



Impact of Fossil Fuels Related to Hawaii's Energy and Economy in 2030 and 2045

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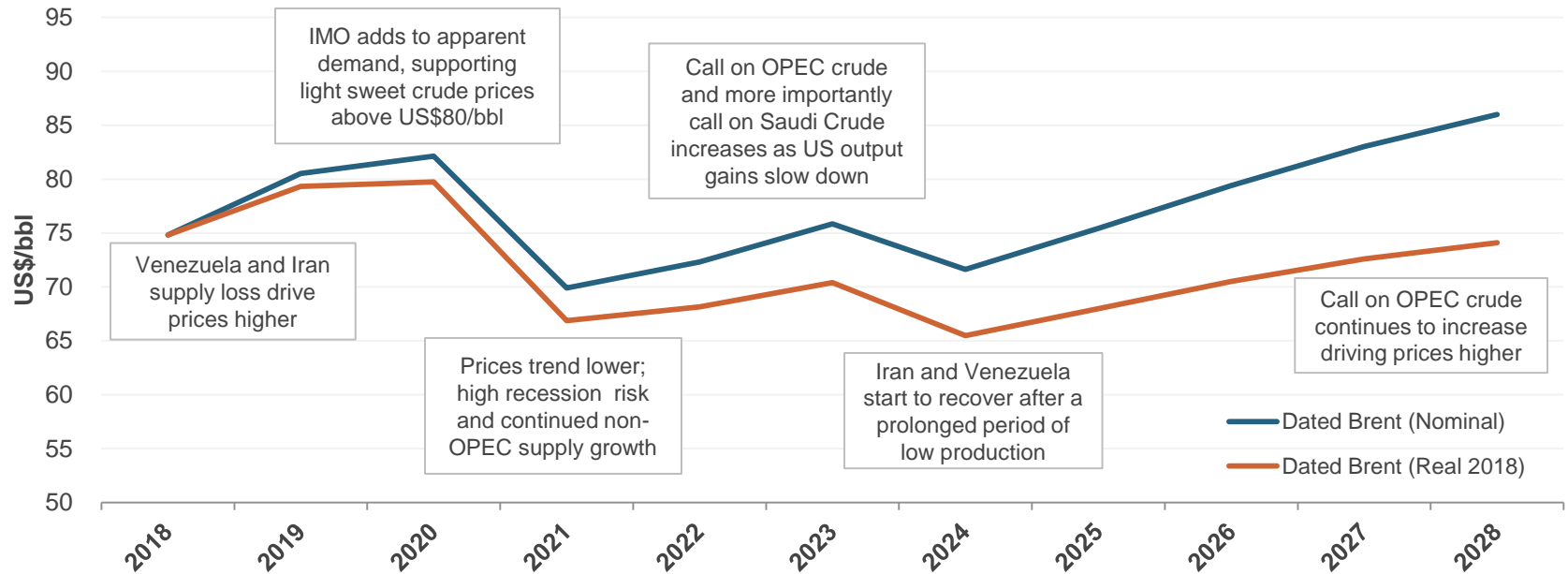
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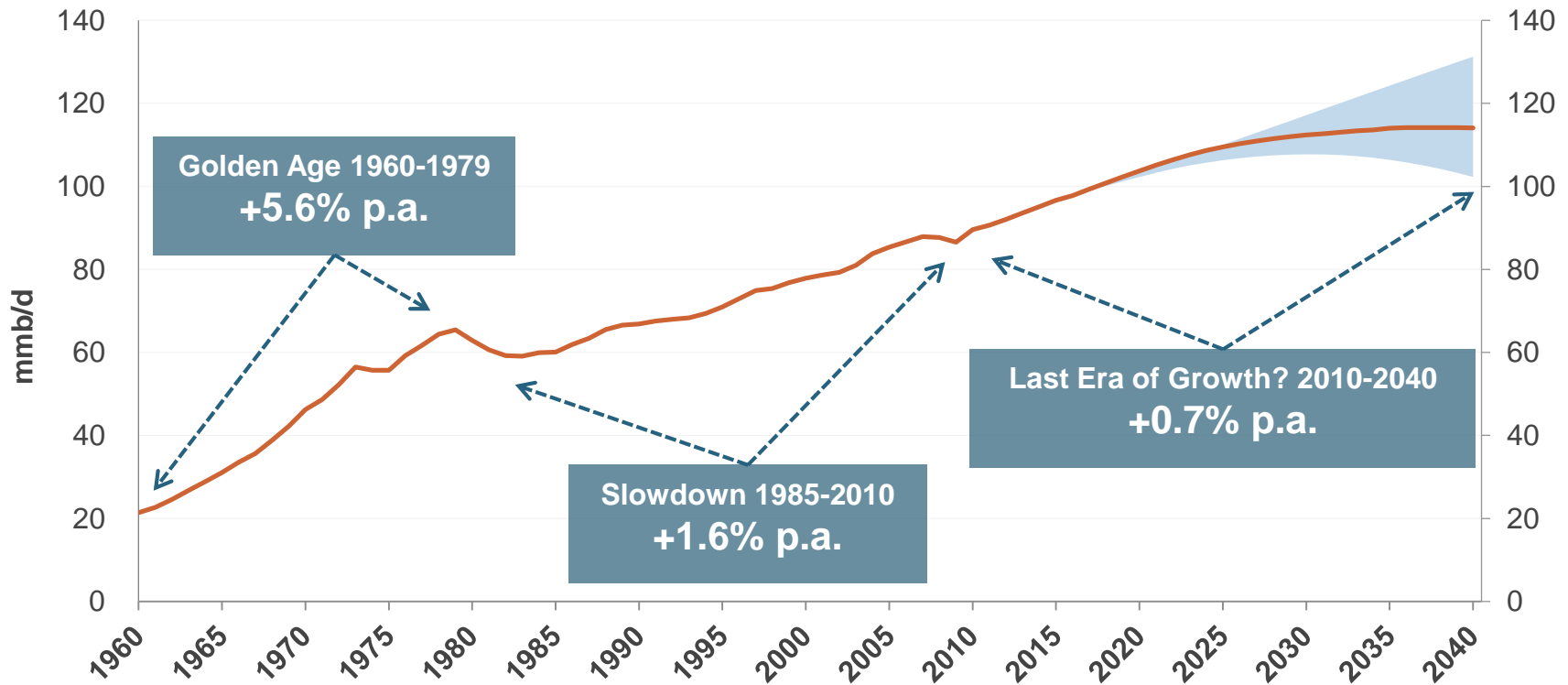
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Brent Crude Outlook: A Bumpy Ride



- In the immediate short term, increased supply outages from Venezuela and Iran will support prices.
- The IMO bunker fuel specification changes in 2020 also present somewhat of a bullish wildcard with the potential to boost fuel oil demand in power generation.
- Post-2020, downside risk to demand growth increases as global recession risk builds. Previous years' relatively high prices will also continue to promote high levels of non-OPEC supply growth.
- Prices are seen correcting back to the US\$65-70/bbl range in 2021.
- The “call on OPEC crude is seen increasing throughout the 2020s, however a recovery in output from Venezuela and Iran will help limit gains in crude prices until later next decade.

World Oil Demand Outlook

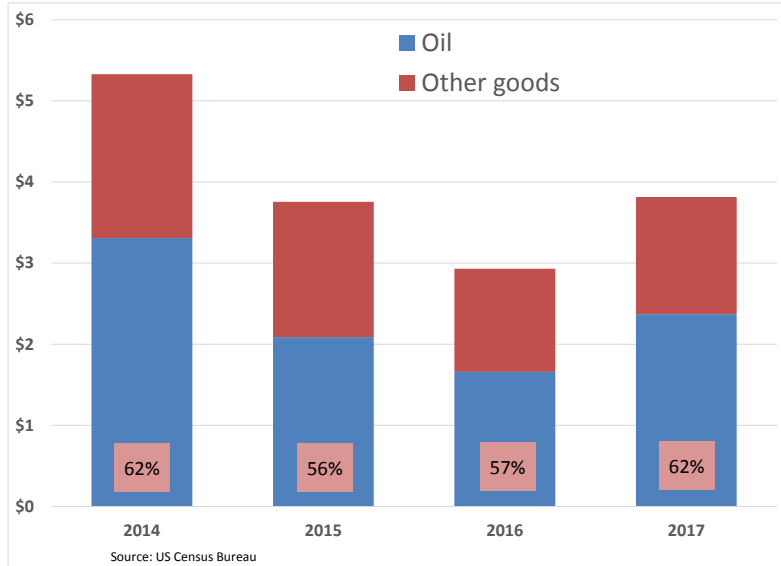


- Base case: 115 mmb/d by 2040, compared with 98 mmb/d in 2016.
- High case: 131 mmb/d by 2040, supported by low oil prices and strong consumer demand.
- Low case: peak at 108 mmb/d around 2030, strict implementation of environmental policies and strong efficiency gains.

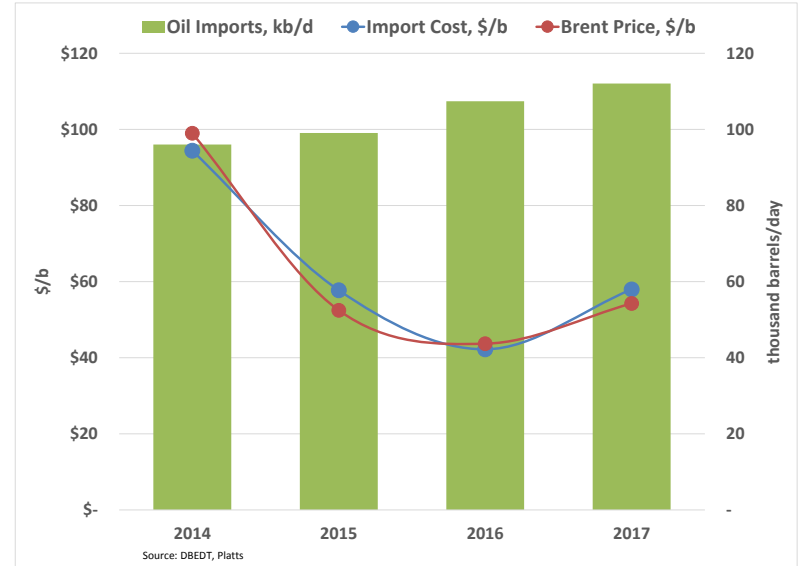
Oil and Hawaii

High Oil Dependence Can Lead to Dramatic Impacts on Import Bill and Electricity Prices

Hawaii Foreign Imports, billion \$

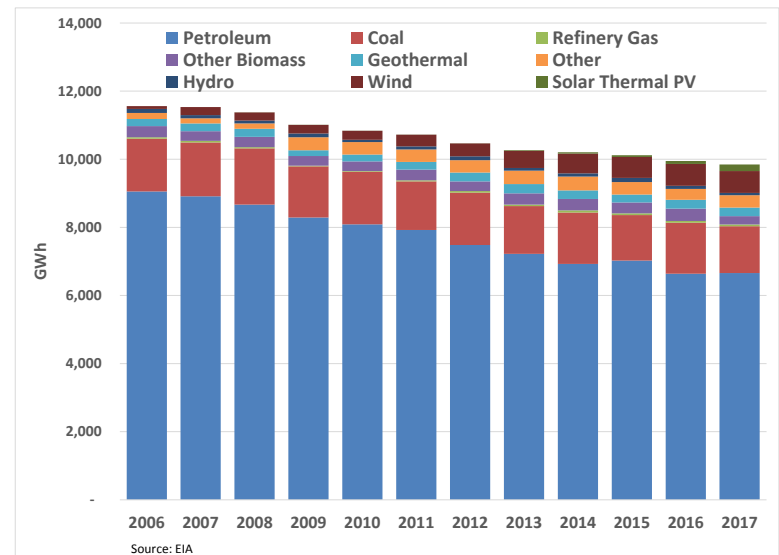


Foreign Oil Imports: Costs and Volumes

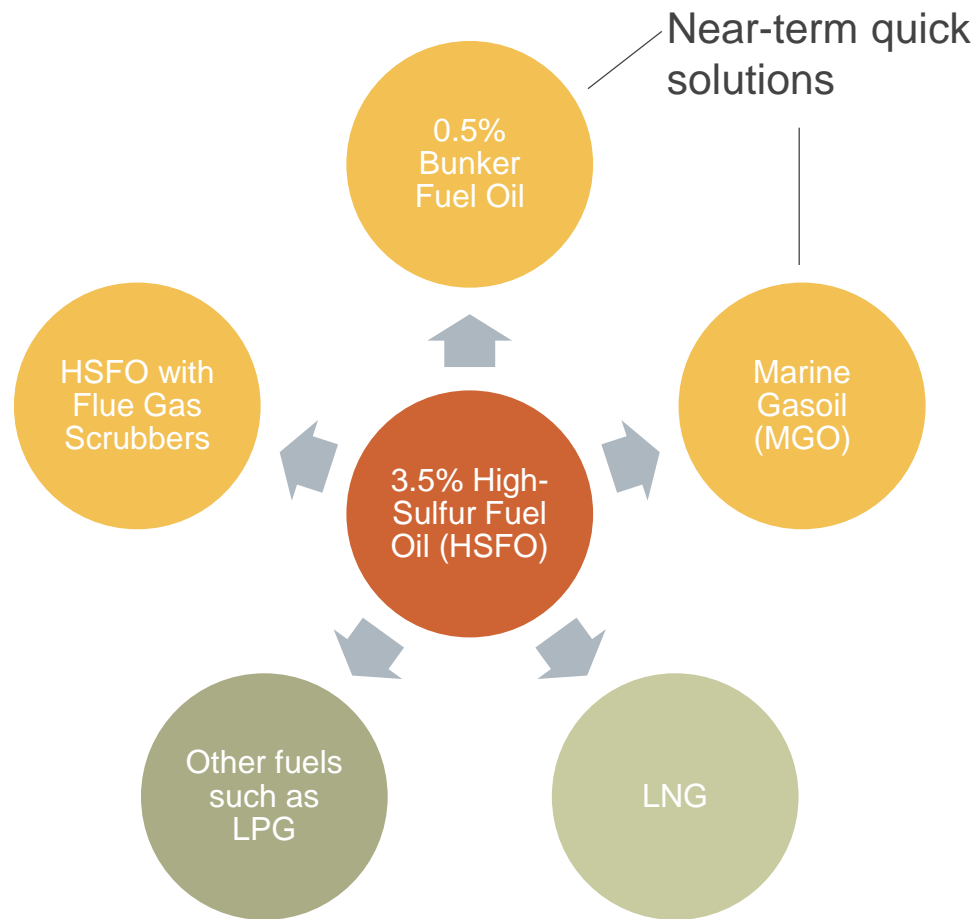
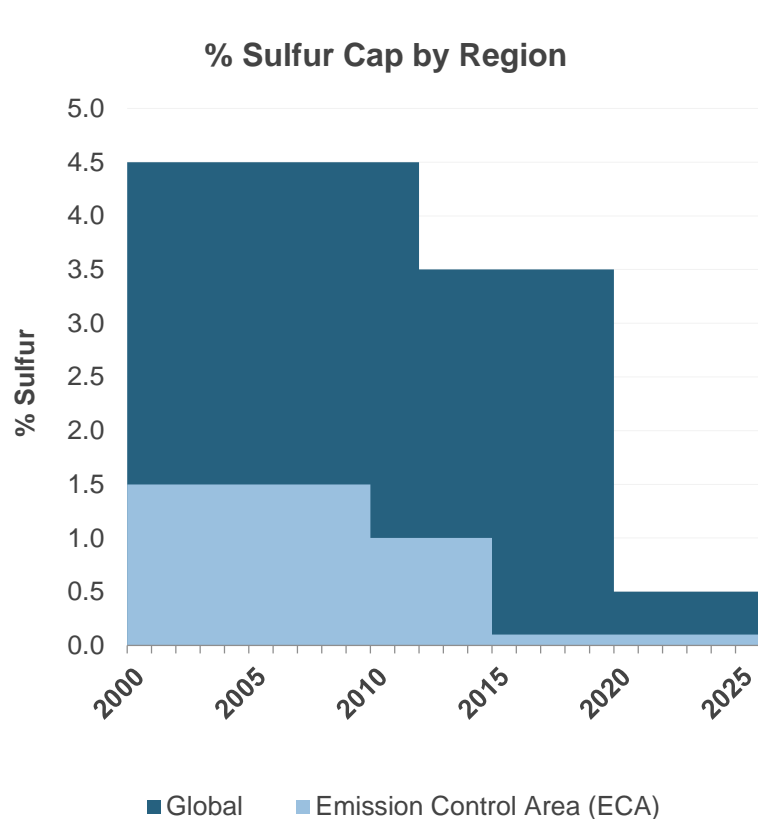


- Oil is the biggest foreign import; volumes are creeping up.
- Oil's share of imports is moved dramatically by external prices.
- Oil accounts for over 80% of Hawaii's primary energy mix.
- Although the HCEI has had a big impact on electricity demand, fossil fuels still account for 82% of power supply; oil for almost 70%. HI power prices more than 2X US average.

Hawaii: Power Generation by Source



New International Maritime Organization (IMO) Spec for Ships to Have Significant Implications for Hawaii's Power Sector

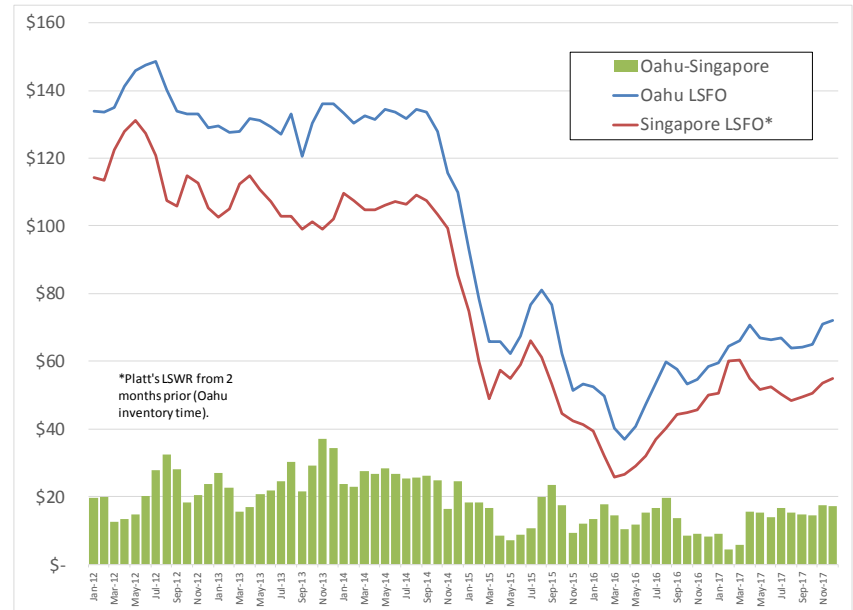


- The new global IMO 0.5% sulfur spec comes into effect in 2020 and is the same as HECO's Low Sulfur Fuel Oil (LSFO) spec. LSFO accounts for the bulk of Hawaii's oil based power generation. Higher global bunker prices will mean higher power costs in Hawaii.

The IMO and Hawaii

- In most places, LSFO costs less than Brent.
- Everyone expects the IMO specs to make LSFO more expensive than Brent.
- Hawaii's LSFO costs are always above the LSFO price in Singapore.
- When foreign LSFO costs go up, they will take Hawaii's LSFO costs with them.
- Low-sulfur crude oils—vital to Hawaii's refining system—will also be dragged upward.
- The effect will be exaggerated by the fact that the cost of shipping will be increased by the IMO—and all of Hawaii's oil is shipped in.
- Although it will be less dramatic, the cost of other imported goods in Hawaii will also be increased.
- To get an idea of the magnitude of the issue, if the cost of foreign oil is increased by 10%, it will cost Hawaii \$250 million per year.
- Fuel is the main cost of electricity, so a jump in LSFO prices will mean a jump in power costs.

LSFO Prices, 2012-17: Oahu vs. Singapore, \$/b



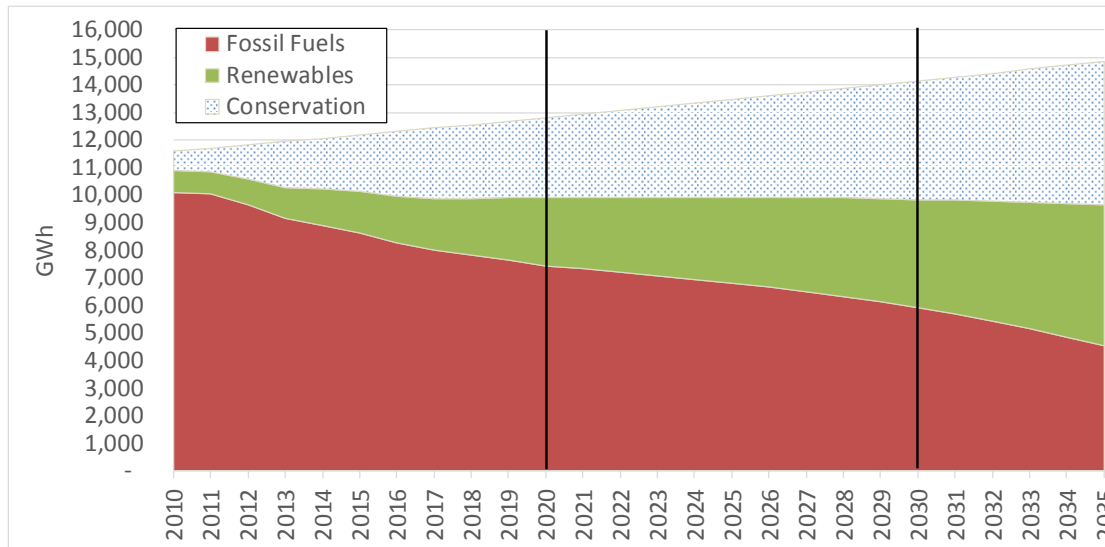
2015-2017 average Oahu vs. Singapore: \$13.60/b (30%)

But, wait a minute! Isn't the Hawaii Clean Energy Initiative going to save us from these sorts of problems?

Well, yes and no...

The HCEI and the RPS

Idealized Power Mix Under the RPS, 2010-2035



- The HCEI goals and the RPS agreement bring the fraction of fossil fuels in the power mix down to a little over 7,000 GWh in 2020, and to about 6,000 GWh by 2030.
- These are feasible goals—and, as the chart shows, progress is roughly on track.

- The problem is, this only reduces today's fossil fuels in power by about 13% in 2020, and about 25% in 2030. **This is an improvement, but not enough to shelter Hawaii from the volatility of the oil market.**
- Furthermore, the IMO specs start in 2020—which is just around the corner. By 2045, there's no problem in the power sector (if all the milestones are met). The tough part is likely to be in the next decade.
- As to the rest of the HCEI, it is not legislated, but rather a series of goals. In areas like air transport (and even ground transport), progress has been minor compared to what has been done in the power sector. The transportation sector accounts for more than 50% of Hawaii's total energy demand, led by jet fuel then gasoline.

The Bad News

- In the power sector, simply bringing on more renewables won't solve the problem. More solar and wind mean more variability. That means more backup power, which means modern turbines (i.e. new \$167M, 50 MW turbine at Schofield Barracks) and improvements to the power grid.
- Fuel-oil steam turbines are poorly suited to working with renewables. In fact, Hawaii is a bit of an antique: **Hawaii consumes more than 90% of all the fuel oil burned in power in the US.** Seriously, folks—nobody does this anymore.
- Batteries may save the day—but they aren't really over the cost and performance hump just yet.
- In the near term, not only will more investments be needed for more responsive equipment, but lighter fuels—diesel, LNG, or similar hydrocarbons—will have to play an expanded role.
- That just describes the power sector. Electric cars (and buses and trucks) won't suddenly replace the existing fleet. And electric jets—well, they'll need a really long cord.

The Good News

- Although the IMO poses price problems, it will make a massive improvement in the global environment. It is possibly the biggest single change ever in the energy space.
- If our crude-price outlook is correct, it is happening at a reasonably good time. Oil prices are volatile, but the outlook is for lower prices than seen in 2010-2014. In 2012, HECO's LSFO prices nearly reached \$150/b. If we faced that same environment in 2020, then the IMO could drive prices far higher than \$150/b!
- Batteries continue to improve and get cheaper. They still haven't seen a major breakthrough, and batteries pose their own environmental issues. But there are suggestions that major changes are on the way (cf. solid-state batteries).
- Several major corporations (including Boeing) are working with jet fuel derived from algae. And Boeing has a design for an LNG-fueled passenger jet. These are many years off—but we're looking out to 2045, right?
- Finally, the IMO has another surprise looming—the decarbonization of the world shipping industry. This could start in the 2020s. Stay tuned!



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