

NUCLEAR ENERGY DEVELOPMENT IN POSTWAR WEST GERMANY: STRUGGLES OVER COOPERATION IN THE FEDERAL REPUBLIC'S FIRST REACTOR STATION

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In the 1950s, a small group of political, scientific and business leaders in West Germany were determined to build a center for nuclear reactor research and development. They characterized the venture as a three-way partnership, intending to set an example for a scientific-technical age. The project was eventually carried out, but not without much conflict. The attempts at cooperation show parties with divergent sets of criteria that they only inadequately reconciled, and the struggles display their conflicted understandings of both the public–private boundary and the scientific role. New archival material lets us inspect more accurately the workings of the proposed collaboration. It shows how the conflicts developed in practice, despite all parties' expressions of commitment to cooperation.

Keywords: Nuclear energy; Reactor development; State-industry-science cooperation; Federal Republic of Germany

INTRODUCTION

Upon achieving sovereignty in 1955, the Federal Republic of Germany officially inaugurated an ambitious program to develop nuclear reactor technology. The program was meant as a showcase venture into high-tech

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industrial policy.¹ The initial efforts, in advance of the formal launch and for the first few years after, centered on planning the country's first nuclear research and development station. In the rhetoric of its advocates in government, business, and science, the station would be a model undertaking that actively created links among the different parties involved. The plans for the center, like many of that era, were instinctively predicated on the predominant linear model of technology development—new science generates new technology, and new technology changes the world. At the same time, however, the participants believed they could create a site where the interests of multiple participants could be brought together in complementary and synergistic ways.

Thus, in West Germany as in other non-state-directed economies, reactor development was conceived as built upon cooperation among three parties. The government had to regulate the sensitive project, provide political backing, and secure the investment. Industry was meant as the long-term instrument; it was to furnish expertise and facilities and some financial support. Science, finally, would supply the new knowledge, imagination and (though this was negotiable) a substantial component of leadership. These three categories were explicit in the thinking of the participants, as was the need for strengthening interchanges among them. Today's notions of triple helices and national innovation systems would have seemed more than comfortable to these historical actors.

The station's planning, however, put on display the complications that collaboration would bring. For the venture proved much trickier than its initiators expected, and the process generated noticeable strains. In general terms, these troubles were not unique to either reactor development or West Germany; they can be seen in many similar cases. What they display is the nature of the obstacles encountered, which were sometimes systemic and generalizable, but at least as often particularistic or idiosyncratic. The discussions of the 1950s also help reveal the historical setting of the notion that systemic tripartite cooperation was the right ideal to invoke. This paper reconstructs the detailed negotiations among the three parties, with particular interest in the role of the scientists because of the linear policy model.

The planning of the reactor station has always occupied a central place in the history of West German nuclear technology.² However, conventional accounts of the station's origins bear revisiting. Historical studies have

finally begun filling in the details of early West German science and technology organizations.³ At the same time, they have advanced our understanding of industrial policy, technological modernization, and business relations to the state.⁴ The established narrative of the reactor project also starts to shift in confrontation with new sources. Better access to federal papers has already exemplarily filled out that side of the story.⁵ Other collections in state (*Land*) and industrial archives bring out its complexity in other ways. The part played by the Max Planck Society (Max-Planck-Gesellschaft, or MPG), Germany's organization of top-flight extra-university research institutes, can now be addressed in more depth; a fuller exploitation of the papers of Werner Heisenberg, the key scientific player, makes clearer his claims for the scientist's role. Finally, a key episode, the struggle over the laboratory site, looks different when all sides' archival documentation is put to use. The resulting picture brings into focus the specific forms of collaboration and conflict.

THE SETTING

The proposed cooperation in nuclear technology posed real questions to the postwar sociopolitical order. In the Federal Republic of the 1950s, contemporary with communism and after the Third Reich, the proper location of such projects—in the domain of the “free market”, “state enterprise” or the “planned economy” in between—was still a matter for dispute.⁶ Under the sign of the West German social market order (*Soziale Marktwirtschaft*), economic activity was to be allowed free play on a liberal model, yet disciplined to serve a common good. Then facing the demands of the Korean War, the oversight of national industrial production was put up for debate. In the context of postwar reconstruction, the notion of a national system of technological innovation had a distinct positive resonance. A coordinated attack on national needs, drawing on the strengths of all relevant parties, was a seemingly natural appeal.⁷

In themselves, questions about cooperation were not really new; they had been around since the railroads, if not even earlier. Much of the international admiration expressed by the late nineteenth century about the German system of science and technology had praised its seemingly seamless integration of the forces of research, industry and the state.

Whatever the reality, that was the perception, and the perception had a power of its own. The forerunner of the Max Planck Society, the Kaiser Wilhelm Society, had been viewed as exemplary, in applied as well as basic research. For the Kaiser Wilhelm Institutes, as one classic account has put it, stood squarely in the force field of politics and society, established as formally independent of all other parties, informally responsive to particular sorts of requests.⁸ Then after World War II, interest in cooperation in technical fields was most certainly not limited to reactors. In other domains, too, it was at stake as the new state's economic policy was concretized. Mechanisms were familiar from fields like aviation and armaments, even if their details were still being worked out. The tone-setting policymakers were Chancellor Konrad Adenauer, a pragmatic politician in most matters of economy, and his economics minister Ludwig Erhard, widely viewed as the father of the social market. These men had at least the ideological (and sometimes the practical) support of the business community's leading spokesmen. The actual implementers of cooperation were often mid-level bureaucrats and industrial managers, whose career trajectories not infrequently crossed.⁹

Yet nuclear technology had complications of its own. Here no cadre of managers and administrators was ready to step back into place. While individuals might bring with them experience and models, the network had to be constituted largely from scratch. In nuclear science, too, new measures would be needed to create a field. At the start of the 1950s, not even a decade and a half had passed since the discovery of fission in Otto Hahn's Kaiser Wilhelm Institute. In Germany there was substantial experience going back to the Third Reich's project to exploit nuclear power. However, the corps of expertise was sparse, with few students yet trained, and it remained heavily concentrated in basic science. Nuclear engineering as a profession was scarcely recognized.

Finally, as a systematic venture, science policy was still ill-established, even if relations between state and private enterprise were not. Again, models might be cited from earlier experience, but it was not always clear how they would apply. Should research policy be directed to industry, universities, or independent institutes? How would basic science be related to development? And central to the rhetoric of the atomic age: what role would scientists play in each stage?¹⁰

STARTING THE DISCUSSION

In practical terms, it is now commonly agreed, the considerations that concretely led to the first reactor station started not from economics, but from politics and science. At the end of World War II, German research and development were put under the oversight of Allied authorities. The occupying powers had an immediate interest in control of these fields, for reasons ranging from exploiting patents to defanging the military to staking claims on technical manpower. While western-zone authorities put aside most plans for industrial and scientific dismantling, they imposed strict supervision on domains with any relation to military research. They specifically outlawed applied nuclear physics and, as the Cold War intensified, tightened their restrictions to include a wide range of related equipment and technology. By the early 1950s, however, West German self-government was drawing nearer. As preparations were made for the Federal Republic's recognition as a coequal sovereign state, atomic research and technology were part of the discussion. To replace Allied restrictions, the Federal Republic would be required to renounce production of nuclear weapons. However, it might be allowed more freedom for other activities, in the framework of a German law to be worked out.

The prospect of a reduction in controls pleased the scientists, and it brought them into closer relations with the national government. For while the new federal economics ministry would have to draft the law and assume the burden of enforcement, technical expertise was needed. How should nuclear materials be managed, and what amounts allowed?¹¹ There was an unofficial procedure for dealing with such questions: Werner Heisenberg was drawn into the negotiations in spring 1952.¹² After the war, the Nobel Laureate and director of the Max Planck Institute for Physics in Göttingen (MPI) had made himself into a spokesman for science and a contact of choice for Adenauer's government. His early investments in science policy, including an ambitious German Research Council, had not panned out, but he had opened channels of communication to Adenauer and Erhard. Few scientists could match his connections, even if they overestimated his influence. As one of the leading figures in the earlier *Uranverein*, which had sought to exploit nuclear energy during the war, he was also assumed, despite being a theoretical physicist, to be informed on the matters at hand.¹³

As discussions grew more specialized, other scientists were drafted, too: Heisenberg's younger associate Karl Wirtz, plus two university professors of nuclear physics, Wolfgang Gentner and Wolfgang Riezler. Things began to move forward. The idea of an atomic energy commission took hold, growing out of research control but taking on an interest of its own. Heisenberg brought the suggestion to Erhard, and Gentner drew up an organizational plan.¹⁴ Already the scientists were offering their own ideas of how the state should be shaped. The economics ministry was slower on the uptake, in part because of internal confusion. A circle of scientists with some experience in the field confronted a government bureaucracy with much less continuity. But by November 1952 Heisenberg had pushed the nuclear issue onto the minister's agenda, and a high-ranking meeting started framing plans.¹⁵

Out of these discussions, a concrete project was emerging. The Allies' specifications focused on enriched uranium and plutonium. They presupposed reactors, even as they placed them under restrictions, and this presumption met a friendly response. For Adenauer, the proposal to build a reactor, the first allowed in Germany since the war, underlined the Federal Republic's coming status as a sovereign state and an industrial power.¹⁶ On the side of the scientists, Heisenberg particularly pushed to move rapidly. For him, too, the reason to pursue the project was the national interest in industrial development. The order of magnitude of this reactor was a megawatt, completely insignificant for power production. Rather than energy generation, which Heisenberg hardly expected within the next decades, he cited radioactive isotopes and the creation of an independent nuclear industry.¹⁷ And so, before there was much interest from industrialists at all, the physicist was hoping to bring them on board. If constructing a reactor had any scientific interest, on the other hand, he did not think much of it. The most he would say was that once it was running, it would open up some nice experimental possibilities.¹⁸

THE SCIENTIST MOVES FORWARD

With the reactor proposal Heisenberg was coming back to a field he had left behind at the end of the war. In British detention in summer 1945, he had expressed the wish to return to it eventually. For the immediate postwar years, however, he had been happy enough to leave it aside.

When Adenauer had inquired in 1949 about the consequences of research control, an almost wistful Heisenberg, already distracted by policy work, had replied that in comparison to applied nuclear studies, basic research in particle physics was “nearly more interesting”. But he ultimately proved willing enough to be drawn back into the field. At Adenauer’s suggestion, he sketched out a program for constructing a modest reactor.¹⁹

Against some suppositions, Heisenberg’s postwar investment in nuclear reactors does not really seem to have been in proving a point about his competence and leadership. To his mind, the wartime project was not a scientific failure, nor an organizational one in a fashion traceable to anyone below the highest Nazi leaders. He explained the *Uranverein*’s course in terms of material shortages and other large-scale constraints of the regime and the war.²⁰ Then after the war, in practical terms, it would be no great triumph to build a reactor. Assuming the atomic energy commission would be set up in a matter of months, its committees could take on some of the work. On the commission itself, what was important was not technical competence, but the authority of “a few personalities” (Heisenberg was imagining four or five) “whose high political position or personal reputation at home and abroad can generate confidence that the misuse of atomic energy is ruled out.”²¹ Logistically, he did not imagine that getting the project going would be hard.

Along the way, conscious of the power of his name and his position, Heisenberg assumed that he would play a leading role, whether shepherding through the nuclear laws, designing the atomic energy commission, or constructing the first reactor. And taking for granted that the reactor would be associated with a physics institute, his own seemed to him an obvious choice. From his earliest concrete comments in 1952, Heisenberg presupposed that the first reactor center would be run by Wirtz and himself.²² For one thing he did have, independent of all else: the discretionary power of a Max Planck Institute director. In allowing room for this development, his MPI was nearly ideal. Indeed, possibilities elsewhere were as yet limited. No government bureau took the lead; continuity of personnel was lacking. While some university researchers had experience, their institutes usually had other burdens. Industrial laboratories sometimes had interest but, with little role in the wartime project, little expertise.²³ By contrast, the Max Planck Society by the early 1950s offered expansive opportunities. When no one else in the MPG staked a claim to leadership, Heisenberg had its resources at his disposal.²⁴

Experiments were planned under Wirtz's direction beginning in 1951 or 1952.²⁵ As usual, Heisenberg gave his division director a free hand in the institute and occupied himself with external relations. The goal of Wirtz's efforts was not so much novel scientific results, but rather the consolidation of a group of scientists and technicians, brought in from academia and industry and gaining experience in measurements, instrumentation, and design. Within two years the neutron physics crew already amounted to about a dozen researchers.²⁶ The story of the reactor station would be thenceforth tied to the internal situation of Heisenberg's institute. Of course, the real bottleneck remained research control. What were the experimenters to experiment with? The MPI had secretly recovered about 100 kg of uranium, plus other nuclear materials, from their wartime supplies. Heisenberg was not the only institute chief who allowed research to continue under the table. He was, however, the one who made reactor preparation a major part of his program.²⁷

EARLY PROGRESS, EARLY TROUBLES

As discussions moved ahead, the reactor plan became more specific and ambitious. What it grew into was a national center for scientific research and technical development. As Heisenberg's references make clear, he came to envision a center like the American one in Brookhaven, Canada's Chalk River, or (in some respects) Harwell in the United Kingdom, a station with more than just a reactor and his MPI, but also an isotope production facility, a medical clinic, and a ring of laboratories for fields like metallurgy and nuclear chemistry.²⁸ And the ambitious models from abroad underlined something Heisenberg, for one, took for granted: the center would be federally overseen, at least partially federally funded, and federally charged to take the lead in this field.

The channels to which the scientist already had access, leading to Erhard and Adenauer, seemed not only appropriate but also adequate. In the absence of an atomic energy commission (or, for that matter, a Research Council), the chancellor would end up relying on *éminences grises*. Still, the connection had its limits: when the press labeled Heisenberg a member of Adenauer's "kitchen cabinet", they exaggerated the relationship's intimacy. He had high-level access denied to other scientists, but no guarantee that his advice would be implemented.²⁹ And the project

required broader backing beyond governmental patronage. Heisenberg's skill at nontechnical explication was put to use in popular lectures. The principal targets were industrial circles: Gelsenkirchen, Dortmund, Essen, Münster, Frankfurt, Düsseldorf, Hamburg, Munich. Heisenberg's personal connections to businessmen were limited, but in the relatively confined network of the West German elite, he knew the men who could make the arrangements.³⁰

On the scientific side, the MPI group set to work. It was not until the physicist again prompted Erhard in early 1953 that the economics ministry got its study panels set up.³¹ These were to deal with uranium supplies, moderators and, as would prove most important, oversight of the overall planning. Headed by Wilhelm Bötzkies, chairman of the board of the Industriekreditbank, the planning commission initially comprised Heisenberg, two further physicists, a ministry staffer, Hermann Reusch of the Ruhr concern Gutehoffnungshütte, and MPG general secretary Ernst Telschow. But despite expectations that the work would rapidly take off, after the commission's next meeting it recessed for half a year.³² More consequential yet was an intervention by Adenauer. After the ministry had already called for a final discussion on forming a full-fledged atomic energy commission, the chancellor, citing foreign sensitivities, put that plan on ice.³³

STATE, INDUSTRY, AND SCIENCE

A tripartite schema for collaboration was explicit in the actors' thinking. How it would work was harder to say. The scientists continued to take for granted a government with certain interventionist powers. The reasons were multiple and not always synchronized, but at least they pointed in the same direction. It was the obvious conclusion from examining other countries; it was a matter of national security and international obligations; also the magnitude of the task and the financial risks exceeded the possibilities of private industry.³⁴ In general, research could not just be left to itself or to the market; the state had a role in peacetime as well as in war. Where matters became more complicated was when the economics ministry and industry were brought in.

Coming out of engagements with other sorts of industrial policy, the ministerial staffers saw their own main role in coordination and oversight.

In this they could count on the backing of their minister, who emphatically cited objections of principle to too much state involvement.³⁵ The staffers would have concurred in Heisenberg's characterization of the task as 90% technical and only 10% scientific, which underlined the industrial role. So for their own reasons, both Heisenberg and the ministry wanted to see private enterprise grasping more initiative; other scientists pushed the point even further.³⁶

This stance met with agreement among the businessmen, too, insofar as the latter had little intent of losing control. The views of the industrial managers brought into the project, as picked out personally by Reusch and Bötzkies, grew from their own experience in the electrical, chemical, metallurgical and mechanical sectors. Their interest was in probing the commercial possibilities of constructing and servicing reactors, with state assistance if possible, but preferably not state interference. Whether their expectations for cooperation were reasonable or their pace was adequate were questions of another sort. Heisenberg was less inclined to trust their disinterestedness and to suspect that their domination would cause problems with the Allies.³⁷

Finally, science, the third party, meant largely the Max Planck Society, at least at this stage. Later, university institutes would be needed to create a pipeline of students; but for the moment, something else was required. What spoke for the MPG, now headquartered in Göttingen and presided over by Otto Hahn, was more than its research facilities (or even its institute directors' license). The Society provided unmistakable prestige, a channel for funding, legal expertise, and preexisting organizational structures.³⁸ Following in the footsteps of the Kaiser Wilhelm Society, the MPG had already developed close and complicated relations with industry and the state. Under the code words of autonomy and self-governance, the MPG's immediate postwar consolidation had momentarily submerged that issue. But relations were reopened for negotiation with the increasing self-confidence of federal authority in the 1950s and the reassertion of newly stabilized economic forces of the West German economic miracle.

The renascent MPG, of course, was concerned to maintain good relations. It accomplished this in no small part by coopting leading representatives of industry and government. Autonomy was the code word; the practice was more complicated. Federal and state ministers were given seats in the MPG's Senate, its formal decision-making body. So too were figures who the Society hoped could secure support from industry.

These included powerful men like Fritz Gummert (Ruhrgas) or Alfred Petersen (Metallgesellschaft), Carl Wurster (BASF)—or Hermann Reusch (Gutehoffnungshütte). In fact, Reusch took over as MPG treasurer when no less than Wilhelm Bötzkkes (as we saw, board chairman of the Industriekreditbank) moved up to become a Society vice-president. The attention given in the MPG to the Rhine and Ruhr showed in the influence of men like Bötzkkes and Reusch. It also surfaced in the bid they promoted to shift the MPG's center of gravity to the western part of the republic, specifically North Rhine-Westphalia, with a new bureau in Düsseldorf and receptions in the Industrieklub.³⁹

The other advantage of the Rhine-Ruhr region was proximity to Bonn. Attempts to switch the MPG to federal funding had failed, and alliance with the federal government, the *Bund*, remained risky as long as the individual German states, the *Länder*, staked claims for prerogative in matters of science. At the same time, some of the Society's institutes, now including Heisenberg's, were supported by specific federal ministries, though this did not appear in the published annual report.⁴⁰ With overall allocations increasing each year, the Society felt more secure about approaching the *Bund*. And what did the MPG owe in return? Although it tried very hard to say it owed nothing, occasionally its actors found themselves speaking of obligations—obligations to “do its part”, as a publicly subsidized institution, for the federal government's national purposes.⁴¹

It was exactly in the intermediate domain among science, industry, and the state that the Max Planck Society was fit to play a role. The connection to Bötzkkes and Reusch was already in place. The economics ministry was then happy to leave to the MPG the day-to-day administration of the nuclear project, even including oversight of the work of the ministry's own commissions. Ernst Telschow, who stepped into this function, was the senior of the Society's general secretaries. He not only ran the affair out of the MPG's Düsseldorf office, but also, once an industrial consortium was set up, became its part-time managing director. It was in the setting of preexisting or easily activated connections that cooperation was conceived as the order of the day.⁴²

The concrete task was to find organizational forms adequate to this three-way coordination. Past experience could be mined for models; most saliently, the celebrated Aerodynamical Research Station, carrying out fundamental research with an eye to questions of flight, had been coupled in various ways to the Kaiser Wilhelm Institute for Aerodynamics and

the Kaiser Wilhelm Society.⁴³ Yet each case brought with it specific problems that challenged the cooperative good will. Doing something like government contract research in Heisenberg's institute put the MPG into a relationship of dependency. When the state bureaucracy failed to transfer monies for months at a time, the Society had to step in with advances.⁴⁴ The MPG was also increasing its component of application-oriented work, eventually bringing industry researchers into Heisenberg's laboratories. A practical consequence was entanglement in patents and consulting arrangements.⁴⁵

Then would the industrialists' proxy be a private registered association like the Max Planck Society (one early option), or a limited liability company more familiar in the corporate world (the choice actually taken)?⁴⁶ Moreover, the plan for the station's operation was still up in the air. What was the industrial partnership actually to do—just plan, plan and build, or plan, build and run? The scientists' role was also losing its contours. Heisenberg remarked to one colleague, "Scientifically, the station will be affiliated with the Max Planck Institute for Physics; but I would be principally involved in the reactor station only as director of the MPI, while the executive powers would lie with the company's board."⁴⁷ And the state's part? As much as the businessmen anathematized dirigism and a planned economy, they were willing to consider cooperation so long as market considerations were given their due. Since government practice on this point could sometimes be flexible, there was room for collaboration, but also room for maneuver.

THE DIFFICULTIES OF COLLABORATION

Most of the players started out believing, or at least saying, that cooperation would be little problem. Probably in no one was this more marked than in the scientist taking the lead. For Heisenberg, collaboration was principally a matter of men of good will working things out. The personalism that reigned among West Germany's elites reinforced his faith in what was really required: these leading individuals needed to agree among themselves, take the initiative, and move forward.⁴⁸ Indeed, a great deal of the planning depended on just a few individuals. Yet, when the different interests they represented were overlaid with personal views and ambitions, the result could be blockage as well as concord. So while the men on

the planning commission had little trouble reaching agreement on some things—a center with a palette of scientific-technical institutes, a construction budget on the order of tens of millions of Deutschmarks—coordination on less straightforward issues could prove more elusive.

For instance, the federal government's representatives agreed to the project's desirability and ambitious scale, also the appropriateness of carrying it out under federal patronage of some sort. They did not, however, share Heisenberg's view of how rapidly the plans needed to be realized. After Adenauer blocked the calling of an atomic energy commission, he continually restrained the physicist's push to move forward. The chancellor said the matter had to be kept quiet until the treaties were ratified. That outcome took far longer than expected; Heisenberg would be called back for a second round of technical negotiations in the fall of 1954.⁴⁹ As the scientist saw it, a manageable handicap in the early part of the decade only grew as time passed, and he did not really believe the foreign policy argument.⁵⁰ The feeling that the government was inattentive was reinforced by happenings outside the chancellor's office. Before releasing funds, the finance minister demanded details on how they would be used; the economics ministry got tangled up in long negotiations. But economics staffers, too, seemed to view the matter with little urgency. Hahn's and Telschow's dunning brought limited relief.⁵¹ Later Heisenberg would take his criticism public, suggesting that the Federal Republic's reentry into civil aviation had been much better prepared.⁵² But the economics staffers had already been alienated before then.

A lack of urgency also characterized the industrial partner. In late 1953, Bötzkies was suggesting that a consortium would be set up soon. Its establishment would take nearly a year.⁵³ The delay was partly due to an auto accident that incapacitated the financier for months; evidently he was considered irreplaceable, or thought so himself.⁵⁴ But consensus, as has not always been noted, was also held up by struggles over representation on the board of trustees. The larger and smaller firms were inclined to mutual distrust.⁵⁵ Then the federal government demanded heavier private-sector financing. Bötzkies and Reusch, taken aback, put on the brakes for nearly two months. More important to them than the building schedule was fixing their participation on their own terms. In fact, certain larger firms threatened to pull out altogether, leaving the scientists and the government to cooperate with each other while industry (or part of it) built a reactor of its own.⁵⁶ Adenauer and the businessmen eventually reached a settlement.

But conflicts enveloped the relation between industry and science, too. Attentive to keeping the scientists (read: Heisenberg) from gaining too much influence, the consortium moved slowly to assemble its technical advisory board. It hesitated to fund research even as the MPG urgently cast about for ways to deal with government arrears.⁵⁷

The tone of the comments was turning less courteous, and tactical maneuvering was clearly in evidence.⁵⁸ The resources in Heisenberg's institute grew constrained; the physicist began to press for more space, which no one could provide.⁵⁹ After government financing ground to a halt, the reactor group was treading water, and he had to pay some of them out of his own budget. Research control was still in force, Wirtz was being pulled in too many directions, and the institute's other experimenters felt neglected. Wirtz's desire for recognizable autonomy went along with strains among the staff, as he remained at least officially subordinate to Heisenberg and publicly in his shadow.⁶⁰ Heisenberg, for his part, was spending his time in all-day meetings rather than doing theoretical physics. As he described it to Hahn, as any remaining scientific interest was preempted, involvement in reactor planning was becoming "less attractive with every month."⁶¹ What seemed natural to the other parties, to slow down or wait, conflicted with his needs as director of a research institute.

SITING

The conflicts came together, finally, in a drawn-out contest over the reactor station's site.⁶² Whichever *Land* got the center might hope to become the hub of a new high-tech industrial sector. It could also expect to gain Heisenberg's MPI, whose move to the station was long taken for granted. A number of localities had their proponents. It was Karlsruhe, in the southwest state of Baden-Württemberg, and Munich, the Bavarian capital, in the Federal Republic's southeast corner, that had the most powerful promoters and left the others behind (Fig. 1).⁶³

What was really at stake, beyond the location itself, was twofold. Who would get to make the decision? And what would count as relevant grounds? Heisenberg argued for a site near Munich, citing above all the city's status as an educational and cultural center. Munich offered the kind of life that would appeal not just to the sort of staff he imagined the reactor station would need, but also to his institute's scientists. For if the institute



FIGURE 1 The Federal Republic of Germany, 1955.

was going to move to the reactor, that placed constraints on where he could imagine the laboratory.⁶⁴ In this respect, Heisenberg saw Karlsruhe as wanting; and if that was the criterion, he was probably right. The city had a good polytechnic but no university. Though Heisenberg was not interested in a teaching professorship, he did not expect that his institute's quantum field theorists and astrophysicists would have much to seek in a polytechnic. There was also the matter of general atmosphere. Federal judges detailed to the city—in the postwar sweepstakes, provincial Karlsruhe ended up with the two highest courts—complained loudly of its cultural deficiencies.⁶⁵ But were those good reasons? The cultural argument also had manifestly personal overtones. Heisenberg himself had long wanted to move to Munich. Growing up and studying there in the 1910s and 1920s, then blocked from returning as a professor by the Third Reich, he spent his vacations south of the city in the Bavarian Alps, where his institute's cosmic ray experimenters had also erected a station. He had begun speaking of moving his institute there years earlier; the city's significance for him was obvious to everyone.⁶⁶

What then spoke for Karlsruhe? "I have the impression", Heisenberg wrote to a colleague, "that the economics ministry staffers [below Erhard, the Bavarian] and representatives of Westphalian industry [read: Bötzkens and Reusch] ... think that working with Bavaria here would be so cumbersome and time-consuming that we should decide for the West." In the early 1950s, Bavarian hospitality to industry could still be called into question, though that would dramatically change as time would pass.⁶⁷ At the same time as Bavarian plans were encountering roadblocks—less than helpful state officials, unruly locals who feared health effects or military attack⁶⁸—the state of Baden-Württemberg and the municipality of Karlsruhe were going out of their way to be accommodating. Heisenberg was sincerely impressed when he first saw their proposed site outside the city on the west bank of the Rhine.⁶⁹ Karlsruhe's location to the west might or might not be important, depending on whether Munich's proximity to the Iron Curtain was a concern. And in the assessment of some parties (particularly its advocates), the proposed site on the Rhine was also simply better suited technically (cooling water from Germany's largest river, industrial-strength power supply).⁷⁰

Finally, the matter got caught up in internal MPG politics, for the decision might affect the balance of power. Bavaria had been attracting Max Planck Institutes. Heisenberg's, one of the most dynamic, would weigh

heavily in fixing the MPG's center of gravity. But recent MPG experience with the Bavarian government had left a bad taste in some mouths. Bötzkes and Reusch were the core of the Rhineland bloc. If they could not shift the MPG's seat to Düsseldorf, Baden-Württemberg was acceptable; Bavaria was not.⁷¹

For this array of considerations it was hard to find a common measure. Reusch offered to have the two options compared, but his assessment was unlikely to be less partial than Heisenberg's.⁷² As the spring of 1954 turned into summer and the industry consortium was still delayed, the parties agreed to form a new, nonpartisan siting committee. Heisenberg, for one, was relieved not to be on it; the thinly veiled conflict was getting to him.⁷³ The trouble was that the committee, too, appears to have done little. At last, in September 1954 the official request for proposals could go out.⁷⁴ Heisenberg finally boiled over late that fall upon returning to find little progress after a long trip to America, where he had seen single university physics laboratories whose equipment exceeded the entire stock in Germany. He criticized the dragging pace of the siting preparations, but also all the delays in funding and planning in general.⁷⁵ And he pointedly withdrew from Bötzkes's planning commission, which had been in recess for the last half-year. On his own initiative (though with Telschow's concordance), he invited the competing architects to a December meeting. The unilateral action did not prevent a mending of fences; the commission was liable to be superseded somehow by a committee of the new consortium anyway.⁷⁶ Siting, however, had become the flashpoint in bigger struggles over control.⁷⁷

To critical minds, particularly those with a preference for Karlsruhe, Heisenberg's arguments about scientists' needs could sound like rationalizations for his thoroughly private preferences. That was too simple; personal interest and impersonal reasons went together here in an uneasy way.⁷⁸ Heisenberg was less apt to accuse his rivals of bad faith, but he did think they were misweighing the different considerations. As long as personal attacks were ruled out in public, debate was conducted over what counted as good reasons. So Baden-Württemberg's advocates reassured one another of their site's advantages. These were what they called the technical, the material, the objective facts—*die sachlichen Gründe*, in a familiar but multivalent expression. Alongside such solid-sounding things as power grid stability, intellectual atmosphere seemed pure ideology.⁷⁹ Yet even technical facts were not so unambiguous. Everyone was willing

to work with the assessment of an independent-minded engineer in Heisenberg's institute. He compared the two sites on an array of technical issues, as far as that was possible at all with the open-ended plans. But what on the list was really important? Reading between the lines was required. Heisenberg laid out his own interpretation. Admitting advantages to both sides, he still gave heaviest weight to proximity to a university (the technical translation of his wishes for Munich). When Reusch found the engineer's list inadequately conclusive, he had his firm's building division rewrite it. The result came out favoring Karlsruhe—now “unequivocally”, as his deputy put it, on all important points, and, of course, “with all objectivity”.⁸⁰ Probably no one was surprised by either response.

Compromise solutions came into discussion. With the camps already formed, an alternative site had little chance. Increasingly mooted instead were plans with two reactors: first a smaller for research, then a larger for development, with some indefinite estimate of the sizes.⁸¹ If kept vague, the arrangement could appeal to many people. Heisenberg would buy into it to some degree, though he thought it potentially problematic. It also had real attractions for the businessmen toying with pulling out of cooperation with the government and going it alone. However, when vagueness persisted—where was the split between research and development? was it the “larger” or the “smaller” reactor that had been under discussion so far?—then everyone could imagine that his own idea was being realized.⁸²

At the same time, early remarks formally leaving open the laboratory-MPI connection were promoted to a real possibility. The MPI's director disliked the idea of separating off the station, but he gradually allowed it as an option. At the same time, it empowered him to state that, whatever the outcome, he intended to move to Munich. If the reactor was built elsewhere, he would go back to basic research. That was read by his opponents as a threat. They could not be sure how seriously he meant the proposal. (At the start, he may not have known himself.)⁸³ However, it also threw open the question of who would serve as patron for the whole effort, presumed by all to default to him.

And this entangled science—the Max Planck Society—more than ever. Unless the *Land* that won the MPI could be persuaded to pay for its new building, the MPG would have to secure the money itself. The Society's Managing Board recommended that Heisenberg's institute be moved to wherever the laboratory ended up. Heisenberg countered by persuading the MPG Senate to allow relocation to some other spot.⁸⁴ Telschow, wearing

his MPG hat, played the two *Länder*'s hopes for the reactor off one another in order to maximize their commitments to the MPI. But by the last phase, in his role in the consortium Telschow was favoring Karlsruhe, and behind the scenes he worked toward removing the laboratory from Heisenberg's control.⁸⁵

DECISIONS AND THEIR AMBIGUITIES

As the conflict ripened, it was not even clear who would fix the site.⁸⁶ What slowly became obvious by spring 1955 was that Adenauer would reserve the decision for himself. This was no longer a scientific decision in almost any sense. Karlsruhe's partisans still unhappily imagined Heisenberg whispering in the chancellor's ear.⁸⁷ While they fretted about his presumed influence, that did not stop them from seeking their own. The two sites' advocates lobbied in all possible ways. Following Heisenberg's argument and against Reusch's wishes, the industrial consortium's board members actually came out in favor of Munich.⁸⁸ But now that was moot; the real need was to persuade Adenauer. And Adenauer's criteria had always been different.⁸⁹

With the long-awaited ratification of the treaties, the Federal Republic finally regained sovereignty in May 1955. Foreign policy sensitivities were out of the way, and Adenauer called a high-level meeting for late June. As his staff sketched it out, the chancellor would propose a multi-centered project. His office had been actively pursuing two-site proposals. This was in fact the direction all parties were moving.⁹⁰ Invited to the meeting were Adenauer's ministers, *Land* representatives, the industrial consortium's leaders, and a few other figures. No one with nuclear expertise was in attendance, however, not even the staffers of the economics ministry.⁹¹

The decision was not supposed to be about science; that was where the cooperation had ended up. Of course, the key player not invited was Heisenberg. The stand attributed to him in favor of concentrating everything in Munich "would make an objective decision more difficult," so thought the chancellor's chief of staff.⁹² Probably part of the reason was also that he could be assumed to object to what was shaping up to be the formal criterion of choice. Whatever his real reasons, Adenauer had made clear that he wanted a military assessment of the two options' defensibility: "The site may not be put at risk." Everyone knew that this could only work to

Munich's disadvantage; the NATO defense line ran up the Rhine.⁹³ Heisenberg suggested that a consistent application of the criterion really meant that Munich should be evacuated of all important industries.⁹⁴ The reasoning *was* fairly dubious; the Americans, after all, had no security objections to building a 200-MW nuclear plant of their own in the middle of West Berlin.⁹⁵ But a twenty-minute consultation with a NATO general who knew little about reactors secured a statement that gave Karlsruhe the nod.⁹⁶

In the meeting of late June, citing the confidential assessment, Adenauer gave the go-ahead for a large reactor for Karlsruhe.⁹⁷ What did this mean for Munich? Assuming MPG concurrence, it would gain the MPI and a smaller reactor, though it was not entirely clear what that involved. The Bavarians thought they were in line to get what they wanted, too. And they did not believe the final word had been spoken.⁹⁸ Karlsruhe promoters briefly gave the same impression. However, they soon closed ranks, seeking to bring the industrialists into line and preparing a statement of their views for official release.⁹⁹ Looking briefly ahead, when they characterized the decision as one *for* Karlsruhe and *against* Munich, they would provoke vigorous protest. But this would take some time to unfold. And even if no scientists were present at the chancellor's meeting, they still had to be brought on board.

WHAT TO DO WITH THE SCIENTIST?

Heisenberg did not immediately learn of the outcome. As far as he was concerned, in early July the matter was not yet decided.¹⁰⁰ Though unhappy about a two-site split, in a lecture he offered his own suggestions for how to do it least harmfully. But even in response to a reporter's solicitation—did he have any personal wish at all?—he would not overtly back Munich in public.¹⁰¹ The task of conveying the news, in the form in which he was supposed to receive it, was given over to Bötzkies. This was in preparation for the consortium's mid-July meeting at which the member firms were to be swung around to the Karlsruhe line.¹⁰² There Heisenberg was faced with the flat statement that strategic considerations dictated the Karlsruhe site on the west bank of the Rhine. His institute in Munich would get a reactor for purely scientific purposes, now scaled down to a few million marks.¹⁰³ Heisenberg had been anticipating a two-reactor plan, but this was, as he saw it, a far-reaching amendment of the previous compromise.

For the new suggestion, with an empty “small” reactor, struck him as technically obtuse.¹⁰⁴ In his mind, a “small” reactor had meant the laboratory they were planning; a “large” one was something bigger yet. He had never thought reactors very interesting for basic science; he did not want one for the institute’s sake. On the other hand, if the MPI was to do research for reactor design, what “small” could reasonably mean was constrained. In the estimates circulating after the chancellor’s meeting, the small reactor’s dimensions fluctuated wildly. But this was not so surprising. The arrangements had been finalized in a circle with next to no technical competence.¹⁰⁵ Given the way Heisenberg had led the planning, no other scientist could be drawn in just yet without alienating him further. When the other parties spared themselves the trouble of working with him, they cut themselves off from their main source of technical knowledge.

In Telschow’s judgment, Heisenberg was deeply hurt by the outcome.¹⁰⁶ What wounded in the *fait accompli* was the mechanism of settlement by exclusion. Heisenberg was willing to acknowledge the legitimacy of nonscientific factors,¹⁰⁷ but he also insisted on a say for the reasons of science (that is, in this case, his own). But still: if the decision was the chancellor’s, then Heisenberg would accept it. So what did he intend he do? The MPI would not go to Karlsruhe. It would return to basic research without the proffered reactor, and the neutron group could work for the station elsewhere. Advising in some form he agreed to take on, after the businessmen urgently reminded him of “the obligations of his name”. But personal responsibility for the laboratory—they suggested he lead it from a distance—he turned down as unrealistic. Someone else would have to do the job.¹⁰⁸

Heisenberg’s preference was of course Wirtz. Privately, things had provisionally settled on Wolfgang Gentner, the particle accelerator specialist whose name Telschow had been mooting for months.¹⁰⁹ With that uncertainty, however, the consortium could live. It reversed its Munich preference and ramped up its planning. A few days later, the MPI drafted a simple statement for the press:

The federal government has decided that a German atomic reactor station will be erected in Karlsruhe. The Max Planck Institute for Physics, whose director remains Professor Heisenberg, will not be moved to Karlsruhe. The relevant authorities have not yet decided whether it will be moved independently of this to Munich. Possible cooperation of the institute and Professor Heisenberg with the reactor station is still under discussion.

And Heisenberg decided he would do best to retire from the affair.¹¹⁰

PUBLIC COLLAPSE

Withdrawing would have been Heisenberg's typical gesture. Resistance, particularly involving personal friction, usually led him to pull back from the scene. This would have marked the quiet end of his expectations for collaboration. However, the connections could not be broken at will. Two obstacles proved more trouble than he might have imagined. The first was the "Atoms for Peace" conference in a few weeks in Geneva, envisaged by the Federal Republic's nuclear planners as its formal debut.¹¹¹ The second was the fact that the siting settlement was unstable: unsettled at the word trickling out, the Bavarians began to enquire.¹¹² All of this unfolded between the consortium meeting in mid-July, when Heisenberg had signed on to the Karlsruhe interpretation, and the federal press release on August 2nd, which made it into a fact. The result was not Heisenberg's withdrawal, but his final emergence into unreserved criticism and open repudiation of the course of the planning.

Regarding the Geneva deputation, the general agreement was that Otto Hahn was to head it, with Heisenberg as the other official scientific delegate. They would be joined by a businessman and two governmental figures, and unofficially accompanied by a flock of other interested individuals. Heisenberg had nonetheless conveyed his presumption that he would be the delegation's *de facto* leader, and the conference secretariat had slotted him to chair a session on nuclear physics.¹¹³ After the industrial consortium meeting Heisenberg asked to withdraw from the delegation, as he was not going to have responsibility for the center. This he did without open reproaches, but he made it clear that he felt excluded by the chancellor's decision. He hoped somehow to avoid a public spectacle—when warned of the prospect he reconsidered for a moment, and he kept his decision within a very tight circle—but the Foreign Office feared the worst.¹¹⁴

At the same time, Baden-Württemberg's advocates and the consortium's leaders were working to consolidate their position. They drew up the press release, to come from the federal press office, speaking of *the* reactor in Karlsruhe.¹¹⁵ But the Bavarians were busy, too, partly determined to secure their own interest and partly honestly confused.¹¹⁶ Conversation with Heisenberg eventually made one thing plain: the message he took away from the consortium meeting was not the same one they took away from the chancellor's office. When the news broke, Bavarian officials protested that

they had been blindsided, insisting that no alternative Karlsruhe–Munich had been posed. As far as Heisenberg was concerned, all bets were now off. What he had had been told was Adenauer’s decision might be someone else’s. He immediately began sketching plans with the cultural minister for a real reactor in Munich costing 10–20 million marks.¹¹⁷

And just then, in a remarkable display of poor timing, the Foreign Office announced on August 1st that Heisenberg was unable to attend the Geneva conference. The reason given, in good diplomatic language, was that the physicist was “occupied with other business.”¹¹⁸ Heisenberg heard the report (on vacation) at the moment that he was contacted by a group of curious parliamentary representatives.¹¹⁹ Pushed over the edge, he dropped his restraint and told the group’s staffer that he was hardly too busy to go to Geneva. He had declined to serve for a whole host of reasons: he objected to the way the government had dragged its feet on organizational measures, delayed disbursement of urgently needed funds, and made decisions without adequately consulting the scientists or explaining the reasons to them after the fact. Unsurprisingly, that did make the headlines. It even edged out the federal press release about Karlsruhe.¹²⁰

And it did not predispose to friendly comments on the German performance in Geneva, where even the internal assessment was “absolute confusion”. Hahn was fine for public display but unable to hold the deputation together. Despite Gentner’s presence (not to mention the industrial scientists’), no one was able to fill in when representatives of countries like Britain asked with whom, if not Heisenberg, they should negotiate. The Foreign Office proved unencumbered by technical competence. And, finally, the reigning unclarity over jurisdiction—which ministry was responsible for nuclear energy anyway?—left even the German representatives fuming.¹²¹ This, then, was the fruit of the several years of attempted cooperation. Heisenberg used his internal knowledge of its troubles to criticize its progress in public.

REACHING A SETTLEMENT

Five months after sovereignty, the federal government created a Ministry of Atomic Affairs. With the energy of Franz Josef Strauß, things looked in place to move forward; Heisenberg and other scientists were gratified.¹²²

Together with other high-powered scientific and industrial leaders, Heisenberg took the proffered seat on the new atomic energy commission. And since Bavaria maintained its offer to build him a new institute, the Max Planck Society agreed in late 1955 to locate it in Munich.¹²³

Heisenberg had anticipated that Wirtz would work in Karlsruhe. But because the terms of the three-party cooperation were still being negotiated, the outcome remained unclear for longer than has generally been appreciated. The chancellor confirmed to the Bavarian minister-president that “the big reactor” would be constructed in Karlsruhe. Yet Heisenberg’s “smaller” reactor in Munich, according to Adenauer, was supposed to enable him “to carry out the requisite scientific work to the full extent.”¹²⁴ The statement was far more ambiguous than Karlsruhe liked. For a while, Heisenberg and the Bavarians were encouraged to interpret it generously by the new atomic minister, a Bavarian patriot, and between the two sites vague ideas were floated about some sort of cooperation.¹²⁵ Meanwhile, Heisenberg’s questioning destabilized the Karlsruhe plans. After what he had seen, he remained skeptical that its backers would get their act together anyway.¹²⁶

All the while, the reactor group remained lodged in the MPI and ballooned to 55 members. This was still a story of Heisenberg’s physics institute, its needs and constraints, just as it had been all the way through. Growing impatient, Heisenberg pushed Strauß to get moving on Karlsruhe and remarked that he wanted to get out of the business.¹²⁷ Of course, all of this depended on Wirtz, to whom the Karlsruhe group had not yet made an offer that he considered satisfactory. Until he had some stability, Heisenberg told Strauß sharply, Wirtz could hardly just be evicted from the MPI.¹²⁸ Only as Karlsruhe plans finally seemed to be coalescing was Heisenberg persuaded that something would happen. He decided to drop reactor development in the summer of 1956.¹²⁹ With this the MPG’s involvement was all but ended. On the same day as Heisenberg formally notified Wirtz, he invited another physicist to take over the MPI’s experimental division. He resolved the frustrated uncertainty in the institute’s planning by switching to plasma physics and nuclear fusion.¹³⁰

Wirtz did leave for the Karlsruhe Nuclear Research Center, where he became head of the Institute for Neutron Physics and Reactor Technology. For the station’s overall scientific leadership a string of other names were discussed. However, after talking with a number of mid-career scientists, management basically dropped the question. Karlsruhe’s backers took

a full year to iron out the public–private partnership; the direction it would take was still up for grabs.¹³¹ With things starting to move and Wirtz on location, construction finally began in spring 1957. At about that time, the Federal Republic's other early reactor projects were launched: North Rhine-Westphalia's installation in Jülich, a maritime reactor center in Geesthacht near Hamburg, plus an assortment of smaller ventures.¹³² Ironically, the much-touted Karlsruhe site raised complications. The original assessments proving technically flawed, it was moved inland and east of the Rhine.¹³³

CONCLUSIONS

When the economics ministry was still responsible for nuclear matters, its stance had been interested but essentially reactive. If there were instruments available beyond forming committees and (hesitantly) funding research, it had not been inclined to seek them out. Erhard's later comment indicated his attitude: Why a ministry for atomic affairs? There was no ministry for steam power.¹³⁴ In his conception, and that of his staffers, the state's job was to encourage industry to move forward, but not to direct. Nor had Adenauer as chancellor pushed. His interest seems to have been directed by purposes entirely different. The passivity may have been encouraged by preferences for market mechanisms, but such principles could be flexible if the situation was urgent. Yet the urgency that Heisenberg perceived, sometimes for particularistic reasons, had not been shared in the ministry and the chancellor's office, where busy civil servants were working under other constraints.

Despite liberal rhetoric, Strauß and his successors in the new atomic ministry then left the hands-off approach behind. They formally sought out the assistance of scientists, even if the voice of the latter was restricted in practice to matters of limited significance. The ministry also actively involved the federal government (and the *Land* of Baden-Württemberg) to build and run the Karlsruhe center in a public–private partnership. But the station's industrial promoters did not unthinkingly enact the vision of their happy cooperation with the state. With the Karlsruhe center under construction, it seemed that the businessmen had finally signed on. But industry pulled out again in 1963, leaving the state and federal government

in charge. Indeed, the next decade of the atomic energy commission's activity would be continually marked by battles over the relative responsibilities of industry and government, and little decisive input from basic researchers.

Looking back with some distance, both of experience and of language, Heisenberg commented on the process as a "complicated balancing of individual interests ... However, in the balancing of economic or political interests," he noted, "I was inexperienced and to such negotiations could thus contribute less than I had hoped."¹³⁵ So what were the terms of his imagined partnership? The oversight of the reactor center, he had come to agree, was not to be left to scientists alone. He envisioned a directorate of an engineer, a scientist, and a manager, who were to function on equal terms.¹³⁶ But though he had no real idea how this triumvirate would function, he was not partitioning off three spheres of competence, either. What *was* the scientist supposed to be contributing? It was still up for grabs. The problem was not really the parties' shared commitment to a linear model of technology springing from basic science. Linearity did not exclude consultation and coordination; all agreed that cooperation and compromise were necessary. The bigger obstacle was that, even sharing this model, Heisenberg and his partners had different ideas about what it entailed. What Adenauer really needed from the physicist was quick access to information, plus a recognized name and some scientific competence. The industrial consortium wanted the Nobel Laureate in a "position of honor" that did not actually mean doing much. Technical knowledge, even of nuclear physics, could be gotten elsewhere. As far as Reusch was concerned, in those terms Heisenberg was readily replaceable.¹³⁷

On all sides, practical attempts at working together came down to highly personal negotiations. At the same time, they were shaped by ideas about cooperation's sociopolitical meanings. Iconically, Franz Josef Strauß would later speak of Heisenberg as the proposed counterpart to Britain's John Cockcroft, a sort of scientific pope. This has usually been interpreted as a sly dig at the physicist's personal ambitions, but that misses the larger significance. The main target, it has been forgotten, was the British model of a single centralized laboratory that Strauß, with great liberal fervor, rejected, calling instead for decentralized competition among many institutions—under the leadership, it bears saying, of one atomic minister overseeing the

lot.¹³⁸ Constructions to balance different parties' concerns were entangled in individual claims for leadership. The businessmen's determination to shape the venture was no less pronounced, and no less sociopolitically loaded, than Heisenberg's, the chancellor's, or his ministers'.

So despite the participants' talk of systemic cooperation, its realization essentially broke down. Certainly positive feedback loops were present, constructive transfers of knowledge and circulation of experts. But negative feedback loops were just as powerful, and their consequences just as long-term. The state-industry partnership failed in the station, and the outcome preshaped expectations for other nuclear domains. Heisenberg went off with great success to put his name behind nuclear fusion, a field years removed, he surely hoped, from industrial meddling. And even though a permanent institution was created, its functioning was not always conducive to cooperation in practice. The scientists in Karlsruhe were continually dissatisfied with how the venture was conducted, and the technical outcome has not been judged unequivocally successful.¹³⁹

Contemporary models of national innovation systems and triple helices are not premised on coherence and smoothness of functioning.¹⁴⁰ However, by their very construction, they spotlight systemicity, interactivity, and positive feedback. The struggles over cooperation in the Federal Republic's first reactor station illustrate how collaborative intentions can fail. Rather than pulling partners together, many-body interactions can also push them apart. The presumption of systemic cooperation and predictable harmony was characteristic of 1950s West Germany. In this case, the assumption, with its ideological bases, obscured misfits of particularistic expectations and needs.

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NOTES

1. Book-length treatments from various perspectives include H. Bufe and J. Grumbach, *Staat und Atomindustrie: Kernenergiepolitik in der BRD* (Köln: Pahl-Rugenstein, 1979); Herbert Kitschelt, *Kernenergiepolitik: Arena eines gesellschaftlichen Konflikts* (Frankfurt: Campus, 1980); Eberhard Posner, *Kernenergie als Beispiel für öffentliche Innovationsförderung in der Bundesrepublik Deutschland* (Essen: Glückauf, 1981); Joachim Radkau, *Aufstieg und Krise der deutschen Atomwirtschaft 1945–1975: Verdrängte Alternativen in der Kerntechnik und der Ursprung der nuklearen Kontroverse* (Reinbek: Rowohlt Taschenbuch, 1983); Michael Eckert and Maria Osietzki, *Wissenschaft für Macht und Markt: Kernforschung und Mikroelektronik in der Bundesrepublik Deutschland* (München: C.H. Beck, 1989); Wolfgang D. Müller, *Geschichte der Kernenergie in der Bundesrepublik Deutschland* (Stuttgart: Schäffer Verlag für Wirtschaft und Steuern, 1990; Schäffer-Poeschel, 1996).
2. Radkau, *Aufstieg und Krise*, ch. II.1; R.-J. Gleitsmann, *Im Widerstreit der Meinungen: Zur Kontroverse um die Standortfindung für eine deutsche Reaktorstation (1950–1955): Ein Beitrag zur Gründungsgeschichte des Kernforschungszentrums Karlsruhe und zu einem Kapitel deutscher Kernenergiegeschichte* (Karlsruhe: Kernforschungszentrum Karlsruhe, 1986; 2nd ed., 1988); Michael Eckert, “Primacy Doomed to Failure: Heisenberg’s Role as Scientific Advisor for Nuclear Policy in the FRG,” *Historical Studies in the Physical and Biological Sciences* (1990), 21(1): 29–58; Müller, *Geschichte der Kernenergie*, v. 1, ch. A.
3. Our sense for how things worked in practice has come largely from in-depth institutional histories: Winfried Schulze with Sven Bergmann and Gerd Helm, *Der Stifterverband für die Deutsche Wissenschaft, 1920–1995* (Berlin: Akademie-Verlag, 1995); Helmuth Trischler and Rüdiger vom Bruch, *Forschung für den Markt: Geschichte der Fraunhofer-Gesellschaft* (München: C.H. Beck, 1999); and the histories of German big-science institutions (*Großforschungseinrichtungen*), some of which will be cited below.
4. On industrial policy with relation to science, see Wolfgang Krieger, “Zur Geschichte von Technologiepolitik und Forschungsförderung in der Bundesrepublik Deutschland: Eine Problemskizze,” *Vierteljahrshefte für Zeitgeschichte* (1987), 35: 247–271; and Joachim Radkau, “Wirtschaftswunder’ ohne technologische Innovation? Technische Modernität in den 50er Jahren”, in Axel Schildt and Arnold Sywottek, Ed., *Modernisierung im Wiederaufbau: Die westdeutsche Gesellschaft der 50er Jahre* (Bonn: J.H.W. Dietz Nachf., 1993), pp. 129–154. Economic history has been enriched by a more sophisticated discussion of West Germany’s corporatist tendencies, evident in the nuclear field as in so many others, as something besides capture of the state by industrial interests. See Werner Abelshausen, “The First Post-liberal Nation: Stages in the Development of Modern Corporatism in Germany,” *European History Quarterly* (1984), 14: 285–318; V.R. Berghahn, “Corporatism in Germany in Historical Perspective”, in Andrew Cox and Noel O’Sullivan, Ed., *The Corporate State: Corporatism and the State Tradition in Western Europe* (Aldershot: Edward Elgar, 1988), pp. 104–122; and Wolfgang Streeck, Ed., *Staat und Verbände*, Sonderheft 25 of *Politische Vierteljahrschrift* (Opladen: Westdeutscher, 1994).
5. Peter Fischer, *Atomenergie und staatliches Interesse: Die Anfänge der Atompolitik in der Bundesrepublik Deutschland 1949–1955* (Baden-Baden: Nomos Verlagsgesellschaft, 1994).
6. On Staatswirtschaft, gelenkte Wirtschaft, and freie Wirtschaft see Thieme, report on meeting in Bundeskanzleramt, 23 January 1954, WHM [Werner-Heisenberg-Archiv, München] Reaktor I.
7. This paper will not follow the interesting question of national autarchy, which is sufficiently discussed in the existing literature. Rather, the focus is on interactions within the national context. On autarchy see Michael Eckert, “Kernenergie und Westintegration: Die Zähmung des westdeutschen Nuklearnationalismus”, in Ludolf Herbst, Werner

- Bührer, and Hanno Sowade, Ed., *Vom Marshallplan zur EWG: Die Eingliederung der Bundesrepublik Deutschland in die westliche Welt* (München: R. Oldenbourg, 1990), pp. 313–334. The literature on the social market is vast; one starting point is Werner Abelshäuser, *Wirtschaftsgeschichte der Bundesrepublik Deutschland 1945–1980* (Frankfurt: Suhrkamp, 1983).
8. Rudolf Vierhaus and Bernhard vom Brocke, Ed., *Forschung im Spannungsfeld von Politik und Gesellschaft: Geschichte und Struktur der Kaiser-Wilhelm-/Max-Planck-Gesellschaft* (Stuttgart: Deutsche Verlags-Anstalt, 1990).
 9. For characteristic examples from aviation see Paul Erker, “Ernst Heinkel: Die Luftfahrtindustrie im Spannungsfeld von technologischem Wandel und politischem Umbruch”, in Paul Erker and Toni Pierenkemper, Ed., *Deutsche Unternehmer zwischen Kriegswirtschaft und Wiederaufbau: Studien zur Erfahrungsbildung von Industrie-Eliten* (München: R. Oldenbourg, 1999), pp. 217–290; Christopher Magnes Andres, *Die bundesdeutsche Luft- und Raumfahrtindustrie 1945–1970: Ein Industriebereich im Spannungsfeld von Politik, Wirtschaft und Militär* (Frankfurt: Peter Lang, 1996); Helmuth Trischler, *Luft- und Raumfahrtforschung in Deutschland 1900–1970: Politische Geschichte einer Wissenschaft* (Frankfurt: Campus, 1992), pp. 285–388; on strategies of rearmament, Michael Geyer, *Deutsche Rüstungspolitik 1860–1980* (Frankfurt: Suhrkamp, 1984), pp. 209–212, 218–219; Werner Abelshäuser, “Wirtschaft und Rüstung in den fünfziger Jahren”, in *Anfänge westdeutscher Sicherheitspolitik 1945–1956*, v. 4, *Wirtschaft und Rüstung, Souveränität und Sicherheit* (München: R. Oldenbourg, 1997), pp. 1–185, on pp. 3–19, 59–77, 139–156.
 10. The classic studies are Thomas Stamm, *Zwischen Staat und Selbstverwaltung: Die deutsche Forschung im Wiederaufbau 1945–1965* (Köln: Wissenschaft und Politik, 1981), pp. 121–150; and Maria Osietzki, *Wissenschaftsorganisation und Restauration: Der Aufbau außeruniversitärer Forschungseinrichtungen und die Gründung des westdeutschen Staates 1945–1952* (Köln: Böhlau, 1984). A second generation of work has followed, including Krieger, “Zur Geschichte von Technologiepolitik”; Andreas Stucke, *Institutionalisierung der Forschungspolitik: Entstehung, Entwicklung und Steuerungsprobleme des Bundesforschungsministeriums* (Frankfurt: Campus, 1993); Cathryn Carson and Michael Gubser, “Science Advising and Science Policy in Postwar West Germany: The Example of the Deutscher Forschungsrat”, *Minerva* (2002), 40: 147–179.
 11. For details see Fischer, *Atomenergie und staatliches Interesse*, pp. 46–60; Müller, *Geschichte der Kernenergie*, v. 1, pp. 83–87; Eckert, “Primacy Doomed”, pp. 37–39.
 12. Kielmansegg, draft note, 24 March 1952, BA-MA [Bundesarchiv-Militärarchiv, Freiburg] BW9/3072; Heisenberg to Herr Kollege [21 colleagues], 26 July 1952, WHM New.
 13. On the *Uranverein* see Mark Walker, *German National Socialism and the Quest for Nuclear Power, 1939–1949* (Cambridge: Cambridge University Press, 1989); David C. Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (New York: W.H. Freeman, 1992), ch. 22–25. The debate over the intentions of Heisenberg’s wartime research is not relevant here; important is rather the experience he brought with him into the Federal Republic. On continuities between the Third Reich and West Germany see Cathryn Carson, “Old Programs, New Politics? Nuclear Reactor Studies after 1945 in the Max-Planck-Institut für Physik”, in Doris Kaufmann, Ed., *Geschichte der Kaiser-Wilhelm-Gesellschaft im Nationalsozialismus: Bestandaufnahme und Perspektiven der Forschung* (Göttingen: Wallstein, 2000), pp. 726–749.
 14. Gentner to Thieme, 16 October 1952, Gentner to Heisenberg, 20 October 1952, and Heisenberg to Gentner, 11 November 1952, WHM 52; minutes of DFG Kommission für Atomphysik, 19 November 1952, WHM Atomphysik.
 15. Pretsch, note of 28 October 1952, BAK [Bundesarchiv Koblenz] B102/40348; Heisenberg to Gentner, 4 November 1952, WHM CERN Korrespondenz; minutes of meeting in economics ministry, 20 November 1952, WHM Reaktor I.
 16. There has been much controversy over possible military intentions for the Federal Republic’s nuclear venture. During the first part of the 1950s, the period covered by this

- paper, Adenauer remained committed to a conventional defense in the framework of NATO. However, by 1956, after a crisis in the German-American relationship, the chancellor was confidentially weighing the thought that the Federal Republic, in cooperation with other European nations, might make nuclear weapons of its own. See most recently Ulrich Lappenküper, *Die deutsch-französischen Beziehungen 1949–1963: Von der "Erbfeindschaft" zur "Entente élémentaire"*, v. 1, 1949–1958 (München: R. Oldenbourg, 2001), pp. 1161–1172. For the period under discussion in this paper, such considerations do surface now and again; examples may be found in Carson, "Old Programs", p. 748.
17. For other goals—research, education, or energy generation—reactors purchased from abroad might be adequate. But national industrial development, and later export, would remain Heisenberg's principal arguments. Heisenberg to Adenauer, 22 January 1952, WHM under Ministerien, Bundes- (verschied.); Werner Heisenberg, *Die Möglichkeiten der angewandten Atomforschung in Deutschland* (München: Landtagsamt, 1956), reprinted in Walter Blum, Hans-Peter Dürr, and Helmut Rechenberg, Ed., *Gesammelte Werke/Collected Works* (München: R. Piper, 1984), v. C.V, pp. 162–175.
 18. Minutes of DFG Kommission für Atomphysik, 19 November 1952 and 28 February 1953, WHM Atomphysik.
 19. *Operation Epsilon: The Farm Hall Transcripts* (Bristol: Institute of Physics Publishing, 1993), p. 182; Heisenberg to Adenauer, 24 October 1949, WHM DFR Bundesregierung, and 22 January 1952, WHM under Ministerien, Bundes- (verschied.).
 20. E.g., Werner Heisenberg, "Über die Arbeiten zur technischen Ausnutzung der Atomkernenergie in Deutschland", *Die Naturwissenschaften* (1946), 33: 325–329, on p. 329, reprinted in *Gesammelte Werke*, v. C.V, pp. 28–32. Heisenberg's postwar representations of the wartime work are contested. The present interpretation of his statements is argued in Cathryn Carson, "New Models for Science in Politics: Heisenberg in West Germany", *Historical Studies in the Physical and Biological Sciences* (1999), 30(1): 115–171, on pp. 135–136.
 21. Heisenberg to Adenauer, 24 February 1953, WHM Reaktor I.
 22. Heisenberg to Adenauer, 22 January 1952, WHM under Ministerien, Bundes- (verschied.).
 23. The Physikalisch-Technische Bundesanstalt was briefly considered as host: Hocker to Heisenberg, 13 February 1953, WHM Reaktor I. The Fraunhofer Society, later a leading applied-research player, was far too insecure to be in the running.
 24. Minutes of DFG Kommission für Atomphysik, 19 November 1952, WHM Atomphysik, specifically Mattauch's comments; interview with Wilhelm Walcher (3 July 1997, Marburg). Within the MPG, it was not only Heisenberg's institute that was involved; a few others did smaller pieces of reactor-related work.
 25. On the research see Eckert, "Primacy Doomed", p. 38; Carson, "Old Programs".
 26. Figures from 1954 are taken from the Halbjahresbericht for 1 October 1953–31 March 1954, WHM Fragebogen. See also Karl Wirtz, *Im Umkreis der Physik* (Karlsruhe: Kernforschungszentrum Karlsruhe GmbH, 1988), ch. 29.
 27. Interviews with Anselm Citron (4 January 2001, Karlsruhe) and Ulrich Schmidt-Rohr (5 January 2001, Heidelberg). On Heisenberg's MPI see Vereinbarung zwischen der Kernreaktor Bau- und Betriebsgesellschaft und Herrn Professor Dr. K. Wirtz, 14 December 1956; Ziegler, Aktenvermerk, 13 February 1957, KfK [Kernforschungszentrum Karlsruhe, Generallandesarchiv Karlsruhe, Bestand 69] GF [Geschäftsführung] 72; Wirtz to Heisenberg, 22 May 1957, WHM; Ballreich to Heisenberg, 28 July 1960; Benecke to Wirtz, 19 August 1960, WHM under MPG + MPI Generalverwaltung der MPG—Schriftwechsel. The substances discussed in these documents correspond to Wirtz's handwritten markings on the institute's copy of Law 22, WHM Fragebogen.
 28. Bemerkungen zur Errichtung einer zentralen deutschen Atomenergiestation, n.d. [1952]; Allgemeine Richtlinien bei der Wahl des Ortes für die Reaktorstation der Bundesrepublik, n.d. [mid-1953], WHM Reaktor I.

29. One press assessment: “Adenauer-Lektüre”, *Der Spiegel*, 1 January 1955, 5. The picture of Heisenberg’s close personal contacts has been taken over by historians. If this is the starting point, the two men’s later differences look agreeably dramatic. However, the appeal of the *Götterdämmerung* should be resisted. Heisenberg’s relations to the economics ministry were similarly fluid. Erhard would answer the physicist’s inquiries, but ministry staffers had already shown their impatience back in the days of the Heisenberg’s German Research Council; see Heisenberg to Eickemeyer, 6 January 1953, WHM DFR Abschlussbericht.
30. The lecture texts are collected in Heisenberg, *Gesammelte Werke*, v. C.V, also “Die Beziehungen zwischen Physik und Chemie in den letzten 75 Jahren”, *Naturwissenschaftliche Rundschau* (1953), 6: 1–7, reprinted in *Gesammelte Werke*, v. C.I (München: R. Piper, 1984), pp. 387–393.
31. Heisenberg to Erhard, 3 February 1953, WHM Reaktor I; minutes of DFG Kommission für Atomphysik, 28 February 1953, WHM Atomphysik.
32. Wirtz to Telschow, 23 March 1953; minutes of Arbeitsausschuß Planung, 30 May 1953, WHM Reaktor I.
33. Hinsch to Globke *et al.*, 17 February 1953, as countermanded by Adenauer to Erhard, 20 February 1953, with a copy to Heisenberg, WHM Reaktor I (which Heisenberg reported for all to hear in the Kommission für Atomphysik, minutes of 28 February 1953, WHM Atomphysik). For the physicist’s objections see Heisenberg to Adenauer, 24 February 1953 and 29 April 1953, WHM Reaktor I.
34. Minutes of DFG Kommission für Atomphysik, 19 November 1952, WHM Atomphysik; Fenge to Kattenstroth, 20 November 1953, BAK B102/40354; cf. Versuch einer Analyse der gegenwärtigen Atompolitik der Bundesregierung, n.d. [September 1955], WHM Reaktor I.
35. Erhard to Staatssekretär des Bundeskanzleramtes, 23 July 1954, WHM Reaktor I; also Radkau, *Aufstieg und Krise*, pp. 132–133; Müller, *Geschichte der Kernenergie*, v. 1, p. 153.
36. 90/10: Heisenberg to Gerlach, 5 May 1955, WHM; taking initiative: minutes of meeting in economics ministry, 20 November 1952, WHM Reaktor I; Heisenberg to Sörensen, 3 June 1954, WHM Reaktor II; other scientists: Haxel to Heisenberg, 25 October 1952, WHM Reaktor I.
37. Müller, *Geschichte der Kernenergie*, pp. 118–120, 340–343. On Heisenberg’s mistrust, Küchler to Winnacker, 20 January 1955, HFF [Hoechst Firmengeschichte, Frankfurt] 2/3/1.
38. A history of the postwar MPG is badly needed that reaches beyond Vierhaus and vom Brocke, Ed., *Forschung im Spannungsfeld*. The closest thing available, ch. 4 of Hans-Willy Hohn and Uwe Schimank, *Konflikte und Gleichgewichte im Forschungssystem: Akteurkonstellationen und Entwicklungspfade in der staatlich finanzierten außeruniversitären Forschung* (Frankfurt: Campus, 1990), is suggestive but highly circumscribed.
39. Bötzkes to Reusch, 3 November 1951, HRK [Nachlaß Hermann Reusch, Rheinisch-Westfälisches Wirtschaftsarchiv zu Köln, Abt. Gutehoffnungshütte (130), 401014] 400101462/8; minutes of Senat and Verwaltungsrat, September 1951–March 1953, MPGB [Archiv zur Geschichte der Max-Planck-Gesellschaft, Berlin] II/1A. Regarding Reusch, a major and controversial player on the postwar scene, see his appearances throughout Volker R. Berghahn, *The Americanisation of West German Industry 1945–1973* (Cambridge: Cambridge University Press, 1986), and S. Jonathan Wiesen, *West German Industry and the Challenge of the Nazi Past* (Chapel Hill, NC: University of North Carolina Press, 2001). Bötzkes’s story is part of Siegfried C. Cassier, *Unternehmerbank zwischen Staat und Markt 1924–1995: Der Weg der IKB Deutsche Industriebank* (Frankfurt: Fritz Knapp, 1996).
40. Hohn and Schimank, *Konflikte und Gleichgewichte*, pp. 107–114; minutes of Verwaltungsrat, 8 February 1952, 4 November 1952, MPGB II/1A; Annual Report, Max-Planck-Gesellschaft, *Jahrbuch*, 1953, pp. 16–17.

41. Annual Report, Max-Planck-Gesellschaft, *Jahrbuch*, 1955, pp. 17–20; 1957, pp. 17–20; minutes of Verwaltungsrat, 5 November 1956, MPGB II/1A (quotation).
42. Telschow to Hahn, 3 March 1953, OHB [Nachlaß Otto Hahn, MPGB, III/14A] 04322.
43. For details, Carson, “Old Programs”, pp. 738, 742.
44. Telschow to Hinsch, 19 March 1954, WHM Reaktor I; Telschow to Heisenberg, 6 January 1955, WHM PSG.
45. Minutes of Verwaltungsrat, 23 February 1956, MPGB II/1A; also MPGB II/1A Az. I L 23/-.
46. On the (nonprofit) Physikalische Studiengesellschaft Düsseldorf mbH see Müller, *Geschichte der Kernenergie*, v. 1, pp. 117–120.
47. Heisenberg to Eickemeyer, 15 April 1954, WHM.
48. If there was one lesson Heisenberg took from his experience in the war, this was it. The same impulse came out in his trust in informal mechanisms—less charitably, his impatience with formal ones.
49. On the Paris treaties see Müller, *Geschichte der Kernenergie*, v. 1, pp. 112–116; Fischer, *Atomenergie und staatliches Interesse*, pp. 147–153; Eckert, “Primacy Doomed”, pp. 39–41.
50. From his own contacts abroad, he suggested that the Allies wanted to see things started while they still had oversight, pressing to proceed with the planning and keep them informed. Heisenberg, Besprechung über die Entwicklung der Atomtechnik für friedliche Zwecke in Deutschland, 28 October 1954, KfK INR [Institut für Neutronenphysik und Reaktortechnik] 21; Heisenberg to Adenauer, 21 January 1955, WHM Reaktor I, with drafts in WHM Reaktor I and KfK INR 21.
51. Other critics: e.g., Kirchheimer to Bayer, 27 February 1953, BAL [Bayer-Archiv, Leverkusen] 312-078. On the government funds (which were separate from those overseen by the DFG commission), see the section Etatfragen, WHM PSG; minutes of planning commission, 13 June 1954, WHM Reaktor I; Telschow to Heisenberg, 6 January 1955, WHM PSG.
52. Heesemann to Rust, 24 June 1955, BAK B102/40403. The best point of comparison is Georg Reul, *Planung und Gründung der Deutschen Lufthansa AG 1949 bis 1955* (Köln: Botermann & Botermann, 1995), pp. 58–95. Heisenberg had a point, though less of one than he thought.
53. Minutes of planning commission, 7 December 1953, HStASt [Hauptstaatsarchiv Stuttgart] EA 6/103 Bü 8710; minutes of industrialists’ meeting, 6 August 1954, WHM PSG; Telschow, notes on preparatory meeting, 19 October 1954, HRK 40010146/486; and finally the minutes of Gründergesellschaftversammlung of Physikalische Studiengesellschaft, 8 November 1954, DAF [Degussa-Archiv, Frankfurt] 20.
54. Telschow to Wirtz, 12 January 1954, KfK INR 21; Reusch to Kirchheimer, 7 November 1954, HRK 40010146/486.
55. The concerns are well-documented in DAF 20.
56. The threat to build their own reactor has been passed over, except briefly in Müller, *Geschichte der Kernenergie*, v. 1, pp. 204. Reusch to Betzold, 6 February 1955; Reusch to Kirchheimer, 6 March 1955, HRK 40010146/488; Karlsruhe city council member, note, 22 March 1955, StAK [Stadtarchiv Karlsruhe] Abt. 1 / H-Reg., Nr. 3768; Boettcher, Bericht, 28 March 1955, DAF 367.
57. Dunkel to Schimmelbusch, 21 September 1954, DAF 20; Telschow to Heisenberg, 14 August 1954, WHM PSG; minutes of Aufsichtsrat of Physikalische Studiengesellschaft, 2 February 1955, BAK B136/6106.
58. Wirtz, Taktischer Plan, n.d. [20 January 1955], KfK INR 21.
59. Minutes of MPG Verwaltungsrat, 22 October 1954, MPGB II/1A; Werner Heisenberg, “Max-Planck-Institut für Physik und Astrophysik in München”, Max-Planck-Gesellschaft, *Jahrbuch*, 1961, 632–643, on pp. 639–641, reprinted in *Gesammelte Werke*, v. C.V, pp. 213–224.
60. Beginning with Wirtz to Heisenberg, 10 August 1954, WHM Physik und Philosophie.
61. Heisenberg to Hahn, 24 January 1955, WHM under Generalverwaltung.

62. To the winning side, of course, the selection was a question of justice and reason. Since the site was what they cared about most, they framed it as a matter of highest drama. Both perspectives are taken over into Gleitsmann, *Widerstreit*. When the losing side's archives are consulted more extensively, the picture looks more complicated.
63. The other candidates included the Eifel (in the state of Rhineland-Pfalz, to the west of the Rhine) and the cities of Cologne (North Rhine-Westphalia, a short drive from Bonn) and Freiburg and Tübingen (also in Baden-Württemberg).
64. Heisenberg to Gerthsen, 14 December 1953, WHM Reaktor I. The reasoning did not change as negotiations advanced; Schimmelbusch to Prentzel, 15 February 1955, DAF 367. To the argument that the scientists could habilitate elsewhere, Heisenberg had already noted (to Joos, 3 February 1952, WHM 52) that Harwell staff rarely bothered to make even the short trek to Oxford.
65. Gögler to von Göler, 22 Dec 1953, HStASt EA 9/101 Bü 1055.
66. Minutes of Senat, 22 July 1949, MPGB II/1A; Heisenberg to Butenandt, 23 March 1953, WHM 53. That he was no longer aiming for Arnold Sommerfeld's old chair is evidenced by Telschow, notes for Heisenberg, 17 October 1953, WHM Reaktor I.
67. Heisenberg to Finkelnburg, 10 May 1954, WHM. Paul Erker, "Keine Sehnsucht nach der Ruhr: Grundzüge der Industrialisierung in Bayern 1900–1970", *Geschichte und Gesellschaft* (1991), 17: 480–511; Stefan Deutinger, *Vom Agrarland zum High-Tech-Staat: Zur Geschichte des Forschungsstandorts Bayern 1945–1980* (München: R. Oldenbourg, 2001).
68. On troubles see the correspondence with Joos, WHM 52 and 53.
69. Heisenberg to Glotz, 22 December 1953, WHM Reaktor I; Heisenberg to Gerlach, 18 December 1953, WHM.
70. For these arguments see Gleitsmann, *Widerstreit*.
71. On the attraction of the MPG seat for the Bavarian government, see Rucker to Hoegner, 31 March 1955, BayHStA [Bayerisches Hauptstaatsarchiv, München] StK 114004. Some observers even saw in Heisenberg the prime candidate for the Society's next president. Carson, "Old Programs", pp. 743–744. On the history of Bavarian troubles, however, see Deutinger, *Vom Agrarland*, pp. 41–111; for Reusch in particular, Reusch to Hermanns, 7 January 1955, HRK 40010146/486; Reusch to Telschow, 14 February 1955, HRK 40010146/488.
72. Minutes of planning commission, 7 December 1953, HStASt EA 6/103 Bü 8710; 8 March 1954, WHM Reaktor I; Reusch to Wirtz, 3 May 1954, HRK 40010146/486.
73. At Adenauer's request, he formally outlined his arguments for Munich, but colleagues agreed he was pulling back and intended to abide by the committee's recommendation. Minutes of planning commission, 13 June 1954, WHM Reaktor I. For confirmation from many sides of the pullback see Gentner to Hoffmann, 27 April 1954, Dienstzimmernachlaß Wolfgang Gentner, MPGB, III/68A, 6; Heisenberg to Joos (draft), 18 June 1954, KfK INR 24; Aktenvermerk, 3 July 1954, StAK Abt. 1/H-Reg., Nr. 3768; Heisenberg to Adenauer, 24 Jun 1954, WHM Reaktor I. For a different reading, Eckert, "Primacy Doomed", pp. 45–47.
74. Telschow to Heisenberg, 14 August 1954 and 29 August 1954; minutes of meeting, 2 September 1954, WHM PSG (a meeting that Heisenberg and Wirtz even had to lead while Telschow was on vacation); Telschow to Gutekunst and Fischer, 18 September 1954, HRK 40010146/486.
75. Heisenberg to Raiser, 29 November 1954, WHM DFG Korrespondenz; Telschow to Heisenberg, 1 December 1954; Heisenberg to Grau, 1 December 1954, WHM Reaktor I; Telschow to Heisenberg, 2 December 1954, WHM PSG.
76. Telschow to Heisenberg, 9 December 1954, WHM PSG. The outcome of the meeting was the technical assessment that everyone accepted. On the conflict with Bötzkes, see Heisenberg, Aktennotiz, and Heisenberg to Bötzkes, 6 December 1954, WHM PSG; Heisenberg to Erhard, 6 December 1954, WHM Reaktor I; Bötzkes to Hinsch, 7 December 1954; and Reusch to Bötzkes, 10 December 1954, HRK 40010146/486, with

- Reusch's handwritten note (dated 14 December) "freundschaftliche und ausreichende Lösung erfolgt".
77. Reusch thought Heisenberg was upset only over the siting issue. But then that was Reusch's own concern. While Hinsch in the economics ministry took the same line, his frustration with Heisenberg's criticisms occasionally brought him to make assertions that were not factually true. Reusch to Meyer, 11 December 1954, HRK 40010146/486; Hinsch, Vermerk, 28 December 1954, BAK B102/40404 (regarding the physicist's absence from planning commission meetings).
 78. Cf. Werner Heisenberg, *Der Teil und das Ganze: Gespräche im Umkreis der Atomphysik* (München: R. Piper, 1969), p. 297.
 79. "Sachliche Gründe": Seifritz to Gögler, 21 June 1955, HStAst EA 9/101 Bü 1055; "Ideologie": Reusch to Kirchheimer, 12 August 1955, HRK 40010146/488.
 80. K. Weimer, Vergleichende Gegenüberstellung der naturgebundenen Eigenschaften und technischen Gegebenheiten, 20 December 1954, HFF 2/3/1; Heisenberg, Die Pläne für die erste deutsche Reaktorstation, 20 December 1954, WHM; Reusch to Hermanns, 7 January 1955, HRK 40010146/486; Hermanns, re: Reaktorstation, 25 January 1955, HRK 40010146/488 (quotations).
 81. "Big" reactors were an option after the Allies eased limits; the scale was now 10 MW or upward.
 82. The idea was far more widely and seriously discussed than has been previously reported. Telschow to Wirtz, 25 November 1954, KfK INR 21; Kirchheimer, notes, 18 March 1955, HStAst EA 6/304 Bü 1377/2; excerpt from minutes of Ministerrat, 22 March 1955, BayHStA StK 114004; Telschow to Globke, 26 March 1955, BAK B136/6099; Heisenberg to Grau, 28 March 1955, WHM Reaktor I; even in the press: "Das neue Element der Zivilisation: Wo soll der erste deutsche Atomreaktor errichtet werden?" *Deutsche Zeitung und Wirtschaftszeitung* (Stuttgart), 20 April 1955. Cf. Deutinger, *Vom Agrarland*, p. 137.
 83. The suggestion has been interpreted principally as a threat: Gleitsmann, *Widerstreit*, pp. 33, 56. Reusch took it that way, but he tended to project his own mindset onto Heisenberg. That Heisenberg grew to consider it a serious option is evident in Wirtz's careful remarks to Heisenberg, 10 August 1954, WHM Physik und Philosophie, with a draft, 8 August 1954, Nachlaß Karl Wirtz, Generallandesarchiv Karlsruhe, 3.
 84. Minutes of Verwaltungsrat, 4 March 1955, and of Senat, 25 March 1955, MPGB II/1A.
 85. Negotiations with the *Länder*: Farny, Aktenvermerk, 14 February 1955, HStAst EA 9/101 Bü 1055; excerpt from minutes of Bavarian Ministerrat, 21 February 1955, BayHStA StK 114004; preferring Karlsruhe: Telschow to Reusch, 11 February 1955, HRK 40010146/488; leaving Heisenberg behind: Telschow to Globke, 21 May 1955, BAK B136/6107.
 86. Various hypotheses (atomic energy commission, planning commission, cabinet, economics ministry, industrial consortium, chancellor): Telschow in minutes of planning commission, 7 December 1953, HStAst EA 6/103 Bü 8710; Heisenberg to Joos, draft of 18 June 1954, KfK INR 24; Grau to Michel, 2 August 1954, BAK B136/6107; Heisenberg to Gutekunst and Fischer, 9 December 1954, WHM Reaktor I; Reusch to Veith [sic: Veit], 19 December 1954, HRK 40010146/486; Kirchheimer to Veit, 17 January 1955, HStAst EA 6/304 Bü 1377/2.
 87. Veit to Reusch, 6 December 1954, HRK 40010146/486; Farny, Aktenvermerk, 3 February 1955, HStAst EA 9/101 Bü 1055. Heisenberg's one letter on the subject during this period (Heisenberg to Adenauer, 21 January 1955, WHM Reaktor I) was not effective.
 88. Minutes of Aufsichtsrat of Physikalische Studiengesellschaft, 28 February 1955, BAK B136/6106. For an example of an assessment, see Schlosser to Bötzkens, 22 February 1955, DAF 20.
 89. Disagreement persists about what Adenauer's criteria were; nearly all the actors suspected domestic political motivations would play in. Behind the confusion, what is clear is that the chancellor intended to make his own choice for his own reasons.

90. Vermerk of 14 June 1955, BAK B136/6107; Michel to Minister and Staatssekretär, 21 June 1955, BAK B102/40402; Heisenberg to Grau, 23 June 1955, WHM Reaktor I. There are indications of a third stage involving Rhineland-Pfalz, but nothing came of it: Michel to Steinlein, 1 August 1955, BAK B102/40402; cf. Finkelnburg to Heisenberg, 19 July 1955, WHM.
91. The ambassador to the United States, Heinz Krekeler, gets half-credit for being trained as a chemist; the Bavarian cultural minister, August Rucker, was a professor of urban planning.
92. Globke to Adenauer, 11 June 1955; Vermerk of 14 June 1955, BAK B136/6107. Heisenberg's deliberate exclusion was first noted by Fischer, *Atomenergie und staatliches Interesse*, p. 224.
93. Adenauer to Grau, 9 March 1955, BAK B136/6107 (quotation, handwritten); Fischer, *Atomenergie und staatliches Interesse*, pp. 178–179. A first response from the proto-defense ministry (Lützow, notice for Gen. Heusinger, 5 March 1955, BAK B136/6107, reprinted in the appendix to Gleitsmann, *Widerstreit*) was indeed critical of locations to the east of the Rhine. This caused problems for two-reactor proposals, so the chancellor's office actually renewed its question with plans for a larger and a smaller reactor detailed in the request for NATO assessment. Heisenberg to Grau, 28 March 1955, WHM Reaktor I; Globke to Heusinger, 2 April 1955, BAK B136/6107. From Lützow's notice for Heusinger it is also clear that the defense ministry had its own interest in the Karlsruhe site.
94. Heisenberg to Grau, 23 June 1955, WHM Reaktor I.
95. Burghard Weiss, "Heiße Zellen, Kalter Krieg: Die Planungen der USA, das erste kommerzielle Kernkraftwerk der Welt im Westteil Berlins zu errichten", in Hubert Laitko and Regine Zott, Ed., *Dahlemer Archivgespräche*, v. 1 (Berlin: Archiv zur Geschichte der Max-Planck-Gesellschaft, 1996), pp. 131–141; Lewis Strauss to Elmer B. Staats, 1 July 1954, DDEA [Dwight D. Eisenhower Library, Abilene, KS] White House Office, National Security Council Staff Papers, OCB 000.9 (File #1) (8). For a slashing critique of the objections to Munich on military-technical grounds see Strauß to Adenauer, 9 August 1955, Nachlaß Franz Josef Strauß, Büro BMVg, Archiv für Christlich-Soziale Politik, Hanns-Seidel-Stiftung, München, 211; cf. Franz Josef Strauß, *Die Erinnerungen* (Berlin: Siedler, 1989), p. 221.
96. SACEUR diary, 20 April 1955, DDEA Alfred M. Gruenther Papers, Appointment Books Series, Box 6; Speidel, Aufzeichnung über Gespräch, 20 April 1955, BA-MA BW9/2884; Speidel to Blank, 23 April 1954, BA-MA BW9/3362. This response forced the chancellor's staff into some fancy footwork to maintain the two-reactor plan: Vermerk of 14 June 1955, BAK B136/6107.
97. No minutes were taken of the meeting of 29 June 1955, and post-facto depictions are contradictory. The fullest depiction is Fischer, *Atomenergie und staatliches Interesse*, pp. 227–229. However, there was more maneuvering going on than has been appreciated, and the Vermerk by Pretsch of 9 July 1955, BAK B102/40402, is not an authoritative source, as Pretsch was partisan and not present either.
98. Notice on nuclear discussions in Ministerrat, n.d. [probably between 11 and 19 July 1955], BayHStA StK 112939, specifically for 7 July 1955: "Es wurde festgestellt, daß der Bundeskanzler sich offenbar für die bayerischen Wünsche einsetzen werde. Die Kosten eines Atomreaktors für wissenschaftliche Zwecke würden etwa 16 Mio DM betragen." For hopes before the meeting, Hoegner to Rucker and Bezold, 15 June 1955, BayHStA StK 114004. Bavarian sources are limited because most of the files were later stolen from the minister's car. Important documents remain, however.
99. Gurk, Aktenvermerk, 30 June 1955, StAK Abt. 1 / H-Reg., Nr. 3768, suggesting a decision in two weeks; "Zwei Standorte für Atommeiler?" *Stuttgarter Zeitung*, 1 July 1955, citing Baden-Württemberg Ministerpräsident Gebhard Müller. Based on the archives of Karlsruhe's proponents, previous accounts have taken up their later depiction of a decision against Munich. That closes down a story that remained open for some time.
100. He did not seem terribly concerned: Telschow to Heisenberg, 6 July 1955; Heisenberg to Telschow, 8 July 1955, WHM PSG. Cf. Eckert, "Primacy Doomed", p. 48.

101. The best record of the lecture is “Reden von Prof. Otto Hahn und Prof. Werner Heisenberg,” 31 August 1955 (date of broadcast), Norddeutscher Rundfunk, Landesfunkhaus Niedersachsen, Archiv, Hannover, 19 534/3; cf., with some differences, Heisenberg, “Die Pläne”; manuscript, 12 July 1955, WHM New. For the reporter’s query, “Gespräch mit Prof. Dr. Werner Heisenberg zur Frage einer Reaktorstation,” 12 July 1955, Westdeutscher Rundfunk, Schallarchiv, Köln, Dok 342/7.
102. Pretsch, Vermerk, 30 June 1955; Hinsch, Vermerk, 16 July 1955, BAK B102/40402.
103. Minutes of Aufsichtsrat of Physikalische Studiengesellschaft, 15 July 1955, WHM PSG; supplemented by Reusch, notes, 15 July 1955, HRK 40010146/488; and Prentzel, Notiz, 21 July 1955, DAF 20.
104. Minutes of Aufsichtsrat of Physikalische Studiengesellschaft, 15 July 1955, WHM PSG; Heisenberg to Finkelburg, 23 July 1955; cf. Heisenberg to Gerlach, 9 July 1955, WHM.
105. Not everyone remembered a size even being fixed, and most had no idea what the scale represented. Even the Bavarians were confused: Rucker, notes on telephone conversation with Strauß, 8 August 1955, BayHStA StK 112939. At least Rucker and Strauß talked in terms of megawatts; most other parties characterized the options only by their cost. The state of knowledge in the chancellor’s office is evident in the categories thrown around in the Vermerk of 14 June 1955, BAK B136/6107.
106. Seifritz, Aktenvermerk, 20 July 1955, HStAst EA 9/101 Bü 1055.
107. Expressed publicly, for instance, in Heisenberg, *Möglichkeiten*, p. 12.
108. Minutes of Aufsichtsrat of Physikalische Studiengesellschaft, 15 July 1955, WHM PSG; “sich der Verpflichtung seines Names bewusst zu sein”: Prentzel, Notiz, 21 July 1955, DAF 20.
109. Note on Atommeiler und Max Planck-Institut für Physik, 10 February 1955, HStAst EA 6/103 Bü 8710; Pretsch, Vermerk, 9 July 1955, BAK B102/40402.
110. Presse-Notiz, 20 July 1955, WHM Presse; Heisenberg to Finkelburg, 23 July 1955, WHM. I have not been able to determine whether the press statement was released.
111. Ilona Stölken-Fitschen, *Atombombe und Geistesgeschichte: Eine Studie der fünfziger Jahre aus deutscher Sicht* (Baden-Baden: Nomos Verlagsgesellschaft, 1995), pp. 155–166; Fischer, *Atomenergie und staatliches Interesse*, pp. 232–237.
112. Gerlach to Heisenberg (telegram), 16 July 1955; Finkelburg to Heisenberg, 19 July 1955, WHM; minutes of Ministerrat, 19 July 1955, BayHStA StK 114004.
113. Minutes of DFG Kommission für Atomphysik, 4 May 1955, WHM Atomphysik; Heisenberg to Raiser, 11 May 1955, KfK INR 26; Ophüls, Aufzeichnung, 21 May 1955, PA-AA [Politisches Archiv des Auswärtigen Amtes, Bonn] 202/208; Giese to Heisenberg, 11 July 1955, WHM under Tagungen I. Atomkernenergie-.
114. Heisenberg to von Brentano, 18 July 1955; Heisenberg to Cockcroft (saying next to nothing), 27 July 1955; Thomsen, Aufzeichnung, 22 July 1955, PA-AA 202/203; compare Overbeck to Consugerma, 19 July 1955, and Overbeck to Dg. 11, 22 July 1955, PA-AA 202/208.
115. On Telschow and Grau’s drafting of the press release of 2 August 1955, see Grau to Adenauer, 27 July 1955, BAK B136/6107; and Farny, minutes of meeting, 29 July 1955, HStAst EA 9/101 Bü 1055. Baden-Württemberg had assistance from within the chancellor’s office. For Grau’s support see von Göler, Vermerk, 23 December 1953, HStAst EA 1/920 Bü 390; Gurk, Aktenvermerk, 15 March 1954, StAK Abt. 1 / H-Reg., Nr. 3768; Aktenvermerk, 8 June 1955, HStAst EA 6/304 Bü 1377/2.
116. “Atommeiler soll nicht nach München”, dpa-Meldung, 28 July 1955, BayHStA StK 114004; Leusser to Hoegner and Haas, 2 August 1955; Guthsmuths, Gedächtnis-Protokoll, 5 August 1955; Rucker, notes on telephone conversation with Strauß, 8 August 1955, BayHStA StK 112939.
117. Rucker to Heisenberg, 2 August 1955, WHM under Bayerisches Kultusministerium, indicating that the two had already been in conversation; Presse- und Informationsamt der Bayerischen Staatskanzlei, statement, 5 August 1955, BayHStA StK 112939.
118. “Heisenberg überraschte”, *Die Welt* (Hamburg), 2 August 1955 (“aus ‘arbeitstechnischen Gründen’”).

119. "Kommission für Atomenergie? Abgeordnete aller Parteien drängen auf baldige Errichtung", *Die Welt* (Hamburg), 16 July 1955; Burhenne to Heisenberg, 1 August 1955, WHM IPAG.
120. Interparlamentarische Arbeitsgemeinschaft, Drucksache Nr. 38, 8 September 1955, WHM IPAG; "Prof. Heisenberg kritisiert die Bonner Atompolitik: Klage über mangelnde Unterrichtung", *Die Welt* (Hamburg), 2 August 1955 (lead story); "Mit Bonn nicht einverstanden: Warum Heisenberg nicht nach Genf geht", *Frankfurter Allgemeine Zeitung*, 3 August 1955; "Auf keinen Fall Karlsruhe", *Der Spiegel*, 10 August 1955, 10–11.
121. Carl Helfrich, Hintergrund von der Genfer Atomkonferenz, 9 August 1955, BAK B136/2047 (quotation); Interparlamentarische Arbeitsgemeinschaft, Drucksache Nr. 38, 8 September 1955, WHM IPAG; "Deutsche Atom-Panne: Niemand weiß, wer zuständig ist", *Die Zeit* (Hamburg), 25 August 1955. On discussions with Cockcroft, Heisenberg to von Brentano, 27 July 1955, PA-AA 202/203.
122. Müller, *Geschichte der Kernenergie*, v. 1, ch. B.1; Fischer, *Atomenergie und staatliches Interesse*, pp. 255–274; Heisenberg to Strauß, 23 October 1955, BAK B138/3283.
123. Minutes of Verwaltungsrat, 10 October 1955; minutes of Senat, 11 October 1955, MPGB II/1A.
124. Adenauer to Hoegner, 15 August 1955, BAK B136/6107; compare the draft. The plan is sometimes confused with the swimming-pool reactor that Heinz Maier-Leibnitz was erecting outside Munich.
125. Unklarheiten in der Frage des Reaktorbaues, n.d. [September 1955], attached to Versuch einer Analyse der gegenwärtigen Atompolitik der Bundesregierung, WHM Reaktor I. On the ongoing negotiations see the notice on the meeting between Hoegner and Strauß on 16 December 1955, BayHStA StK 112939; Heisenberg, Stellungnahme zu dem Fragebogen der Obersten Baubehörde, 4 June 1956, Bay HStA MK 67132; also Heisenberg to Jähne, 8 June 1956, WHM 50s, proposing that Wirtz oversee the construction in Karlsruhe but remain in Munich in his own "Forschungs- und Entwicklungsstelle für Kernreaktoren beim MPI für Physik."
126. Fischer, *Atomenergie und staatliches Interesse*, pp. 241–246; Greifeld, notes, 21 January 1956, KfK GF 304; Telschow to Jähne, 25 May 1956, WHM under Generalverwaltung.
127. Bericht über die Arbeiten der Reaktorgruppe, October 1956, WHM 50s; Heisenberg to Strauß, 20 February 1956, OHB 05515; Telschow to Hahn, 19 April 1956, OHB 04323.
128. Heisenberg to Hahn, 31 July 1956, OHB 01529; Wirtz to Heisenberg, 3 March 1956, KfK INR 18. On the reluctance to bring Wirtz to Karlsruhe, see Müller, *Geschichte der Kernenergie*, v. 1, pp. 215–216.
129. Heisenberg, "Die Möglichkeiten"; Heisenberg to Wirtz, 17 July 1956, OHB 05515; also Strauß's comments in minutes of Bayerischer staatlicher Kommission zur friedlichen Nutzung der Atomkräfte, 6 June 1956, WHM Bayer. staatl. Kommission; Hahn and Heisenberg to Strauß, 2 July 1956, WHM under BMA Bundesminister—Schriftwechsel.
130. Heisenberg to Schmelzer, 17 July 1956, WHM; Heisenberg to Generalverwaltung der MPG, 17 September 1956, WHM under Generalverwaltung; definitively Heisenberg to von Elmenau, 29 March 1957, WHM under Bayerisches Kultusministerium.
131. On station leadership see Müller, *Geschichte der Kernenergie*, v. 1, pp. 215–216; Günther Oetzel, *Forschungspolitik in der Bundesrepublik Deutschland: Entstehung und Entwicklung einer Institution der Großforschung am Modell des Kernforschungszentrums Karlsruhe (KfK) 1956–1963* (Frankfurt: Peter Lang, 1996), pp. 139, 159–160. This phase of Karlsruhe's history must not be treated as though the outcome were already known. For instance, for talk of an American reactor that would preempt previous (i.e. Wirtz's) plans, see Heisenberg to Finkelnburg, 2 September 1955, WHM 50s; Heisenberg to Hahn, 13 March 1956, WHM under Generalverwaltung; cf. Oetzel, *Forschungspolitik*, p. 85.
132. Eckert and Osietzki, *Wissenschaft*, ch. 3–4; Müller, *Geschichte der Kernenergie*, v. 1, pp. 115–116 and ch. B.3–B.4; Bernd-A. Rusinek, *Das Forschungszentrum: Eine Geschichte der KFA Jülich von ihrer Gründung bis 1980* (Frankfurt: Campus, 1996);

- Monika Renneberg, *Gründung und Aufbau des GKSS-Forschungszentrums Geesthacht* (Frankfurt: Campus, 1995); Burghard Weiss, *Großforschung in Berlin: Geschichte des Hahn-Meitner-Instituts* (Frankfurt: Campus, 1994).
133. See KfK GF 61, 304, 311, 348, and 624.
 134. Radkau, *Aufstieg und Krise*, p. 138; cf. Strauß, *Die Erinnerungen*, pp. 225–227.
 135. Heisenberg, *Teil*, p. 297.
 136. Werner Heisenberg, “Die Pläne für eine Reaktorstation im Gebiet der Bundesrepublik”, in Harry W. Zimmermann, Ed., *Zur Ökonomik und Technik der Atomzeit* (Tübingen: List-Gesellschaft, 1957), pp. 1–7 on p. 3, delivered 1955, reprinted in *Gesammelte Werke*, v. C.V, pp. 150–156.
 137. Schimmelbusch, Aktennotiz, 15 February 1955, DAF 20; Reusch to Kirchheimer, 19 January 1955, HRK 40010146/488.
 138. The context is given in the minutes of the Deutsche Atomkommission, 20 April 1956, BAK B138/3297. The remark is interpreted otherwise in Eckert, “Primacy Doomed”, pp. 53, 55, citing Radkau, *Aufstieg und Krise*, p. 145. Connecting it to Edward Teller’s tactical promotion of the model of competing laboratories, see minutes of Arbeitskreis Kernphysik, 27 June 1956, WHM under BMAAt AKKP II/3a; cf. Peter Westwick, “The National Laboratory System in the U.S., 1947-1974,” Ph.D. dissertation, University of California, Berkeley, 1999, exploring the latter’s political meanings.
 139. For one pointed assessment, see Otto Keck, “The National System for Technical Innovation in Germany”, in Richard R. Nelson, Ed., *National Innovation Systems: A Comparative Analysis* (New York: Oxford University Press, 1993), pp. 115–157, on pp. 142–145.
 140. Useful overviews of these contemporary concepts can be found in Charles Edquist and Maureen McKelvey, Ed., *Systems of Innovation: Growth, Competitiveness and Employment* (Cheltenham, UK, and Northampton, MA: Edward Elgar, 2000) and the theme issue of *Research Policy* (2000), 29:2.