

The Wedge from Substituting Natural Gas Power for Coal Power

BAU

Activity level(AL)

- 2.8Gt coal
- 1400 GW installed capacity and 10,800 TWh output

Assumptions

- Carbon content: 70.7%¹

Total emissions

- $=2.8*71\%=1.98$ Gt-C/year

Target

Activity level(AL)

- 1.3 Gt Natural Gas (69,350 Billions of standard cubic feet)²
- 1400 GW installed capacity and 10,800 TWh output

Assumptions

- Carbon content: 75%

Total emissions

- $=1.3*75\%=0.98$ Gt-C/year

Thus, we derive a wedge.

Comments

The pace associated with this wedge is 28 GW of new natural gas power displacing 28 GW of new coal power every year. At these power plants, 1 GtC/y will be emitted from natural gas instead of 2 GtC/y from coal. The 3x3 matrix for 2054 above would read, after one such wedge: 1 GtC/y from coal to electricity and 3 GtC/y from natural gas to electricity, for a total 2054 emission of 4 GtC/y associated with electricity production, instead of 5 GtC/y. A full second wedge of this kind would not be available.

We can relate a wedge of natural gas to flows through specific large pipelines and LNG tankers:

¹ “70.7 percent carbon describes coal equivalent within +/- 2%,” according to G. Marland, et. al. (S35) . This percentage is consistent with the bituminous coal atomic ratios of $\text{CH}_{0.8}\text{O}_{0.1}$, if the coal is 85% ($\text{CH}_{0.8}\text{O}_{0.1}$) and 15% “other”, by weight. “Other” might be ash.

² We assume that the volumetric carbon content of natural gas is 538 gC/Nm³, where Nm³ is “normal cubic meter.” We use the equivalence of two gas volumes, both defined at atmospheric pressure, but defined at different temperatures: 1 Nm³ = 37.24 scf, where scf is “standard cubic foot.” (The scf is at 60 degrees F, and the Nm³ is at 0 degrees C.) The arithmetic, then, is that 1 GtC/y is $37.24/(538*10^{-6}*365)$ Bscf/d = 190 Bscf/d. Here, both G and B are one billion, or 10⁹.

The Alaska natural gas pipeline currently under negotiation is to carry about 4 Bscfd. A wedge of flowing natural gas (190 Bscfd, or 1 GtC/y) is equivalent to bringing one Alaska pipeline on line every year for 50 years³.

A wedge of flowing natural gas (190 Bscfd, or 1 GtC/y) is equivalent to 50 large LNG tankers docking and discharging every day⁴. Current LNG shipments create about one-tenth as large a flow of carbon.

Reference

S35 Marland, G., et. al. 1989. *Estimates of CO₂ emissions from fossil fuel burning and cement manufacturing, based on the United Nations energy statistics and the U.S. Bureau of Mines cement manufacturing data*. Oak Ridge, TN: Oak Ridge National Laboratory, Environmental Sciences Division. Publication No. 3176, 1989.

³ Another large natural gas pipeline is being built across China, from Kovyktinskoye, “Kovykta,” in eastern Siberia, to Beijing. It is similar in size to the Alaska pipeline.

⁴ We assume the LNG tanker has 200,000m³ capacity. The density of LNG is 610 times the density of standard natural gas.