



Evolution of China's power dispatch principle and the new energy saving power dispatch policy

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ABSTRACT

With social economic reform in the past decades, the power industry of China is gradually evolving from a highly integrated one toward an electricity market, which can be characterized based on the transition of the power dispatch principle. To attract investment in the power generating industry, China introduced non-state-owned power plants to the original system of a highly vertically integrated power industry with annual power generation quota guarantees, which makes the traditional economic dispatch principle not applicable. The newly debuted energy saving power dispatch (ESPD) is an attempt to fully exploit the maximum energy savings and was implemented by an administrative code. Starting in August 2007, the pilot operation of the ESPD was implemented in five provinces, but after two years, it is still not widely applied all over the country. This paper details the transition of China's power dispatch principle with particular attention to its origin and content. Moreover, the factors that influence the ESPD's actual energy saving effect are discussed, as well as the sustainability of the policy.

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1. Introduction

Electricity is the most convenient form of energy consumed in the world. Therefore, primary energy, such as hydro energy, coal, oil, natural gas, or nuclear energy, is often converted into electricity by power plants and provided to end users by a transmission and distribution network. China's generation capacity reached 874 GW at the end of 2009 (State Electricity Regulation Commission of China, 2010), and China is expected to become the largest power producing country in the world, with a capacity of 1186 GW in 2020 (International Energy Agency, 2007). The quickly developing economy drastically increases the demand for electricity, exerting great pressure on the Chinese government. Because the efficiency of energy consumption largely depends on both the type of primary energy and conversion technology, to save energy and reduce pollutant emission, renewable energy and high efficiency generation units need to be promoted to dispatch power.

Generally speaking, the traditional vertically integrated power system is operated by strictly regulated monopolist-franchised companies or a sector of the government. Economic dispatch, which aims at gaining the greatest economy within the bounds of prescribed limitations, is the classic power dispatch principle and has been intensively studied in the past several decades (Luo

et al., 1986; Lin et al., 1987). The well-known equal incremental principle is developed and applied to allocate the load among all the generators by minimizing production cost, taking into account line losses. After the deregulation of the power industry, IPPs (independent power producers) were introduced, and their power dispatch is defined based on the outcome of market transactions and considering security constraints (Ongsakul and Chayakulkeeree, 2003; Fernandes and Almeida, 2003). Market results in these industries will be fully respected, while the security of the system with regard to reactive power management, frequency control, AGC (automatic generation control), and others can be assured by purchasing ancillary service in the corresponding markets or can be provided setting compulsory obligations for the market players. Whether the power of one generator can be dispatched largely depends on its offering price, set to promote competition and increase efficiency. An obvious distinction between the power dispatch mechanism before and after deregulation is that it formerly operated to minimize the overall production cost for all of the generators with a predefined selling price. Since deregulation, it has functioned to dispatch power based on the voluntary prices and quantities determined by the various market participants, whose objective is to maximize their own profits, and the price is determined by the market. Therefore, higher efficiency generated energy was dispatched with a higher priority before deregulation, and it is also more competitive in the electricity market, where strategic bidding is allowed. However, neither before nor after deregulation has there been any economic advantage to using renewable resource-generated electricity, which is not economically competitive enough with current

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technology, and special measures are necessary to foster the development of renewable source electricity.

The current situation in China is much more complicated with respect to the cases mentioned above. While it started in 1998, the transition of China's power industry toward an electricity market is still under way. Great efforts have been devoted in the past 10 years to unbundle the vertically integrated power industry and introduce competition, but the actual time schedule for establishing a market mechanism remains unclear. Moreover, reform of the electricity industry is tightly related to the political situation. In the national campaign for saving energy and reducing pollutant emission, the power industry, which represents about two-thirds of the total coal consumption of the country, is expected to make a significant contribution. A strict energy saving power dispatch (ESPD) policy that determines the power dispatching order in terms of the efficiency and pollutant emission indices of the generating units was jointly issued by the National Development and Reform Commission (NDRC), the State Electricity Regulation Commission (SERC) and the Ministry of Environmental Protection (MEP) on August 27, 2007 (State Council of China, 2007b). Apparently, this policy fits neither the market mechanism nor the traditional economic dispatch mode, and it lessens the prospect of the electricity market target defined in the 11th national five-year plan¹ (Chang and Wang, 2010; State Council of China, 2007a).

In this paper, we will examine the dispatch policy in China and analyze the background, content and impact of the ESPD policy in detail. The remainder of this paper is organized as follows: Section 2 introduces the traditional power dispatch principle that was in place in China before the deregulation of the power industry started; in Section 3, two power dispatch approaches that had once been temporarily applied or tried during the reform of the electricity sector are discussed; while the ESPD policy is thoroughly investigated with respect to motive, content and implementation in Section 4; numerical analysis is presented in Section 5; and finally, conclusions are drawn in Section 6.

2. Power dispatch principle before the electricity market was targeted

The power industry of China had gone through a tremendous transition even before the competitive market was targeted. This was the consequence of the political and economic reform that has taken place since 1978, when the ten-year Cultural Revolution ended, and the market economy started to be introduced. The power dispatch principle was altered with the institutional change, such that local government, private and even overseas investments were allowed in addition to the investment of central government to boost the development of the power industry.

2.1. Economic dispatch

Before 1978, the power industry was solely operated by the Ministry of Water Conservancy and Electric Power (MWCEP), and the only financial source was the annual planning appropriation for infrastructure construction issued by the National Planning Commission, which fit the planning economy in China at that time very well. Investment in the power sector is roughly 7–8% of the country's overall annual infrastructure investment. The power industry was completely owned and operated by the state, which was the basis for the economic dispatch during that period. The aim of the dispatch was that generation loads should be optimally

allocated among hydro-electric plants with different volumes of storage and thermal generators with different levels of efficiency. All profit from the industry went to the state, which was also responsible for power infrastructure investment. Until 1978, the accumulated profit and tax contributed by the power industry were greater than the investment in the industry, and the power industry became the mainstay of Chinese state finance (Chen, 2008).

However, due to insufficient investment and the industrialization of the country, China suffered from power shortages for a long period, although during 1949–1978, the average rates of increase in generation capacity and electricity production were 12.4% and 15.1%, respectively, but this still could not satisfy the needs of national economic development. It became a common phenomenon that factories had to suspend production for two or three days a week due to power shortages, which can be inferred from the yearly average operation hours of the thermal units. As shown in Fig. 1, the latest extreme situation of power provision deficiency occurred in 2004, and the corresponding average operation hours of the thermal units were nearly 6000. In that year, more than 20 provinces suffered from severe power shortages, and in some provinces, even the valley load could not be met, which made the load curve a horizontal line. While before 1978, the average operation hours of the thermal units reached 6000 or even 7000 h per year, some storage hydro-electric plants had to generate electricity 5–10 m below the level of dead water, which would not be allowed in a normal situation because the dead water level is the lowest limit of the water level considering the constraints of irrigation, shipping and sediment accumulation, etc. (Chen, 2007). Therefore, the economic power dispatch made no sense because all capacity should be dispatched in most cases, except for those reserved for security reasons.

2.2. Power dispatch based on predefined quota and prices

After 1978, political deregulation finally resulted in a reform of the economy, which boosted economic development greatly, hence significantly increasing power demand. Figs. 2 and 3 report the GDP and the corresponding electricity demand in 1978–2009. Investment from the state could no longer support the quickly developing economy. This reform also allowed the flexibility of different financing approaches, introducing a diversity of plant ownership schemes (State Council of China, 1985).

From the reform, there emerged power plants owned by different corporations, including local government, private companies or even international companies. The traditional economic dispatch could not provide enough incentives for capacity expansion. To assure return of investments, both price and volume quotas for selling electricity were predefined based on the principle of *cost plus reasonable profit*. The contract between the investor and the grid defined the minimum quota for electricity transactions in future years to reduce risks to the producer, which greatly enhanced the confidence of investors. Obviously, the quota contract was in contradiction to the economic dispatch because the contract had nothing to do with optimization. During that special period, this policy was justified by the huge amount of unsatisfied load demand, and the contract-based power dispatch greatly pushed forward capacity expansion all over the country. Theoretically, the introduction of various financing methods made it difficult for the application of economic dispatch. However from another perspective, economic dispatch has no meaning if there is not enough capacity to serve the load.

With the assurance of a good return of investments, infrastructure construction of power generation boomed in this period. At the beginning of 1990s, approximately 50 companies went public in the domestic or international stock market.

¹ The 11th five-year plan (2006–2010): the official plan to guide the development of the country for the next five years.

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