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**Fact Checking Bill S. 2754**

Dear Ladies and Gentlemen who are working on Bill S. 2754,

Thank you for your very valuable time to review our written testimony.

The promises in Bill S. 2754 are not accurate,

and the facts we are presenting in this letter will dispute the claims that it will “create jobs and drive innovation and economic growth in the United States by supporting and promotion the manufacture of next-generation technologies, including refrigerants, solvents, fire suppressants, foam blowing agents, aerosols, and propellants”.

In fact, supporting a forced promotion of so called “next-generation technologies” (which is clearly referring to Hydrofluoroolefins, or HFOs, like HFO-1234yf) will cause all the industries mentioned above to lose 200,000 jobs – rather than add 33,000 new jobs. There is even a chance many more jobs will be lost!

Please find our justification to these claims in our report below:

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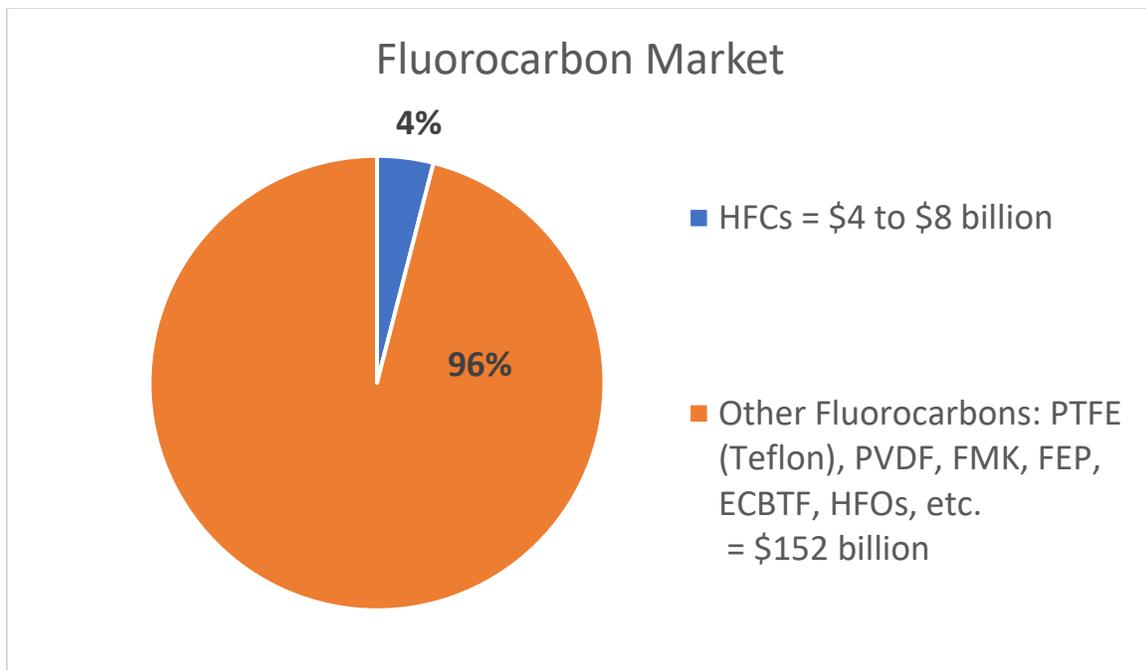
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**Evidence 1:** HFC's only make up 1%-2% of industry cost, but HFO replacements will increase to 16% of industry cost, resulting in hundreds of thousands of jobs lost!

Section 2.a.1.A of the Bill describes the economic contribution to the United States from industries that use and produce fluorocarbons as \$158,000,000,000 annually.

Currently, the Hydrofluorocarbons (HFCs) described in this Bill for phase out make up only 2%–5% of the total fluorocarbon industry:

- HFC-134
- HFC-134a
- HFC-143
- HFC-245fa
- HFC-365mfc
- HFC-227ea
- HFC-236cb
- HFC-236ea
- HFC-236fa
- HFC-245ca
- HFC-43-10mee
- HFC-32
- HFC-125
- HFC-143a
- HFC-41
- HFC-152
- HFC-152a
- HFC-23



**Data source:** Clean Energy Manufacturing Analysis Center

The Clean Energy Manufacturing Analysis Center states that worldwide production of HFCs is 1,050,000,000 kg in total.

Since the current pricing of HFCs range between \$4.00 - \$8.00 per kg, then the real economic contribution of HFC used is only between \$4.2 billion and \$8.4 billion per year shown by the chart below. Once again, this is only 2% to 5% of the \$158 billion described in the Bill!

**Market Size of HFC Production and Consumption**

<b>Price of HFC (\$/kg)</b>	<b>Annual Quantity (kg)</b>		<b>Annual Market (\$)</b>
\$4.00 /kg	1,050,000,000	× 4.00 =	\$4,200,000,000
\$5.00 /kg	1,050,000,000	× 5.00 =	\$5,250,000,000
\$6.00 /kg	1,050,000,000	× 6.00 =	\$6,300,000,000
\$7.00 /kg	1,050,000,000	× 7.00 =	\$7,350,000,000
\$8.00 /kg	1,050,000,000	× 8.00 =	\$8,400,000,000

Although HFC’s are only \$4 to \$8 billion, HFC’s directly impacts industries that equal about **\$345 billion!**

HFC’s that would be eligible for phase out will directly affect these industries: HVAC, Refrigeration, Spray Foam Insulation, Aerosols, and Fire Suppressants.

The market size of each of these industries in the table below is equal to \$345 billion that will be affected from this type of phase out!

<b>Industries that rely on HFCs that would be subject to phase out:</b>	<b>Market Size</b>
HVAC	\$130 billion
Refrigeration (Commercial)	\$32 billion
Refrigeration (Industrial)	\$30 billion
Refrigeration (Residential)	\$6 billion
Aerosols	\$87 billion
Fire Suppression	\$60 billion
<b>Total Market Size:</b>	<b>\$345 billion</b>

**Data sources:** Grandview Research, Markets and Markets, Allied Market Research

Currently, HFC’s make up only 1%-2% of the cost of these \$345 billion of industries because:

$$\frac{\$4 \text{ to } \$8 \text{ billion HFC Market}}{\$345 \text{ billion industries that would phase out HFCs}} = 1\% \text{ or } 2\% \text{ of industry}$$

If HFCs are phased out, the only alternative options are Hydrofluoroolefins (HFOs) which are 4x to 8x higher in price than HFCs!

This means HFOs will become 16% of the cost of these industries, instead of 2% like HFCs.

With much more expensive raw materials, companies will not be able to absorb an additional 14% increase to their cost! Many companies (especially small and mid-size companies) will have to close down and let go all of their employees!

With the affected market size being \$345 billion and average salary of \$80,000, there are about 4.3 million middle class jobs at risk!

$$\$345 \text{ billion market} \div \$80,000 \text{ average salary} = 4.3 \text{ million jobs at risk!}$$

Furthermore, Section 2.a.2.B suggests this Bill will “add approximately \$12,500,000,000 per year to the economy of the United States.”

But this additional \$12.5 billion is misleading and simply comes from the pockets of consumers who will be paying 1) the exorbitantly higher prices of HFO alternatives, and 2) the fact, more HFOs must be used to replace HFCs per unit of HFC because of their respective gas expansion ratios. At the same time, jobs will be lost so how can consumers possibly pay 4x-8x the price!

Today, the price of HFO-1234yf is \$20.00/kg, and they are meant to replace currently used HFCs. Once again, the pricing of HFCs range from \$4.00 - \$8.00 per kg, so the new replacement HFOs are in total \$12.00-\$16.00 per kg more expensive!

Taking the smallest price increase of \$12.00 per kg, we can find how they calculate:

$$1,050,000,000 \text{ kg} \times \$12.00 \text{ per kg higher for HFOs} = \mathbf{\$12,600,000,000 \text{ price increases}}$$

That is how they calculate **\$12,500,000,000** of “additional” revenue. It is really just a price increase to American consumers!

But the \$12,500,000,000 that consumers will pay is even too low. This is because HFO-1234yf is not a 1:1 drop-in replacement. For example, to replace HFC-152a, you will need 2.1 times the amount of HFO-1234yf to achieve the same performance as HFC-152a.

Therefore, it is not \$12.00-\$16.00 more expensive, but 2.1 times that which is \$25.00-\$34.00 per kg more expensive!

Below is a calculation to show the huge additional costs that companies (primarily small to mid-size businesses) will have to pay for much higher priced HFOs, based on material being either \$12.00/kg, or \$16.00/kg, more expensive:

### Additional Cost from HFO Alternatives

Quantity of HFC per year (kg)	Amount of HFO needed to replace HFC	Price difference \$12 to \$16 per kg	Additional Cost for HFO per year (\$/kg higher)
1,050,000,000 kg	× 2.1	× \$12.00 per kg	\$ 26,460,000,000
1,050,000,000 kg	× 2.1	× \$13.00 per kg	\$ 28,665,000,000
1,050,000,000 kg	× 2.1	× \$14.00 per kg	\$ 30,870,000,000
1,050,000,000 kg	× 2.1	× \$15.00 per kg	\$ 33,075,000,000
1,050,000,000 kg	× 2.1	× \$16.00 per kg	\$ 35,280,000,000

This means that price increases will be total of \$35,280,000,000!

It most likely to be even more. To remind you, only two HFO manufacturing companies in the USA have patents to produce this next generation technology like HFO-1234yf.

Should HFCs be phased out, HFO producers will have the opportunity to take advantage given the absence of competition. There is no telling how much further the price of HFOs will be increased.

It is worth noting that the Center for the Study of Science at the Cato Institute categorize HFO's as costing \$71 per pound (\$157 per kg). "While HFCs are out of patent and cost a mere \$7 a pound, their patented replacements, go for around \$71 a pound." This estimation puts HFO's costing \$141 per kg more than HFCs!

Using the same math above (that 2.1 x HFOs are needed to replace HFCs), the total price increase could be \$310,905,000,000 according to the numbers from the Cato Institute!

### Additional Cost from HFO Alternatives as per Study of Science at the Cato Institute

Quantity of HFC per year (kg)	Amount of HFO needed to replace HFC	Price difference estimation from Cato Institute	Additional Cost for HFO per year (\$/kg higher)
1,050,000,000 kg	× 2.1	× \$141.00 per kg	\$ 310,905,000,000

There will be catastrophic job loss when companies are unable to pay 4x, 5x, 8x or even 10x times more for these raw materials! Especially when other countries will still be able to use HFCs as explained in the next section.

Additionally, Section 2.a.1.B of the Bill states these industries employ 700,000 people with a payroll of \$32,000,000,000. At this rate, it claims the average salary per employee for the 700,000 jobs is equivalent to \$457,000 per employee annually!

$$\$32,000,000,000 / 700,000 \text{ jobs} = \$457,000 \text{ average salary per year}$$

In reality, it is known the average salary in these industries is closer to around \$80,000 per year, so an average salary of \$457,000 per employee is impossible!

But we did calculate that the Industry that relies on HFCs has about 4.3 million jobs that will be at severe risk for being lost. Even if HFO producers are able to add 33,000 jobs, it will be nothing compared to the hundreds of thousands (possibly millions) of jobs lost by the exorbitant cost burden of 10x higher priced raw materials!

## Evidence 2: Putting the USA into a Disadvantaged Position, by Phasing Down 9 years or even 15 years earlier than Other World Markets

Please find the Kigali Amendment phase down timeline on the next page.

From this graph, we can conclude:

- China, Mexico, Brazil will begin phase down 9 years later than the USA.
- India, Iran, Kuwait, Saudi Arabia will begin phase down 12 years later than the USA.

HFC phase downs have different timelines in different countries. This Bill is requesting the United States start from 2020 with baseline of annual averages from 2011, 2012, and 2013.

China, however, as the second biggest economy zone in the world, begins their phase down by 10% starting 9 years after the USA, in 2029. Their baseline is based on 2020, 2021, and 2022.

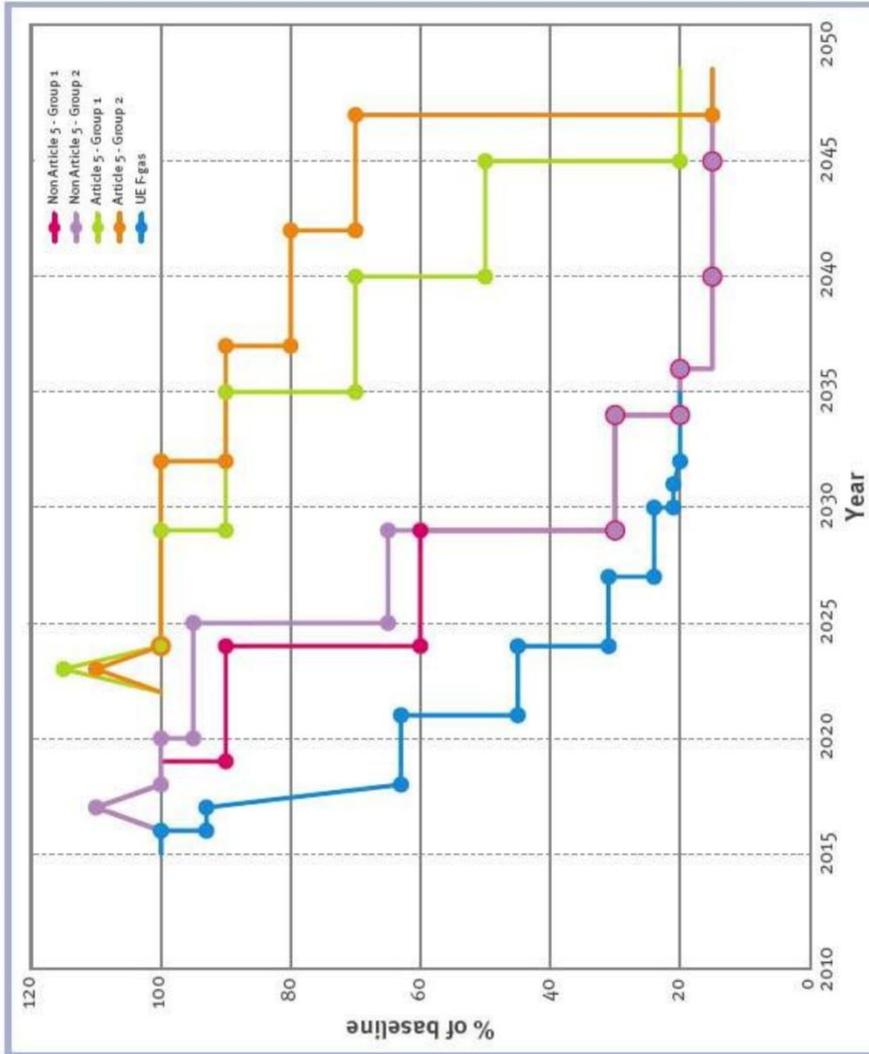
India is the largest populated country now, with economic growth of 6-7% annually, and they are even starting in 2032 with a baseline using 2024, 2025, and 2026. That is 12 years later than USA.

Iran, Kuwait, Saudi Arabia, etc., begins 12 years after the USA as well.

In fact, most of these countries make up the top 15 GDP's globally:

Global Rank	Country/Territory	2019 est GDP (US\$million)
2	 China	14,140,163
5	 India	2,935,570
9	 Brazil	1,847,020
15	 Mexico	1,274,175

## Kigali Amendment Phase Down Timeline



### Developed Country, Group 1

Baseline Years: 2011, 2012, 2013  
 Country: USA, European, Japan, Canada etc.  
 Start Year: 2019 (10% reduction)

### Developed Country, Group 2

Baseline Years: 2011, 2012, 2013  
 Country: Belarus, the Russian Federation, Kazakhstan, Tajikistan, Uzbekistan.

Start Year: 2020 (5% reduction)

### Developing Country, Group 1

Baseline: 2020, 2021, 2022  
 Country: China, Mexico, Brazil, etc.  
 Start Year: 2024 Freeze, 2029 10% reduction

### Developing Country, Group 2

Baseline: 2024, 2025, 2026  
 Country: India, Iran, Kuwait, Saudi Arabia, etc.

Start Year: 2028 Freeze, 2032 10% reduction

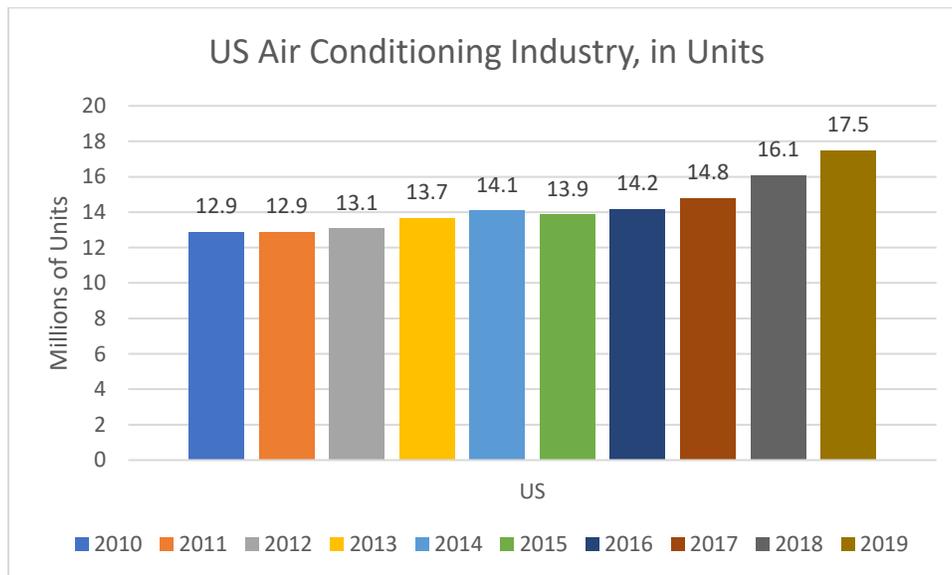
Unfortunately, or fortunately, the growth of Hydrofluorocarbon consumption has almost doubled between 2011-2019 and will continue to go up. Does the United States want to give 9 to 12 years for China, India and Brazil, Mexico, Saudi Arabia to build up their base quantity so much before beginning to phase out?

It means the US will have to use expensive HFOs 9-12 years earlier than many other countries, and to use the expensive raw materials 9-12 years earlier will cause the US to lose out on revenue and job creation.

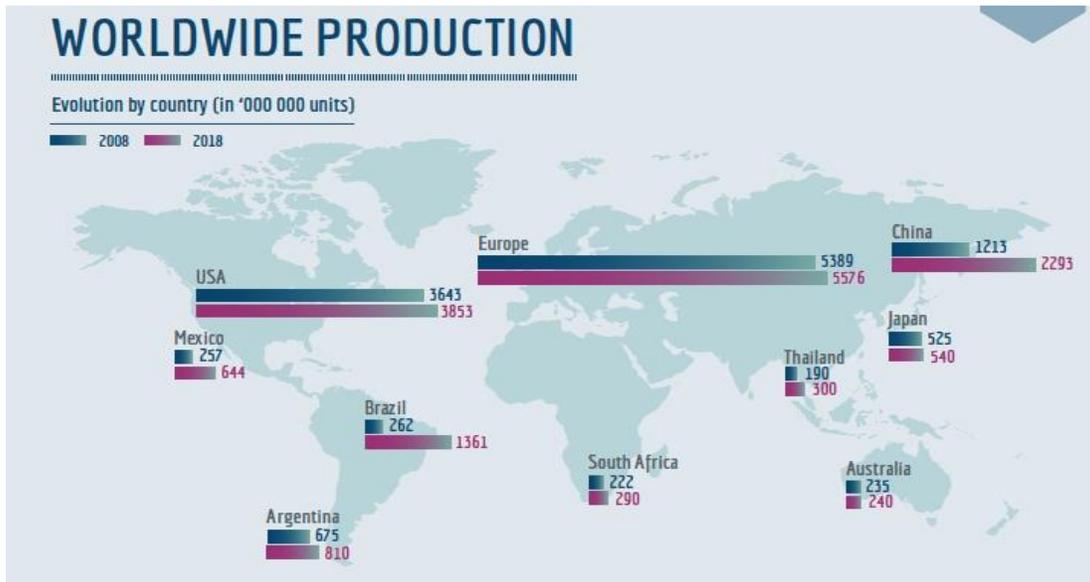
It is unfair for the United States, and unfair for refrigerants, solvents, fire suppressants, foam blowing agents, aerosols, and propellants industries within the United States.

In particular, the refrigerant, aerosol and propellant industry will suffer the most. The overwhelming majority of HFCs are used in air conditioners and personal care products, and so it is highly relevant to discuss the upward global trend of the industry.

Since 2010, the US air conditioning industry, in terms of millions of units, grew 36%. The chart below shows the tracking growth from 2010 to 2019, where 12.9 million units rose to 17.5 million units.



## Global Aerosol Production increases 2008 - 2018



As you can see, China, Brazil, and Mexico have been increasing production of products using HFCs every year. Having the United States pay much more for HFO alternatives will cause even more business to move to these countries. There will be a net loss in Production in the United States that is barely hanging on to the current allocation.

**Evidence 3:** Much higher cost HFOs (\$71/lb HFOs vs \$4-7/lb HFCs) will be 10x more expensive that'll hurt many industries of America negatively.

The airlines industry (including the US military) will be severely affected having to change equipment to support the patented HFO alternatives. How will the airline industry and US Military afford to buy new planes and equipment to accommodate these HFOs? It is not just huge additional cost concerns but also safety concerns when making modifications to aircrafts. They are already being bailed out by recent COVID-19 pandemic and this Bill will certainly require them to need another bail out the US government cannot afford.

Small, medium and even large businesses will suffer from mandatory equipment changes. Once again, US air conditioning industry, in terms of millions of units, grew 36% since 2010. Many of these units (even though relatively new) will have to be replaced in order to support to new HFO's even with a phase out schedule which will be incredibly expensive. It is likely many lower income Americans will even be without air conditioning.

As we mention earlier, the raw material cost will already add \$35 billion of cost (by our calculation) or even \$311 billion of additional cost (by the Cato Institute).

This is simply the additional raw material cost. The Cato Institute estimates that filling a new residential HVAC system will be about \$1,000 more than the cost of HFCs.

However, existing units likely cannot use HFOs, so owners will have to shell out several thousand more for a new heat pump, along with the installation cost. All of this will be required when if having to service an HFC-driven system.

It will be very difficult for the lower income households to justify several thousands of dollars additional money to cool their homes and will be unable to make changes to much more expensive systems.

#### **Evidence 4: Comparing HFC and HFO Exchange Values vary greatly and should not be grouped together**

Firstly, HFCs and HFO both have zero ODP (Ozone Depleting Potential).

Their main reason for the Bill to urge to use of HFOs is that their GWP (Global Warming Potential) are lower than HFCs. Please find the following chart:

<b>Chemical Name</b>	<b>Common Name</b>	<b>Exchange Value (GWP)</b>
CHF <sub>2</sub> CHF <sub>2</sub>	HFC-134	1100
CH <sub>2</sub> FCF <sub>3</sub>	HFC-134a	1430
CH <sub>2</sub> FCHF <sub>2</sub>	HFC-143	353
CHF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>	HFC-245fa	1030
CF <sub>3</sub> CH <sub>2</sub> CF <sub>2</sub> CH <sub>3</sub>	HFC-365mfc	794
CF <sub>3</sub> CHF <sub>2</sub> CF <sub>3</sub>	HFC-227ea	3220
CH <sub>2</sub> FCF <sub>2</sub> CF <sub>3</sub>	HFC-236cb	1340
CHF <sub>2</sub> CHF <sub>2</sub> CF <sub>3</sub>	HFC-236ea	1370
CF <sub>3</sub> CH <sub>2</sub> CF <sub>3</sub>	HFC-236fa	9810
CH <sub>2</sub> FCF <sub>2</sub> CHF <sub>2</sub>	HFC-245ca	693
CF <sub>3</sub> CHF <sub>2</sub> CHF <sub>2</sub> CF <sub>3</sub>	HFC-43-10mee	1640
CH <sub>2</sub> F <sub>2</sub>	HFC-32	675
CHF <sub>2</sub> CF <sub>3</sub>	HFC-125	3500
CH <sub>3</sub> CF <sub>3</sub>	HFC-143a	4470
CH <sub>3</sub> F	HFC-41	92
CH <sub>2</sub> FCH <sub>2</sub> F	HFC-152	53
CH <sub>3</sub> CHF <sub>2</sub>	HFC-152a	124
CHF <sub>3</sub>	HFC-23	14800

It is true some of HFC have higher GWP (labeled as Exchange Value in the Bill). Although you will find not all HFCs have a high GWP such as HFC-152a and HFC-152, with exchange values of 53 and 124, respectively.

This Bill defines a “regulated substance” of having an exchange value of greater than 53.

According to this, HFCs that are greater than 53 exchange value, such as HFC-134 (1100), HFC-125 (3500) etc., must be prioritized to be replaced by HFO. Yet, there are some special ones such as HFC-152 and 152a, whose exchange value is only 53 and 124.

If we once again consider how the cost of HFO is \$20/kg, and HFC-152a is about \$4/kg, HFC-152a’s smaller exchange value should not be categorized for replacement. If HFO 1234yf was used to replace HFC-152a, the American end user will spend an additional 500% of the original cost.

It will be inordinately expensive and ineffective at cutting CO2 emission to replace HFC by using HFOs!

### **Evidence 5: HFO’s Disadvantages: production actually has a higher carbon footprint than some HFC production and harmful to living organisms!**

Furthermore, why it’s expensive and ineffective to use HFO to replace HFC-152a, the Bill conveniently ignores the indirect contribution of exchange value during the production of HFOs. HFO production requires the use of a huge amount of energy from fuel, natural gas or coal.

Calculations based on the available data on energy consumption and CO<sub>2</sub> emissions attest that the carbon footprint of HFO-1234yf manufacturing both in the US and China is very high. In fact, there is 20 times higher carbon emissions from manufacturing HFOs compared to HFCs such as, for example, HFC-152a. (see **Exhibit 1**)

Although there are many claims that HFCs contribution negatively to the effects of Global warming, the EPA published Greenhouse Gas Emissions Report for fluorinated chemicals shows a decrease of 8.8% year over year between 2011 and 2018. This decrease in Greenhouse Gas emissions is much greater than the increase in HFC usage, a testament to the optimization of technologies using HFCs. (see **Exhibit 2**)

Although there are advantages of HFOs are the short atmospheric lifetime (hence the low GWP), more detrimental effects can be expected as more and more HFO emissions are released into the atmosphere.

For example, HFO-1234yf, the most abundant HFO has the atmospheric lifetime of 11 days, which is caused by its chemical instability. The nature of this molecule makes it chemically reactive, which evokes two major consequences:

- **Generation of Trifluoroacetic Acid in the atmosphere.** According to recent scientific data published by the American Chemical Society, the sole decomposition product of HFO-1234yf is trifluoroacetic acid (TFA), and because of the chemical's short lifetime, the TFA deposition will be enhanced and more localized. TFA is a strong acid, highly persistent, with a lifetime of thousands of years. TFA contributes to the acid rains and is phytotoxic.
- **Acute and chronic exposure.** HFO-1234yf is lethal at high inhalation exposure. According to scientific literature data, it also demonstrated developmental toxicity in rabbits and delayed toxicity to aquatic life through its main metabolite, TFA.

### **Evidence 6: Insufficient Exceptions laid out in the Bill threatens supply availability**

The phase out's current standards for an exception to the phase out are:

1. Due to factors relating to a substitute's technological achievability, commercial demands, safety, or other factors, or
2. If the regulated substance's supply is insufficient.

However, the bill limits the exceptions to only a 10% increase in the phased down quantity. This is irresponsibly low, especially in the case of a Force Majeure, where substitutes may no longer be available to supply, and US companies need materials.

This does not allow flexibility or mobility to industries that account for many jobs, and economic contribution to the United States. The 16-year phase out is already challenging the entire redesign on industries, but to even regulate the exceptions in case of emergency, displays the inflexibility and controlling aim of this proposal.

### **Evidence 7: Inconsistent with the American Government's Goals and EPA's SNAP Program**

NERA Economic Consulting research report and United States government believes the Paris Agreement in 2017, would have cost the USA nearly \$3 trillion in economic losses, 6.5 million industrial jobs, and would've required the US to provide financial assistance to other countries if followed the Paris Agreement.

The revenue opportunities that are available to US companies in the global HFC market will only grow over the next 10-15 years, and it is imperative that the US remain a leader while other countries such as India and China continue to escalate their usage unabated – until their own respective phase outs.

The table in **Exhibit 3** visualizes the similarities between the bills and how Bill S. 2754 is the Kigali Agreement.

## Conclusion

The numbers and evidence outlined in Bill S. 2754 are inconsistent with reality and hurt Americans. That'll go against "America First".

It should not pass in its current form, especially until phase out date considerations are revisited, and phase out prioritization for individual HFC grades like HFC-152a are assessed separately.

Very Best Regards,

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**Exhibits**

**Exhibit 1:** Carbon Footprint of HFO-1234yf Manufacturing ..... 14  
**Exhibit 2:** Greenhouse Gas Emissions for Fluorochemicals have decreased with HFCs ..... 15  
**Exhibit 3:** Bill’s similarities to already rejected legislation by current Administration..... 16

**Exhibit 1: Carbon Footprint of HFO-1234yf Manufacturing**

Calculations based on the available data on energy consumption and CO<sub>2</sub> emissions<sup>1</sup> attest that the carbon footprint of **HFO-1234yf** manufacturing both in the US<sup>2</sup> and China<sup>3</sup> is very high. For 1 metric ton, it is **20 times higher** than the carbon footprint of manufacturing 1 metric ton of a typical HFC such as, for example, HFC-152a.

**Comparative Analysis of Carbon Footprints of 3 HFO and HFC manufacturing**

<b>Chemical</b>	<b>Production</b>	<b>Assumptions</b>	<b>CO<sub>2</sub> footprint</b>
HFO-1234yf	7,000 kta	2.46 MT of coal translates into 20 MWh	9 MT per 1 MT of HFO-1234yf
HFO-1234yf	12,000 kta	536 thousand MT of CO <sub>2</sub> emissions for all 5 plants within the facility	9 MT per 1 MT of HFO-1234yf
HFC-152a	20,000 kta	24 thousand MT of CO <sub>2</sub> emissions for whole plant	0.4 MT per 1 MT of HFC-152a

<sup>2</sup>Assumptions for CO<sub>2</sub> emissions are from the EPA Greenhouse Gas Reporting Program available for public at <https://www.epa.gov/ghgreporting/ghgrp-chemicals>

<sup>3</sup>Assumptions for the energy consumption by the Arkema plant in China are from the City of Suzhou government, which approved construction of the Arkema Changshu plant: [http://www.zfxxgk.suzhou.gov.cn/sjjg/szsfzhggwyh/201401/t20140103\\_346327.html](http://www.zfxxgk.suzhou.gov.cn/sjjg/szsfzhggwyh/201401/t20140103_346327.html), translated from Chinese

**Exhibit 2: Greenhouse Gas Emissions for Fluorochemicals have decreased with HFCs**

Although there are many claims that HFCs contribute negatively to the effects of Global warming, the EPA published Greenhouse Gas Emissions Report for fluorinated chemicals shows a decrease of 8.8% year over year between 2011 and 2018. This decrease in Greenhouse Gas emissions is much greater than the increase in HFC usage, a testament to the optimization of technologies using HFCs.

**Chemicals Sector — Greenhouse Gas Emissions Reported to the GHGRP**  
(all emissions values presented in million metric tons CO<sub>2</sub>e)

<b>Emissions by subsector</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>
Non-fluorinated chemicals	163.1	158.6	161.2	165.4	167.3	169.9	174.5	183.2
Fluorinated chemicals	17.3	14.4	13.4	11.7	10.3	7.5	9.9	8.1

Source: <https://www.epa.gov/>

**Exhibit 3: Bill’s similarities to already rejected legislation by current Administration**

**HFC’s proposed for Phase Out based on Legislation**

✓ - HFC’s proposed for phase out    ✗ - HFC’s not proposed because GWP already less than 150

	<b>EPA SNAP program</b>	<b>Kigali Amendment</b>	<b>Bill S. 2754</b>
<b>Action Taken:</b>	US Federal Court rejected back EPA SNAP program	President Trump did not ratify amendment to support US economic interest	TBD
HFC–134	✓	✓	✓
HFC–134a	✓	✓	✓
HFC–143	✓	✓	✓
HFC–245fa	✓	✓	✓
HFC–365mfc	✓	✓	✓
HFC–227ea	✓	✓	✓
HFC–236cb	✓	✓	✓
HFC–236ea	✓	✓	✓
HFC–236fa	✓	✓	✓
HFC–245ca	✓	✓	✓
HFC–43–10mee	✓	✓	✓
HFC–32	✓	✓	✓
HFC–125	✓	✓	✓
HFC–143a	✓	✓	✓
HFC–23	✓	✓	✓
HFC–41	✗	✓	✓
HFC–152	✗	✓	✓
HFC–152a	✗	✓	✓