

The background of the entire page is a close-up, vertical stack of numerous metal drums, likely containing industrial liquids or gases. The drums are arranged in several columns, creating a strong sense of depth and repetition. The lighting is dramatic, with bright highlights on the metallic surfaces and deep shadows in the recesses between the drums.

# **BLOWING IT:** Illegal Production and Use of Banned CFC-11 in China's Foam Blowing Industry

July 2018





Team from Dacheng Wan Fu Chemical Co. Ltd spraying foam in a cold storage warehouse in Hebei Province, China

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## ABOUT EIA

We investigate and campaign against environmental crime and abuse. Our undercover investigations expose transnational wildlife crime, with a focus on elephants and tigers, and forest crimes such as illegal logging and deforestation for cash crops like palm oil. We work to safeguard global marine ecosystems by addressing the threats posed by plastic pollution, bycatch and commercial exploitation of whales, dolphins and porpoises. Finally, we reduce the impact of climate change by campaigning to eliminate powerful refrigerant greenhouse gases, exposing related illicit trade and improving energy efficiency in the cooling sector.

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Cover image:  
Image taken at Dacheng Desheng Chemical Co., Ltd, silver barrels are confirmed by the staff as containing CFC-11.

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# INTRODUCTION

In May 2018 scientists revealed that atmospheric levels of CFC-11, a potent ozone depleting substance banned since 2010, were significantly higher than expected, leading them to conclude that new illegal production and use of CFC-11 was occurring in East Asia.

Information obtained by the Environmental Investigation Agency (EIA) demonstrates conclusively that the use of CFC-11 in China's rigid polyurethane (PU) foam insulation sector, in particular in the building and construction subsector, is widespread and pervasive. CFC-11 is used as a foam blowing agent for the manufacture of molded foam panels and spray foam used for insulation purposes.

EIA has evidence from eighteen companies in ten provinces that they use CFC-11. Detailed discussions with company executives make clear that these are not isolated incidents but instead represent common practice across the industry.

EIA's calculations show that emission estimates associated with the level of use reported by these companies can explain the majority of emissions identified in the atmospheric study. In addition there is significant potential for illegal international trade in CFC-11 containing pre-formulated polyols for foam manufacturing in other countries.

The scale of the compliance issue is such that it cannot be treated as a series of isolated incidents. EIA urges the Government of China and the Parties to the Montreal Protocol to acknowledge the scale of this environmental crime and take immediate action to investigate further, implement legislative reform and ensure effective intelligence-led enforcement. Only through urgent and comprehensive action can the Montreal Protocol ensure that it continues to merit its reputation as the most effective global environmental treaty.

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**EIA has evidence from eighteen companies in ten provinces that they use CFC-11. Detailed discussions with company executives make clear that these are not isolated incidents but instead represent common practice across the industry.**

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## SUMMARY OF FINDINGS

- A scientific paper published in Nature found significant and unexplained increase in emissions of banned CFC-11 in the atmosphere, originating in East Asia, since 2012.
- EIA's investigations have revealed that wide-spread illegal production and use of CFC-11 is occurring in China to supply the rigid PU foam industry.
- Traders and buyers of CFC-11 in China estimated that it is used in the majority of China's rigid PU foam sector.
- A total of 18 polyol blend producing factories out of 21 that EIA sources spoke to confirmed using CFC-11.
- When describing their own rate of use, nearly all the companies stated or indicated that it was the majority of their production (70 per cent-100 per cent).
- Several companies acknowledged the illegality of their actions and explained that it was used because it was cheaper and made more effective foams;
- Several companies described exporting the preblended foam mixtures (formulated polyols) containing CFC-11.
- China has a significant compliance issue to address which requires an immediate clampdown on illegal production and use of CFC-11, along with policy reform and effective intelligence-led enforcement.
- The Montreal Protocol must thoroughly examine necessary steps required to ensure enforcement and compliance with the obligations of the Montreal Protocol for all controlled substances, including new controls on HFCs. Applying lessons from a thorough investigation of the illegal CFC-11 production and use will be critical to the Protocol's continued success.

## BACKGROUND AND CONTEXT



Image taken at Dacheng Aoyang Chemical Co.Ltd of raw materials used to produce blowing agent.

**Information collected from foam production companies in China confirms that CFC-11 continues to be extensively produced and used illegally in China's PU foam industry. The evidence gathered from conversations with multiple industry sources, including traders of CFC-11 and 18 different Chinese factories points to its widespread use in the foam blowing production industry as the primary source of the illegal emissions.**

CFC-11 – trichlorofluoromethane - is a potent ozone depleting gas with a high global warming potential (GWP) 4,750 times that of carbon dioxide. Being a major contributor to stratospheric ozone depletion, control of its production and consumption (along with four other potent CFCs) was written into the original text of the Montreal Protocol in 1987. Production and consumption of CFCs officially ended in developed countries in 1996 and in developing countries by 2010.<sup>1</sup>

CFC-11 was first discovered in the late 1950s to be an excellent physical blowing agent, with low molecular weight, boiling point around room temperature, low toxicity, non-flammable and low thermal conductivity. This along with low cost made CFCs the blowing agent of choice for polyurethane (PU) foam, especially rigid thermal insulation foam.

Although countries have reported nearly zero new production and consumption since 2006, scientists recently found that CFC-11 emissions from 2012-2016 increased by 25 ( $\pm 13$ ) per cent, equating to emissions of  $13 \pm 5$  gigagrams per year.<sup>2</sup> The scientific study, published in *Nature*, also noted that the rate of decline in CFC-11 emissions began to diverge from those expected by scientific models as far back as 2002, declining at a less rapid rate than expected.

While there were some reports as recently as 2017 already pinpointing illegally produced CFC-11 being used in the foam sector, specifically in the Shandong province,<sup>3</sup> EIA has uncovered shocking new evidence that explains at least the majority of the mystery of the unaccounted CFC-11 emissions. Information collected from foam production companies in China confirms that CFC-11 continues to be extensively produced and used illegally in China's PU foam industry. The evidence gathered from conversations with multiple industry sources, including traders of CFC-11 and 18 different Chinese factories points to its widespread use in the foam blowing production industry as the primary source of the illegal emissions.

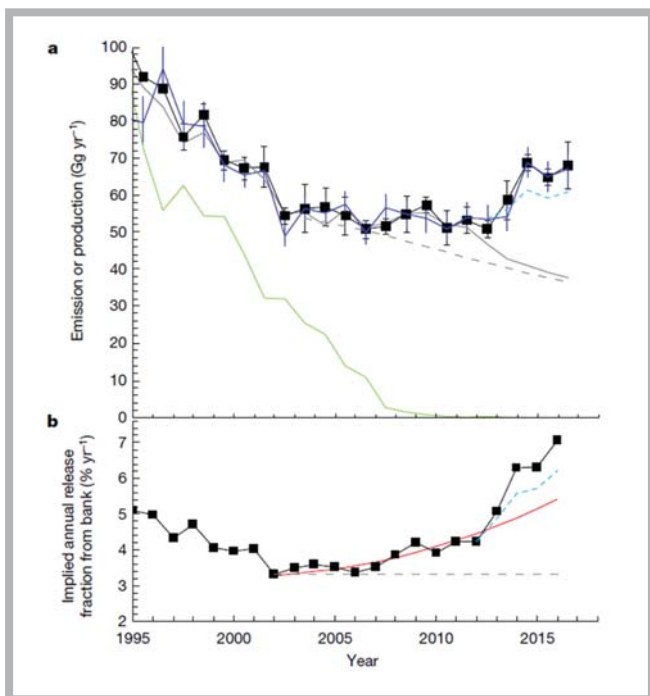


Figure from Montzka et al. showing CFC-11 emissions detected in atmosphere vs. reported production of CFC-11 (green line)

## CHINA'S FOAM INDUSTRY

Foamed plastics are used in a variety of applications for insulation, cushioning, weight reduction, energy dissipation, buoyancy, convenience and comfort. PU foams are the most versatile and are widely used for construction and building insulation as well as appliance insulation (including domestic and commercial refrigerators and freezers, refrigerated containers, water heaters and coolers).<sup>4</sup>

PU foam is generally made by reactions of isocyanates with active hydrogen-containing compounds. The typical process method of making PU foams is by mixing two components: One component, commonly known as component "A" or "black agent", contains the isocyanate. The other component, "B" or "white agent", contains the polyol premixed with other chemical ingredients (such as flame retardants or additives) and includes the blowing agent such as CFC-11.<sup>5</sup>

China has a growing PU foam market, estimated to represent about 34 per cent of the global market in 2011.<sup>6</sup> The rigid foam industry is concentrated in the provinces of Shandong, Henan, Hebei and Tianjin where the majority of systems houses and foam enterprises are located.<sup>7</sup> Nearly 57 per cent of total PU blowing agent used is pre-blended with the polyol.<sup>8</sup> According to documents submitted to the Executive Committee of the Montreal Protocol's Multilateral Fund (ExCom MLF) the industry sector comprises about 3,500 small and medium-size enterprises.

## EVIDENCE FROM THE FIELD

In response to the findings of the Nature paper, EIA researchers identified several potential sellers of CFC-11, some of which had advertised online through internet retailers including Alibaba.com.

In June 2018, EIA sources contacted 25 white agent and/or foam manufacturing factories based on internet searches. Of a total of 21 companies that responded, 18 companies from 10 different provinces confirmed illegal use of CFC-11 in the production of foams used for insulation in buildings and other applications. The details given during conversations with company representatives demonstrate that the use of CFC-11 in China's PU foam insulation sector, in particular in the building and construction subsector, is widespread. The CFC-11 is used to make the premixed "white agent" (component B) which is combined with other ingredients to manufacture molded foam panels and spray foams.

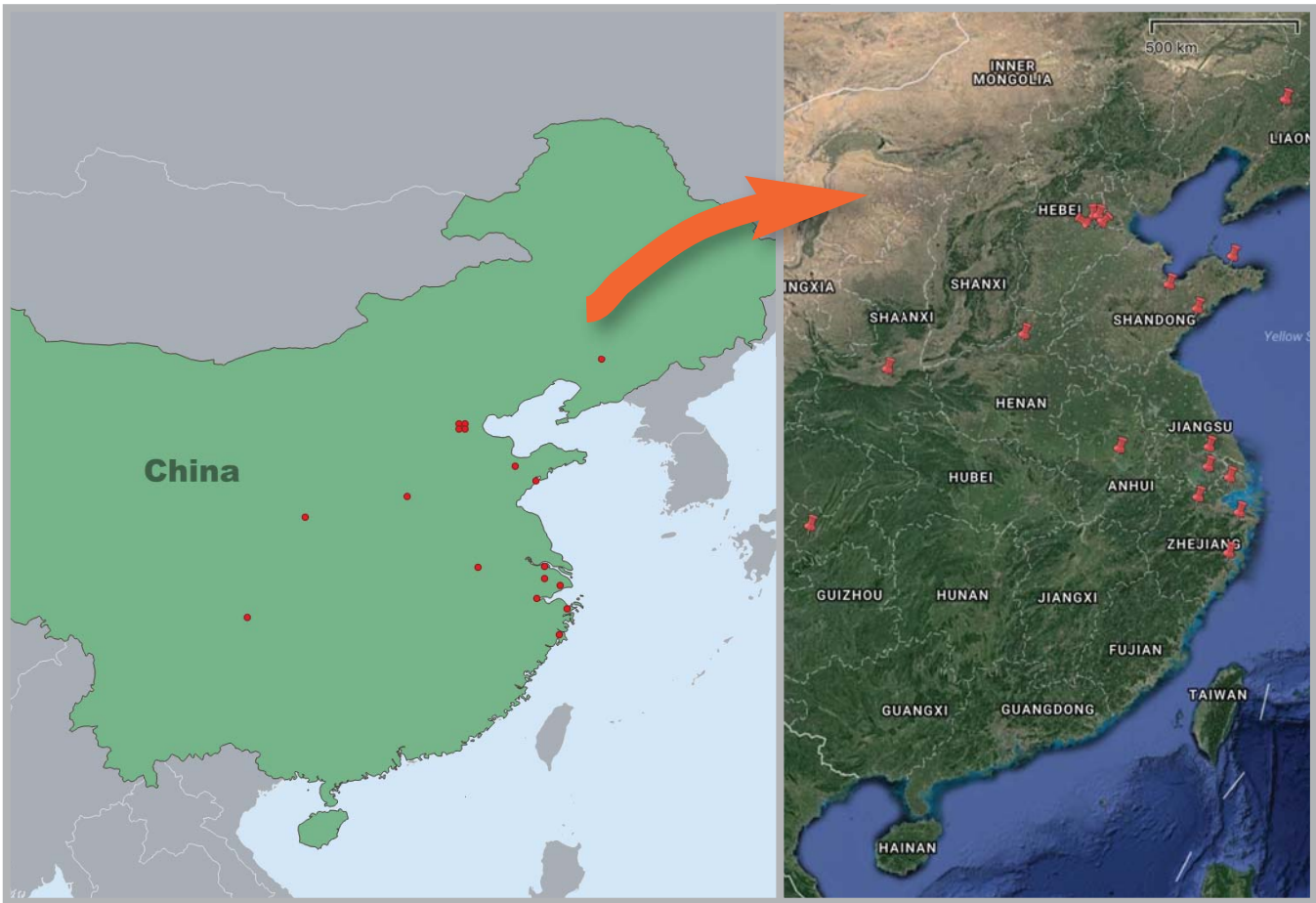
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**"Producers and traders of PU foam blowing agent told EIA sources that the majority of China's foam industry continues to use CFC-11 due to its better quality and lower price."**

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Dacheng Shengshi Tianchuang Chemical Co. with a board declaring itself as a "Farming Plant" to disguise CFC-11 usage



EIA map illustrating enterprises confirming CFC-11 usage

Producers and traders of PU foam blowing agent told EIA sources that the majority of China's foam industry continues to use CFC-11 due to its better quality and lower price. One seller of CFC-11 gas, Yantai Jinpei International Trade Co., Ltd estimated that 70 per cent of domestic blowing agent used CFC-11 and explicitly discussed exports in addition to his domestic sales. He stated that if CFC-11 was mixed with 'white agent' it could be exported without a license and that, unlike CFC-11 gas, it could not be tested. When questioned about the use of environmentally friendly blowing agents, the seller stated "BASF and Bayer have their own blowing system. But if you go with their environmental-friendly blowing agent, you'd have to purchase other ingredients from them too. And it's a price fixing system. Very different from what you can get from us pricewise."

Large stacks of drums containing the banned CFC-11 were shown to EIA sources and their use demonstrated in the production of foam. Several factory representatives acknowledged the illegality of their actions; one factory confirmed keeping a stockpile of the legal alternative to CFC-11, HCFC-141b, as "just for show" when inspections occurred. The factory owners were reluctant to disclose the exact location of the illegal CFC-11 production, but one referred to "guerilla tactics" employed by such producers who change locations frequently in order to avoid government inspections. Further details of some specific companies are outlined in the following sections.

### 1. Dacheng Aoyang Chemical Co. Ltd, Dacheng, Hebei Province

Aoyang Chemical Co. Ltd is a family-owned company with a stated annual turnover of tens of millions of dollars that started 14 years ago producing polyether. Three years ago they expanded their product line to "white agent" (polyol blend), PU foam and PU downstream products. The company mostly supplies the domestic market, and occasionally sells to traders for export.

The representative estimated that 99 per cent of their products used CFC-11, produced by unlicensed factories with "shady and hidden operations" based in Inner Mongolia. When questioned if CFC-11 was used nationwide the representative estimated that the total HCFC-141b volume in the market was one-tenth of CFC-11, and that only large prominent companies like Haier would use HCFC-141b (and even then, they did not oversee all manufacturing).

With respect to exporting foam blowing agents containing CFC-11, the company representative stated "Do you know how we deal with strict export custom inspection? We get those big lumber core boards, build up a container for four barrels of [white agent] and seal it carefully. Nobody at the custom would open it up. Seriously, how can anyone do inspections on that? We also spread putty on those containers to make it really messy. No one cares to take a look."

The representative also claimed to hold a CFC-11 stockpile of hundreds of tonnes.

## 2. Dacheng Desheng Chemical Co., Ltd, Dacheng, Hebei Province

According to the company representative, Desheng is by far the biggest supplier of “white agent” (polyol blend) in the region. They only produce white agent and PU foam mix.

The company representative stated that CFC-11 was used for 90-95 per cent of their production as it was more cost-effective than HCFC-141b.

## 3. Dacheng Shengshi Tianchuang Chemical Co., Ltd, Dacheng, Hebei Province

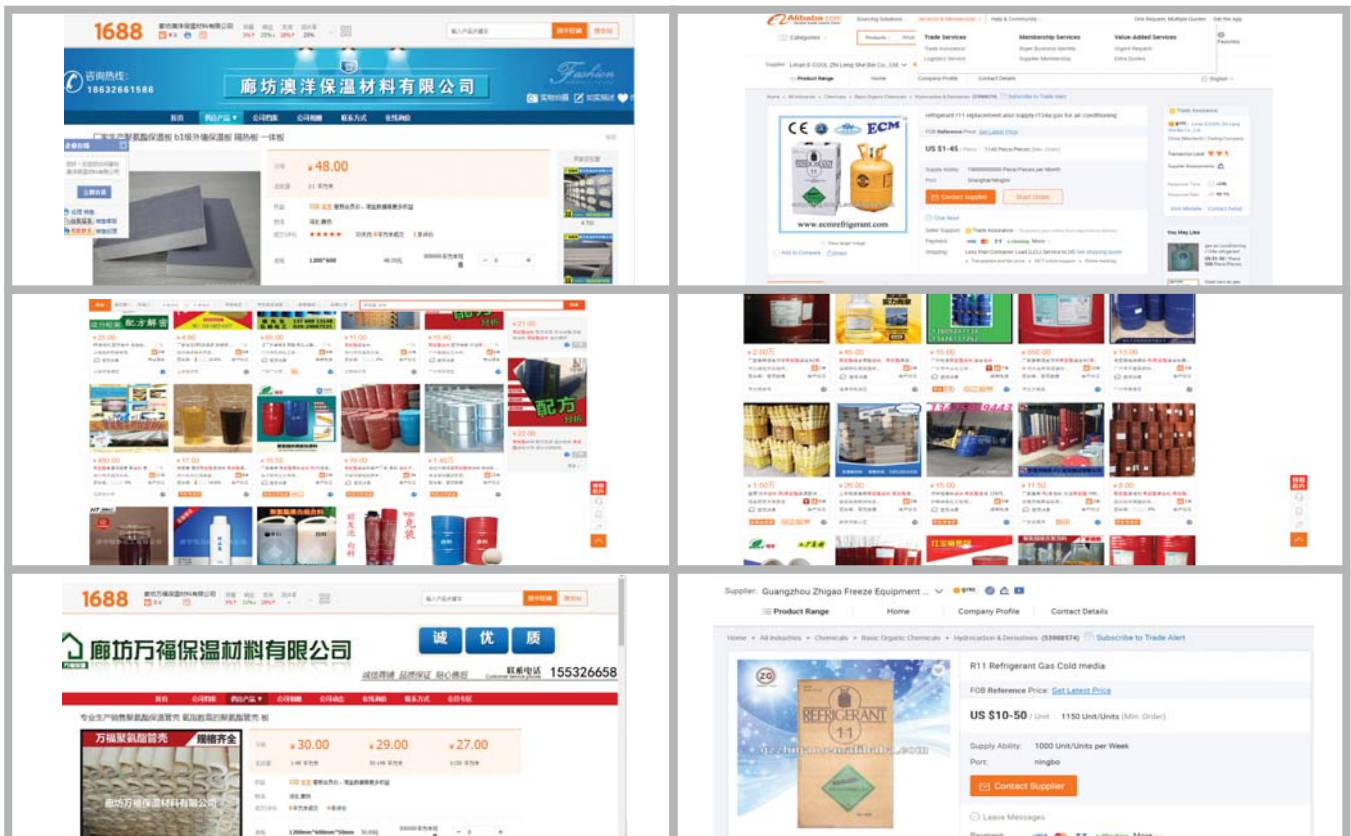
The owner of Dacheng Shengshi Tianchuang Chemical Co., Ltd has three factories in Dacheng, manufacturing cold storage insulation panels with Class B3 PU foam and PU foam spray. The company has exported through a trader to North Korea and Mongolia before.

The company representative stated that 100% of their white agent production is using CFC-11. The company produces CFC-11 for their own use at a factory in Inner Mongolia. He said HCFC-141b is not as efficient as CFC-11 to produce blowing agent, and 1000RMB/tonne more expensive. The representative also stated that they had capacity to produce two containers of foam agents (20 tonnes of white agent and 20 tonnes of black agent) per day. The representative also stated that CFC-11 containing foam agents could be exported by labelling them as HCFC-141b.

**“Do you know how we deal with strict export custom inspection? We get those big lumber core boards, build up a container for four barrels of [white agent] and seal it carefully. Nobody at the custom would open it up. Seriously, how can anyone do inspections on that? We also spread putty on those containers to make it really messy. No one cares to take a look.”**



Image taken at Dacheng Desheng Chemical Co., Ltd, barrels with ingredients to make white agent containing CFC-11



Illustrative examples of screenshots of CFC-11 sellers found online.



Image taken at Dacheng Aoyang Chemical Co.Ltd: two tanks with mixtures for white agent (polyol blend)

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**“We have connections with the local environment administration. When the municipal environmental bureau runs a check, our local officers would call me and tell me to shut down my factory.”**

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#### **4. Dacheng Wan Fu Chemical Co. Ltd, Dacheng, Hebei Province**

Wan Fu Chemical Co. Ltd directly purchases white agent from De Sheng or sometimes shares the same supplier. The company confirmed that there are only a few white agent suppliers in the region, De Sheng being the largest.

The company representative stated that 70-90 per cent of their production used CFC-11 and that HCFC-141b represented just a small amount of use. He also stated “We purchase CFC-11 and mix it up. You see, nobody comes to inspect on our processing work...How do I explain this...in times of frequent environmental policy enforcements, we get inspected too. But the truth is we don't have any pollution! We have connections with the local environment administration. When the municipal environmental bureau runs a check, our local officers would call me and tell me to shut down my factory. Our workers just gather and hide together. It's pointless... government is going too far in these environmental protection efforts.” Additionally, he mentioned that he had customers based in Shandong province where there was a high demand for white agent.



Barrels of “black agent” at Dacheng Shengshi Tianchuang Chemical Co used to mix with “white agent” containing CFC-11



## 5. Suzhou Chang Xing Hui, Jiangsu province

The company confirmed CFC-11 was used for all their white agent production. The representative stated that it is not good for the environment but "everyone uses it". They have several factories, including one in Suzhou called Jiangsu Guanyue Chemical. When asked if there were concerns about availability of the CFC-11 going forward, the representative said: "No problem at all. F11 is the best blowing agent... Oh, don't worry [about the consistency of F11 supply]."

## 6. Taizhou Mingyu Chemical Co., Ltd, Zhejiang Province

This factory stated that it has a daily capacity of producing 20 tonnes of white agent. The owner of the company also owns two other factories and warehouses in Hebei province and Jiangsu province. He expressed confidence about the consistency of supplying CFC-11 based white agent.

## 7. Shenyang Dahao Insulation Materials Co., Ltd, Liaoning Province

The company representative stated that his factory located in Shenyang, Liaoning Province has a daily capacity of producing approximately 10 tonnes of white agent. When asked if they produce their own CFC-11, the factory representative said: "We produce it ourselves... For 20 tonnes if you pay today, we can deliver the day after tomorrow. Two to three days, no problem to deliver."

## 8. Hefei Baiwangxing Trading Co., Ltd, An' hui province

Although this company is located in Hefei, the owner of company originally comes from Yantai, Shandong province and still owns a factory there. When asked about CFC-11 usage, he said "We have been selling this chemical [CFC-11 based white agent] for over 20 years."

## INTERNATIONAL TRADE IN CFC-11?

Although large foam manufacturing enterprises tend to blend all chemical ingredients by themselves in-house, purchasing blowing agent separately as a stand-alone chemical, smaller foam producers normally purchase pre-formulated polyols from systems houses or chemical suppliers. In many countries, these are imported. The scale of international trade in pre-blended polyols is difficult to assess accurately. The agents can be imported under two HS codes, HS3907.20 (other polyethers) or HS3909.50 (polyurethanes) however both codes cover all kinds of polyols.

According to UN comtrade, between 2012-2016 on average 413,000 tonnes of 'other polyethers' and 128,000 tonnes of 'polyurethanes' were exported each year from China, primarily to countries in Asia and the Middle East but also to the US and Turkey.

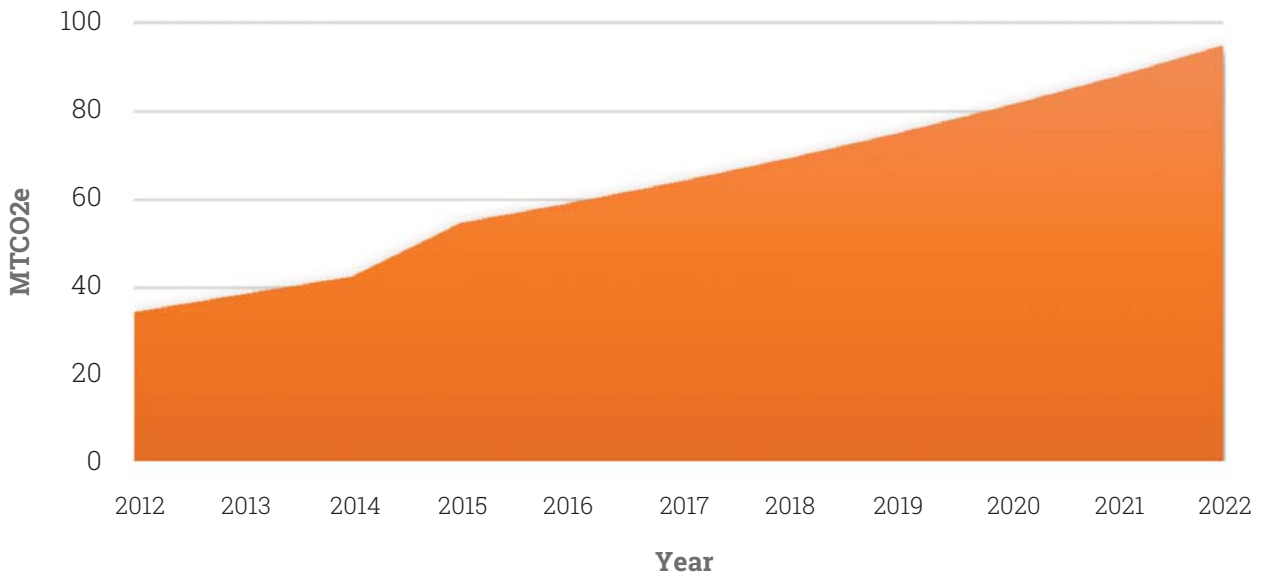
## List of companies confirming CFC-11 use to EIA sources:

1. Dacheng Aoyang Chemical Co. Ltd, Dacheng, Hebei Province
2. Dacheng Desheng Chemical Co., Ltd, Dacheng, Hebei Province
3. Dacheng Shengshi Tianchuang Chemical Co., Ltd, Dacheng, Hebei Province
4. Dacheng Wan Fu Chemical Co. Ltd, Dacheng, Hebei Province
5. Suzhou Chang Xing Hui, Jiangsu Province
6. Zhang-jia-gang Dongcheng Changhe, Jiangsu Province
7. Qingdao Derun Jia International Trade, Shandong Province
8. Xinxiang Hong Fu, Henan Province
9. Hefei Baiwangxing Trading, Anhui Province
10. Yantai Jinpei International Trade Co. Ltd, Shandong, Province
11. Taizhou Mingyu Chemical, Zhejiang Province
12. Xi'an Lvjianbao Construction Materials, Shanxi Province
13. Chongqing Chudian Insulation Materials, Chongqing
14. Weifang Keyuan Fine Chemicals, Shandong Province
15. Shenyang Dahao Insulation Materials, Liaoning Province
16. Hangzhou Xiangzun Construction Material, Zhejiang province
17. Shanghai Ruiwo Construction Materials, Shanghai
18. Ningbo Hi-tech Park Huadongxing Insulation Materials, Zhejiang Province

Given the volume of export in polyols from China together with EIA's information from Chinese producers, it is clear that there is a possibility that CFC-containing pre-blended polyols have been imported by other Montreal Protocol Parties, with or without the knowledge of the importer.

Under Paragraph 7 of Decision XIV/7 information on illegal trade should be reported to the Ozone Secretariat. While a number of cases of illegal trade in CFC-12 cylinders are reported, there are no records of CFC-11 illegal trade.<sup>9</sup> However at least one reported case confirms the illegal international trade of CFC-11 for foam production.

## Potential CFC-11 Emissions if Action Not Taken



EIA analysis of potential emissions if immediate action is not taken to stop usage of CFC-11 in foam sector in China



Board outside Dacheng Aoyang Chemical Co.Ltd



Dacheng Desheng Chemical Co., Ltd main office and production site

In January 2014 Russia's Ministry of the Interior detained and arrested criminals engaged in smuggling ODS including 18.8 tonnes of CFC-11 from China into the Russian Federation. The operation resulted in seizure of more than 1,500 cylinders of various size with CFC-11, CFC-12, HCFC-22 and HCFC-141b, along with home-made reclamation and filling equipment, documents, seals and labelling devices such as templates and stencils.<sup>10</sup>

The seized refrigerants were of Chinese origin and were transferred from original cylinders into ones labelled as containing ozone-safe refrigerants. The CFC-11 was imported under the guise of ethylene-glycol and contained in a 250kg drum typically used for blowing agents.

## CAN ILLEGAL USE OF CFC-11 IN THE FOAM BLOWING INDUSTRY ACCOUNT FOR THE MYSTERY EMISSIONS?

EIA has calculated potential emissions from the illegal use of CFC-11 in China's PU foam blowing industry using findings from the field, market data and emissions scenarios based on consultations with industry experts. According to these calculations, during the 2012-2017 time period annual average CFC-11 emissions would be in the range of 10,307 to 12,165 tonnes depending on the CFC-11 emissions to atmosphere during production and installation (See below and reference 14 for full explanation). Differences in the foaming agent volatility as well as production, operation and destruction emissions assumed are likely to affect this value. This is near the center of the range estimated by the Nature scientific study which estimated average emissions of  $13 \pm 5$  gigagrams per year, or 8-18,000 tonnes, over the same period.

The model has a variety of assumptions that have a high degree of uncertainty, particularly the emission rates, extrapolation from survey to total foam sector and scale of “spray foam” use within the sector, but it is highly robust vis-à-vis the question of whether this sector likely explains the majority of the atmospheric study. Even if the estimated emissions calculated below are reduced by 30% they are still within the range of emissions estimated by the Nature study, and if they are further reduced by 50% they still explain the majority.

Emissions were calculated based on the following assumptions:

- China’s rigid foam production data from market reports;<sup>11</sup>
- Foam blowing agent (CFC-11) is estimated to comprise 10 per cent of the finished foam by weight.
- CFC-11 is used as blowing agent for 70 per cent of rigid foam production (EIA sources were told 70 to 100 per cent by multiple white agent producers);<sup>12</sup>
- Emissions of CFC-11 from spray foam (which is assumed to account for 11 per cent of rigid PU foam) is 15 per cent;<sup>13,14</sup>
- Production emissions from other rigid PU foam agents are five per cent;<sup>15</sup>
- The foam industry in China is growing at a Compound Annual Growth Rate (CAGR) of 8.2 per cent.<sup>16</sup>

If illegal CFC-11 use continues unabated in China’s rigid foam sector according to the assumptions above, total CFC-11 emissions between 2012 and 2022, based on the expected growth of the industry, would amount to over 148,000 tonnes and 702 million tonnes (MT) CO<sub>2</sub>e. This is equivalent on average to the CO<sub>2</sub> emissions from 16 coal fired power stations each year.

## EIA FINDINGS CORROBORATED BY OFFICIAL DOCUMENTS AND INDEPENDENT INVESTIGATION

EIA’s findings are backed up by official Chinese government documents and other research. Journalists from the New York Times interviewed a number of companies that admitted to using CFC-11 to make foam insulation. A 2016 report from environmental officials in Shandong, a key area for foam production, stated: “Currently there is still a large volume of illegally produced CFC-11 being used in the foam industry,” and “quite vigorous illegal production of outmoded CFC-11,” which it said was “bringing risks to the market and environment.”<sup>17</sup>

According to the Shandong official, illegal production of CFC-11 is “highly concealed” and “evidence is hard to obtain”. For this reason her report stated that only a small number of suspects had received adequate

punitive measures. Documents detailing enforcement efforts in Shandong province showed one factory to have been illegally producing 1,100 tonnes of CFC-11 in a year.<sup>18</sup>

Further, a 2017 presentation available on the official government website of Shandong International Convention Implementation states: “For the past few years, Shandong Environmental Protection Bureau worked jointly with Public Security Bureau to shut down illegal ODS producers, most of which were CFC-11 producers. Due to the prohibition of CFC-11 production, CFC-11 price increased in underground ‘black market’. Therefore, some enterprises produce ODS despite of related government regulations. These enterprises generally lack well-performing facilities and thorough management. Their production is damaging to the ozone, soil and underground water. These enterprises usually locate in remote places. They are unlicensed and don’t even have a name. Some of them move regularly, making it challenging for acting government agencies to act oversight.”<sup>19</sup>

The presentation further states “Currently the most frequent usage of ODS in cold chain industry is CFC-11 as PU foam blowing agent for cold storage and pipe insulation. Although there are alternatives (of CFC-11), its blowing efficiency, supporting facilities and blowing techniques are still to be improved.

## MONTREAL PROTOCOL FUNDED ACTIVITIES

At the time of the CFC phase-out, the foam sector was the largest CFC consuming sector in China. It was initially addressed through a series of conversion projects at key manufacturers, with PU foam enterprises converting primarily to non-ODS alternatives in the majority of applications except for rigid insulation and integral skin applications, where HCFC-141b was selected.<sup>20</sup> However the project by project approach failed to reduce CFC consumption and a sector approach was agreed in 2001 for a total phase-out of CFC-11 in the PU foam sector by 2010 at a cost of \$53.846 million.<sup>21</sup>

Phaseout actions included controlling CFC-11 supply, a ban on CFC-11 consumption in the PU foam sector by the end of 2009, individual conversion projects, training and public awareness, technical assistance to enterprises, an enforcement and supervision system, research and development and safety standards.<sup>22</sup> The World Bank, as the implementing agency, was tasked to submit verification reports on an annual basis in order to secure subsequent tranches of funding.

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**A 2016 report from environmental officials in Shandong stated: “Currently there is still a large volume of illegally produced CFC-11 being used in the foam industry,” and “quite vigorous illegal production of outmoded CFC-11,”**

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While the CFC phase-out was being finalized, China was already preparing and implementing the phase-out of HCFC-141b in the foam sector, focused initially on conversions in the refrigerator and freezer sub-sector, refrigerated trucks and reefers, small electrical appliances and solar water heater sector. China's Stage 1 HCFC phase-out management plan (HPMP) was agreed in July 2011 at the 64th ExCom meeting at a total cost of \$265 million plus support costs. Funding to meet the 2015 HCFC target included \$73 million for the PU foam sector plus \$5.3 million for support costs for the World Bank. The second stage HPMP, agreed in 2016, proposed the total phase-out of HCFCs in PU foam by 2026 at a cost of \$141.471 million plus agency costs. The plan included the conversion of around 2,100 enterprises, starting with those producing insulation foam for solar water heaters and pipes and followed by the gradual conversion of the remaining enterprises (including construction foams) in the other sectors. The request for the second tranche of the second stage HPMP was submitted to the 81st ExCom meeting in June 2018.

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**The economic benefits of using CFC-11 are significant and are likely the primary motivation for its illegal use. One company representative told EIA sources that HCFC-141b is 1000RMB (\$150) per tonne more expensive than CFC-11.**

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Wall containing foam produced in Dacheng Desheng Chemical Co., Ltd, holes poked to showcase strength of foam by factory representative

## POTENTIAL DRIVERS FOR ILLEGAL USE OF CFC-11

China is a major production market for foams that are used in a range of applications for insulation in buildings, appliances, and other products.<sup>23</sup> Its rapidly expanding economy and building and construction sector is driving an eight per cent annual growth rate in demand for energy efficient rigid insulation foams.<sup>24</sup> Cold storage construction in China doubled each year from 2008 to 2012 and refrigerated warehouse capacity saw a CAGR of 34 per cent.<sup>25</sup>

Following several catastrophic fires, in 2011 China began tightening fire retardant requirements for building insulation. Decree No. 65 issued by the Ministry of Public Security requires all foams to meet Class-B1 flammability standards after 2012.<sup>26</sup> While possible to produce foams that meet Class B flammability standards using hydrocarbon blowing agents, there are technical and cost issues due to the need for additional flame retardant in the foam agent mix.<sup>27</sup>

China also began investing heavily in energy efficiency programs and improved energy codes that promote and require insulation in buildings to improve energy efficiency. For example, the Ministry of Housing and Urban-Rural Development (MOHURD) issued an energy code for rural residential buildings, which went into effect in May 2013.<sup>28</sup> Discussions with CFC-11 users in China suggests that this may have contributed to more spray foam (which is more emissive) being used in building insulation.

Reductions in HCFC-141b supply may have also spurred demand for CFC-11. As the largest consuming sector of HCFC-141b and with approximately 3,500 SMEs, China's PU foam sector has posed a particular challenge to its HCFC-141b phase-out.<sup>29</sup> Concerns surrounding the successful phase-out of HCFC-141b in China's foam sector were raised at the 62nd meeting of the ExCom MLF in 2010. In an addendum to its project proposal the World Bank stated:

*"...the foam industry does not see any benefits in changing over to a new blowing agent. Without strong policies and regulations, foam enterprises will not sign phase-out contracts. Conversion to a new blowing agent is time consuming, expensive and requires substantive internal resources."<sup>30</sup>*

While some sectors were specifically addressed with multiple conversion projects, compliance from the construction and building foam subsector, as with the CFC phase-out, is primarily being addressed through limiting supply of HCFC-141b to the market.<sup>31</sup> And while climate-friendly alternatives to HCFCs are readily available, there are cost implications to their adoption. In the case of hydrocarbons they require equipment upgrades to deal with increased flammability, or in the case of HFOs and HFCs they are significantly more expensive.

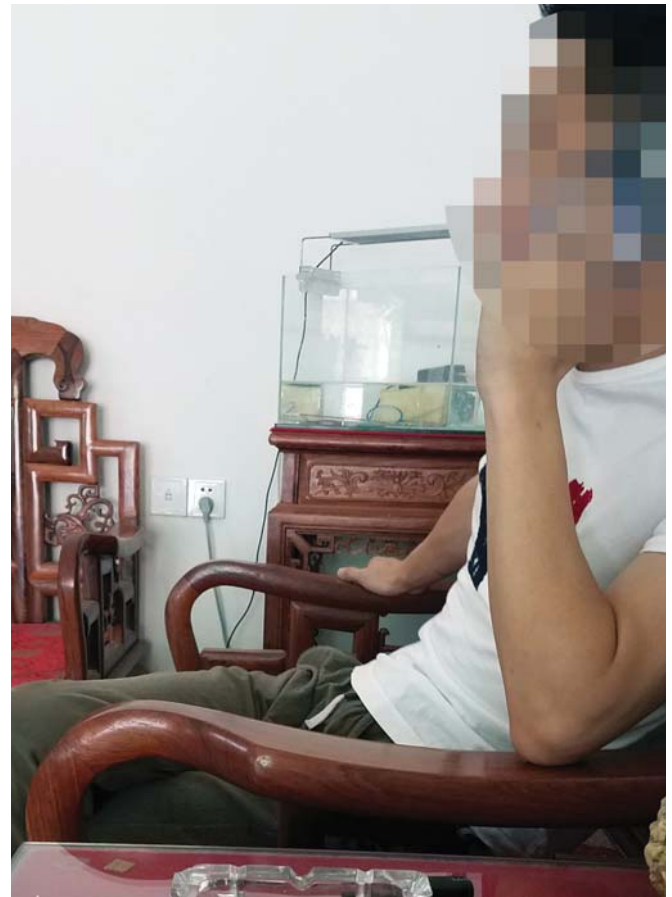
In contrast, the economic benefits of using CFC-11 are significant and are likely the primary motivation for its

illegal use. One company representative told EIA sources that HCFC-141b is 1000RMB (\$150) per tonne more expensive than CFC-11. CFC-11 is also easy to produce, requiring a few feedstock materials that are readily available. One such feedstock, carbon tetrachloride (CTC) has also been found to be present in much higher amounts (~ 35 Gg per year) in the atmosphere from observation-based methods, in stark contrast to emissions estimates of 3Gg per year from reported numbers to UNEP under the Montreal Protocol.<sup>32</sup>

In addition, penalties associated with producing, selling or consuming ODS beyond the variety, quantity or term in the quota permit mostly entail confiscation and fines ranging RMB 5000 (~USD750) to RMB 1 million (~USD 150,000) depending on the violation, but do not seem to include harsher penalties.<sup>33</sup>

Although some enforcement efforts were undertaken to shut down illegal CFC-11 producers, such as by the Shandong Environmental Protection Bureau jointly with Public Security Bureau,<sup>34</sup> these efforts seem to have had limited impact.

In EIA's view, it is likely that the explosive growth in demand for PU insulation foams, combined with additional environmental and safety policy measures, restricted supply and rising prices of HCFC-141b, easy and cheap availability of CFC-11 and an absence of strong enforcement, has led SMEs to choose CFC-11 as the most convenient and cost-effective option.



High level executive of the Aoyang Chemical Group in his office



Image taken at Dacheng Desheng Chemical Co., Ltd of other chemicals on site

# CONCLUSIONS AND RECOMMENDATIONS

Climate-friendly foam-blowing agents are readily available but ineffective monitoring and enforcement combined with the significant cost benefits of using CFC-11 are undermining the success of the Montreal Protocol. An immediate and effective clampdown of the illegal use of CFC-11 in China is critical to ensuring the recovery of the ozone layer.

Continued use of CFC-11 in this sector will lead to an ongoing and rapid rise in emissions over the next decade, thereby significantly undermining the positive impacts of the Montreal Protocol on both the ozone layer and the global climate. EIA has confidence that Parties to the Montreal Protocol will act with the necessary urgency and thoroughness to address this environmental crime and strengthen the enforcement regime of the Protocol in order to meet the challenges of future control measures agreed by the Parties.

## **EIA urges the Government of China to:**

1. Immediately crackdown on the illegal activities of the companies identified and their network;
2. Conduct a comprehensive nation-wide intelligence-led investigation into the sector beyond the identified factories and including online markets, resulting in seizures, arrests and prosecutions;
3. Ensure penalties for production, use and sale of CFC-11 are severe enough to deter repeat offenses;
4. Pass policies that force legal responsibility of avoiding CFC-11 down the supply chain, to include construction projects;
5. Ensure that penalties and enforcement efforts are widely publicized in order to signal the market and increase public understanding of ODS regulations, the need to protect the environment, and the implications of unlawful behavior;
6. Carry out targeted testing of foam products and pre-blended polyols, including at foam production facilities and construction sites;
7. Engage national and international industry, the Montreal Protocol, the Multilateral Fund and other relevant stakeholders to enable the swift adoption of environmentally-friendly blowing agents in the foam industry;
8. Investigate through regular customs checks and testing procedures the export of CFC-containing foam agents;
9. Regularly report on these efforts to the Montreal Protocol.

## **EIA recommends the Montreal Protocol and its Parties to:**

1. Set up a multi-stakeholder task force to investigate and report on the CFC-11 issue to the 30th Meeting of the Parties;
2. Work with the relevant governments in the region to procure data from data-monitoring stations to confirm and pinpoint emissions of CFC-11;
3. Request the Scientific Assessment Panel (SAP) and Technology and Economic Assessment Panel (TEAP) to further analyze the atmospheric measurements and foam sector and provide information and recommendations to the Parties;
4. Undertake national measures to ensure that CFC-containing polyols are not being imported, including legislative measures, customs inspections and testing of polyols and foams;
5. Support customs to address the logistical and bureaucratic challenges faced in testing large containers (e.g. iso tanks) of ODS and HFCs.
6. Ensure licensing systems including ODS- and HFC-containing polyols;
7. Conduct a comprehensive review of the monitoring and enforcement regime of the Montreal Protocol, in order to ensure compliance with ODS controls and prepare for new controls on HFCs.
8. Consider recommendations to Parties to include requiring legal responsibility of banned substance use by downstream users, such as final construction contractors;
9. Ensure that the current global system of atmospheric monitoring stations and satellites is maintained and enhanced to ensure it can continue to act as an early warning system for supporting compliance with Montreal Protocol controls.



Staff at Dacheng Desheng Chemical Co., Ltd shows barrels containing CFC-11

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