Existing and Future Electrical Supply Challenges

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Abstract

Most large countries will change their existing electricity generation to reflect existing generation characteristics and in response to growth and a reduction of carbon gaseous emissions. Country and company responses will not be uniform in time and nature. To some extent it will also be dependent on new and improved technologies. Electrical generation is likely to increase dramatically. Some existing generation will be shut or expanded, and new generation may be developed to generate to power electric vehicles and hydrogen for new heat sources and process chemicals. As part of this change there will be increased generation using limited time of day renewables. Some generation will be for direct use and a faster growth for power storage systems. There will be major changes in electrical grids to increase connectivity and conductivity between remote generation and customer loads as well as how sparing is provided. The size of smelters, management of demand, grids, sparing contracts as well as the determination of price will also change so as to overcome the increasing complexity of generation types, operating and capital cost structures, periods of supply and sharing of risk. There will also be a need to change the electrical market(s) to reflect changes in timing of new installations, differences in old market structures that evolved of a long period of time and ranking by operating cost and short period bidding and new markets, which need to evolve rapidly and are dominated by long periods of supply and capital costs. New markets structures are proposed. Aluminium is currently the largest electrical base load in most large producing countries. The key issues covered in the paper include comparisons between China and Australia.

Keywords: Electrical generation, Grids, Markets, Costs.

1. Present

1.1 Electrical Generation

Electricity underpins most residential, commercial process industries and services within all modern economies. Currently, one-third of global electricity generated (kWh), but a lot less of the total energy comes from low carbon sources [1-4] and is outlined in Figure 1.

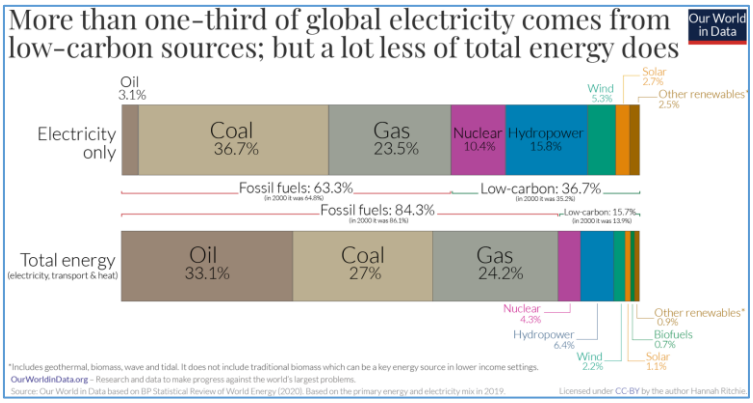

Figure 1. Global electricity and total energy.

It is useful to focus initially on the generation of electricity, then examine how this might change as decarbonization occurs when some total energy is generated by renewables. Individual fuel sources of global electricity generation per capita [2] are shown in Figure 2.

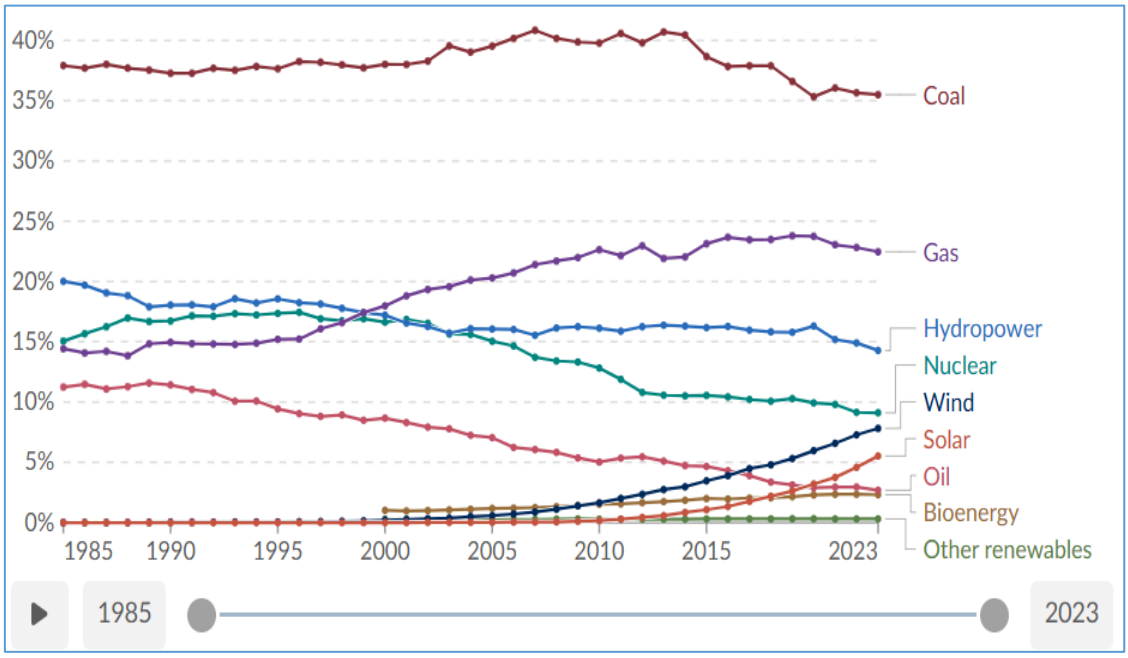

Figure 2. Fuel sources for global electrical generation [2].

Overall, the consumption of coal is declining, but in some countries such as China it continues to grow. The present electricity generation by source [2] is shown in Figure 3.

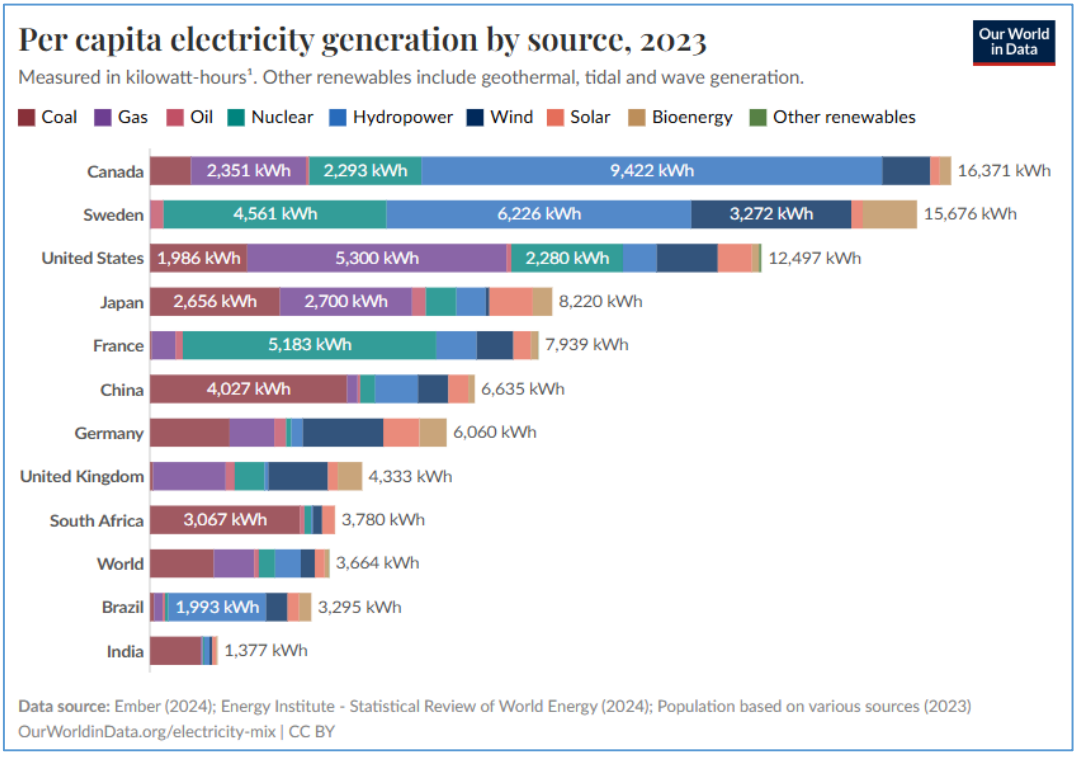

Figure 3. Per capita electricity generation by source [2].

5.2 Sparing

Few, if any smelters are directly connected to a power source, without some strong backup in loss of power supply for an hour or more. There is a history of power failures from a variety of reasons that involve operations and weather-related issues [40].

With the increasing size of smelters, matched with the use of large Power Purchase Agreements for renewable based power supply, it will become increasingly important to develop strong back up arrangements.

6. Aluminium and other 24/7 Markets

Coal will form an important part of many power systems until China, USA and India reduce consumption significantly.

It is unlikely that the present levels of internationally competitive reliable electricity for many process industries and services will be able to survive this change, unless special attention is focused on the transition and advantage is taken on emerging technologies, most of which are capital based.

Relevant to the aluminium industry, these technologies and work practices include:

(1) Electrolysis and materials selection for aluminium, steel, batteries, and hydrogen processes.
(2) Internationally competitive 24/7 power and adequate sparing, within a specific market structure.
(3) Major reductions of capital costs of smelters, power plants and process materials, including replication, defining and controlling scope, management of the capital process as capital considerations will define the future.
(4) Carbon capture and storage for some process elements.
(5) Nature and role on nuclear electrical generation.
(6) AI for process control, automation and robots.
(7) Major improvements in demand and sparing management.
(8) Mandated specific energy consumption for smelters.
(9) A major increase in recycling.

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