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Power failure: the electrification of Central-Eastern Europe, 1918–39

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ABSTRACT

The authors argue that the new states of Central-Eastern Europe after 1918 faced a tension between investing in emerging network technologies (such as electricity) and safeguarding their newly gained national sovereignty against foreign influence. This can be seen as a dilemma between energy equity and energy security, which was present elsewhere as well, but particularly important in the region for three reasons. First, the new borders increased the need for new infrastructure to connect locations with energy resources (especially coal and water) to the centres of demand. Second, the region faced a shortage of capital and relied more than other parts of Europe on foreign direct investment. Third, the region was dependent on foreign technology and affected by cartel agreements between the leading foreign companies. Based on new data on the production and consumption of electrical energy across the region, the authors argue that this dilemma impeded the electrification of the region.

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1. Introduction

One major consequence of the First World War was the formation of several new states in Central-Eastern Europe on the territory of the former German, Habsburg and Russian empires, namely Austria, Czechoslovakia, Hungary and Poland. These states did not form a homogeneous group but their economies shared some features marking a contrast to Western Europe. At the beginning of the war, the standard of living was on average significantly below that of Western Europe and this gap was widening during the interwar period. In the 1920s all four states showed very notable regional variations in living standards and economic development, with some dynamic city regions at par with Western Europe and remote regions hardly touched even by nineteenth-century technology.

In their new political borders, these states also faced a mismatch in infrastructure. Generally, the capital regions were poorly connected to their hinterland as a consequence of their history as parts of larger empires.¹ They needed new infrastructure to connect locations with energy resources (especially coal and water) to the centres of demand. For example, Poland had gained parts of coal-rich Upper Silesia but lacked an infrastructure that would connect the

region to the capital, other industrial centres or a Polish port. Czechoslovakia had inherited resource-rich regions (Bohemia, Silesia), which needed to be connected to the more backward parts of the new state (Slovakia). Among the few energy resources in Hungary was the water power of the Danube, the use of which required cooperation with Czechoslovakia.

However, all these states clearly had enormous potential for development that increased further after 1918. Already from the 1860s onwards and in line with the rest of Europe they had experienced a boom in the formation of 'civil society' reflected in the foundation of many associations, cooperatives and societies for charitable, cultural, economic and political purposes.² The rates of school enrollment, the number of technical schools and universities and with them the numbers of students increased significantly after 1918, especially in Poland where the educational system had been restricted under German and Russian dominance.³ Bas van Leeuwen and Peter Földvári show in a careful study how the stock of human capital increased after 1920.⁴ During the 1920s we can also see a modernization of institutional systems, for example the formation of national statistical offices in Czechoslovakia and Poland or the creation of largely independent central banks in all four states.⁵ While large parts of the region were still dominated by agriculture, there existed since the mid-nineteenth century several industrial districts not only in Austria, the Czech part of Czechoslovakia with the Skoda works in western Bohemia, the Bata works in Moravia or the mining and heavy industries in Upper Silesia, but also in major cities such as Warsaw (for example, the huge plants of Lilpop, Rau and Lowenstein), Poznan (for example, Cegielski SA) or Budapest (for example, Ganz & Co. or Tungsram). At least in some product markets these industries produced at high technical and managerial standards and were considered by Western contemporaries to be serious local and even international competitors.

So why was the economic performance of Central-Eastern Europe so disappointing during this period? Similar to Europe at large a major role can be attributed to political instability and tensions that inhibited development. More specifically, we focus in this paper on the question of how domestic and international political tensions affected the adoption of a new large-scale technology – electrification. Our main contribution to the literature is twofold. First, we add to the large and growing historiography of European infrastructure some new and hopefully useful data on Central-Eastern Europe. The studies by van der Vleuten and Kaijser, Lagendijk or Hausmann are rich in detail for Western Europe but less so for countries like Poland, Hungary or Czechoslovakia.⁶ We collected new data on the progress of electrification in these countries that might help to complement our perspective on Europe. Second, we highlight the remarkable differences between and within these countries, ranging from strong industrial dynamics in the Czech lands to extremely backward agrarian areas in eastern Poland. We hope that this helps to gain a more nuanced perspective on the economic development of Central-Eastern Europe.

Markets struggled to provide the funds needed for the adoption of new network technologies and the related development of infrastructure, because of the size and long-term nature of these projects and due to the high uncertainty of future returns on investment in the region. Governments on the other hand not only had difficulties in attracting foreign capital,⁷ but also tried to limit possible dependencies on foreign investors and governments – in other words, they attempted to attract 'friendly' capital. They were reluctant to grant long-run concessions to private investors and (already in the 1920s) attempted to reduce the economic dependency on their neighbours. That is, for both private and government actors the new borders drawn across the region after 1918 became crucial. Albeit the new borders

had only a limited direct effect on trade flows, insofar as trade had already been fragmented along the same lines before the war,⁸ their effect on capital flows was much larger because the borders implied new risks to creditors and debtors alike. This limited investment and the potential to catch up in terms of technology with long-run effects on trade and growth. In this sense 'the national frontiers [were] a means of capitalistic sabotage'.⁹

We focus on the electrification of Central-Eastern Europe, because this was likely a precondition for aggregate productivity growth in the region. While the available evidence for the United States and other industrial economies suggests a considerable time lag between the diffusion of electricity and aggregate productivity,¹⁰ the lack of reliable energy at affordable prices clearly limited the establishment of new industries,¹¹ restricted productivity in agriculture,¹² and probably productivity in other sectors and impeded the accumulation of capital.¹³ In a recent and detailed study on the long-run effects of the Tennessee Valley Authority (TVA), Kline and Moretti find that the investment in local electrification had already had very substantial effects on productivity in the 1940s.¹⁴ Put differently, we argue that electrification was one of several necessary conditions for economic growth, but clearly not a sufficient condition. Electrification required the construction of power stations and the development of a high-voltage transmission network based on some common technical standard. The delay in electrification impeded the catch-up to Western Europe.

The remainder of this paper is organized as follows: we first outline the basic dilemma between equity and security with respect to the electrification of the region. After this we briefly survey the economic situation of Central-Eastern Europe after 1918 and argue in more detail how electrification was affected by security concerns, which emerged after the war. Next, we describe the process of electrification in the region between 1913 and 1939 based on a new dataset on installed capacities and electricity production in the region and compare this to the development in Germany and the United Kingdom. Finally, we discuss some of the wider economic implications and conclude.

2. Development and electrification between concerns for security and equity

With the spread of industrialization, the availability of energy (notably coal) became an important policy issue. Before the Great War, the main policy objective was energy equity or affordability: the provision of energy at affordable prices to as many members of society as possible. With the war, energy security started to be in the focus. Access to coal, oil and gas started to matter for military success more than ever before.¹⁵ More importantly, with the spread of motorization and electrification, the objective of energy equity required very substantial investment in infrastructure and agreement on legal and technical standards.

In case of electrification, the technological challenge was twofold. First, a substantial reduction of transmission loss was necessary to make use of distant, rich energy sources in production – making the increasing efficiency of energy generation technology unfold and making up for the fact that storage technology was considerably lagging behind.¹⁶ Second, a wide range of electrical devices for production, consumption, transport and communication had to be developed. The construction of large regional networks using different energy sources and serving enough customers with different types of demand could even out daily and seasonal changes in energy demand reducing the costs of building and operating the system. The construction of such large regional or national networks required

the cooperation of producers of electrical equipment and financiers but also a set of legal regulations to balance the interests between financiers, producers, consumers and the state. Access to up-to date technology and substantial capital was further controlled by a global oligopoly of large manufacturers, organized through vertical and horizontal agreement.¹⁷ They financed the construction of power plants and the electrification of tramways, too, creating in this way their own market.¹⁸ The main advantage of these powerful international holdings was their expertise concerning the management of the financial, technical and legal complexity of building and operating large electricity-supply networks. But this network character of the new technology required technical and legal standards as well as financial cooperation, which put limits on national sovereignty. Governments, especially in small and late-industrializing economies were forced to cooperate with foreign producers and financiers as well as with their neighbours to an extent that was unseen before.

While all this was true in most parts of the developed world, the issue of energy security as a constraint to affordability gained sudden importance for the new sovereign states of Central-Eastern Europe after 1918. The new states that had just regained political sovereignty after the war faced the combined challenge of securing their territories and simultaneously fostering their economic development. This involved three main problems, which we will consider in more detail later in this article. First, a legal framework had to be developed that would allow the adoption of new technologies and provide legal security and technological standards. Second, the technical possibilities to provide affordable energy (notably from water and coal) had to be balanced against the political risk of a dependency on the resources of foreign states. The considerable regional differences within the states of Central-Eastern Europe, with islands of development within large backward areas intensified the challenge to provide energy equity. Third, the incentives to attract the necessary foreign capital to the region had to be weighed against the risk of losing control over strategic infrastructure to foreign investors. We argue that this dilemma – arising from a combination of technological and political changes after 1918 – was incompletely solved in the region and delayed the electrification of Central-Eastern Europe.

3. Dilemma of electrification: legal prerequisites, border disputes and dependence on foreign capital in times of technological change

3.1. Technology adoption as a prerequisite for development

After the First World War and the subsequent dissolution of the Habsburg, Russian and Ottoman Empires a handful of new states emerged in Central-Eastern Europe: notably Czechoslovakia, Hungary, Poland and the Baltic states. The formation of these states was the result of decades of struggle for political sovereignty related to high hopes that the new scope for political decision-making would improve the living standard of the people and eventually catch up to Western Europe. But these hopes were disappointed. Figure 1 gives as a general background some estimates of gross domestic product (GDP) per capita in Austria, Czechoslovakia, Hungary and Poland in interwar borders, expressed relative to the average of Germany and the UK (in interwar borders), 1913–37.

We see that none of these countries managed to close the gap with Western Europe during the interwar years. With a look at the dismal performance of several states before 1945, Svernilson emphasized the importance of ‘technical congruence’ for economic growth.¹⁹

Figure 1. GDP per capita (in 1990 International Dollars), relative to German and UK averages. Source: Broadberry and Klein ("Aggregate and Per Capita GDP in Europe, 1870–2000"); all data refer to interwar borders.

This is also supported by van Leeuwen and Földvári, who find that technical efficiency is indeed an important factor to explain long-run growth differences between Central-Eastern Europe and Western Europe.²⁰ In this paper we want to highlight the role for a legal framework and cross-border cooperation for the adoption of a large-scale network technology – electrification – as a prerequisite for economic development.

It is important to stress that, while all countries faced similar challenges, the situation differed between them. In a study for the Second World Power Conference, Hungarian engineer Ernő Haidegger calculated 'energy balance sheets' for various European states, comparing their total energy production with current energy demand and the resulting shortfall or surplus. Table 1 shows the energy balance sheets for Germany, Poland, Czechoslovakia, Austria and Hungary, reflecting the situation around 1926. As can be seen, Austria and Hungary have a calculatory deficit, while Germany, Poland and Czechoslovakia all have a surplus of production exceeding demand. This in itself clearly suggests that political cooperation should have been beneficial. However, if we use the level of energy demand per capita in Germany as of 1926 as a benchmark to which other economies might converge over time (and which indeed they quickly surpassed after 1945), the overall shortage of energy production becomes visible (Table 1, last column). To close this gap, large-scale investment

Table 1. Energy balance sheets of Central European countries (c. 1926).

	Demand in 10 ¹² kcal, 1926 (in brackets: per mio. population)	Production in 10 ¹² kcal, 1926	Shortage in %, 1926	Counterfactual shortage (with 1926 German per capita level of demand as counterfactual)
Germany	1261.81 (19.9)	1572.40	–45.36	–
Poland	155.06 (5.4)	271.12	–64.25	52.9
Czechoslovakia	156.33 (11.0)	178.46	–14.15	36.7
Austria	62.58 (9.5)	25.22	59.70	80.8
Hungary	44.27 (5.4)	26.57	40.00	83.8

Sources: Haidegger ('Die Energiebilanz und ihre Gestaltung in den Staaten Mitteleuropas – Bericht Nr. 386') and own.

and energy trade (either in the form of the coal trade or the electricity trade) was needed. The main question here is why it took these countries so long to generate this investment.

The new borders caused a main shift in the energy sources leaving Czechoslovakia and Poland with abundant coalmines, but leading to debates about the economic viability of the new small countries Austria and Hungary. In all the countries plans were elaborated to build a power grid serving the needs of the spatially restructured economies but progress in realizing them was very uneven.

3.2. Energy resources and legal prerequisites for electrification

3.2.1. Czechoslovakia

Czechoslovakia, which inherited the richest coal basins of the Austro-Hungarian Monarchy, had already issued a law about systematic electrification in 1919. This swift legislative act can be explained by the fact that the Moravian and Bohemian Landtage (Parliaments) paid much attention to the question of systematic electrification well before the outbreak of the First World War: in 1905, Frantisek Krizik, pioneer of the Czechoslovakian electro-technical industry, had already presented to the Bohemian Landtag his plan for systematic electrification. In 1913, the Moravian Landtag sent a group of representatives and engineers to study the organization of public and private electric energy supply in Germany and received their draft of the organization of the public electric energy supply in 1914. These Landtage had been very well aware of the potential of systematic electrification for deepening market integration and underpinning their struggle for economic autonomy, which explains why in 1909 and 1914 they refused plans for a systematic electrification of Cisleithania.²¹ The electrification law from 1919 directly made use of the draft from 1913. That law aimed at exploiting all the energy resources of the country to gradually construct an electricity supply system for the entire national territory along common technical standards ('systematic electrification'). That law also ensured that the state gained full control over the course of electrification.

Such systematic electrification was declared to be of utmost public interest; regional authorities were to respect such interests in case of issuing territorial concessions. Not only did the development of electrification in Western Europe explain that turn of public attention towards systematic electrification. Due to the huge demand of war on manpower and the demonstrated strategic importance of a reliable, affordable and independently controlled energy supply, electricity became part of basic infrastructure, a necessary means of everyday life and of international competitiveness.²² Government support to systematic electrification manifested itself on the one hand in the form of legislative measures to rule out legal and technical obstacles to setting up a unified network.

On the other hand, direct financial participation of the central government (and of regional authorities) in the public power supply companies demonstrated the political importance of the electrification issue. The government also guaranteed the return on investment in case of obligations issued by these public power-supply companies, which considerably reduced private costs of investment. In consequence, installed capacity grew substantially quicker in the case of power-supply companies in mixed public-private ownership (1920: 209.198 kVA, 1928: 510.255 kVA, 1933: 851.914 kVA) than in industrial plants (718.506 kVA, 1,188.957 kVA and 1,406.047 kVA respectively). Thus, while installed capacity only doubled in case of industrial plants, public-supply companies succeeded in

raising installed capacity fourfold. However, this investment into public-supply companies did not reduce the regional differences in electricity supply. The progress in the Czech lands, Moravia and Silesia was much quicker than in Slovakia and Pod-Carpathia. The sharp rise of total national installed capacity in the early 1930s (Figure 2) is largely explained by the increasing capacity of public companies in the former regions.

Furthermore, due to state financial support, rural electrification made significant progress in Czechoslovakia, though regional differences remained very articulated here, too. Already in 1930, 37.1% of agricultural plants (Betriebe) had electricity in the Czech lands, 25.6% in Moravia & Silesia, 1.8% in Slovakia and 0.13% in Pod-Carpathia, adding to a total of 19.5% of the agricultural plants in Czechoslovakia.²³

Due to the higher initial costs of water-power plants, the relatively small quantity of usable energy from this source (around 6 billion kWh/year of exploitable water power from mainly small streams), and the interests of the powerful coalmines, the emerging national grid was based on coal. Though the importance of rural electrification was already recognized in 1919, it was only in the late 1920s that the government increased its support for the exploitation of water power also as a means to set economic growth in Slovakia and Pod-Carpathia in motion.²⁴

3.2.2. *Poland*

Similar to Czechoslovakia, Poland quickly recognized the potential of systematic electrification for furthering the economic integration of territories that formerly belonged to different empires and strengthening the economic sovereignty of the new state. Legislative activity was prompt enough to set the course for state-controlled electrification (a law was issued on 21 March 1922, a by-law to its execution, 20 May 1933). One beneficial consequence of legislation was a relative uniformity of the system. In 1929, among the 56 power centres with a capacity over 5000 kW, only one used direct current.²⁵ The slower progress of electrification in Poland in contrast to Czechoslovakia was a consequence of the political instability of the early 1920s, the considerably lower level of industrialization, and the financial constraints on public investment into the supply grid. It was only after the stabilization of the currency in 1927 that substantial, notably American, foreign capital could – at least temporarily – be attracted, as we argue below. Due to high initial costs of water-power generation (regulating rivers, building dams), it was only in the late 1920s when substantial public investment into the exploitation of Poland's water power was put on the political agenda, and subsequent legislation (1933) attempted to encourage the exploitation of water and other types of energy sources. The Great Depression limited these activities, before a state-led investment programme (1937–41) inspired by Roosevelt's Tennessee Valley Authority (TVA) led to the construction of some notable power centres, for example at Roznow and Czechow on the Dunajec.²⁶

3.2.3. *Austria*

The most fundamental change of energy supply took place in Austria, which provides an interesting contrast. Initially, the loss of access to the coal resources in Silesia and Northern Bohemia was seen as proof of the impossible independent existence of the Austrian crown lands. Water power, 'the white coal', paved the way to overcoming fears for the economic viability of the country, to reduce its dependency on foreign coal: 'It became a matter of faith for all political parties that Austria could only be saved by electrification.'²⁷ The building of

Figure 2. Installed capacity (KWh) per capita, 1913/14–1938. Sources: Czechoslovakia: Statistika Elektrén v republice ceskoslovesnké za léta 1913 a 1919 az 1928. / Statistique des centrales électriques dans la république tchécoslovaque pour les années 1913 a 1919 à 1928 (Prague: Vydal státní úřad staistický, 1932); Statistisches Jahrbuch der Čechischen Republik (Prague: Statistisches Bundesamt, 1935), 73; Annuaire statistique de la république Tchécoslovaque (Prague: Office de la Statistique de la République Tchécoslovaque/Orbis, Prague, 1938), 61; Hungary: Statistical Yearbook of the World Power Conference No. 1, 1933 & 1934 (London, 1936), 96–7, 108–9; E. Haidegger, “A magyar energiagazdaság időszerű kérdései,” in Gy. Feyér, ed., *A magyar gazdasági élet műszaki teendői: A Magyar Mérnök- és építészegylet 75 éves fennállása fordulóján tartott előadássorozat* (Budapest: Centrum, 1942), 223. Poland: Pilatowicz, “Rozwoj elektryfikacji w Polsce Miedzywojennej,” 16 (see Table 3b); Statistical Yearbook of the World Power Conference No. 1, 1933 & 1934 (London, 1936), 96–7, 108–9. Austria, Germany, UK: Statistical Yearbook of the World Power Conference No. 1, 1933 & 1934 (London, 1936), 96–7, 108–9; Statistical Yearbook of the World Power Conference No. 4. Data on Resources and Annual Statistics for 1936–1946 (London: WPC Publ. Central Office, 1948), 160–1, 192–3.

water-power plants, promoted by tax relief, guarantees for return on investment, administrative measures (laws issued in 1921, 1925, 1928, 1929) and to some extent by direct public investment, too (for example, 80 million Schilling of the stabilization loan) went hand in hand with the electrification of the railways. During the interwar years a nearly complete shift towards electricity generation from water took place (1920: 51%; 1937: 82%). An important difference to other states in the region was Austria’s increasing integration with Germany: already from 1925 onwards increasing quantities of electricity could be exported to nearby Southern Germany.²⁸ Not least, this development was also due to the commercial interests of large German electricity firms. These did meet some political resistance in Austria as well, but the joint economic interests proved stronger.²⁹

3.2.4. Hungary

In contrast to the early efforts of the neighbouring countries to provide a stable legal framework for systematic electrification, and despite the existence of bills for the regulation of electrification in wartime plans for building a national supply network,³⁰ Hungary had not issued a law about electrification before 1931 (1931: XVI). Only the conditions for import and transport of different types of fuel were regulated.³¹ During the war and the immediate post-war years, the government had focused on a reduction of the consumption of coal instead of legislating electrification.³² Potential investors were said to have been reluctant

to invest larger sums without granting them monopoly rights for the electricity supply of specific regions and without limits to towns' and individuals' property rights in order to build the high-voltage network. In the absence of technical and economic control by the government a patchwork of town power centres and supply networks emerged by the late 1920s.

Furthermore, cartel agreements among the largest electro-technical producers and electricity-supply companies ensured high profits to these market participants. In contrast, each municipality negotiated on its own, and had to bear a larger share of costs and risks.³³ Due to this asymmetry, the supply of electricity had become one of the few branches in post-war Hungary that yielded low but steady returns for business. That in turn made investors determined to lobby against any national legislation that would have given the government strong control rights.³⁴

Another issue was technical standardization. Town and county supply systems were built by Hungarian and foreign, mostly German, companies, using different voltages and machinery not being able to communicate with each other, often leading cables parallel to each other and leaving other towns aside, and so on.³⁵ In the absence of technical standards, the Hungarian electro-technical industry could not reach a viable output either, as its Czech counterpart did. The prices for machinery remained high in comparison to Germany,³⁶ while regional price differences remained considerable. Obviously, the large consumption of the capital city and the high efficiency of the large power centres supplying it allowed for taking the lead in both price reduction and introducing tariffs tailored to specific consumer groups. Hence, Hungary experienced the very opposite of a systematic electrification in the 1920s.

By the mid-1930s, then, the government was expected to finally embark on rural electrification as there was no realistic hope for the private sector's investment after they had cherry-picked the supply of larger towns and industrial centres. Private investors criticized the authorities' practice of granting concessions, the absence of specific regulations and especially the stipulations of the 1931 law, which only further impeded private investment in the power grid. The electrification law did nothing to mend the problems hindering private investment except for regulating the property rights of supply cables and allowing these to use the shortest connecting lines possible. However, the authorities could refuse to lay cables along roads on state or municipal property. But using private property for that purpose raised costs significantly and required more time. Also, maintenance costs skyrocketed due to the inaccessibility of many sections of the power grid. Municipal concessions had to be negotiated among investors and a large number of public stakeholders, which again raised costs. Moreover, in 1931 the Ministry of Trade declared all previous and future municipal concessions that were exclusive unlawful. This decision would have made previous business plans nearly useless in the case of the presence of a sufficient number of investors ready to compete; therefore, electric-supply companies rather criticized cutting back on previous entitlements in general. The Association of Hungarian Power Centres argued that the law focused on sanctions for legal violations, made administrative and bureaucratic obligations of supply companies more burdensome and reduced their freedom of price fixing.³⁷ Hence, the electrification law failed to bring down costs, since it did nothing to unify regulations for municipal concessions and to reduce bureaucracy, nor did it substantially alleviate private investment. During the Great Depression, private investment in the power grid actually decreased much more than public investment. In 1929, public investment amounted to 41.6 million Pengő; it fell to 16.2 in 1931 and no more than 9.3 in 1932. Private investment in turn fell from 12.6 million Pengő in 1929 to 11.7 in 1931 and a mere 2.7 in 1932.³⁸

3.3. *Dependence on foreign investment: security concerns*

Thus, the provision of a suitable legal framework on a national scale was a first prerequisite for successfully adopting the new technology in Central-Eastern Europe. Another important aspect was to what extent a technically efficient solution was considered a threat to national security. Concerns over the national security of energy supply manifested themselves in the region mainly in attempts to avoid dependence from German capital on the one hand, and to reduce intraregional dependencies on the delivery or joint exploitation of energy sources on the other.

Consider the first aspect: substantial investments into a planned Polish national supply grid took place shortly after winning Northern Silesia by disconnecting its thermal power stations from German territories and connecting them to the Polish central region. Reducing the German hold on the Czechoslovak power supply, especially in Silesia, Bohemia and Moravia, became in Czechoslovakia a goal of systematic electrification equally as important as ensuring an affordable electricity supply for the entire state. In order to protect the economic independence of Czechoslovakia from both the potentially greater loyalty of German citizens towards Berlin than Prague and from the threat that German electro-technical producers like AEG, Siemens and their joint ventures operating in Czechoslovakia might have represented, the government in Prague was eager to centralize control over the national energy supply.³⁹ Dimmer financial prospects – in contrast to public power-supply companies – must have, in turn, reduced the willingness of the German public-private electricity supply undertakings to share their pre-war experiences with building regional electricity-supply networks.

In what way may fears from German capital have delayed electrification in the region? After a short post-war competition between Great Britain and France for political and economic hegemony in the Danube region all parties concerned realized that this region was not a priority for any of these European Great Powers. They were not ready to provide substantial investment capital to help Central-Eastern European countries restructure their economies and set their economic growth in motion.⁴⁰ Several British and French industrialists hoping for political support to take over German market positions gradually withdrew from this region in the middle of the 1920s such as Vickers.⁴¹ That left the terrain to German industry and capital, which was recovering from the consequences of the war, reparations and hyperinflation. By 1929 the German electro-technical producers had come to an agreement with their most important competitors, General Electric and Westinghouse, about dividing the world market. According to this agreement Central-Eastern Europe was declared to be mostly German territory. Hence, security concerns about substantial German influence were not unjustified and they mattered for the further course of electrification. Let us consider some more detailed evidence from Poland and Hungary on this.

3.3.1. *Evidence from Poland*

The failed attempt of the American investor William A. Harriman to realize a large-scale systematic electrification project in Poland in 1929 is a telling example. Harriman had been active in the Polish zinc industry since 1925 and in 1927 entered Bank Handlowy in Warsaw, the largest private bank in the country.⁴² In January 1929 Harriman filed a formal request for far-reaching and exclusive concessions in exchange for a US\$100 million investment in the electrification of the country.⁴³ The Polish government was initially keen on this proposal,

given the dramatic shortage of capital and the prospect to gain a reduction in the price of electricity by up to 25% in some parts of the country.⁴⁴ However, the publication of this offer in May 1929 was followed by a heated public debate that centred on two main points: first, while some technical experts were fascinated by the proposed systematic approach, others argued that the conditions of Harriman's offer were unfavourable for the Polish state. Second, the political opposition and increasingly the government itself were worried about foreign influence over Poland's energy resources. These concerns grew after Harriman had founded in mid-1929 in cooperation with the German Flick group the Consolidated Silesian Steel Corporation, which controlled about 50% of Polish iron and 20% of Polish coal resources.⁴⁵ An internal report by A. Woytkiewicz, financial advisor at the Polish Embassy in Washington, dated from early September 1929, warned against Harriman's complex network of financial and political interests, which might harm Poland's independence.⁴⁶ Harriman's offer was finally turned down, also due to warnings from military intelligence.⁴⁷ The next plan for a systematic electrification of the country – this time fully state-sponsored – was designed by Eugeniusz Kwiatkowski as part of the formation of the Central Industrial District, but it could not be implemented before Germany's attack on the country in 1939.

3.3.2. Evidence from Hungary

The fact that the largest single water-power source of Hungary, the Danube, was ultimately not used for power generation is an example of the lack of intraregional political trust and its consequent long-term material losses. Due to high intraregional political tensions, no country wished to be dependent on their neighbour's energy sources.⁴⁸ Czechoslovakia, heiress of the richest coalmines of the Austro-Hungarian Empire and abundant in water power did not meaningfully participate in the electricity trade despite many technologically sensible and viable options.⁴⁹ Not using the abundant water power of the Danube caused financial losses for many private companies⁵⁰ and led to the quicker extraction of the coal resources of Hungary (and those of Czechoslovakia, too) the amount of which was seen at the time to be sufficient for at most 100 years.⁵¹

Related concerns about the long-term economic viability of Hungary, however, certainly fuelled public and private investment into making use of the remaining low-quality brown coal and peat mines, establishing the first pillars of the post-1945 national power grid.⁵² and, ultimately, into the development of diesel traction.⁵³ In both these cases, the debate on Harriman's offer in Poland and the missed opportunity to use the power of the Danube, we observe that attempts to improve access to affordable energy were limited by concerns for energy security (and more broadly national sovereignty).

In Hungary we see yet another dimension of this tension at work – a trade-off between local and short-term benefits from electrification versus government control. The dire state of Hungarian public finances made concerns over affordability a powerful argument to the opponents of central control: because of the urgent need for large capital investment into the electricity supply system of the country, domestic and foreign private investors were, as they said, not to be alienated by too tight a regulation.⁵⁴ The parliamentary debates in 1930–31 about the bill for the law on systematic electrification reveal a clear recognition of its economic potential especially for the remote agricultural regions of the country. However, because private investors, most of all the leading commercial banks, were eager to keep one of the very few profitable investment opportunities reserved for private capital, legislative action and public investment was further delayed.

The government's role for inducing a coordinated use of resources is exemplified by the construction of power centres in Hungarian rural towns. During the 1920s, many large municipalities financed the construction of power centres through loans provided by the American Speyer Bank. These loans were issued in 1926 (US\$10 million) and 1927 (US\$6 million); only 8% of the first US\$10 million was used for electrification.⁵⁵ The Hungarian government acted as a mediator.⁵⁶ Instead of concentrating the use of that expensive capital, local power centres were built serving local demand with very little hope for economies of scale and a reduction of consumer prices. Not surprisingly, provincial power centres suffered more from the stagnation after the Great Depression. While electricity generation in Budapest for motive power more than doubled in 1927–36 (279% of the 1927 level), the provincial power centres did not even reach pre-crisis levels by 1936. Electricity generation for lighting grew much quicker in the provincial towns, reaching 159% of the 1927 level, which indicated the construction of municipal supply grids during the Great Depression.⁵⁷

While the main concern of parliamentary debates during the interwar era was certainly on the question of attracting foreign capital, the security issue figured prominently. One reaction of the Hungarian government to the territorial changes after the First World War provides an early example of serious, though late realized, concerns about foreign control over key infrastructure. The government tried to win over France to modify the territorial stipulations of the Peace Treaty by allowing French capital to take over a major part of one of the largest Hungarian commercial banks, the Hungarian General Credit Bank, which had a substantial interest in key industrial enterprises. Moreover, the government mortgaged the State Railways and built an international port at the Danube financed completely by Hungary, but transferring 50% of the operating company's capital into French ownership. France was mainly interested in preserving the Versailles peace system and finally withdrew from the Danube Basin. While negotiations with France gradually revealed different interests, the opposition to foreign control over key elements of infrastructure grew and fears from foreign capital endangering Hungary's economic autonomy were articulated. The Hungarian government finally took over controlling ownership over these key elements of basic infrastructure.⁵⁸ More generally, in parallel to the case of Poland, there was an increased concern from the mid-1920s onwards that foreign countries might exert hostile influence in Hungary via large financial groups.⁵⁹ Security was much less an issue in the case of countries with similar interests as to the territorial stipulations of the peace treaties. Not security concerns, but financial constraints and reduced demand thwarted plans for electricity trade between Austria and Hungary during the Great Depression (Miksa, "Kereskedelmi miniszter a villamosításról"). As far as German capital was concerned, fears for the economic autonomy of Hungary were first articulated after the Anschluss.

3.3.3. Comparing Hungary and Poland

A comparison between Hungary and Poland, two countries characterized by a similar degree of capital scarcity, reveals similarities but also an interesting difference. The programme of the electrification policy of the Polish Government had been directed towards ensuring uniformity of the concessions for the generation and distribution of electric energy from 1922 on. Power plants, except for their parts that had not yet been depreciated by the expiry of the concession, gratuitously became the property of the State.⁶⁰ In

Hungary, however, the state only acquired the right to buy such power plants with the law of 1931. In short, while the Polish legislation ultimately aimed for government control and ownership of the electricity-supply network, the Hungarian law, which finally was to set unified terms for private participation and governmental support for the electrification, gave priority to the promotion of the 'spirit of enterprise', as it was said, in order to attract much-needed private capital; state intervention was confined to superintendence and supervision.⁶¹

The result was similar in both countries: in the case of Poland, the state's attempt to stay in control limited foreign investment, while in Hungary a weak central state delayed the emergence of legal and technological standards. This shows that it was the character of electrification as a network technology, which required large-scale investment, that led to an energy dilemma: affordable energy required a common framework. But for capital-scarce countries, affordability came increasingly at the cost of energy security.

4. Power failure: the disappointing development of electrification after 1918

How did these debates around security and equity affect the actual process of electrification? The progress of electrification is demonstrated in Figures 2 and 3. Our database completed the scattered information provided by Etemad and Luciani, Mitchell and Svernilson with data from national archives and with material published by the World Power Conferences.^{62,63} The World Power Conferences became the most important platform for the scientific exchange of information and dissemination of ideas among engineers and government officials about the latest achievements in scientific and industrial research and different aspects of energy policy. Starting in 1924 in London, they were organized at regular intervals.

The capacity data shows that the level of electrification stayed far below that of their largest western neighbour, Germany. Only in the main industrial regions of Upper Silesia, and in the main industrial regions of the former Austro-Hungarian Monarchy, most of all in Bohemia and Moravia, were there regional power supply systems built before the war. The majority of the power centres in Poland and Hungary were of a very small scale, with a production capacity of around 50 kW. The private power centres of the main industrial enterprises and coalmines and the communal power centres of the main cities produced the bulk of the electricity generated.⁶⁴ During the interwar years, the installed capacity clearly grew in all the countries, but with considerable differences. As expected, the Czechoslovak development was most impressive but still lagged substantially behind that of Germany. The Hungarian and the Polish capacity installed grew from the same very low level to around 100 kWh, resp. 50 kW per capita at the end of the 1930s, or 40%, resp. 22% of the level of Germany.

A similar picture emerges from data on actual production. Compared to the fast growing German and British electricity output, Central-Eastern Europe showed sluggish development and was falling back. While the Czechoslovak electricity generation accelerated somewhat in the second half of the 1930s, production in Hungary and Poland basically stagnated. In Austria, the 1930s witnessed a growing concentration of production and enhancement of network efficiency. Furthermore, established capacities were used to their full potential after the Great Depression.

Table 2. The development of electrification in Czechoslovakia 1932–37.

		Towns and villages			Population		
		Total	Electrified		Total	In electrified towns and villages	
			Number	%		Number	%
Czechoslovakia							
Czech lands	1932	8392	5640	67.21	6,671,000	5,627,000	84.35
	1937	12,674	7715	60.9	7,109,376	6,243,602	87.8
Moravia & Silesia	1932	3325	2282	68.63	3,335,000	2,837,000	85.07
	1937	3828	2862	74.8	3,565,010	3,198,246	89.7
Slovakia	1932	3478	647	18.60	2,997,000	1,334,000	44.51
	1937	3529	830	23.5	3,329,793	1,690,844	50.8
Pod-Carpathia	1932	487	53	10.88	605,000	157,000	25.95
	1937	491	58	11.8	725,357	236,036	32.5
Total	1932	15,682	5498	54.98	13,608,000	9,955,000	78.16
	1937	20,522	11,465	55.9	14,729,536	11,368,728	77.2

Source: Statistisches Jahrbuch der Tschechischen Republik (Prague: Statistisches Bundesamt, 1935), 88; Annuaire statistique de la république Tchécoslovaque (Prague: Office de la Statistique de la République Tchécoslovaque/Orbis, 1938), 83.

Moreover, this modest growth in electrification affected only cities and the few industrial regions. For example, within the central industrial regions in both Poland and Czechoslovakia, over 70% of the villages and towns had access to electrical power (Table 2).

In contrast, in remote rural areas like in the north-eastern part of Poland or the Carpathian region in Czechoslovakia, less than 10% had access to electrical power in the early 1930s. In practice, even that usually meant public lighting and not the connection of households and plants to a power-supply grid. The Hungarian data show a clear correlation between electrification and population density: By 1927 87% of towns with 10,000–25,000 inhabitants had some kind of electricity supply, in marked contrast to only 27% of towns with 2500 to 5000 inhabitants – down to a meager 12% in the case of villages with 1000 to 2500 inhabitants.⁶⁵ Pilatowicz gives a detailed account of the state of electrification of Poland in the late 1930s at the level of voivodships.⁶⁶ As shown in Tables 3a and 3b, he highlights two levels of regional differences, which were both substantial.

While nearly all Polish cities had access to the electricity grid in 1939, large parts of the countryside were still in the dark, with remarkable differences. In the eastern part of Poland, electricity had not yet arrived, while in western Poland, notably in Upper Silesia and Pomerania, a substantial portion of villages had electricity. This implies that by far the largest sector of the Polish economy, agriculture, was still mostly untouched by the new technology. Neither the investment funds of the Ministry of Agriculture nor that of the Ministry for Agrarian Reform provided credits for electrification in 1928 and 1929; only steam-powered machines worked in agriculture.⁶⁷ Similarly, in Czechoslovakia in the 1930s, electrification had made considerable progress in the more industrialized Czech lands, Moravia and Silesia, but lagged dramatically behind in Slovakia and the Carpathian region. However, compared to Poland, state financial support did succeed in advancing the new technology in agriculture. Already in 1930 37.1% of agricultural plants (Betriebe) had electricity in the Czech lands, 25.6% in Moravia & Silesia, 1.8% in Slovakia and 0.13% in Pod-Carpathia, adding to a total of 19.5% of the agricultural plants in Czechoslovakia.⁶⁸

Figure 3. Electricity production (KWh) per Capita, 1913/14–1938. Sources: Czechoslovakia: Statistická Příručka Republiky Československé IV, Nákladem Státního Úřadu Statistického (Prague, 1932), 141; M. Kubín Rozvoj energetiky v Československu. České energetické závody concern (Prague), 85, 90; Transactions of the 3rd World Power Conference, vol. II, p. 146; Statistischer Bericht für die Elektroindustrie International, Wirtschaftsgruppe Elektroindustrie (Berlin, 1935), 139; A villamosenergiatermelés alakulása Szovjetunióban és a népi demokráciákban és a főbb kapitalista országokban (1929–1954) [Development of power generation in the Soviet Union, in the Peoples' Republics and in the main capitalist countries]. (Budapest: KSH [National Statistical Office], 1955), 8. Hungary: Iván T Berend and György Ránki, *The European Periphery and Industrialization 1780–1914* (Cambridge: Cambridge University Press; Editions de la Maison des Sciences de l'Homme, Paris, 1982), p. 150; Kálmánné Németh and Balázs Lázár, "Az államosítás előtt működött villamosenergia-ipari és áramszolgáltató vállalatok repertórium," *A Magyar Országos Levéltár segédletei* 16. (Budapest, 2005), 8; Ernő Haidegger, "A magyar energiagazdaság időszzerű kérdései," in Gyula Feyér, ed., *A magyar gazdasági élet műszaki teendői: A Magyar Mérnök- és építészegylet 75 éves fennállása fordulóján tartott előadássorozat* (Budapest: Centrum, 1942), 213–32 (222); Ödön A Kerényi, ed., *Villamosenergia-ipari visszatekintő adatok 1925–1994* (Budapest: MVM, 1996), 72, 74. Poland: Pilatowicz, "Rozwoj elektryfikacji w Polsce Międzywojennej," 16. Austria: Die Elektrifizierung Österreichs [Austria electrified] (Vienna: Wasserkraft- und Elektrizitäts- Wirtschaftsamt/ Wirtschafts-Zeitungsverlags-GmbH, 1925), 76; Bundesamt für Statistik, *Statistisches Handbuch für den Bundesstaat Österreich Vol. XV* (Vienna: Druck und Verlag der Österreichischen Staatsdruckerei, 1935), 97. Germany: Statistischer Bericht für die Elektroindustrie Deutschland (Berlin: ZDEI, 1930), 284; Statistischer Bericht für die Elektroindustrie Deutschland (Berlin: Reichsgruppe Elektroindustrie, 1939), 165. 42066 MkWh in 1937 according to Frederick Brown, ed., *Statistical Yearbook of the World Power Conference No. 4. Data on Resources and Annual Statistics for 1936–1946* (London: WPC Publ. Central Office, 1948), 162–3, 194–5.

Table 4 illustrates a similar problem in Hungary. The table shows the time at which municipalities received access to electricity, distinguishing between seven classes of size. While all cities and larger towns had access to electricity by the early 1930s at the latest, nearly half of the remaining small municipalities remained without any sort of electric supply until the early 1950s.

Hence, electrification did make some progress in the region after 1918, but the gap with Western Europe, exemplified by Germany and the UK, grew and very large areas remained entirely untouched by the new technology.

Table 3a. Regional differences in electricity generation in Poland 1925–29 (Power centres with a generating capacity over 5000 kW).

Regions	Number of power centres	Production capacity (kW)	Production (million kWh)				
			1925	1926	1927	1928	1929
Poland	57	635,420	1297	1441	1742	1925	2355
Central vojvodships	19	131,570	242	263	327	415	550
Eastern vojvodships	–	–	–	–	–	–	–
Poznan and Pomorske	2	15,000	18	22	28	42	39
Silesia	26	403,510	916	1020	1219	11284	1555
Southern vojvodships	10	85,340	121	136	168	184	211
Industrial establishments	40	388,500	766	826	974	1083	1507
Municipal power centres	9	196,020	450	530	658	550	359
Regional power centres	8	50,900	81	85	110	292	489

Note: These power centres generated around 75% of Poland's total production.

Source: Rocznik Statystyki Rzeczypospolitej Polskiej 1930, 123.

Table 3b. Poland, regional differences within and across vojvodships, late 1930s.

	Share of population in cities with access to electricity in all cities (1939)	Share of population in villages with access to electricity in all villages (1936)
Central vojvodships	96.7	8.1
Eastern vojvodships	95.6	0.9
Western vojvodships	92.9	33.3
Southern vojvodships	92.1	6.5

Source: Jozef Pilatowicz, "Rozwoj elektryfikacji w Polsce Miedzywojennej" [Developpement de l'Electrification en Pologne pendant l'entre-deux-guerre], *Roczniki Dziejow Spoecznych i gospodarczych* 41 (1980): 15–42 (28, 34).

5. Conclusion and outlook

After the Great War several new sovereign states were established in Central-Eastern Europe following long struggles for political independence from Germany, the Habsburg Empire and Russia. One of the many challenges that the new states faced was electrification, and the need to create a suitable legal framework and mobilize sufficient financial resources for this emerging network technology.

Our new data showed that during the years 1913 until 1938 installed capacities and electricity production did not catch up but stayed far behind the levels in Germany and the UK. Moreover, we have shown that regional differences within Central-Eastern Europe stayed persistently high. The observed progress in terms of electrification was in fact limited to capitals and industrial regions but hardly touched the large sector of agriculture.

We argued that a dilemma between concerns for security on the one hand and equity on the other may have delayed the adoption of electrification in the region. The failure to use the water resources of the Danube in the case of Czechoslovakia and Hungary or the security concerns against American investment in Poland's electrification are examples of this tension. While clearly the uneven allocation of resources and the capital scarcity of the region would have made cooperation beneficial, concerns over security and safeguarding the newly gained national sovereignty against foreign influence hampered the adoption of new technology.

Table 4. The regional development of electrification in Hungary.

Inhabitants	Number of municipalities with electricity in 1950	Electric supply installed before ...											
		1921		1921–29		1930–38		1939–44		1945–50		Number	%
		Number	%	Number	%	Number	%	Number	%	Number	%		
0–500	168	1	0.6	55	32.7	33	19.6	22	13.1	57	34.0		
500–1000	362	12	3.2	92	25.4	89	24.6	48	13.3	121	33.5		
1001–2000	478	7	1.4	113	24.0	135	28.5	63	13.3	155	32.8		
2001–5000	486	28	5.7	150	30.9	143	29.5	29	5.9	136	28.0		
5001–10,000	141	29	20.6	63	44.7	18	12.8	6	4.2	25	17.0		
10,001–	53	23	43.4	26	49.1	4	7.5	–	–	–	–		
Together	1683	100	5.9	499	29.7	422	25.1	168	10.0	494	29.3		
Cities	53	45	84.9	8	15.1	–	–	–	–	–	–		
All together	1736	145	8.3	507	29.2	422	24.3	168	9.7	494	28.5		

Note: In 1929, there were 3437 municipalities in Hungary; in 1950, 3222. Source: Sándor Szalay, "A községek villannyal való ellátottsága" [Electric supply in municipalities]. *Statistikai Szemle* 5 (1951): 451–457 (455).

It would be worthwhile to analyze in more detail how the slow electrification affected economic development, especially to quantify the effect of electrification on labour productivity in a long-term perspective. While any such study is empirically challenging, recent work for other countries suggests that the effects may have indeed been very substantial. At least a few indications for this can be extracted from our dataset. First, as consumption of electricity from Hungarian rural power centres indicates, industrialization of rural areas was hampered by prices for electricity which remained high due to the absence of a coordinated use of financial and natural resources. Second, in the 1930s, more benefits of large network technologies such as electric grids could be drawn from raising efficiency than from extending the system. Hungary and Poland stayed far behind the concentration process of the power supply in Czechoslovakia and Austria. Our discussion of the legal framework for electrification highlighted the benefits of legal and technical standards. Standards motivated rationalization and specialization of producers of electric machinery in Austria and Czechoslovakia, while the lack of standards reduced the growth potential in Hungarian machine building and kept prices of electric machinery high. Hence, while we cannot prove it with our data, it is likely that late electrification hampered economic development more generally, and contributed to the broad inefficiencies that were found in other studies. We conclude that with the rise of new network technologies, the need for policy coordination within and across national borders increased, and so did the costs of national sovereignty.

Notes

1. Wolf, "1918 als Zäsur?"
2. Hoffmann, "Democracy and Associations."
3. Crayen and Baten, "Global Trends in Numeracy;" Roses and Wolf, "Aggregate Growth, 1913–1950."
4. van Leeuwen and Földvári, "Capital Accumulation and Growth."
5. Wandschneider, "Central Bank Independence."
6. van der Vleuten and Kaijser, *Networking Europe. Transnational Infrastructure*; Lagendijk, *Electrifying Europe*; Hausmann, *Global Electrification*.
7. Bordo, Edelstein, and Rockoff, "Was Adherence to the Gold Standard?"
8. Wolf, Heinemeyer, and Schulze, "On the Economic Consequences of the Peace."
9. Veblen, "The Passing of National Frontiers," 387.
10. Devine, "From Shafts to Wires;" Ristuccia and Solomou, "Electrical Power as a Case Study."
11. Carlton, "The Location and Employment Choices of New Firms."
12. Lewis and Severnini, "The Value of Rural Electricity."
13. Kander and Stern, "Economic Growth and the Transition."
14. Kline and Moretti, "Local Economic Development."
15. Eloranta and Harrison, "War and Disintegration, 1914–1950."
16. Ausschuß zur Untersuchung der Erzeugungs- und Absatzbedingungen der Deutschen Wirtschaft, *Die deutsche Elektrizitätswirtschaft*, 16; Petersen, "Technische und wirtschaftliche Entwicklung der Elektrizitätserzeugung und -verteilung," 182–3.
17. Hausmann, Hertner, and Wilkins, *Global Electrification*.
18. Hausmann, Hertner, and Wilkins, *Global Electrification*, 59–62.
19. Svernilson, *Growth and Stagnation*, 102–3.
20. Van Leeuwen and Földvári, "Capital Accumulation and Growth."
21. Hallon, "Die Konzeption einer systematischen Elektrifizierung," 62–3.
22. Tománek, *Elektrisace Československa 1918–1928*, 131; see the Law about the electricity fund, 22.03.1929 § 7 in Siegel, *Die Elektrizitätsgesetzgebung der Kulturländer der Erde*, 505.
23. Kubín, *Rozvoj energetiky v Československu*, 83.

24. Krecke, *Die Energiewirtschaft der Welt*, 142–3; Hallon, “Die Konzeption einer systematischen Elektrifizierung,” 58–74; Hallon, “Systematic Electrification in Germany and Four Central Europe States,” 141.
25. *Rocznik Statystyki Rzeczypospolitej Polskiej*, 123.
26. Jezierski and Leszczyńska, *Historia gospodarcza Polski*, 280–2; Krecke, *Die Energiewirtschaft der Welt*, 181.
27. Kraus, *Weißer Kohle für Österreichs Bahnen*, 24; Rotschild, “Size and Viability,” 168–70.
28. Siegel, *Die Elektrizitätsgesetzgebung der Kulturländer der Erde*, 314; Sandgruber, “The Electrical Century,” 236; Hinterbuchner, *Die Entwicklung der oberösterreichischen Elektrizitätswirtschaft*, 5.
29. Kittler, *Der internationale elektrische Energieverkehr*, 48.
30. Szterényi and Ladányi, *A magyar ipar a világháborúban*, 246–7; Hajdú, “A magyarországi vízi energia hasznosításának száz éve,” 946–8; Jakobovits, *A villamos energia törvényjavaslat-tervezetről*, 473–4.
31. Haidegger and Nagy, “Staatliche Förderung der allgemeinen Energieversorgung in Ungarn,” 226–7.
32. Hoór-Tempis, *Az európai államok*, 5.
33. See MOL Z425_3_23 Erősáramú kartellegyezmény [Cartel agreement of the producers of high-current electro-technical machinery], sent to the Department of Trade on 3 November 1931, actually a prolonged agreement from 1908; MOL Z248_4_85 Direktion, Hungaria Electrical Ltd., A villamosítás problémája [The electrification problem] Budapest, 9 March 1929.
34. See Siegel, *Die Elektrizitätsgesetzgebung der Kulturländer der Erde*, 54; Haidegger and Nagy, “Staatliche Förderung der allgemeinen Energieversorgung in Ungarn” or the respective parliamentary debates in Hungary 1927–31.
35. Verebely, *Tanulmány Csonkamagyarország villamosításának tervszerű fejlesztésére* [Study for the systematic electrification of Hungary], 10–12.
36. Siemens Corporate Archives 9345 Siemens, Wirtschaftspolitische Abteilung: Ungarn [Report, Siemens economic policy department, Berlin, 1938], 24–6.
37. Zipernovszky, *Report of the Year 1931*; Dembitz, *A villamos energia törvényjavaslathoz*.
38. Pétery, *Magyarország villamosításának fejlődése az 1930–1933*, 59.
39. Hallon, “Die Konzeption einer systematischen Elektrifizierung,” 70–1.
40. Ránki, “Hitel vagy piac.”
41. Davenport-Hines, “Vickers and Schneider.”
42. Landau, “Poland and America.”
43. Madajczyk, “Spory wokół sprawy elektryfikacji,” 154.
44. *Ibid.*, 174.
45. Popkiewicz and Ryszka, *Przemysł Ciepki Gornego Slaska*, 210–12.
46. Madajczyk, “Spory wokół sprawy elektryfikacji,” 175f.
47. Landau, “Poland and America,” 44.
48. Verebely, *A New System for Main Line Electrification*, 923.
49. Kittler, *Der internationale elektrische Energieverkehr*, 142–6.
50. One such company was the Donau-Wasserkräfte AG (Danube Water Power Ltd.), founded in 1920 (K 10,000.000) for the sake of generating water power on the Danube (Moson-Danube-stream), by Electric and Transport Undertakings Co. Ltd, called Trust for short, uniting mostly Hungarian and German capital. The legal person of the Danube Water Power Ltd. was maintained, obviously in the hope of finally having the chance to build the proposed water-power centre; however, these hopes vanished, the capital of the company diminished and no dividends were paid during the whole interwar era. *Compass Pénzügyi Évkönyv/Finanzielles Jahrbuch*, 682, 696.
51. Verebely, *A New System for Main Line Electrification*, 924, 929.
52. Haidegger, “Die Energiebilanz und ihre Gestaltung,” Haidegger, “Die systematische Untersuchung der Energiewirtschaft Ungarns,” 11–25, 47–9.
53. Hidvégi, “A Ganz-Jendrassik dízel motorkocsik Argentínában;” Hidvégi, *Anschluss an den Weltmarkt: Ungarns elektrotechnische Leitunternehmen 1867–1949*.

54. See the parliamentary debates about the law on systematic electrification of 1931, such as the speech of Prof. Söpkéz on 26 September 1930 or a memorandum on one of the largest Hungarian power-supply holding companies, the Hungaria Electrical Ltd., MOL Z248_4_85 A villamosítás problémája [The electrification problem], 1929, Budapest, 9.03.1929.
55. Éber, "A magyar nemzeti tőke alakulása," 203.
56. MNL Z51_221 Agreement. Government, Kingdom of Hungary 'acting on behalf of certain Hungarian Cities'/Speyer & Co., New York. Hung. Cons[olidated] Municipal Loan, 11 July 1925.
57. "Magyar Gazdaságkutató Intézet 1937," 99.
58. Ránki, "Hungarian General Credit Bank," 359; Ránki, "Hitel vagy piac."
59. This is reflected in several parliamentary debates, for example, Minutes of the National Assembly 1922–1925, vol. XXII, Sessions 26 March–10 April 1924, Session 10 April 1924, p. 314, Minutes of the House of Representatives 1927–1931, Vol. XIII, Sessions 21 May–12 June 1928, Session 25 May 1928, p. 164, Minutes of the Upper House, 1927–1931, Vol. IV, Sessions 20 December 1928 – 28 June 1929, Session 28 June 1929, p. 358, Speech by János Hadik, to the issue of mortgage loans for agriculture and water-regulating companies, Minutes of the National Assembly 1922–1925, Vol. XXIX, sessions 30 January– 13 February 1925. Session 374, 11 February 1925, p. 307.
60. Kuzmicki, "Governmental Control," 594.
61. Bodócsi and Haidegger, "Organization of Private Electric and Gas Utilities," 548.
62. Etemad and Luciani, *World Energy Production (1800–1985)*; Mitchell, *International Historical Statistics: Europe 1750–2005*; Svennilson, *Growth and Stagnation in the European Economy*, 114–15.
63. For Poland, we rely on the data in Pilatowicz ("Rozwoj elektryfikacji w Polsce Miedzywojennej"), for Czechoslovakia we complement Mitchell (*International Historical Statistics*) using data from the Czechoslovak National Committee ("Energy Resources and Power Development in Czechoslovakia Since 1924") and *Annuaire statistique de la république Tchécoslovaque* (Office de la Statistique de la République Tchécoslovaque/Orbis: Prague, 1938). Hungarian sources include Szilvási, "Budapest székesfőváros Elektromos Művei," 19–20, 75–6; Pétery (*Magyarország villamosításának fejlődése az 1930-1933. években*), Kerényi, *Villamosenergia-ipari visszatekintő adatok 1925–1994*; a description of the early development of electrification in Austria *Die Elektrifizierung Österreichs/Austria Electrified* (1925), for later development: *Statistisches Handbuch für den Bundesstaat Österreich Vol. XV* (Bundesamt für Statistik: Vienna, 1935).
64. Verebely, *A New System for Main Line Electrification*; Jezierski and Leszczynska, *Historia gospodarcza Polski*.
65. Miksa, "Kereskedelmi miniszter a villamosításról," 1.
66. Pilatowicz, "Rozwoj elektryfikacji w Polsce Miedzywojennej."
67. *Rocznik Statystyki Rzeczypospolitej Polskiej*, 212–13.
68. Kubín, *Rozvoj energetiky v Československu*, 83.

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