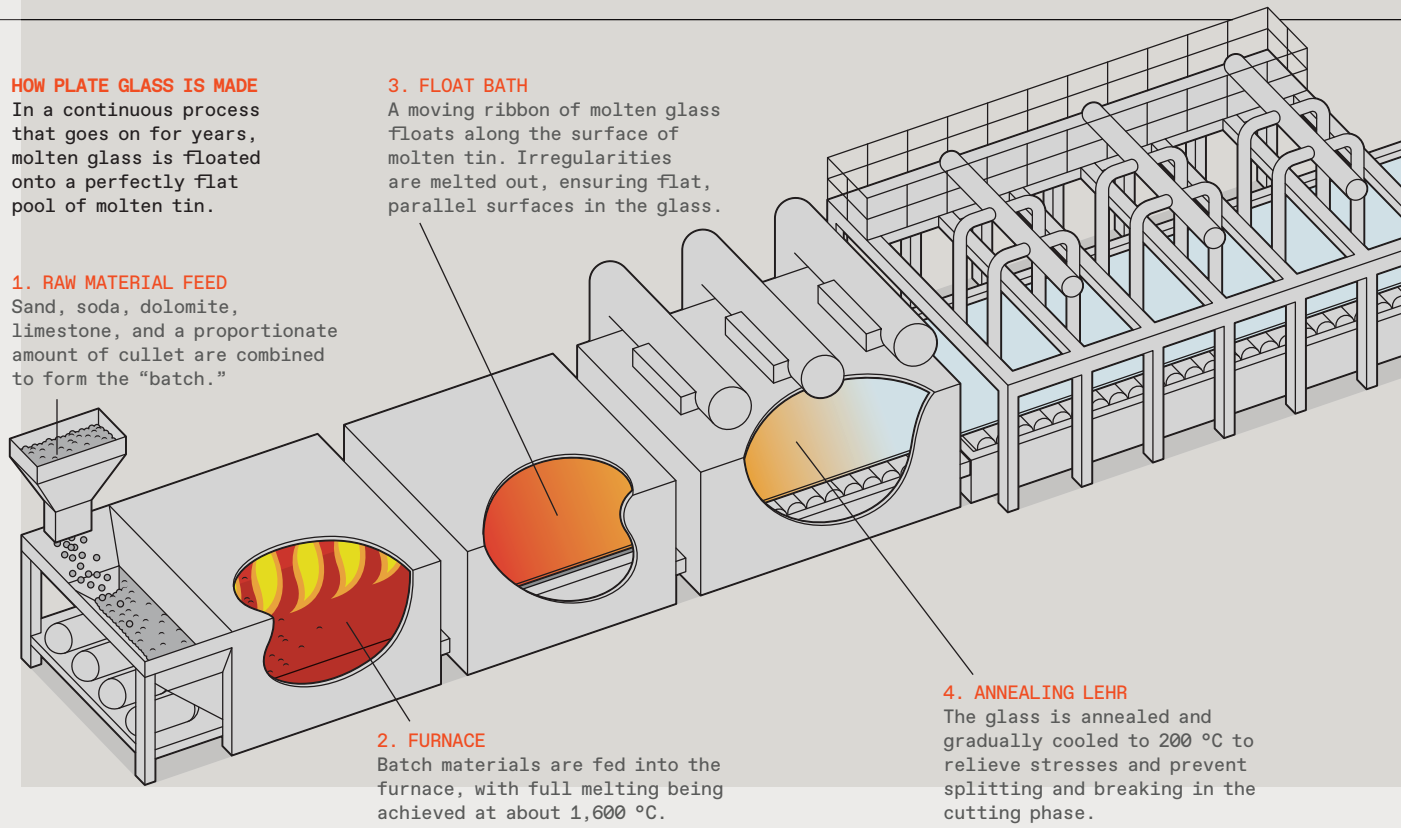
Crosstalk



The Carbon Footprint of Plate Glass

The energy required is not transparent

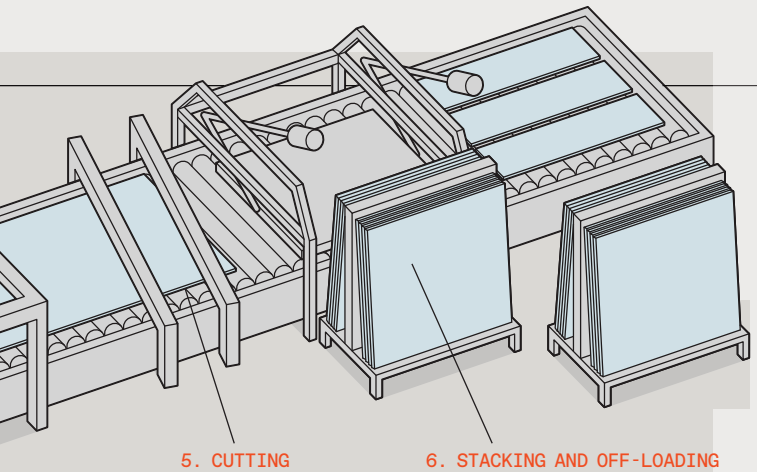
Plate glass, like steel, is all around us. It is taken for granted, and most people have no idea how it is made. Although both materials are ancient, their production was fundamentally improved only after World War II—primary steelmaking with the introduction of basic oxygen furnaces, and plate-glassmaking by the successful application of the old idea of floating molten glass on a large bath of molten tin. The tin provides a perfectly level surface.

Alistair Pilkington, of Great Britain, was the first to operate a continuous production line. The achievement was announced in January 1959, the first licensee was Pittsburgh Plate Glass, and the new method quickly conquered the market.

The ingredients are sand (SiO_2, about 73 percent of the charge), sodium dioxide (Na_2O, about 13 percent), lime (CaO, about 9 percent), and magnesium (4 percent). The combustion of natural gas or a liquid fuel heats the mixture to about 1,050 °C, and the molten glass is then poured from a ceramic spout onto a 6-centimeter-thick layer of molten tin, at a temperature of 230 °C. The baths range from 4 to 8 meters in width and up to 60 meters in length, and they are kept under a protective blanket of nitrogen and hydrogen, to prevent the oxidation of the tin.

The glass spreads out in a way that can be regulated to produce sheets as thin as 0.12 millimeters and as thick as 25 mm. After the sheet cools to about 600 °C it is passed through a long container, called a lehr, that cools it gradually, an annealing process

Illustration by Chris Philpot



5. CUTTING
The glass ribbon is cut automatically as it moves.

6. STACKING AND OFF-LOADING
Automatic stackers off-load the glass. Using overhead cranes and forklift trucks, the glass is warehoused for distribution.

Plate glass is made around the world in many facilities [gray], each one having one or more production lines [orange].

SOURCE: NATIONAL GLASS ASSOCIATION/GLASS MAGAZINE

that prevents cracking. When cooled it can be cut into rectangles as large as 6 x 3.2 meters.

Like blast furnaces, float glass plants work nonstop for 11 to 15 years, which obviates the need to add large amounts of energy to restart the process. A plant produces anywhere from 50 to 1,200 tonnes or more of glass per day. Most plants have a single line, with the largest float glass factories in China operating 10 or more lines at one site.

In many countries, including the Netherlands, Portugal, and Romania, a single line suffices to serve the local market. The United States now has only 23 plants with 31 lines, while China, by far the world's largest glass producer, has more than 50 factories and 190 lines. This means that even in population-adjusted terms China tops such formerly dominant glass powers as Germany, France, and Italy. Only Poland, the Czech Republic, and Luxembourg are "glassier" than China on a per capita basis. In contrast, several major nations have no plate-glass capability; they include not only Africa's three most populous states but also Canada (the last plant closed in Quebec in 2005) and Sweden.

Plate-glassmaking is fairly energy intensive and cannot do without fossil fuels, using today's practices.

As is the case with primary steel, plate-glassmaking is fairly energy intensive and cannot do without fossil fuels, using today's practices. The theoretical minimum to produce molten float glass is nearly 3 gigajoules per tonne (compared to about 10 GJ/t to smelt primary iron), and actual requirements are up to 9 GJ/t, with about 90 percent of the energy coming from natural gas. Float glassmaking is thus yet another industrial process (along with primary iron, ammonia, cement, and plastics) that cannot be easily decarbonized.

Energy can be saved by recovering more heat, designing better line architectures, and charging higher shares of recycled glass (cullet). But alternative processes that burn hydrogen or carbon-free synthetic methane (made from captured carbon dioxide) remain about five times as expensive. However, in contrast to other important materials whose production depends on fossil carbon, amorphous silicon can be added to plate glass to create transparent, electricity-generating photovoltaic windows, a convenient and invisible contribution to lower carbon intensity. ■