(Dis)empowered Communities:
A Comparative Study of Decommissioning Nuclear Sites (2025-2030)

Dr. Davide Orsini

Change! Fellow

Rachel Carson Center, LMU – Munich

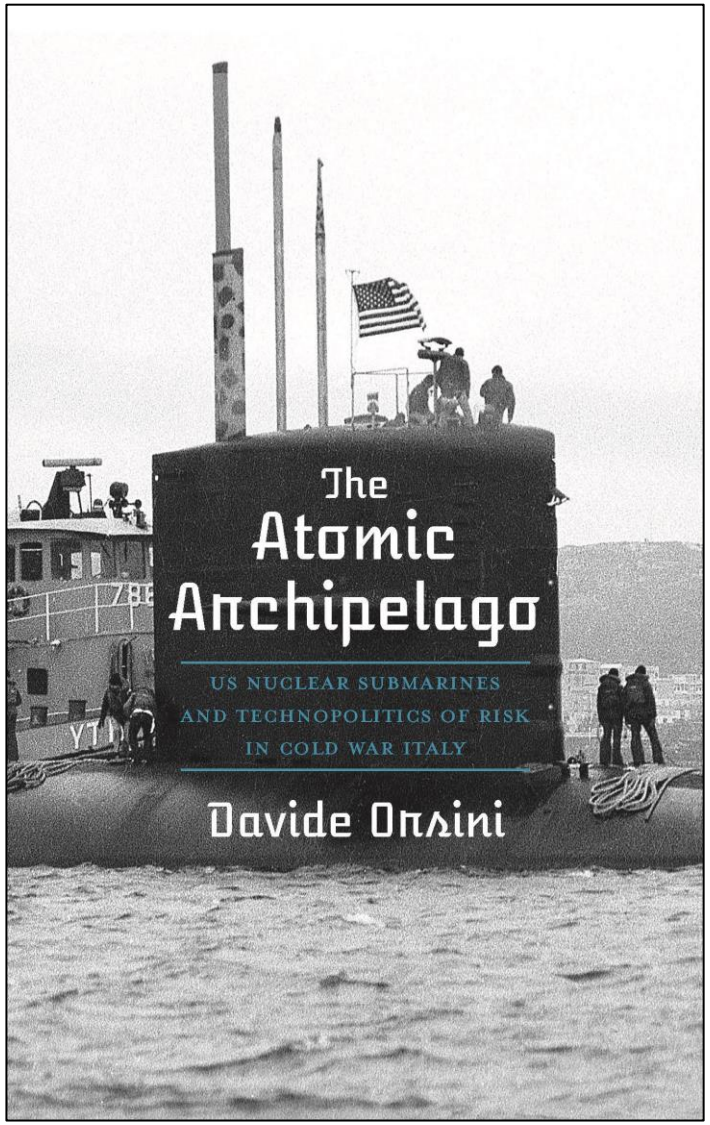
P.I. (Dis)Empowered Communities Project

www.disempoweredcommunities.com

Observatoire Hommes Milieux Fessenheim

Les lundis de l'OHM, June 1, 2026

It started from a question…



What happens to nuclear submarines after they become obsolete?

During my previous project I lerned more about radioecology, and that helped me understand the interactions between nuclear technology and the environment.

It's then that I started realizing the need to develop and apply a socioecological approach to the social/humanistic study of nuclear power and technology.

The Atomic Archipelgo: US Nuclear Submarines and Technopolitics of Risk in Cold War Italy.
(University of Pittsburgh Press, 2022)

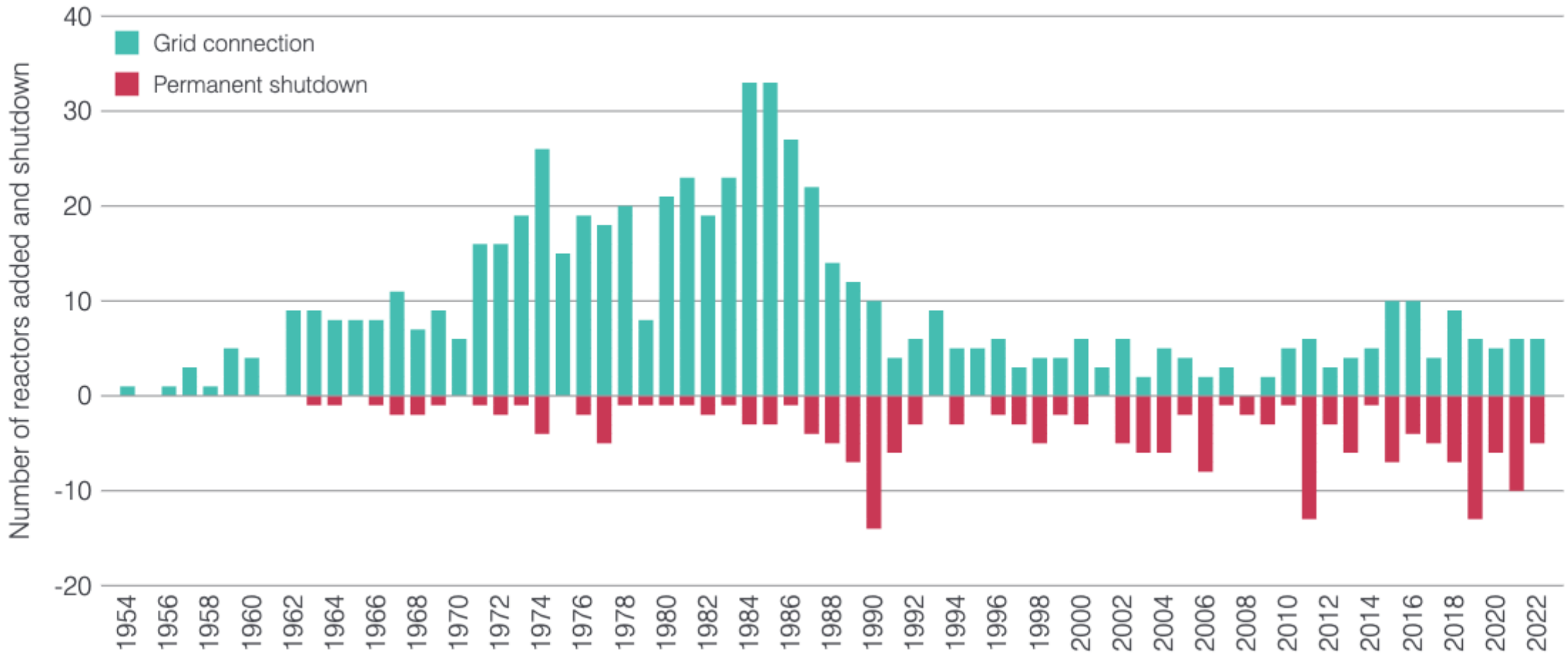
Problem statement and main research questions

- What happens when nuclear facilities reach the end of their operating life and need to be retired?

- Public debates on nuclear power revolve around two or three main issues: risk, construction costs, and final waste disposal, BUT we know very little about how long and how much money it takes to decommission NPPs. Furthermore, we know very little about the social, economic, and environmental implications of decommissioning projects for host communities.

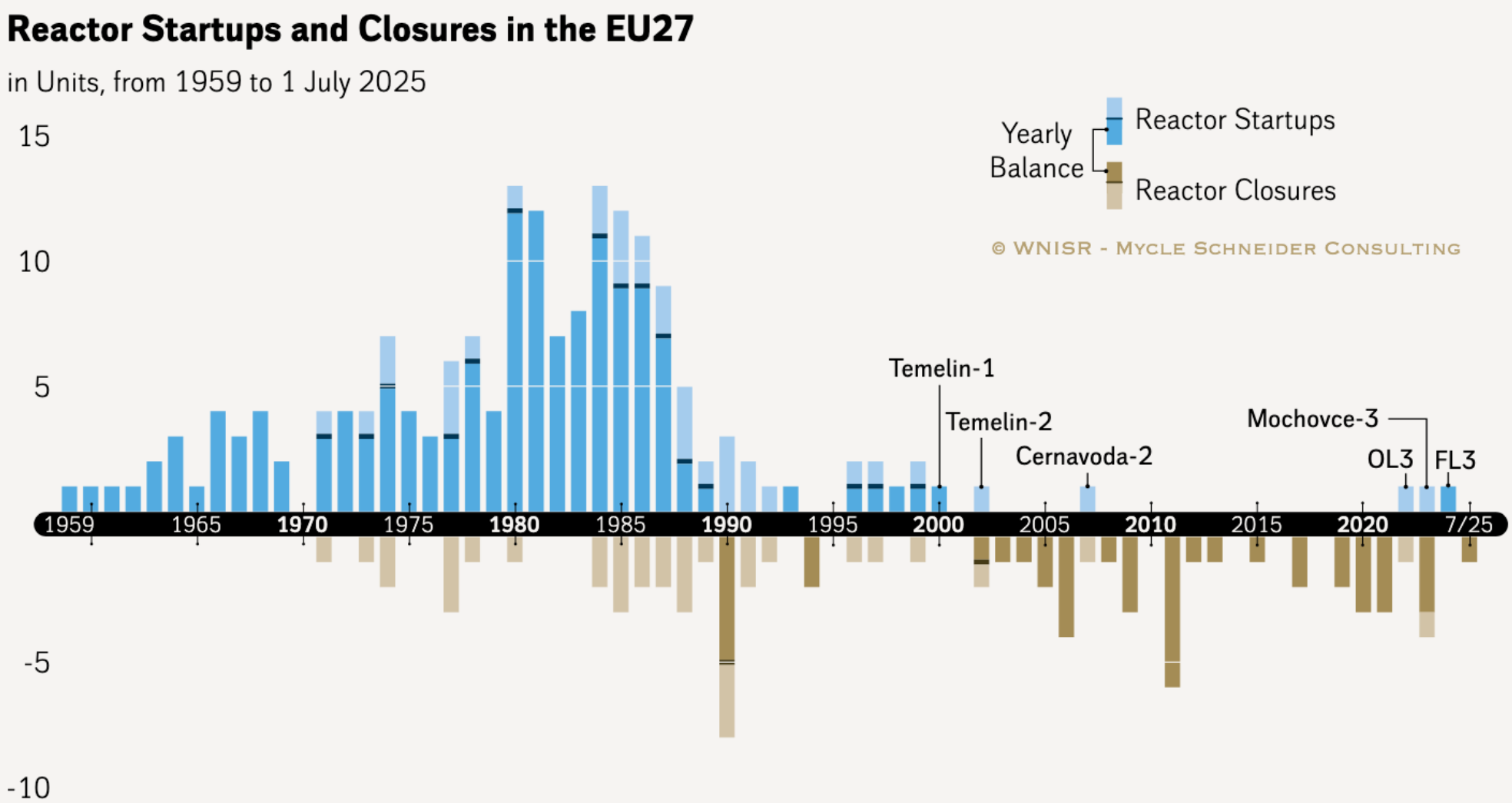
- Why should we know and talk more about decommissioning?

Figure 14. Reactor first grid connection and shutdown 1954-2022



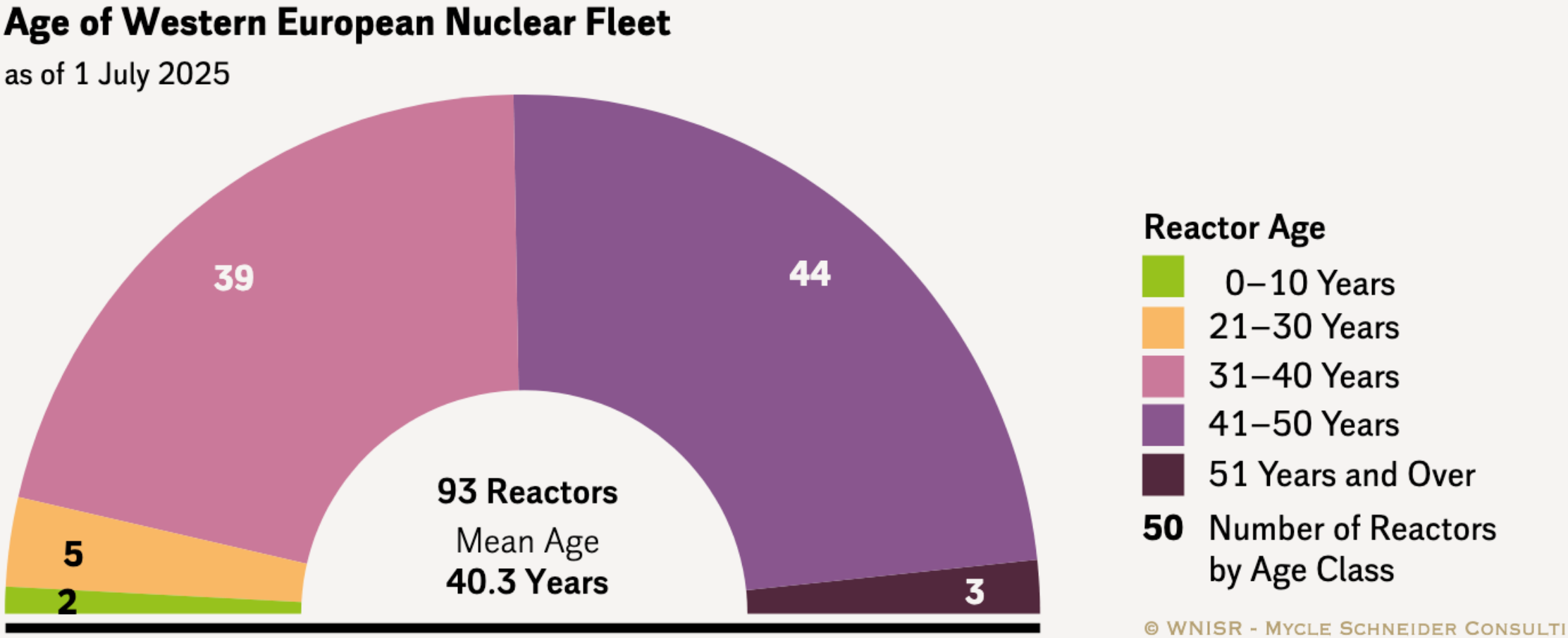
Source: World Nuclear Association, IAEA PRIS

Figure 80 · Nuclear Reactors Startups and Closures in the EU27, 1959–1 July 2025



Sources: WNISR with IAEA-PRIS, 2025

Figure 85 · Age Distribution of the Western European Reactor Fleet (incl. Switzerland and the U.K.)

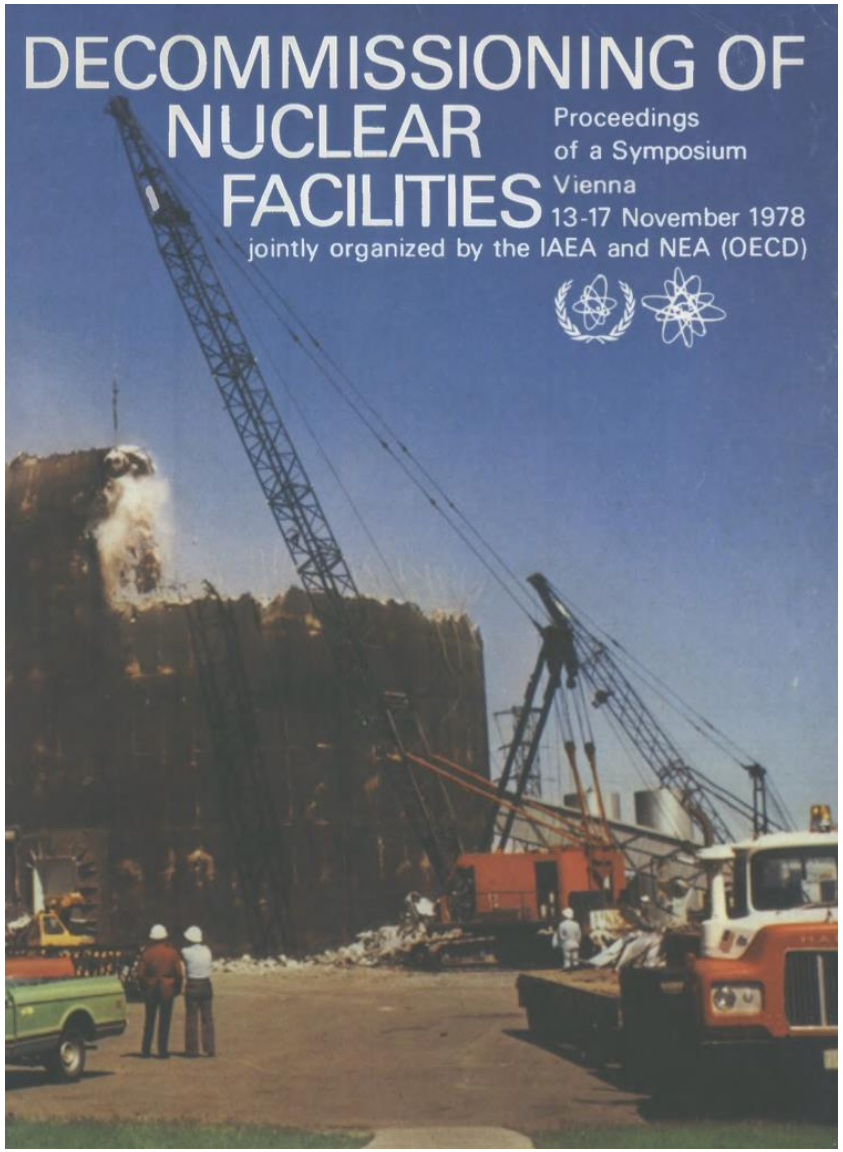


Sources: WNISR with IAEA-PRIS, 2

“Worldwide, as of mid-2024, **213 nuclear power reactors have been closed**, corresponding to over 106 GW of permanently retired capacity. **Only 23 have been fully decommissioned**, although some are still awaiting release from regulatory control, **and only 9 have been returned to greenfield conditions**, meaning the sites are available for unrestricted use. An additional 145 reactors are in some state of decommissioning, while 45 reactors are in a long-term enclosure (LTE) state.”

Source: World Nuclear Industry Status Report 2024, p. 297.

What to do with obsolete nuclear power plants?



First IAEA Technical Reports 1973-1975

6. CONCLUSIONS

Increasing nuclear power programs in many countries make it important that a good understanding should be obtained on the feasibility and costs of making nuclear facilities safe beyond all reasonable doubt at the end of their operating lives.

The need for this understanding is already becoming urgent as a number of nuclear facilities have been taken out of service and it is unlikely that they will ever be operated again.

Decommissioning to one or other of the stages outlined in this paper has been applied to a few nuclear facilities and together with the experience from normal nuclear operations and repair work a better understanding has been obtained of the problems involved and the techniques, tools and other resources required for performing decommissioning work.

It is clear that each specific nuclear plant to be decommissioned will have to receive special consideration and the plans will need to be discussed and agreed between responsible and competent authorities. It is our view that the work will be made easier and probably less costly if care has been taken by people who have been associated with the plant at

Increasing nuclear power programs in many countries make it important that a good understanding should be obtained on the feasibility and costs of making nuclear facilities safe beyond all reasonable doubt at the end of their operating lives.

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and effective decommissioning

(d) Assessments have been carried out to provide data on comparable plant, in the areas of ease of decommissioning, costs, volume of waste produced and surveillance requirements

(e) Financial arrangements have been worked out to ensure that the resources of the plant owner are not unduly strained, whether because at the outset of the plant's life a decommissioning capital sum has been provided, or payments have been made to such a fund from revenues, or because some other mutually agreeable arrangement has been reached between owners and authorities.

We feel that international collaboration in decommissioning matters should be fruitful, as there is a high degree of agreement that the environ-

G.R. Bainbridge et Al., 1974, "Decommissioning of Nuclear Facilities: A Review of Status," Atomic Energy Review 12 (1): 145-160

Nuclear decommissioning

- The process of safely closing a nuclear power plant (or other facility where nuclear materials are handled) to retire it from service after its useful life has ended. This process primarily involves decontaminating the facility to reduce residual radioactivity and then releasing the property for unrestricted or (under certain conditions) restricted use. This often includes dismantling the facility or dedicating it to other purposes.

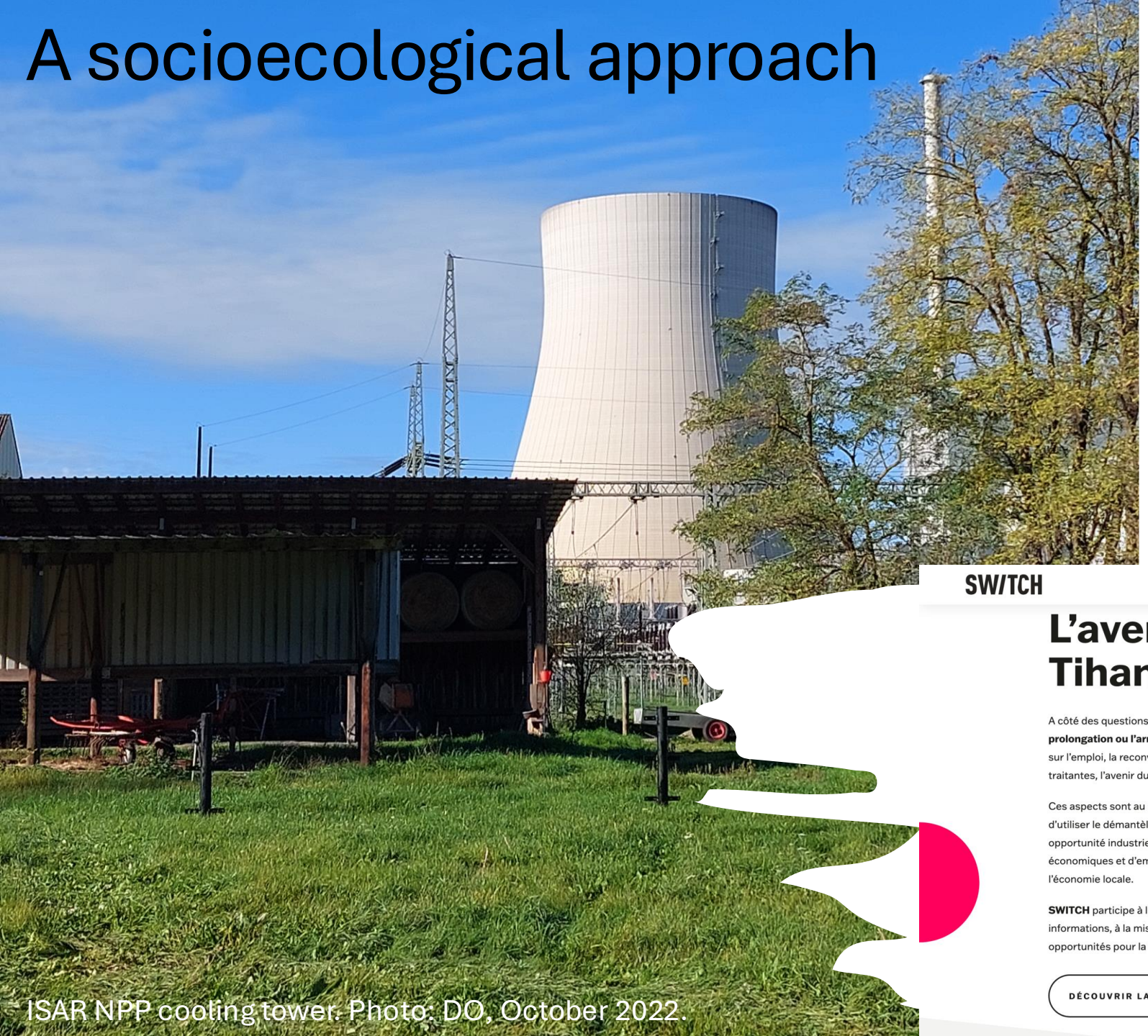
- Source: US Nuclear Regulatory Commission

- A long and uncertain transitional phase during which a “place” of production becomes a site with material “out of place” that needs to be isolated, treated, and eventually transported elsewhere to be disposed of.

Main problems and the challenges

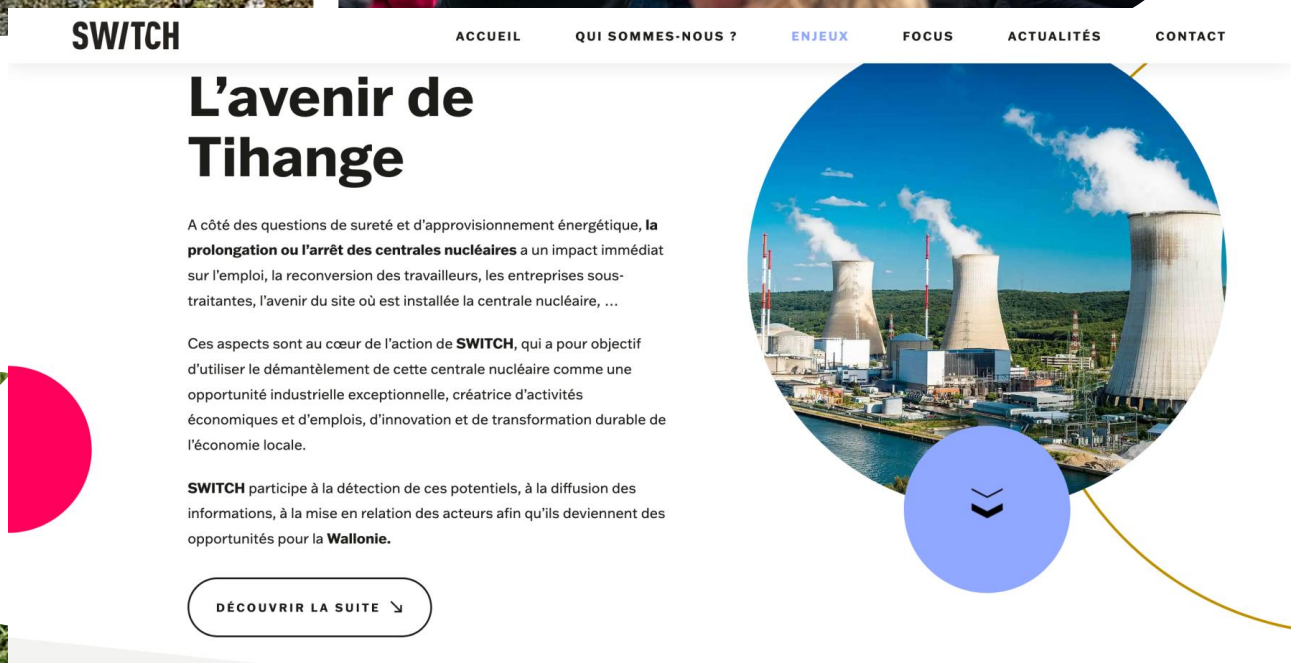
- EnviroTechnical
  - Each facility has technical and environmental characteristics that require a specific decommissioning plan, time, and approach.
- Financial
  - How much does it cost to decommissioning different nuclear facilities?
  - Who pays?
- Socioecological and economic
  - Environmental impact assessment
  - What to do with the site?
  - What happens to host communities during and after decommissioning?

A socioecological approach



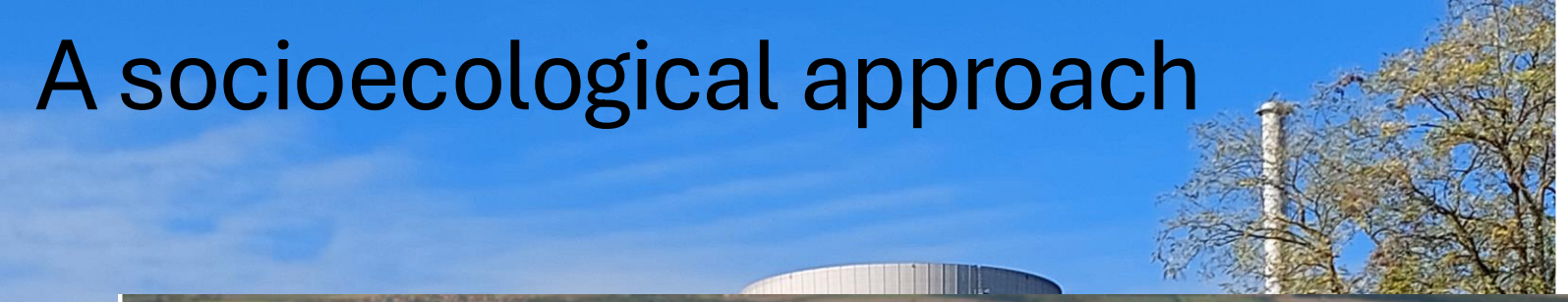
ISAR NPP cooling tower. Photo: DO, October 2022.

Credit: Hongyu Liu/The Patriot Ledger



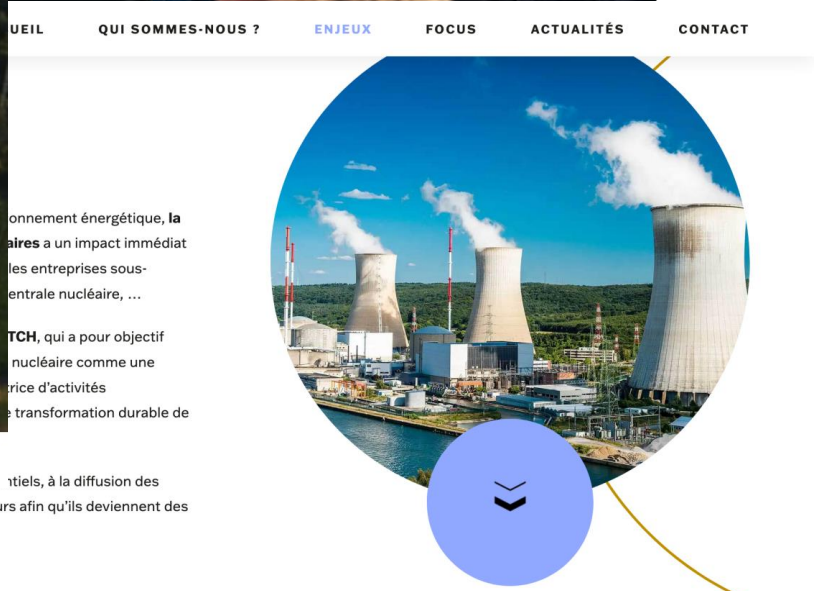
A socioecological approach

Credit: Hongyu Liu/The Patriot Ledger



The cooling towers are reduced to rubble (Image: PreussenElektra)

ISAR NPP cooling tower. Photo: DO, October 2022.



More than a technical endeavor

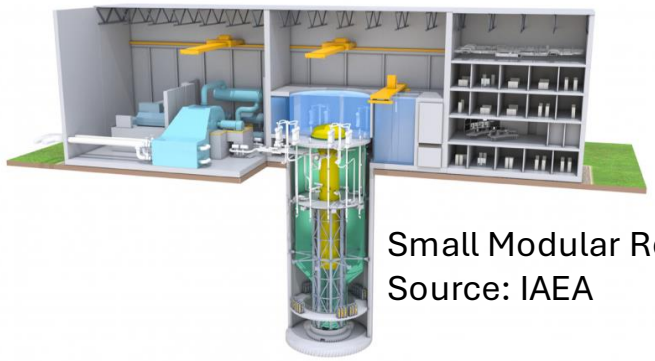
- History and memory
- Identity and socio-cultural tranformations
- Environmental changes and justice
- Public health and environmental pollution/preservation
- Economic struggles and post-nuclear (?) imaginations

What kinds of assistance to host communities?

- Tax cuts
- Recovery fund transfers
- Technical assistance (assessment of decommissioning and post-decommissioning scenarios)
- Creation of alternative industrial sites/districts
- Financial assistance to employees and workers
- Stimulation packages for local/regional economic development
- Environmental restoration and environmental impact assessment
- Community empowerment and active participation tools

Post-decommissioning?


Dry casks for spent nuclear fuel at NPP.
Source: US NRC


Small Modular Reactor
Source: IAEA


Niederaichbach NPP site, Bavaria.
Source: Davide Orsini

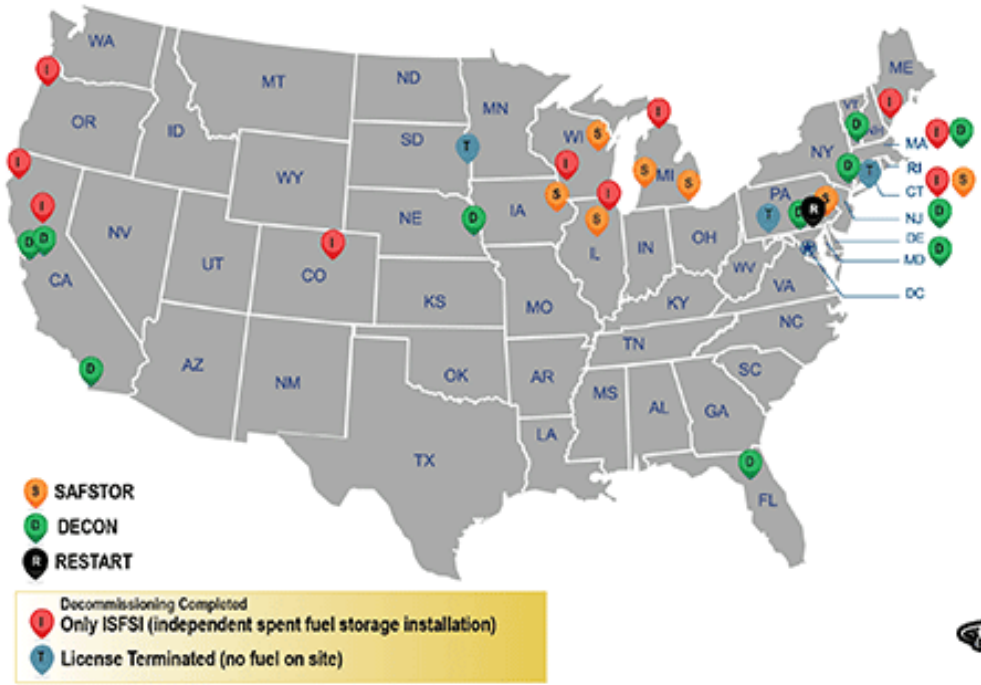
Gundremmingen, 25 ottobre, 2025 12:00 pm

Battery park and pilot fusion plant at Gundremmingen

Italy

- In 2003 the Italian government has established a compensatory fund for communities hosting decommissioning nuclear sites, administered by the Ministry of the Environment.
- The amount has changed over time.
- Today a total 15,000,000 € are distributed yearly across various sites according to the radioactive inventory of each decommissioning facility (I.e. places with the most radioactive material get more money).
- The money is disboursed directly to the local administrations, who can use the funds for investments related to environmental restoration projects and social sustainability.
- Tracking and monitoring of funds use have become stricter over time, although the system for verifying the consistency of local expenditures with the criteria established by central authorities has been lax and unconsequential.
- For this reason recently the Ministry for the Environment and the interministerial body assigning the funds have introduced more rigorous reporting requirements for monitoring the respect of the original categories of allowed investments.

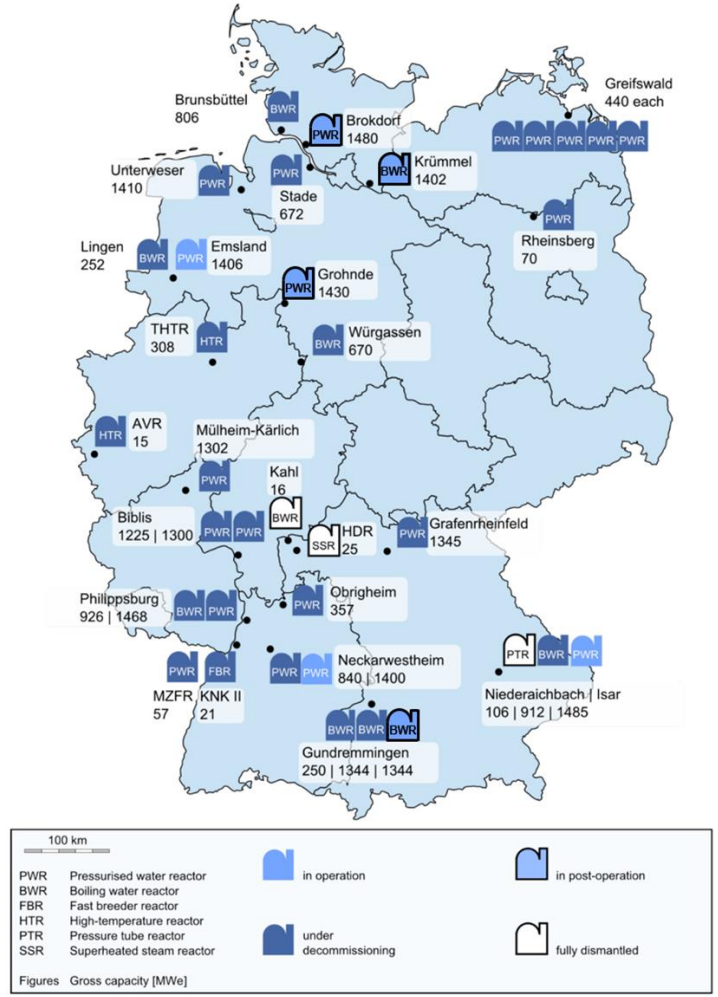
Power Reactor Decommissioning Status



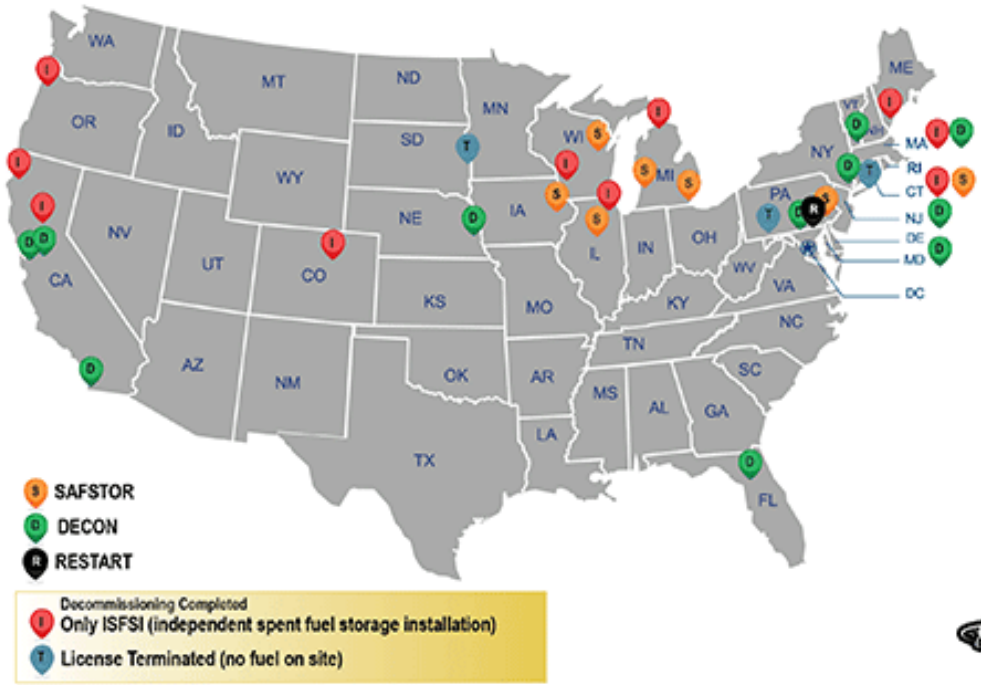
U.S.NRC
January 2025

Belgium's nuclear power plants

BBC



Power Reactor Decommissioning Status



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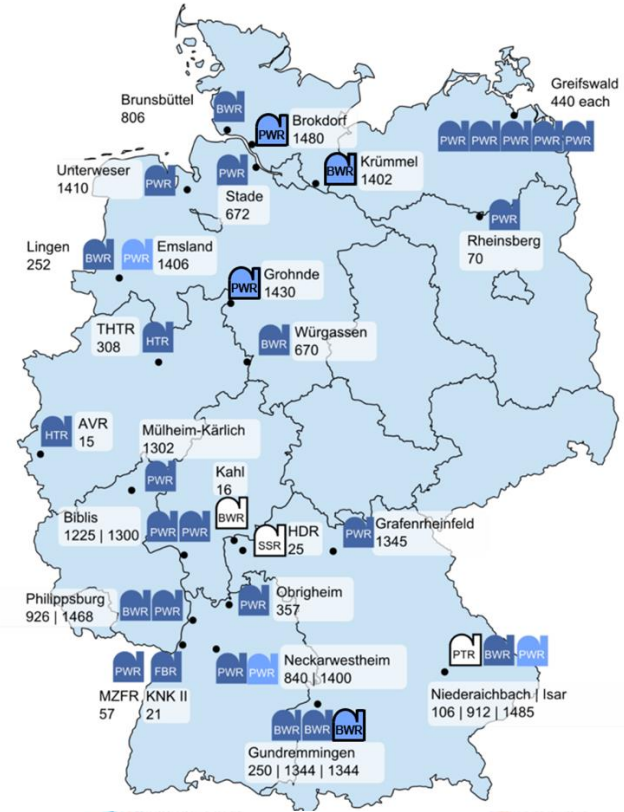


Belgium's nuclear power plants

BBC

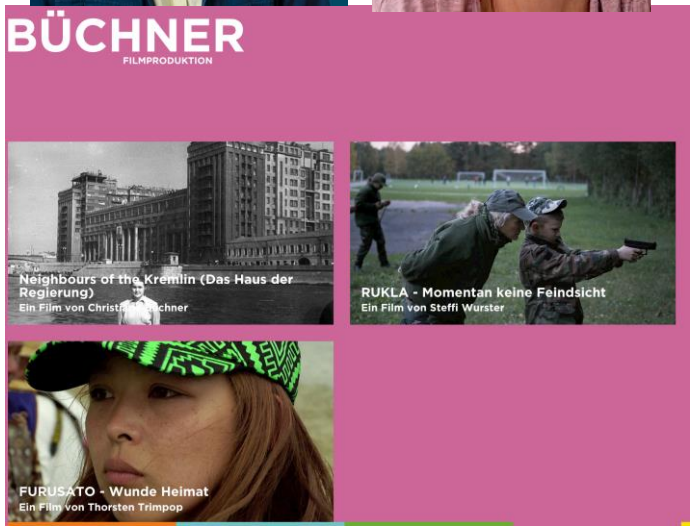
Rachel Carson Center, LMU – Munich

Dr. Davide Orsini, Ph.D., P.I.

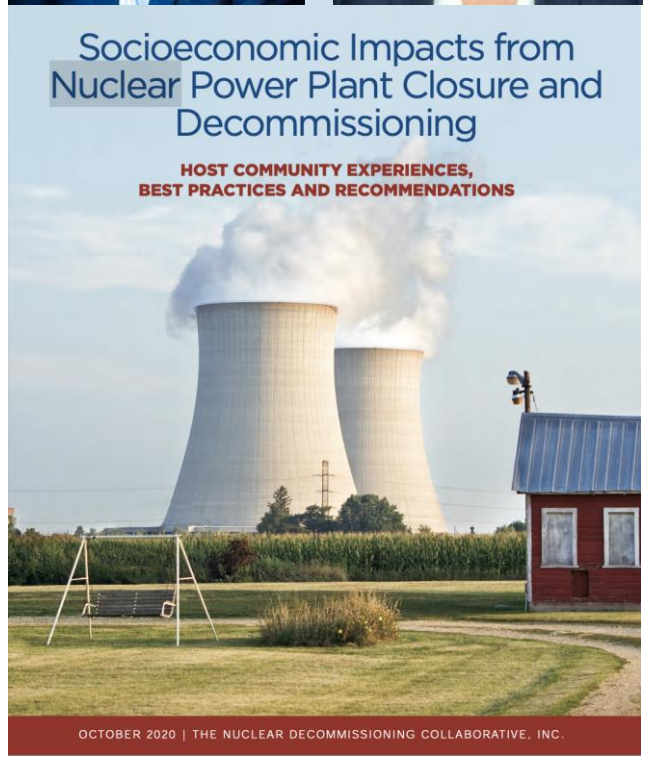
Two PhD Students

Yaroslav Koshelev

Hannah Heath



Büchner Filmproduktion
Tobias Büchner and Sabine Herpich



Nuclear Decommissioning Collaborative
Jim Hamilton and Cindy Winland

Our project for Change!

- **Objectives**
- Fostering a public debate
- Initiating a transformative process of knowledge production, exchange, and participation between and among experts, policy makers, and local communities to address and potentially fill current gaps.
- HOW?
  - Series of short documentaries and construction of an open multimedia archive.
  - Two open workshops (Chicago and Munich), and production of policy briefings.
  - Classic academic outputs

Article

S|S|S

Social Studies of Science
1–32
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Nuclear Decommissioning and the Political Economy of Waste: Exploring Nuclear Attachments in Italy

Davide Orsini[1]

Abstract

Overshadowed by expert and public debates over reactor safety and waste disposal solutions, nuclear decommissioning is a variably long transitional phase during which host communities face numerous uncertainties regarding their future and nuclear sites' cleanup results. What happens to nuclear facilities when they become obsolete and need to retire? How much does it cost to dismantle a nuclear plant, and what are the socioecological implications of decommissioning projects? Focusing on one case in Italy, this study adopts a longitudinal approach to nuclear site biographies, demonstrating how national regulations, decommissioning funding schemes, technical and environmental characteristics of the facilities, and the socioeconomic conditions of affected communities concur to shape decommissioning projects. My approach builds on recent works on nuclear attachments exploring local communities' ambivalence toward nuclear installations. I argue that decommissioning processes should be analyzed considering larger management schemes, interests, and constraints that at multiple levels concur to form political economies of nuclear waste.

Keywords

nuclear decommissioning, containment, political economy of nuclear waste, nuclear attachments, nuclear facilities' biographies

[1]Rachel Carson Center for Environment and Society, Ludwig-Maximilians Universität, Rachel Carson Center, Munich, Germany

Corresponding author:
Davide Orsini, Rachel Carson Center for Environment and Society, Ludwig-Maximilians Universität, Rachel Carson Center, Munich 80802, Germany.
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SPRINGS

THE RACHEL CARSON CENTER REVIEW

Issue #9

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4 November 2025

READING TIME: 20 MINUTES

(Dis)Empowered Communities: A Conversation with Davide Orsini

by Davide Orsini and Uwe Lübken

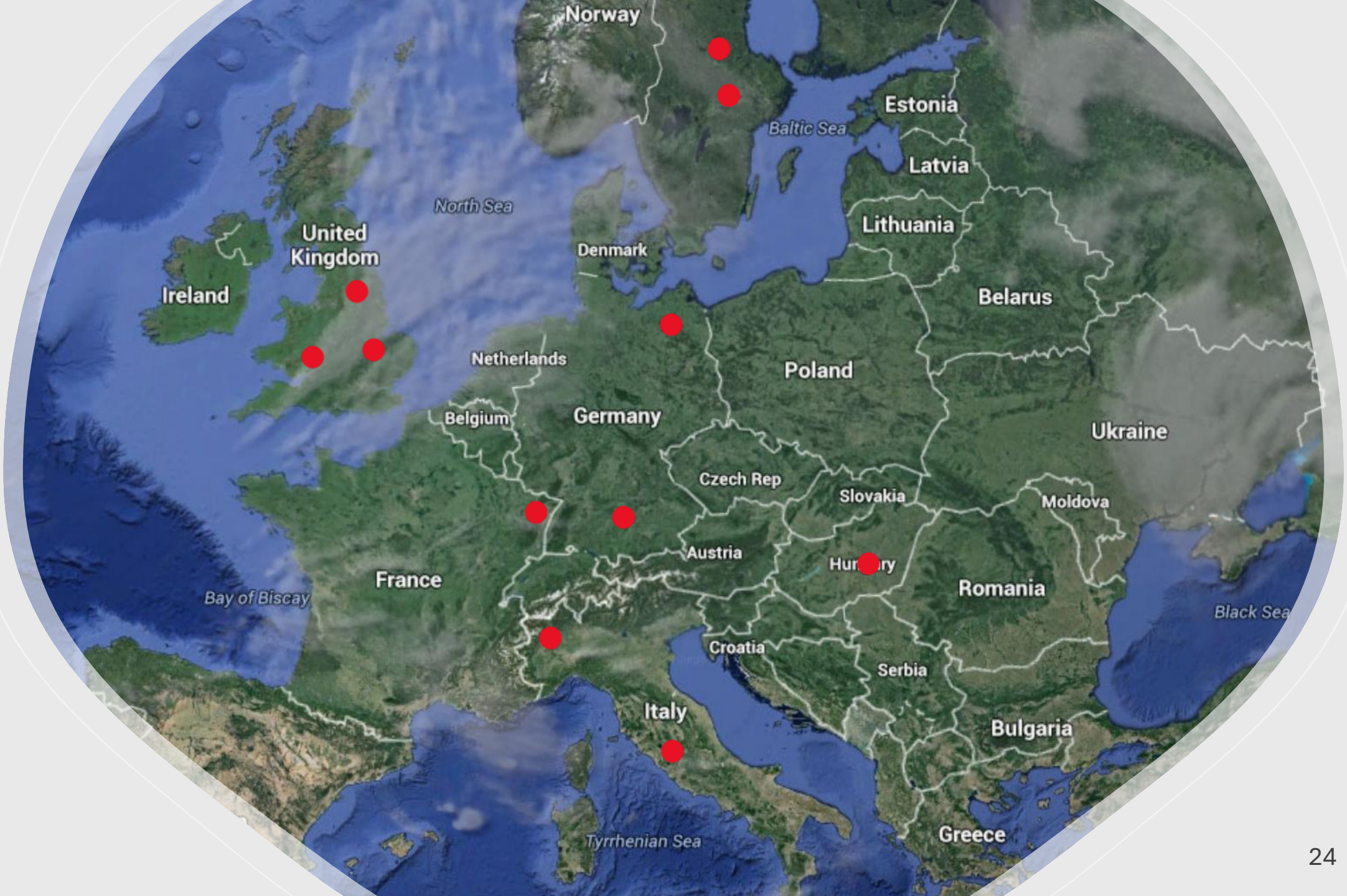
Davide Orsini holds a PhD in anthropology and history and a certificate in science, technology, and society (STS) from the University of Michigan. His research has focused on the social, political, and ecological implications of nuclear-power applications after WWII. Davide is PI of the research project "(Dis)Empowered Communities: A Comparative Study of Decommissioning Nuclear Sites," based at the RCC. He previously was a Marie Skłodowska-Curie Fellow at the RCC, a Zurich-Munich Fellow, and assistant professor at Mississippi State University.

Uwe Lübken is lecturer and coordinator of the MA program Environment and Society at the RCC. He has held teaching and research

https://springs-rcc.org/disempowered-communities/

Orsini, D. (2026). Nuclear Decommissioning and the Political Economy of Waste: Exploring Nuclear Attachments in Italy. *Social Studies of Science*. (Open access available online).

DECOMMISSIONING



PROJECTS MAP WE

Thanks!

KKN Niederaichbach green field. Photo: DO, October 2022.

Initiatives in the United States

Nuclear Closure Communities Technical Assistance Program

This effort utilizes Federal funds under award ED20HDQ3030068 from the U.S. Economic Development Administration (EDA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the project team and do not necessarily reflect the views of EDA or the U.S. Department of Commerce.

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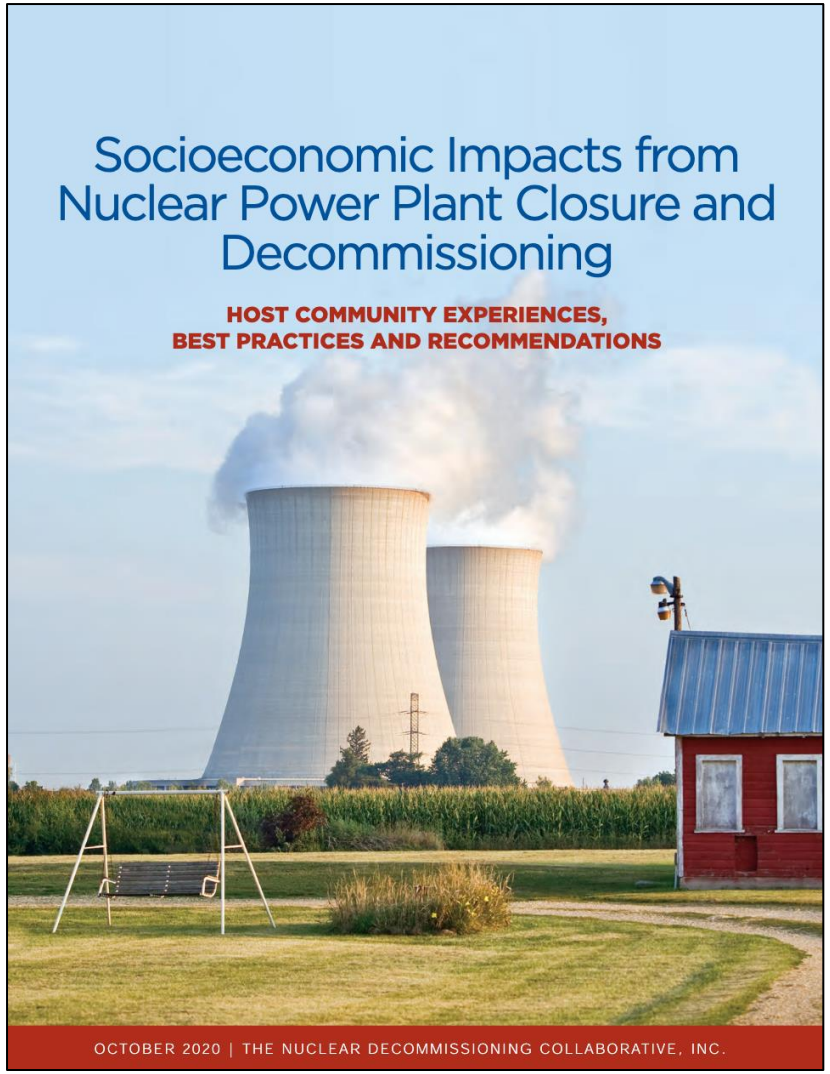
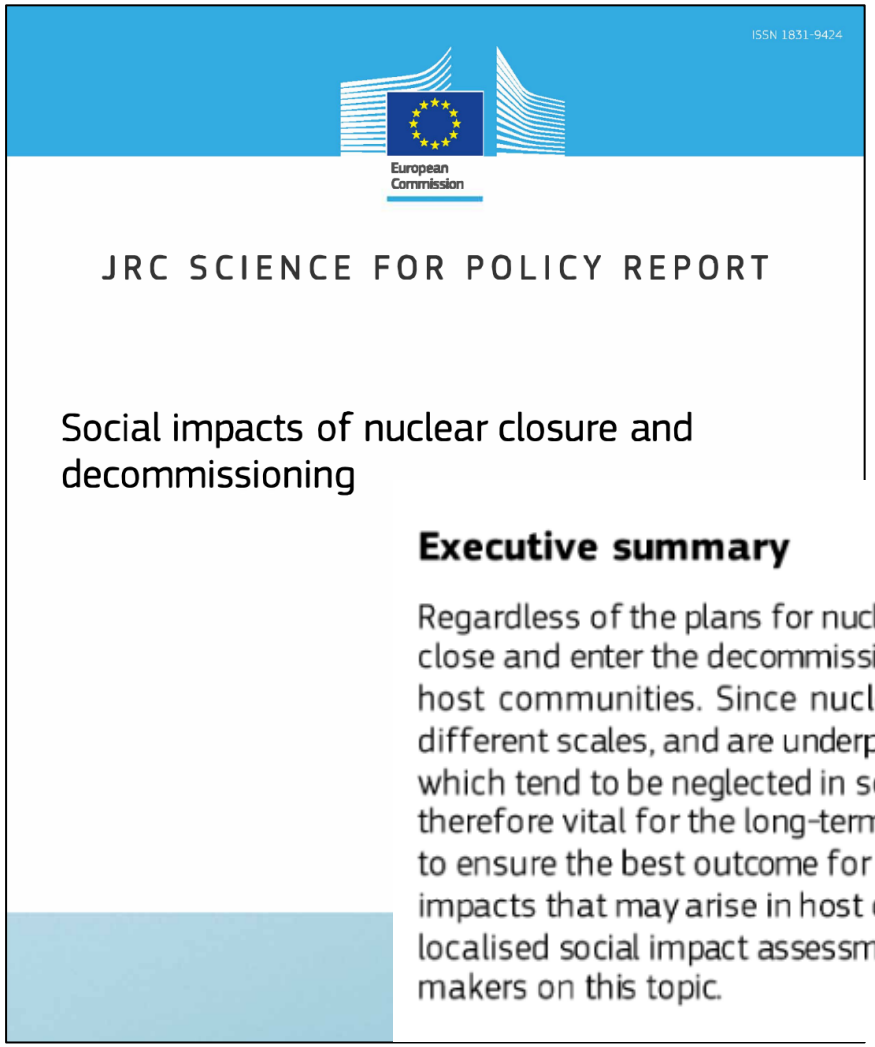


Initiatives in EUcountries



ISSN 1831-9424

European Commission

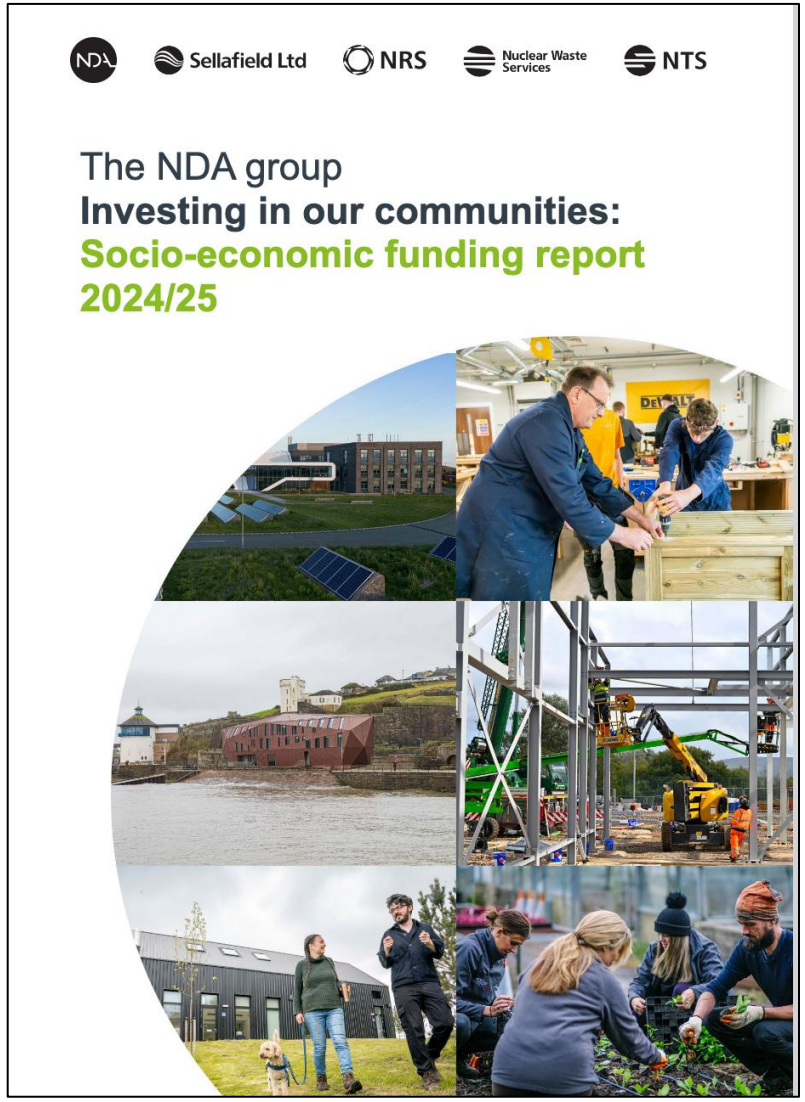
JRC SCIENCE FOR POLICY REPORT

Social impacts of nuclear closure and decommissioning

Executive summary

Regardless of the plans for nuclear energy at national level, each nuclear power plant (NPP) will eventually close and enter the decommissioning phase. If not properly managed, this may result in negative impacts for host communities. Since nuclear decommissioning projects are complex, involve many stakeholders at different scales, and are underpinned by uncertainty, it is especially important to consider social impacts, which tend to be neglected in socio-economic assessments due to their subjective or 'hidden' nature. It is therefore vital for the long-term prosperity of the community to pre-emptively identify possible social impacts to ensure the best outcome for the closure strategy. This study represents an initial analysis of the social impacts that may arise in host communities in EU member states, with the aim of providing guidance for localised social impact assessments (or similar undertakings) when they may occur and also to guide policy-makers on this topic.

Programs in the UK



Impact assessment

The economic contribution of the NDA to the West Cumbria economy, April 2022

An assessment of the economic contribution that Sellafield Ltd and Low Level Waste Repository (LLWR) Ltd made to the West Cumbria and UK economies in 2021.

From: Nuclear Decommissioning Authority, Low Level Waste Repository Ltd and Sellafield Ltd

Published 28 September 2022

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Documents

PDF

The economic contribution of the NDA to the West Cumbria economy, April 2022

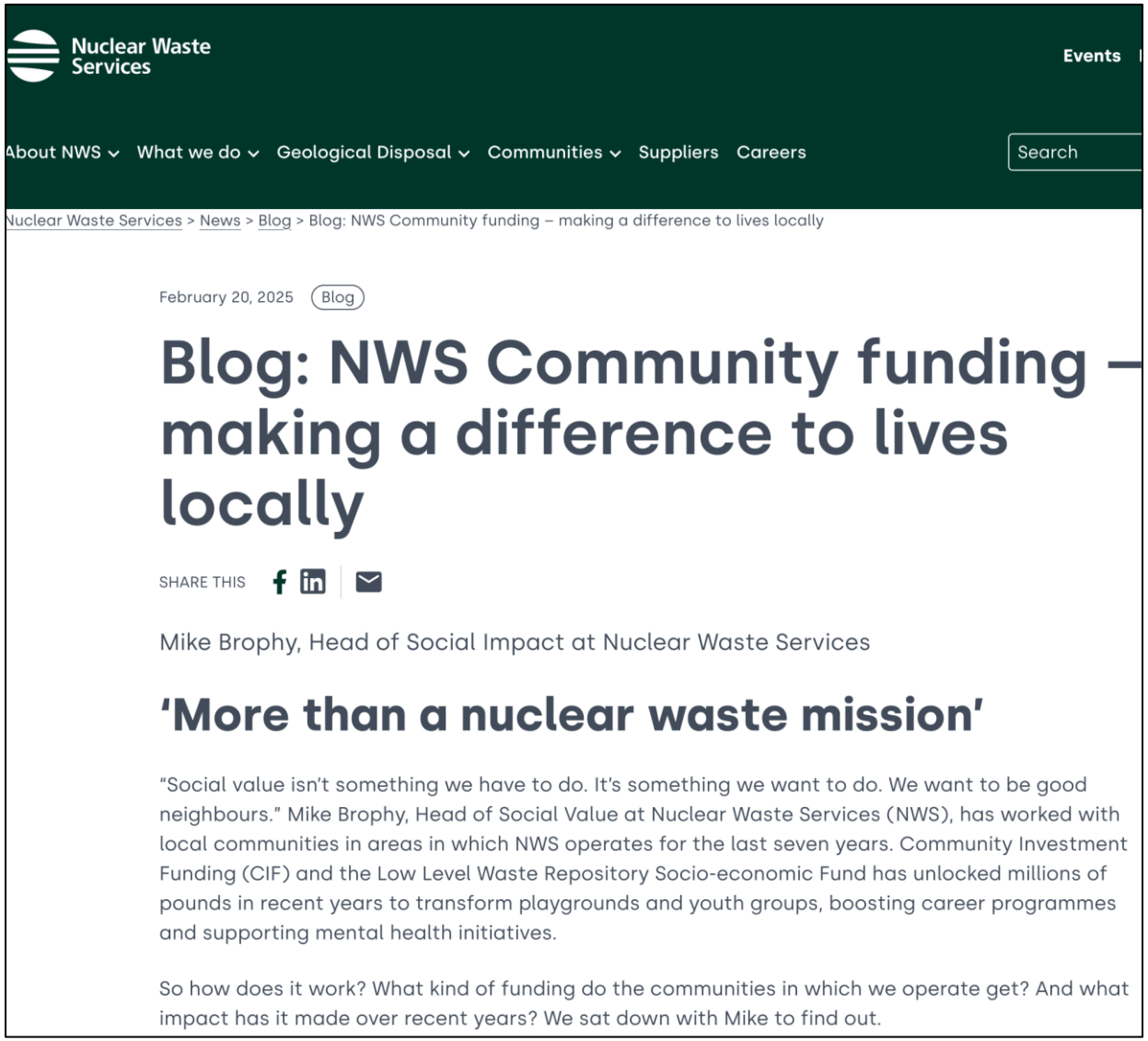
PDF, 1.42 MB, 56 pages

DOUNREAY SOCIO-ECONOMIC REPORT (EXTERNAL)

September 2022

Version 4.0

mace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February 20, 2025
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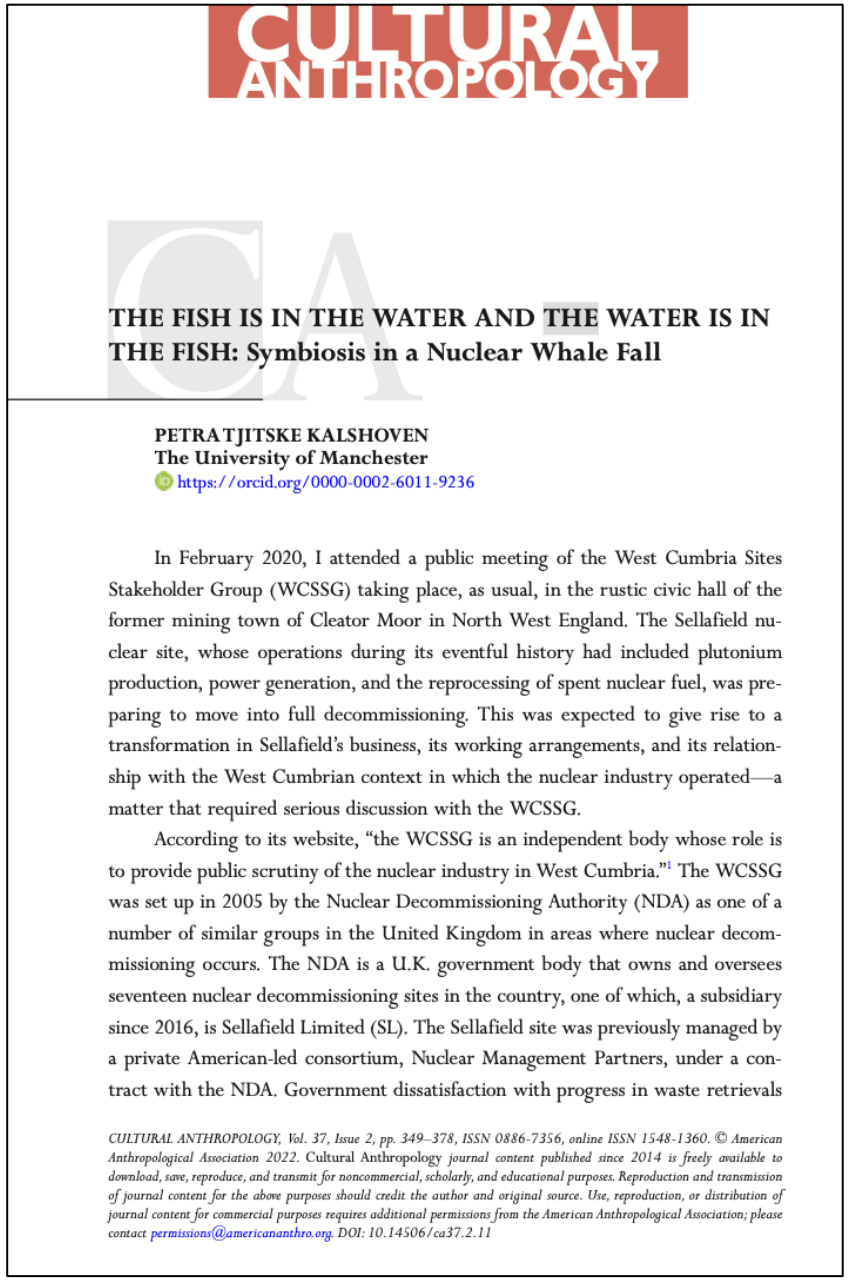
Mike Brophy, Head of Social Impact at Nuclear Waste Services
'More than a nuclear waste mission'
"Social value isn't something we have to do. It's something we want to do. We want to be good neighbours." Mike Brophy, Head of Social Value at Nuclear Waste Services (NWS), has worked with local communities in areas in which NWS operates for the last seven years. Community Investment Funding (CIF) and the Low Level Waste Repository Socio-economic Fund has unlocked millions of pounds in recent years to transform playgrounds and youth groups, boosting career programmes and supporting mental health initiatives.
So how does it work? What kind of funding do the communities in which we operate get? And what impact has it made over recent years? We sat down with Mike to find out.


CULTURAL ANTHROPOLOGY
THE FISH IS IN THE WATER AND THE WATER IS IN THE FISH: Symbiosis in a Nuclear Whale Fall
PETRA TJITSKE KALSHOVEN
The University of Manchester
https://orcid.org/0000-0002-6011-9236
In February 2020, I attended a public meeting of the West Cumbria Sites Stakeholder Group (WCSSG) taking place, as usual, in the rustic civic hall of the former mining town of Cleator Moor in North West England. The Sellafield nuclear site, whose operations during its eventful history had included plutonium production, power generation, and the reprocessing of spent nuclear fuel, was preparing to move into full decommissioning. This was expected to give rise to a transformation in Sellafield's business, its working arrangements, and its relationship with the West Cumbrian context in which the nuclear industry operated—a matter that required serious discussion with the WCSSG.
According to its website, "the WCSSG is an independent body whose role is to provide public scrutiny of the nuclear industry in West Cumbria."[1] The WCSSG was set up in 2005 by the Nuclear Decommissioning Authority (NDA) as one of a number of similar groups in the United Kingdom in areas where nuclear decommissioning occurs. The NDA is a U.K. government body that owns and oversees seventeen nuclear decommissioning sites in the country, one of which, a subsidiary since 2016, is Sellafield Limited (SL). The Sellafield site was previously managed by a private American-led consortium, Nuclear Management Partners, under a contract with the NDA. Government dissatisfaction with progress in waste retrievals
CULTURAL ANTHROPOLOGY, Vol. 37, Issue 2, pp. 349–378, ISSN 0886-7356, online ISSN 1548-1360. © American Anthropological Association 2022. Cultural Anthropology journal content published since 2014 is freely available to download, save, reproduce, and transmit for noncommercial, scholarly, and educational purposes. Reproduction and transmission of journal content for the above purposes should credit the author and original source. Use, reproduction, or distribution of journal content for commercial purposes requires additional permissions from the American Anthropological Association; please contact permissions@americananthro.org. DOI: 10.14506/ca37.2.11

Belgium

SWITCH

ACCUEIL QUI SOMMES-NOUS ? ENJEUX FOCUS ACTUALITÉS CONTACT

L'avenir de Tihange

A côté des questions de sureté et d'approvisionnement énergétique, **la prolongation ou l'arrêt des centrales nucléaires** a un impact immédiat sur l'emploi, la reconversion des travailleurs, les entreprises sous-traitantes, l'avenir du site où est installée la centrale nucléaire, ...

Ces aspects sont au cœur de l'action de **SWITCH**, qui a pour objectif d'utiliser le démantèlement de cette centrale nucléaire comme une opportunité industrielle exceptionnelle, créatrice d'activités économiques et d'emplois, d'innovation et de transformation durable de l'économie locale.

SWITCH participe à la détection de ces potentiels, à la diffusion des informations, à la mise en relation des acteurs afin qu'ils deviennent des opportunités pour la **Wallonie.**

DÉCOUVRIR LA SUITE ↘

SWITCH

Qui sommes-nous ?

MISSION DE SWITCH

Le **Gouvernement wallon**, anticipant les effets d'une fermeture totale ou partielle de la Centrale nucléaire de Tihange, a décidé de créer **SWITCH** pour définir et mettre en œuvre un plan de reconversion socio-économique de l'arrondissement de **Huy-Waremme**.

DÉCOUVRIR LA SUITE ↘

The Spanish situation

APPLIED ECONOMICS, 2017
VOL. 49, NO. 47, 4782–4792
https://doi.org/10.1080/00036846.2017.1293793

Routledge
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Check for updates

Socio-economic impact of a nuclear power plant: Almaraz (Spain)

Patricia D. Fuentes-Saguar[a], Juan A. Vega-Cervera[b] and Manuel Alejandro Cardenete[c,d]

[a]Department of Economics, Pablo de Olavide University, Seville, Spain; [b]Department of Economics, Extremadura University, Badajoz, Spain; [c]Department of Economics, Loyola University of Andalusia, Seville, Spain; [d]School of Management and Business, Universidad Autónoma de Chile, San Miguel-Santiago, Chile

ABSTRACT

An analysis is made of the socio-economic impact in a region in which a nuclear plant is decommissioned. The average age of nuclear power plants around the world is high, so that many are close to the end of their useful life. The issue of this impact will be important in a few years for various reasons, especially because those plants tend to be drivers of the economic activity in the areas in which they are located. The focus of this communication is on these socio-economic effects. Methodologically, socio-economic analysis uses a linear Social Accounting Matrix model that improves traditional Input–Output approaches by covering the induced effects generated from the receptors of income out to other sectors of the economy. The procedure is applied to an empirical analysis of the Almaraz Nuclear Power Plant in Spain. This was purposely chosen as sharing many of the general characteristics of nuclear plants around the world. If the plant is closed down, our results suggest that there will be a clear negative impact in terms of employment and added value generation.

KEYWORDS
Social Accounting Matrices; economic impact; linear models; nuclear power

JEL CLASSIFICATION
D57; Q43

1. Introduction

Nuclear fission has been a source of electrical power in the world since the second half of the twentieth century. Nuclear power plants (NPPs) as we now know them began to come on-line in the 1960s, with there being a boom in this type of energy in the 1970s and especially the 1980s. Given their years of service, many of these plants are beginning to have problems connected with their age. Most international nuclear watchdogs have been sounding warnings concerning this issue, but no clear conclusion has yet been reached as to what is the effective operating lifetime of a nuclear plant. The two options which owners and regulators have to consider are extending a plant's operating life by making a considerable investment in updating and maintaining it, or closure and subsequent decommissioning. It would be of great interest to be able to compare the effects of the two. In the former case, these would include the reduction in activity during the updating as well as the impact of the investment required. Although an interesting possibility because of the shock that this would generate on incomes in the region, there are no pertinent data available, thus making it difficult to quantify. However, it is the impact of the latter case, the closure of the plant that we shall be evaluating in this present work, focusing on the effects from a socio-economic perspective.

The problems involved in decommissioning a nuclear plant are not only technical but also social and socio-economic. However, while the technical procedures have been carefully studied with specific action protocols, the socio-economic implications in many cases remain unknown. Indeed, one finds technical details in the decommissioning reports, but nothing on the economic and social impacts. Such impacts may be of at least two types – micro-economic and macroeconomic. Microeconomic impacts are more important because of the direct, indirect, and induced effects on the environs of the plant. Most NPPs are located in rural areas, and constitute a major motor of the local economy. Closure of the plant will logically impact the area's employment and value generation. There are also macroeconomic impacts affecting national energy accounts since the amortized cost of a kWh produced by a NPP is extremely competitive with respect to other energy sources. In this article, we

CONTACT Patricia D. Fuentes-Saguar pfuesag@upo.es Universidad Pablo de Olavide, Ctra. de Utrera, km. 1, Seville 41013, Spain

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3.14. The Just Transition Fund

The Just Transition Fund is a new financial instrument under the **European Union's cohesion policy** which aims to support territories facing severe socio-economic challenges resulting from the transition to climate neutrality and to avoid exacerbating regional disparities. The Just Transition Fund will facilitate the implementation of the European Green Deal, aiming to achieve a climate-neutral Union by 2050.

Its main objective is to **mitigate the impact of the energy transition** by providing funding for the diversification and modernisation of local economies and mitigating negative impacts on employment. The Fund will support investments in areas such as digital connectivity, clean energy technologies, emission reductions, regeneration of industrial sites, training and re-skilling for workers affected by the transformation. **It will be managed by the regional governments** and **coordinated by the Just Transition Institute**.

Support measures included as part of this Fund will be essential to boost development in the areas, both for revitalising SMEs and for promoting tractor projects that emulate the economic pull effect that coal-related activities used to have in these areas.

The main areas of action of the **Territorial Plan of Spain** are as follows:

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VOLUME 2

PROCEEDINGS OF THE SECOND AEC ENVIRONMENTAL PROTECTION CONFERENCE

HELD AT
ALBUQUERQUE, NEW MEXICO
APRIL 16-19, 1974

Sponsored by the
U.S. Atomic Energy Commission
Division of Operational Safety

Conf-750827

CONF-750827

PROCEEDINGS OF THE FIRST CONFERENCE ON DECONTAMINATION AND DECOMMISSIONING (D&D) OF ERDA FACILITIES

Held at Idaho Falls, Idaho
August 19-21, 1975

Sponsored by the
U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
AND
AEROJET NUCLEAR COMPANY
WASTE MANAGEMENT PROGRAM DIVISION

BNWL-SA- 5834
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B. C. Lunis - Aerojet Nuclear Company

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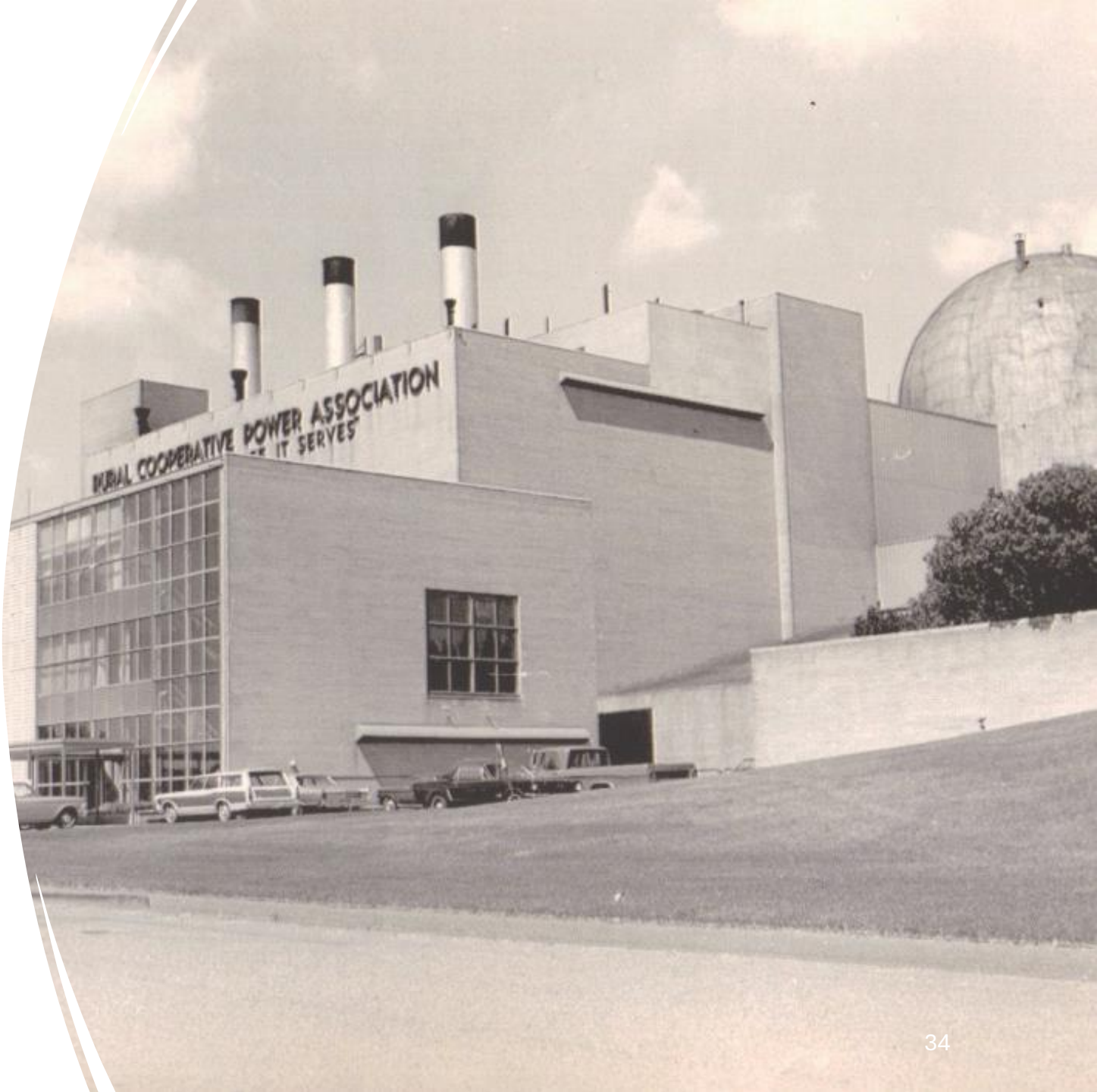
1972 Decommissioning of Elk River Reactor, Minnesota

- First fully dismantled NPP
- Boiling water reactor
- Operated from 1964 to 1968
- Small size US AEC demonstration reactor of 58 MWe
- Dismantling techniques: Plasma torch arc and underwater cutting
- Costs: baseline for future decommissioning cost estimates



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ENVIRONMENTAL STATEMENT

ELK RIVER REACTOR DISMANTLING

Elk River, Minn.

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MAY 1972

UNITED STATES ATOMIC ENERGY COMMISSION

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RESPONSIBLE OFFICIAL:

R. E. HOLLINGSWORTH
GENERAL MANAGER

Conf-731105--2

THE REMOTELY OPERATED PLASMA TORCH A TOOL FOR NUCLEAR REACTOR DISMANTLING*

Robert M. Beckers
Robert Blumberg
Clarence H. Wodtke**

Abstract

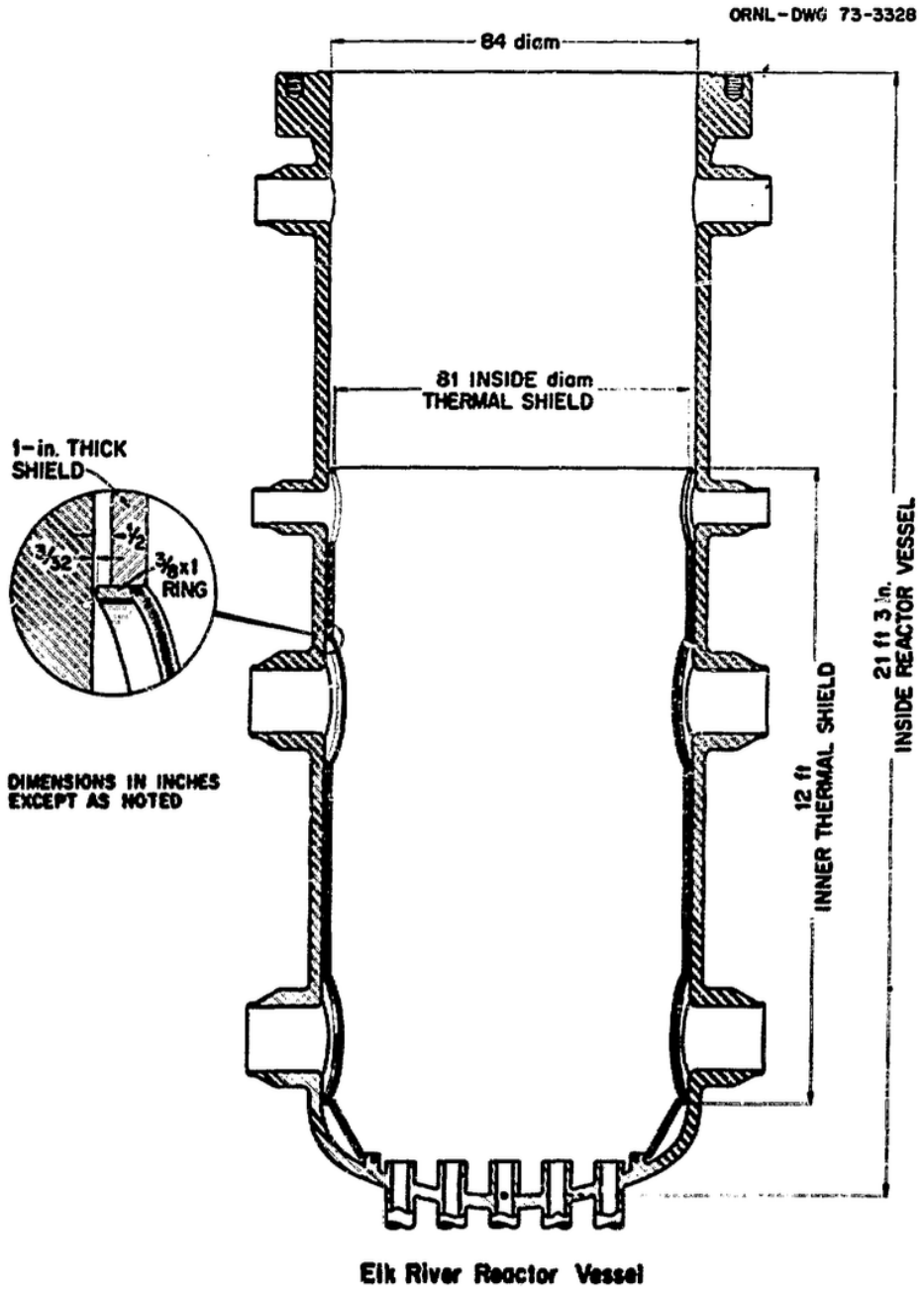
The Elk River Reactor facility is being dismantled in order to return the site to unrestricted use. The highly radioactive components - the reactor internals, the pressure vessel, and the outer thermal shield - have been cut up and shipped to a burial ground. Approximately 10,000 Ci of radioactive metal was removed without significant release of activity and without any overexposure to personnel. The dismantling was accomplished with a remotely operated plasma torch system. The design of the system, the results obtained, and evaluation of this technology are given.

Introduction

The Elk River Reactor (ERR), a 58-MW(t) boiling water, indirect-cycle reactor, was built and owned by the U. S. Atomic Energy Commission (AEC) under the Power Reactor Demonstration Program. It was operated by the United Power Association (UPA),† owner of the land on which the

Dismantling Elk River Reactor

- Two important technical developments:
  - Remotely controlled plasma arc torch used for underwater cutting, developed at the Oak Ridge Laboratory. Could cut up to 3-inch-thick contaminated steel.
  - Execution of certain operations under a filtrated air line which reduced sensibly both gaseous effluents and the spread of airborne contamination outside the cutting area.



Elk River Reactor Vessel

Decommissioning: Technically feasible?

- Experience with decontamination, post-accident recovery, and entombment of excess experimental and demonstration facilities provided useful.
- Were those early experiences applicable to decommissioning commercial reactors of 1,100 Mwe?
- Different reactor designs and site characteristics demanded different decommissioning strategies
- Focus on Light-Water Reactors, BWR and PWR, which became dominant in the 1970s.

AN ENGINEERING EVALUATION OF NUCLEAR POWER

REACTOR DECOMMISSIONING ALTERNATIVES

Prepared by

Nuclear Energy Services Division,

Automation Industries, Inc.

William J. Manion
Thomas S. LaGuardia

National Environmental Studies Project

Atomic Industrial Forum, Inc.

November 1976

AIF/NESP-036

GUIDELINES FOR PRODUCING COMMERCIAL NUCLEAR POWER PLANT DECOMMISSIONING COST ESTIMATES

Volume 1

Prepared for the
National Environmental Studies Project
of the
Atomic Industrial Forum, Inc.

by

TLG ENGINEERING, INC.

Brookfield, Connecticut

Thomas S. LaGuardia
John F. Risley
Francis W. Seymore
William A. Cloutier
Emile G. Smith
Joseph J. Adler
Kathleen M. Hubbard

May 1986

Estimating methods and their applicability

- Extrapolation: Elk River decommissioning costs as basis to calculate typical 1000 Mwe commercial NPP.

$$\text{Cost of } i^{th} \text{ plant} = \frac{\text{Cost of Elk River Dismantlement} \times i^{th} \text{ plant energy output}}{\text{Elk River energy output}}$$

- Unit cost factor: Developed first in 1976 by W. J. Manion and T. LaGuardia for the U.S. Atomic Industrial Forum. Updated in 1986 with the intent of providing general and uniform guidelines for general costs estimates for LWR's decommissioning allowing for site specific characteristics and contingencies inputs.

- Engineering analysis: Method based on actual plant design study and site visits, ideally applicable to same reactor types. Based on Battelle North West Laboratories studies commissioned by U.S. NRC (1978-1982). These are the so-called NUREG Series Reports.

R.I. Smith, *Approaches to Estimating Decommissioning Costs.* PNL-SA-18160. 1990.