HoNESt History of Nuclear Energy and Society

D4.2

Comparative cross-country analysis on preliminary identification of key factors underlying public perception and societal engagement with nuclear developments in different national contexts

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CAVEAT

Following the HoNESt research approach, the empirical basis for this deliverable consists of the so-called 'short country reports' produced by HoNESt historians who are experts of the history of nuclear energy of 'their' specific countries. The aim of social science research in HoNESt Work Package 4 is to analyse these reports in terms of perception and engagement. In the process of this analysis we are only occasionally able to refer to original primary sources and to reference them since these are often not accessible e.g. for language reasons. In line with received scholarly practice of such 'secondary analysis', we will reference to the relevant short country reports, where the full reference to the primary sources can be found. In addition, it is all the more important to mention that these **'short country reports' are still in a draft status and not yet approved by the EC**.

PREFACE

This document Deliverable 4.2 'Comparative cross-country analysis on preliminary identification of key factors underlying public perception and societal engagement with nuclear developments in different national contexts' is an update – in response to the HoNESt midterm review – of the previous version of D4.2 which was submitted in September 2016. The revision consists of four elements:

1. Update of country studies: The first issue of D4.2 had to be based on preliminary versions of HoNESt historians short country reports. In the meantime, the final drafts of these reports are available, which offered the opportunity to amend D4.2 social science country studies in the light of the latest versions of the short country reports.
2. USA country study: Following the emphasize put on US nuclear developments by the midterm review, D4.2 has been enhanced by an additional country study analysing the US case.
3. Update of comparison section: Revising the existing country studies, and adding one more country, required updating the cross-country comparisons.
4. Conclusions section: A conclusions section has been added aiming at summarizing findings, but also pointing to the limits and approach of D4.2.

EXECUTIVE SUMMARY

This report deals with the history of nuclear-society interactions from a social science perspective. Since the beginning of project HoNESt in September 2015, historians have elaborated 20 so-called 'short country reports' covering most European and major non-European countries (e.g. USA). On the basis of this comprehensive collection of individual studies – each encompassing about 60 years of history – we have selected seven countries to be analysed in terms of public perception of, and public engagement with, nuclear energy: Austria, Bulgaria, the Federal Republic of Germany (FRG), the Netherlands, Spain, the United Kingdom (UK), and the United States of America (USA). Our findings reveal that each country follows its own nuclear development path with corresponding preference profiles and engagement traditions. However, there are similarities among countries allowing researchers to classify them analytically as either neutral to supportive (e.g. UK) or refusing (e.g. FRG) with regard to deploying nuclear power for electricity production. The varying preference profiles of each country hints at the fact that people refer to a broad scope of heterogeneous evaluation criteria when assessing nuclear technologies. Arguments such as security of energy supply, (dis)trust in decision-makers, climate change, or national prestige play an important role in the debate. Citizens argue from different points of view. Their perceptions and arguments reflect the complexity of the debate comprising environmental, economic, social, and political considerations. Except for the UK and Bulgaria, where protests only occasionally occurred, all countries have faced active civil society opposition against nuclear issues, i.e. *public forced communication* activities. Pro-nuclear *communication* processes commissioned by regulators and industry promoters of nuclear power are part of the history of nuclear-society interactions in each country. However, there is only a handful of examples of *consultation* initiatives, and just one case of a public *participation* process.

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1. Introduction

This document is part of the research undertaken in the context of HoNESt Work Package 4. It provides a report on key factors underlying societal perception and engagement with nuclear developments in selected European countries and the United States. It relies on a systematic approach of scrutinizing a range of country reports using an overall evaluation framework in analysing historical narratives of nuclear developments and outstanding events related to the use of nuclear energy.

Against this background, we aim at testing the validity and feasibility of our concepts of public perception and public engagement in different national nuclear environments, focusing on nuclear power and research reactors and referring only occasionally to waste issues and nuclear weapons – namely where these are prominent in the debate about nuclear power. In order to be able to make useful cross-country comparisons, we decided to assess seven countries – Austria, Bulgaria, FRG, Netherlands, Spain, UK, and USA – based upon on the following selection criteria:

- *Country size*
  - Large: FRG, Spain, UK, USA
  - Small: Austria, Bulgaria, Netherlands
- *Political system*
  - Democratic: Austria, FRG, Netherlands, UK, USA
  - Transition from authoritarian regime to democracy: Bulgaria, Spain
- *Status of the use of nuclear energy*
  - Reactors in operation: Bulgaria, FRG, Netherlands, Spain, UK, USA
  - Governmental decision to stop future use: FRG
  - Governmental decisions regarding future use to be taken: Bulgaria, Spain
  - New reactors under construction or research: UK, USA, Netherlands
  - Nuclear never part of electricity supply: Austria

The data bases for this deliverable are the following HoNESt draft short country reports provided by historians in the context of the project's Work Package 2::

- Berkers, E., 2017. The Netherlands Short Country Report, February 2017. HoNESt Project Report.
- Butler, S., Bud, R., 2017. United Kingdom Short Country Report, February 2017. HoNESt Project Report.
- Forstner, C., 2017. Austria Short Country Report, February 2017. HoNESt Project Report.
- Josephson, P.R., 2017. United States Short Country Report, February 2017. HoNESt Project Report.
- Kirchhof, A.M., Trischler, H., 2017. Federal Republic of Germany Short Country Report, February 2017. HoNESt Project Report.
- Rubio-Varras, M.d.M., De la Torre, J., Espluga, J., Presas i Puig, A., 2017. Spain Short Country Report, February 2017. HoNESt Project Report.
- Tchalakov, I., Hristov, I., 2017. Bulgaria Short Country Report, February 2017. HoNESt Project Report.

The structure of the report is as follows. Section 2 gives a brief overview of the concept of 'public perception', explains the method deployed for identifying nuclear energy evaluation categories, and delivers a list of those categories elicited by analysing country reports. Section 3 deals with engagement and the type of actors involved in engagement processes. Section 4 provides our results of analysing historians' country studies in terms of public perception and public engagement. Section 5 discusses the results focussing on cross-country comparisons. Finally section 6 summarizes the findings and points to the limits and approach of this report.

2. Public perception

As the transformation of the energy system has become a key policy issue in many countries, public perception and acceptance of both the transition process and single energy technologies has become a major topic in energy research and policy advice literature (Bickerstaff et al. 2008; Demski et al. 2015; Devine-Wright 2008; Ellis et al. 2007; Hauff et al. 2011; Kim et al. 2013; Scheer et al. 2014, 2017). Rather than assuming knowledge that identifies a human or social

system to be objective and one that can be readily identified and improved, HoNESt social scientists understand reality as the creative construction of human beings. This assumption is underlying our concept of 'perception'; a definition that seeks to understand reality as the construction of people's interpretation of their experiences, in this case nuclear energy and its interaction with civil society.

Quantitative and qualitative evidence of public acceptance of nuclear technologies reveals an interplay between numerous complex factors influencing and shaping perceptions and values. These include factors such as institutional trust, procedural fairness, risk tolerability, availability of scientific information, and nuclear power's role in mitigating anthropogenic climate change (Besley 2012; Parkhill et al. 2010; Pidgeon et al. 2008; Poortinga et al. 2006; Visschers/Siegrist 2012). Such complex factors go beyond simple direct interactions with government and the nuclear industry and reflect a spectrum of interactions within local communities and within wider society (Whitton et al. 2016).

Against this background, this deliverable presents preliminary results of public attitudes and preferences towards nuclear energy within the seven countries listed above. By means of qualitative analysis of HoNESt reports on countries' nuclear history, data were synthesized into a set of country-specific acceptance profiles. In doing so, content analysis has been conducted using an inductive category development procedure referring to Mayring (2004). Each nuclear history report of the seven countries investigated for this deliverable was examined in-depth in order to create categories representing the evaluation basis for preference making towards using nuclear power stations for electricity production. In a second step, the text passages assigned to these categories were further investigated in order to deduce sub-categories specifying the main category. This process has been performed by the two lead authors of this deliverable in a way that each country report was analysed by a single researcher. In particular, Konrad is responsible for the evaluation of Austria, Bulgaria, FRG, Netherlands, UK, and USA, Espluga for Spain. Overall, we identified the following eight categories for evaluating nuclear energy.

- *Trust:* This issue captures whether (dis)trust in politics, institutions, and business plays a role in evaluating nuclear energy.

- *National economics:* This evaluation category gathers arguments related to a collective, i.e. national economic perspective, encompassing topics such as security of supply, wealth and industrial progress, or resource requirements.
- *Consumer economics:* The issue of consumer economics considers microeconomic considerations on individual and household level, e.g. concerns about energy prices.
- *Local impact:* This aspect refers to effects raised by citizens living close to planned or realized nuclear sites. Perceptions influenced by proximity can be both supportive (e.g. stressing benefits of job creation) or refusing (e.g. locally unwanted land uses). Moreover, this factor gathers reasoning patterns hinting at a gap between individual and collective technology acceptance (e.g. a nuclear reactor is not rejected *per se* but when living close to it).
- *Environmental impact:* This issue consists of positive or negative assessments as to the environmental impacts of nuclear energy. This applies e.g. for statements about climate change or radioactive contamination.
- *Social & ethical impact:* This category serves to collect arguments related to values of national or local identity, fairness and justice from both an inter- and intra-generational perspective, and non-proliferation of nuclear blueprints, technologies, and materials.
- *Health impact:* This factor captures fears of being exposed to health risks originating from nuclear power plants.
- *Risk of catastrophic accident*: This issue compiles arguments centred on the high or low damage potential of nuclear power.

3. Public engagement

Understanding public perceptions is an important prerequisite when it comes to engaging with citizens about nuclear energy. Since the limitations of a one-way information process from institutions to society has become clear, public participation seems to be the means of choice to make (energy) policy decisions socially acceptable (Whitton et al. 2016). For Rowe and Frewer (2005), public participation is the “practice of involving members of the public in the agenda-setting, decision-making, and policy-forming activities of organizations/institutions responsible for policy development” (Rowe/Frewer 2005:253). Based on the flow of information between

participants and promoters, i.e. those who have commissioned the engagement initiative, the authors differentiate between three engagement types (Rowe/Frewer 2005:254ff.).

- *Public communication* refers to a process where information is transferred from the sponsor of an initiative to the public. There is no involvement of the public *per se*, i.e. public feedback is not required or sought.
- *Public consultation* refers to a process of conveying information from members of the public to the sponsors of the initiative, following a process initiated by the sponsor. In this process, there is no formal dialogue between individual members of the public and the sponsors.
- *Public participation* means the existence of information exchange between members of the public and the sponsors. The most significant feature of a participatory engagement is that there is some degree of dialogue in the process. The flow of information is two-way, with the exchange of information opening up the possibility of perception change in both the sponsors and the public.

These three categories have proven to be effective in capturing and classifying nuclear-related engagement activities initiated by state authorities or industrial organisations. However, it turned out that beyond such 'official engagement' in the history of nuclear-society interactions the public or its representatives often created and conducted their own participation activities. We suggest designating engagement actions directed from the public to regulators or nuclear companies as *'public forced communication'*.

In order to enable clear distinctions between different originators and receptors of engagement processes, HoNESt researchers have developed the following scheme consisting of four actor types.

- *Promoters (or private sponsors)*: Companies, scientific bodies (supporting promoters arguments/interests), interest organizations, political parties.
- *Regulators (and other public institutions):* Regulators at local, regional, national, international, and transnational level, scientific bodies (supporting policy making).

- *Receptors (or affected people):* Civil society (organized people such as environmental groups, associations, neighbourhood groups, NGOs, labour unions), interest groups, political parties, public in general, scientific bodies (supporting affected people).
- *Other:* Media (opinion pieces supporting promoters', regulators', or affected peoples' arguments/interests), non-nuclear scientific bodies.

Figure 1 demonstrates how to differentiate between these actor types.

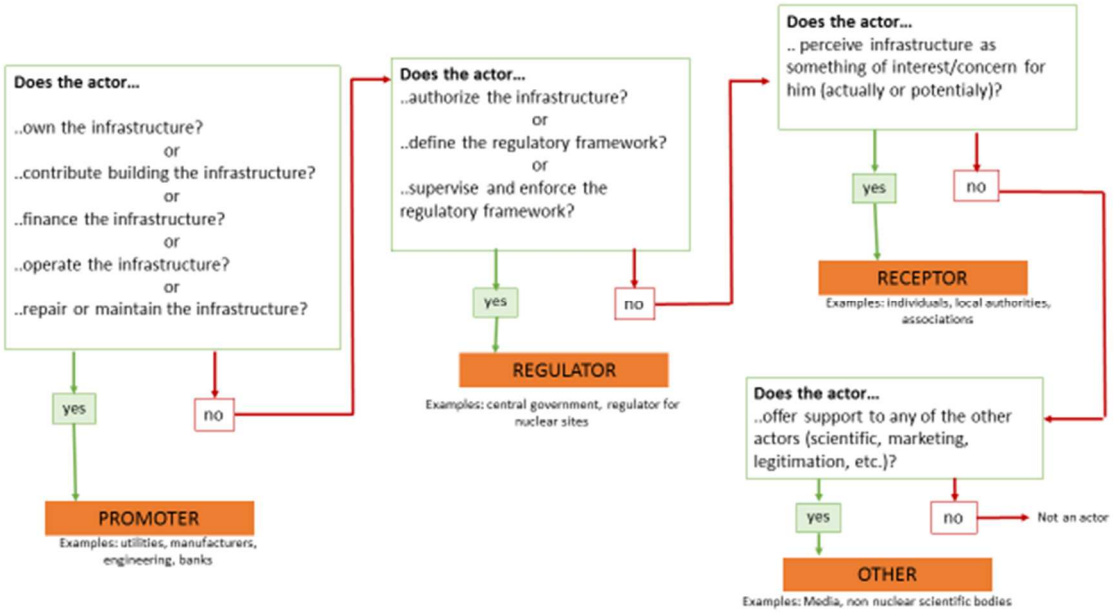

Figure 1: Actor's taxonomy

Source: Rubio-Varas et al. (2016)

4. Social science country studies

The purpose of this section is to present the results of the social science investigations of the historians' country reports. Each country portrait starts with a table providing latest and historical facts on the country's nuclear programme, followed by significant techno-economic as well as perception and engagement highlights. Subsequently, light is shed on nuclear-society interactions by analysing in detail the characteristics of the nations' public perception and public engagement

history. This scheme has been employed for the analysis of seven countries that in this section are presented in alphabetical order.

4.1. Austria

The purpose of the following table is to provide a brief overview of basic facts on nuclear power in Austria.

Table 1: Basic facts on nuclear power in Austria

Current status	
• No. of electricity producing reactors • Share of electricity mix (2016) • Future use	• 0 • 0% • No reactors planned
Historical data	
• Overall number of reactors built • Start of nuclear energy supply	• 1 commercial & 3 research reactors (one research reactor still in operation) • Not at all
Technical and economic characteristics	
• Research reactors projected immediately after regaining national sovereignty in March 1955 • 3 commercial reactors planned (1971, 1976), only one (Zwentendorf) was built, but was never operational	
Public perception and engagement	
• Vote against the start of Zwentendorf power station in national referendum 1978 • To be nuclear-free central part of Austrian identity with constitutional status since 1999	

Source: own depiction

4.1.1. Public perception in Austria

In the history of nuclear energy in Austria, the anti-nuclear movement managed to convince the country's population to narrowly vote against the introduction of commercial nuclear power in a referendum in 1978, so that the already completed nuclear power plant at Zwentendorf never went critical. At first, mainly taking place at the local level in the light of a public opinion at least partly in favour of technical progress, civil society opposition against nuclear power grew to nation-wide protests that finally caused policy-makers to incorporate a ban on the use of nuclear energy in the Austrian constitution. As the short country report data show, public criticism of nuclear reactors was nurtured by national economics, local impacts, and health concerns.

National economics

The first stirrings of protest against the Zwentendorf power plant had become visible with a memorandum of the Lower Austrian Chamber of Physicians from 1969. Among other arguments, the authors questioned the viability of this project and argued in favour of increasingly deploying Austrian's hydropower capabilities (Forstner 2017:25).

Local impact

At the end of the 1950s, the first siting decision for the research reactor of the Austrian universities (TRIGA MARK II) was criticised by residents due to plans of locating it at a World War II above-ground flak tower in the Augarten, a central Vienna pleasure ground (Forstner 2017:18). Another argument raised against using this facility was the bad condition of the building.

Health impact

A key argument both in the debate about the location of research reactors and the use of nuclear energy at all was concern about the hazards to human health coming from nuclear radiation. These fears not only had a medical background, but also rested on eugenics ideas of radiation having harmful impacts on the genotype of the Austrian people (Forstner 2017:25).

Table 2: Acceptance profile Austria

Evaluation categories	Arguments	Evaluation
National economics	- Increasing use of hydropower rather than nuclear power	●
Local impact	- Central city pleasure ground as research reactor site - Construction defects at suggested plant location	● ●
Health impact	- Hazards to human health connected with radioactivity - Concerns about peoples' genotype based on eugenics ideas	● ●

● = contra ⦿ = ambivalent O = pro

Source: own depiction

4.1.2. Public engagement in Austria

In the course of Austria's nuclear history we can observe the implementation of communication and consultation processes as well as examples of public forced communication.

Public communication

Faced with a growing, in its beginning in 1969 widely ignored campaign against nuclear power plants, the Austrian government in April 1976 commenced a public information campaign consisting of expert discussions ('hearings') in ten Austrian cities (Forstner 2017:25ff.) Both supporters and opponents of nuclear energy were represented among those experts. Far from yielding the desired success in terms of creating a pro-nuclear morale among the public, the government's communication exercise on the contrary helped local protest groups in May 1976 to form an umbrella organization (Initiative of Austrian Nuclear Power Opponents) aiming at preventing Zwentendorf from being commissioned (Forstner 2017:28).

Public forced communication & Public consultation

Austria's civil society played an active role in campaigning against nuclear power plants, strongly arguing with negative impacts of radiation on the human body using examples from Hiroshima and Nagasaki as evidence. At the end of the 1950s, protests of residents led to moving the site of the planned Austrian universities' research reactor from a Vienna's central pleasure ground to a peripheral area (Forstner 2017:18). Between 1972 and 1975, up to 20,000 inhabitants of the state of Vorarlberg protested against the projected Swiss nuclear power station Rüthi. As this plant should be built near the Austrian border, the so-called Anti-Rühti Marches crossed the border to Switzerland (Forstner 2017:40). Initially local criticism and protests against the planned nuclear power stations Zwentendorf and Stein/St. Pantaleon emerged into a nation-wide anti-nuclear movement consisting of a wide range of social and political groups, e.g. mothers, teachers, natural scientists, pupils, Catholics, artists, trade unionists, socialists, communists, and even right-wing communities arguing on the basis of ideas of eugenics. One anti-nuclear key event was a panel discussion with about 3,500 participants in Linz in April 1975. This discussion was broadcasted all over Austria, both Chancellor Kreisky and the Minister of Trade were among the discussants. Alarmed by the 1976 Swedish parliamentary elections, in which the controversy

on nuclear power had supposedly cost the Swedish Social Democrats crucial votes (Kolb 2007), and domestically under pressure of the protest movement, the social democratic Austrian Chancellor Bruno Kreisky enacted both a construction freeze of the Stein/St. Pantaleon plant and decided to hold a public national referendum on whether the Zwentendorf plant should go into operation or not. In November 1978, a narrow majority of 50.47% voted against the start up, and only a month after the plebiscite the parliament adopted a new law that forbade the use of nuclear fission in Austria for energy production. However, this was not the end of the Austrian anti-nuclear movement. Following the TMI and Chernobyl accidents, the anti-nuclear movement gained even more importance and significantly influenced the government in declaring Austria in 1999 – by constitutional law – to be a non-nuclear country (Forstner 2017:20f., 27ff., 38f.). The 'Bundesverfassungsgesetz für ein atomfreies Österreich' (Federal Constitutional Act for a Non-Nuclear Austria) determines that:

- "Nuclear weapons cannot be produced, tested, stored or transported,
- Nuclear power plants cannot be constructed anymore and those that are already built cannot start operation,
- Transport and storage of compounds for nuclear fission are forbidden, except those for peaceful uses although not those for energy production,
- The Republic of Austria is liable for any injuries due to accidents with radioactive compounds or has to enforce the claims from foreign causers,
- The Federal Government is responsible for the implementation of the law" (Forstner 2017:21).

4.2. Bulgaria

The purpose of the following table is to provide a brief overview of basic facts on nuclear power in Bulgaria.

Table 3: Basic facts on nuclear power in Bulgaria

Current status	
• No. of electricity producing reactors • Share of electricity mix (2016) • Future use	• 2 • 35,03% (IAEA 2017) • Permanent construction freeze of two reactors at Belene
Historical data	
• Overall number of reactors built • Start of nuclear energy supply	• 7 (6 commercial, 1 experimental) • 1974 (Kozloduy I to grid)
Technical and economic characteristics	
• Bulgarian power plants are based on Soviet reactor types • By the time all 6 reactors were running Bulgaria was able to export up to 20% of its power production • In 2007 reliability and safety levels of the 2 operating reactors were brought into conformance with Western European standards	
Public perception and engagement	
• No public participation in nuclear issues during communist era • Polls show public in favour of nuclear power • Pro nuclear energy referendum results not valid due to low turnout	

Source: own depiction

4.2.1. Public perception in Bulgaria

Until the beginning of the 1990s, when the country's political system changed from a communist regime into a parliamentary democracy, what Bulgarian citizens' thought about utilizing nuclear technologies for electricity production did not enter a public space and remained politically largely irrelevant. Nevertheless, before 1990, as everywhere in Eastern Europe the Communist authorities had promoted nuclear power as part of Soviet style development and modernity. Since then, nuclear energy has become a subject of discussion within both the political and public arena. Although the civil society debate on nuclear power started in 1989 with the foundation of the nuclear-critical Ecoglasnost environmental organisation, a slight majority of the Bulgarian population seems to accept nuclear power plants, according to an opinion survey conducted after Fukushima in March 2011. In that poll, 50.9% said that Bulgaria should still build new nuclear reactors, while 45.2% disagreed. Asked for a decision about realising or not realising two reactors

at Belene, 44% agreed with constructing one plant and another 24% agreed with constructing two plants, while 32% indicated that they would build no reactors at all (Tchalakov/Hristov 2017:49f.). This predominantly positive attitude, as the country report shows, is, however, interwoven with concerns and compromises resulting from the evaluation of government decisions in terms of trust, national economics, and health impact.

Trust

The government's policy of not informing the Bulgarian population about the real consequences of the Chernobyl accident led to the creation of an overall feeling of distrust in nuclear technologies (Tchalakov/Hristov 2017:17.). This policy was implemented under the influence of the Soviet Union and its probably misleading suggestions towards handling the Chernobyl case.

National economics

One of the preconditions Bulgaria had to accomplish to be allowed to become a member of the EU was to shut down four of the six reactors of the Kozloduy power plant for safety reasons. Critics of this decision argued Bulgaria would lose a crucial part of its industrial capability when fulfilling the European Commission's request.[1] Economic considerations were also put on the agenda in the debate on the question of whether construction of the Belene power plant should be completed or not. Those who supported completion said the plant would prevent Bulgaria from importing electricity from Romania and Turkey; those against argued that this would increase energy dependency from Russia since a Russian company would build the Belene plant. (Tchalakov/Hristov 2017:43).

Health impact

In the years following the Chernobyl accident a share of the Bulgarian population has developed fears about radiation pollution – according to the Bulgarian country report, in "1993 more than

[1] The Bulgarian country report suggests a direct link between the Kozloduy case and EU membership of Bulgaria. In a poll of 1999 more than 70% wanted Bulgaria to become an EU member state, and almost 60% agreed with the statement 'Membership in the EU needs sacrifices and privations now, but its worth for the future.' The authors of the report conclude: "In this period Bulgarian society sees the EU membership as better opportunity than keeping the nuclear industry in its former scale" (Tchalakov/Hristov 2017:41).

38% of Bulgarian population considers radiation pollution as the most dangerous threat" (Tchalakov/Hristov 2017:18.).

Table 4: Acceptance profile Bulgaria

Evaluation categories	Arguments	Evaluation
Trust	- Partly distrust in nuclear technologies resulting from Chernobyl accident information policy	●
National economics	- Loss of industrial capabilities - Saving from vs. running into energy dependency of foreign countries	○ ◉
Health impact	- Partly believing that radiation pollution is a dangerous threat	●

● = contra ◉ = ambivalent ○ = pro

Source: own depiction

4.2.2. Public engagement in Bulgaria

Public engagement in the Bulgarian nuclear history centred on communication and consultation processes; in addition activities of public forced communication can be observed.

Public communication

During the communist era, the public had no voice in nuclear power decision-making. Debates about the Bulgarian energy policy and the role of nuclear reactors in the country's energy portfolio took place within the political, economic and scientific nomenklatura. Citizens had no other choice than to notice and accept what government had decided. Hence, public communication about nuclear issues was processed within a top-down framework without any feedback opportunity for the receivers of the state's messages. The government relied on this one-way approach when only insufficiently informing the public about the Chernobyl accident, since – as the Bulgarian country report says – "Bulgarian communists were just too loyal to the Russians" (Tchalakov/Hristov 2017:37).

Public forced communication & Public consultation

One of the first activities of the Ekoglasnost environmental organisation founded in 1989 in the course of the Bulgarian regime change was urging the provision of reliable information about Chernobyl and the accident's impacts. But this has only been the starting point for the rise of protests of parts of the Bulgarian public against the country's nuclear programme that, amongst

other factors (e.g. lack of funds), contributed to the construction freeze of the Belene plant in 1990 (Tchalakov/Hristov 2017:25.). Another key event of public engagement has been the referendum of January 2013. The referendum was concerned with voting on whether Bulgaria should develop nuclear energy through construction of a new nuclear power plant. (However, it was widely presumed that it actually was on restarting the frozen Belene project.) The ballot yielded two results. First, a clear majority of participants voted in favour of nuclear energy with 61.49% 'Yes' votes and 38.51% 'No' votes. Second, with a turnout of just 20.22%, this result was politically non-binding since the referendum significantly missed the required 60% quorum of registered voters. Therefore, the referendum did not change the state of the Belene project since the government "refused to restart the project pointing to the non-binding rate of participation" (Tchalakov/Hristov 2017:5; cf. 27, 50).

4.3. Federal Republic of Germany

The purpose of the following table is to provide a brief overview of basic facts on nuclear power in the Federal Republic of Germany (FRG).

Table 5: Basic facts on nuclear power in the FRG

Current status	
• No. of electricity producing reactors • Share of electricity mix (2016) • Future use	• 7 • 13,12% (IAEA 2017) • No new reactors planned, phase out of nuclear energy by 2022
Historical data	
• Overall number of reactors built • Start of nuclear energy supply	• More than 90 commercial & prototype reactors • 1961 (Kahl to grid)
Technical and economic characteristics	
• Development and exports of own reactors • All domestic reprocessing activities ceased • Phase-out decision after Fukushima in 2011 reaffirmed and accelerated: immediate shut down of 8 reactors, close down of remaining reactors step by step by 2022 (2000: initial phase-out decision ['Atom Consensus']; 2010: lifetime extensions to running power plants partly until the end of 2030s) • Dismantling of nuclear power plants emerges as new business opportunity	
Public perception and engagement	
• Negative perception of nuclear power reinforced by major accidents at Chernobyl and Fukushima • Massive and, in some cases, violent protests against nuclear projects • Public opposition key factor for both ceasing single nuclear projects and eventually phasing out of utilizing nuclear energy	

Source: own depiction

4.3.1. Public perception in the FRG

Since the 1960s, nuclear energy has been a controversial societal issue in West Germany. The conflict, however, was not dominated by the discourse of specialized groups of advocates and opponents, but was strongly influenced by a broad involvement of often local civil society actors, often around reactor sites throughout the country in the 1970s and 1980s. Citizen action groups carried their protest into the political realm by founding the German Green party in the late 1970s. The relatively strong green party has given the nuclear issue a prominent presence in German politics, contributing – along with other factors – to the phase-out decision of the Merkel government in 2011.

An early example of public opposition took place in Karlsruhe. Local women's associations were critical of the nuclear research center operating since 1962 "because of the danger posed to citizens in a city with a high population density" (Kirchhof/Trischler 2017:8). However, the main starting point of the German anti-nuclear movement is connected with the protests against the proposed Wyhl power plant in the mid-1970s (Radkau 2012). As opposed to the United States (cf. below), civilian energy production and military use of nuclear technologies had been perceived as being independent issues until the 1980s. Electricity and weapons production were considered as being two sides of the same coin only in the context of the opposition against the proposed Wackersdorf reprocessing plant. The anti-nuclear movement suspected that this plant would serve weapon-technical purposes and should be built as part of the NATO double-track decision of December 1979 (Radkau 2012:119). Investigating the FRG short country report (Kirchhof/Trischler 2017, the factors determining public perception of nuclear energy in the FRG can be assigned to the evaluation categories trust, national economics, environmental impact, social & ethical impacts, health impact, and risk of catastrophic accident.

Trust

In the course of the nuclear debate, time after time it has become obvious that lack of trust is a popular point of criticism among those against nuclear energy. Mistrust was raised against both political and economic actors. Critics suspected that regulators, the state, and the nuclear industry colluded and were not trustworthy. The political handling of big industry projects were perceived as non-transparent and authoritarian, with opponents blaming policy-makers for not seriously considering alternative energy technologies (Kirchhof/Trischler 2017:6, 13). Left-wing critics perceived this collusion between the state, the regulators and industry in terms of left-wing ideas current in the 1970s, such as the leftist tenet 'state-monopoly-capitalism', with the state being the saviour of industry in late capitalism. Ideas of the high-security 'nuclear state' – drawing on Jungk's 'Der Atomstaat' (Jungk 1979) – also played a role in this debate.

National economics

From an economic point of view, critics addressed the high cost of nuclear energy as a major disadvantage. In the opinion of many citizens, "the costs of the facilities far exceeded the benefits" (Kirchhof/Trischler 2017:14).

Environmental impact

Negative environmental impacts have been assumed for both the construction and running of nuclear power stations. For instance, farmers and wine growers feared negative environmental impacts resulting from the cooling towers of the projected Breisach power plant (Kirchhof/Trischler 2017:25).

Social and ethical impacts

Nuclear opponents claimed an ethical duty to act against nuclear energy for the sake of a nuclear-free future of the coming generations. However, arguing for inter-generational justice did not follow only altruistic ambitions, rather a major driving factor was the fear of being accused by succeeding generations of failing to act against the nuclear industry. Here, arguments drawing on the example of earlier generations having failed in the face of the ethical challenge posed by the Nazi dictatorship played an important role (Kirchhof/Trischler 2017:13f., Schüring 2012).

Health impact

Worries about the risks of low-level radiation have been discussed with respect to both public health in general and children's health in particular (the latter issue mostly raised by women), and locally in certain regions, such as the vicinity of the power plant Krümmel (East of Hamburg) (Kirchhof/Trischler 2017:27).

Risk of catastrophic accident

The public felt troubled by both the dangers of nuclear waste disposal and the risks imposed to the population in case a disaster would happen at a power plant. The latter argument became specifically relevant in debates in the aftermath of the Chernobyl accident and about the fast breeder project in Kalkar (which was never put into service). In a trial in 1984 against Kalkar launched by a local farmer, nuclear experts like the physicist Reiner Szepan assessed this reactor

type as more difficult to control than a conventional plant, thus in their view it would involve significantly higher risks of serious accidents: “On the one hand a Bethe-Tait accident could not be ruled out; on the other hand liquid sodium was used for cooling, which was chemically especially aggressive” (Kirchhof/Trischler 2017:20).

Table 6: Acceptance profile FRG

Evaluation categories	Arguments	Evaluation
Trust	- Mistrust in regulators, the state, and the nuclear industry - Non-transparent and authoritarian handling of big industry projects - Ignoring of technological alternatives	● ● ●
National economics	- High cost of nuclear energy	●
Environmental impact	- Negative impacts of both construction and running of reactors	●
Social & ethical impact	- Duty of contributing to nuclear-free future (inter-generational justice)	●
Health impact	- Public health concerns - Worries about children’s health	● ●
Risk of catastrophic accident	- Disaster risks of nuclear plants (e.g. fast breeder) - Dangers of nuclear waste disposal	● ●

● = contra ⦿ = ambivalent ○ = pro

Source: own depiction

4.3.2. Public engagement in the FRG

Although German decision-makers over decades have been constantly engaged in *public communication* activities – striving to provide citizens with information about the advantages of nuclear power – the key feature of (West)Germany’s history of nuclear-society interactions is an increasingly critical civil society participating in numerous anti-nuclear *public forced communication* initiatives. The toponyms Wyhl, Brokdorf, Gorleben, Kalkar, and Wackersdorf signify key locations of civil society resistance against nuclear power plants, radioactive waste disposals, and reprocessing facilities taking place throughout the 1970s and 1980s (Kirchhof/Trischler 2017:9ff.). Except for the Brokdorf power plant, none of these nuclear projects went into operation. One – but not the sole – reason[2] for the projects’ failures had been massive protest demonstrations at all of these sites of up to 100.000 people, which were sometimes

[2] Besides public resistance, for each project eventually not realized there are specific political or economic reasons additionally important for understandig decisions to terminate the project. However, the particular weight of each argument in the decision process is not always cleary apparent. For instance, regarding the Wackersdorf case, the German country report argues that “it is still unclear whether protests, plant economics, or the death of Minister-President Franz-Josef Strauss, a strong proponent of the plant, in 1988 led to the decision” (Kirchhof/Trischler 2017:28).

accompanied by the occupation of building sites. Repeatedly these protests turned into violent clashes with the police, causing observers in the Brokdorf case to speak of “civil-war-like confrontations between police forces and opponents of the project” (Glaser 2012:12). A reason for the strength and partly violent nature of the German anti-nuclear movement stems from the deeply rooted mistrust in state and industry, culminating in activists’ perceptions of citizens being victims of the machinations of the nuclear complex. Left-wing activists inspired by ideas of a high-security ’nuclear state’ (cf. above) “saw a connection between the extension of atomic energy and democratic deficits and argued that the atomic lobby lacked transparency as well as honesty” (Kirchhof/Trischler 2017:13). Underpinned by such a rationale that argues against nuclear energy from a political and not a technical point of view, brutal police responses led militant anti-nuclear actions to gain even more support. Another explanation of the high level of violence committed by parts of the anti-nuclear movement is that German activists perceived and practiced civil disobedience in different terms than US activists, for whom it implied strictly non-violent conduct, even in the face of arrest (Kirchhof/Trischler 2017:14; Hughes 2014).

4.4. The Netherlands

The purpose of the following table is to provide a brief overview of basic facts on nuclear power in the Netherlands.

Table 7: Basic facts on nuclear power in the Netherlands

Current status	
• No. of electricity producing reactors • Share of electricity mix (2016) • Future use	• 1 • 3,39% (IAEA 2017) • Plans for new nuclear plants shelved
Historical data	
• Overall number of reactors built • Start of nuclear energy supply	• 9 commercial, demonstration & research reactors • 1968 (Dodewaard to grid)
Technical and economic characteristics	
• Netherlands was a frontrunner in the development of ultracentrifuge technology for uranium enrichment in the 1950s and 1960s • URENCO Netherlands hosts one of world's largest uranium enrichment capacities • High flux reactor in Petten is leading producer of medical radioisotopes	
Public perception and engagement	
• Dutch public changes between advocating and rejecting nuclear power • Peaks in anti-nuclear public mood after TMI and Chernobyl accidents • Active civil society opposition deployed various engagement activities • Government ignored vote against new power plants resulting from nationwide participation process 'Broad Societal Discussion on Energy Policy' initiated by the Government	

Source: own depiction

4.4.1. Public perception in the Netherlands

The timespan from the late 1960s to the early 1970s marks both the years when the Netherlands became a nuclear nation and when anti-nuclear activists and citizen groups performed activities against nuclear projects. The 1960s had seen optimism about the modernization potential of nuclear technologies as well as a massive decrease in public attention to this topic. The commissioning of two nuclear power plants, the building of a uranium enrichment plant, and the decision to participate in the fast breeder project in Kalkar (Germany) between 1968 and 1973, renewed public interest in nuclear issues, this time focussing on in the opinion of opponents critical issues related to trust, economic, or environmental factors (cf. below). Opinion polls portray the Dutch public changing between advocating and rejecting nuclear power. After the nuclear

accident of Chernobyl, Eurobarometer data of 1987 and 1989 reports 54% and 58% negative votes (Berkers 2017:67). When after signing the Kyoto protocol nuclear technologies were discussed as an option of greening the energy system with a view to lower CO_2 emissions, Dutch public opinion shifted to a more positive attitude. Pro-nuclear answers prevailed in polls conducted in 2005, 2008 and 2010, and in 2005 a two-third majority of the participants supported plans of extending the lifetime of the Borssele plant (Berkers 2017:19, 67). However, public preferences changed again in the light of the Fukushima accident. In a poll of the market research company Synovate commissioned by Greenpeace 51% of the interviewed citizens were against building new power plants in the Netherlands (Synovate 2011). A recent paper by the European Atomic Forum on public acceptance of nuclear energy reports that "after a dip just after the accident, public acceptance of nuclear has recovered" (FORATOM 2017:157).

The analysis of the Netherlands' short country report (Berkers 2017) has revealed the following evaluation criteria as being decisive for Dutch citizens' nuclear perceptions: trust, national economics, consumer economics, environmental impact, social & ethical impact, and risk of catastrophic accident.

Trust

In the 1970s, environmental groups, so-called 'critical scientists' or left-wing political activists viewed nuclear energy from the perspective of a general attitude of mistrust in institutions, representatives, and actions of modern democratic states: "Progress itself was questioned as was the scientific and political establishment and the data they provided as arguments for their cause were distrusted" (Berkers 2017:15). A lack of trust, for instance, was even virulent in the context of the government's initiative for a 'Broad Societal Discussion on Energy Policy' (in Dutch: BMD; cf. below for more details), which took place from 1980 to 1984. Anti-nuclear groups questioned the fairness of the process and suspected it of aiming to weaken the anti-nuclear movement and obscure a decision already taken in favour of nuclear energy. Actually, the BMD had two conclusions regarding the future of nuclear energy in the Netherlands. First, a majority of participants did not want new nuclear reactors. Second, an immediate shut down of the two running nuclear plants was not required. When in January 1985 the government decided to reject

the BMD majority's plea against new nuclear plants, the feeling of mistrust was confirmed, reinforcing the gap between politics and society (Berkers 2017:50ff.).

National economics

In the beginning of the process of entering the nuclear domain, arguments linked to the modernization of industry and society and to prospects of growing economic wealth helped to create a nuclear-friendly public opinion. When nuclear technologies became a societally contested issue, their assumed economic benefits were questioned by alleging economic reasons against expanding both the Netherlands power plant and uranium enrichment capacities. In a petition to the parliament (1976) of the Think Tank 'Bezinningsgroep Energie' signed by 1200 scholars these plans had been criticised as unnecessary because the existing facilities already met the electricity demand, furthermore the planned developments were unlikely to stimulate Dutch industry, would prove to be too costly in the light of the expectation of increasing uranium prices (which peaked in the mid-1970s; cf. Pool 2013),[3] and would not lead to new jobs in the region of the uranium enrichment factory (Berkers 2016:79). Moreover, anti-nuclear actors regarded nuclear investments as misallocation of scarce resources that could be better used for the development of alternative energy sources (Berkers 2017:43f.).

Consumer economics

In order to finance its part of the fast breeder project in Kalkar (Germany), the State government created the so-called 'Kalkar levy', a surcharge of 3% to the electricity bill of Dutch households. Overall, the public reacted with outrage, and many of those who did not agree with the fee refused to pay for it (Berkers 2017:47). Nowadays, the Kalkar levy is judged to be the biggest mistake the pro-nuclear actors could have made since it accelerated the formation of the anti-nuclear movement which by the time was still relatively small (Berkers 2017:49).

[3] Since the share of fuel prices on nuclear energy costs are much lower than in the cases of coal or gas, one may argue that pointing to increasing uranium prices is not a particulary convincing argument. Nonetheless, the purpose of our analysis is not to assess the validity or quality of the arguments made at the time, but to give evidence of the different kinds of arguments made by the contemporaries. Clearly, to the contemporary critics of nuclear power, rising uranium prices were an economic argument they made, also as they expected prices to rise further in the future as a result of the growing use of nuclear power.

Environmental impact

When by the early 1970s anti-nuclear groups set out to put nuclear energy on the agenda of the public debate, the environmental movement, which had until then focused on chemical pollutants and landscape transgression, made ecological concerns surrounding nuclear energy its main target. In recent years, the challenge of climate change endowed nuclear energy with a new reputation as a promising low-carbon electricity technology (Berkers 2017:19).

Social & ethical impact

In the beginning of the Dutch post-war nuclear energy history, when nuclear electricity was decoupled from nuclear weapons and positively connected to technical progress, the Netherland's ability to construct and run a nuclear reactor was perceived as a reason for national pride. These capabilities had been demonstrated at an exhibition called 'The Atom' in 1957, where visitors could experience a working reactor that was manufactured by Dutch engineering and electro-technical companies. Ethical concerns about the circumstances of uranium mining especially in African countries, and about the unwanted spreading of knowledge, blueprints and technologies required for the construction of nuclear weapons, in the late 1970s, played a crucial role in the anti-nuclear movement's arguments against an expansion of the Netherland's uranium enrichment capacities at Almelo. Regarding proliferation, protesters argued about an espionage case related to the Pakistani nuclear weapons programme, a contract between Germany (one of the three partners of the Almelo plant) and Brazil to deliver enriched uranium, and the danger of Germany becoming a nuclear power (Berkers 2017:43f.).

Risk of catastrophic accident

Public discussion addressed nuclear safety on several occasions, namely on the security of the Dodewaard reactor (triggered by a little leakage in a connection to the reactor's pressure vessel), the safety of transporting nuclear material in general, and after the TMI accident (Berkers 2017:29).

Table 8: Acceptance profile Netherlands

Evaluation categories	Arguments	Evaluation
Trust	- Lack of trust in nuclear proponents and their arguments - Distrust in fairness and aims of societal participation process on energy policy	● ●
National economics	- Nuclear technologies as a means of modernisation and prosperity vs. no growth effects on industry and jobs - Electricity demand already met by existing plants - Expectations of increasing uranium prices - Nuclear investments hampers development of alternative energies	⦿ ● ● ●
Consumer economics	- Outrage about extra levy to finance Dutch participation in fast breeder project	●
Environmental impact	- Negative ecological impacts of nuclear energy - Positive climate mitigation effects	● ○
Social & ethical impact	- National ability to manufacture reactors is source of pride - Participating in uranium enrichment activities causes proliferation problems - Non-transparent fuel chain - Uranium mining in Third World countries	○ ● ● ●
Risk of catastrophic accident	- Safety concerns related to nuclear facilities and nuclear material transports	●

● = contra ⦿ = ambivalent ○ = pro

Source: own depiction

4.4.2. Public engagement in the Netherlands

The massive increase in public awareness of nuclear technologies in the Netherlands at the end of the 1960s came along with a shift in strategies and actors of nuclear engagement processes. Until the late 1960s business and political actors had been organizing communication campaigns in order to create a nuclear-friendly atmosphere, and subsequently in the 1970s and 1980s nuclear issues were debated and contested in the course of public participation activities pushed on by both the government and civil society organizations.

Public communication

Official and unofficial communication campaigns conducted by political and industrial actors in the formative phase of the Netherlands' nuclear endeavours had the primary objective of convincing society of the manifold civil applications of nuclear power by stressing its wealth and progress potentials. Nuclear power was cast in terms of economic and social welfare and disassociated from the nuclear bomb (Verhees 2012). Two communication actions had particularly enjoying broad popularity. The first was two educational slide shows called 'Men and

Atom' and 'Benefits of the Atom', which were made available by the US Information Service, and which strived to stage nuclear power as one of the most important inventions in the history of mankind (Berkers 2017:8f.). The second and most influential action in arousing pro-nuclear enthusiasm, however, was 'The Atom' exhibition that took place in 1957 in a hangar at Amsterdam Schiphol Airport. The show-stopper of this event was a working 10 kW nuclear reactor which fascinated the public. Altogether, the exhibition attracted about 750,000 visitors, i.e. it reached almost 5% of the Dutch population directly and many others indirectly via different media (Berkers 2017:32ff.).

Public forced communication

From the early 1970s onwards, nuclear power discussions overcame the boundaries of expert circles of industry, science or politics and civil society started to develop its own independent ideas about nuclear technology issues. The growing anti-nuclear movement did not focus on only one or two components of the Netherlands nuclear ambitions. Rather, with varying intensity, it challenged the whole programme by conducting various engagement activities ranging from protest marches and civil disobedience to petitions and memoranda. As depicted above, imagining nuclear power as a dangerous technology here was just one factor among concerns based on economic or ethical perceptions. The following list provides examples of anti-nuclear actions (Berkers 2017:14ff.):

- In opposition to the ultracentrifuge project in Almelo, a group of young scientists in 1970 published the report 'The ultracentrifuge: godsend or a threat to peace?'.
- When in the summer of 1973 the second Dutch nuclear energy reactor at Borssele got its licence, petitions against it were written.
- The building of a suspension reactor in Arnhem was in 1973 challenged by a group called 'Purple September'.
- In September 1974 about 10.000 Dutch citizens protested at the Kalkar site, just across the Dutch-German border, against the building of the fast breeder reactor. Some weeks later the Dutch Parliament was offered a petition pleading for the end of the project. It was signed by 155.000 citizens. Dutch and German activists also engaged in transnational cooperation.

- In January and February 1976 several hundred people gathered for anti-nuclear demonstrations in Dodewaard and Borssele, the sites of the two Dutch nuclear reactors.
- About 10.000 citizens demonstrated in April 1977 at the Almelo uranium enrichment facility.
- In September 1977 about 60.000 people protested in Kalkar against the fast breeder reactor.
- A number of anti-nuclear organizations jointly published an 'Almelo information bulletin' in October 1977.
- In May 1980, a two-day discussion camp joined by up to 5.000 participants was held about the strategy to get the nuclear energy reactor at Dodewaard closed. The camp participants decided to announce the blocking of the plant's entrance gates. This was realized with about 15.000 people who blocked the site for one day in October 1980.

Public participation: the 'Broad Societal Discussion on Energy Policy'

From the mid-1970s to the end of this decade, a societal debate about nuclear energy emerged that resulted in the decision of the national government to organize a 'Broad Societal Discussion on Energy Policy' (in Dutch: BMD; Berkers 2017:50ff.). The starting point of this engagement process was the intention of the Dutch government to build three further nuclear energy plants. The plans to do so had been announced in 1974, containing the participatory element that people were granted the right to be heard regarding impacts on the location. However, soon it became clear that civil society participants would not be satisfied with discussing siting issues, instead they urged for the opportunity to debate about nuclear energy as such. Reflecting these demands, it was decided to carry out the BMD engagement process. This initiative consisted of the following two phases.

a) Information phase: Beyond stakeholder consultations, a key element of the information phase (September 1981 to October 1982) consisted of publication of a full-page 'bulletin' in all nationwide newspapers, asking the general public about opinions concerning energy policy. On the basis of the input obtained this way, the topics 'costs of nuclear energy', 'structure of the electricity provision', 'risk analysis and perception' and 'processing and storing of radioactive waste' had been identified as frames for drafting four different scenarios for socio-economic,

energy and environmental policies. Throughout the Netherlands 13 hearings about these topics were organized, resulting in scenarios that would serve as input for the second BMD part.

b) Discussion phase: During the discussion phase (January 1983 to December 1984), the four scenarios were discussed nationwide in hundreds of moderated discussions, namely local discussions organized by municipalities (1811 meetings), organizational discussions organized by non-governmental organizations (1120 meetings), and school debates.

When the final report was published in early 1984, the main conclusion was that a majority of the Dutch people did not want new nuclear reactors. The government, however, did not feel committed to follow this vote and decided in January 1985 to reject the conclusions of the BMD. For the anti-nuclear movement this was like a punch in the face that delegitimized the seriousness of the government's participation process. From the beginning activists encountered the BMD with a rather sceptical view, being suspicious about the way the government would deal with the outcomes. The government's ignoring of the BMD results confirmed the "anti-nuclear movement in its opinion that the Government together with nuclear industry already had decided in favour of nuclear energy and that the BMD was just window dressing" (Berkers 2017:58).

4.5. Spain

The purpose of the following table is to provide a brief overview of basic facts on nuclear power in Spain.

Table 9: Basic facts on nuclear power in Spain

Current status	
• No. of electricity producing reactors • Share of electricity mix (2016) • Future use	• 7 • 21,38% (IAEA 2017) • Nuclear moratorium 1984 for new builds, confirmed in 1994; no new building plans although nuclear plants allowed again since 1997
Historical data	
• Overall number of reactors built • Start of nuclear energy supply	• 15 (10 went into operation, 5 were built but did not go on line) • 1968 (Zorita to grid)
Technical and economic characteristics	
• Plans for more than 40 reactors, of which the government pre-authorized 22 • Of the 10 plants that actually were connected to the grid 8 were built by US companies (6 Westinghouse, 2 GE), 1 by EDF (France) and 1 by KWU (FRG) • Mid-70s economic crisis (slowing down expected electricity needs) and transition from dictatorship to democratic system played a crucial role in slowing down and eventually paralyzing the Spanish nuclear programme	
Public perception and engagement	
• Early nuclear projects barely faced opposition; competing uses of the territory brought critical voices and administrative complaints by the late 1960s • Latest Eurobarometer poll of 2010 show a majority of Spaniards in favour of reducing the current level of nuclear energy • Terrorism and military threatened democracy's early steps with the former including Basque nuclear power plants to their target list • Local and alternative press key for anti-nuclear movement in the 1970s	

Source: own depiction

4.5.1. Public perception in Spain

Following the draft Spanish short country report (Rubio-Varas et al. 2017), government's and industry's perception of nuclear energy is characterized by a positive perspective focusing on emphasizing factors of reliability, efficiency, and safety of nuclear power plants. This was underpinned by pointing at beneficial indirect environmental impacts resulting from heat emissions on local agriculture (Rubio-Varas et al. 2017:25). A risk-benefit approach was the dominant paradigm among the promoters. Although acknowledging some risks, the benefits were

considered substantially greater, and protests of environmentalists were considered to be not consistent with the reality of nuclear power plants. The public regulatory bodies tended to highlight the economic dimension of nuclear energy, emphasizing particularly that employment would be created in rural and economically depressed areas. Following a period characterized by the emergence of quite a few isolated critical voices, since 1974 local and, in the Basque Country and Catalonia, regional groups occurred acting against nuclear power.[4] After the nuclear moratorium of 1984, anti-nuclear action groups developed more organized structures and contributed to a nationwide latent public opposition to nuclear power (Rubio-Varas et al. 2017:6). The latest Eurobarometer poll shows a majority of Spaniards in favour of reducing the current level of nuclear energy: when answering the question 'should the current level of nuclear energy as a proportion of all energy sources be reduced, maintained the same or be increase', in 2010 49% said reduced, 33% maintained, 9% increased, and 9% don't know (Eurobarometer 2010). A poll of June 2015 said that 28% are in favour of nuclear energy and 60% against (FORATOM 2017:159). In this context, the factors shaping public perception of nuclear energy in Spain can be assigned to the following evaluation categories:

Trust

Distrust in risk management of both electricity utilities and governmental actors on national, regional, and local level. On the one hand, as for other Western countries one can assume for the Spanish case that a general distrust in modern institutions has merged with anti-nuclear sentiments. A strong hint to this issue is the rhetoric of the anti-nuclear movements that "include aspects identifying nuclear power with technological colonialism and imperialism" (Rubio-Varas et al. 2017:15). Another reason for developing distrust in utilities and administrative authorities was that in the opinion of anti-nuclear activists electricity companies would act with an "abusive attitude" by "ignoring the law in their dealings" and "imposing their will on the locals" (Rubio-Varas et al. 2017:15, 26 with reference to interviews with anti-nuclear people and books and pamphlets of the anti-nuclear movement).

[4] Large-scale protests already happend before the TMI accident, for instance in June 1978 100,000 people demonstrated against nuclear energy in Barcelona. In this situation, TMI had the effect of reinforcing the strength of the anti-nuclear movement (Rubio-Varas et al. 2017:41, 47).

National economics

Arguments stressing economic benefits were important evaluation criteria for local governments when it came to decisions on siting a nuclear power plant. The expectation of economic benefits of nuclear facilities, e.g. thousands of jobs, for their municipality is one driving factor for the people in favour of nuclear energy, sometimes even reinforced when previous experiences had created an atmosphere of familiarity with nuclear energy (Rubio-Varas et al. 2017:18, 29f., 37). Regional polls commissioned between 1985 and 1992 by the Extremadura government revealed that the population's majority evaluated the economic impact of building a nuclear power plant in Valdecaballeros as beneficial (Rubio-Varas et al. 2017:29).

Local impact

The early nuclear projects barely faced opposition. Yet competing uses of the territory (tourism at coastal areas, agriculture's water needs) caused the rise of critical voices and administrative complaints by the late 1960s. As we know from news articles, local magazines, and several in-depth interviews with key historical players, these complaints were not directed against nuclear technology *per se*, but more against the alteration of traditional land uses. Thus, other industries would have faced the same opposition, i.e. some would agree with building the nuclear reactors elsewhere (Rubio-Varas et al. 2017:4, 15f.).

Environmental impact

Concerns about contamination of the surroundings and water and marine resources arose among members of social movements. However, notably affected populations at the local level expressed their perception that in comparison with other risky industrial activities there is no special risk in using nuclear power. (Rubio-Varas 2017 et al.:36, 55).

Social & ethical impact

The concerned population and environmental social movements perceived a disruption of the way of life of local populations (changes in productive activity, traditions, natural and cultural values, etc.) (Rubio-Varas et al. 2017:36). In the view of some social and environmental movements siting decisions could be blamed of being based on an unequal distribution of risk

over the territory. They argued, for instance, that the power plant "Valdecaballeros was chosen because it was a disinherit village and nobody cared if they host the 'worst industry'" (Rubio-Varas et al. 2017:26 with reference to Costa Morata 2011). Moreover, there was a feeling of lack of public participation in decision-making about nuclear energy infrastructures. With the end of the Franco government and in the light of the TMI accident, the national and regional governments changed and attributed more importance to the political dimension of exerting an anti-nuclear turn. Nuclear policy played a role in both party cohesion and the expression of power in negotiations with political or institutional authorities. In some cases (e.g. Regional Government of Extremadura), the local authorities looked for their legitimation faced with citizens who were not keen on the status of autonomy, while in other regions it seemed as if the local authorities would challenge the Spanish government (e.g. the case of the Catalan parliament in front of the nuclear waste repository). The Valdecaballeros plant provides an example of how the controversy of nuclear power also served to further other political objectives, in this case to strengthen the autonomous rights of Extremadura: "Saying no to the NPP, besides environmental motives, was showing people from Extremadura that the regional political power could slam both – the economic power and central government" (Rubio-Varas et al. 2017:23f. quoting the regional socialist president Rodriguez-Ibarra).

Health impact

As in the case of environmental impacts, the general public in Spain in principle splits up into two groups with opposing evaluations of the health impacts of nuclear power. While the anti-nuclear citizens emphasize the health risks of small amounts of radioactivity, the supporters evaluate nuclear power as no more/no less dangerous than any industrial operation and claim that it do produce not more radiation load than a TV or natural radiation (Rubio-Varas et al. 2017:57).

Table 10: Acceptance profile Spain

Evaluation categories	Arguments	Evaluation
Trust	- Mistrust in regulators and nuclear industry - Past experiences of unfilled political promises - Electricity companies openly breaching law	● ● ●
National economics	- Belief in economic benefits of nuclear energy - Positive economic view fostered by familiarity with nuclear power - Beneficial economic impact of building a nuclear power plant	○ ○ ○
Local impact	- Conflicts about land use - Building nuclear plants elsewhere fair enough	● ○
Environmental impact	- Concerns about contamination - Usual risks of industrial operations	● ○
Social & ethical impact	- Disruption of way of life - Unfair distribution of risks - Anti-nuclear attitude as catalyst for social identity formation	● ● ●
Health impact	- Specific health risks vs. usual risks of industrial operations	⦿

● = contra ⦿ = ambivalent ○ = pro

Source: own depiction

4.5.2. Public engagement in Spain

Public communication

During the first period (1950s to 1970s), only little information was spread about nuclear energy by state controlled cinema newsreels, press reports and the publication of special studies. US efforts played a key role here by promoting within the 'Atoms for Peace' programme an exhibition in 1958 and later in 1964, but also providing motion pictures shown nationwide in cinemas and on TV as part of an official visual bulletin. When – not at least in the wake of the TMI and Chernobyl accidents – facing growing pressure by citizens during the second period (1980s to 1990s), promoters increased their communication activities (Rubio-Varas et al. 2017:61). While these communication processes essentially were top-down in nature, we find in the period from 1990 to 2000 examples for more interactive public relation approaches. For instance, the Vandellós nuclear power plant (which at that time was being dismantled) had been transformed into a center allowing visits of international experts, pupils, etc. Nowadays, most nuclear plants and facilities run visitor centers basically oriented towards schools, local populations, and so on. The governments of the highest level in the hierarchy (national and regional ones) published advertisements in the press in favour of nuclear energy. More recently, promoters and regulators

started to publish their opinions on internet web sites and to provide information by giving press conferences (Rubio-Varas et al. 2017:62).

Public consultation

The public agencies who act as regulators of nuclear energy and the infrastructure on its territory, in the past have made little effort to communicate with and include the population. In some cases, general meetings were held where the citizens of a municipality could express their opinion, but this did not happen very often (cf. the concept of 'deliberative speak'; Hindmarsh/Matthews 2008). Another means of consulting the public were opinion polls commissioned by governmental authorities (cf. above).

Public forced communication

Over the years, the environmental social movements and the concerned population have persistently sought for citizens' participation in decisions about nuclear issues. In the 1970s, local and alternative press products had been a key communication channel of anti-nuclear activists. After the death of Franco in 1975, nuclear opponents for instance performed the following engagement actions (Rubio-Varas 2017 et al.:16, 31, 41f.):

- Small informative meetings.
- Mass demonstrations against nuclear energy, e.g. 'green march' of 1977; 50,000 people demonstration in Barcelona March 1978; 100,000 people demonstration in Barcelona June 1978 on the occasion of the 'International day against nuclear energy'.
- Submission of complaints.
- Presentation of petitions to town halls and other political institutions.
- Issuing manifestos.
- Carrying out press conferences.

4.6. United Kingdom

The purpose of the following table is to provide a brief overview of basic facts on nuclear power in the United Kingdom (UK).

Table 11: Basic facts on nuclear power in the UK

Current status	
• No. of electricity producing reactors • Share of electricity mix (2016) • Future use	• 15 • 20,4% (IAEA 2017) • 8 new reactors planned, the first being Hinkley C
Historical data	
• Overall number of reactors built • Start of nuclear energy supply	• 45 commercial & prototype reactors • 1956 (Calder Hall to grid)
Technical and economic characteristics	
• Leading role in the development of nuclear power • Development and exports of own reactors • Existence of fuel reprocessing plants and facilities for fuel cycle	
Public perception and engagement	
• Positive perception of nuclear power despite accidents such as Chernobyl and Fukushima • Nuclear energy as – in contrast to nuclear weapons – the 'good' face of nuclear power • Lack of organised national protest • Little public opposition to nuclear energy • Use of nuclear reactors has never been the object of sustained public protests	

Source: own depiction

4.6.1. Public perception in the UK

Two distinctive features characterize public attitudes towards nuclear energy in the UK. First, in contrast to the experience of other countries, the UK has not seen a shift in public acceptance from supporting to opposing the use of nuclear energy. Based on a pronounced trust in nuclear safety, regulators and utilities, survey results usually hovered around 40% in favour, 30% opposed and 30% holding no strong opinion/don't know on nuclear energy issues. The TMI, Chernobyl and Fukushima accidents only had short-lived impacts of not more than a year and lead just to a balance between opponents and advocates of nuclear energy (Butler/Bud 2017:5, 57). Second, combined with climate change and energy security issues, nuclear energy considerably rises in

public favourability. A survey conducted in March 2010 by Corner et al. (2011) yielded the following results:

- ca. 35% in general were either mainly or very favourable towards nuclear power,
- ca. 55% were willing to accept new nuclear if it helps tackle climate change,
- ca. 55% were willing to accept new nuclear if it helps improve energy security,
- ca. 55% agree nuclear needed because renewables alone cannot meet our energy needs,
- ca. 75% agree Britain needs a mix of energy sources to ensure reliable supply of electricity, including nuclear and renewables (Corner et al. 2011:4829).[5]

Assessing in detail the UK short country report (Butler/Bud 2017), six overriding evaluation categories have been identified covering a broad variety of single arguments and reasons: trust, national economics, local impact, environmental impact, social & ethical impact, and risk of catastrophic accident.

Trust

On the one hand, because of the safety record of UK operators the public has developed a high level of trust in regulators supported by media reports characterizing the UK as having the toughest regulators (Butler/Bud 2017:13). On the other hand, citizens' trust in regulators and industry are not completely uncritical. People have raised doubts over whether regulators are independent enough from the nuclear industry lobby, and felt misinformed by risk communications using statistical probabilities that contradict individuals' everyday risk estimations (Butler/Bud 2017:16). Some other hints at distrust can be found at the local level. For example, as a result of focus group research carried out in West Cumbria (Sellafield nuclear fuel reprocessing plant) the authors report that "Greenpeace is seen by a significant number of local people as one of the most effective 'regulators' of BNFL,[6] even by individuals who do not identify with its aims. This appears to be more a reflection of the fragility of trust in 'official' regulatory institutions than of any assumption of 'reliability' or 'objectivity' by Greenpeace, as a 'watchdog'" (Wynne et al. 2007:3;

[5] In the terminology of Corner et al. (2011) the first item refers to 'unconditional acceptance', the following items to 'conditional acceptance'; cf. below for the notion of 'reluctant acceptance'.
[6] British Nuclear Fuels Limited, Sellafield owner until 2005.

Butler/Bud 2017:13). Moreover, a book published by a former director of BNFL claimed that mismanagement by BFNL would contribute to undermine public trust in the nuclear industry (Bolter 1996; Butler/Bud 2017:36).

National economics

Triggered by rising oil prices and mineworker strikes in the coal industry, security of energy supply became a major concern in the UK in the 1970s and 1980s. Against this background, the importance of nuclear energy increased to the point that the public viewed it as the most reliable form of energy production. In term of cost, sceptical views about the cost-effectiveness of a nuclear-based electricity supply in the mid-1980s have been changing recently in favour of viewing nuclear technology as a source able to provide electricity at a competitive cost level (Butler/Bud 2017:12).

Local impact

Empirical research in communities near the nuclear power stations Bradwell-on-Sea and Oldbury-on-Severn revealed that local perceptions were significantly positively shaped by economic and trust factors. Regarding the former, citizens have described the power stations as “a great asset to the community over the years”, while trust was “associated with the perceived familiarity, reliability, and competence” of the local plant and particularly its staff (Venables et al. 2008:22, 25). However, the shutdown of the plants created a feeling of uncertainty amongst the local population: “The storage of radioactive waste on the site following decommissioning was a strong concern and there was a clearly stated willingness to mobilise against any attempt to establish a permanent waste facility on the site” (Venables et al. 2008:10; cf. also Parkhill et al. 2010).

Environmental impact

Since the early 2000s, the UK public has started to consider the environmental impacts of nuclear energy from the perspective of climate change. Nuclear power has been reframed from an environmentally problematic technology to a crucial element in the transition to a future low-carbon energy supply (Butler/Bud 2017:49). But segments of the public seem to understand nuclear energy as something like a “necessary evil” to solve climate change and energy security issues: the survey conducted by Corner et al. (2011; cf. above) showed 57% agreeing with the

statement “I don’t really like the idea of nuclear power, but I reluctantly accept that we will need it to help combat climate change and energy security in the UK” (Corner et al. 2011:4830). Environmental concerns were expressed with regard to CO_2 emissions from the mining of uranium (Rincon 2008) and the nuclear waste issue (Bickerstaff et al. 2008).

Social & ethical impact

The public linked the UK nuclear programme with a feeling of national pride. So in 1977, 56% of survey respondents said the UK should keep on building nuclear plants because of the national prestige this garnered (White 1977).

Risk of catastrophic accident

The framework used by the public for evaluating the danger of nuclear stations seems to be industrial safety. UK citizens view industrial safety, on the whole, as a major concern and rate nuclear power plants as less hazardous than chemical plants (Butler/Bud 2017:13). The fact that UK nuclear electricity production would not be threatened by a major incident, and the use of domestic (gas-cooled) reactors, leads to high confidence in the safety of running nuclear stations, which was not even durably obstructed by a serious accident such as the Chernobyl incident (Butler/Bud 2017:4f.). Also the fire at a military plutonium producing pile at Windscale (now Sellafield) in 1957 had little impact since this major accident was disconnected from nuclear energy.[7] Noteworthy safety concerns related to nuclear power plants did almost only occur in the context of the debate of building for the first time in UK nuclear history a PWR based on the design of the US company Westinghouse (Sizewell B). As this debate took place the late 1970s/early to mid-1980s, opponents referred to the TMI accident and described “PWRs as an essentially flawed and unsafe technology” (Davies 1984:23). In their study on siting of UK nuclear power installations Grimston and Nuttal (2013) concluded that “because the PWR was a new design to Britain at that time a precautionary approach was taken” that contributed to conducting a “very long Public

[7] Another reason for not creating public worries about nuclear energy may be seen in studies reporting very low potential cancer rates caused by the accident. With reference to estimations made by Clarke (1990), Wakeford shows “that the accident had caused, or would cause, ~100 fatal cancers (of which <10 are thyroid cancers due to exposure to ^{131}I and ~70, mainly lung cancers, are due to exposure to ^{210}Po) and ~90 non-fatal cancers (of which ~55 are thyroid cancers due to exposure to ^{131}I and ~10 are due to exposure to ^{210}Po)” (Wakeford 2007:214).

Inquiry into Sizewell B" (Grimston/Nuttal:36, 44). Only a minority of 35% doubt that the "disposal of radioactive waste can be done in a safe manner" while a majority of 53% agree with this statement (Eurobarometer 2010:63).

Table 12: Acceptance profile UK

Evaluation categories	Arguments	Evaluation
Trust	- Safety record of UK operators - NGOs (e.g. Greenpeace) are most successful 'regulators' of industry's actions (Sellafield) - Difference between public perception of risk and expert's risk communication	○ ● ●
National economics	- Major contribution to reliable and secure energy supply - Nuclear power is cost-effective way of delivering electricity	○ ○
Local impact	- Nuclear power plants as asset to the local community - Trust associated with familiarity, reliability, and competence of the local plant and particularly its staff - Decommissioning of nuclear plants creates uncertainty	○ ○ ●
Environmental impact	- Low carbon energy generation - Nuclear energy necessary to combat climate change - CO_2 impact of uranium mines - Lack of solution for nuclear waste	○ ○ ● ●
Social & ethical impact	- Building nuclear stations garnered national prestige	○
Risk of catastrophic accident	- Nuclear plants less dangerous than chemical plants - UK gas-cooled reactors have been regarded as safe - Accidents abroad have had almost no effect on public opinion - Majority beliefs in possibility of safely disposing nuclear waste - Fear of alleged unsafe foreign reactor type (PWR at Sizewell)	○ ○ ○ ○ ●

● = contra ⦿ = ambivalent ○ = pro

Source: own depiction

4.6.2. Public engagement in the UK

Throughout the history of nuclear energy in the UK, using nuclear reactors for electricity generation has never been the cause for persistent public protests, rather "direct action against nuclear power in Britain was sporadic and small scale" (Doherty et al. 2000:6). One of the rare examples of resistance is associated with the Torness nuclear power station. Initiated by the Scottish Campaign to Resist the Atomic Menace (SCRAM; founded in 1976 with the aim of protesting the construction of the Torness nuclear power station) in 1978/79 various protests took place, for instance the occupation of the Torness site by several thousand people in May 1978 (Doherty et al. 2006:6; GNAD n.d.). Against this background, there is evidence for communication and consultation processes, while public participation is limited to a case where feedback from a consultation exercise had an impact on policy decisions (cf. below).

Public communication

Public communication activities, commissioned by both promoters and regulators of nuclear energy, have been addressing two major topics, namely (1) safety and risk, and (2) climate-related issues.

1. Safety and risk

Under the safety and risk framework, one can distinguish the following three rationales for communication processes:

a) General information on nuclear programme: The government published a series of films presented in cinemas nationwide with the aim of informing the public about nuclear power as clean, safe, and necessary source of electricity generation. One example of this movie series is 'Atomic Achievement', which was released in 1956 to be the first major description of the UK's nuclear energy strategy (Butler/Bud 2017:34).

b) Risk communication: Concerns about citizens overestimating the risks of nuclear energy led industry and government actors to publicly discuss how the public could be enlightened about the low risk nature of nuclear stations. In the course of this debate, a probabilistic risk approach was chosen focussing on statistical chances of the occurrence of accidents. An example of this risk communication method is the Health and Safety Executive's document 'The Tolerability of Risk from Nuclear Power Stations' (HSE 1992). Relying on findings of sociological research in risk perception, government and industry in the recent past has adopted a new approach of risk communication that takes the subjective nature of perceiving risks by the public into account (Butler/Bud 2017:17; Adams/Thompson 2002; HSE 2001).

c) Incidents: Leaks and other failures at nuclear sites were major reasons for public information activities. The main objective for such communication is to (re-)establish public confidence in the harmlessness of nuclear stations, and to create trust in the effectiveness of health measures undertaken. For instance, in 1957 the government reacted to a fire at Windscale (now Sellafield) plutonium producing facility both with a strict control of newspaper reports about the event and by attending local meetings organized e.g. by Windscale staff and resident farmers (Butler/Bud 2017:35ff.). In order to answer to doubts that might occur among the public after the Chernobyl

accident, an extensive media campaign, consisting of newspaper and television adverts, was launched by the then state-owned Central Electricity Generating Board (CEGB) to reassure citizens that such an accident could not happen in the UK since this technology (Soviet reactor type RBMK-1000) does not exist in the UK. A frequently criticised communication practice is the power plant companies' custom to inform the public about noticeable events only after a delay. The reason for behaving this way is that the industry wish to get the incidents under control and to know the full extent of any problems before making announcements. However, focus group research hinted to the point that people felt deceived by such information policy, "the argument that the industry wished to get the incidents under control before announcing them did not allay these feelings; indeed it seemed sometimes to exacerbate them, because in the interim period of 'cover-up' people felt denied their right to take precautionary action if they wished to" (Wynne et al. 2007:42).

2. Low-carbon electricity production

After privatisation of the UK's nuclear power industry in the 1990s, many of the new companies commenced engaging in public communication processes aimed at depicting nuclear energy as a vital and reliable source of power. A key argument of public relations activities (e.g. at newly established visitor centers) was the environmental friendliness of nuclear power as a clean and low-carbon base-load energy technology.

Public consultation

Until today, the consultation format of the local planning inquiry is the major instance for the public to have a say in decision processes on new nuclear power plants. The UK regulatory framework requires approval by local council authorities for any large-scale construction. In the course of a planning inquiry, actors in favour of a project and its opponents (e.g. campaign organisations, citizens) must demonstrate that it met/not met relevant legislative demands. While planning inquiries usually take place when a planning permission has been rejected, in the nuclear domain many inquiries have been mandated by government (Butler/Bud 2017:14). Examples of this public consultation method encompass inquiry processes for nuclear stations at Bradwell (1956), Sellafield (Thermal Oxide Reprocessing Plant, 1977/78), and Sizewell B (sole Pressurised Water

Reactor in the UK, 1982 to 1985). The later was acknowledged as a key event of public involvement since for the "first time, the whole nuclear safety case is fully available for public scrutiny" (Davies 1984:21). It has been described as a fair process because all necessary information was available and the proponents (e.g. CEGB) of the nuclear plant "have positively welcomed questions, and all comers have had a chance to appear at an open public inquiry" (Davies 1984:29). Yet, opponents (e.g. Friends of the Earth) felt disappointed by the inquiry process mainly for two reasons. First, in contrast to their hopes of being able to debating on a general level about nuclear energy, the process was bound by a specific line of examination based on the legal instructions for public inquiries. Thus, the investigations mainly had to focus on three principal areas: the "need and the economics of the station; its safety, and its effects upon the local environment" (Davies 1987:104). Second, citizen interest was far below the expectations. Solely at the opening day a large crowd of people attended the inquiry, then public interest rapidly declined. In opponents' opinion this was a result of the duration and complexity of the process and its thematic focus, while others hinted at the UK public's overall low concerns regarding nuclear energy (Davies 1984).

Another type of consultative engagement process was performed by the government in the course of developing its 'White Paper on Nuclear Power' released in 2008 (Department for Business, Enterprise & Regulatory Reform 2008). The purpose of the consultation was to gain insights into the people's views on nuclear power. Hosted and evaluated by agencies contracted by the government, a broad range of citizens' panels and focus groups took place nationwide. At a late stage, some environmental NGOs such as Greenpeace and Friends of the Earth decided to withdraw from the consultation process. This was meant as a protest against a consultation process that in the view of those NGOs was biased in favour of a decision that government had already taken (Butler/Bud 2017:48). However, other participants did not agree with this perspective and expressed "their disappointment that these groups were not present. Their absence from some of the meetings meant that a more vigorous opposing view was only present in a very limited form" (Department for Business, Enterprise & Regulatory Reform 2008:17). Moreover, since the outcomes of consultation had impacts on the White Paper and were fed into the policy-making process, one may conclude that this engagement exercise goes further than just being consultative because it incorporates elements of a citizen-policy dialogue.

4.7. United States of America

The purpose of the following table is to provide a brief overview of basic facts on nuclear power in the United States (USA).

Table 13: Basic facts on nuclear power in the USA

Current status	
• No. of electricity producing reactors • Share of electricity mix (2016) • Future use	• 99 • 19,74% (IAEA 2017) • 4 reactors under construction; plans for about 30 new reactors; plant lifetime extensions may add up to an equivalent of ca. 10 new reactors
Historical data	
• Overall number of reactors built • Start of nuclear energy supply	• More than 130 commercial reactors • 1957 (Vallecitos and Shippingport to grid)
Technical and economic characteristics	
• Leading role in the development of nuclear power • Development and exports of own reactors • Atoms for Peace Programme 1953 • Three Mile Island (TMI) accident 1979	
Public perception and engagement	
• Public perception evolved over three phases from support to refusal to again a positive attitude • Recurring protests against nuclear stations • Public protest waned as industry developed innovative reactor concepts and ceased building new reactors for a long time after TMI accident	

Source: own depiction

4.7.1. Public perception in the USA

With the first commercial reactors going critical in 1957, the United States (US) belongs to those nations to use nuclear power for electricity provision in its very early stages of development. The main proponents of nuclear energy are both the government, represented by agencies such as the Department of Energy and the Nuclear Regulatory Committee, and the private sector consisting of manufactures, utilities, and operators. Another important group of actors among nuclear supporters are national laboratories carrying out military and civilian research, e.g. the Los Alamos National Laboratory that had been key for developing the atomic bomb (Manhattan Project). However, taking off in the context of the US-USSR competition on technological, military,

and ideological supremacy, it had been the government which pushed nuclear power and persuaded private companies to develop and build reactors, not least by applying standard technology policy instruments such as providing direct and indirect subsidies (Josephson 2017:11 with reference to Balogh 1991).

A decisive step for the evolution of both the US and the worldwide development of civilian nuclear technologies had been the 'Atom for Peace' programme publicly introduced on December 8, 1953 by President Dwight D. Eisenhower's speech at the United Nations. This programme had been intended to internationally promote the peaceful face of nuclear technologies with solutions for medical, industrial, energy and other purposes (Josephson 2017:4).

The formation of anti-nuclear movements in the US can be back traced until the 1960s when anti-(Vietnam)-war, environmental, or civil and women rights campaigns entered the public stage (Josephson 2017:4). Throughout the period from the 1960s to the 1990s, local protests time after time took place on the occasion of new reactor projects, e.g. Ravenswood (1962), Bodega Bay (1963/64), Diablo Canyon (late 70s to early 80s), and Seabrook (mid 70s to early 90s). In retrospect, the event of the partial meltdown at Three Mile Island (1979) appears to be a turning point in terms of intensity of anti-nuclear activities. Instead of boosting protests, there have been no continued protests over TMI, and protests – except for a couple of small-scale protests on some plant sites taking place later on – waned after the accident since no new construction started for about 20 years, enhanced reactor concepts were developed, or reforms of the Nuclear Regulatory Commission's regulatory procedures were implemented (Josephson 2017:40ff.).

Based on the findings of surveys on public opinions about nuclear power, one can distinguish three phases of different perceptions regarding running nuclear stations for electricity production. In the 1960s and 1970s clear majorities of US citizens were in favour of nuclear power, albeit throughout the 1970s the share of those against nuclear had been constantly growing. Important reasons for this development were the opposition against the military use of nuclear power, the series of nuclear tests where soldiers had been exposed to high radiation doses, the potential radioactive fallout of Soviet bombs, and fears of catastrophic accidents in nuclear power plants. The second phase is directly connected with the accident at Three Mile Island and characterized by diminishing agreement with nuclear energy. Opponents got over 50%, and a large majority

rejected the building of new plants in or near their communities. This, on the other hand, did not mean that the majority would ban nuclear completely as a means of energy generation. On the contrary, many people saw it as a solution to the country's long-term energy problems, and in 1982 the majority voted against a halt to new construction or a permanent shutdown of all operating reactors (OTA 1984). Finally, since the 1990s and until today public opinion on nuclear power has changed again, and those rejecting it are a minority even after the Fukushima accident (Josephson 2017:19f.).

The factors shaping public perception of nuclear energy in the US can be assigned to the following evaluation categories:

Trust

A recurring issue throughout the history of the US nuclear energy is the fact that anti-nuclear groups had been accusing both US regulators and power companies at several occasions to perform a non-transparent information policy. For instance, in 1970 the environmental NGO Friends of the Earth claimed on the basis of documents accessed by a Freedom of Information Act request that in 1964 the Atomic Energy Committee had suppressed publication of an update of a reactor safety study (Josephson 2017:35). In 1981 the San Jose Mercury newspaper claimed that Pacific Gas and Electricity (PG&E) had concealed to the public and regulators for at least one year the existence of an offshore seismic fault nearby Diablo Canyon power station (Josephson 2017:36).[8] This suspected behaviour of keeping undesirable events or evidence secret is a key factor when it comes to understand the public's decreasing trust in governmental and private nuclear actors. Another major factor for the emergence of distrust were reports that have been criticizing both regulators and utilities for poor supervision procedures and the inability of plant operators to handle emergency situations adequately, e.g. in the case of the Three Mile Island accident (Josephson 2017:39ff. with reference to Kemmeny 1979).

[8] From the perspective of PG&E, Diablo Canyon is not in danger to get damaged by an earthquake since it is designed to withstand a 7.5 magnitude quake in a – according to PG&E, NRC and US Geological Survey studies– 6.5 zone (Josephson 2017:36 with reference to Sneed 2014).

National economics

Regarding the economic characteristics of nuclear energy, supporters and opponents use to accentuate different attributes. The former say it is a crucial element of US energy independence (e.g. it would help to reduce OPEC oil imports) and a reliable source for future base-load provision. The latter critically emphasize state subsidies for nuclear power and argue that the building of reactors may been facing cost overruns (Josephson 2017:9, 18) (of course, both points are features of other technologies and large scale projects as well).

Local impact

While public opinion in the US even after the TMI accident did value nuclear power as an important part of the nation's energy system, citizens' perceptions had been changing with a view of living next door to a nuclear station. In early years Americans said they would not worry when having a nuclear plant in their community. In the aftermath of TMI the majority has turned its mind, now opposing the construction of new plants nearby (Josephson 2017:19f.).

Environmental impact

In the context of the climate change debate, nuclear power was being framed as technology that – since it would not emit CO_2 – is a valuable means of fighting against global warming. On the other hand, opponents viewed nuclear technology as being destructive or disruptive to nature, both on a general level and with respect to specific siting decisions. For instance, the anti-nuclear group Clamshell Alliance criticized the Seabrook nuclear reactors since from their view the proposed construction site, the Hampton-Seabrook estuary, represented a critical habitat for birds and other fauna (Josephson 2017:17, 46).

Social & ethical impact

Anti-nuclear activists framed nuclear power critically from a political point of view. For instance, from the perspective of the Abalone Alliance, an anti-nuclear coalition of about 60 groups, nuclear technologies are undemocratic as they are characterized by a lack of democratic possibilities surrounding governance because the centralized nature of nuclear power would take control of energy away from local communities. Furthermore, in the view of the Abalone Alliance there is a

direct relationship between nuclear power plants and nuclear weapons, thus exporting nuclear power plants would create the possibility of spreading the nuclear bomb to nations all over the world (Josephson 2017:38 with reference to Direct Action 1981).

Risk of catastrophic accident

Warnings of catastrophic reactor accidents, e.g. due to unforeseen technical failures or a natural disaster such as an earthquake, are almost always among those issues raised by individuals, citizens, and movements when arguing against nuclear power. Fears are associated especially with the damaging of people and property and the impossibility of a timely evacuation, particularly when the accident would happen in a plant near a population center (Josephson 2017:17). Ambivalent perceptions are to be observed regarding how to evaluate risks resulting from running nuclear reactors after the TMI accident. Some believe that the events surrounding TMI has revealed an underestimation of risks, and that this miscalculation continues until today when government and industry promote a new generation of inherently safe nuclear power plants. However, others stress the absence of significant accidents in the post-TMI era, taking this fact as proof of the high safety standards of US power plants (Josephson 2017:49).

Table 14: Acceptance profile USA

Evaluation categories	Arguments	Evaluation
Trust	- Secrecy creates mistrust in regulators and industry - Lack of confidence in control structures and emergency handling	● ●
National economics	- Vital element of US energy independence - Reliable source for provision of base-load - Early stage government subsidies for developing nuclear energy - History of cost overruns	○ ○ ● ●
Local impact	- Supporting vs. opposing nuclear stations in own community	◉
Environmental impact	- Positive impact on global warming - Nuclear power is destructive or disruptive to nature - Negative environmental effects from siting decisions	○ ● ●
Social & ethical impact	- Lack of democratic governance - Spreading the nuclear bomb by exports of nuclear power plants	● ●
Risk of catastrophic accident	- Risk of accidents caused by technical failures or natural disaster - Accidents may damage people and property - Timely evacuation impossible - Risk of accident still underestimated vs. safely operating reactors	● ● ● ◉

● = contra ◉ = ambivalent ○ = pro

Source: own depiction

4.7.2. Public engagement in the USA

Public engagement with nuclear issues in the US seems to be a matter of communication attempts from promotors to the public and vice versa. Measures to be classified as being consultative, or even participative, were not reported in the US short country report (Josephson 2017).

Public communication

Before the launch of the 'Atoms for Peace' programme in 1953, military had an important say in nuclear programs which therefore remained largely unknown to the public (Josephson 2017:4). After the birth of the 'Atoms for Peace' initiative public communication by promoters of nuclear energy was intended to inform the public about the positive impacts of this power resource in terms of energy independence, national security, clean energy, and reducing greenhouse gases. Moreover, government agencies and industry tried to create the image of nuclear as a modern, safe, and efficient technology that provides a reliable basis for meeting future electricity demands. Especially the 1950s and 1960s saw pro-nuclear movies that were attended by millions of people, e.g. the films 'Power and Promise: The Story of Shippingport Nuclear Power Plant,' 'Atomic Venture', and 'Atomic Power Today: Service with Safety' (Josephson 2017:18)

Public forced communication

A number of nuclear power plants, projected or operating, had seen public opposition of anti-nuclear movements. The following list provides examples of anti-nuclear actions:

- Protests against a nuclear station in Ravenswood, Queens, intended to be located only two miles from the UN building (1962) (Josephson 2017:23 with reference to Mazuzan 1986).
- Action encampment aiming at blockading the site of Diablo Canyon power plant; over the course of two weeks about 30,000 people descended on the site, about 2000 protesters were arrested (1981, hence after the TMI accident of 1979) (Josephson 2017:37 with reference to Rogers 1981).

- Plans to build Seabrook nuclear plant generated several protest actions and occupations of the construction site, e.g. in summer 1976 (200 residents rallied at the edge of the site), April 1977 (2000 people came to the site in order to reclaim the land), and June 1985 (hundreds of demonstrators of which 627 were arrested for trespassing) (Josephson 2017:50 with reference to Gunter 1990).

5. Public perception and public engagement in a cross-country perspective

The evidence detailed in the previous sub-chapters clearly point out that each country follows its own nuclear development path with corresponding preference profiles and engagement traditions signifying the nation's unique nuclear-society relationship. On the other hand, it is apparent that not only differences are characteristic for the various nuclear histories. Rather, there are similarities suggesting classifying the countries investigated to be either neutral to supportive or refusing with regard to deploying nuclear power plants for electricity production.

- The UK and Bulgaria are countries where a majority of citizens do accept nuclear power, anti-nuclear movements could not gain substantial influences, and significant drops in approval rates after accident events abroad (e.g. Fukushima) did not occur.
- The US population, like those of the UK and Bulgaria, predominantly accepts nuclear power, although the Three Mile Island accident temporarily resulted in majorities of nuclear opponents. In contrast to the UK and Bulgaria, the US nuclear history is influenced by protests against various power plant projects. Often recurring on environmental concerns and worries about evacuations in the case of accidents in potentially plutonium producing LWR plants, these protests were deeply rooted in an opposition to the military use of nuclear power and the fear of fallout from nuclear explosions.
- Austria, (West-)Germany, Spain, and the Netherlands, on the contrary, are nations with large segments of the public not in favour of nuclear power. While in Austria and Germany concerns about nuclear energy had been publicly expressed already in the 1960s, the

Netherlands has experienced a shift from supportive public attitudes to negatively connoting nuclear issues, whereby recently favourable perceptions has gained more ground amongst Dutch public. Nevertheless, in each of these countries more perceivable local protest and opposition started in the mid-1970s, e.g. the protests around the Wyhl construction site in Germany or the protests in Austria leading to the 1978 referendum. Clearly, across countries the TMI accident in 1979 reinforced and nationalised anti-nuclear opposition.

5.1. Public perception

The country acceptance profiles gathered in Table 15 mirror the differentiation in nations more likely to be either nuclear-friendly or nuclear-critical. We see for Austria and the FRG that nuclear power is considered negative from all perspectives the public refers to when reasoning about nuclear energy, while attitudes critical of nuclear power dominate the Dutch, the US, and – certainly less pronounced – the Spanish acceptance profile. The UK is the only country in our sample with a prevalence of positive evaluations.

Table 15: Evaluation categories according to countries

Country / Category	*Austria*	*Bulgaria*	*FRG*	*Nether-lands*	*Spain*	*UK*	*USA*
Trust		●	●	●	●	○/●	●
National economics	●	○/⊙	●	⊙/●	○	○	○/●
Consumer economics	-	-	-	●	-	-	
Local impact	●	-	-	-	●/○	○/●	⊙
Environment	-	-	●	●/○	●/○	○/●	○/●
Social & ethical impact	-	-	●	○/●	●	○	●
Health impact	●	●	●	-	⊙	-	
Risk of catastrophic accident	-	-	●	●	-	○/●	●/⊙

● = contra ⊙ = ambivalent ○ = pro

Source: own depiction

Besides a cross-country perspective, Table 15 also allows for a comparative perspective across evaluation categories. The latter reveals three clusters of preference categories each with high,

modest and low relevance among countries. National economics, trust, environmental impact, and social and ethical issues are the most important evaluation categories in the public perception of nuclear power across the countries.

The issue of *national economics* was evident from our analysis as an evaluation topic in all of the seven countries investigated. Views in favour of nuclear power centred on it as a means for a secure energy supply and being a key sector of the country's or region's industrial infrastructure (Bulgaria, Spain, UK, USA). On the other hand, contra opinions are present, raising doubts about the economic feasibility of nuclear power in terms of e.g. cost, uranium prices, or creating expensive over-capacities in energy markets (FRG, Netherlands). Beyond this, views concerning the wealth effects and the contribution of nuclear power to national energy independence were controversially (Netherlands).

Trust was often lacking both vis-à-vis political and nuclear business actors (FRG, Netherlands, Spain, UK, USA). State and business communication in participation processes or non-transparent project management contributed to such lack of trust. Parts of the Bulgarian population had developed distrust in nuclear technologies due to the government's hesitant information policy required by the Soviet Union after the Chernobyl accident. In the UK, however, nuclear promoters enjoyed a better image since the civilian nuclear energy industry has never had a major accident.

Environmental impact considerations were also important for the evaluation of nuclear technology. The public rejected nuclear power due to from their view negative ecological consequences of running nuclear power stations and uranium mining, because of the unsolved waste issue, and because of siting power plants on places considered to be sensitive natural habitats (FRG, Netherlands, Spain, UK, USA). In Spain, however, supporters of nuclear power raised the point that it is just another industrial activity without any specific risk. Opposite public perceptions are also to be observed when it comes to the role nuclear power might play in fighting against climate change. While the supporters of nuclear power highlight positive mitigation effects from a nuclear-based low-carbon energy production, critics point at the CO_2 emissions from the mining of uranium (UK).

On *social and ethical* statements, there is much controversy, too. While supporters of nuclear power present the domestic ability to build nuclear power stations as a source of national prestige and pride (Netherlands, UK), notably in the FRG and the Netherlands critics highlighted social and ethical disadvantages emphasizing problematic impacts on intra- and intergenerational justice resulting from Third World uranium mining and burdening future populations with nuclear waste. Nuclear critics in the US focus on governance and see a lack of democratic participation in nuclear issues.

The three categories local impact, health impact, and risk of catastrophic accident were less frequently identified as relevant factors as those discussed above. Public attitudes connected to the *local impact* category in the UK were centred around the concept of familiarity, i.e. the close acquaintance with or knowledge of something. We see that living next to a nuclear plant and hence being accustomed to it can create a positive opinion about using nuclear power. On the contrary, when situations change and new developments appear, familiarity can diminish and turn into a lack of acceptance of nuclear projects. Living next to a nuclear power plant is also a key factor for the US public perception, with opposing views of accepting or rejecting of having a nuclear station in the own community. In Austria and Spain, citizens argued against nuclear projects because they were in favour of using the land for different purposes (e.g. tourism, pleasure ground).

Not surprisingly, only negative impacts were put centre stage when reasoning about the *health risks* of nuclear power. The fear of radiation exposure was expressed on a general public health level (Austria, FRG, parts of Bulgarian population after Chernobyl accident) as well as specifically addressing children's health issues (FRG). In Austria, there were even right-wing activists arguing that radioactivity would damage the Austrian people's genotype. In Spain, citizens also addressed nuclear health risks, though many of them evaluated it no higher than those associated with other dangerous industrial operations.

Public evaluations of nuclear energy in the FRG and the Netherlands reflecting on the *risks of catastrophic accidents* imagine the risk of disasters happening along the whole fuel cycle (e.g. transport, plant operation, waste disposal). In the US we found fears of accidents that damage people and property and may prevent timely evacuations of huge amounts of residents. Public

perceptions in the UK, however, are remarkably different, estimating chemical plants as being more dangerous than nuclear power stations. Safety concerns related to nuclear power plants did only occur in the context of the debate of building for the first time in UK nuclear history a PWR based on the design of the US company Westinghouse. As this debate took place the late 1970s/early 1980s, opponents referred to the TMI accident and described "PWRs as an essentially flawed and unsafe technology" (Davies 1984:23).

Finally, the third 'cluster' consists of just one category, i.e. *consumer economics*. This issue found attention only in the Dutch case of the public's critical reaction against the extra levy collected in 1973 to finance participation in the fast breeder project.

5.2. Public engagement

Conducting public *communication* processes is a component element of the nuclear history of each country analysed in this document. Commissioned by regulators and sponsors, public relation methods have included media campaigns, slide shows, exhibitions, and movie series, most often aimed at informing citizens of the low-risk nature of nuclear power and its advantages for the country's energy supply and economic growth. We also found a few cases were nuclear opponents suspected that facts had been provided in a selective manner or with the intention of concealing the truth. The former refers to complaints about power companies' way of informing about critical events like accidents or releases of radiation, the latter to the Bulgarian government's policy of not comprehensively informing the population about the Chernobyl accident (as in other Warsaw Treaty states, this decision was taken upon request of the Soviet Union). Accusations of anti-nuclear activists that nuclear programs, accidents, or safety reports had been kept secret are also to be found in the US history of nuclear power.

While communication processes are relatively often to be observed, there are only scarce examples of *consultation* initiatives performed by regulators in order to give the public a say in nuclear issues. Both the Austrian and Bulgarian governments used the instrument of a national referendum to elicit citizens' opinion about key aspects of each country's future in deploying nuclear energy. In the UK, the government had commissioned citizen panels and focus group research to get to know the public's views on nuclear energy. Moreover, the UK's regulatory

framework contains the formal consultation tool 'local planning inquiry' that provides actors in favour of a project and its opponents with the opportunity to demonstrate whether it did or did not meet relevant legislative demands. In Spain, local regulators hosted public meetings on nuclear issues, and national and regional governments commissioned nuclear-related opinion surveys.

Except for the UK and Bulgaria, where protests mainly and only occasionally occurred locally, all countries evaluated above had faced active civil society opposition against nuclear issues. When anti-nuclear *public forced communications* overcame the boundaries of local activities usually organized by neighbouring inhabitants, we see movements composed of a broad variety of civil society actors united in nuclear-critical perceptions and objectives, ranging in political terms from left-wing activists to right-wingers worrying about eugenics. In order to coordinate actions and to increase their political outreach, activist groups joined forces and created umbrella structures such as the Dutch 'Landelijke Stroomgroep Stop Kalkar', which collaborated transnationally with anti-nuclear groups in Germany or even Denmark. Another crucial type of anti-nuclear actors are professional international environmental NGOs such as Greenpeace and Friends of the Earth.

Eventually, just one engagement procedure could be categorised as public *participation* process in the sense of the definition given above. The Dutch 'Broad Societal Discussion on Energy Policy' (BMD) had been more than a comprehensive approach to learn about citizens' power technology preferences; rather it aimed at involving the public in particularly nuclear-energy related opinion-making. However, the BMD resulted in disappointment for the anti-nuclear movement since the government decided not to adopt the BMD's conclusion that the majority of the participants did not want new nuclear reactors.

6. Conclusions

The ambition of this deliverable has been to carry out a stocktaking with respect to perception factors and engagement activities. The objective of this descriptive analysis has been to provide a landscape of categories and activities indicating the range of public opinions pro and contra nuclear energy and the spectrum of nuclear-society interactions initiated and performed by regulators, industry, NGOs, or citizens. We have seen that public perception of nuclear energy is based on a variety of categories such as trust, economics, environmental impact, health or fear

of accidents. Each category is characterized by different reasons used to express negative or positive views with respect to nuclear energy. Hence, the acceptance or rejection of nuclear energy is not the result of one single factor but rather influenced by a multi-dimensional mix of perception categories each consisting of pro and contra opinions. The stocktaking of engagement activities has clearly revealed that dialogue-based engagement only exceptionally had been carried out. Instead unidirectional approaches prevail aiming at distributing messages from regulators and industry to the public and vice versa.

Based on our descriptive analysis we were able to hint at some differences and similarities between the countries studied in this report in terms of perception and engagement. As a result of our analysis of HoNESt short country reports we were also able to point to the relative frequency at which perception factors and engagement types did occur. That allowed us to see that, for instance, reasons related to trust or health impacts more often were raised than arguments in the context of consumer economics, and that in terms of types of engagement communication is more often to be observed than consultation and participation. In a historical perspective, we could identify fears of a nuclear war and the radioactive fallout it would produce as well as the Nevada experiments which exposed thousands of soldiers to high radiation doses as very important in inducing critical opinions against the civilian use of nuclear technologies. Moreover, we could mark the TMI accident as a decisive event in the history of nuclear-society relations since anti-nuclear activists used it as an opportunity for organising public protests, trying to push forward nuclear-critical attitudes.

At this point a statement on the analytical limits of this deliverable is necessary. The descriptive approach has been chosen for gaining preliminary results, it suits for identifying the spectrum of perception factors and engagement activities. In-depth analyses e.g. on the mechanisms for effective nuclear-society interactions are explicitly beyond the scope of this report and will comprehensively be addressed by the two further WP4 deliverables. In other words, D4.2 serves as a starting point for more elaborate analyses: *D4.3* will propose a model that explains the relationship between the various perception factors of nuclear energy and will investigate historical contexts by carrying out specific analyses for three periods (1950-1970, 1970-1990, 1990-2015) in order to depict and understand the evolution of perceptions and engagement. *D4.4*

will aim for an integrated comparison of mechanisms of public engagement in relation to their national, historical context and in terms of effectiveness or success (success in what regard? success for whom?).

Finally, two more comments seem to be helpful in clarifying the approach of this report when mentioning public opinions about nuclear energy. First, we are aware that when reasoning in favour or in opposition some arguments were put on the agenda that would also be applicable for other innovative (energy) technologies or large-scale projects, for instance opinions with regard to cost overruns, subsidies, or environmental effects of mining. In a study interested in comparing the perception of nuclear power with the perception of coal, wind or solar power, we of course would focus on common factors and factors that are technology specific. However, since this report centres on nuclear energy we are not able to carry out cross-technology comparisons. This would be indeed highly interesting and enlightening but would have required a research design and empirical basis particularly adapted for investigating nuclear power as part of the overall transformation of the countries' energy mixes.

Second, we are aware that this report presents reasons, assumptions or attitudes which from an expert's point of view are wrong or purely ideological since they are not based on technical facts or scientifically sound risk assessments. Furthermore, the arguments need to be read in the context of the knowledge, perceptions and expectations of the time, such as the peak of uranium prices in the mid-1970s that critics extrapolated into a trend for the future. For each case it is possible to find evidence that can be used to challenge it. For instance, against the fear of nuclear accidents one can say that a nuclear plant could not have a catastrophic accident because not high but only low doses of radioactivity will be emitted that cannot cause the health consequences of high doses. Another example refers to the evacuation measures following the TMI accident. While critics blamed regulators and utilities for not handling this emergency situation adequately, on the other hand there are hints indicating that the TMI radioactivity releases did not justify the amplitude of the evacuation of the surrounding population: "This was the most serious accident in U.S. commercial nuclear power plant operating history, although its small radioactive releases had no detectable health effects on plant workers or the public" (NRC 2013). Nonetheless, in this report we do not differentiate between wrong or right assumptions but do document each opinion

because it has been used in the discussion about nuclear energy at a certain point in time. Furthermore, this report does not distinguish between major and minor topics, instead it follows the guideline of gathering and not evaluating the views of advocates and opponents. As said above, D4.2 marks the first step of investigating nuclear-society interactions in terms of perception and engagement. Going beyond this preliminary, descriptive approach, the forthcoming deliverables D4.3 and D4.4 will provide conceptual frameworks and findings with the objective of more analytically explaining nuclear-society connections.

7. List of short country reports

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