CHAPTER 1

ELECTROPOLIS BERLIN

A NEW URBAN VISION FUELED BY COAL AND IMPERIAL AMBITIONS

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In its "Golden Twenties" Berlin was renowned internationally as the most modern city in Europe. As an "electropolis," the city had turned into a symbol for technical modernity and a new urban vision, with its dynamic growth inspiring creative works such as Fritz Lang's film *Metropolis* or Walther Ruttmann's *Symphony of a City*, both screened for the first time in 1927. However, this impressive dynamism was the fruit of earlier developments. After winning the war against France and the subsequent unification of the German Reich under Prussian leadership in 1871, and then in 1880 coinciding with the start of the electrical revolution, Berlin developed rapidly and the formerly provincial city emerged as a new world city within just two decades. In its so-called *Gründerzeit* (founding period), Berlin also rose to become the largest industrial metropolis on the European continent for a time.

FOUNDING MYTH OF A METROPOLIS

The economic background for this unprecedented rise was the Second Industrial Revolution, characterized by new technologies that emerged during this period, in particular electrical engineering and electrification and the chemical industries. The recently united German Reich and the United States, in permanent competition and cooperation, led both sectors on the

global markets. While in 1838, the year in which Emil Rathenau, who later founded the Allgemeine Elektricitäts-Gesellschaft (AEG), was born, Berlin still had a population of just four hundred thousand inhabitants, from 1880 on its growth presented "a speed hitherto only observed in American cities," as Karl Baedeker put it in 1904.[1]

New urban narratives on Berlin were not only expressed in contemporary (silent) film, but also in literature. As early as 1910 Karl Scheffler, for example, published his book *Berlin—Ein Stadtschicksal* (A city's destiny). Otfried Hanstein followed in 1928 with his "novel of the future," *Elektropolis. Die Stadt der technischen Wunder* (The city of technical wonders) and Erich Kästner in 1931 with his novella for children *Der 35. Mai oder Konrad reitet in die Südsee* (The 35th of May, or Konrad rides to the South Seas), which contains a separate chapter called "Elektropolis." In architecture and urban design too, new metropolitan visions and forms developed. Names such as Peter Behrens, Walter Gropius, and Bruno Taut are closely associated with this beginning of technical modernism in Germany. Behrens in particular, who would later become the house architect of the Berlin company AEG and also worked for other industrial giants in different cities of the Reich, not only became famous as an architect, but also created specific designs for industrial products and even the AEG company logo. The invention of corporate design is, in fact, attributed to his work at AEG.[2]

The sober and functional style of *Neue Sachlichkeit* (new objectivity) and Berlin Modernism, which also found its expression in the Bauhaus movement from 1919 on, clearly and consciously set itself apart from the contemporary signature of traditional historic metropolises such as Paris or London, which had emerged centuries earlier as royal capitals and were slow to change their architectural and urban structures and traditions. Berlin was the exact opposite: with momentum the new German imperial capital threw itself forward into the future. These developments were embedded in a modernist discourse, oscillating between utopia and the fear of dystopia, but nevertheless marked by a fundamental belief in progress and growth, two characteristic ideas in this dawning era of technical modernity. And so electropolis itself, far beyond purely technical aspects, stands as a symbol and sign of a new time and a new idea of modern society. It is inseparably linked to the founding myth of Berlin, and it made an existential contribution to the city's global fame. As an electropolis, Berlin became the epitome of the modern metropolis in the early twentieth century, where technology and culture interacted closely and combined with great urban dynamism to create something that had not existed before.[3]

The Golden Twenties, with which the perception of Berlin is closely associated to this day (see for example the extremely successful TV series *Babylon Berlin* broadcast since 2017), were thus the fruit of earlier technical

and cultural, but also economic and geopolitical, developments. Given the capital required for both the prefinancing of planning and the construction of large-scale facilities for electrification, banks played a central role from the start of the electrical revolution. While around 1880 it was still private financial institutes that dominated the capital sector, already by the turn of the century large joint-stock banks gained momentum, giving birth to international financial capitalism. Significant parallel concentration processes took place also in the electrical industry. It was in this context that Siemens and AEG in Berlin together with General Electric and Westinghouse in the United States succeeded in establishing themselves during the first decade of the twentieth century as the four global players on worldwide electrical markets.

These processes were deeply embedded in imperial ambitions. The founding of Deutsche Bank in Berlin in 1870, that is, the year before the German Empire was founded, was born of an explicit geopolitical mission, the ultimate aim of which was to make German industry independent of British currency in order to be able to act independently on the world market.[4] Thus the expanding financial sector and new industries cooperated to conquer electrical markets worldwide, and in the course of this Berlin, Germany's imperial capital, also became increasingly attractive for the location of banks.[5] Indeed, at the beginning of the twentieth century it surpassed Frankfurt am Main as the most important financial center in Germany.[6]

Reviewing the historiography of Berlin's *Gründerzeit* period, these economic developments have to date generally been interpreted only as success stories. Even though urban historical research and the social sciences have dealt extensively with the related phenomenon of Berlin's tenements, that is, the development of an industrial proletariat and the expansion of working-class quarters,[7] it must be noted that the discourse in the disciplines of technical and economic history has so far been dominated almost exclusively by celebratory narratives that focus on the global players of the time: the big Berlin-based companies as well as the key people that stood behind them. Among the best known are Deutsche Bank with its directors Georg Siemens and Arthur Gwinner, the electro-technical company Siemens & Halske, created as early as 1847 with Werner Siemens at its head; and of course the other Berlin-based company AEG with its founder Emil Rathenau, who maintained close relations with Deutsche Bank since the creation of AEG in 1887, until the bank increasingly sided with Siemens from 1897 on.[8]

In recent years, however, critical perspectives have emerged to challenge this dominant narrative. Postcolonial interpretations demonstrate to what extent these powerful people acted with global imperial motivation and colonial ambitions to conquer markets worldwide.[9] Closely interconnected

with this, interdisciplinary and transnational research focusing on environmental history helps us understand how carbon-based infrastructure systems that emerged from specific territorial contexts turned into a model for development worldwide.[10]

Combining these perspectives in a multidimensional critical analysis of Berlin's coming-of-age as an industrial metropolis in a global context is the main purpose of this chapter. In the following sections I will explain how the fossil logic and convictions of Berlin's new entrepreneurial elites, who used coal from Silesia and the Ruhr to generate electricity in power plants within and outside their growing city, not only were closely intertwined with urban expansion in Berlin but also pushed the adoption of fossil-fueled technologies by hundreds of other cities around the world—sometimes resisting technological alternatives that might have been more suitable to local conditions.

BERLIN'S COAL-FUELED URBAN AND INDUSTRIAL GROWTH

The invention of new electric technologies in the German capital coincided with the unprecedented growth of the city during its *Gründerzeit*, and during this process emergent technical infrastructures and their respective networks and grids came to be the backbone of Berlin's spatial expansion. At the same time the city itself served as an urban laboratory for testing and implementing the new technologies.

The new urban transportation system that was gradually installed in Berlin from 1880 on is particularly revealing to understand how much the new networked technologies based on the use of electricity have shaped the "urban" in Electropolis Berlin. From 1881 electric trams replaced horse-drawn trams in the city; from 1896 the new electric subway (U-Bahn) was also gradually built. Its core line, known as *Stammstrecke*, was designed as an elevated railway and connected the new working-class districts of Friedrichshain and Kreuzberg in the east with the wealthier municipalities of Schöneberg and Charlottenburg in the west from 1902.[11] The routing of the second subway line, U2, which was to connect the core line from Potsdamer Platz to the city center, was not then designed to run via Leipziger Straße, which would have been the most direct connection, as this one was already served by several tram lines. To avoid competition the new line was eventually routed beneath the city's former fortifications via Spittelmarkt and Hausvogteiplatz to Alexanderplatz and then north to connect to the circular line of the Berlin S-Bahn (*Ringbahn*).[12] At the end of the 1920s, the Great Electrification (*Große Elektrisierung*) of the Berlin S-Bahn took place,[13] further determining spatial hierarchies between central and more peripheral locations in the emerging metropolitan area. The socio-technical

1.1. Aerial view of AEG City, around 1928. *Source*: Historical Archives, Deutsches Technikmuseum Berlin.

configuration of Berlin's urban expansion was thus decisively shaped by the routing of the new electric transportation lines. Along these arterial routes, transporting people as well as goods, the city grew as a radial system.

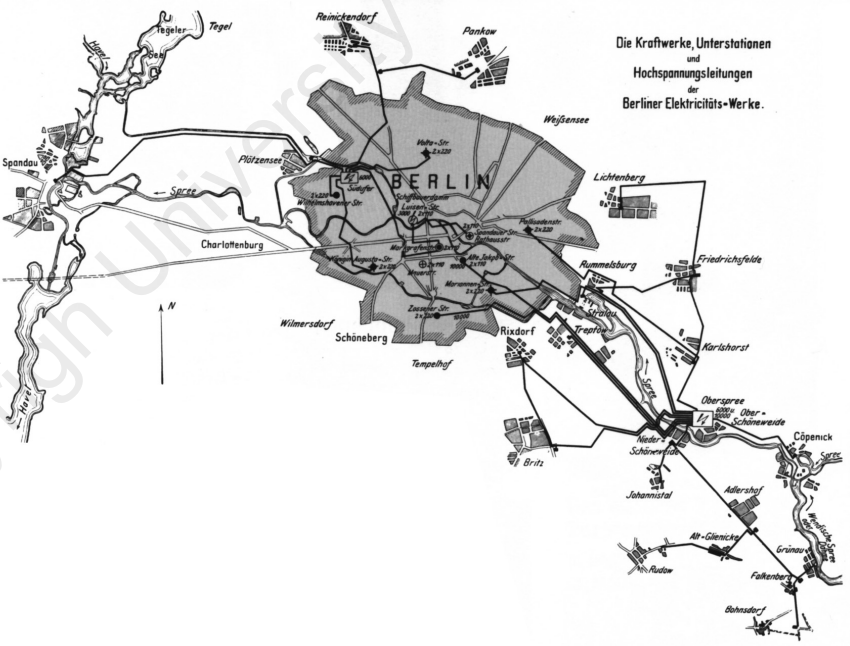
Industry also increasingly moved beyond the gates of the growing city. While the first factories were still located in the center of Berlin, such as the headquarters of Siemens & Halske in 1847 on Askanischer Platz in Kreuzberg,[14] the first wave of industrial suburbanization (the "First Relocation" trend of Berlin industries) in the 1870s and 1880s saw the first settlements in what was then the outskirts of the city. A second wave followed in the 1890s, during which both Siemens and AEG invested in the construction of new factories that again required a large amount of space. Consequently AEG moved to the Oberspree in the southeast in 1897, while Siemens bought property in the northwest. The AEG site on the *Schöne Weyde* (beautiful pastureland) then gradually developed into something like "AEG City" (fig. 1.1). "Siemensstadt" in the northwest also emerged around another new factory site, including housing for the workers and their families and social infrastructure such as churches, cemeteries, and so on.[15] Needless to say, both Schöneweide and Siemensstadt permitted excellent transportation facilities for moving raw materials and finished products in and out via regional train, river, and canal systems.

With the industrial and urban growth of Berlin, political pressure arose to plan the larger area of the city for the future. As early as the 1910s, proposals were made for the creation of an administratively unified Greater Berlin. At the same time similar considerations were also taking place in other regions that were becoming heavily industrialized and urbanized, such as the Ruhr region. In her research on the urban planning competitions of the 1910s, Cosima Götz explains that there were parallel developments in many cities and metropolitan regions around the world.[16] In Berlin this process culminated after World War I in the founding of Greater Berlin in 1920 as a uniformly administered territorial entity after the incorporation of formerly independent cities like Charlottenburg, Spandau, and Treptow into Berlin. For decades this process was accompanied by great concern from the social elites, who feared that the political influence of communist forces would become too strong in the new industrial megacity.

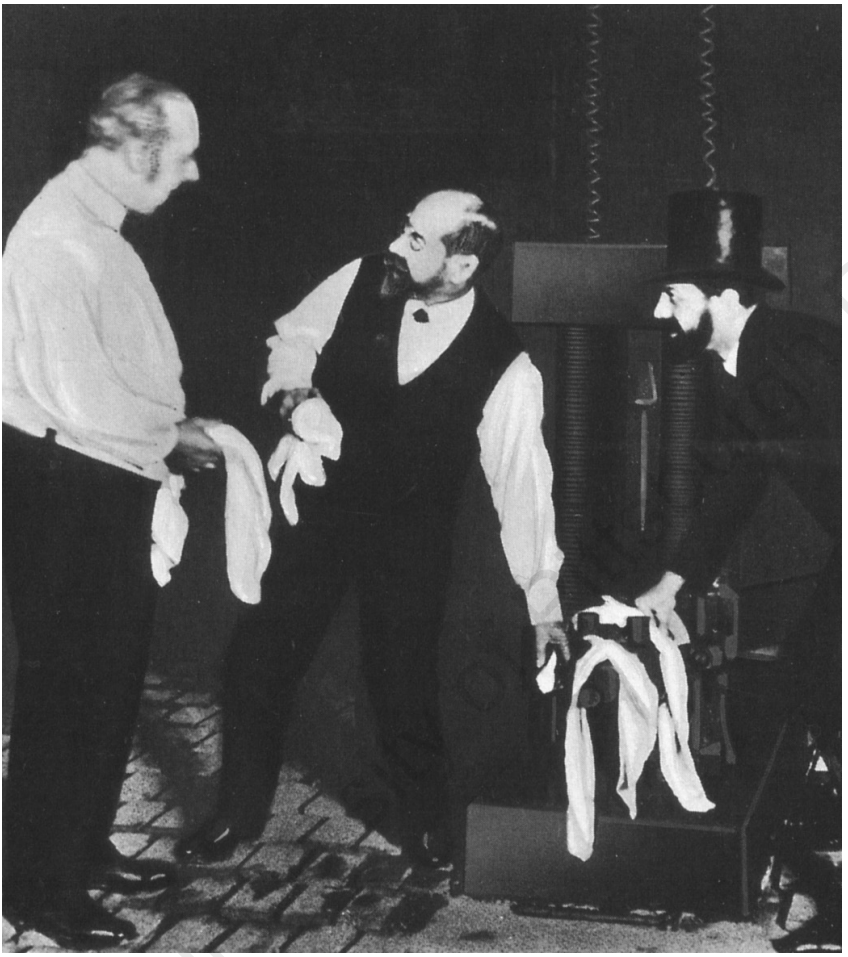
It was basically coal that fueled the growth of Berlin. There already was a certain tradition of using coal as an energy source for the city's development. A well-known painting by Karl Eduard Biermann represents *Feuerland* in Berlin-Mitte, where steam power–based factories were established as early as 1804 with the creation of the Royal Iron Foundry and then Egells in 1825 and Borsig in 1836 (fig. 1.2).[17] At the dawn of the electrical revolution, this new infrastructure was also fossil-fueled. One key factor to explain Berliners' preference for coal to generate energy is the city's topographical location in a former glacial valley, distant from any slope that would allow the use of hydropower on a large scale. The topographical situation here was quite different from that in the south of the German Empire, for example, where hydroelectric power was used early on in and around the Alps. In Berlin, on the other hand, the electricity that pushed the city's expansion was generated in coal-fired power plants that were built within and increasingly outside the rapidly growing city (fig. 1.3).

Thus the backbone of Berlin's electricity grid was a series of coal-fired power plants. First, in 1882 Emil Rathenau convinced the city's politicians of the advantages of electricity over gas, which was prevalent at the time, by demonstrating an electric lighting system in prestigious members-only clubs for Berlin's business elite. The pioneering installations in the Ressource von 1794 and the Club von Berlin proved successful, representing an important step toward winning the municipality as a customer for his company (fig. 1.4).[18] On September 13, 1884, the first *Blockstation* went into operation at Friedrichstraße 85, and from October 2, 1884, the first *Zentralstation* (central station), which is considered "the first public power station in Germany," was built at Markgrafenstraße 44 on Gendarmenmarkt, starting operation on August 15, 1885.[19] In the same year, at the request of the municipality, a second plant was commissioned in Mauerstraße.[20] At

1.2. Borsig factories in Berlin, painting by Karl Eduard Biermann, 1847. *Source*: GS 07/35 GM, Stadtmuseum Berlin.



1.3. Berlin's electricity grid in its early phase, 1906. *Source*: Bewag Archives, Deutsches Technikmuseum Berlin.



1.4. During a demonstration of his electric lighting system in the Ressource von 1794, Emil Rathenau cools the generator with ice from champagne buckets, 1882. *Source*: Bewag Archives, Deutsches Technikmuseum Berlin.

the end of the 1890s *Kraftzentralen* (power stations) followed, such as the Oberspree power station in 1896–1897 and the Moabit power station in 1899–1900. They were complemented a little later by *Kraftwerke* (power plants), such as the Rummelsburg power plant in 1906, and followed in the late 1920s by overland power stations such as Großkraftwerk Klingenberg in 1927 or Kraftwerk West in 1931.[21] With this leap in scale from an early island operation to an increasingly centralized territorial network, one can speak of the city's power supply as a "large technological system."[22]

Along the way the technical problem of transmitting electricity over longer distances had to be solved. This was accompanied by a lively system dis-

pute between direct current (DC) and alternating current (AC) supporters, with the International Electrotechnical Exhibition in Frankfurt am Main in 1891 proving a decisive moment in this matter.[23] Here AEG, together with its Swiss partners from the Maschinenfabrik Oerlikon (MFO),[24] succeeded in demonstrating for the first time and with great public impact that electricity can be transported over long distances. Their pioneering AC project successfully transmitted electricity over 175 kilometers from Lauffen to the exhibition site in Frankfurt, thus showing that it was possible to spatially disaggregate the generation of power from its use in factories and any other kind of application. Just a few years later, based on AC technology, AEG's Oberspree power station in Schöneweide went into operation in 1897 and supplied electricity primarily to AEG's nearby cable factory, but also to the city of Berlin. This power station is probably one of the oldest from the early days of alternating current that still exists today.[25] Some two decades later the interregional substation built in 1918 in Rummelsburg, just across the street from the power station that had been built in 1906, connected Berlin to an interregional electricity grid for the first time, thereby putting an end to the electrical independence of the metropolis.[26]

AEG's Lauffen-Frankfurt AC transmission project was also decisive in the sense that it pointed the path to electric household appliances that the company started to develop and produce; after all, if you sell electricity, you also need to create a social desire or need for the new products. In addition to urban infrastructure systems such as electric tramways and public street lighting, AEG thus started to build electric cars, like the Klingenberg Wagen in 1901 for instance, and to prompt the electrification of the private sphere, as Nina Lorkowski explains.[27]

The coal needed to generate and supply electricity to the city was transported to Berlin via railway and canal connections to favorably located power plant sites. It came mainly from Silesia and certainly also from the Ruhr (although there has been no in-depth research in this area to date) as the most important coal mining regions of the German Empire. There was easy access to, and an oversupply of coal from, these regions in the Reich's capital since both were located on national territory. Here the Prussian geopolitical interventions of earlier decades were now bearing new fruit, for even before the founding of the German Empire in 1871 under Prussian leadership, it had gained access through wars to these hard, anthracite coal deposits.

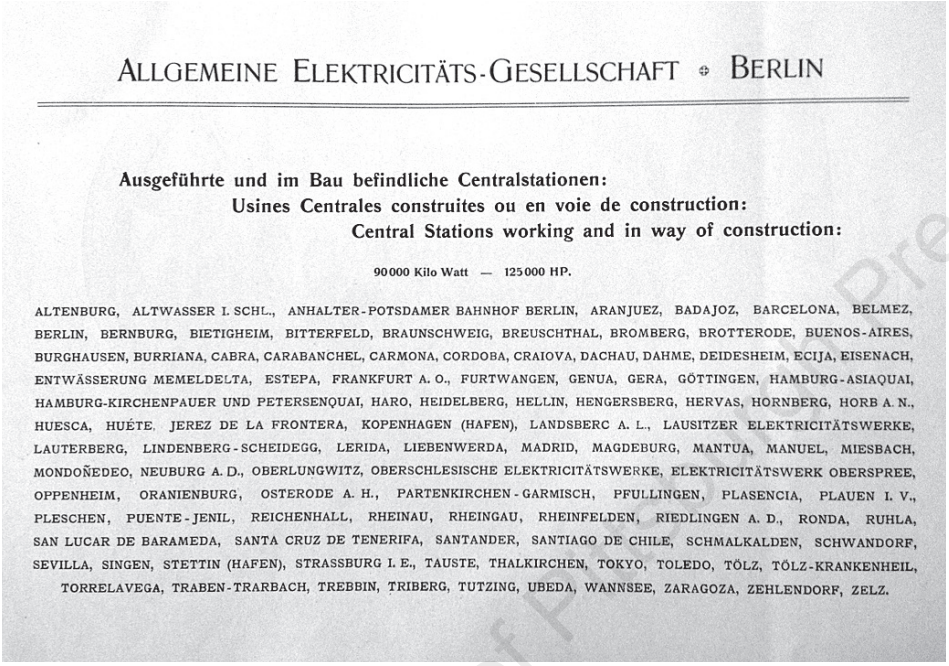
CARBON STRATEGIES FOR URBAN DEVELOPMENT WORLDWIDE

The fossil logic of Berlin's development, however, got embedded in the envisioning and practice of electropolis not only on location. The new

entrepreneurial elites of the electropolis, who came to dominate electrical markets globally, also pushed the adoption of fossil-fueled technologies for urban expansion in many other cities around the world. Thus, in the face of other technologies that might have been more suitable to local conditions on the ground, Berlin's coal-based electrification model was exported to and adopted by hundreds of cities worldwide, including the use and implementation of business strategies that were characteristic of the electropolis.

The most common starting point to get into the business of electrifying cities on all continents was to create local operating companies based on an electrification license obtained from the corresponding municipality.[28] This modus operandi started in Berlin with the foundation of the first electric operating company for the city, the Berliner Elektricitäts-Werke (BEW), created in 1887 by AEG together with Deutsche Bank. Only two years later the same AEG–Deutsche Bank group set up the first operating company outside the German Reich's territory: the Compañía General Madrileña de Electricidad. The power supply system that they built in the capital of Spain, back then an internationally important financial center and business location, was based on the use of coal-fired power, as in Berlin. Decisive for this deal were the personal relations between Arthur Gwinner, later Deutsche Bank director, who was working as a private banker in Madrid at the time and also acted as the German consul there, and the mayor of the Spanish capital, through whom it was possible for AEG to obtain the concession for the city's electrification.[29]

This procedure followed the logic of what was already called *Unternehmergeschäft* (entrepreneurial business) in Germany at the time. Investors and manufacturing companies jointly founded operating companies for the electrification of cities in which they had secured the corresponding concession; the contracts for the construction of the systems were then awarded to those companies that themselves had a stake in the operating company.[30] It was this construction business that ensured the profit for the companies involved and not, as one might think, the permanent operation of the systems, which on the contrary were, if possible, sold at a profit after a few years, sometimes to the cities themselves. Following this model, AEG pushed ahead with the establishment of other operating companies in Spain, especially in the country's most important industrial centers. In 1894 the Compañía Sevillana de Electricidad and the Compañía Barcelonesa de Electricidad were founded on the initiative of AEG, and in 1896 the Compañía Vizcaína de Electricidad was founded for Bilbao, the capital of the Basque Country, which at the time was Spain's second most important industrial region after Catalonia.[31] Within a few years the AEG–Deutsche Bank group thus gained a dominant position in the Spanish electricity market (fig. 1.5).[32]



ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT ⊕ BERLIN

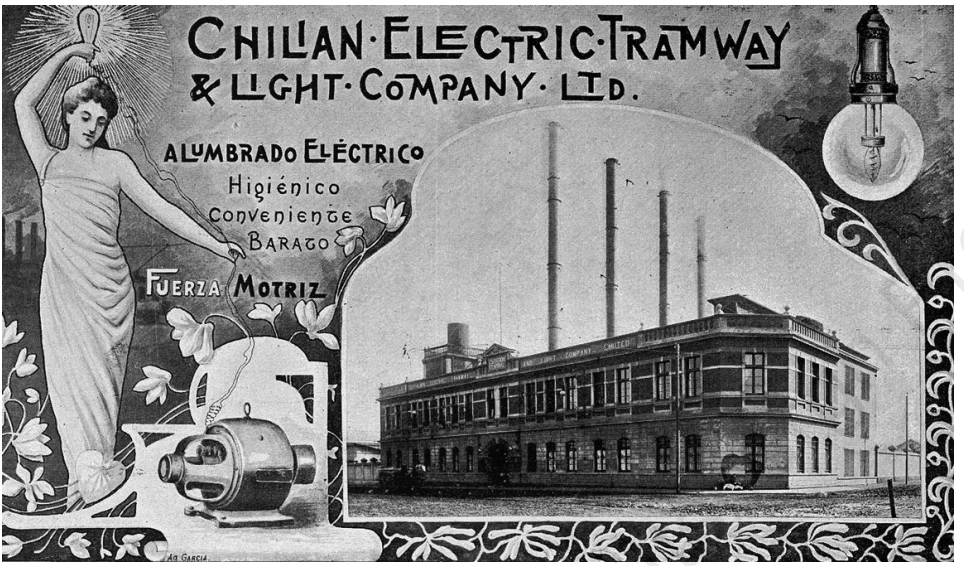
Ausgeführte und im Bau befindliche Centralstationen:
Usines Centrales construites ou en voie de construction:
Central Stations working and in way of construction:

90000 Kilo Watt — 125000 HP.

ALTENBURG, ALTWASSER I. SCHL., ANHALTER-POTSDAMER BAHNHOF BERLIN, ARANJUEZ, BADAJOZ, BARCELONA, BELMEZ, BERLIN, BERNBURG, BIETIGHEIM, BITTERFELD, BRAUNSCHWEIG, BREUSCHTHAL, BROMBERG, BROTTERODE, BUENOS-AIRES, BURGHAUSEN, BURRIANA, CABRA, CARABANCHEL, CARMONA, CORDOBA, CRAIOVA, DACHAU, DAHME, DEIDESHEIM, ECIJA, EISENACH, ENTWÄSSERUNG MEMELDELTA, ESTEPA, FRANKFURT A. O., FURTWANGEN, GENUA, GERA, GÖTTINGEN, HAMBURG-ASIAQUAI, HAMBURG-KIRCHENPAUER UND PETERSENQUAI, HARO, HEIDELBERG, HELLIN, HENGERSBERG, HERVAS, HORNBERG, HORB A. N., HUESCA, HUÉTE, JEREZ DE LA FRONTERA, KOPENHAGEN (HAFEN), LANDSBERG A. L., LAUSITZER ELEKTRICITÄTSWERKE, LAUTERBERG, LINDENBERG-SCHEIDEGG, LERIDA, LIEBENWERDA, MADRID, MAGDEBURG, MANTUA, MANUEL, MIESBACH, MONDOÑEDEO, NEUBURG A. D., OBERLUNGWITZ, OBERSCHLESISCHE ELEKTRICITÄTSWERKE, ELEKTRICITÄTSWERK OBERSPREE, OPPENHEIM, ORANIENBURG, OSTERODE A. H., PARTENKIRCHEN-GARMISCH, PFULLINGEN, PLASENCIA, PLAUEN I. V., PLESCHEN, PUENTE-JENIL, REICHENHALL, RHEINAU, RHEINGAU, RHEINFELDEN, RIEDLINGEN A. D., RONDA, RUHLA, SAN LUCAR DE BARAMEDA, SANTA CRUZ DE TENERIFA, SANTANDER, SANTIAGO DE CHILE, SCHMALKALDEN, SCHWANDORF, SEVILLA, SINGEN, STETTIN (HAFEN), STRASSBURG I. E., TAUSTE, THALKIRCHEN, TOKYO, TOLEDO, TÖLZ, TÖLZ-KRANKENHEIL, TORRELAVEGA, TRABEN-TRARBACH, TREBBIN, TRIBERG, TUTZING, UBEDA, WANNSEE, ZARAGOZA, ZEHLENDORF, ZELZ.

1.5. AEG coal-fired central stations working and under construction, 1899 (note the many Spanish cities). *Source*: AEG 1900, "Electric Tramways," iii, III.2 01465, Historical Archives, Deutsches Technikmuseum Berlin.

Sticking to this logic of entrepreneurial business and based on the experience gained in Berlin and Madrid, the AEG–Deutsche Bank group founded more operating companies for the electrification of numerous cities around the world in rapid succession, using the statutes of Madrileña as a blueprint, especially in Spanish-speaking countries. Important deals were also concluded in other European countries, for example in Genoa, Stockholm, Warsaw, and St. Petersburg as well as overseas, such as in Santiago, Chile.[33] In the Chilean capital the Mapocho coal-fired power station went into operation in 1900, and on September 2 of the same year the electric tramway, also built by AEG, was festively inaugurated. For their operations in Santiago, the Berlin players had founded an operating company especially for this city, the Chilian Electric Tramway & Light Company (CET&L), using an English name with headquarters based in London (fig. 1.6). The English appearance was designed to make the German company attractive to the Chilean elite, who were very Anglophilic and had hitherto associated German products more with wooden toys than with the technical systems "Made in Germany" that were later to gain and retain international acclaim.[34] Another reason for registering the operating company CET&L in



1.6. Advertisement for the Chilean Electric Tramways & Light Company, with the Mapocho coal-fired power plant in Santiago de Chile, 1903. *Source*: Tornero, *Chile*, 130.

the British capital was that important German-born financial partners of AEG were based in London, the world's financial center at the time.[35]

During the Mapocho power plant's first year of operation in Santiago, 50 percent of the coal consumed there came from the region of Lota in southern Chile; the other 50 percent came from Australia, which was still a British colony at the time.[36] The fact that half of the needed coal was shipped across the Pacific Ocean shows how blatant the fossil logic was on which the Berlin business strategy was based. Emil Rathenau, head of the AEG, even once spoke of hydroelectric power as a "specter that has completed its tour around the world."[37] The price of coal was so low, he argued, that it was not worth venturing into another type of technology and wasting time and money trying to find solutions to problems which according to him were simply irrelevant. This situation changed only with the outbreak of World War I in 1914, which made all shipping drastically more expensive.

However, the contracts signed with the Santiago municipality in 1897, like those to be signed with Valparaíso in 1902, were all based on the use of locally available hydropower.[38] AEG, though, had no technical experience of its own with hydropower, even though it had been triumphantly successful at the great International Electricity Exhibition in Frankfurt in 1891, in the heyday of the dispute between direct and alternating current,

precisely with a hydroelectric project.[39] This had only been possible thanks to AEG's cooperation with their Swiss friends from the MFO, based near Zurich and the Alps, and its two chief engineers Charles Brown and Walter Boveri, who founded their own company Brown, Boveri & Co. just a few weeks later.[40]

LOCAL STRUGGLES IN METROPOLITAN CHILE OVER COAL VERSUS WATER POWER

In the case of metropolitan Chile, comprising the country's two most important cities of the capital Santiago and the port city Valparaíso, it is interesting to note that the AEG–Deutsche Bank group founded not only the already mentioned CET&L as the electric operating company for Santiago in May 1898. In January of the same year they had already launched the Deutsche Ueberseeische Elektricitäts-Gesellschaft (German Overseas Electric Company), which, although it started as an operating company for Buenos Aires, from the beginning was designed as a holding company for the group's electricity business on the entire South American continent, thus minimizing the business risks for its shareholders.[41] For the geostrategically important port city of Valparaíso, AEG and Siemens arranged, in an agreement signed in July 1898, that AEG would take the lead here, while Siemens in return would run the business in the Brazilian port city of Salvador in Bahía.[42]

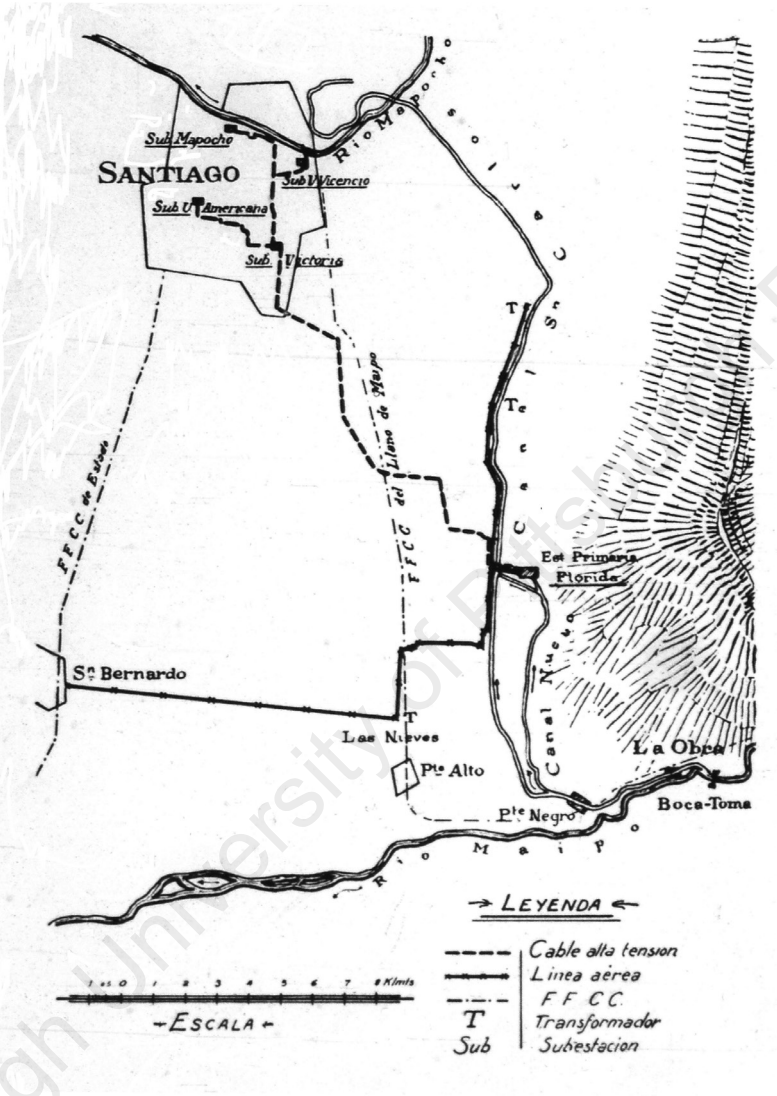
The minutes of the first meetings of the local directorate of the CET&L in Santiago from August 1898 on make it clear that the Berlin actors did not actually intend to build the hydroelectric power station in Santiago at all—in addition to the coal-fired power system that was already at the planning stage by then—although the implementation of a hydropower system had been agreed to in their contract with the city.[43] Even though CET&L publicly and repeatedly reaffirmed their will to fulfill the contract during the vehement discussions on the issue,[44] the facts tell a very different story. The construction of a hydroelectric power system did not start for many months and the dispute ended up in court in 1900.

One of the reasons for the conflict was the very different perception of the actors involved as to which energy source would be the most convenient to generate electricity. While the Berlin actors stubbornly followed the fossil logic of their energy model, the Chilean elites knew perfectly well that electricity could also be generated from hydropower. Always aware of the latest events and technological advances in Europe and North America, they knew that hydroelectric projects had been underway since the 1880s in Switzerland and Norway—countries with a topography similar to their own. They had in all likelihood also read the news about the commissioning

of the world's first large-scale hydroelectric power plant, which started operating on alternating current near Niagara Falls in 1895. Even in Chile itself there was already a very relevant precedent. The Chivilingo hydroelectric power station in the south of the country, which served to electrify the coal mines of Lota, was put into service in 1897 as the first hydroelectric power plant in South America. Built on the initiative of Isidora Goyenechea, some sources indicate that it was designed by Thomas Edison himself and that he was directing its construction from a distance, via correspondence by letters with Goyenechea, considered the richest woman in the world at that time and also, notably, a very close friend of Edison.[45]

Ultimately, the first lawsuit was decided by an arbitral tribunal in favor of the municipality of Santiago and confirmed by the Chilean Court of Appeal on October 22, 1900, which also detailed CET&L's obligation to implement the hydroelectric system within a maximum of seven years from that date. From a comparative international perspective, this was the very first time that AEG began to build hydroelectric power systems as a member of an operating company, as it did in Santiago and also Valparaíso, where there were no further disputes after the appeals court decision. To give just one example of the pattern of AEG projects around the world, their investment in hydropower in Spain only happened after AEG's supremacy in the Spanish electricity market was challenged in Barcelona in 1911. This occurred when North American competitors began to invest in hydroelectric projects in the Pyrenees in collaboration with Catalan politicians as part of a large-scale territorial development project. AEG failed to recognize this potential, biding by Rathenau's negative perception of hydropower. This entrepreneurial misjudgment rapidly led to the loss of AEG's dominant position in the Spanish electricity market years *before* the outbreak of World War I.[46]

Long before the hydroelectric power plant La Florida in Santiago, with its network of four substations in the city center (fig. 1.7), finally went into operation in 1909–1910, the hydroelectric power plant El Sauce in the hinterland of the port city of Valparaíso (fig. 1.8) had already started operation in May 1906. Via the operating company Elektrische Straßenbahn Valparaíso A.-G. (Electric Tramways Valparaíso Co.), which was founded in 1903 with its headquarters in Berlin, all the key players of the Electropolis Berlin were involved in its construction. In addition to AEG and Deutsche Bank as the initiators of the project, who had already set up the CET&L for Santiago in 1898, Siemens was now also on board. A key role as a local actor and crucial intermediary in the global electrification business was played by the German-Chilean trading house Saavedra, Bénard & Cía., which even became an official partner of the operating company in 1903 after they had signed the contracts with the municipality on behalf of their



1.7. Electrical grid in Santiago de Chile around 1910, with the hydropower plant La Florida. *Source*: CATE, *La Compañía*, microformatos 427850, National Library of Chile.

German partners in 1902. Through two German-born brothers, Luis and Victor Bénard, this trading company operated between Valparaíso (Luis) and Hamburg (Victor), but also maintained good connections with Berlin, and in 1907 even became the springboard for the founding of Siemens in Chile.[47]

1.8. Hydroelectric power plant El Sauce in the hinterland of Valparaíso, put into service in May 1906, decommissioned in 1997. Photo by Marion Steiner, 2014.

The German electrical actors in metropolitan Chile tried to impose their own cultural convictions not only in technical but also in other areas, which in general did not correspond to local realities either. One example is their decision to "suppress women as conductors on electric trams," which was recorded in the minutes of the extraordinary session of the CET&L Local Committee on March 10, 1900.[48] The presence of women on Chile's trams was a particular phenomenon at the time, beginning during the War of the Pacific (1879–1884) due to the lack of an available male workforce. The US chronicler Marie Robinson Wright, who visited the country some three years after this decision was recorded, reported in 1904: "As far as emancipation is concerned, there is in Chile an institution that is far ahead of North America and Europe. The conductors of all the trams are women!"[49] We can conclude from her statement that, at least up to that date, the German male-only engineers of CET&L had not succeeded in implementing their idea. This attempt to dismiss women from their service as conductors was most probably such an absurd undertaking from the Chilean point of view that it simply could not succeed.[50]

A NEW SOCIO-TECHNICAL DISPOSITIVE FOR THE TWENTIETH CENTURY

In a global comparison of the urban electrification projects that were implemented by the AEG–Deutsche Bank group at the end of the nineteenth and early twentieth centuries, it is noteworthy to state that the two cases of early hydropower in metropolitan Chile outlined here are in fact "unruly" developments, that is, they are the great exception to the general rule of the fossil-fueled energy systems that these Berlin-based actors built in cities around the world.

The analysis of these unruly Chilean cases nonetheless reveals fundamental characteristics of the Berlin energy model. Thus we are able to note that Berlin's urban and industrial expansion was in fact exclusively fueled by coal, which as a result of previous wars was easily accessible in large amounts at the time within German national territory. The fossil logic of the new electric infrastructure systems, including transportation as well as utility grids, then configured new networked technologies and shaped the urban environment in the Reich's capital. Within only two decades at the turn to the twentieth century, in the context of the Second Industrial Revolution, Berlin as electropolis became a global pioneer and a reference not only in technical terms, but also with regard to symbolic representation. In the dawning era of technical modernity, it came to express a new urban vision and new ideas for urban design and development that inspired social elites around the world.

In the process of transferring the Berlin energy model to other parts of the world, its fossil logic became culturally and politically inscribed into local contexts that were fundamentally different. As our two Chilean cases demonstrate, the Berlin actors tried to ignore the specific geographic and cultural conditions on the ground as much as possible. The trilingual AEG advertising catalog on electric tramways from 1900 is a good example, as it outlines how sophisticated the promotion strategies for the global marketing of the new monopolized electric products were. For South Africa there even seems to be some evidence that there were catalogs promoting the construction of entire electrical systems based on the use of coal, including the presentation of architectural models for power plants.[51] In probably all cases, though in some with less success than in others, the Berlin actors actively opposed proposals for the use of different technologies and energy sources that might have been more suitable to local conditions, but would have meant a greater investment of time and money in their development.

This actually not only demonstrates the imperial ambition of the AEG–Deutsche Bank group to conquer the emerging electrical world markets, but also makes us understand their expansionist international business

strategies. Their very specific financing methods came to dominate global trends in the installation of strongly monopolized technical systems around the world, while other, more decentralized, local, and alternative modernities could not prevail. In summary, with the powerful implementation of coal-fueled electrical systems, early international financial capitalism, and the cultural convictions of the electropolis's new entrepreneurial elite, a new socio-technical dispositive emerged that would dominate the thinking on urban modernity for over a century, not only in Europe, but on a global scale.

This also happened against the backdrop of the very particular geopolitical context of the time, when hierarchical global power relations started to change due to the emergence of the new electric and chemical industries, which represented the two major technological pillars of the Second Industrial Revolution and were quickly dominated by US actors and their counterparts in the recently united German Reich. With this economic rise of two new powers challenging the previously dominating British Empire, an imperial race for global hegemony commenced that was ultimately won by the United States after World War I. The fact that Berlin became an electropolis at the end of the nineteenth and early twentieth centuries in the wake of the Second Industrial Revolution is therefore anything but a coincidence—especially if one considers that this was also a time when technology transfers and foreign capital investments became instruments of power to conquer markets worldwide and execute imperial domination. This was accompanied by a strong symbolic discourse on progress and economic growth that undermined, or simply ignored, proposals for alternative modernities that did exist locally—as we can see from the Chilean struggle for hydropower that proved to be successful in the end but was the great exception to the rule.[52]

I want to close with a look back at our two unruly cases and a final remark on the fate of hydropower in metropolitan Chile. Despite its successful and unprecedented implementation in Santiago and Valparaíso during the first decade of the twentieth century and despite all the good arguments by local actors on water resources being available on the ground, providing clean, renewable, and cheap energy and thus assuring a greater independency from foreign money and domination (energy autonomy was already an important issue back then), hydroelectricity did not become the new leitmotif there in the long run. In Valparaíso, for example, the return to coal as the most important energy source happened in the late 1930s with the Laguna Verde coal-fired power plant built by US capitalists,[53] and a similar development took place in the rest of Chile around that time. From the 1940s and 1950s on, large-scale hydropower plants were built in many parts of the country that are also considered nonrenewable in Chile

today because of their environmental damage and the dispossession of local people from their land.[54]

Despite the historic success of local actors in favor of hydropower in the two most important cities in Chile, there was, taking a long-term perspective, no energy transition. On the contrary, consumption increased in all sectors at all times.[55] This problem of ever-growing energy consumption (and the increasing global power of the extremely monopolized product systems) has only become a larger challenge to humanity since the electrical revolution started around 1880. And despite all the fine soapbox speeches, a solution is not in sight.

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CHAPTER 1: ELECTROPOLIS BERLIN

1. Karl Baedeker wrote in 1904, "So begann nun, namentlich seit 1871, jener wunderbare Aufschwung der Industrie und des Handels, welcher Berlin mit einer sonst nur bei amerikanischen Städten beobachteten Geschwindigkeit in die Reihe der Weltstädte einführte" (Thus began, especially since 1871, that wonderful upswing in industry and trade that introduced Berlin into the ranks of the world's cities with a speed hitherto only observed in American cities); Baedeker, *Berlin und Umgebung*, 44.

2. Steiner, *Die chilenische Steckdose*, 1:82, 163; Pohl, *Emil Rathenau und die AEG*, 119.

3. See Steiner, *Die chilenische Steckdose*, 1:87–92. On the concept of electropolis, see also Dame, *Elektropolis Berlin*, 24–30; and Dame, "Elektropolis Berlin."

4. See Steiner, *Die chilenische Steckdose*, 1:51–63; Gall et al., *Die Deutsche Bank*, 8.

5. Steiner, *Die chilenische Steckdose*, 1:62; see also Hausman, Hertner, and Wilkins, *Global Electrification*, 35–72; Hentschel, *Wirtschaft und Wirtschaftspolitik*, 127–28; Jaeger, *Geschichte der Wirtschaftsordnung in Deutschland*, 110; and Fohlin, *Finance Capitalism and Germany's Rise to Industrial Power*.

6. See Dame and Steiner, "Banking District," in BZI, *Berlin's Industrial Heritage*, 1st ed. 2013.

7. See, e.g., the classical three-volume book series by Geist and Kürvers, *Das Berliner Mietshaus*. For a source in English, see Poling, "Shantytowns and Pioneers." The 1931 novel, Noth, *Die Mietskaserne*, is also insightful.

8. Steiner, *Die chilenische Steckdose*, 1:79–80, 162. On the AEG–Deutsche Bank alliance, see Pohl, *Emil Rathenau und die AEG*, 56–64; Dame, *Elektropolis Berlin*, 73–77. On Deutsche Bank siding with Siemens, see Loscertales, *Deutsche Investitionen in Spanien*, 227.

9. See, e.g., Steiner, *Die chilenische Steckdose*, "Strom für die Welt," and "Reflexiones postcolonialistas"; Steiner and Fuentes, *Luz para Valparaíso*. See also Reitmayer, *Bankiers im Kaiserreich*; and the lecture "Zur Industriekultur Berlins aus globaler Perspective" by Steiner at the 2020 BZI Forum on Industrial Culture and Society, December 3, https://youtu.be/ZjPTVYWcfSs.

10. See, e.g., the interinstitutional research project Circulation of Experts and Expertise—A Historical Approach to Their Mediating Role in Energy Transitions: The Chilean Case, carried out by the Max Planck Institute for the History of Science (Berlin) and the Universidad de Chile, Santiago, from 2021 to 2023, with funding from the Alexander von Humboldt Foundation. A book presenting its research results is forthcoming.

11. Dame and Kupfer, "The Core Line of Berlin's U-Bahn," in BZI, *Berlin's Industrial Heritage*, 2nd ed., 2014.

12. Hochbahngesellschaft Berlin, *Die Hoch- und Untergrundbahn*.

13. Dame and Steiner, "The Berlin S-Bahn Power Grid," in BZI, *Berlin's Industrial Heritage*, 3rd ed., 2015. See also Stiftung Bahn Sozialwerk, *"Große Elektrisierung."*

14. Kupfer, "Mövenpick Hotel Berlin / Siemens House," in BZI, *Berlin's Industrial Heritage*, 1st ed.

15. Dame and Steiner, "Schöneweide" and "Oberschöneweide Housing Estate," both in BZI, *Berlin's Industrial Heritage*, 1st ed.; Dame and Steiner, "Siemensstadt" and "Gesundbrunnen" both in BZI, *Berlin's Industrial Heritage*, 3rd ed.; Hoppe and Kupfer, *Spandau Siemensstadt*, *Treptow-Köpenick* and *Charlottenburg Moabit*.

16. Götz, "Der 'Wettbewerb Groß-Berlin.'"

17. Dame and Steiner, "Gesundbrunnen," in BZI, *Berlin's Industrial Heritage*, 3rd ed.

18. Steiner, *Die chilenische Steckdose*, 1:84.

19. Steiner, *Die chilenische Steckdose*, 1:28; Dame, *Elektropolis Berlin*, 52–55, 65, 67, 68.

20. Dame and Steiner, "E-Werk in the Buchhändlerhof Substation," in BZI, *Berlin's Industrial Heritage*, 1st ed.

21. See Steiner, *Die chilenische Steckdose*, 1:28; Dame, *Elektropolis Berlin*; Dame and Landesdenkmalamt Berlin, *Elektropolis Berlin*; Dame and Steiner, "Oberspree Power Station and Substation" and "Rummelsburg," both in BZI, *Berlin's Industrial Heritage*, 1st ed.; Dame and Steiner, "Klingenberg Power Station," in BZI, *Berlin's Industrial Heritage*, 2nd ed.

22. On this concept from the social sciences, see in particular Mayntz and

Hughes, *Development of Large Technical Systems*; Hughes, "Evolution of Large Technological Systems."

23. Steiner, *Die chilenische Steckdose*, 1:28. The Swiss historian David Gugerli analyzed this exhibition from a social constructivist perspective, describing its effect as a new "point of reference" and "possible future paradigm" (*Redeströme*, 108).

24. On the particular relationship between AEG and their Swiss friends from MFO, see Steiner, "'El fantasma de la fuerza motriz del agua'"; Steiner, *Die chilenische Steckdose*, 1:273–77, 278, 300–302.

25. It was "one of the first alternating current power stations for public energy supply in the world and, with its subsequent expansions and modifications, has been largely preserved until today," Dame and Steiner, "Oberspree Power Station and Substation," in BZI, *Berlin's Industrial Heritage*, 1st ed.

26. Dame and Steiner, "Rummelsburg," in BZI, *Berlin's Industrial Heritage*, 2nd ed.

27. See the chapter by Lorkowski in this book. On the Klingenberg Wagen, see Dame and Steiner, "Peter Behrens Building, Former NAG," in BZI, *Berlin's Industrial Heritage*, 1st ed.

28. See Hausman, Hertner, and Wilkins, *Global Electrification*, 75–124, for more detail on this modus operandi.

29. For details, see Steiner, "'El fantasma de la fuerza motriz del agua'"; Steiner, *Die chilenische Steckdose*, 1:191–96.

30. See Steiner, "'El fantasma de la fuerza motriz del agua'"; Steiner, *Die chilenische Steckdose*, 1:163–68; Hertner, "Foreign Direct Investment in Chile and Local Public Utilities," 92.

31. See Steiner, "'El fantasma de la fuerza motriz del agua'"; Steiner, *Die chilenische Steckdose*, 1:165–66. More detailed information on the Sevillana is in Pohl, *Emil Rathenau und die AEG*, 148, 150; Loscertales, *Deutsche Investitionen in Spanien*, 156–89. On the Barcelonesa and the Vizcaína, see Loscertales, *Deutsche Investitionen in Spanien*, 189–201.

32. Pohl, *Emil Rathenau und die AEG*, 150; Loscertales, *Deutsche Investitionen in Spanien*, 149.

33. AEG, *Elektrische Straßenbahnen*, 7; Steiner, *Die chilenische Steckdose*, 1:166–67; see also Hausman, Hertner, and Wilkis, *Global Electrification*.

34. See Steiner, *Die chilenische Steckdose*, 1:167–68, 253 (English names), 318–19 (wooden toys "Made in Germany").

35. On the German Randlords Julius Wernher and Alfred Beit, see Steiner, *Die chilenische Steckdose*, 1:196–203.

36. Technical detail: in order to guarantee the smooth operation of the plants, the coal from Lota had to be mixed with coal from other properties in order to achieve the necessary quality. Sources on the origin of the coal are from transcripts of the minutes of the meetings of the Local Committee of the CET&L, 28th meeting, October 12, 1899, and 30th meeting, October 26, 1899, personal archives of

Silvia Castillo, Historical Institute, Cuaderno no. 1, 68, 72, Pontificia Universidad Católica de Chile, Santiago.

37. Emil Rathenau to the president of the Sevillana operating company, April 1902, S 1213, Historical Archives Deutsche Bank, Frankfurt am Main; excerpted in Loscertales, *Deutsche Investitionen in Spanien*, 333. See also Steiner, *Die chilenische Steckdose*, 1:274–75; Steiner, "'El fantasma de la fuerza motriz del agua.'"

38. See CET&L, *Recopilación de los bases, antecedentes i contratos*; Municipalidad de Valparaíso, *Recopilación de leyes, ordenanzas, reglamentos y demás disposiciones*.

39. A detailed analysis is provided by Gugerli, *Redeströme*, 94–96, 104–17.

40. For details, see Steiner, "'El fantasma de la fuerza motriz del agua'"; Steiner, *Die chilenische Steckdose*, 1:276, 278; Gugerli, *Redeströme*.

41. See Seidenzahl, "Die Anfänge der Deutsch-Ueberseeischen Elektricitäts-Gesellschaft"; Steiner, *Die chilenische Steckdose*, 1:161, 177–80.

42. On the 1898 agreement between AEG and Siemens, see Pohl, *Emil Rathenau und die AEG*, 161, 260–61 (extract); original source: SAA 23/Li 747, Siemens Archives, Berlin. See also Steiner, *Die chilenische Steckdose*, 1:79, 173, 236.

43. The transcripts of the minutes of the meetings of the Local Committee of the CET&L, 1898–1902, are contained in the two corresponding *Cuadernos* in the personal archives of Silvia Castillo, which she donated to the Historical Institute of the Pontificia Universidad Católica de Chile in 2014. I accessed them at the time via Fernando Purcell, the institute's director back then; they should by now have been integrated into the institute's library catalog.

44. Santiago City Council minutes, in Municipalidad de Santiago, *Boletín de actas y documentos*. For a detailed outline of the entire discussion and results, see Steiner, "'El fantasma de la fuerza motriz del agua'"; Steiner, *Die chilenische Steckdose*, 1:279–88.

45. See Steiner, "'El fantasma de la fuerza motriz del agua'"; Steiner, *Die chilenische Steckdose*, 1:269–73.

46. See Steiner, "'El fantasma de la fuerza motriz del agua'"; Loscertales, *Deutsche Investitionen in Spanien*, 149.

47. In 1907 the trading house Saavedra, Bénard y Cía already had its own electrical department, which was taken over by Siemens that year, thus creating the new company Siemens-Schuckert Limited, which initiated the direct presence of Siemens in Chile. See Steiner, *Die chilenische Steckdose*, 1:188–90.

48. Original quote in Spanish: "Se acordó suprimir en los tranvías eléctricos las mujeres como conductoras"; transcripts of the minutes of the meetings of the Local Committee of the CET&L, 6th extraordinary meeting, March 10, 1900, 105, Cuaderno no. 1, personal archives of Silvia Castillo.

49. Robinson Wright, *Republic of Chile*, 73.

50. See also Steiner, *Die chilenische Steckdose*, 1:314–17; Steiner and Fuentes, *Luz para Valparaíso*, 46.

51. According to a statement in 2014 by the then-head of the Berliner Elek-

trizitätswerke A.G. archive at Vattenfall Europe. This archive has since been included in the collections of the Historical Archives of the German Museum of Technology Berlin; "Metropole unter Strom," *Der Tagesspiegel*, September 26, 2022.

52. Other recent and interesting research on locally specific aspects of electrification worldwide has been conducted by Diana J. Montaña, *Electrifying Mexico*; and Anto Mohsin, *Electrifying Indonesia*.

53. US-Americans took over in 1928 from the British capitalists who had owned the German-built electrical systems of Santiago and Valparaíso for some years, after having taken them over from the Germans in 1918 as a consequence of World War I rearrangements; see Steiner and Fuentes, *Luz para Valparaíso*, 124–29. It is likely that the coal was primarily imported from the United States at the time; today, a great part comes from China.

54. See CORFO, *Plan de Electrificación del país*; ENDESA, *Plan de electrificación del país. Segunda publicación*; CNE and GTZ, *Las Energías Renovables no Convencionales*.

55. A thesis argued in detail by Cecilia Ibarra; see her contributions to the interinstitutional research project of the Max Planck Institute for the History of Science and the Universidad de Chile mentioned in note 10, and to the forthcoming book: Carlos Sanhueza and Helge Wendt, eds., *A Global History of Energy in Chile: Experts, Transitions, and Imaginaries* (Leiden, Netherlands: Brill).

BIBLIOGRAPHY

AEG (Allgemeine Elektricitäts-Gesellschaft). *Elektrische Straßenbahnen—Electric Tramways—Tramways Électriques*. Berlin: AEG, 1900.

Baedeker, Karl. *Berlin und Umgebung. Handbuch für Reisende*. Leipzig: Verlag von Karl Baedeker. Accessed May 12, 2023. https://archive.org/details/berlinundumgebun00karl.

BZI (Berliner Zentrum für Industriekultur). *Berlin's Industrial Heritage: Substantial Past—Sustainable Future*. Berlin: BZI & SenStadtUm, 2013–2016, Faltmappe, three editions, translated by Barry Fay. Accessed May 12, 2023. https://industriekultur.berlin/wp-content/uploads/Berlins-Industrial-Heritage-Sheets.pdf.

CATE (Compañía Alemana Transatlántica de Electricidad). *La Compañia Alemana Transatlántica de Electricidad en Santiago: A los señores representantes de las Empresas de Electricidad en Chile en conmemoración de la 1a. Conferencia celebrada en Santiago, el 15 de marzo de 1916*. Santiago: CATE, 1916.

CET&L (Chilian Electric Tramway and Light Company). *Recopilación de los bases, antecedentes i contratos con la Ilustre Municipalidad de Santiago para los tranvías i concesión para alumbrado eléctricos de Santiago*. Santiago: CET&L, 1914.

CNE (Comisión Nacional de Energía) and GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit). *Las Energías Renovables no Convencionales en el Mercado Eléctrico Chileno / Non-conventional Renewable Energy in the Chilean*

Electricity Market. Santiago: Proyecto Energías Renovables no Convencionales, ByB Impresores, 2009.

CORFO (Corporación de Fomento de la Producción). *Plan de Electrificación del país. Directivas generales y Plan de Electrificación Primaria del País*. Santiago: Impr. Universo, 1942.

Dame, Thorsten. *Elektropolis Berlin: Die Energie der Großstadt. Bauprogramme und Aushandlungsprozesse zur öffentlichen Stromversorgung in Berlin*. Berlin: Mann (Gebr.), 2011.

Dame, Thorsten. "Elektropolis Berlin. 'I Didn't Stop at Cologne, for I Don't Care for Old Things.'" In *Metropole Berlin. Die Wiederentdeckung der Industriekultur*, edited by Joseph Hoppe and Heike Oevermann, 121–31. Berlin: be.bra, 2020.

Dame, Thorsten, and Landesdenkmalamt Berlin, eds. *Elektropolis Berlin. Architektur- und Denkmalführer*. Petersberg: Michael Imhof, 2014.

ENDESA (Empresa Nacional de Electricidad, S. A.). *Plan de Electrificación del país. Segunda publicación*. Santiago de Chile: ENDESA/CORFO, 1956.

Fohlin, Caroline. *Finance Capitalism and Germany's Rise to Industrial Power*. Cambridge: Cambridge University Press, 2007.

Gall, Lothar, Gerald D. Feldman, Harold James, Carl-Ludwig Holtfrerich, and Hans Büschgen. *Die Deutsche Bank 1870–1995*. Munich: C. H. Beck, 1995.

Geist, Johann Friedrich, and Klaus Kürvers. *Das Berliner Mietshaus.* 3 vols. Munich: Prestel, 1980–1989.

Götz, Cosima. "Der 'Wettbewerb Groß-Berlin,' vor Ort und in der Welt." In *Metropole Berlin. Die Wiederentdeckung der Industriekultur*, edited by Joseph Hoppe and Heike Oevermann, 173–85. Berlin: be.bra, 2020.

Gugerli, David. *Redeströme. Zur Elektrifizierung der Schweiz, 1880–1914*. Zurich: Chronos Verlag, 1996. Accessed May 12, 2023. https://doi.org/10.3929/ethz-a-001599321.

Hausman, William J., Peter Hertner, and Mira Wilkins. *Global Electrification: Multinational Enterprise and International Finance in the History of Light and Power, 1878–2007*. Cambridge: Cambridge University Press, 2008.

Hentschel, Volker. *Wirtschaft und Wirtschaftspolitik im wilhelminischen Deutschland. Organisierter Kapitalismus und Interventionsstaat*? Stuttgart: Klett-Cotta, 1978.

Hertner, Peter. "Foreign Direct Investment in Chile and Local Public Utilities: Electric Tramways and the First Electrical Power Plants in Santiago de Chile and Valparaiso between 1898 and 1920." In *Chile y América en su Historia Económica*, edited by Asociación Chilena de Historia Económica, 89–100. Valparaíso: El Mercurio de Valparaíso Impresores, 2013.

Hochbahngesellschaft Berlin, ed. *Die Hoch- und Untergrundbahn vom Spittelmarkt über Alexanderplatz nach Schönhauser Allee (Nordring)*. Commemorative publication for the opening of the subway line, Berlin 1913. http://www.u-bahn-archiv.de/dokumente/1913_hochbahn.html.

Hoppe, Joseph, and Nico Kupfer, eds. *Charlottenburg Moabit. Berliner Industriekultur—Die Metropole neu entdecken*. Berliner Schriften zur Industriekultur, edited by BZI, vol. 3. Berlin: Ammian-Verlag, 2022.

Hoppe, Joseph, and Nico Kupfer, eds. *Spandau Siemensstadt. Berliner Industriekultur—Die Metropole neu entdecken*. Berliner Schriften zur Industriekultur, edited by BZI, vol. 1. Berlin: Ammian-Verlag, 2021.

Hoppe, Joseph, and Nico Kupfer, eds. *Treptow-Köpenick. Berliner Industriekultur—Die Metropole neu entdecken*. Berliner Schriften zur Industriekultur, edited by BZI, vol. 2. Berlin: Ammian-Verlag, 2021.

Hughes, Thomas Parke. "The Evolution of Large Technological Systems." In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, edited by Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, 51–82. Cambridge, MA: MIT Press, 1989.

Jaeger, Hans. *Geschichte der Wirtschaftsordnung in Deutschland*. Frankfurt am Main: Suhrkamp, 1988.

Loscertales, Javier. *Deutsche Investitionen in Spanien 1870–1920*. Stuttgart: Franz Steiner Verlag, 2002.

Mayntz, Renate, and Thomas P. Hughes, eds. *The Development of Large Technical Systems*. Publications of the Max Planck Institute for Social Research 2. Frankfurt am Main: Campus-Verlag, 1988.

Montaño, Diana J. *Electrifying Mexico: Technology and the Transformation of a Modern City*. Austin: University of Texas Press, 2021.

Mohsin, Anto. *Electrifying Indonesia: Technology and Social Justice in National Development*. Madison: University of Wisconsin Press, 2023.

Municipalidad de Santiago. *Boletín de actas y documentos de la Ilustre Municipalidad de Santiago. Tomo Duodécimo. Del 1° de Julio al 31 de Diciembre de 1900*. Santiago de Chile: Imprenta, Litografía y Encuadernación Barcelona, 1900.

Municipalidad de Valparaíso. *Recopilación de leyes, ordenanzas, reglamentos y demás disposiciones vijentes en el territorio municipal de Valparaíso*. Valparaíso: Babra, 1902. (Includes the calls for tenders for electric lighting on pp. 995–98 and for electric traction on pp. 998–1010, agreed to at the extraordinary municipal session of January 17, 1902.)

Noth, Ernst Erich. *Die Mietskaserne*. Frankfurt am Main: Societäts-Verlag, 1931.

Pohl, Manfred. *Emil Rathenau und die AEG*. Mainz: v. Hase & Koehler Verlag, 1988.

Poling, Kristin. "Shantytowns and Pioneers beyond the City Wall: Berlin's Urban Frontier in the Nineteenth Century." *Central European History*. 47:2 (2014): 245–74. doi.org/10.1017/S0008938914001241.

Reitmayer, Morten. *Bankiers im Kaiserreich: Sozialprofil und Habitus der deutschen Hochfinanz*. Göttingen: Vandenhoeck & Ruprecht, 1999. https://mdz-nbn-resolving.de/bsb00040358.

Robinson Wright, Marie. *The Republic of Chile: The Growth, Resources and Industri-*

al Conditions of a Great Nation. Philadelphia: G. Barrie & Sons; London: C. D. Cazenove & Son, 1904.

Seidenzahl, Fritz. "Die Anfänge der Deutsch-Ueberseeischen Elektricitäts-Gesellschaft." In *Beiträge zu Wirtschafts- und Währungsfragen und zur Bankgeschichte*, edited by Manfred Pohl, vol. 7, 169–75. Mainz, Germany: v. Hase & Koehler, 1984. (First published in 1968.)

Steiner, Marion. "'El fantasma de la fuerza motriz del agua': Emil Rathenau y sus redes eléctricas en Chile y España." In *La electricidad y el territorio. Historia y futuro*, edited by Miriam H. Zaar, Magno Vasconcelos P. Junior, and Horacio Capel. Barcelona: Universitat de Barcelona-Geocrítica, 2017. http://www.ub.edu/geocrit/Electr-y-territorio/Electr-y-territorio-Portada.htm.

Steiner, Marion. *Die chilenische Steckdose. Kleine Weltgeschichte der deutschen Elektrifizierung von Valparaíso und Santiago, 1880–1920.* 2 vols. Weimar: Bauhaus Universität Weimar, 2019. doi.org/10.25643/bauhaus-universitaet.3925.

Steiner, Marion. "Strom für die Welt: Wie die Elektropolis Berlin den Weltmarkt eroberte. Das Beispiel der chilenischen Steckdose." In *Metropole Berlin. Die Wiederentdeckung der Industriekultur*, edited by Joseph Hoppe and Heike Oevermann, 131–45. Berlin: be.bra, 2020. Offprint available at www.patrimoniocritico.cl.

Steiner, Marion. "Reflexiones postcolonialistas acerca de la percepción de Berlín como ciudad modelo de la modernidad técnica." In *Historia, trauma, memoria*, edited by Cristobal Balbotin and Laura Rodríguez, 37–61. Santiago: Libros del amanecer, 2021. Offprint available at www.patrimoniocritico.cl.

Steiner, Marion, and Pamela Fuentes. *Luz para Valparaíso. El Complejo Hidroeléctrico El Sauce y La Luz. Un patrimonio industrial compartido entre Placilla de Peñuelas y la Elektrópolis Berlín*. Valparaíso: Centro Cultural Placilla, 2021.

Stiftung Bahn Sozialwerk, ed. *"Große Elektrisierung" 1928–1929. Stadt-, Ring- und Vorortbahnen in Berlin. 80 Jahre S-Bahnstromwerk Berlin Ostkreuz*. Berlin: Stiftung Bahn Sozialwerk, 2008.

Tornero, Carlos, ed. *Chile: Descripción física, política, social, industrial y comercial de la República de Chile*. Santiago: Librería C. Tornero y Cía., 1903.