

Technical Standard in Transition: The Distribution Voltage Conversion Project in South Korea, 1967-2005*

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On November 3, 2005, the Korea Electric Power Company (KEPCO) put out a press release announcing that the “thirty-two year project to raise the distribution voltage to 220V is now complete.” According to KEPCO, the project began in 1973, comprising a complete transition of the national electric utility system, which had employed the 100V standard since the beginning of electrical service during the Japanese colonial period.¹ As one could expect, the implications of converting the voltage standard from 100V to 220V went far beyond simply raising the voltage from the supplier’s end. It involved the replacement of power plugs and electrical appliances in each and every household, as well as the active participation of electrical manufacturers to change their product specifications in accordance to the new standard. Simply put, the success of the project hinged upon a comprehensive transition of the national electrical grid at every level.

The story of South Korea’s voltage standard conversion raises interesting questions on the character of large-scale technological systems. As is widely known, the late historian of technology Thomas P. Hughes has extensively discussed the life cycle of sociotechnical systems, of which the electrical grid is a prime example. In his masterful comparative analysis of electric power systems in the United States, Great Britain, and Germany, he observes that technological systems invariably experience stages of growth and decline throughout their lifetimes.² As a system matures, it acquires what Hughes calls “technological

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¹ KEPCO Public Relations Office, “Hanjeon, 32nyeone geolchin 220V seung-ap sa-eop wallyo (KEPCO completes the voltage conversion project after thirty-two years),” 3 November 2005.

² Hughes identified five stages in the evolution of large-scale technological systems: (1) invention, (2) development, (3) innovation, (4) technology transfer, (5) growth, competition &

momentum” which, like its counterpart in physics, makes it difficult to change its course.³ Hughes’ insight provides partial explanation for the Korean project’s longevity. Given the large technological momentum that the Korean electrical system had acquired in the early 1970s, it was no surprise that it took more than three decades to complete the transition.

In broad strokes, the Hughesian theory of technological systems is a version of evolutionary theory of economics. We can take standards as a critical system component, in which a large portion of the technological momentum is vested. The difficulty of converting from one standard (100V) to another (220V) can be explained by the notion of path dependency. Analyzing the competing Qwerty and Dvorak standards in keyboards, economic historian Paul A. David argues that the dominance of the former in the age of electronic computers is a product of historical accident during the mechanical typewriter era. Once a standard “locks in” to a particular version, it becomes extremely difficult to break away due to the massive economic, technological, and social vested interest. This is why we still use the Qwerty keyboard even when there are more efficient options available.⁴ Both Hughes and David focus on the stability of mature systems, rather than transitions.

But some technical standards do undergo transitions. Other economists – mostly those of a neoclassical bent – have pointed to the power of market mechanisms and entrepreneurs in overcoming path dependencies. From the neoclassical viewpoint, the persistence of an inferior standard poses profit opportunities for entrepreneurs, who will find ways – such as product promotion, coordination, and cooperation – to make possible the transition to superior standards. Although technological momentum, path dependency, and network externalities make standard conversion difficult, profit-driven entrepreneurs overcome the obstacles in the long run to make the transition to an alternative, more superior, standard. From this point of view, the persistence of Qwerty simply means that the standard was superior to the available alternatives at the time.⁵

stabilization. See Thomas P. Hughes, “The Evolution of Large Technological Systems,” *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, eds. (Cambridge, MA: MIT Press, 1987), pp. 51-82; idem, *Networks of Power: Electrification in Western Society* (Baltimore: Johns Hopkins University Press, 1983).

³ A classic discussion of technological momentum is Thomas P. Hughes, “Technological Momentum in History: Hydrogenation in Germany 1898-1933,” *Past and Present* 44(1) (1969): 106-132.

⁴ Paul A. David, “Clio and the Economics of QWERTY,” *The American Economic Review* 75(2) (1985): 332-337. See also W. Brian Arthur, *Increasing Returns and Path Dependence in the Economy* (Ann Arbor, Michigan: University of Michigan Press, 1994).

⁵ Based on thorough historical research, S. J. Liebowitz and Stephen E. Margolis, “The Fable of the Keys,” *Journal of Law and Economics* 33(1) (1990): 1-25, argue that the technical superiority of the Dvorak standard was exaggerated. Thus, the continued dominance of the Qwerty standard was not due to path dependency, but rather because entrepreneurs did not see a profit opportunity in the Dvorak standard.

Indeed, throughout the history of technology we can find many examples of standard conversion. The task, then, is to identify when and how one standard transitions to another.⁶ Who were the key players in the South Korean distribution voltage conversion project? What were the strategies that they have employed to overcome technological momentum? What were the broader circumstances that allowed and hindered the task? Similar to the entrepreneurs in the neoclassical argument, the initial motivation and rationale for the South Korean project came from economic considerations. The proponents of voltage conversion claimed that the economic benefits that will accrue to the nation by adopting the new voltage standard would outweigh the cost of its implementation by significantly reducing power loss and increasing the power utilization capacity.

Economic motivation alone is not sufficient for explaining the successful completion of the project, however, especially as it dragged along for more than three decades. Therefore, this paper pays particular attention to the role of *technocratic entrepreneurs* in KEPCO, the Ministry of Commerce and Industry (MCI, Sanggong-bu), the Ministry of Energy and Resources (MER, Dongnyeokjawn-bu), and other related government agencies, as key players that made possible the conversion of a technical standard.⁷ Like the neoclassical entrepreneurs, the technocratic entrepreneurs took the risk of implementing a drastic change of a major technical standard in the national electrical grid with the aim of securing economic benefits for the nation.⁸ However, unlike conventional entrepreneurs, they wielded the power to direct market behavior by drafting policy directives, laying out detailed plans, and issuing administrative orders, especially within the context of the South Korean “developmental state” during the 1970s and 80s.⁹ Since the mid-1960s, these technocratic entrepreneurs drew plans, persuaded

⁶ A recent study along this line is Douglas J. Puffert, *Tracks across Continents, Paths through History: The Economic Dynamics of Standardization in Railroad Gauge* (Chicago: University of Chicago Press, 2009).

⁷ The term “technocratic entrepreneur” is used to signify the group of technically-trained bureaucrats, who were responsible for managing the nation’s electrical system. Within the context of South Korea at the time, this group comprised a tightly-knit group of people at KEPCO and the relevant government agencies (MCI, MER), which may be called the government-industry complex. Although KEPCO, as a public corporation, was not part of the government bureaucracy per se, the company was charged with providing monopoly electrical services to the nation, and therefore maintained strong ties with MCI and MER.

⁸ The Merriam-Webster dictionary defines “entrepreneur” as “one who organizes, manages, and assumes the risks of a business or enterprise.” The defining character of entrepreneurs is that they take calculated risks in introducing innovations for the purpose of reaping disproportionate economic benefit. Thus, we believe that the officers at MCI, MER, and KEPCO were not merely bureaucrats or technocrats, but should be referred to as “technocratic entrepreneurs” in order to capture their behaviors of taking risks and implementing innovations.

⁹ Chalmers Johnson, *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925-1975* (Stanford: Stanford University Press, 1982), first used the term “developmental state” to explain Japan’s rapid economic growth. For an overview of the South Korean developmental state, see Alice H. Amsden, *Asia’s Next Giant: South Korea and Late Industrialization* (New York:

various stakeholders, and implemented technological fixes to overcome the technological momentum vested in the 100V standard. The project could be completed only with the persistence of the technocratic entrepreneurs, who perceived the problem through the lens of national planning. In the end, it was the bureaucratic momentum vested in the project itself that accounts for the successful transition of the technical standard.

From ECAFE to Initial Planning, 1963-1970

The initial spark that began the South Korean voltage conversion project came from outside the country. In 1963, the Economic Committee in Asia and the Far East (ECAFE) of the United Nations made a recommendation that it would be beneficial for Asian countries in the early stage of electrification to standardize their distribution voltages to the international standard recommended by the International Electro-Technical Commission. Established in 1947, ECAFE initially aimed to address the “short-term needs of reconstruction and rehabilitation [of the region] in the aftermath of the [Second World] war.”¹⁰ By 1960, as more Asian nations joined ECAFE as members, the committee set its eyes upon longer-term industrialization and regional harmonization. ECAFE’s initiatives in the 1960s included statistical development, economic planning, international trade, and survey of regional natural resources.¹¹

ECAFE’s interest in electric power was part of its broader mission in regional integration and harmonization. As early as December 1961, the committee held the Regional Seminar on Energy Resources and Electric Power Development in Bangkok, Thailand, during which it “emphasized the urgent [sic] need for standardization in the countries of the region to permit interchange of personnel, transmission of power across national boundaries and rapid growth of electricity supply in general.” Therefore, the committee continued, it would be beneficial for member countries to adopt the “internationally accepted standard voltages, for example, the 240/415 volt, 3-phase, 4-wire system.”¹² Toward this goal, ECAFE

Oxford University Press, 1989) and John Minns, “Of Miracles and Models: The Rise and Decline of the Developmental State in South Korea,” *Third World Quarterly* 22(6) (2001): 1025-1043.

¹⁰ Leelananda de Silva, “From ECAFE to ESCAP: Pioneering a Regional Perspective,” in *Unity and Diversity in Development Ideas: Perspectives from the UN Regional Commissions*, ed. Yves Berthelot (Bloomington, IN: Indiana University Press, 2004), 132-167, on 140.

¹¹ Ibid, 157-165.

¹² Economic Commission for Asia and the Far East, *Annual Report (21 March 1961 – 19 March 1962), Economic and Social Council Official Records: Thirty-Fourth Session Supplement No. 2* (New York: United Nations, 1962), 4. The 240V was domestic voltage and 415V was power voltage. Individual nations adopted slightly different voltage standards of 220, 230, 240V, all of which were regarded as “200V grade” within permissible tolerance. South Korea decided its standard voltage to be 220/380V.

set up an expert working group to “study the problems of standardization of equipment, methods and practices in the field of electric power.”¹³

Within a few years after ECAFE’s recommendation, voltage conversion was firmly on the South Korean policymakers’ agenda. After a few years of pilot projects at select locations around the country, KEPCO officially announced the beginning of the project in early August 1967. The kick-off of the project revealed the haphazardness of the South Korean bureaucracy at the time. On August 2, KEPCO president Pak Yeongjun, a former military general who had been appointed to the post in 1961, hastily claimed that voltage conversion will take place alongside the Second Five-Year Economic Development Plan (1967-1971). Pak’s premature announcement was quickly revoked the following day, and the plan expanded to a more leisurely (or, so it seemed at the time) fifteen-year plan. KEPCO decided that the project would begin in the rural areas that were just getting a kick start in electrification.¹⁴ This would give the public utility some time to prepare for the more heady problems in the urban areas, such as Seoul and Pusan, with relatively high rates of electrification.¹⁵

Despite the bumpy start, it was clear that the Korean policymakers were committed to voltage conversion. The available evidence supported their decision. Raising the distribution voltage to 220V would lower power loss and yield higher quality electricity to the consumers. Why else, as a 1968 KEPCO report claimed, would almost all the major countries (50 out of 57) around the world have adopted the “200V grade” standard voltage for household use? The conspicuous exceptions to this global trend were the United States and Japan.¹⁶ The KEPCO officials were highly confident of their judgment. “Considering this international trend,” they concluded, “raising the standard voltage to the 200/400V grade is essential for the future of our nation.” The project was worth pursuing and the time was ripe. “We are currently standing at a critical juncture,” the report continued. “We must take resolute action to grab this opportunity, which will modernize our infrastructure and provide better quality electricity more cheaply and safely to the consumers.”¹⁷

What was the “critical juncture” mentioned in the KEPCO report? South Korea in the early 1960s was in the eve of economic take-off and policymakers were well aware of its beginning rumbles. Between 1961 and 1968, the national power

¹³ Ibid, 72.

¹⁴ The “Rural Electrification Project (nong-eochon jeonhwa sa-eop)” began in 1965, raising the electrification rate in rural areas from 12% in 1964 to 33.5% (expected) in 1971. *Nong-eochon jeonhwa sa-eob hyogwajeogin chujinbang-an* (Effective measures to promote the Rural Electrification Project), Asea Gyeongjegaebal Hyeophoe, October 1970, p. 61.

¹⁵ “Seung-ap’eun 15nyeong-gyehoek-euro,” *Donga Ilbo*, 4 August, 1967.

¹⁶ According to the report, the only countries that used a 100V grade voltage standard were the U.S., Canada, Japan, the Philippines, Taiwan, and South Korea. O Changseok, Yuk Naeseung, Im Gwangjae, “200V baejeon munjereul yeohahi chujinhae nagal geosin-ga? (How to promote the 200V power distribution problem?)” [n.d., 1968?], 21, copy provided to the authors by Nam Jungil.

¹⁷ Ibid, 127.

generation capacity grew more than three-fold from 367MW to 1,274MW.¹⁸ Consumers, especially in the urban areas, were beginning to purchase more electrical appliances. Overall, however, South Korean electrification was still in its infancy. The country was still far behind Japan, a country that had experienced rapid economic growth during the 1950s. According to the KEPCO report, 93.8% of Japanese households possessed at least one television in 1966. The number was 8.85% for South Korea in August 1967. For electric washing machines, the figures were 41.6% for Japan versus 0.075% for Korea.¹⁹ Thus, it is not difficult to understand why it was virtually impossible for Japan (as with the U.S.) to transition into the 200V grade standard. Indeed, Japanese bureaucrats had abandoned the idea in the late 1950s after a detailed assessment of Japan's situation.²⁰ The ironic burden of economic development did not apply to South Korea. But the window of opportunity was closing quickly.

The policymakers may have been correct in recognizing the latter 1960s as the "critical juncture," but the disorganized and unilateral planning process led to confusion and inconveniences for the households affected by the project. As a major newspaper noted, there was "fierce resistance" to voltage conversion among consumers, especially at the initial stages of the project.²¹ The largest complaint was the lack of new electric appliances meeting the new voltage standard. Manufacturers were not given enough time to prepare for the conversion and were still selling 100V appliances. Consumers, therefore, were forced to purchase transformers, at their own expense, to reduce the voltage from 220V to 100V. The widespread use of transformers meant higher electric bills, inefficient use of electricity, and more frequent malfunctioning of the appliances. This clearly shows that, at the early stages of the planning process, the proponents of voltage conversion had their eyes fixed on the big picture with little regard for individual consumers, perhaps typical of technocrats in late industrialization.

Persuading the Stakeholders, 1970-1979

A critical component of the voltage conversion project was the widespread availability of newly designed electrical appliances for the new standard. Throughout the 1970s, KEPCO and MCI focused on persuading the appliance manufacturers to make the conversion in their product lines. The gradually changing standard required 100/220V dual-use appliances to be competitive in the marketplace. As late as 1972, however, a newspaper article reported that there was

¹⁸ Korea Electric Power Company, *Han-gukjeollyeok baengnyeonsa* (The centennial history of KEPCO) (Seoul: KEPCO, 1989), 1476.

¹⁹ O, Yuk, and Im, "How to Promote," 103-105.

²⁰ Ibid, 101.

²¹ "Banbal geosen 'seung-ap' gajeongjeon-ap 2baekbolteu-ui deuksil," *Donga Ilbo*, 5 August 1967.

“not a single domestic manufacturer that is producing 220V-exclusive or dual-use devices.” There were two reasons for the lack of enthusiasm on the part of the manufacturers. First, in the initial stages of voltage conversion KEPSCO seemed to think that converting 100V appliances for 220V would be relatively easy. Hence, less pressure was exerted toward the manufacturers to make dual-use devices. The other reason was the rising production costs. According to an expert estimate, production costs for 100/220V dual-use devices were at least 7.7% higher than the regular 100V ones. Thus, it was understandable that manufacturers were reluctant to make the transition especially when the voltage conversion project was progressing at a much slower pace than originally expected.²² Even by 1977, a decade after the initial plan, the conversion rate was only 28.4%, the majority of which was conducted in the rural areas with significantly less demand on electric appliances.²³

Thus, by the early 1970s, it became clear that something had to be done to incentivize the electrical appliance manufacturers. On February 26, 1973, KEPSCO proposed a new fifteen-year plan emphasizing, among other things, the development of dual-use devices.²⁴ The plan included subsidizing the costs of developing dual-use and 220V-exclusive appliances. The subsidy was determined by the price difference between the new device and the regular 100V device. For example, for every dual-use television set produced, Goldstar Electronics received 772 won for up to 3,000 units.²⁵ The subsidy, which was less than 1% of the retail price, was simply not enough to jump-start the industry to convert to the new standard. In short, the market was not responding to the policy directions of the government. If the industry was not responding to incentives, KEPSCO and the government had no other choice but to force them. Despite the dictatorial military regime under President Park Chung-hee, it was by no means clear whether this would be successful.²⁶

²² “Munjejeom maneun seung-ap songjeon,” *Kyunghyang Shinmun*, 20 January 1972.

²³ Ministry of Commerce and Industry, “220V Baejeon jeonap seung-ap gyehoek (Plan for 220V distribution voltage conversion),” 1977, DA0729672, p. 439, National Archives of Korea.

²⁴ “Hanjeon 89nyeonkkaji 220V-ro seung-ap,” *Maeil Kyongje*, 26 February 1973.

²⁵ Korea Electric Power Company, “Baejeon seung-ap sumeun dwinyaegi (3) (Behind-the-scenes story of distribution voltage conversion [3]),” *Jeon-gi seolbi* (November 2006), 51. In 1973, the price of a 19-inch Goldstar Electronics TV was about 87,500 won. “Sihwang,” *Maeil Kyongje*, 14 April 1973.

²⁶ In October 1972, Park had managed to revise the constitution, known as the *Yushin* constitution, to allow for a virtual life-term as the President with unprecedented power. For more details on the *Yushin* regime, see Hyug Baek Im, “The Origins of the *Yushin* Regime: Machiavelli Unveiled,” in Byung-Kook Kim and Ezra F. Vogel, eds., *The Park Chung Hee Era: The Transformation of South Korea* (Cambridge, MA: Harvard University Press, 2011), 233-264.

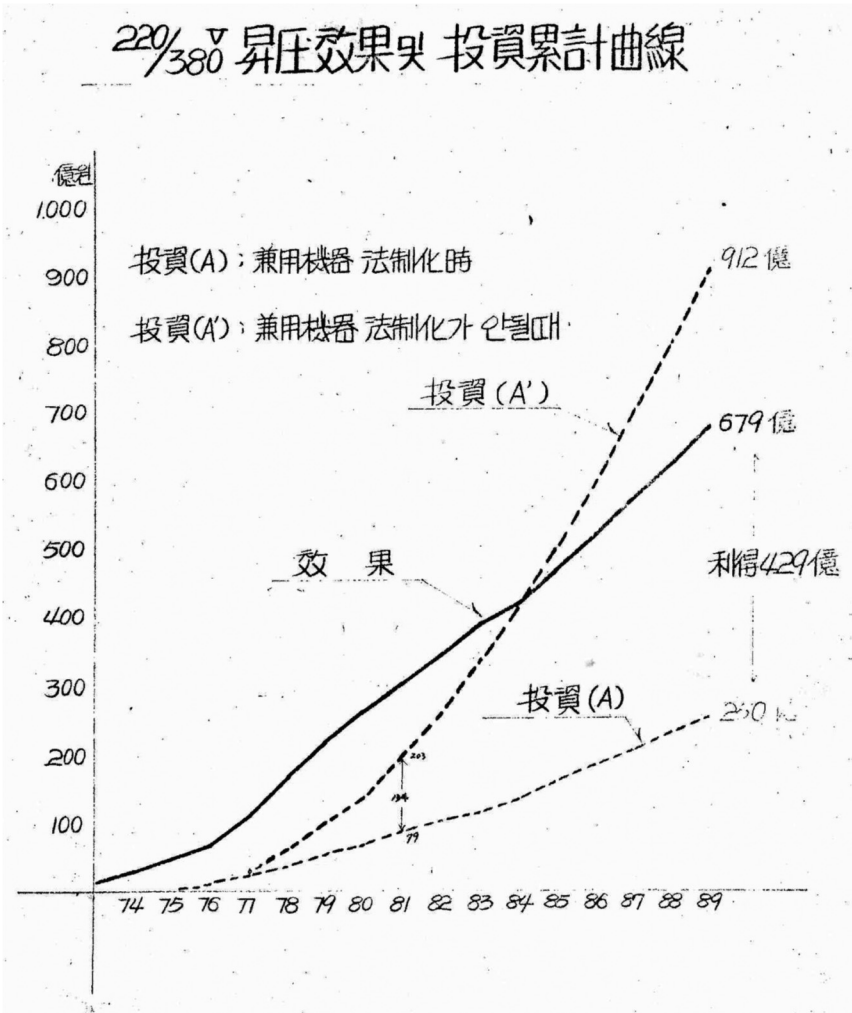


Figure 1. “Effects of 220/380 Voltage Conversion and Accumulated Investment,” 1976, DA0729672, p. 473, National Archives of Korea. Note that the potential investment without the prohibition of dual-use devices (A’) was estimated to overtake the economic benefit of voltage conversion (unbroken line) by 1984, while the investment with prohibition (A) would remain well below the unbroken line.

The new policy stance was reflected in the “220V Voltage Conversion Short-Term Five-Year Plan” of 1978. The new strategy was initiated in January 1976, when Kim Youngjun, a former Minister of Agriculture, was appointed as the new president of KEPCO. Upon assuming office, Kim placed priority on accelerating the voltage conversion project that had been in quagmire during the last decade. He identified the lack of dual-use devices as the major bottleneck. KEPCO’s proposed solution was to prohibit the model approval of 100V-exclusive appliances. To support the proposal, the company prepared a graph titled “Effects of 220/380V Voltage Conversion and Accumulated Investment.” The graph indicated the economic benefits of voltage conversion as 67.9 billion won.²⁷ The expected investment, if the prohibition were to be enacted, was 25 billion won, as opposed to 91.2 billion won without the prohibition.²⁸ The implication of the graph was clear. Unless the government took immediate action, the economic benefit of the voltage conversion project would be completely nullified.

KEPCO’s new plan to accelerate the project was not met with unanimous support even within the government. The first line of resistance came from the Industrial Advancement Administration (IAA, Gong-eopjinheungcheong), an agency under MCI responsible for approving model specifications for industrial products. On 8 July 1976, a KEPCO representative visited IAA to explain the necessity of the voltage conversion project and formally request IAA’s cooperation in prohibiting the 100V-type appliances. Three schemes were put on the table. (1) The first scheme was to make 100/220V dual-use appliances mandatory by law, which was what KEPCO wanted. (2) The second plan was to reduce the commodity tax for dual-use appliances. (3) The third was to subsidize the manufacturers for the increased production costs from KEPCO’s budget. The IAA bureaucrat who attended the meeting favored “inducing the voluntary participation of manufacturers” rather than taking coercive legal measures. He pointed out that regulating the 100V-exclusive appliances in the marketplace would be close to impossible. The IAA bureaucrat’s final recommendation was to go with plan #2, or plan #3 depending on the budgetary situation.²⁹ Even under the authoritative *Yushin* regime, governmental power over private industry was not unilateral.

In the end, however, MCI overrode IAA’s recommendation and granted KEPCO’s wish. The decision reflected the South Korean government’s—as well as KEPCO’s—strong will to cut the Gordian knot of voltage conversion. In order to signal its switch to a tougher stance, MCI hosted a government-industry meeting on 21 December 1976 to “promote the production and dissemination of dual-use

²⁷ In 1977, the sales profit of KEPCO was 89.9 billion won and the net profit was 71.8 billion won. Korea Electric Power Company, *Han-gukjeollyeok baengnyeonsa*, 1468.

²⁸ “220/380V seungap hyogwa mit tujja nugye kokseon (Effects of 220/380V voltage conversion and accumulated investment),” 1976, DA0729672, p. 473, National Archives of Korea.

²⁹ Kim Yujae, “2-cha jeonap seung-abe ttareun munjeom mit daechaek (Problems and countermeasures in secondary voltage conversion),” 24 July 1976, DA0729672, pp. 462-466, National Archives of Korea.

products” with major manufacturers such as Goldstar and Samsung Electronics.³⁰ In early 1978, the ministry announced an ambitious roadmap to complete the voltage conversion project by the end of 1982—hence the “Short-Term Five-Year Plan.” This was not simply an accelerated version of the previous plans. In contrast to the earlier efforts, the plan in the late 1970s focused on the populated urban areas, where households already owned a significant number of electric appliances. Therefore, the precondition of this plan was the legal prohibition of 100V-exclusive devices with an appropriate grace period. The prohibition would officially begin in January 1979, the first stage banning relatively simple devices, such as television, radio, and VTR. The prohibition plan was to gradually expand to the full range of electrical products, enforcing manufacturers to invest in the development of new models for the 220V standard.³¹ As the media at the time put it, the government measures of the late 1970s were tantamount to a “revolution in electricity.”³²

All revolutions are followed by reactions, and the situation can be either a threat or an opportunity for those involved. The strongest reaction came, not surprisingly, from the electrical appliance manufacturers. Even before the beginning of the official prohibition of 100V-exclusive appliances, industry leaders were threatening to boycott the production of dual-use devices if the government does not allow for a significant rise of cost. The majority of the manufacturers perceived the government’s change of pace as a “220V shock.”³³ But for others, this was an opportunity to win additional market share. In May 1979, Goldstar Electronics launched its “Snow (nunpyo)” refrigerator claiming that it was the “only 100/220V dual-use product in the market.” The advertisement explained that “Goldstar have developed [the new product] to cooperate with government policy and accommodate customer needs.” “After 1982,” the ad continued, “you cannot use the 100V-exclusive refrigerators anyway,” signaling the company’s support for the Short-Term Five-Year Plan.³⁴ Now was the time for customers to make the switch.³⁵

³⁰ “100-220volt gyeomyong gajeonjepum saengsan jedohwa bang-an geomto,” *Maeil Kyongje*, 22 December 1976.

³¹ “100V-gajeonjepum nanyeonbuteo saengsan geumji,” *Maeil Kyongje*, 11 May 1978.

³² “Jeokgi danhaengdoen ‘jeongi hyeokmyeong,’” *Kyunghyang Shinmun*, 11 May 1978.

³³ “100-220volt gyeomyong gajeonpum apdanggyeo saengsan,” *Maeil Kyongje*, 11 April 1978; “Gajeonjepum upgye ‘220V shock,’” *Donga Ilbo*, 13 May 1978.

³⁴ Goldstar’s ad for the “Snow” refrigerator was published in *Kyunghyang Shinmun*, 23 May 1979.

³⁵ Some controversies ensued after Goldstar’s release of the Snow refrigerator. Its main competitor, Samsung Electronics, claimed that it was false advertisement and Snow was an “abnormal” product that “ignored the common sense of electrical technology.” Samsung’s point was that there was nothing novel about Goldstar’s product that meets the latter’s claim. Goldstar had simply internalized the transformer to convert the voltage, which was what many customers have been doing all along. This episode was known as the “refrigerator battle.” “Naengjanggojepum seongneung ‘gyeomyong’ sibi ssago Geumseong Samsung nonjaeng jaeyeon,” *Kyunghyang Shinmun*, 25 May 1979.

기술·상징
주식회사 금성사

**승업에도 관계없이 쓸 수 있는
100V·220V 겸용냉장고는
금성사 냉방냉장고뿐입니다.**

● 금성사, 국내 최초로
100V·220V 겸용냉장고 개발

많은 분들이 전압이 220V도 되면 한꺼번에 100V용 가전제품은 어떻게 해야하는지 궁금해하고 계십니다. 220V용으로 제조를 하든지, 장남용(雙用型)트랜스를 달아 쓰셔야 합니다. 그러나 이제, 승압이 되어도 구매에 계조를 하거나 별도로 트랜스를 달지 않아도 되는 새로운 냉장고가 나왔습니다. 금성사는 정부의 승압정책에 호응하고 소비자의 편의를 도모하기 위하여 우리나라에서는 최초로 100V·220V 겸용 냉장고를 개발한 것입니다.

100V·220V 겸용

● 100V·220V 겸용냉장고는 이런 점에서

100V·220V 겸용 냉장고는 냉장고는 스위치 하나만 전압을 자유롭게 선택할 수 있는 새로운 타입의 냉장고입니다. 여기서——

(이점 1) 세로아래에 코팅은 트랜스를 내장하여 별도의 코로브나 별도의 트랜스를 달 필요가 없습니다.

(이점 2) 100V·220V 겸용 냉장고는 냉장고로 설계되어서 220V 이외에서는 물론 100V에 대해서도 전압이 바뀌어 줍니다.

(이점 3) 100V 전용 냉장고는 냉장고입니다.

이와 같은 별도의 트랜스를 달지 않고 10여 년 전부터 100V·220V 겸용 냉장고를 추가로 부단히 연구하고 있습니다. 그러나 100V·220V 겸용 냉장고는 트랜스를 따로 달 필요가 없으므로 승압이 되면 소비자의 편의를 크게 줍니다.

(이점 4) 220V에서 100V로 전압을 바꾸기 위해서는 별도의 코로브나 트랜스를 달아야 합니다. 사용이 편리하도록 제조를 하거나 트랜스를 달아야 합니다. 따라서 이제, 겸용냉장고를 사시는 것이 이익입니다.

(이점 5) 100V에서 220V로 전압을 바꾸기 위해서는 별도의 코로브나 트랜스를 달아야 합니다. 사용이 편리하도록 제조를 하거나 트랜스를 달아야 합니다. 따라서 이제, 겸용냉장고를 사시는 것이 이익입니다.

220V에서는 이차의 100V전을 냉장고는 그대로 쓸 수가 없습니다. 이때와 때로는 100V·220V 이차나 쓸 수 있는 겸용냉장고를 구입하십시오. 나중에 설계된 전압으로 전압이 바뀌는 것보다는 이제, 겸용냉장고를 사시는 것이 이익으로 이익입니다.

금성사 냉방냉장고

● 금성사 제품인 100V·220V 겸용냉장고는 전압을 자유롭게 선택할 수 있는 새로운 타입의 냉장고입니다. 여기서——

(이점 1) 세로아래에 코팅은 트랜스를 내장하여 별도의 코로브나 별도의 트랜스를 달 필요가 없습니다.

(이점 2) 100V·220V 겸용 냉장고는 냉장고로 설계되어서 220V 이외에서는 물론 100V에 대해서도 전압이 바뀌어 줍니다.

(이점 3) 100V 전용 냉장고는 냉장고입니다.

(이점 4) 220V에서 100V로 전압을 바꾸기 위해서는 별도의 코로브나 트랜스를 달아야 합니다. 사용이 편리하도록 제조를 하거나 트랜스를 달아야 합니다. 따라서 이제, 겸용냉장고를 사시는 것이 이익입니다.

(이점 5) 100V에서 220V로 전압을 바꾸기 위해서는 별도의 코로브나 트랜스를 달아야 합니다. 사용이 편리하도록 제조를 하거나 트랜스를 달아야 합니다. 따라서 이제, 겸용냉장고를 사시는 것이 이익으로 이익입니다.

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● 금성사 제품인 100V·220V 겸용냉장고는 전압을 자유롭게 선택할 수 있는 새로운 타입의 냉장고입니다. 여기서——

(이점 1) 세로아래에 코팅은 트랜스를 내장하여 별도의 코로브나 별도의 트랜스를 달 필요가 없습니다.

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Figure 2. The newspaper advertisement for the Goldstar “Snow” refrigerator. The main copy in the upper left reads: “The Goldstar Snow refrigerator is the only 100V/220V dual use refrigerator that can be used after voltage conversion.” *Kyunghyang Shinmun*, 23 May 1979. Courtesy of LG Electronics.

Persuading the appliance manufacturers was one thing; enrolling tens of millions of households to make the switch was something quite different. Active participation of the consumers was pivotal, among other things, for the success of the voltage conversion project, since the completion of the project required changing the electrical equipment – such as power outlets – in individual households. This was not something that the government could mandate, as it attempted to impose legal prohibition upon manufacturers, at least in a nominal capitalist economy. KEPCO officials understood this, and launched a major public relations campaign in 1982. In June and July of that year, KEPCO placed advertisements (prepared by a renowned cartoonist Shin Dong-woo) in eight national and seven regional newspapers. A similar notice was published in monthly bulletins of neighborhood meetings around the country. KEPCO officials also held twenty-four town hall meetings to explain the benefits of switching to 220V. The

전기제품을 220볼트로 사용하면 여러분에게 이익이 됩니다

전기제품을 220볼트로 사용할때의 잇점

냉장고나 냉장용 쇼케이스를
220볼트로 사용하면 전기요금
이 절약됩니다



100/220볼트 겸용 냉장고를 220볼트로 사용할때 연간 전기요금절감액

냉장고 용적	소비 전력량 감소 (연간)	월 100kwh 사용하는 경우	월 150kwh 사용하는 경우	월 200kwh 사용하는 경우
200~250리터	48~84 kwh	4,121~7,212원	5,631~9,854원	8,165~14,290원
251~300리터	84~96 kwh	7,212~8,242원	9,854~11,262원	14,290~16,331원
301~400리터	84~120 kwh	7,212~10,303원	9,854~14,078원	14,290~20,414원

●전기요금은 82.6 기준임

양수기를 220 볼트로 사용시 전등이나 텔레비전의 깜박거림이 없어집니다

500 와트 이상의 양수기를...

100볼트로 사용할때 { 전등, } 깜박거림 발생 ▶ 수송가 부담 공사비 추가발생
220볼트로 사용할때 { 텔레비전 } 깜박거림 없음 ▶ 한국전력 무료 공사로 해결



에어콘등 용량이 큰 전기
제품도 옥내 배선을 추가로
시설하지않고 사용할수 있
습니다

100볼트 가정에서 220볼트 전기제품을 사용하고자 할때
양전압 공사를 신청하면 무료로 공사하여 드립니다



한국전력공사

0191

Figure 3. Public relations pamphlet distributed by KEPCO in 1982. The illustrations in the pamphlet were prepared by the renowned cartoonist Shin Dong-woo. “220V seung-ap gongsa hongbo jaryo (Statistics of public relations on 220V voltage conversion work),” August 1982, DA0729675, p. 191, National Archives of Korea.

main message was that “using 220V saves electricity.” The ad claimed that by using 220V, each household could save between 48 and 120KWh of electricity per year, which would significantly lower their electric bills. Moreover, KEPCO emphasized that it would install the new electric wiring free of charge to the consumers.³⁶

By the late 1970s, economic development finally caught up, slowly but surely. Throughout the decade, the South Korean economy was well into rapid-growth mode with its national income growing at approximately 7% per annum on average. From the perspective of the voltage conversion project, this meant a rapid increase of the number of electric appliances. The premise of KEPCO’s “Short-Term Five-Year Plan” strategy was that each household owned 5.26 units of appliances in 1978. However, when KEPCO officials conducted a comprehensive survey of all households in Yangju County, Gyeonggi Province, they found more than 8 units per household, the bulk of which were 100V-exclusive devices.³⁷ The disparity represented higher expenditures for KEPCO for the completion of the project, as well as significant delay in the natural extinction of 100V appliances. The realization that the voltage conversion project would take much longer and would be more expensive than originally expected led the KEPCO officials to start thinking about a strategic retreat from the short-term plan.³⁸ By January 1979, MER was considering a two-year extension of the plan, aiming to complete the project in 1985, acknowledging that the original plan was “unreasonable.”³⁹

Given the lack of systemic statistics, this was understandable. The statistical disparity in Yangju was not an isolated incident. The numbers used in the planning process before 1979 was based on a KEPCO survey of five thousand households, divided by rural (20%), small and medium-sized cities (60%), and metropolitan areas (20%). The survey was conducted by KEPCO employees lacking formal training in statistical methodology. Furthermore, within the context of KEPCO’s intense campaign emphasizing the preservation of electricity, customers were more likely to under-report the number of appliances. In order to obtain the full picture, in June 1979 KEPCO asked Pak Hongnae, the President of the Korean Statistical Society and professor at Seoul National University, to conduct a sample survey

³⁶ “220V seung-ap gongsa hongbo jaryo (Statistics of public relations on 220V voltage conversion work),” August 1982, DA0729675, pp. 180-219, National Archives of Korea.

³⁷ “Jintong gyeokneun seung-ap gyehoek,” *Maeil Kyongje*, 27 November 1978.

³⁸ Of course, KEPCO and the Ministry of Energy and Resources (MER, a new ministry created in December 1977 that took over part of MCI’s domain) categorically denied that there was a change of policy. On 20 February 1979, IAA Director An Yeongcheol sent a memo to MER inquiring whether there was a “change of policy in the voltage conversion plan.” The chief of the MER Electricity Bureau replied that, while there had been a “slight delay,” the policy stands firm. Minister of Energy and Resources to Director of Industrial Advancement Administration, “Baejeon jeonap 220V seung-ap gyehoek chujin (Policy for the 220V distribution voltage conversion plan),” 27 February 1979, DA0729672, p. 197, National Archives of Korea.

³⁹ “Seung-ap gyehoek jeonmyeon jaejojeong,” *Kyunghyang Shinmun*, 10 January 1979.

based on formal statistical methods.⁴⁰ The results were striking. Pak's survey showed that the number of electrical appliances per household was 15.32, or more than 2.5 times the number originally believed by KEPCO.⁴¹ It was no surprise that the voltage conversion project was moving at a much slower pace than expected. The time was ripe for an exit strategy.

The Technological Fix and the Beginning of the Waiting Game, 1979-2005

When the South Korean government and KEPCO realized the realistic status of the project in mid-1979, it became clear that the "Short-Term Plan" was no longer viable. The project would not be completed by 1983, or even 1985. KEPCO's dilemma was that it was already on a one-way highway. Four out of ten households had already been converted to the new voltage standard, and the accumulated investment in the project had grown to a significant amount during the last decade or so. Now there was no turning around. On the other hand, customers were continuing to purchase new 100V-exclusive appliances at increasingly higher rates. Most manufacturers, except for a few large companies, dragged their feet in making the transition to 220V devices, either because of cost considerations or technical incapability. South Korea was well on its way to full electrification by the end of the 1970s. The new reality undermined the basic assumption of the project – the need to "grab the opportunity" of underdevelopment – when it began in the late 1960s.

At this point, KEPCO sought a technological fix to the problem. In the middle of 1979, the company adopted the "dual voltage method" using a single-phase three wire system, which would allow for the usage of both 100V and 220V devices in each household. KEPCO's plan was to add another wire to the electric line from the pole transformer to the electric meter in each household. Through this method, the customer could have access to both voltages, depending on the wire connection.⁴² In September 1979, the dual voltage method was officially accepted by KEPCO and MER. In a meeting held at the MER headquarters that month,

⁴⁰ Yun Seokgong (former KEPCO manager), interview with the authors, 20 June 2012.

⁴¹ Korea Electric Power Company, "Baejeon seung-ap sumeun dwinniyagi (4) (Behind-the-Scenes Story of Distribution Voltage Conversion [4])," *Jeon-gi seolbi* (December 2006), 45.

⁴² "Dongjabu dansang 3seonsik baejeon seontaek," *Maeil Kyongje*, 16 June 1979. It is not entirely clear who first came up with this idea. According to KEPCO records, the technical advice of Yi Seung-won (professor of electrical engineering at SNU) was critical to the decision. Korea Electric Power Company, "Baejeon seung-ap sumeun dwinniyagi (4) (Behind-the-scenes story of distribution voltage conversion [4])," *Jeon-gi seolbi* (December 2006), 46. On the other hand, technocrat O Woncheol claims that he had observed the method in a U.S. Air Force base in South Korea during the Korean War, and it was adopted by KEPCO per his suggestion. O Woncheol, *Han-gukhyeong gyeongjeonseol 6 – Eneoji jeongchaek kwa jungdongjinchul* (Korean Style Economic Development 6: Energy Policy and Expansion into the Middle East) (Seoul: Kia Economic Research Institute, 1997), 174-175.

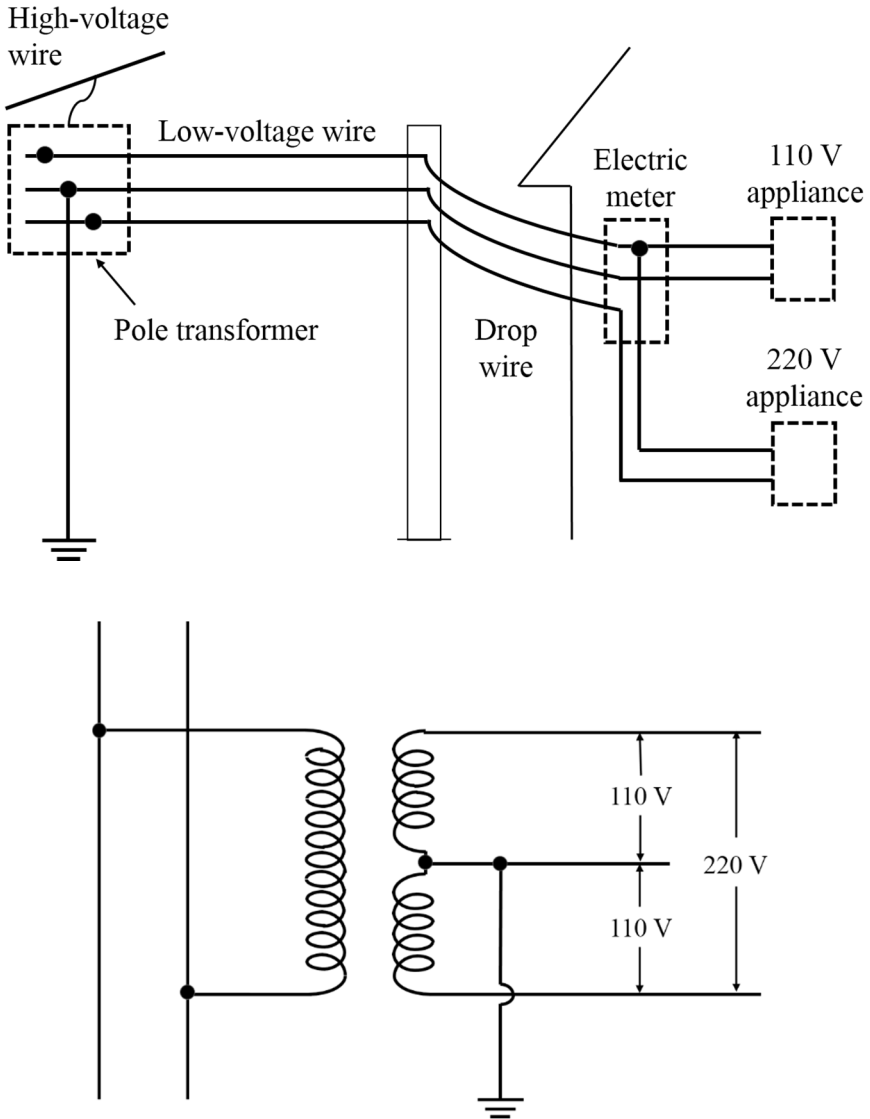


Figure 4. A schematic diagram for the “dual voltage method.” Adapted from “Baejeon seung-ap sumeun dwinyaegi (4),” *Jeon-gi seolbi* (December 2006), 48.

government officials, electrical engineers, and the vice president of KEPCO decided that the “most realistic” strategy moving forward would be to install dual voltage wires throughout the country at the customers’ cost.⁴³

Undoubtedly, the decision was a step back from the ambitious plan laid out in the previous year. The adoption of the dual voltage method reflected KEPCO’s judgment that the voltage conversion project would require a long transition period, during which electrical manufacturers and consumers could adjust their age-old practices. As a professor of electrical engineering Yi Seung-won remarked, the new method allowed the customers to “use their current electrical appliances until the end of the product lifespan.” The key to the project’s success, he continued, was in “supplying 220V-exclusive devices as soon as possible.”⁴⁴ Once the generational change in the products available in the marketplace is complete, the conversion would move along more smoothly. The only difficulty was that it was difficult to assess the average product lifecycle. According to the survey results of the Korean Statistical Society, the average lifespan was 4.9 years with a large variety among products (e.g., 10 years for electric blankets to 1.7 years for hairdryers).⁴⁵

The technocrats in the government and KEPCO understood that the success of the voltage conversion project hinged upon persuading the manufacturers to change their product specification. However, as we have seen above, the policy to prohibit the production of 100V-exclusive devices had been met with resistance from the electrical manufacturers. A unilateral and wholesale prohibition would not go over well with industry. Hence, the government engaged in lengthy negotiations with industry representatives. On 22 October 1979, the deputy director of IAA called a meeting, with representatives from industry and academia, to discuss the scope of the prohibition policy. Naturally, most manufacturers demanded an extension of the prohibition deadline, arguing that a cost increase within the context of the recent economic recession would be fatal to their financial well-being. Others pointed out that they still had a large amount of surplus parts that could only be used for 100V-exclusive products. After a series of meetings, the demands of industry representatives were partially accepted. For example, for electric rice cookers and frying pans, the prohibition deadline was moved back to 1 January 1982; for refrigerators, they deferred the decision to a future meeting.⁴⁶

⁴³ Kim Jintae, “220V seung-ap chujine ttareun hoeui (Minutes of the Meeting on 220V Voltage Conversion),” 2 October 1979, DA0729672, p. 439, National Archives of Korea.

⁴⁴ Yi Seung-won, “2-cha baejeon jeonap seung-abe gwanhayeo (On the secondary distribution voltage conversion),” *Jeon-gi hyeophoeji* 39 (March 1980), 33-41.

⁴⁵ “Gajeonjepum pyeonggyun sumyeong-eun 5nyeon,” *Kyunghyang Shinmun*, 6 September 1979.

⁴⁶ Kim Jintae, “220V seung-abe ttareun gwallyeon danche mit eopgyewaui hoeui gyeolgwa bogo (Report of the results of the meeting on 220V voltage conversion with related organizations and industry representations),” 30 October 1979, DA0729672, pp. 142-152; *ibid.*, “220V seung-ap gyehoek byeon-gyeong-e ttareun gwan-gye gigwan hoeui bogo (Report of the meeting on 220V voltage conversion plan change with related organizations),” 14 November 1979, DA0729672, pp. 65-68, National Archives of Korea.

The dual voltage method and the associated policies to prohibit 100V-exclusive appliances became a target of severe criticism, at least at the time. One newspaper even scorned the decision as a “temporary makeshift” policy, worthy of the disgraceful title “the worst blunder in the history of MER.”⁴⁷ In effect, the critics argued, the government was sending out mixed signals without a well thought-out plan. As a result, the tug-of-war between the government and the industry continued through most of the 1980s and the deadline for complete prohibition continued to be pushed back. The MER and IAA was forced to make a series of retreats, first by deciding to allow 100V-exclusive devices until the conversion rate reaches 95%, then by announcing a new plan with a renewed end date of 1996. According to the news report, the conversion rate in 1985 was 42.6%, far behind the expected schedule.⁴⁸ That the waiting game would succeed was by no means a foregone conclusion in the mid-1980s.

As it turned out, the waiting-game strategy proved effective in forging a new relationship between the technocrats and stakeholders. Negotiating with industry members, the government and KEPCO turned to a flexible attitude in determining the prohibition date, but only with a firm assurance that there was no way out but completing the project.⁴⁹ Of course, the government still had coercive power and the negotiation between the government and the industry was bound to be uneven. But the negotiation process was based on the mutual and tacit premise that the voltage conversion project will be eventually completed at all costs. In dealing with consumers, technocrats made constant efforts to improve the visiting service of individual households, shifting the terms from government-citizen to corporate-customer relations.⁵⁰ While responding to consumer concerns over the project through the dual-voltage method, KEPCO continued to expand the 220V coverage, especially in the rural community and small- or medium-sized cities where the resistance was relatively weak.⁵¹ In 1989, KEPCO adopted a new policy that made the individual household, not a pole-connected community, the basic unit of voltage conversion. By 1992, the conversion rate reached 82%, and a few remaining holdouts were found isolated in the midst of 220V households.⁵² In short, the dual-voltage method not only mediated two different technical standards and made the waiting game possible, but also served as the basis upon which new

⁴⁷ “Gonyok chireun deung-yu sodong,” *Maeil Kyongje*, 26 November 1979

⁴⁸ “Jeon-gi sa-eopbeop gyujeong jeonap 220volt-hwa 96nyeonkkaji wallyo,” *Maeil Kyongje*, 20 August 1985.

⁴⁹ “100V-jeonyong jepum saengsan-geumji sigi yeonjang,” *Maeil Kyongje*, 27 July 1981; “100volt-jeonyong jeon-gi jepum saengsan-geumji sigi jeojeong,” *Maeil Kyongje*, 28 December 1981; “Sanggong-bu jeon-gi bapdong 100volt-heoyong geomto,” *Maeil Kyongje*, 11 March 1983.

⁵⁰ Korea Electric Power Company, “Baejeon seung-ap sumeun dwinniyagi (6) (Behind-the-scenes story of distribution voltage conversion [6]),” *Jeon-gi seolbi* (February 2007), 80-81.

⁵¹ Korea Electric Power Company, “Baejeon seung-ap sumeun dwinyaegi (8) (Behind-the-scenes story of distribution voltage conversion [8]),” *Jeon-gi seolbi* (April 2007), 78-79.

⁵² *Ibid.*, 81-84.

corporate-customer relations could arise.

Through these efforts in the 1980s, the situation began to make a turn for the better toward the end of the decade, to the great relief of KEPCO and the South Korean government. The decelerating rate of voltage conversion gradually bounced back in the mid-1980s and continued to maintain a steady pace into the 1990s. The 50% conversion rate was reached by the end of 1985 and the three-fourth mark in 1990-1991. The 1990s saw the familiar outbreak of several stakeholder resistances, negotiations, and finally a complete ban of not only 100V-exclusive, but also 100/220V dual-use appliances.⁵³ The complete ban, which officially began in 1996 save a few exceptional items, drove the stake into the heart of the die-hard target. The distribution voltage standard conversion project had definitely reached the stage of final stretch. By 1999, according to KEPCO's measure, the conversion rate reached the 100% mark. During the next few years, the power company worked on tying up the loose ends, such as organizing the

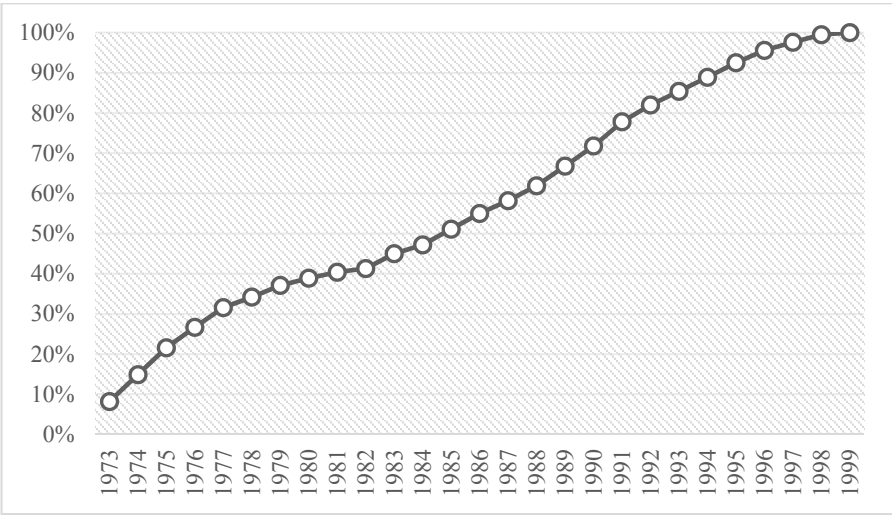


Figure 5. Voltage conversion rate as percentage of households, 1973-1999. Note the inflection point in the mid-1980s. Prepared from data presented in “Baejeon seung-ap sumeun dwinyaegi (9),” *Jeon’gi seolbi* (June 2007), 77-78.

⁵³ “97-nyeonbuteo 220V-jeonyongman heoyong,” *Maeil Kyongje*, 12 August 1992; “Samsung, Daewoo-deung saengsan chajil,” *Donga Ilbo*, 14 July 1993; “Gongjincheong jeon-giyongpum 110-220V-gyeomyong saengsan jeheoyong,” *Maeil Kyongje*, 18 February 1995, “110-220V gyeomyong gajeonpum saengsan jungdan,” *Donga Ilbo*, 17 April 1996.

mismatch between incoming and indoor wires.⁵⁵ Only when these miscellaneous tasks were complete in 2005 could KEPCO make the official public announcement, as we have seen in the introduction of this paper, for the completion of the project.

Conclusion

At the time of the project's beginning in 1967 (or 1973), no one would have guessed that the completion of the project would take more than three decades. This was in large part due to the underestimation of the impact of the nation's rapid economic growth. During the initial phase of the project, the technocratic entrepreneurs at KEPCO and the South Korean government believed that it would be possible to make a swift transition. Their belief was based on the premise that South Korea was still in the early stages of electrification, especially in the rural areas, which was reflected the KEPCO report of the late 1960s describing the project as a unique "opportunity." In other words, the technocrats miscalculated the magnitude of the technological momentum in the mid-1960s, as well as how it would grow in leaps and bounds in subsequent decades. As the target continually shifted, they were obliged to update, adjust, and postpone their plan accordingly. This was the unexpected burden of rapid economic growth in the 1960s and 70s.

Nevertheless, the technocratic entrepreneurs remained steadfastly committed to the idea of voltage conversion throughout the period, despite intermittent resistances and criticisms from stakeholders and commentators. They utilized a variety of strategies to override the technological momentum or path dependency associated with the 100V standard. The technocrats drafted and updated project roadmaps, first in 1967 (fifteen-year plan), next in 1973 (fifteen-year plan), once again in 1978 (short-term five-year plan), and finally in 1979 (two year extension). In implementing these plans, KEPCO and the government provided financial incentives for manufacturers, gradually banned the 100V appliances from the market, and persuaded the stakeholders through public campaigns to jump on the bandwagon of standard conversion. They also solicited technological solutions from academic researchers to alleviate the transition process when the project seemed to have hit a wall. These efforts reflect the technocratic mindset, singularly aimed at the rational transformation of the nation's political economy.

Despite the technocratic rationality, the South Korean voltage conversion project experienced a series of miscalculations, setbacks, and resistances. Manufacturers of electrical appliances and lay consumers of electricity resisted, sometimes fiercely, to the government directive when it ran contrary to their interests. The technocrats gradually prodded the stakeholders toward making the conversion, using both

⁵⁵ This did not mean that all the households were converted to the 220V standard, as KEPCO regarded areas with less than one hundred "resisters" as "complete." Korea Electric Power Company, "Baejeon seung-ap sumeun dwinyaegi (9) (Behind-the-Scenes Story of Distribution Voltage Conversion [9])," *Jeon-gi seolbi* (May 2007), 74.

carrots and sticks. The completion of the project could only be achieved through an elongated process of negotiation among the technocrats, appliance manufacturers, and the public. Even under the authoritarian regime, power of the technocratic entrepreneurs was not unilateral or absolute. Thus, the story of the South Korean distribution voltage conversion project is not only about overcoming the technological momentum vested in the 100V standard. It is also about the bureaucratic momentum vested in the project itself, and the technocratic entrepreneurs' persistence in bringing the project to completion.

Abstract

In 2005, the Korea Electric Power Company (KEPCO) announced that the project to raise the distribution voltage from 100V to 220V was complete. This marked the official completion of a thirty-two year project to change a major technical standard of the South Korean electrical system. Focusing on the role of “technocratic entrepreneurs” in KEPCO and several government agencies, this paper examines their strategies to overcome the technological momentum vested in the voltage standard. Although the technocrats were motivated by profit opportunities when they made the initial decision to launch the project in the mid-1960s, they also proved extremely tenacious when the project experienced unexpected delays in the 1970s and 80s. The project could be completed only with the persistence of the technocratic entrepreneurs, who perceived the problem through the lens of national planning. In the end, it was the bureaucratic momentum vested in the project itself that accounts for the successful transition of the technical standard.

Key words: technical standard, technological momentum, path dependency, voltage conversion, Korea Electric Power Company, technocratic entrepreneurs