chernobyl and Fukushima nuclear disasters. Surveys from the late 2000s showed that about 46% of Italians were in favour of building nuclear power plants in the country, whereas 44% were against (European Commission, 2010).[12] The number of opponents increased to 50% when people were asked if they were willing to have a NPP in their province. Younger people and centre-left voters were more against the nuclear option, which was mainly supported by

[12] See the data available at http://www.demos.it/a00231.php (accessed 25 October 2021).

elderly people and voters from centre-right political parties. The Fukushima disaster represented the turning point. After that event, opponents of nuclear energy increased. Surveys show that the number of citizens against nuclear energy has been constantly over 60% since 2012.[13] In 2021, this figure reached 67%. Interestingly, among those against nuclear energy, 60% motivated their opinion by worries about possible mismanagement in the treatment of nuclear waste. This figure is even larger than the number of opponents that were worried about possible accidents in NPPs (49%). This apparent paradox has its roots in the low level of trust citizens have in public institutions in charge of environmental safety and protection. The trust in national institutions has progressively reduced over the last decade, and is lower than the average in OECD countries; a trend that correlates with the emergence and reinforcement of populist parties. In 2020, only 37% of the respondents trusted the government, and merely 28% of citizens trusted the Italian parliament.[14] Moreover, this paradox is also linked to the legacy of the past top-down nuclear waste siting policy, which was a failure.

3.5.2 The Failure of the Past Top-Down Siting Policy

In Italy, the direct involvement of civil society in (large) infrastructural projects is still in an infant stage. Until a few years ago, siting processes have been inspired by Decide-Announce-Defend (DAD) strategies, even at time when the designation of a national site for waste disposal represented a political priority.

As anticipated, the "Task Force Site" created by ENEA in 2002, identified 33 areas with favourable physical and territorial characteristics for a national repository (Ventura, 2003). The list of potentially suitable national sites did not find a consensus. After a technical evaluation, a site in the region Basilicata (Scanzano) was selected by the government, and was included in the *Legislative Decree 314/2003* ("Urgent Dispositions for the collection, disposal and storage of radioactive waste"). This Decree also established an extraordinary Commissioner in charge of the validation of the site, the approval of the economic and financial plan, as well as the procurement and tenders for planning and constructing the national repository (Cianciullo, 2003a, b). The Government then mandated the

[13] See the data available at https://nucleareeragione.org/2021/07/05/sondaggio-swg-oltre-un-italiano-su-due-possibilista-sui-nuovi-reattori-nucleari/ (accessed 29 October 2021).

[14] See https://www.statista.com/statistics/1264813/citizens-who-express-trust-in-public-institutions-in-italy/ (accessed 31 May 2022).

Chairman of SOGIN, a former army General acting as "Extraordinary Commissioner", to select a location for radioactive waste of category I and II. Experts identified underground salt caverns in Scanzano Jonico as a potentially suitable repository for HLW at 700 m depth (La Repubblica, 2003; Di Nucci, 2015). This location had been selected in spite of criticism about the high population density and the proximity to the sea. Local residents had not been consulted (Cianciullo, 2003b). Zinn (2007) talks about "militarisation" of the project. The site was defined as a military defence installation of national property. Some of the press, praised *Decree 314* and considered it a courageous move which represented a break with the modus operandi of postponing difficult choices, described as typically Italian.

Indeed, the top-down, militaristic procedure triggered harsh reaction. For nearly two weeks, residents blocked motorways and shut down shops and businesses. Approximately 150,000 people marched in what was described as the largest demonstration held in the southern region of Basilicata (Rossano, 2003). The regional, provincial and municipal administrations of Basilicata opposed *Decree 314*. The regional council declared the area a denuclearised zone and initiated a lawsuit against the government decree. As a result of the protest, the Berlusconi government was forced to withdraw from the decision to make Scanzano Jonico the site of the main nuclear waste repository in Italy. It amended the decree (deleting the name of the designated location), and commissioned SOGIN to undertake the search for a new site.

3.5.3 Site Identification and Participatory Siting Procedures

The popular revolt in Scanzano has gained an iconic status for civic protest. The resistance was articulated at two parallel and complementary levels, institutional and popular, and was characterised by a deep and continuous discourse exchange (Zinn, 2007). The lessons learned are that siting procedures require an open, democratic process, where all stakeholders' interests can be discussed and where both residents' opinions and scientific arguments are considered, rather than *de lege* enforcement (Di Nucci, 2015).

Currently, the newly started siting procedures try to focus on transparency and openness, but the legacy of the past represents a serious hurdle to create the trust necessary for such a process. Politicians and authorities have often given misinformation in the past, and these mistakes represent a critical burden. After a long stalemate, and with over five years delay, on 5 January 2021 a new map was

published with potential sites considered suitable to host the surface repository to store all radioactive waste. Elaborated by SOGIN, the National Map of Potentially Suitable Areas (CNAPI) proposal has been validated by the regulator ISIN, and subsequently by the responsible ministries. The release of the documents represents the first step on a new participatory path that should lead to the identification of the single site at national level where to realise the national repository and technology park.

The CNAPI proposal identifies the areas whose characteristics meet the location criteria defined by the regulator ISIN in *Technical Guide no. 29* (ISPRA, 2014). The CNAPI proposes a grouping of the 67 potentially suitable areas subdivided into four sets, with decreasing order of suitability with "equal safety conditions" (A1, A2, B and C). This classification has been reached by considering socio-environmental, logistic and seismic aspects. For each of the potentially suitable areas identified, a report on the geological, naturalistic and anthropic characteristics at a regional scale has been prepared and made available online.

The map identifies 67 locations in seven regions (Piedmont, Tuscany, Latium, Apulia, Basilicata, Sardinia and Sicily) (Table 3.2). A1 sites are located only in two regions: Piedmont (7) and Latium (5), which also host 3 A2 sites. Several A2 sites are located between Apulia and Basilicata. Sardinia and Sicily, mainly due to their insular positions, only host B and C sites. A table attached to the map indicates the 69 municipalities involved. The most likely are expected to be in two areas in the province of Turin (Caluso and Carmagnola), five in the province of Alessandria (including Bosco Marengo and Novi Ligure), and in the province of Viterbo.

Table 3.2 Number/category of potential sites for the national repository in each Region. (Source: Authors' elaboration on the data available at www.depositonazionale.it/documentale/documenti_proposta_cnapi/ordine_di_idoneita/dngs00226_procedura_risultati_classificazione_aree.pdf)

Region	A1	A2	B	C	Tot.
Piedmont	7	1			8
Latium	5	2		15	22
Apulia/Basilicata		6		11	17
Tuscany		2			2
Sardinia			14		14
Sicily			1	3	4
Tot.	12	11	15	29	67

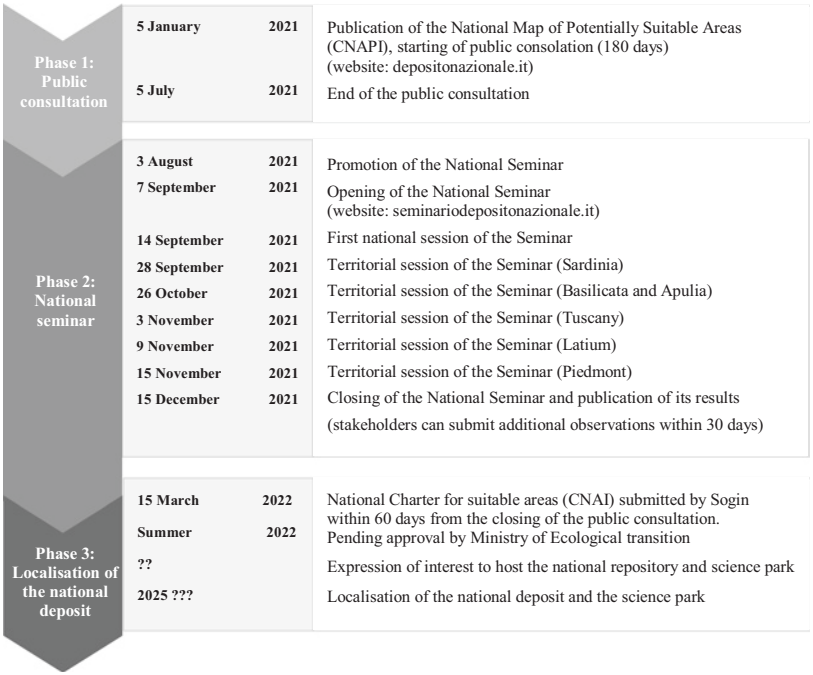

Fig. 3.2 Timeline of the consultation process. (Source: Authors' elaboration on the data available at www.depositonazionale)

The publication of the potential sites marked the start of a two-month phase of public consultation of the documents, which were made available on a dedicated website (i.e. depositonazionale.it) (Fig. 3.2). This was followed after four months by a national debate (the National Seminar) involving local authorities, trade associations, trades unions, environmental NGOs, universities and research bodies, as well as citizens. During this phase, all aspects of the proposed facility were analysed, including the possible economic benefits and related territorial development. Subsequently, regions, provinces and municipalities have been allowed to submit observations regarding the map. On 7 September 2021, the national seminar began, with the aim of reaching a shared decision on the location of the site for the national repository. The seminar was organised on a dedicated website (https://www.seminariodepositonazionale.it/) and was articulated into seven work sessions, one national and six territorial, which covered the potentially suitable

areas in the regions involved (Table 3.2). ISIN guaranteed the correct application of national and international criteria (ISIN, 2021b).

At the end of this process, SOGIN updated the CNAPI. On 15 December 2021, the results of the seminar were presented (Deposito Nazionale 2021). Subsequently SOGIN needed to skim further through the candidate territories, arriving at a new map: the National Charter for suitable areas (CNAI). This provides the final shortlist of sites from which to choose the future location of the national repository. At the end of the National Seminar, a second stage of the public consultation started and lasted thirty days, during which any further observations and technical proposals could be sent. The procedure was finalised by 14 January 2022.

On 15 March 2022, the CNAI has been submitted by Sogin to the Ministry of Ecological Transition within the within 60 days from the closing of the public consultation, as envisaged by Legislative Decree 31/2010. In the next step, the Ministry of Ecological Transition following ISIN's technical opinion will approve the map by its own decree. The map will then be published (Deposito Nazionale, 2022c).

The final draft of the CNAI will need the approval of the ministries involved in nuclear decommissioning, and from the regulator ISIN which will review comments and documents received by SOGIN to arrive at a shortlist of suitable sites. Following the publication of the CNAI, municipalities will be able to submit expressions of interest for hosting the storage facility. The interesting point is that Legislative Decree 31/2010 recognises that these expressions of interest are non-binding until the final identification of the site, which is a procedure resembling the "decision in principle" from Finland (Di Nucci 2019). The final decision rests in the hands of the Ministry for Ecological Transition (in accordance with the Ministry of Transport and Infrastructures) who will identify the area with a decree, after a Strategic Environmental Assessment is performed. The goal is to build the repository by 2025.

3.5.4 Participation in the Consultation Process and Position of the Main Actors

The first phase of the consultation process following the publication of CNAPI lasted 180 days. Several institutional and civil society actors took part in this process, submitting documents, technical reports and expressing their positions and concerns. Overall, 318 participants were involved in this phase. The largest group were regional and local governments (62%), followed by associations and

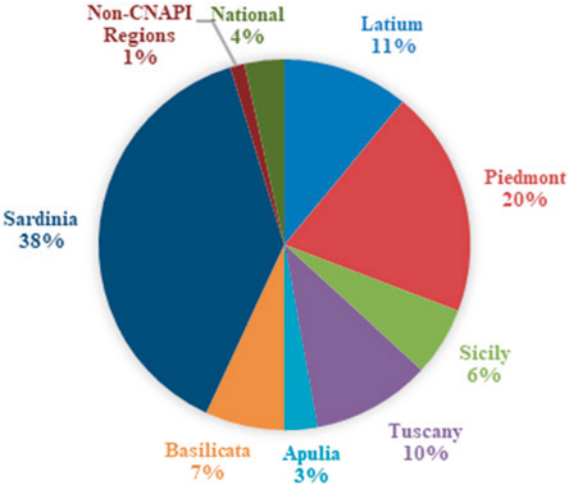

Fig. 3.3 Territorial distribution of the participants in the consultation stage. (Source: Authors' elaboration on the data available at www.depositonazionale)

civic committees (20%), citizens (13%) and companies (4%) (Deposito Nazionale 2022a, b). The territorial distribution of the participants reflects, in part, the distribution of the geographical areas possibly affected by the siting of the national repository (Fig. 3.3).

Participation has been particularly high in Sardinia and Piedmont. This fact is not surprising, as seven out of twelve of the A1 sites are located in Piedmont. In Sardinia however, there are no A1 and A2 sites, although there are 14 C sites. In the Southern regions (Sicily, Basilicata, Apulia), participation has been lower. This is likely because they host fewer potential areas for siting the national repository, and because these regions are generally characterised by lower levels of public participation than those located in Northern and Central Italy.

Overall, the position of the main actors has manifested dissent with regard to the CNAPI proposals. Regions involved have expressed their firm opposition, both within the framework of the consultation process and in institutional bodies, such as the Conferenza Stato-Regioni. This opposition came from both regions governed by centre-right (Piedmont, Sardinia, Sicily, Basilicata) and centre-left (Apulia, Latium, Tuscany) political parties. Several regions have contested the CNAPI proposal, pointing to technical gaps in the selection process of the sites, which they claim have underestimated several important risks. For exam-

ple, Sicily pointed to the very high risk posed by the sea transportation of nuclear waste. Besides, many regions have highlighted the 'incompatibility' between the national repository and local development strategies based on tourism, agriculture and the valorisation of local traditions and landscape. For example, Apulia and Basilicata protested that their areas are unsuitable to build a national repository, as they are of particular natural value. Similar arguments were put forward by other regions with a strong tourism sector, such as Tuscany and Sardinia. For these assessments, regions have involved their technical bodies, experts and regional environmental agencies (the ARPA). Some regions have established 'Scientific and Technical Committees' with experts from universities and the research community.

The mayors of several municipalities throughout Italy also stressed the unsuitability of their respective territories to host nuclear waste. Concerns about the potentially negative impact of the national repository on agriculture, tourism and places of high natural value have represented the most common observations submitted during the consultation phase, both by local governments and civil society organisations.

In addition, some regions, along with civil society organisations, pointed to their limited involvement in the process that led to the CNAPI formulation (Deposito Nazionale, 2022a, b). The governor of the Piedmont Region, for example, complained that the CNAPI map was drafted without actively involving the region and the mayors of the areas affected. Piedmont is the region that already hosts the majority of nuclear waste.[15]

Worries about potentially underestimated risks were further expressed by environmental NGOs and civil society organisations. For example, WWF-Italy provided 73 pages of observations, in which they indicated fundamental limits and gaps in the CNAPI. Legambiente, the largest environmental NGO in Italy, underlined that the single national repository should be chosen wisely, objectively and transparently, in full compliance with the exclusion and investigation criteria. They reiterated that the identification of a single site for the safe storage of LILW radioactive waste is the only way to ensure the proper treatment and disposal of radioactive waste.

Finally, among the research community, criticisms have been expressed by two important organisations including experts from universities and research

[15] It is estimated that 75% of radioactive activity from nuclear waste is concentrated in the area where there are three nuclear sites of Saluggia, Trino Vercellese and Bosco Marengo.

institutions, i.e. the Scientific Commission on Decommissioning (established in 2014) and the Interuniversity Research Centre for Sustainable Development (CIRPS). Both these organisations criticised the choice to apply the criteria of *Technical Guidelines no. 29* (ISPRA, 2014)—which was drafted for LLW and ILW—to HLW, as well as the limited independence of ISIN and SOGIN from the government.

3.5.5 Plans vs. Reality: A Preliminary Assessment of the Participation Process

According to SOGIN (2020), the siting process is based on three fundamental principles: transparency, information and participation. But how transparent and genuinely participatory is the search process?

The National Seminar can be considered as the first public consultation in Italy regarding an infrastructure of national importance. Invited parties had to register by 30 September 2021, according to the procedures indicated in the letter sent on 10 August 2021. Information and transparency can be considered as partly achieved. The National Seminar, which took place online, was subdivided into nine working sessions (three national sessions and six regional sessions). Each meeting was broadcast live via streaming, and was made accessible from the page dedicated to each event. Each session was moderated by an expert in participatory processes, and envisaged an hour in which the operator SOGIN commented on the observations and technical proposals received during the first phase of the process (which were available on the dedicated website). Other members of the scientific community were also invited to illustrate specific elements of the project, such as experts from ISIN, NUCLECO or researchers from universities, particularly from the Polytechnic University of Milan. The rest of the time was left for discussion. Spokespeople from the local communities had ten minutes and five slides at their disposal, other comments or questions could be sent by email. Moreover, citizens could use this channel for questions or comments or to get involved in a dedicated chat on the event platform. Experts commented and replied to these inputs at the end of the session (a total of 66 questions were asked during all the events) (SOGIN, 2021b). In addition, after each session, all the material has been made available on the dedicated website of the National Seminar together with a summary of the session. SOGIN considers this format as an assurance in terms of transparency and information sharing. But are the formats chosen also participatory? Can the future operator both lead the participation process and be perceived as neutral?

Table 3.3 Number and groups of actors involved in the territorial sessions of the National Seminar.

Regional session	Regional governm	Local gov-ernm	NGOs	Civic Com-mit-tees*	Citizens	Ass.**	RI^	Others	Tot
Piedmont	1	16	4	4	5	5	–	2	37
Latium	–	7	4	2	4	7	–	4	28
Apulia/ Basilicata	1	6	1	1	–	4	2	3	18
Sardinia	1	6	1	7	1	–	–	1	17
Tuscany	1	2	1	–	–	1	–	1	6
Sicily	1	0	1	–	1	–	–	–	3
Tot.	5	37	12	14	11	17	2	11	109

(Sources: Authors' elaboration on the data available at https://www.seminariodepositonazionale.it/. Notes: (*) Including committees against nuclear waste (e.g. Comitati No Scorie). (**) Ass. = associations (e.g. trade unions, business associations, business tourism associations); (^) RI = Research institutions (e.g. Universities, national research agencies). The sessions of Latium and Piedmont lasted two days)

Overall, more than 100 stakeholders took part in the regional sessions (see Table 3.3). Participation has been higher in those regions where the majority of A1 potential sites are located, i.e. Piedmont and Latium (see Table 3.2).

In Apulia/Basilicata and Sardinia participation has also been significant. These regions host respectively 17 and 14 potential sites, although no A1 site is present in their territories. Finally, Tuscany and Sicily show the lower level of stakeholders' involvement, but they are also the regions with fewer potential sites.

Local governments (municipalities and provinces) have been the most active parties in the regional sessions (34%), followed by associations representing several organised interests (e.g. business associations, business tourism associations) (16%), civic committees (e.g. committees created to oppose the siting of the national repository) (13%), and environmental NGOs (11%) (Fig. 3.4). Among the latter, Legambiente has been the most active and joined each regional session. A few citizens and other actors (e.g. companies, park authorities) also took part in the regional sessions, along with research institutions which participated only in the Apulia/Basilicata session. Regional governments have been involved in almost all the territorial sessions.

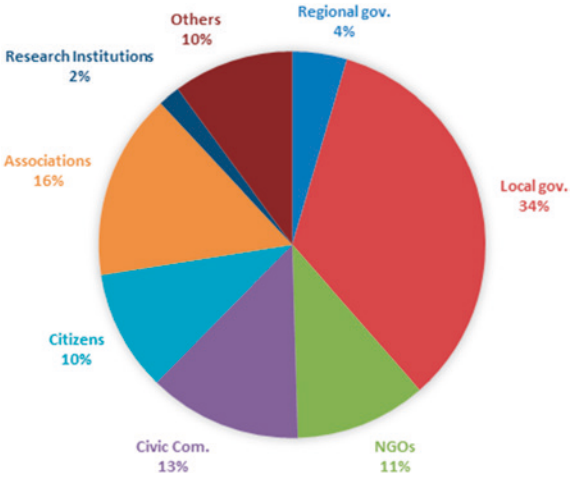

Fig. 3.4 Actors' participation in the regional sessions. (Source: Authors' elaboration on the data available at https://www.seminariodepositonazionale.it/)

As in the previous stage of the participatory process, local governments and associations have generally contested the selection of the sites and criticised the scarce consideration for the socio-economic impact of the national repository, often by highlighting the limited compatibility of the national repository with local development strategies based on agriculture or tourism. Some actors also disputed site decisions, pointing to technical shortcomings in addressing specific risks, such as ground water, seismic criteria or environmental issues. Environmental NGOs also pointed to technical shortcomings in the selection of the sites. Concerning the Piedmont region, it has been noted that especially the areas around the Saluggia and Trino sites already host notable radioactive volumes and that a further site would involve a concentration of health and environmental risks for local population, thus rendering this area a hot-spot from the nuclear risk point of view (see also Borgogno-Mondino et al., 2021).

Only Confindustria, the general Italian industry confederation, has shown support for the national repository and the technological park. Trades unions have been mostly critical, although in some cases they have been sensitive to the potential positive impact of the repository on jobs. Local governments have often coordinated their actions with regional governments, civic committees and local associations in order to build a common front to oppose the siting procedure. Nonetheless, the large majority of stakeholders showed a positive attitude towards

the new participatory process and SOGIN's role. SOGIN in turn appreciated the process and claimed that the new information and data provided by the participants would be duly taken into consideration when drafting the CNAI.

3.5.6 Voluntarism as an Option to Break the Stalemate?

With the approval of the CNAI a phase of voluntary expression of interest will be initiated. According to this voluntarist perspective, which is the first option in the current nuclear waste management framework, SOGIN will check whether any municipality is interested in hosting the national repository. But what are the prerequisites to make the procedures understandable and to gain political and societal acceptance for a repository at regional and local level? Is voluntarism, as in the Scandinavian countries, a path that can also be followed in Italy? Are the planned compensation measures attractive enough to persuade the affected population to host a repository?

Compensation mechanisms are provided for the communities involved. In particular, economic compensation for the territory is subdivided according to criteria set in Art. 23 of the Legislative Decree 31/2010, and is to be paid by SOGIN according to criteria to be set by the Ministry of Economic Development in agreement with the Ministries of Environment and of Finance, depending on the level of radioactivity. There are additional expected benefits for the hosting area of the national repository.[16] These include an employment impact for over 4000 people (of which 2000 are direct) per year during the four years of construction. In addition, in the operating phase lasting 40 years, direct employment is estimated on average at around 700 employees, whilst downstream activities could help increasing employment for around a thousand people.

Yet, the first reaction from regions and local communities to the CNAPI proposal has been a firm 'No'. No regional or local government has explicitly considered claiming the compensation mechanisms provided by the legislation or appears attracted by the direct and indirect benefits connected with the repository and technology park. This strong reaction is common within the majority parties supporting regional and local governments as well as within the opposition. The leeway for changing this position during the next phase of the participatory process appears rather limited.

[16] See the data available at https://www.depositonazionale.it/deposito-nazionale/pagine/quali-sono-i-benefici-del-deposito.aspx#territorio (accessed 26 October 2021).

3.6 Conclusion

Fierce opposition over three decades and a contradictory nuclear policy have provoked a stalemate, and still render the mandatory search for a national repository site for nuclear waste in Italy a political and societal challenge. In the last few years progress has been made, at least on the institutional side. The legal framework and main governance bodies for nuclear waste management are in place and are becoming robust. It was certainly a success that after so many years ISIN could be established in 2018 as the competent licensing authority and as a body independent of economic interests, and that there is a clear demarcation between the regulatory authority and the developer/operator.

However, the reinforcement of a competent and independent authority that can be considered trustworthy by the largest majority of stakeholders and by the entire society, as well as the initiation of an unambiguous participation process that deserves public confidence remain the Gordian knot in Italy as elsewhere in the European Union (Di Nucci et al. 2021). The "independence" and distribution of roles and responsibilities are partly disputable, especially because of the direct dependence of the regulator ISIN on the Executive. Moreover, the double involvement of the operator SOGIN as implementer and future operator of the repository, and as the main actor responsible for the whole public participation process does not help to make it trustworthy to the sceptical or opposing local authorities and population.

In the consultation and participation process, SOGIN represented the official technical and scientific standpoint. Its technical competence is acknowledged by a wide spectrum of stakeholder groups, but the search for a nuclear repository is only partly a technical and scientific matter. Especially in siting issues, the affected population has built up knowledge over decades. For these reasons, siting strategies can no longer rely merely on "official" scientific knowledge. SOGIN technical expertise has been increasingly confronted with lay expertise, e.g. citizen science and alternative expert opinions. There have been criticisms about the suitability of many territories selected by SOGIN in the national map. For example, in a recent analysis of siting criteria adopted by SOGIN, Borgogno-Mondino et al. (2021, p. 20) point out that a site in Piedmont is located in a critical area as the depth of the ground water table can interfere in a substantial way with the vault of the repository.

Social conflicts and opposition are deeply rooted and are exacerbated by the fact that in the past technical approaches have neglected socially relevant questions and have not been made transparent. It appears that in this most recent attempt, Italy is also risking the opportunity to address real and potential conflicts

in a rigorous and open way by failing to integrate the potentially affected local authorities and local residents in the decision-making process. Finding a nuclear waste disposal option requires iterative learning, addressing societal conflicts, and the possibility of readjusting strategies. Following the disclosure of the generally suitable sites, it should have been necessary to gather the consensus of the communities concerned and local institutions, through a more full-fledged public consultation, eventually extended over a longer period of time. However, the participation remained limited to a few hundred people and was concentrated over approximately three months.

The site search procedure could have represented an opportunity for structuring a process in which science and society together cultivate a new art of discourse and are prepared to learn from each other. SOGIN as the responsible actor for the consultation could have gone beyond just informing the public comprehensively, and could have tried to involve the potentially affected territories in the selection process as "co-designers". Such an innovation could have helped to overcome the difficult legacy of the past that has triggered what can be described as a vicious circle of (low) trust. Indeed, the previous top-down approach and the limited involvement of local communities has undermined citizens' trust in public institutions in charge of nuclear waste policy. In general, the relationship between the state and civil society is fundamental to generate and maintain public trust in governmental institutions, and often implies the willingness to delegate negotiation of agreements to them, as this is perceived to be in the public interest (Di Nucci et al., 2021). Exactly this lack of perceived communities' interests makes the new participatory approach problematic, as the standard reaction of the social and institutional local actors involved is a firm 'No', followed by the persistent "protection" of competing local interests. Hence, there is a risk that also decision-makers may lose confidence in the process. No matter how this process is designed and implemented, it can be expected that the actors involved will not change their initial negative stance. They are confronted with other stakeholders and political decision-makers who see little room for manoeuvre in their own logic and standpoints, and this generates mutual distrust. Distrust is also triggered and reinforced by technical, social and political uncertainties and complexities.

Although the whole procedure somehow depended on SOGIN's goodwill, in a preliminary assessment the consultation and role of SOGIN can be considered as fair. The stakeholders expressed their satisfaction, especially with respect to transparency and openness of communication and of the procedures, and were prepared to have confidence in SOGIN's declaration that criticism is going to be taken into consideration.

A timely solution for the waste problem is urged by the Euratom directive (European Council, 2011). However, against this background, 2025 as the point in time envisaged for the localisation is totally illusory. Moreover, it appears that in spite of the good intentions, the initial steps taken towards transparency and openness are not sufficient to instigate trust in the process and in the institutional actors in charge of it. There are no signals of the intention to open up a phase of co-decision for the local communities in the designated sites on the short list. This would be an important step to build confidence in the procedures and to break the enduring stalemate situation. In spite of the potential compensation mechanisms for the affected communities it is unlikely that there will be successful cases of voluntary candidates for the repository, not even by municipalities close to existing nuclear sites. If no candidature is put forward, SOGIN will have to promote bilateral negotiations to find a shared solution. The final decision rests in the hands of the Ministry for Ecological Transition. The worst-case scenario would be for the government to revert to its old reflex and, justified by the pressure to implement the Euratom directive, move back to the old Decide-Announce-Defend strategy. But history has shown that this will not solve the problems and could end up increasing mistrust between society and the government and further hindering the implementation of Italian nuclear waste governance. A more radical way to involve local communities, interest and visions is needed to avoid this rollback and to make steps forward.

References

ANPA (1987). *Guida tecnica n. 26. Gestione dei rifiuti radioattivi*. https://www.depositonazionale.it/raccoltadocumenti/linee-guida/guida_tecnica_n26_gestione_rifiuti_radioattivi.pdf.

Baracca, A. (2008). *L'Italia torna al nucleare. I costi, i rischi, le bugie.* Jaca Book.

Beck, U. (1986). *Risikogesellschaft. Auf dem Weg in eine andere Moderne.* Surkamp.

Borgogno-Mondino, E., Borgia, A. & Cigolin, C. (2021). Locating the Italian Radioactive Waste Repository: Issues and Perplexities Arisen from Open Data-Based Analyses about the TO-10 Site (NW Italy). *Land*, 10, 932. https://doi.org/10.3390/land10090932.

Cianciullo, A. (2003a, June 25). Cimiteri nucleari: slitta la decisione. *La Repubblica*.

Cianciullo, A. (2003b, October 15). Tutti i rischi del cimitero nucleare, *La Repubblica*.

Deposito Nazionale (n. d.). https://www.depositonazionale.it/ Accessed 24 February 2022.

Deposito Nazionale (2020). Stima dei rifiuti radioattivi da conferire al Deposito Nazionale. Rapporto Tecnico: https://www.depositonazionale.it/documentale/progetto_preliminare/sicurezza_del_deposito_nazionale/dnsm00007_stima_rifiuti_radioattivi_da_conferire_al_deposito_nazionale.pdf Accessed 29 October 2021.

Deposito Nazionale (2021). Deposito nazionale rifiuti radioattivi: gli atti del seminario Sogin. https://www.recoverweb.it/deposito-nazionale-rifiuti-radioattivi-gli-atti-del-seminario-sogin/ Accessed 22 February 2022.

Deposito Nazionale (2022a). Procedura di localizzazione del "Deposito Nazionale eParco Tecnologico" ex D.lgs. n.31/2010 e ss.mm.ii. Atti conclusivi del seminario nazionale. https://www.depositonazionale.it/seminario_nazionale_documenti/atti-conclusivi-seminario-nazionale.pdf Accessed 24 February 2022.

Deposito Nazionale (2022b). Proposta di Carta Nazionale delle Aree Potenzialmente Idonee. https://www.depositonazionale.it/consultazione-pubblica/proposta-di-cnapi/pagine/default.aspx Accessed 30 May 2022.

Deposito Nazionale (2022c). Deposito Nazionale scorie radioattive: al MiTE la mappa delle aree idonee https://www.recoverweb.it/deposito-nazionale-scorie-radioattive-al-mite-la-mappa-delle-aree-idonee/ Accessed 30 May 2022.

Di Nucci, M. R. (2009). Between Myth and Reality: Development, Problems and Perspectives of Nuclear Power in Italy. In L. Mez, M. Schneider, & S. Thomas (Eds.), *International Perspectives on Energy Policy and the Role of Nuclear Power* (pp. 279–300). Multi-Science Publishing.

Di Nucci, M. R. (2015). Breaking the stalemate. The Challenge of Nuclear Waste Governance Italy. In: A. Brunnengräber, M. R. Di Nucci, A. M. Isidoro Losada, L. Mez, & M. Schreurs (Eds.), *Nuclear Waste Governance. An International Comparison* (pp. 299–322) Springer VS.

Di Nucci, M. R. (2019). Voluntarism in Siting Nuclear Waste Disposal Facilities: Just a Matter of Trust? In: Brunnengräber A. & Di Nucci M.R. (2019). *Conflicts, Participation and Acceptability in Nuclear Waste Governance*. Springer VS, 145–174.

Di Nucci, M. R., Isidoro Losada, A. M., & Themann, D. (2021). Confidence gap or timid trust building? The role of trust in the evolution of the nuclear waste governance in Germany. *Journal of Risk Research,* (1–19).

ENEA. (n.d.) *Situazione in Italia*, https://www.enea.it/it/seguici/le-parole-dellenergia/fissione-nucleare/i-rifiuti-radioattivi-1/situazione-in-italia. Accessed 15.10.2021.

European Commission. (2010). *Europeans and Nuclear Safety Report*. Eurobarometer 324.

European Council. (2011). Council Directive 2011/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. 1/199/48 *Official Journal of the European Union*, Brussels.

ISIN. (2020). *Inventario nazionale dei rifiuti radioattivi. Aggiornamento al 31 Dicembre 2019*. https://www.isinucleare.it/sites/default/files/contenuto_redazione_isin/inventario_isin_aggiornato_al_dicembre_2019.pdf. Accessed 7 January 2022.

ISIN (2021a). Inventario nazionale dei rifiuti radiottivi, aggiornato al 31 Dicembre 2020. : https://www.isinucleare.it/sites/default/files/contenuto_redazione_isin/inventario_nazionale_rifiuti_radioattivi_al_dicembre_2020_0.pdf. Accessed 12 December 2021.

ISIN (2021b). *National seminar, one of the most important experiences of public debate at national level.* ISIN guarantor of the correct application of national and international criteria. https://www.isinucleare.it/en/news/national-seminar-one-of-the-most-important-experiences-of-public-debate-at-national-level-isin. Accessed 8 September 2021.

ISIN (2021c). Guida Tecnica n. 32. Criteri di sicurezza e di radioprotezione per impianti ingegneristici di smaltimento in superficie di rifiuti radioattivi. October https://www.isinucleare.it/sites/default/files/contenuto_redazione_isin/all_2_gt32_ottobre_consultazione_pubblica.pdf. Accessed 8 December 2021.

IAEA (2021). *Italy*. https://cnpp.iaea.org/countryprofiles/Italy/Italy.htm. Accessed 15 October 2021.

ISPRA (2014). *Guida Tecnica n. 29, Criteri per la localizzazione di un impianto di smaltimento superficiale di rifiuti radioattivi a bassa e media attività.* http://www.isprambiente.gov.it/files/nucleare/GuidaTecnica29.pdf. Accessed 4 September 2021.

La Repubblica (2003, November 19). Scorie a Scanzano Jonico entra in vigore il decreto.

Nuclear Energy Agency – NEA/OECD. (2013). *Radioactive waste management and decommissioning in Italy (Report).* https://www.oecd-nea.org/jcms/pl_33730/radioactive-waste-management-and-decommissioning-in-italy?details=true. Accessed 11 October 2021.

Rossano, A. (2003, December 1). Scanzano, la vittoria della piazza e la forza della comunicazione, *La Gazzetta del Mezzogiorno*.

Rovai, D. (2009). L' eredita nucleare SOGIN, un'esperienza allarmante. http://www.nonukes.it/nonukes/sogin.htm. Accessed 2 September 2021.

SOGIN. (2003). *Studio per la localizzazione di un sito per il deposito nazionale centralizzato dei rifiuti radioattivi*. PDN RT 002. http://www.archivionucleare.com/files/studio-sogin-deposito-nazionale-2003.pdf. Accessed 12 October 2021.

SOGIN. (2020). *Company Profile, April*. https://www.sogin.it/uploads/governanceetrasparenza/SoginCompanyProfile_apr2020_EN.pdf. Last accessed 12 October 2021.

SOGIN. (2021a). *Relazione_sulla_Gestione_e_Bilancio_Esercizio_2020 (Consolidated Financial Statement 2020)*. https://www.sogin.it/en/group/economicdata/Pagine/default.aspx https://www.sogin.it/SiteAssets/uploads/2021/societa-trasparente/Bilanci/Sogin_Relazione_sulla_Gestione_e_Bilancio_Esercizio_2020.pdf.

SOGIN. (2021b). *Atti conclusive del seminario nazionale*. https://www.depositonazionale.it/seminario_nazionale_documenti/atti-conclusivi-seminario-nazionale.pdf. Last accessed 18 December 2021.

SOGIN. (2021c). *Rapporto Tecnico. Stima dei manufatti di rifiuti radioattivi da conferire al Deposito Nazionale. Rev. 4 Rapporto Tecnico ELABORATO DN SM 00007. Status 30.12.2020.* www.depositonazionale.it/documentale/progetto_preliminare/sicurezza_del_deposito_nazionale/dnsm00007_stima_rifiuti_radioattivi_da_conferire_al_deposito_nazionale.pdf. Accessed 7 January 2022.

Ventura, G. (2003). *Sistema Informativo Geografico per il sito del Deposito Nazionale dei Materiali Radioattivi.* ENEA GSP3 SITO. http://www.archivionucleare.com/files/studio-gsp3-sito-deposito-nazionale-2003.pdf. Accessed 11 October 2021.

World Nuclear Association. (2021). Nuclear Power in Italy. https://world-nuclear.org/information-library/country-profiles/countries-g-n/italy.aspx. Accessed 18 September 2021.

World Nuclear News. (2021, January 29). *Italy begins search for national radwaste storage site*. https://www.world-nuclear-news.org/Articles/Italy-begins-search-for-national-radwaste-storage. Accessed 15 October 2021.

Zinn, D. L. (2007). Il caso di Scanzano: la ragione di stato e le ragioni di una ribellione. *Quaderni di Sociologia*, 44, 151–174.

Maria Rosaria Di Nucci is an energy economist and a Senior Researcher at the Department of Political and Social Sciences, Freie Universität Berlin. Currently she is the principal investigator of the Horizon 2020 research project COME RES on community energy. Previously she coordinated a Horizon 2020 project on acceptance of wind energy and cooperated in the project TRANSENS: "Transdisciplinary research on the management of

high-level radioactive waste in Germany", and other projects on nuclear waste governance (ENTRIA and SOTEC-radio). She is co-editor of a number of volumes on nuclear waste issues and authored several articles on nuclear waste governance. Rosaria's research interests comprise: Multi-level governance, regulation of energy markets, comparative nuclear and energy policy and politics, support instruments for renewable energy, acceptance of contested technologies.

Andrea Prontera is a political scientist and an Associate Professor at the Department of Political Science, Communication and International Relations of the University of Macerata (Italy). He has a degree in economics and social sciences, and a PhD in political science. His main research interests lie in the areas of energy policy and politics, international political economy, comparative public policy and European politics.