




RESEARCH ARTICLE

# The rise and fall of Japan's municipal electricity regulation, 1889–1939

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## Abstract

This article explores the history of Japan's municipal electricity regulation. We find that in the early phase of Japanese electrification, rights-of-way and municipal franchises remained undefined compared with these concepts in Western societies. Consequently, Japanese cities started electrification without municipal regulations. Although municipal franchises were introduced to Japan as a regulatory framework in the 1900s, they were tailored to Japan's political and ideological context. Moreover, the Road Law of 1919 weakened the legal basis for municipal regulation. With the revision of the Electric Utility Law in 1932 and World War II, the decline of municipal regulation became inevitable.

## Introduction

The origins of electrification can be traced to small electric power systems in major cities around the world. In 1882, Thomas Edison constructed the world's first central station system on Pearl Street, New York.<sup>1</sup> It was called a central station because there was an electricity generator and a network of cables that distributed electricity to other city quarters. Within a decade of the opening of the Pearl Street system, major cities in the world – such as London, Berlin, Shanghai and Tokyo – saw the installation of electric lights, power stations and distribution networks.<sup>2</sup> By the 1930s, most of these local systems had developed into regional systems, with transmission lines originating from large cities like spider webs. The history of electrification is about the evolution of urban electric power systems and their economic, political and social consequences. Through the lens of the utility–politics relationship, Thomas Hughes examined the history of electrification in Chicago, Berlin and London and categorized electrification in these cities into three patterns: co-ordination between technology and politics (Berlin), dominance of technology

<sup>1</sup>T.P. Hughes, *Networks of Power: Electrification in Western Society, 1880–1930* (Baltimore, 1983), 42.

<sup>2</sup>For London, see *ibid.*, 227–61; for Berlin, see T. Dame, *Elektropolis Berlin: Die Energie der Großstadt* (Berlin, 2011), 52–6; for Shanghai, see Y.J. Tan, *Recharging China in War and Revolution, 1882–1955* (Ithaca, NY, 2021), 18–38; for Tokyo, see Tōkyōdenryoku, *Kantō No Denki Jigyō To Tōkyōdenryoku* (Tokyo, 2002), 7–9.

(Chicago) and dominance of politics (London).<sup>3</sup> Hughes mentioned in his preface to *Networks of Power* that he had wished to study Japanese electrification. If we follow Hughes' comparative perspective and move our scope to East Asia, then which category did Japan's municipal electrification belong to?

Japan's electrification appears miraculous by international standards of comparison. First, with respect to technology education, William Edward Ayrton (1847–1908), the world's first professor of electrical engineering, taught in Japan from 1873 to 1878.<sup>4</sup> Japan's electric engineering education has since been considered top-class in the world.<sup>5</sup> Second, Japan's earliest electric utility, Tokyo Electric Light (the forerunner of today's Tokyo Electric Power), was set up in 1883, at approximately the same time as those in Britain, Germany and the USA. Third, in terms of hydroelectricity, in 1889, engineer Tanabe Sakuro (1861–1944) designed Asia's first hydroelectric power station in Kyoto.<sup>6</sup> Fourth, before World War I, Japan pioneered high-voltage transmission, having constructed a system with the highest voltage in the world with the exception of that in the USA.<sup>7</sup> Fifth, in terms of finance, the sum of the Japanese electricity bonds issued in New York in 1923–29 amounted to 39.6 per cent of the collective Japanese government and corporate bonds floated there after World War I; the share of electricity bonds was 77.5 per cent of all Japanese corporate bonds floated in the USA; and the asset of electric utilities amounted to 12 per cent of all Japanese companies listed in stock markets.<sup>8</sup> Sixth, in terms of electricity usage, the percentage of households using electric power in Japan reached 89 per cent in 1935, higher than that in Germany (85 per cent) and the United States (68 per cent),<sup>9</sup> and 89 per cent of Japanese factories used electric power in 1930, compared to 72 per cent of German factories in 1933.<sup>10</sup> Electrification improved Japanese productivity.<sup>11</sup> Finally, Japan's per capita consumption of electricity was 393 kwh in 1936, approaching that of Germany (472 kwh in 1931) and Britain (370 kwh in 1931) and higher than that of Italy (260 kwh in 1931).<sup>12</sup> These achievements are miraculous for a latecomer to industrialization.

However, the political consequences of Japan's electrification differ greatly from those of Western countries. First, in Western countries, municipal electricity regulation often began simultaneously with electrification, but Japanese electrification

<sup>3</sup>Hughes, *Networks of Power*, chs. 7–9.

<sup>4</sup>Y. Takahashi, 'William Edward Ayrton at the Imperial College of Engineering in Tokyo: the first professor of electrical engineering in the world', *IEEE Transactions on Education*, 33 (1990), 198–205.

<sup>5</sup>A. Okochi and H. Uchida, *Development and Diffusion of Technology: Electrical and Chemical Industries* (Tokyo, 1980), 135–6.

<sup>6</sup>M. Yamamoto and M. Yamaguchi, 'Electric power in Japan: rapid electrification a century ago', *IEEE Power and Energy Magazine*, 3 (2005), 74–9.

<sup>7</sup>W. Hausman, P. Hertner and M. Wilkins, *Global Electrification: Multinational Enterprise and International Finance in the History of Light and Power, 1878–2007* (New York, 2008), 20–1.

<sup>8</sup>T. Kurihara, *Denryoku* (Tokyo, 1964), 160; Tokyodentō, *Tokyodentō Kabushikikaisha Kaigyō Gojunen-shi* (Tokyo, 1936), 221.

<sup>9</sup>Kurihara, *Denryoku*, 181.

<sup>10</sup>Y. Kozakura, 'Kōchi ken niokeru kōgyō yūchi seisaku no keisei to kenei denki jigyō', *Keizai Ronsō*, 112 (1973), 105; W. Zängl, *Deutschlands Strom: die Politik der Elektrifizierung von 1866 bis heute* (Frankfurt, 1989), 76.

<sup>11</sup>M. Morimoto, 'Effects of electrification on the coal industry's production and distribution: evidence from 1900s Japan', *Singapore Economic Review*, 68 (2023), 1917–42.

<sup>12</sup>Kurihara, *Denryoku*, 180.

preceded regulation. For example, the Berlin municipal government regulated the German Edison Company, Germany's first electric utility, through a franchise from its beginning in 1884.<sup>13</sup> The earliest Japanese municipal regulation did not appear until 1905, as we will detail later. Second, in the process of electrification, the majority of electric utilities in Western countries such as the USA, Germany and Britain became government-owned, whereas private ownership dominated Japan. In the USA, there were already 15 publicly owned electric utilities in 1885, and the number increased to 1,737 in 1912.<sup>14</sup> In Britain, two-thirds of electric utilities were publicly owned before World War I.<sup>15</sup> In Germany, 23 per cent of electricity was generated by publicly owned utilities in 1900, and in 1913, the number reached 40 per cent.<sup>16</sup> However, Kyoto remained Japan's only government-owned electric utility from 1889 to 1907, and the number of publicly owned utilities was no more than 21 in 1930.<sup>17</sup> Why did Japanese municipal regulation appear late, and why did Japanese public ownership of electric utilities, especially municipal utilities, develop so slowly?

Bearing international comparisons in mind, this article examines the origin and evolution of Japanese municipal electricity regulation. The wider literature on the history of electrification may be divided into two categories.<sup>18</sup> The first examines the geographical dimensions of electrification, whether rural, urban or national. Rural electrification has long been in the shadow of urban development both in history and historiography, but scholars are beginning to fill this research gap.<sup>19</sup> Urban historians are most familiar with the history of urban electrification, as represented by recent scholarships on Southeast Asian and European cities.<sup>20</sup> One may also take a country as a unit and examine electrification from a national perspective.<sup>21</sup> Alternatively, and as the second category, one can explore the history of electrification through the lens of a specific thematic focus, such as gender, environment, American literature, political change, etc.<sup>22</sup> These two research categories usually overlap with each other.

The goal of this article is to explore the history of Japan's urban electrification through a thematic focus on municipal regulation. The framework of the article is

<sup>13</sup>Hughes, *Networks of Power*, 175–200; Dame, *Elektropolis Berlin*, 220–39.

<sup>14</sup>J.E. Kwoka, *Power Structure: Ownership, Integration, and Competition in the U.S. Electricity Industry* (Boston, MA, 1996), 5.

<sup>15</sup>S. Takashi, *Igirisu Denryoku Sangyō No Seisei Hatten To Denki Jigyō Hōno Hensen* (Nagasaki, 1983), 53.

<sup>16</sup>Denkikyōkaichōsabū (ed.), *Doitsu Denki Keizai No Kokumin Teki Hensei* (Tokyo, 1939), 46.

<sup>17</sup>T. Kikkawa, *Nihon Denryokugyo Hatten No Dainamizumu* (Nagoya, 2004), 107–8.

<sup>18</sup>For an overview on electrification historiography since Thomas Hughes, see W.B. Carlson and E.M. Conway, 'Introduction', in W.B. Carlson and E.M. Conway (eds.), *Electrical Conquest: New Approaches to the History of Electrification* (Cham, 2023), 4–10.

<sup>19</sup>U. Hasenöhrl, 'Rural electrification in the British empire', *History of Retailing and Consumption*, 4 (2018), 10–27; R. Hirsh, *Powering American Farms: The Overlooked Origins of Rural Electrification* (Baltimore, 2022).

<sup>20</sup>K.W. Endres, 'City of lights, city of pylons: infrastructures of illumination in colonial Hanoi, 1880s–1920s', *Modern Asian Studies*, 57 (2023), 1772–97; S. Murray, 'The battle for Bankside: electricity, politics and the plans for post-war London', *Urban History*, 45 (2018), 616–34; T. Moss, 'Navigating electricity dependencies in Cold War Berlin: an instructive history of urban infrastructure security', *Urban History*, 51 (2024), 616–32.

<sup>21</sup>Tan, *Recharging China*; R. Shamir, *Current Flow: The Electrification of Palestine* (Stanford, 2013); J.A. Cohn, *The Grid: Biography of an American Technology* (Cambridge, 2017).

<sup>22</sup>A.H. Moore and R.W. Sandwell (eds.), *In a New Light: Histories of Women and Energy* (Montreal, 2021); J. Meier et al. (eds.), *Urban Lighting, Light Pollution and Society* (London and New York, 2015); J.L. Lieberman, *Power Lines: Electricity in American Life and Letters, 1882–1952* (Cambridge, 2017); L. Coleman, *A Moral Technology: Electrification as Political Ritual in New Delhi* (Ithaca, NY, 2017).

based on Thomas Hughes' concept of 'technological style'. Hughes coined the term 'technological style' to refer to the different characteristics of technology at different times and in different places.<sup>23</sup> This concept is part of Hughes' large technical system (LTS) framework. By placing the evolution of technology in a system of human geographical, economic, political and cultural factors, the LTS framework refutes technological determinism and remains a useful tool for analysing the interactions between technology and non-technological factors in the history of infrastructure.<sup>24</sup> Hughes exemplified different styles of urban electrification in his international comparison of Berlin, Chicago and London, whereas Schott's comparison of Darmstadt, Mannheim and Mainz showed that urban electrification in the same country could also have varying styles across cities.<sup>25</sup> This article highlights the international differences in technological style between Japan and Western countries, but we will also see how Japanese cities such as Kyoto and Osaka had different experiences.<sup>26</sup>

The structure of the article is organized as follows. The first section, centred on the 1890s, illustrates Japan's earliest experience with municipal regulation through the case of Kyoto. The second section, beginning with the example of Osaka, explores how Japanese cities learned European utility regulation methods and adapted them to Japan in the 1900s–1910s. The third section discusses how municipal regulation contradicted central-state regulation in the 1920s and declined in the 1930s.

### Kyoto: electrification without municipal regulation

Kyoto was a pioneer in Japan's urban electrification. The city constructed Japan's earliest hydropower station at a place called Keage in 1889. The Keage station was the first Japanese power station that supplied electricity to industrial consumers, at

<sup>23</sup>T.P. Hughes, 'The evolution of large technological systems', in W.E. Bijker (ed.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, 2012), 62–3. Also see T. Mori, *Doitsu Kindai Toshi Shakai Keizaishi* (Tokyo, 2009), 18.

<sup>24</sup>See for example A.M. Coles *et al.*, 'A "poor man's carriage": system building and social interactivity in UK urban tramway development, 1860–1890', *Industrial and Corporate Change*, 32 (2023), 605–21. Recently, David E. Nye suggests a revisionist framework which combines Hughes with path dependency theories to explain decarbonization in D. Nye, 'A model for heterogeneous energy transitions', in Carlson and Conway (eds.), *Electrical Conquest*, 21–48.

<sup>25</sup>D. Schott, *Die Vernetzung der Stadt: Kommunale Energiepolitik, öffentlicher Nahverkehr und die 'Production' der modernen Stadt Darmstadt – Mannheim – Mainz, 1880–1918* (Darmstadt, 1999).

<sup>26</sup>Whereas this article primarily addresses an English audience, it is advisable to briefly review Japanese scholarship. As a distinctive feature, the Japanese historiography tradition highlights painstaking archival research, rather than formulating or adopting new frameworks as often observed in English scholarship. Electrification studies in Japanese can be divided in two strands by thematic focus. The first strand focuses on the business historical aspect, as in T. Kikkawa, *Nihon Denryokugō No Hatten To Matsunaga Yasuzaemon* (Nagoya, 2022); D. Asaoka, *Kigyō Seichō To Seido Shinka: Senzen Denryoku Sangyō No Keisei* (Tokyo, 2012); T. Ito, 'Kokusaku kaisha dengenkaiatsu (kabu) no daiinamizumu: Kakushin-teki gijutsu no dōnyū to jishhō wo tōshite', Hitotsubashi University Ph.D. thesis, 2015. The second strand centres on the political dimension of electricity, as in T. Uchikawa, '1930 Nendai Nihon kaisei denki jigyōhotaisei no shūen to denryoku kokka kanri no seiritsu', Tokyo University of Foreign Studies Ph.D. thesis, 2022; K. Hanaki, 'Senzen ki kōei denki jigyō niokeru kōkyō sei: Osaka shidenkikyoku no katsudō wo tsūjite', Osaka City University Ph.D. thesis, 2019. Although Takeo Kikkawa's authoritative works highlighted the role of private-owned utilities in Japanese electrification, the younger generation of scholars are more interested in political aspects and challenging Kikkawa therewith.

a time when electricity was mainly used for lighting. In 1895, Japan's earliest electrical tramway appeared in Kyoto. In 1915, Kyoto reached almost 100 per cent residential electrification, when only 5.5 per cent of households in Berlin were electrified.<sup>27</sup>

An observer from Berlin might have wondered at Kyoto's electrification but also have been puzzled by the absence of electricity regulation. In Berlin, the German Edison Company had to apply for a franchise from the municipal government of Berlin before it could sell electricity to the public. According to the franchise signed in 1884, the municipal government gave the utility a monopoly, but retained the authority to approve prices, claim 10 per cent of the gross income and 25 per cent of the profit, and municipalize the utility after 10 years.<sup>28</sup> The franchise, as the first such franchise in Germany, laid the basis for municipal electricity regulation in that country. Therefore, electrification in Germany has been under municipal regulation since the beginning. The main reason for regulation, in addition to natural monopoly and municipal revenue, is to be found in rights-of-way. Utilities, including electric utilities, must place their distribution systems on land they do not own. We can identify this from Figure 1. As a practical matter, public rights-of-way must be used for laying distribution systems. Since in most cases, public land is managed by the municipality, utilities have to apply for a franchise from the municipality and compensate for the use of public land by accepting regulation. This was the Western experience when electrification started in the 1880s.<sup>29</sup>

Japan's experience was different. First, in Japan, the institutional framework for modern municipal administration did not begin until the end of the 1890s. When the Meiji government revolutionized the Tokugawa period's local administration and established prefectures in the 1870s, the municipality as an administrative unit was not yet born. Although the Meiji government institutionalized municipalities in 1888, it also applied a special law to Tokyo, Osaka and Kyoto, Japan's three most populated and strategically most important cities, so that the prefectural government took over their municipal administration. It was not until 1898 that Tokyo, Osaka and Kyoto were allowed to elect their mayors for the first time in history. In Japan, modern municipal administration appeared later than electrification.<sup>30</sup>

Second, Japanese electrification started at a time when municipal governments still had no idea about rights-of-way as implemented by European municipalities. By the time electrification started in Germany, German municipalities already had experience with regulating modern public utilities such as gas, waterworks and tramways; they adapted the existing regulation framework to electricity. However, Japanese municipalities had to learn about how to regulate modern infrastructures; the technologies were imported from Western countries, as were the regulations. For Japan, the ownership of public rights-of-way was a Western concept. The Meiji Civil Law, proclaimed in 1895, the first civil law code in Japan's history, did not clearly state who owned or regulated public roads, although local governments managed them.<sup>31</sup>

<sup>27</sup>For the statistics of Kyoto, see Kyōtofuritsusōgōshiryōkan, *Kyōto Fu Tōkei Shiryō Shu: Hyaku Nen No Tōkei Daiichikan* (Kyoto, 1969), 297; for Berlin's data, see Hughes, *Networks of Power*, 190.

<sup>28</sup>Hughes, *Networks of Power*, 185.

<sup>29</sup>J. Fujiwara, *Jukku Seiki Beikoku Niokeru Denki Kisei No Tenkai* (Tokyo, 1989), 9–20.

<sup>30</sup>T. Kobayashi, 'Bakumatsu ishin ki Kyōto no toshi gyōsei', in I. Yukio (ed.), *Kindai Kyōto No Kaizō: Toshi Keiei No Kigen 1850–1918 Nen* (Kyoto, 2004), 24–30.

<sup>31</sup>Kyōtoshisanjikai, *Berurinshi Gyōsei No Kiō Oyobi Genzai* (Kyoto, 1901), 2–6.

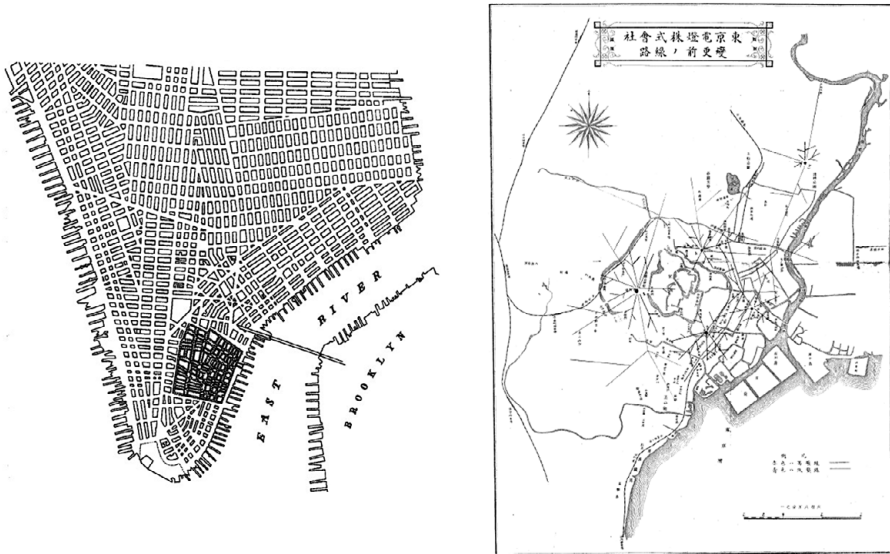


Figure 1. Urban electric power system of Pearl Street in 1882 (left) and of Tokyo in 1895 (right).  
 Source: Cohn, *The Grid*, 28; F. Ichisuke, 'Tōkyō shinai dentō kakuchō Kōji', *Denki Gakkai Zasshi*, 95 (1895), 316.

Tokyo Electric Light, Japan's first electric utility, was launched without having to obtain a franchise from the Tokyo prefectural government, which at the time assumed the function of the municipal government.<sup>32</sup> A similar process occurred in Osaka, Kobe, Kyoto, Nagoya and other cities. Throughout the 1880s to 1890s, Japanese municipalities were unaware of the principle of franchises or rights-of-way. This situation applied not only to electricity but also to gas and tramways.<sup>33</sup> With respect to other utilities, Japan nationalized the telegraph in 1869, and telecommunications fell under central-state ownership until privatization more than a century later in the 1980s. Modern water and sewerage systems first appeared in 1887 in Yokohama and a ministerial ordinance in 1890 placed water and sewerage systems under municipal ownership, while the railway was nationalized in 1906. Thus, the rise of government ownership from early on helped keep telecommunications, water and railways away from regulation disputes. When electrification started in Japan, however, municipal regulation was non-existent.

To return to the case of Kyoto, the relation between electric utilities and politics was a central theme in Kyoto's electrification, but this did not lead to municipal regulation. The city's earliest electric utility, Kyoto Electric Light, was launched in 1887 by Tanaka Gentaro (1853–1922) with support from Kyoto Prefectural Governor Kitagaki Kunimichi (1836–1916). In 1888, Kyoto's young engineer Tanabe Sakuro, by chance, read about hydropower projects in Colorado. Excited by the prospect of importing the new technology to Kyoto, the municipal assembly, which took the role of municipal administration, sent him to Colorado to learn about

<sup>32</sup>Tokyodentō, *Tokyodentō Kabushikikaisha Kaigyō Gojunenshi*, 1–23.

<sup>33</sup>See Tōkyōhiseichōsakai, *Denki Jigyō Hōshō Keiyaku* (Tokyo, 1928).



hydropower.<sup>34</sup> In 1889, Kyoto became a municipality, and in the same year, Tanabe Sakuro convinced the newly launched municipal council to build Japan's earliest hydropower station. In the case of Berlin, the municipal government was mainly concerned with how to regulate a new infrastructure; for Kyoto, the focus was on how to import new technologies. Tanabe Sakuro's report on Colorado's hydropower mentioned nothing about regulation.

However, there is evidence that Kyoto once had a chance to adopt a franchise. In 1889, Kyoto Electric Light submitted a proposal to the Kyoto Municipal Council suggesting that the municipality lease the Keage power station to Kyoto Electric Light, granting the firm a monopoly in using hydroelectric power, and in return, the municipal government would hold the right to check tariffs, claim a part of the firm's income and purchase Kyoto Electric Light under certain conditions. Had Kyoto accepted the proposal, we might have seen a Japanese version of the franchise. However, the Kyoto Municipal Council voted against it.<sup>35</sup> The relationship between the municipal government and Kyoto Electric Light was not one between a regulator and a regulated utility but one of market demarcation. Kyoto Electric Light supplied electricity to residents for lighting, whereas Kyoto supplied electricity to factories for industrialization; together, electric light and electric power were believed to have contributed to Kyoto's modernization.<sup>36</sup> In fact, the municipal-owned utility continued to lose money until 1897, although its installed capacity increased from 36 ps in 1891 to 2,223 ps in 1901.<sup>37</sup>

The example of Kyoto indicates the difference in belief and value systems behind German and Japanese municipal governments. In Germany, the long tradition of municipal administration gave rise to the consensus that the municipal government should regulate public infrastructures for both the public interest and municipal revenue.<sup>38</sup> In the 1880s, electricity was still a new technology whose business prospects were rife with uncertainty. German municipal governments preferred to leave the risk to private companies, grant them franchises, claim monetary compensation from them and maintain the authority to communalize the utilities in the future if they should become profitable.<sup>39</sup> This explains why Berlin, based on the franchise signed in 1884, municipalized the Berliner Elektrizitäts-Werke (former German Edison Company) in 1915, and the municipal-owned utility contributed tremendously to municipal revenue in the 1920s.<sup>40</sup> However, Kyoto considered

<sup>34</sup>Kyōtoshidenkikyokushomuka, *Biwako Sosui Oyobi Suiryoku Shiyō Jigyō* (Kyoto, 1940), 623–4. The municipal assembly was composed of townspeople in the Japanese sense. In the Edo period (1603–1868), the townspeople in Kyoto and Osaka developed the tradition of managing the cities' public infrastructures by themselves. This laid a basis for modern municipal administration.

<sup>35</sup>Kyōtoshidenkikyokushomuka, *Biwako Sosui Oyobi Suiryoku Shiyō Jigyō*, 654–5.

<sup>36</sup>To modernize cities with imported technologies was a common practice for emerging countries, see for example K. Chatzis *et al.*, 'Supplying the city of Ioannina with "modern" waters, 1913–1940: the "modern infrastructural ideal" in a mid-size Greek town', *Urban History*, 48 (2021), 71–86; S. Gunn *et al.*, 'Cities, infrastructure and the making of modern citizenship: the view from North-West Europe since c. 1870', *Urban History*, 50 (2023), 565–83.

<sup>37</sup>Kyōtoshidenkikyoku, *Kyōto Shiei-Denki Jigyō Enkaku Shi* (Kyoto, 1933), 706–7; also see M. Shiraki, 'Meiji kōki no Biwako sosui to denki jigyo', in Yukio (ed.), *Kindai Kyōto No Kaizō*, 87. People used ps (pferdestarke) to measure electricity at the time; 1 ps equals 0.7355 kilowatt.

<sup>38</sup>Mori, *Doitsu Kindai Toshi Shakai Keizaishi*, 7–13.

<sup>39</sup>R. Millward, *Private and Public Enterprise in Europe* (Cambridge, 2005), 76.

<sup>40</sup>S. Mitsuo, *Doitsu Toshi Keiei No Zaisei Shi* (Hachiōji, 1997), 192–4.

electricity to be a symbol of modernization, and the municipal government bore the risk of setting up, operating and financing its municipal-owned utility.<sup>41</sup> Other cities would find Kyoto's example difficult to follow. Japan's second oldest government-owned utility was not launched until 1907 in the north-eastern town of Sakata, nearly 20 years later than that established in Kyoto. In Japan, it was not until the 1910s that electricity could provide stable incomes and became an incentive for municipal ownership.<sup>42</sup> Kyoto's electrification started with municipal ownership but without municipal regulation.

Kyoto did not learn about the European regulation framework until the turn of the century. In 1900, using the opportunity presented by the Paris World Exposition, Kyoto dispatched a delegation to Europe to study public administration. It was the first such delegation from a Japanese municipal government, heralding the beginning of modern municipal administration in Japan. After a tour of Europe, the delegation concluded that Berlin could offer the best example for Japan. It stayed there for 61 days and compiled a detailed report, *The Past and Present of Berlin's Administration*. After returning to Kyoto, the delegation provided an introduction to how Berlin regulated electric power and other public utilities, noted that rights-of-way were problematic in Japan and recommended that the municipal government should take immediate steps to regulate public utilities.<sup>43</sup> With this new information, in 1902, the Kyoto Municipal Council voted for the acquisition of Kyoto Electric Light.<sup>44</sup> The plan failed because the city was unable to raise municipal bonds on the eve of the Russo-Japanese War. However, Kyoto's delegation to Berlin represented the first time a Japanese municipal government discovered the municipal regulation framework of Europe. From the 1900s, Japanese municipalities took pains to import franchises and adapt municipal regulation to the Japanese context.

### Osaka: municipal regulation tailored to the Japanese context

By the turn of the century, the municipality of Osaka was also studying European and American municipal administrations. At the time, Osaka Gas Company was preparing to open a business. Like other urban infrastructures, its gas distribution networks would be laid out on public roads. Osaka grasped the opportunity and initiated a negotiation with Osaka Gas Company over signing a franchise. In 1903, Osaka and Osaka Gas Company reached an agreement to form the earliest public utility franchise in Japanese history between a municipality and a private company. However, in the negotiation process, the legal basis of the franchise came into focus. The newspaper *Osaka Daily News* commented that if public roads were owned by the central state, then Osaka had no authority to sign the franchise.<sup>45</sup> The municipality

<sup>41</sup>For Kitagaki Kunimichi, Kyoto's hydropower project primarily aimed at rejuvenating the ancient capital and transforming handcraft workshops to modern factories using mechanization, see Kyōtoshidenkikyōkushomuka, *Biwako Sosui Ryaku Shi* (Kyoto, 1939), 1. This is also testified by Higashieda Kichibei's speech at the Kyoto Municipal Council, 'the purpose of building the canal is to use hydropower and electric light to develop the prefecture's industries'. See *Kyoto shikai gijiroku*, 1 Aug. 1893.

<sup>42</sup>For the economic performance of Japanese municipal electric works, see T. Kikkawa, *Nihon Denryōkugyo Hatten No Dainamizumu*, 106–8.

<sup>43</sup>Kyōtoshisanjikai, *Berurinshi Gyōsei No Kiō Oyobi Genzai*, 1–5.

<sup>44</sup>*Kyoto shikai gijiroku*, 18 Jan. and 11 Apr. 1902.

<sup>45</sup>*Osaka Maimichi Shinbun*, 5 Aug. 1902.



rejoined that even though public roads could be central-state-owned, Osaka managed them using municipal revenue and thus had the right to sign franchises. The essence of the dispute was that rights-of-way, being a Western concept, were still undefined for the Japanese.

Additionally, in 1903, Osaka began negotiating with Osaka Electric Light over signing a franchise. The common practice in Europe, as in Berlin's case, was to sign a franchise before the utility opened a business. This was also the case for Osaka Gas Company. However, Osaka Electric Light, which was launched in 1887, was Japan's second oldest electric utility and had been building electric power systems in the city for 16 years.<sup>46</sup> Osaka's demand provoked fierce debates among businessmen, politicians, lawyers and scholars. Osaka Electric Light and the Japan Electric Association declared themselves against the franchise. Some jurisprudence professors judged the demand to be illegal. The civil law professor Ume Kenjiro (1860–1910) and the public law professor Minobe Tatsukichi (1873–1948) both argued that the municipal government did not have the authority to enforce regulation on a firm if it had already opened the business, nor did the firm have an obligation to accept the regulation.<sup>47</sup> After protracted negotiations, Osaka municipality and Osaka Electric Light agreed upon signing a franchise in 1906.<sup>48</sup> A year before, the small city of Sasebo had already realized the earliest electricity franchise in Japan. Although Osaka was the second oldest, its influence was formidable considering Osaka's status as the second most populous Japanese city. Other large city governments followed suit to sign franchises with urban utilities: Nagoya in 1908, Tokyo in 1912 and Kobe in 1914. By 1919, 12 Japanese cities had signed franchises with electric utilities.<sup>49</sup> However, Kyoto signed no franchise with Kyoto Electric Light; instead, they demarcated the supply area.

Although the introduction of franchises to Japanese cities can be understood as the beginning of municipal electricity regulation, Japanese franchises were tailored to the Japanese context. Their contents varied from city to city. Not all of the Japanese franchises had clauses about monopoly, price regulation and monetary compensation. For example, Tokyo's, Osaka's and Kobe's franchises mentioned nothing about electric utilities' monopolistic use of public roads. This is because these municipalities were already operating or were planning to open their municipal-owned utilities: Tokyo in 1911, Osaka in 1903 and Kobe in 1917.<sup>50</sup> Tokyo's franchises said nothing about the municipality's right to approve electricity tariffs or the right to receive monetary compensation.<sup>51</sup> This can be explained by the Tokyo municipalities' plan to launch price competition with privately owned utilities to promote electrification. However, in most cases, the municipal governments claimed a certain percentage of

<sup>46</sup>Moreover, in the 'battle of systems' between direct current (DC) and alternating (AC) current, Osaka Electric Light was the first utility that adopted AC current in Japan in 1888 and thereby convinced Tokyo Electric Light of AC's advantage. Osaka Electric Light played a decisive role in settling the 'battle of systems' in Japan. See Kikkawa, *Nihon Denryokugyo Hatten No Dainamizumu*, 43.

<sup>47</sup>Tōkyōshiseichōsakai, *Denki Jigyō Hōshō Keiyaku*, 11–12.

<sup>48</sup>H. Yamada, *Shiei Kōeki Jigyō To Toshi Keiei No Rekishi: Hōshō Keiyaku No 80 Nen* (Suida, 2013).

<sup>49</sup>Tōkyōshiseichōsakai, *Denki Jigyō Hōshō Keiyaku*, appendix.

<sup>50</sup>T. Nishino, 'Senzen niokeru shiei denki jigyō no tenkai to tokusei', *Chūki Seisaku Kenkyū*, 16 (2014), 1–19.

<sup>51</sup>For the original text of those franchises, see Tōkyōshiseichōsakai, *Kōeki Kigyō Hōan Sanshō Yō Genkō Kōeki Kigyō Hōki Ruishū* (Tokyo, 1931).

profit from private utilities. In general, the common point of Japanese municipal franchises was compensation rather than regulation. The Japanese term for franchising, 'Hōshōkeiyaku', compensation contract, indicated that monetary revenue was understood as an important incentive.

Given the case-by-case situation of franchises in Japanese cities, it is difficult to find a common definition for the term franchise in Japanese. Generally, there were two sets of definitions in Japan. The first set understood the franchise as an agreement between the municipal government and the public utility regardless of the content. In other words, franchises had nothing to do with the right-of-way and were not necessarily related to regulation. This view was held by historian Watari Tetsuro and by the Tokyo municipal government.<sup>52</sup> The second set of definitions emphasized the monopoly granted by the municipal government to the public utility. Historian Shirakisawa Ryoko defined franchise as something granted by the municipal government to public utilities to ensure their monopoly and business stability at the early phase of electrification.<sup>53</sup> In 1939, the Tokyo municipal government surveyed Kyoto's gas franchise and concluded that the franchise was between the municipality and public utilities and pertained to the use of public land, and the monopoly, compensation and regulation related to the use of land.<sup>54</sup> The first set of definitions covers the general situation of franchises in Japanese cities, whereas the second focuses on their legal basis, on rights-of-way and consequences, such as monopolization.

Japanese municipalities did not understand electricity as a natural monopoly or as a public utility that should be regulated. The relationship between Japanese municipalities and private electric utilities was one between market competitors. The Japanese publicly owned electric utilities were a division of the government, but their behaviour did not differ greatly from that of privately owned companies. Price wars occurred in Tokyo between the Tokyo municipal-owned utility and Tokyo Electric Light from 1910 to 1917 and between the Kyoto municipal-owned utility and Kyoto Electric Light from 1910 to 1915.<sup>55</sup> Municipal socialism appeared through price wars as a result of the municipal government's strategy to sell electricity at a price lower than that of private-owned utilities so that more households could afford to be electrified.<sup>56</sup> From the perspective of urban electrification, this competition paid off. The percentage of Tokyo's households using electricity increased from 22.6 per cent in 1909 to 78.6 per cent in 1917, and that of Kyoto increased from 13.8 per cent in 1909 to 97.7 per cent in 1917.<sup>57</sup>

### The central state and the decline of municipal regulation

If Japan had a different conception of municipal franchises from that in Western countries, then the meaning of regulation should also be understood in the Japanese context. In the 1890s, Japan's electrification started without municipal regulation, but

<sup>52</sup>T. Watari, *Senzen Ki No Wagakuni Denryoku Dokusentai* (Kyoto, 1996), 107; H. Ikeda, *Hōshō Keiyaku Ni Tsuite* (Tokyo, 1931), 5.

<sup>53</sup>R. Shirakisawa, 'Senzen ki niokeru chihōjichitai to denki jigyō', *Nihon Rekishi*, 732 (2010), 74–90.

<sup>54</sup>Tōkyōshiseichōsakai, *Kyōto Shi No Shingasu Hōshō Keiyaku Nitsuite* (Tokyo, 1939), 1.

<sup>55</sup>Tsūshōsangyōshō, *Tsūshōsangyōshōshi Dainijuyōkan Gasu Denryokujigyo* (Tokyo, 1979), 40–5.

<sup>56</sup>*Kyoto shikai gijiroku*, 13 Jan. 1913; 25 Nov. 1914; 22–3 Feb. 1915.

<sup>57</sup>Teishinshōdenkikyoku, *Denki Jigyō Yōran* (Tokyo, 1917), 372–5.

the central state did have administrative authority over electric utilities. In 1890, a fire occurred at the Imperial Diet Hall and was believed to have been caused by an electricity cable. Consequently, the following year, the Ministry of Communication, which regulated railways and telecommunications, issued an ordinance regulating electric utilities. The ordinance was concerned with safety issues and mentioned nothing about monopoly or pricing. In 1896, the Ministry of Communication implemented a new ordinance that centralized registration; electric utilities had to apply to the central state for approval before being launched.<sup>58</sup> The ordinance still did not mention monopoly or price regulation.

When Gotō Shinpei (1857–1929) was the minister of communications in 1910, he drafted the Electric Utilities Law, which contained a clause that authorized the Ministry of Communication to check and approve electricity prices.<sup>59</sup> However, the question of whether the central state should oversee electricity prices caused a fierce debate in the Imperial Diet of Japan, with the majority of the opinion arguing that electricity should be a market of free competition. After Gotō Shinpei deleted the price regulation clause, the Electric Utilities Law passed the Imperial Diet in 1911. The Electric Utilities Law of 1911 had two consequences. First, if there was a municipal franchise, then price regulation was left to local governments; if the municipal franchise mentioned nothing about price regulation, then the electric utility received no price regulation. Second, the spirit of the Electric Utilities Law was that electricity should be a free market. Therefore, there is little wonder that even municipal-owned utilities would participate in market competition with privately owned utilities.

From a comparative perspective, the rise of central-state regulation is a common phenomenon in the history of electrification. Electric power systems began from urban networks with direct current, which could not transmit electricity across distance. In this case, the municipal governments suitably regulated the electric utilities, whose supply area was located within city borders. However, over time, alternating current began to dominate, and long-distance transmission occurred at high voltages. As electric power systems developed into regional and even national networks beyond city borders, provincial and national governments replaced municipal governments as regulators. The USA, for example, is essentially composed of three regional grid systems: one for the west, one for the east, and one for Texas.<sup>60</sup> Germany developed a regional system from the Ruhr valley to the Alps in the 1920s.<sup>61</sup> By the 1920s, Tokyo's urban system had also become regional.<sup>62</sup> As long as the systems developed beyond municipal, provincial and even national boundaries, the regulation became upgraded from the municipal to the provincial to the national levels. In the USA, 45 states had established committees regulating electric utilities by 1914, the Federal Power Commission was launched in 1920 and the Federal Power Act was promulgated in 1935.<sup>63</sup> In contrast with the USA, German states had an ideological preference for public ownership and launched

<sup>58</sup>Kurihara, *Denryoku*, 117.

<sup>59</sup>Tsūshōsangyōshō, *Tsūshōsangyōshōshi Dainijuyonkan Gasu Denryokujigyo*, 28–32 and 102–5.

<sup>60</sup>Cohn, *The Grid*, 3.

<sup>61</sup>Hughes, *Networks of Power*, 425–7.

<sup>62</sup>K. Kato, 'Tōkyō dentō no kigyō gappei to kōiki denki kyōkyū mō no keisei', *Keiei Shigaku*, 41 (2006), 3–27.

<sup>63</sup>J.L. Neufeld, *Selling Power: Economics, Policy, and Electric Utilities before 1940* (Chicago, 2016), 46–72.

provincially owned electric utilities in the 1910s; a nationwide Energy Industry Law was promulgated in 1935.<sup>64</sup>

Compared with Japan, the differences are that, first, in Germany and the USA, municipal regulation appeared earlier than (central) state regulation, but in Japan, the opposite occurred. Second, Japan's central-state regulation did not increase because electric power systems developed beyond the administrative boundaries of municipalities but, rather, because the Japanese administrative system as a whole was a centralized structure.<sup>65</sup> Japan's prefectural governments, whose governors were appointed by the home ministry, were not regulators of electricity. Third, the rise of (central) state regulation did not eliminate municipal regulation in Germany and the USA, but it did in Japan. Finally, the rise of central-state regulation in Japan discouraged public ownership at the local level, but this was not the case in Germany and the USA. In Germany, the central state, provinces, cities and local authorities controlled 90 per cent of the electricity supply in 1933.<sup>66</sup> In the USA, as of 1937, 55.7 per cent of electric utilities were publicly owned.<sup>67</sup> In Japan, as of 1937, only 16.4 per cent of them were publicly owned.<sup>68</sup>

In 1919, the Imperial Diet of Japan passed the Road Law. This stipulated that public roads were the creation of the central state and that the right to install and manage them belonged to the state; the law also stipulated that local governments such as cities, towns, villages and provinces should manage public roads on the basis that they acted as agents of the central state.<sup>69</sup> For the first time in Japan's modern history, the Road Law defined the ownership and management of public roads, eliminating legal ambiguities regarding rights-of-way. On the other hand, the Road Law weakened municipal electricity regulation.

With the promulgation of the Road Law, the validity of municipal franchises again became a point of dispute. Legal scholars had different opinions on this topic. Intriguingly, jurists from Tokyo Imperial University, such as Hatoyama Hideo (1884–1946) and Minobe Tatsukichi, believed that municipal franchises had become invalid, while jurists from Kyoto Imperial University, such as Sasaki Soichi (1878–1965) and Oda Man (1868–1945), argued that they were still valid.<sup>70</sup> Minobe Tatsukichi's view can be summarized as follows: with the enactment of the Road Law, local governments no longer had the right to permit the use of public roads or to claim compensation. In contrast, Sasaki Soichi understood the municipal franchise as an administrative function because the public utility occupied a part of the public road, and the franchise itself had nothing to do with whether the ownership or management of the road belonged to the central state or the local government.<sup>71</sup>

Not only jurists but also electric utilities themselves were beginning to question the validity of municipal regulation. At the beginning of 1920, Osaka Electric Light, based

<sup>64</sup>Denkikyōkaichōsabū (ed.), *Doitsu Denki Keizai No Kokumin-Teki Hensei*, 1–4.

<sup>65</sup>H. Murakami, *Nihon No Chihō Jichi To Toshi Seisaku: Doitsu – Suisu To No Hikaku* (Tokyo, 2003), 3.

<sup>66</sup>G. Ambrosius, *Der Staat als Unternehmer: öffentliche Wirtschaft und Kapitalismus seit dem 19. Jahrhundert* (Göttingen, 1984), 71.

<sup>67</sup>Kwoka, *Power Structure*, 5.

<sup>68</sup>Kikkawa, *Nihon Denryokugyo Hatten No Dainamizumu*, 107.

<sup>69</sup>Shirakizawa, 'Senzen ki niokeru chihōjichitai to denki jigyo', 74–90.

<sup>70</sup>Y. Koishikawa, 'Hōshō keiyaku no seishitsu to kōryoku: senzen niokeru hōgaku mono no giron wo chūshin to shite', *Toshi Mondai*, 9 (2015), 93–4.

<sup>71</sup>*Ibid.*, 95.

on the franchise signed in 1906 with the Osaka municipal government, applied for permission for an increase in electricity tariffs, but the municipal government rejected it. In March 1920, Osaka Electric Light's board of directors passed a resolution stating that 'at present, with the Road Law being enacted...our company has to declare that the franchise (compensation contract) has been invalidated'.<sup>72</sup> In doing so, Osaka Electric Light denied the validity of the municipal franchise. Eventually, Osaka municipalized Osaka Electric Light in 1923 to settle the dispute.<sup>73</sup>

The dispute over the validity of franchises continued throughout Japanese cities. Many of the municipal franchises signed in the 1900s–1910s were to expire within approximately 20 years, after which the municipal government could municipalize the utility or renew the franchise. However, with the Road Law, many utilities rejected municipal acquisition because they no longer regarded municipal franchises as valid.<sup>74</sup> In 1924, the city of Sasebo, which witnessed Japan's earliest electricity franchise in 1905, decided to municipalize the city's electric power system from Toho Electric Power, as the franchise between them was approaching its 20-year expiration. Toho Electric Power rejected the move. The city of Sasebo filed a lawsuit with the court, requesting that the court confirm the validity of the acquisition.<sup>75</sup> The lawsuit indicated that the validity of municipal franchises had also been weakened in small cities and prevented municipal acquisition of electric utilities.

The Ministry of Communication stood behind the scenes until the 1930s. In 1931, the Imperial Diet revised the Electric Utilities Law. The revision authorized the Ministry of Communication to check and approve prices and stipulated that the utilities' ownership transfer should also be approved by the Ministry of Communication beforehand. First, the electricity price was to be regulated by the central state regardless of whether a municipal franchise was already regulating the price. This added another blow to the validity of the municipal franchise. Second, from then on, successful municipal acquisition depended on whether the central state approved the acquisition rather than on the validity of the municipal franchise. This made the municipal acquisition of electric utilities more difficult than ever before.

In the 1930s, the Ministry of Communication thwarted many municipal acquisition plans. When franchises signed in the 1910s expired in the cities of Nagoya, Kumamoto and Hakodate, the three city governments sought to municipalize privately owned utilities based on municipal franchises.<sup>76</sup> In the case of Hakodate, for example, the city government decided to municipalize the Hakodate Water and Electricity Company based on a franchise signed in 1914. The utility disagreed with the acquisition price and declared that the franchise was invalid under the Road Law and the revised Electric Utilities Law. In response, Hakodate filed a lawsuit with the Tokyo District Court. However, in 1932, the Ministry of Communication issued an ordinance that forbade local governments from acquiring electric utilities.<sup>77</sup> At the time, even prefectures such as Gunma, Chiba, Shizuoka, Aomori, Nagano, Iwate and Shimane were planning to communalize private utilities to relieve the monetary

<sup>72</sup>H. Hagihara, *Osaka Dentō Kabushikigaisha Enkakushi* (Osaka, 1925), 535–6.

<sup>73</sup>T. Umemoto, *Senzen Nihonshihonshugi To Denryoku* (Tokyo, 2000), 64–8.

<sup>74</sup>Tokyodentō, *Tokyodentō Kabushikikaisha Kaigyō Gojunenshi*, 109.

<sup>75</sup>Koishikawa, 'Hōshō keiyaku no seishitsu to kōryoku: senzen niokeru hōgaku mono no giron wo chūshin to shite', 92.

<sup>76</sup>Umemoto, *Senzen Nihonshihonshugi To Denryoku*, 243–9.

<sup>77</sup>R. Shirakizawa, 'Shōwa shoki no denki ryōkin nesage undō', *Rekishi Kenkyū*, 660 (1994), 16–34.

revenue of prefectural governments, which had deteriorated during the Great Depression.<sup>78</sup> The Ministry of Communication, however, was worried that public ownership of local electricity systems might balkanize Japan's electricity supply. As a result, with the exception of the remote prefecture Aomori, other public acquisition plans, such as Hakodate's, were invariably rejected by the ministry.<sup>79</sup> In addition to the invalidity of the municipal franchise, the central state's intervention was another reason for the incompleteness of Japan's public ownership of electricity compared with that in Germany and the USA.

The decline of Japan's municipal regulation became inevitable with the outbreak of World War II. For the central state, electricity was a strategic resource that should be put under national control after the war with China started in 1937. The Electricity Control Law, aimed at nationalizing Japan's electric power generation, was promulgated in 1938, and the Power Distribution Ordinance was promulgated in 1942. By 1943, electric utilities all over Japan had been reorganized into one giant generation company and nine distribution companies, all under state ownership or state control. Municipal regulations were no longer necessary, and all municipal-owned utilities were merged with the distribution companies. After the war, Japan reorganized the electric power industry into nine privately owned utilities under the regulation of the Ministry of International Trade and Industry. The municipal governments did not see their former utilities being returned to them, nor were there any municipal regulations.<sup>80</sup> Japan's electricity regulation has been a centralized structure ever since.

## Conclusion

In this article, we explored the history of municipal electricity regulation in Japan. Japan's municipal electricity regulation differs in the trajectory of its origin and evolution compared with that of Western countries. In Western societies, municipal governments regulated electricity because electric power systems established their distribution system on public land; based on rights-of-way, municipal governments granted monopolies to public utilities and claimed monetary returns and price regulations from the beginning of electrification. This agreement usually took the form of a municipal franchise, which could lead to public acquisition of electric utilities at a future date when the franchise expired. Japan's experience differed in that, first, electrification and municipal regulation did not occur simultaneously; second, municipal franchises, when they appeared, were not based on rights-of-way

<sup>78</sup>Osaka Asahi Shinbun, 29 Apr. 1934.

<sup>79</sup>Kikkawa, *Nihon Denryokugyo Hatten No Dainamizumu*, 154–5. However, the central state had a different policy for gas. Following the franchise between Osaka and Osaka Gas Company in 1903, many municipalities also signed franchises with gas companies. Their validity also fell into dispute with the promulgation of the Road Law in 1919. But the dispute was resolved by the Gas Industry Law of 1923, which recognized local government acquisition of gas utilities. See Y. Koishikawa, 'Kindai nihon niokeru kōeki jigyo nohoshigaku-teki kenkyū gasu suidō jigyo wo chūshin toshite', Kyoto University Ph.D. thesis, 2010. The differences between gas and electricity can be explained by technological reasons: electricity developed from urban to regional systems which ran the risk of being balkanized by municipal acquisition, whereas the supply area of gas was centred on urban areas. Regional systems such as railways and telecommunications might have experienced a similar policy framework if they had not been nationalized.

<sup>80</sup>Kōeidenkifukugen undōshi henshūinkai, *Kōei Denki Fukugen Undō Shi* (Tokyo, 1969); Miyazakiken-denkifukugen undōshihensanīnkai, *Miyazaki Ken Denki Fukugen Undōshi* (Miyazaki, 1963).



because these were not yet defined by Japanese law; third, although municipal franchises were introduced to many cities, the central state centralized rights-of-way and thus weakened the legal basis of municipal franchises; fourth, the central state intervened and hindered the municipal acquisition of electric utilities.

The rise and fall of Japan's municipal electricity regulation occurred within half a century, from approximately 1889 to 1939. Although Japan imported electricity technology at approximately the same time that electrification started in Western societies, Japan at first did not import the Western electricity regulation framework. As a result, Japanese cities in the 1880s–1890s were electrified without municipal regulation. The Japanese central state also did not understand regulation in the same way as did Western governments, leaving electricity to free competition. It was not until the 1900s, when modern municipal administration started in Japan, that Japanese cities discovered the municipal franchise framework. From the 1900s to the 1910s, Japanese municipal governments took pains to import municipal franchises, but rights-of-way remained undefined, and the content of municipal regulation varied from city to city. Although the Road Law of 1919 clarified ambiguities in rights-of-way, the legal basis of municipal regulation was open to question. The dispute over municipal franchises continued throughout the 1920s until the revision of the Electric Utilities Law in 1931, which finally centralized regulative authority within the Ministry of Communication. The outbreak of World War II further strengthened centralization and made the decline of municipal regulation inevitable.

According to Thomas Hughes' classification of the utility–politics relation in *Networks of Power* based on case-studies of Chicago, Berlin and London, the general history of the Japanese utility–politics relations we presented in this article may be categorized by the dominance of technology. Japan's municipal electrification did not resemble that of London, where excessive regulation hindered the application of electricity technology. Japanese cities did not co-ordinate with utilities as in the case of Berlin, except in the early phase of Kyoto's electrification. As in the case of Osaka, Sasebo and Hakodate, Japanese municipal governments and electric utilities usually disputed regulations. The central state's denial of municipal acquisitions prevented Japan's electric power system from being balkanized and also contributed to the dominance of technology.