

Dataset Description of the Doctoral Dissertation

“The Energy to Come: Promises, Imaginaries and Ecology of Nuclear Fusion”

by Alessio Giacometti, PhD in Social Sciences

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Here is a brief description of the dataset used in the frame of the Doctoral Dissertation “The Energy to Come: Promises, Imaginaries and Ecology of Nuclear Fusion” by Alessio Giacometti, PhD in Social Sciences at the University of Padova, Italy, in the period 2021/2024. The research has utilized a qualitatively driven, mixed-methods strategy (Hesse-Biber, 2010), which combines qualitative discourse analysis of verbatim transcripts by fusion leaders and insiders from over a hundred and fifty sources publicly available online with interviews to fusion scientists and multi-sited ethnographic materials. While interviews and ethnographic evidence have been used only to support and expand the scope of the investigation, its core has been the qualitative discourse analysis of a constellation of differentiated sources available online (Herring, 2009). These are fusion-related documentaries and feature films, talks and podcast episodes, webinars and conferences, speeches at institutional events and public interviews.

What is common in all these online sources is that they see the central and prominent presence of at a fusion scientist, official, spokesperson, CEO or representative, speaking speak up to shape the public discourses about fusion research and its prospects. These sources therefore correspond to the broader category of so-called “bridging events” (Bakker et al., 2011), namely those science-society exchange sites such as promotional events, speeches and roundtables, where insiders like scientists, developers and entrepreneurs present and describe their field or technology in question to outsiders like potential investors, stakeholders and the public. Bridging events like these are particularly important, for these are places where the public perception of technoscience is built through “future talks” (Samimian-Darash et al., 2024), since they can be conceived as arenas where expectations, promises, imaginaries and visions disclosed by new technologies like nuclear fusion are constructed, shared by the core set of insiders with outsiders, and made circulate across the public (Pollock & Williams, 2010).

Different criteria have been followed to build up the dataset of online fusion-related sources. First, I selected sources in which fusion insiders take word in the first-person, considering for the analysis their verbatim transcripts only. I therefore avoided any kind of media analysis of discourses about fusion taking place through scientific newswires, newspaper articles, magazines or social networks, as I was interested in how fusion is told by insiders, not by outsiders like journalists, science communicators or other intermediaries. Second, I opted for sources that, with respect to news articles, provide a broader coverage and a deeper commentary on fusion research, with several fusion insiders invited to talk together about their field (e.g. speeches at institutional events, documentaries and feature films) or a single expert about fusion allowed to speak long without too strict time constraints (podcasts, public interviews, webinars and conferences). Third, I included in the dataset sources of shorter duration, but that a

layperson abruptly interested in getting information about fusion energy might likely and easily come across through a simple online search (TED talks, ITER Talks, ITER Stories). Fourth, I mainly considered materials uploaded online during the period of my research (2021-2024), with the exception of some sources from previous years and even historical materials that were available online and particularly relevant for the longitudinal analysis on how the public discourse on fusion energy by insiders has remained the same, or changed, over time and particularly the last decade. Fifth, the sampling strategy that I adopted was to include the entire population of a category of sources when available, and when not to choose sources where fusion insiders talk about the following aspects: what fusion energy is meant to do and what it serves for, what the barriers to its development or to its faster commercialisation are, what the politics of fusion research is and why alternative approaches might be preferable, why a public-private shift in research leadership is taking place in the field, what the prospects for fusion energy are and how this new source of energy is expected to impact society when finally available. If the population of a category of sources was not available online, the adequate sample size was determined according to the principle of saturation, with the search of new sources that stopped when they were beginning to repeat and further data collection appeared to be redundant (Hennink & Kaiser, 2022; Saunders et al., 2018).

More in detail, a first set of sources is represented by a selection of historically relevant documentaries (A1 and A2), video series by business news channels (A5, A8, A10, A12, A13 and A15) or by science channels (A9, A11 and A14), as well as featured films (A3, A4, A6 and A7). These materials have been contributing to popularize fusion to the public, giving word to fusion insiders and providing a state-of-the-art representation of research in the field or its prospects. The dataset then comprises the “ITER Talks”, namely formal presentations of technical aspects of the ITER project by some of its research leaders (B1 to B11), and the “ITER Stories” podcast, more broadly related to cultural and managerial aspects of the project (C1 to C13). These sources are part of the official representation that the flagship project of the whole international fusion program wants to give of itself and of fusion research in general. Then come the TED talks delivered by fusion scientists in English language (D1 to D21), with prominent fusion scientists, research leaders, start-ups’ CEO, consultants and spokespersons on stage as speakers. TED talks, which are increasingly considered as an influential genre for specialised knowledge dissemination and technoscience popularisation (Mattiello, 2017), are widely known videos available online with speakers from education, business, technoscience and other spheres that get invited to give a 10-to-18-minutes presentation on their research, results and ideas. As such, they are not surprisingly used as empirical material for discourse analysis in science-communication studies (Kinnaird & Laudun, 2019; Meinsma et al., 2023; Sugimoto et al., 2013).

What follows in the dataset is a selection of episodes from podcasts specifically dealing with nuclear energy (E1 to E5, E8, E12 and E17), or provided by ecomodernist circles (E7, E10, E11, E17, E18 and E19), business news channels (E14 and E15) and generalist podcasters (E6 and E13). I considered only podcasts with the participation of fusion

scientists and not just PhD students, as in the case of *A glass of Seawater* by the University of York in the UK. Like TED talks, podcasts are rapidly becoming popular tools for science communication, and therefore they are being increasingly studied or used themselves as empirical evidence for discourse analysis (Lundström & Lundström, 2021; McGregor, 2022; Picardi & Regina, 2008). What is interesting about fusion discourses taking place via podcasts is that invited insiders are given an apparently confidential space and an extended time to elaborate on their reasoning, and therefore provide detailed and thorough accounts. The dataset then comprises a selection of talks, webinars and conferences held by institutions like The Royal Institution (F1, F2, F16, F19, F21 and F22), the International Atomic Energy Agency (F8, F10, F13, F14), and others (F3, F4, F5, F9, F11, F12, F15, F17, F18, F20 and F23). These bridging events are of a particular type, as they merge peer-group conversations among scientists and the confrontation with the public: the richness of questions, doubts, and curiosities arising from such a heterogeneous audience is remarkable and makes extraordinarily valuable the discursive material to analyse.

The same can be said with reference to fusion-related speeches at institutional events included in the dataset, like hearings at the US Congress, Senate or the White House (G1, G3, G4, G6, G7, G16, G19, G27), the UK Parliament (G2, G18), and the European Parliament or Commission (G13 and G25), or like opening ceremonies and press conferences (G10, G11, G15 and G24) and institutional events at the UK Atomic Energy Authority (G8 and G26), at the United Nations COPs for the climate (G9, G22, G23, G28 and G29), at the World Economic Forum (G12), and others (G5, G14, G17, G20, G21 and G30). In this kind of bridging event, fusion leaders and officials face political decision-makers and stakeholders, whose questions would be unimaginable for a single interviewer to ask the same panel of fusion representatives. Hearings by fusion leaders at Committees or Subcommittees of the US Congress or Senate, for instance, are a particularly interesting setting for discourse analysis: called to testify at the US Congress, fusion leaders have indeed been attacked by Congressmen and Congresswomen with questions I could not have imagined, and this natural experiment of a “collective intelligence” interrogating scientists has sensibly expanded the reach and enriched the quality of the material for the analysis – even though the deliberative system of the public legislator tends to polarize positions so that they become more black and white, while in the messy and fuzzy landscape of fusion research they are still sort of grey.

Finally, a last set of sources I have considered are public interviews to fusion scientists retrieved from the fusion-related podcast *Fusion Focused* by Ella Fox-Widdows and the vodcast *CoffeeBreakDown* by Aaron Ho and Luca Vialetto, with a different fusion scientist invited at each of their episodes, as well as public interviews to private-fusion investors retrieved from the startup and technology news channel TechCrunch+ Investor Surveys and the ecomodernist vodcast *Age of Miracles* by Packy McCormick. This research therefore collects discursive evidence retrieved from public speeches, talks, and public interviews where fusion scientists and stakeholders, ITER’s spokespeople and start-ups’

representatives contribute to socially construct the representation of fusion as a viable source of energy for the future.

Data collected from publicly available online sources for qualitative discourse analysis have been triangulated with semi-structured interviews to fusion scientists working in national research centres or fusion start-ups and with evidence from an ethnography conducted in a nuclear fusion facility. Aware of their limitations, non-representativeness and exploratory character, such methods have been treated as only complementary and supportive to the analysis of online sources, as they do not constitute the core of this research. They nonetheless helped me improve my understanding of fusion research, refine the analysis, test my hypothesis and directly share my viewpoint with fusion scientists. The procedures for collecting ethnographic materials and interviews used in this study are complying with the ethical requirements of the University of Padova, and informed consent for participation, data use and publishing was obtained from all participants.

More specifically, I have interviewed either in person or online 42 fusion scientists, both physicists and engineers (excluded PhD students), by means of a snowball sampling strategy that started from the informants I got in contact with and interviewed at the nuclear fusion research centre Consorzio RFX in Italy and from there expanded to other nuclear fusion facilities in Europe and the US. As interviewees agree to take part in this research under anonymity, only a general reference to the venue of their workplace is given when quoted: at the moment of my interview, 35 of them were working in European national labs, 3 in US national labs, 4 in start-ups (1 based in the US, 1 in the UK and 2 in Europe). As a selection criterium for interviewees, I opted for fusion scientists who were not spokespersons or officials of their own organisations, therefore unlikely to be the opinion leaders appearing “on stage” in talks, podcasts, institutional events and the other online sources already included in the dataset for the analysis of the public discourse on fusion energy. Those who got chosen for interviewing were fusion scientists with no management responsibilities who rarely express their view on fusion politics publicly, but who openly have it to share when asked by an outsider. With interviews usually lasting between one and two hours, my questions to them regarded both their own specific work, their career choices and the general view they had about fusion research, its prospects, its challenges, its representations, ITER, the start-ups, and so on with topics that informants brought their own into the interviews.

The other method used to support the analysis of the public discourse on fusion has been ethnography, in the wake of participant observation in nuclear fusion facilities already carried out by other scholars (Alexander, 2023; Chen, 2022; Kinsella, 1996, 1999; Virtová & Vostal, 2021). From September 2022 to September 2023, I spent overall a hundred days of participant observation at the already mentioned research centre Consorzio RFX in Padova, the main experimental facility for fusion research in Italy, with average two-three research visits to the laboratory per week. Such a facility got chosen as the ethnographic case study of this research for both, pragmatic and scientific considerations. It was a pragmatic choice for reasons of geographical proximity and easy

access, which got negotiated without difficulties thanks to a gatekeeper and the generous availability of the laboratory top managers. Moreover, Consorzio RFX was chosen also for theoretical reasons, as its laboratories host two different facilities: the Neutral-Beam Test Facility (NBTF), the only ITER's facility outside the headquarter in France with the task of testing one of its heating systems, and the RFX facility, venue of a detached experiment on the reverse-field pinch (RFP) configuration, in course of shut-down and updating when I entered the research centre. In the same laboratory, therefore, there were activities connected with the ITER-DEMO mainline of research and on an alternative configuration that got progressively de-funded in recent years as efforts got concentrated around ITER. Such research activities on the NBTF make the Consorzio RFX an "influential" case study for a national lab working in service to ITER, while its research line on the RFP configuration make it "diverse" with respect to the mainstream (Seawright & Gerring, 2008). In addition, my presence at the Consorzio RFX allowed participation also to the research activities of the EUROfusion work package on the Socio-Economic Studies (SES) of fusion energy, which helped me make contact with other national labs in Europe and remotely attend important fusion-related conferences worldwide.

During my stay at the Consorzio RFX, I took part at tens of formal and informal meetings and shadowed 20 fusion scientists in their daily work: experimentalists upgrading diagnostics, theoreticians and modellers running computer simulations, or engineers concerned with completing the procurement of components on time as well as with fusion machines assembling and testing to make them work. Moreover, I shadowed each fusion scientist consequently for two or three working days, at the end of which I had an ethnographic interview to discuss the notes I had taken about their own work and more broadly about fusion research in general. At the beginning informants were generally rather suspicious of my interest to their work, but after two or three days of shadowing they became more open to share their view and curious about my research. I nonetheless carried out my participant observation with a "superficial cover" approach, where research is overt but its objectives remain implicit to informants (Fine, 1993).

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Alessio Giacometti

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