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The Trans-Atlantic Plastics Pipeline: How Pennsylvania's Fracking Boom Crosses the Atlantic

America's oil and gas rush is now coming to Europe, polluting both sides of the pond, contributing to climate change and threatening coastal wildlife. Over the past decade, the US fossil fuel industry has surged by employing new techniques and technologies that combine horizontal drilling and hydraulic fracturing (or fracking) to extract oil and gas from shale and other underground rock formations. Fracking, which causes many negative public health and environmental impacts, injects large quantities of water, sand and chemicals under high pressure to release oil or gas tightly held in rock layers.¹

The boom, combined with low-priced fossil fuel-based natural gas, also spawned a resurgence in North American petrochemical and plastics manufacturing — and the pollution that comes with it.² Wall Street investor-funded US fracking produced an oversupply of cheap gas and ethane in the past few years.³ The volume of gas pumped out of US wells has risen by one-third, and the industrial price for gas fell by half over the same period from 2007 to 2016.⁴ Collapsing prices undermined the profitability of oil and gas companies, but all that additional gas has been a boon to the US plastics industry.⁵

Ethane is a hydrocarbon present in gas and a primary raw material for petrochemical manufacturing. Due to its low costs, in 2012 chemical companies began aggressively investing in petrochemical plants and export facilities to capitalise on the ethane glut.⁶ Less than four years later, ethane derived from US fracked gas was exported to Europe for the first time.⁷

The new ethane export route connects Pennsylvania fracking with European petrochemical manufacturing. The Europe-bound ethane is produced in Pennsylvania by the US oil and gas companies CONSOL Energy and Range Resources, and is carried by Sunoco's Mariner East pipeline to its Marcus Hook export facility near Philadelphia. From there, large vessels dubbed "dragon ships" carry the ethane more than 5,600 kilometres across the Atlantic Ocean to ethane crackers in Norway and Scotland owned by Ineos, a European chemical company founded by billionaire Jim Ratcliffe. The crackers turn ethane into ethylene for the production of finished petrochemicals — such as plastics.⁸

In May 2017, Ineos' Grangemouth petrochemical facility in Scotland had a substantial ethylene leak that forced the evacuation of employees, scrambled emergency responders and caused the lockdown of a local elementary school.⁹ The resurgent plastics production

fuelled by Pennsylvania fracked gas could put even more communities at risk of industrial accidents.

As with fracking, transforming ethane into plastics and other products can be toxic, polluting the environment and exposing workers and nearby communities to public health risks. European countries must protect the environment and public health and reject America's headlong rush to fracking and cracking pollution and environmental damage.

Converting Fracked Gas Into Petrochemicals

The US fracked gas boom has spurred a related plastics manufacturing resurgence. The petrochemical industry produces hydrocarbon-based chemicals derived primarily from processed natural gas and, to a lesser extent, crude oil. Petrochemicals are the building blocks for manufacturing a wide range of goods — including plastic packaging, beverage bottles, tyres and more.¹⁰

Although natural gas primarily contains methane and smaller amounts of other hydrocarbons, including natural gas liquids (NGLs), what the industry calls “wet” natural gas has higher concentrations of these NGLs.¹¹ NGLs are the raw materials used to manufacture petrochemicals — predominantly ethane but also propane, butane, isobutane and pentanes.¹²

The fracking boom across the Midwest and Northeast United States has produced large volumes of ethane.¹³ A few shale plays — including portions of the Utica and Marcellus Shale gas reserves underlying vast portions of Appalachia — contain more “wet” natural gas.¹⁴ The wet gas drilled in the US state of Pennsylvania has become the key source of the ethane being transported to Norway and Scotland.¹⁵

Turning ethane into plastic is an energy-intensive process that requires separation from the other hydrocarbons present in natural gas. A petrochemical facility known as a cracker plant applies steam (or just heat) processes to “crack” ethane into ethylene, which creates the most common type of plastic.¹⁶ Petrochemical companies convert ethylene into small plastic pellets (called polyethylene resin) through another chemical procedure called polymerisation. The resin pellets are used to manufacture plastic products.¹⁷

The Polluting Perils of Plastics Production

Plastic represents the worst of our overly disposable society, and most plastic is just wasted — used once and discarded. Most plastic manufacturing goes into packaging, which creates materials that are immedi-



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Pre-production plastic pellets called nurdles are frequently found in areas of marine debris concentration.

ately thrown away.¹⁸ Much of this plastic waste ends up in our oceans and surface waters. A 2015 study estimated that nearly 200 coastal countries generated over 275 million tonnes of plastic waste in 2010 — and as much as 4.8 million to 12.7 million tonnes ended up in the oceans.¹⁹ In the central Pacific Ocean, a “plastic soup” circulates among four major ocean currents. Dubbed the “Great Pacific Garbage Patch”, it is the world’s largest dump.²⁰

A 2017 study found that plastic — mainly in the form of small pellets called nurdles — has littered 73 percent of the United Kingdom’s (UK) 279 shorelines.²¹ For example, near Ineos’ Grangemouth petrochemical complex, the Firth of Forth’s beaches and old fishing towns have been polluted by “worryingly large” amounts of nurdles, and scientists have found that 15 percent of endangered puffins in the area contain these pellets in their stomachs.²² In 2017, one scientist filmed the moment when plankton ingests plastic, documenting how it enters the food chain.²³ The fracking-driven industry expansion will likely generate even more coastal and ocean plastic pollution as ethane crackers produce more plastic resins.

The petrochemical boom does more than generate plastic that is overfilling our landfills and spilling into the oceans; the manufacturing process itself releases pollutants into our air. In the United States, for example, the Houston Ship Channel in Texas produces



about one-quarter of America's petrochemicals.²⁴ In 1999, when Houston's ozone levels were the highest in the country, the state conducted several studies that found large industrial leaks. The worst originated from cracker plants producing ethylene and propylene. "The plants were having 1,000-pound releases, 5,000-pound releases, 20,000-pound releases, in one case 200,000-pound releases", explained a now-retired University of North Carolina chemist who analysed Houston's air pollution problem.²⁵ These studies led regulators to specifically target the petrochemical industry, and despite some temporary progress, Houston continued through 2015 to fail to meet federal ozone standards.²⁶

Similarly, monitoring stations at petrochemical plants in Gela, Italy recorded sulphur dioxide — an air pollutant that can affect the lungs and respiratory health — as well as high concentrations of toxic heavy metals in road dust. In soil and water, various carcinogenic pollutants were recorded at levels that exceeded allowable limits. For example, arsenic concentrations were 7,000 times the allowable amount in local water, and mercury concentrations exceeded the permitted threshold by 6,600. Another Gela-based study found that a petrochemical plant appeared responsible for raised levels of metals including nickel, sulphur, selenium, zinc and arsenic in atmospheric particulate matter.²⁷

And according to the European Environment Agency, ozone pollution could worsen in the future from increasing activity in certain sectors, including the petrochemical industry.²⁸ As a result, smog pollution can form if ozone combines with particulate matter — such as from shipping traffic emissions and petrochemical facilities, which has been observed near major harbours in Europe.²⁹ Smog is linked to asthma and to low birthweight in babies.³⁰

The Players and the Plan: Getting Pennsylvanian Fracked Gas to Europe

In June 2010, Ineos launched its brainchild project — importing ethane from the United States to Norway and the UK — in part because it is cheaper than purchasing European ethane, but also because gas supplies from the North Sea are declining.³¹ But shipping fracked ethane from the United States to Europe proliferates fracking's toxic legacy in Pennsylvania and threatens human health, the climate and the environment — not just through the gas drilling and production, but also through the plastics manufacturing.

Ineos Constructs the Fracking-Cracking Cross-Atlantic Connection

Headquartered in Switzerland for tax purposes, the chemical giant Ineos (originally called Inspec Ethylene Oxide and Specialities) was the UK's largest privately owned company in 2010.³² It operates 65 manufacturing facilities in 16 countries worldwide, including 9 sites in Europe.³³ The controversial billionaire owner of Ineos, Jim Ratcliffe, has been one of the UK's 10 richest men, owns a "super yacht" and won a confrontational union battle at the company's biggest factory.³⁴

In a 2016 *BBC* interview Ratcliffe sloughed off concerns about environmental safety, comparing these problems to getting a flat tyre: "...it is not perfect. It is like a puncture in your car — occasionally you get a puncture and occasionally we have an accident in chemicals."³⁵ Ineos also pushed to be exempt from complying with climate fees and policies under Brexit and the fees that polluters pay to support green energy in the UK.³⁶

Ratcliffe, also the primary shareholder of Ineos, is one of the biggest fracking boosters in the UK and throughout Europe and is the biggest owner of shale licences in the UK.³⁷ In addition to pursuing shale gas in the Sherwood National Forest in Nottinghamshire, England, Ineos is pressing the Scottish Government to lift its current moratorium on fracking — which is seemingly moving towards a permanent ban.³⁸

Drilling and fracking in the UK is only in the exploratory phases in some parts of the country. But a January 2017 briefing paper by the House of Commons highlighted that the "recent approval of two planning decisions in Lancashire and North Yorkshire suggest that the UK is getting closer to commercial shale gas exploitation".³⁹ Moreover, there is widespread and growing opposition to fracking throughout the UK.⁴⁰

In 2012, Ineos struck a deal with US companies, including Range Resources and Sunoco Logistics, to become the first European petrochemical company to import US ethane feedstocks. The companies would provide ethane derived from shale gas for an Ineos cracker plant in Rafnes, Norway.⁴¹ A year later, Ineos entered into a 15-year contract with the Danish ship operator Evergas, which had the ships built in China.⁴² In 2014, Ineos secured even more Pennsylvania ethane under an agreement with Pittsburgh, Pennsylvania-based CONSOL Energy.⁴³ It also expanded its agreement with Evergas to increase the number of ships carrying ethane to Rafnes as well as to a facility in Grangemouth, Scotland.⁴⁴

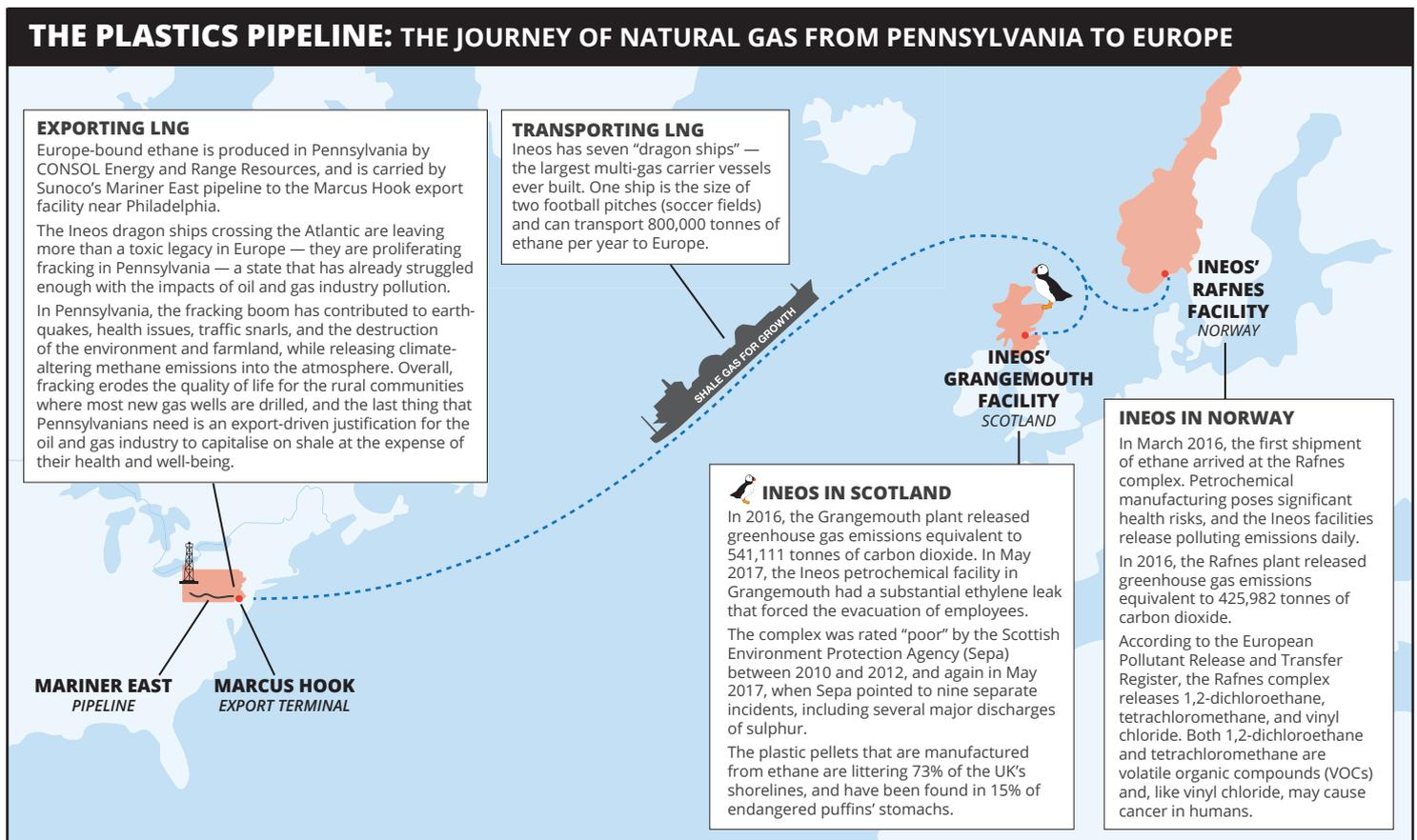
Shipping Ethane to Norway and Scotland

Ineos started with four “dragon ships”; it now has seven and is aiming for a fleet of eight — creating a virtual pipeline of ethane from US fracking facilities to Europe.⁴⁵ Each ship is between 180 and 240 metres long (200 and 260 yards) — the size of two football fields — and the vessels are the largest multi-gas carrier ships ever built.⁴⁶ Each vessel is capable of transporting 800,000 tonnes of ethane (or liquefied natural gas (LNG) or liquefied ethylene gas) a year to Norway or Scotland.⁴⁷

The engines can run on diesel, LNG or the ships’ other gaseous cargo — as it does when transporting ethane from Pennsylvania.⁴⁸ Although LNG-powered ships have lower emissions of some pollutants, the impact on climate is outweighed by emissions of methane, a powerful greenhouse gas.⁴⁹ Ethane, however, is an extremely flammable gas. In the event of a collision, as much as 27,500 cubic metres of liquid ethane could explode.⁵⁰ And if boat personnel have direct contact with liquid ethane, they could develop frostbite.⁵¹

In March 2016 the first shipment of ethane arrived at Ineos’ Rafnes petrochemical complex.⁵² Ineos owns a 50 percent stake in the Rafnes cracker as well as three polyolefin plants at nearby sites in Bamble, Norway — a location that Ineos dubbed a “petrochemical cluster”.⁵³ The Rafnes cracker is equipped with 10 small and 2 large furnaces that process up to 650,000 tonnes of ethane annually to create ethylene. The ethylene is manufactured into plastics at both a Rafnes chlorine/vinyl chloride monomer (VCM) plant and an Ineos’ facility in Bamble, Norway; a portion of the ethylene is also exported.⁵⁴

The new supply of US ethane allowed Ineos to re-open a cracker unit at its Grangemouth, Scotland complex — its biggest manufacturing site — after being largely mothballed for eight years.⁵⁵ Ineos capitalised on its new hydrocarbon supply to ink a deal with ExxonMobil



and Shell to deliver ethane manufactured from US fracked gas to the Fife Ethylene plant (which is operated by Exxon and co-owned by Shell) in Scotland beginning in 2017.⁵⁶ Ineos' Grangemouth also was the scene of a bitter 2013 labour dispute where the company used lockouts and threatened shutdowns to force extreme concessions from workers — including pay freezes, elimination of final salary pensions, prohibiting on-site union officials and a three-year strike moratorium.⁵⁷

In September 2016 the Grangemouth site received its first delivery of ethane, and the facility will process 315,000 tonnes annually,⁵⁸ potentially releasing a significant source of ozone-creating volatile organic compounds (VOCs).⁵⁹ The complex also contains Scotland's only oil refinery, producing a majority of the country's fuels.⁶⁰ On top of that, Ineos' ethane crackers in Norway and Grangemouth are co-located with other chemical manufacturing operations,⁶¹ potentially compounding existing pollution. Ineos' plastic resins are supplied to distributors that ultimately sell products worldwide to other manufacturers in North America, Europe, the Middle East, Africa and Asia.⁶²

Pollution, Public Health and Safety

Petrochemical manufacturing poses significant human health risks. In May 2017, for instance, the Ineos' Grangemouth petrochemical plant in Scotland was partially evacuated after ethylene gas leaked from a pipeline at its on-site Kinneil Gas plant.⁶³ But even beyond industrial accidents, the plants that convert natural gas into petrochemicals are known to emit massive amounts of air and climate pollutants including polycyclic aromatic hydrocarbons, carbon dioxide and ozone-creating VOCs (such as benzene and toluene) and nitrogen oxide.⁶⁴ Prolonged contact with ground-level ozone is linked to asthma and chronic obstructive pulmonary disease. When mixed with particulate matter, which has been linked to various cancers, smog forms.⁶⁵ The Ineos plants at Grangemouth and Rafnes had total climate change-accelerating greenhouse gas emissions equivalent to 967,093 tonnes of carbon dioxide in 2016.⁶⁶

More generally, chronic exposure to air pollution can cause various illnesses, including cognitive deficits.⁶⁷ Several studies have demonstrated that people's exposure to petrochemical facility pollutants is associated with heightened cancer risks, acute irritative symptoms (such as nausea and eye and throat irritation) and respiratory-related illnesses, especially for children.⁶⁸

The Ineos facilities regularly release emissions into the air during daily operations. According to the European

Pollutant Release and Transfer Register, the Rafnes complex releases 1,2-dichloroethane, tetrachloromethane, and vinyl chloride,⁶⁹ and the Bamble location releases non-methane VOCs.⁷⁰ The Grangemouth facility releases a vaster spectrum of pollutants, including VOCs, carbon dioxide, methane, particulate matter and more.⁷¹ These chemicals, however, can endanger both the environment and public health. Both 1,2-dichloroethane and tetrachloromethane are VOCs and, like vinyl chloride, may cause cancer in humans.⁷² With increased ethylene production, it is conceivable that emissions could compound and worsen.

The Scottish facility also has a disturbingly checkered environmental record. The Scottish Environment Protection Agency (Sepa) found that the pollution performance at Ineos' Grangemouth oil refinery was "poor" between 2010 and 2012 — noting that there was "unabated emissions via an unauthorised emission point". Sepa also said that in 2011 there was a "significant breach of the permit due to poor operational control during a plant upset". And between January and March 2015 there were nearly 400 safety incidents and over 20 work-related injuries.⁷³ An investigative story on the Grangemouth complex uncovered that between 2011 and 2014 the government's Health and Safety Executive served Ineos with 11 legal enforcement notices for breaking the rules on 34 different occasions, compared to 3 enforcement notices in the previous four years.⁷⁴ More recently in 2016, the air quality management area including the Grangemouth petrochemical complex reported sulphur dioxide emissions that exceeded legal limits.⁷⁵

US Frackers Fueling Ineos' Plastics Push

The Ineos dragon ships crossing the Atlantic draped with "Shale Gas for Europe" banners⁷⁶ are leaving more than a toxic legacy in Europe — they are proliferating fracking in Pennsylvania, a state that already has struggled enough with the impacts of oil and gas industry pollution.

Pennsylvania has been ground zero of the fracking boom, with just over 10,000 shale gas wells drilled between 2005 (when commercial production first began) and 2016.⁷⁷ The number of new wells drilled has tapered off considerably as the price of natural gas has fallen. After the early and dramatic increase in drilling, from 9 wells in 2005 to 1,957 in 2011, the number dropped to 504 in 2016.⁷⁸ The US gas industry is promoting exports to maintain fracking's profitability, and more gas exports would drive additional drilling and gas extraction.⁷⁹

Once a well is fracked, during oil or gas production, methane can escape from the well and mix with nitrogen oxide emissions from diesel-fuelled vehicles and drilling equipment to form ground-level ozone.⁸⁰ When combined with particulate matter of a certain size (less than 2.5 micrometres), ozone can form smog. Chronic exposure can lead to asthmatic conditions and chronic pulmonary disease.⁸¹

Shale gas is about 90 percent methane,⁸² and escaping methane emissions from oil and gas operations, including pipeline transmission, are the leading human-caused source of methane pollution in the United States — and the second largest source worldwide. Science shows that kilo-for-kilo, methane is over 86 times more potent than carbon dioxide at trapping heat over 20 years, and over 34 times more potent than carbon dioxide at trapping heat over 100 years.⁸³ These widespread methane leaks from the fracking industry mean that gas cannot be considered a low-carbon fuel — it must receive the same treatment as coal and oil. Fossil fuel-based gas is incompatible with EU climate objectives, with the obligations resulting from the Paris Agreement and with the need to act quickly to tackle climate change. Ethane can also leak during shale development. When ethane is in the atmosphere it forms ozone through a reaction between sunlight and other molecules — a major contributor to human-caused global warming.⁸⁴

Overall, fracking causes many public health, climate and environmental problems,⁸⁵ and Pennsylvanians will likely endure increased shale gas development — all to benefit oil and gas companies at home and abroad.

Range Resources: Range Resources was the first company to drill and frack a modern Marcellus shale well in Pennsylvania, and it contracted to supply Ineos with ethane through the Mariner East pipeline in 2012.⁸⁶ The company may be most notoriously known for contaminating drinking water in Parker County, Texas in 2010.⁸⁷ Now, it primarily operates in Pennsylvania, where the Pennsylvania Department of Environmental Protection (DEP) has fined it nearly \$21 million for harming the environment.⁸⁸ Between 2005 and 2016, the DEP charged Range Resources with 516 environmental health and safety violations.⁸⁹

CONSOL Energy: Pittsburgh-based CONSOL Energy (CONSOL) contracted to deliver Ineos Pennsylvania ethane in 2014.⁹⁰ CONSOL used to be primarily a coal mining company, but it is now refocusing its business solely on oil and natural gas development.⁹¹ The Ineos deal may right CONSOL's ailing balance sheet, but



given CONSOL's dubious environmental track record, increased production may mean increased violations.

Since 2005 the DEP has fined CONSOL Energy's subsidiaries — CONSOL Gas and CONSOL PA Coal LLC — \$224,350 for harming the environment. And between 2005 and 2016, these subsidiaries were slapped with 34 environmental, health and safety violations.⁹² These violations may not reflect the full extent of the environmental damage that CONSOL has imposed, as the company has been involved in many coal pollution-related lawsuits. In August 2016, for example, CONSOL was charged \$3 million due to allegations that one of its mines polluted streams in southwestern Pennsylvania.⁹³

Sunoco: In 2011, Sunoco began rebuilding its infrastructure necessary to transport ethane to Europe by revamping its retired Marcus Hook, Pennsylvania oil refinery facility and developing its Mariner East pipeline system to bring NGLs to Marcus Hook.⁹⁴ At the end of 2011, Sunoco inked a deal to deliver ethane to Ineos.⁹⁵

Sunoco, a subsidiary of Energy Transfer Partners (the company behind the Dakota Access pipeline), owns both the Mariner East pipeline and the Marcus Hook facility.⁹⁶ The newly minted, American Petroleum Institute (API)-backed US Secretary of Energy, Rick Perry, was a former board member of both Sunoco and Energy Transfer Partners.⁹⁷ API highlighted Perry's "opportunity to encourage increased exports of domestically produced natural gas" in its official endorsement.⁹⁸

According to a *Reuters* analysis, Sunoco has had a higher rate of oil spills compared to its competitors, with more than 200 leaks since 2010.⁹⁹ The company released 4.5 million litres of hazardous liquids into the environment, causing over \$53 million in property

damages from 2006 to 2016, according to the Pipeline and Hazardous Materials Safety Administration (PHMSA).¹⁰⁰

Marcus Hook: The Marcus Hook facility is located near what the Pennsylvania DEP identifies as an “environmental justice area”.¹⁰¹ The old refinery had a troubled history of spewing large amounts of pollution. Between 2000 and 2008 it was one of the top three US refineries with the largest benzene emission increases.¹⁰²

The refinery shut down in 2011, but Sunoco developed a scheme to revive it into a “world-class NGL Hub”.¹⁰³ Now operating as the Marcus Hook Industrial Complex, the facility encompasses an 324-hectare site along the Delaware River near Philadelphia. It includes an export terminal for liquefied petroleum products and crude oil, a comprehensive petroleum and processing complex, storage facilities with capacity for roughly 5 million barrels of NGLs, and an ethane-loading facility that is capable of exporting up to 1.9 million tonnes annually.¹⁰⁴ The export terminal went into operation in March 2016, when it first shipped ethane to Norway.¹⁰⁵

Mariner East: The Mariner East pipeline project was a building block to Sunoco's Marcus Hook revitalisation.¹⁰⁶ The project connects pipelines across the Mid-Atlantic fracking belt that will transport large quantities of NGLs to Marcus Hook. Mariner East 1 is a 480-kilometre pipeline that can carry about 70,000 barrels per day (bpd) of propane and ethane to Marcus Hook.¹⁰⁷ Mariner East 2, the second phase, is a \$2.5 billion construction project that runs parallel to the existing Mariner 1. Mariner 2 will initially increase the pipeline systems' capacity to 275,000 bpd and eventually up to 450,000 bpd.¹⁰⁸

In 2017 Pennsylvania granted approval for Sunoco to begin construction on Mariner East 2.¹⁰⁹ A possible third phase could increase the total capacity to over 700,000 bpd.¹¹⁰ The approval of permits by the Pennsylvania DEP for Mariner East 2 came as a blow to some communities.¹¹¹ According to the grassroots group Middletown Coalition for Community Safety, “The public has been disenfranchised throughout the process, with no public comment period on the current application submission and no public hearing ever held in Delaware County, despite the fact that 11½ miles of the proposed route traverse our communities.”¹¹² Now, communities along the pipeline route are shifting to strategies focused on blocking the pipeline through local municipal governments.

Conclusion and Recommendations

In Pennsylvania, the fracking boom has contributed to earthquakes, health issues, traffic snarls and the destruction of the environment and farmland, while releasing climate-altering methane emissions into the atmosphere.¹¹³ Overall, fracking erodes the quality of life for the rural communities where most new gas wells are drilled,¹¹⁴ and the last thing that Pennsylvanians need is an export-driven justification for the oil and gas industry to capitalise on shale at the expense of their health and well-being.

Shipping fracked NGLs from the United States to Europe makes no sense for the climate, the environment or human health. We do not need more plastics, petrochemicals or fracked hydrocarbons. What we do need is fresh air, clear drinking water and an intact environment. Rather than continually investing in fossil fuels and chemical industries, we must act swiftly and with determination and invest in clean, renewable energy. Climate change demands action, and here are our recommendations:

- Fracking should be banned everywhere — in the United States and across Ireland, Scotland and throughout the United Kingdom.
- The United States must stop fossil fuel exports and the construction of infrastructure to support these exports.
- The EU should not accept fossil fuel imports and should stop the expansion of LNG infrastructure.
- People should limit their purchases of non-biodegradable plastic products that effectively support and finance the oil and gas industry, as well as working for public policies that discourage the use of these plastics.
- Both the United States and the EU should enact aggressive energy conservation policies, including large public transport investments and widespread deployment of other energy-saving solutions.
- Both the United States and the EU should establish ambitious programmes for deploying and incentivising existing renewable energy and energy efficiency technologies in order to slash fossil fuel demand to reach 100 percent clean renewable energy by 2035, while modernising electrical grids to cater to distributed renewable power generation.
- Both the United States and the EU should invest in research and development to overcome technological barriers to the next generation of clean energy and energy efficiency solutions.

Endnotes

- 1 American Petroleum Institute. "Freeing Up Energy. Hydraulic Fracturing: Unlocking America's Natural Gas Resources." July 19, 2010 at 1, 2 and 4; US House of Representatives. Committee on Energy and Commerce. [Minority Staff report]. "Chemicals Used in Hydraulic Fracturing." April 2011 at 2 and 8 to 9; See McDermott-Levy, Ruth et al. "Fracking, the Environment, and Health." *The American Journal of Nursing*. Vol. 113, No. 6. June 2013; Arthur, J.D. et al. "Hydraulic fracturing considerations for natural gas wells of the Marcellus shale." Prepared for presentation at The Ground Water Protection Council. Cincinnati, Ohio. September 21-24, 2008 at 7.
- 2 American Chemistry Council (ACC). Economics & Statistics Department. "Shale Gas and New Petrochemicals Investment: Benefits for the Economy, Job and US Manufacturing." March 2011 at 5; Fraizer, Reid R. "Houston cleaning up pollution by going after ethane cracker emissions." *The Allegheny Front*. October 27, 2013.
- 3 Kraus, Clifford and Eric Lipton. "After the boom in natural gas." *New York Times*. October 20, 2012; US Department of Energy (DOE). Energy Information Administration (EIA). "Ethane production expected to increase as petrochemical consumption and exports expand." April 1, 2016.
- 4 EIA. Data Series N9010US2. US Natural Gas Gross Withdrawals (MMcf). US gas withdrawals rose from 24.7 trillion cubic feet in 2007 to 32.7 trillion in 2016 and (698.4 billion and 924.6 billion cubic metres, respectively); EIA. Data Series N3035US3. United States Natural Gas Industrial Price (Dollars per Thousand Cubic Feet). Available at www.eia.gov. Accessed March 2017.
- 5 ACC. "Plastic Resins in the United States." July 2013 at 15; Kraus, Clifford. "Low oil prices pinch Exxon and Chevron earnings." *New York Times*. April 29, 2016; Kraus and Lipton (2012).
- 6 EIA (2016); EIA. "Growing U.S. HGL production spurs petrochemical industry investment." January 29, 2015.
- 7 Ineos Olefins & Polymers Europe. [Press Release]. "Ineos Intrepid leaves USA carrying first shale gas shipment to Europe." March 9, 2016.
- 8 *Ibid.*; Davies, Rob. "First shipment of fracked shale gas set to arrive in UK." *The Guardian*. September 27, 2016; Farag, H. and Anwar El-messirie. "Maturity in the petrochemical industry features, motives and coming." *TESCE*. Vol. 30, No. 2. December 2004 at 722.
- 9 Robertson, Alexander. "School pupils stay inside after Grangemouth gas leak." *Daily Mail* (UK). May 2, 2017; "Probe launched into gas leak at Ineos Grangemouth refinery." *BBC News*. May 2, 2017.
- 10 ACC (2013) at 14 and 15.
- 11 EIA. "Glossary: natural gas." Available at <https://www.eia.gov/tools/glossary/?id=natural%20gas>. Accessed August 2016; Troner, Al. James A. Baker III Institute for Public Policy. Rice University. "Natural Gas Liquids in the Shale Revolution." April 29, 2013 at 4.
- 12 EIA. "What are natural gas liquids and how are they used?" April 20, 2012.
- 13 EIA. (2016).
- 14 Pickett, Al. "Marcellus, Utica Shales make Northeast focal point of growing U.S. production." *American Oil & Gas Reporter*. November 2013 at 3 and 5; Energy Ventures Analysis, Inc. "Outlook for Natural Gas Supply and Demand for 2015-2016 Winter." 2015 at 23 to 25.
- 15 Macalister, Terry. "First US shale gas sails into Europe as Ineos carrier arrives in Norway." *The Guardian*. March 23, 2016; Brockett, Dan. Pennsylvania State University Extension. [PowerPoint]. "Natural Gas Liquids." At Slide 2, 14 and 21.
- 16 Pennsylvania State University Extension. "Fractionator? Cracker? What Are They?" April 15, 2012; Emerson Process Management. "Chapter 1. Ethylene Production." 2010 at 1 to 2; Ghanta, Madhav et al. "Environmental impacts of ethylene production from diverse feedstocks and energy sources." *Applied Petrochemical Research*. Vol. 4, Iss. 2. 2014 at 167 and 169; PricewaterhouseCoopers. "Shale gas. Reshaping the U.S. chemicals industry." October 2012 at 6; Lyle, Sarah K. Magruder. American Fuel & Petrochemical Manufacturers. National Conference of State Legislatures, Capitol Forum, Energy Supply Task Force. [PowerPoint]. "The Shale Revolution: Realizing America's Manufacturing Renaissance." December 8, 2015 at Slide 7.
- 17 DOE. Energy Efficiency and Renewable Energy. "Formosa Plastics Corporation: Plant-Wide Assessment of Texas Plant Identifies Opportunities for Improving Process Efficiency and Reducing Energy Costs." January 2005 at 1; Siemens. "Process Analytics in Polyethylene (PE) Plants." December 2007 at 2.
- 18 Jambeck, Jenna R. et al. "Plastic waste inputs from land into the ocean." *Science*. Vol. 347, Iss. 6223. February 13, 2015 at 768.
- 19 *Ibid.*
- 20 Harse, Grant A. "Plastic, the Great Pacific Garbage Patch, and international misfire at a cure." *UCLA Journal of Environmental Law and Policy*. Vol. 29, Iss. 2. 2011 at 332 to 334; Grant, Richard. "Drowning in plastic: The Great Pacific Garbage Patch is twice the size of France." *The Telegraph*. April 2009.
- 21 "Who are the nurdle hunters on Britain's beaches?" *BBC News*. February 17, 2017.
- 22 The Great Nurdle Hunt. Project of Fidra. "The Forth at Risk." Available at <http://www.nurdlehunt.org.uk/scotland-at-risk/the-forth.html>. Accessed March 2017; Miller, David. "Public urged to track 'nurdles' on Scotland's beaches." *BBC Scotland*. May 5, 2016; Amos, Ilona. "Plastic pollution found inside dead seabirds." *The Scotsman*. March 25, 2015.
- 23 Kinver, Mark. "Video captures moment plastic enters food chain." *BBC News*. March 11, 2017.
- 24 Fraizer (2013).
- 25 *Ibid.*
- 26 Carroll, Susan. "Houston saw smoggier skies in 2015, analysis shows." *Houston Chronicle*. December 20, 2015; Fraizer (2013); Carroll, Susan. "Obama administration issues rules to curb ozone." *Houston Chronicle*. October 1, 2015; See Couzo, Evan et al. "Houston's rapid ozone increases: preconditions and geographic origins." *Environmental Chemistry*. Vol. 10, Iss. 3. June 2013.
- 27 Mudu, Pierpaolo et al. World Health Organization. Regional Office for Europe. "Human Health in Areas with Industrial Contamination." 2014 at 144, 220 and 221; US Department of Health and Human Services. Centers for Disease Control. Agency for Toxic Substances and Disease Registry. [Fact Sheet]. "Sulfur Dioxide." June 1999 at 1.
- 28 European Environment Agency. "32. Tropospheric ozone." 2008 at 6.
- 29 Contini, Daniele et al. "Comparison of PM10 concentrations and metal content in three different sites of the Venice Lagoon: An analysis of possible aerosol sources." *Journal of Environmental Sciences*. Vol. 24, Iss. 11. 2012 at 1961; Colborn, Theo et al. "Natural gas operations from a public health perspective." *International Journal of Human and Ecological Risk Assessment*. Vol. 17, No. 5. September 2011 at 1042.
- 30 Salam, Muhammad T. et al. "Birth outcomes and prenatal exposure to ozone, carbon monoxide, and particulate matter: Results from the Children's Health Study." *Environmental Health Perspectives*. Vol. 113, No. 11. November 2005 at 1638 and 1643; Kheirbek, Iyad et al. "PM2.5 and ozone health impacts and disparities in New York City: Sensitivity to spatial and temporal resolution." *Air Quality, Atmosphere and Health*. Vol. 6. 2013 at 473.
- 31 Ineos AG (Ineos). "Why shale gas from the US still works with \$30 oil." *Inch Magazine*. Iss. 10. July 2016; Brice, Andy. "Voyage of discovery." ICIS Special Supplement/Ineos Supplement. April 11-17, 2016 at 3; Brice, Andy. "A collaborative effort." ICIS Special Supplement/Ineos Supplement. April 11-17, 2016 at 6.

- 32 Allen, Katie. "Ineos moving headquarters to Switzerland to cut tax bill." *The Guardian*. April 11, 2010; Bell, Alex. "Meet billionaire Ineos' Jim Ratcliffe, one of Manchester's most successful entrepreneurs of all time." *Manchester (UK) Evening News*. September 10, 2015.
- 33 "The Top 10 Major Players in the Global PVC Market." *Mordor Intelligence*. June 23, 2016; Ineos Olefins & Polymers Europe. "O&P Sites." Available at www.ineos.com/businesses/ineos-olefins-polymers-europe/sites/. Accessed February 2017.
- 34 Pfeifer, Sylvia. "Ineos Group Jim Ratcliffe." *Financial Times*. November 20, 2014.
- 35 "First shale gas arrives at Ineos plant in Scotland." *BBC News*. September 28, 2016.
- 36 Vaughan, Adam. "Fracking firm Ineos leads industry lobbying to avoid green tax." *The Guardian*. April 3, 2017.
- 37 Ward, Andrew. "Ineos boosts efforts to bring US-style fracking to UK." *Financial Times*. March 9, 2017; Pfeifer (2014); Edwards, Rob. "Revealed: Grangemouth Ineos boss urged Osborne to break unions." *Glasgow (Scotland) Herald*. February 25, 2017; Ineos. "A land of opportunity." *Inch Magazine*. 2014.
- 38 Topham, Gwyn. "Robin Hood's Sherwood Forest faces fracking threat." *The Guardian*. January 1, 2017; Hope, Christopher. "Robin Hood oak in frackers' sights as chemical firm plans extraction under Sherwood Forest." *The Telegraph*. December 31, 2016; Kasperkevic, Jana. "In Ohio, frackers are drilling. Soon Ineos will be doing the same in Britain." *The Guardian*. September 17, 2016; Brooks, Libby. "Scottish parliament votes narrowly in favour of ban on fracking." *The Guardian*. June 1, 2016; Ward (2017); Gall, Charlie and Alan McEwan. "Oil tycoon Jim 'JR' Ratcliffe takes stranglehold on Scotland's oil supply after £200m deal for pipelines." *Scottish Daily Record*. April 4, 2017; Kirkaldy, Liam. "Paul Wheelhouse: Ministers will respect Parliament's view on fracking." *Holyrood (UK)*. March 31, 2017; Holder, Michael. "Scottish government launches public consultation on fracking." *The Guardian*. February 1, 2017; Wright, Scott. "Ineos chief makes fresh case for fracking in Scotland." *Glasgow Herald*. July 11, 2016.
- 39 Delebarre, Jeanne et al. House of Commons. [Briefing Paper]. "Shale gas and fracking." January 4, 2017 at 4.
- 40 Vaughan, Adam. "UK support for fracking hits new low." *The Guardian*. April 28, 2016.
- 41 Ineos Olefins & Polymers Europe. [Press Release]. "Ineos Europe and Evergas enter into long-term shipping agreements." January 23, 2013; Brice. "Voyage of discovery" (2016) at 3; Ineos. "Ineos signs second deal to ship more ethane to Europe — and orders more ships." *Inch Magazine*. Iss. 6. 2014.
- 42 Ineos Olefins & Polymers Europe (2013); Brice. "A collaborative effort" (2016) at 6; Brice. "Voyage of discovery" (2016) at 3; Doyle, William P. "On the docks at Marcus Hook." *Maritime Professional*. February 29, 2016.
- 43 CONSOL Energy. [Press Release]. "CONSOL Energy announces plans to supply European cracker facilities with ethane from the Marcellus Shale in Western Pennsylvania." February 13, 2014.
- 44 Ineos Olefins & Polymers Europe. [Press Release]. "Ineos expands its contract with Evergas to six vessels for the transportation of US shale gas to its European cracker complexes." May 7, 2014.
- 45 Brice, Andy. "Enter the dragon." *ICIS Special Supplement/Ineos Supplement*. April 11-16, 2016 at 4; Blum, Jordan. "New dragon ships carry Texas ethane to Europe and beyond." *Houston Chronicle*. September 9, 2016; "Evergas names seventh LNG-fueled carrier." *LNG World News*. April 26, 2017.
- 46 "Pitch dimensions." *BBC Sport*. Available at http://news.bbc.co.uk/sport2/hi/football/rules_and_equipment/4200666.stm. Accessed February 2017; Brice. "Voyage of discovery" (2016) at 5.
- 47 Brice. "Voyage of discovery" (2016) at 2.
- 48 Brice. "Enter the dragon" (2016) at 5; Brice. "Voyage of discovery" (2016) at 3.
- 49 Anderson, Maria et al. "Particle- and gaseous emissions from an LNG powered ship." *Environmental Science & Technology*. Vol. 49, Iss. 20. 2015 at 12568, 12572 and 12573.
- 50 Brice. "Voyage of discovery" (2016) at 3; Brice. "Enter the dragon" (2016) at 5; National Oceanic and Atmospheric Administration, CAMEO Chemicals. [Chemical Datasheet]. "Ethane, Refrigerated Liquid." Available at <https://cameochemicals.noaa.gov/chemical/661>. Accessed February 2017.
- 51 National Institutes of Health. US National Library of Medicine, National Center for Biotechnology Information. Open Chemistry Database. "Ethane." Available at <https://pubchem.ncbi.nlm.nih.gov/compound/ethane#section=Top>. Accessed February 2017
- 52 "First US ethane shipment docks at Ineos Rafnes complex." *ICIS News*. March 23, 2016.
- 53 Ineos. [Press Release]. "Ineos Group acquires Borealis AS and secures ownership of Noretyl Cracker at Rafnes." June 5, 2007; Ineos. [Press Release]. "Ineos completes purchase of Borealis AS." September 3, 2007; Ineos Olefins & Polymers Europe. "Ineos Bamble, Norway Rønningen Industrial Site." December 3, 2014 at 1.
- 54 Ulsnaes, Ole Bjorn. "Ineos invests NOK 300 million in the new cracker furnace at Rafnes." Herøya Industrial Park (Porsgrunn, Norway). February 5, 2014; *ICIS News* (2016); Corkhill, Mike. "Inaugural US ethane heralds a new gas trade." *LNG World Shipping*. March 18, 2016.
- 55 Ineos (July 2016); Ineos. "£230M loan guarantee helps Ineos raise finance for Grangemouth's future." *Inch Magazine*. Iss. 7. 2014; Ineos. Grangemouth. "About." Available at www.ineos.com/sites/grangemouth/about/. Accessed March 2017.
- 56 Ineos. [Press Release]. "INEOS signs agreement with ExxonMobil Chemical Limited and Shell Chemicals Europe BV to supply ethane from US shale gas from Grangemouth to the Fife Ethylene Plant in Scotland." November 9, 2015.
- 57 Seymour, Richard. "How Ineos humiliated Unite in Grangemouth." *The Guardian*. November 9, 2013.
- 58 "Ineos Grangemouth cracker receives first US ethane shipment." *ICIS News*. September 27, 2016; Corkhill (2016); *BBC News* (2016).
- 59 Benchaita, Tayeb. Inter-American Development Bank. Environmental Safeguards Unit. "Greenhouse Gas Emissions from New Petrochemical Plants. Background Information Paper for the Elaboration of Technical Notes and Guidelines for IDB Projects." July 2013 at 3 to 5, 10 and 15; Frazier, Reid R. "'Cracker' plant will bring jobs, but what about the air?" *The Allegheny Front*. March 24, 2012; Chen, Mei-Hsia. "A feasible approach to quantify fugitive VOCs from petrochemical processes by integrating open-path Fourier transform infrared spectrometry measurements and Industrial Source Complex (ISC) dispersion model." *Aerosol and Air Quality Research*. 2015 at 1110; Rivas-Arancibia, Selva et al. "Oxidative stress caused by ozone exposure induces loss of brain repair in the hippocampus of adult rats." *Toxicological Sciences*. Vol. 113, No. 1. 2010 at 187.
- 60 Ineos. Grangemouth. "About."
- 61 Ineos Olefins & Polymers Europe (2014) at 1; Wright, Scott. "Ineos chief makes fresh case for fracking in Scotland." *Glasgow Herald*. July 11, 2016.
- 62 PolyOne Corporation. Securities and Exchange Commission (SEC). 10-K filing. February 16, 2017 at 83; Esposito, Frank. "Bayer, Ineos ink deals with distributors." *Plastics News*. April 6, 2009; PolyOne Distribution. "Ineos." Available at <http://www.polyonedistribution.com/content/ineos>. Accessed April 2017; Esposito, Frank. "Amco Polymers adds ABS, other resins from Ineos." *Plastics News*. September 23, 2015; Bloomberg. "Company Overview of AMCO Polymers, LLC." Available at www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=36424616. Accessed April 2017;

- Nexo Solutions. "Ineos Styrolution." Available at <http://www.nexo-solutions.com/suppliers/plastics-styrolution/>. Accessed April 20, 2017; Nexeo Solutions Inc. SEC 10-K filing. December 12, 2016 at 13.
- 63 Robertson (2017); BBC News (May 2, 2017); "Grangemouth gas leak: Staff evacuated at Scottish refinery after leak detected." *Daily Telegraph (UK)*. May 2, 2017.
- 64 Benchaita (2013) at 3 to 5, 10, 11 and 15; Frazier (2012); Chen (2015) at 1110; Rivas-Arancibia et al. (2010) at 187.
- 65 Colborn et al. (2011) at 1042; Wong, Chit Ming et al. "Cancer mortality risks from long-term exposure to ambient fine particle." *Cancer Epidemiology, Biomarkers & Prevention*. May 2016 at 839.
- 66 European Commission. European Union Transaction Log. "Ineos Chemicals Grangemouth Limited." Available at <http://ec.europa.eu/environment/ets/>. Accessed April 2017; European Commission. European Union Transaction Log. "Noretyl AS." Accessed April 2017.
- 67 Calderón-Garcidueñas, Lilian et al. "Exposure to severe urban air pollution influences cognitive outcomes, brain volume and systemic inflammation in clinically healthy children." *Brain and Cognition*. Vol. 77, Iss. 3. 2011 at 345 and 353; Mokoena, Mmalebuso Lynnette et al. "Ozone inhalation induces central oxidative stress, cognitive deficits, depressogenic-and anxiogenic-like behavior in stress sensitive rats." *The FASEB Journal*. Vol. 27, No. 1. April 2013 at Abstract; Rivas-Arancibia et al. (2010) at 187, 195 and 196; Wong et al. (2016) at 839.
- 68 Yang, Chun-Yuh et al. "Respiratory and irritant health effects of population living in a petrochemical-polluted area in Taiwan." *Environmental Research*. Vol. 74, No. ER973762. 1997 at 145, 147 and 148; Belli, S. et al. "Case-control study on cancer risk associated to residence in the neighborhood of a petrochemical plant." *European Journal of Epidemiology*. Vol. 19. 2004 at 49, 50 and 53; Wichmann, Fernando A. et al. "Increased asthma and respiratory symptoms in children exposed to petrochemical pollution." *Journal of Allergy and Clinical Immunology*. Vol. 123, No. 3. 2009 at 632; White, Neil et al. "Meteorologically estimated exposure but not distance predicts asthma symptoms in schoolchildren in the environs of a petrochemical refinery: a cross-sectional study." *Environmental Health*. Vol. 8, No. 45. September 25, 2009 at 1; Sopian, Nor Ashikin. "Risk of respiratory health impairment among susceptible population living near petrochemical industry — A review article." *Iranian Journal of Public Health*. Vol. 45, No. 1. February 2016 at 9, 10, 11 and 15; Kongtip, Pornpimol et al. "Health effects of people living close to a petrochemical industrial estate in Thailand." *Journal of the Medical Association of Thailand*. Vol. 96, No. 5. 2013 at S67 and S70.
- 69 European Pollutant Release and Transfer Register. Inovyn Norge AS, klor/VCM fabrikken, Rafnes. 2014. Available at <http://prtr.ec.europa.eu/#/facilitylevels>. Accessed February 2017.
- 70 European Pollutant Release and Transfer Register. INEOS BAMBLE AS. 2014. Available at <http://prtr.ec.europa.eu/#/facilitylevels>. Accessed February 27, 2017; Scottish Environmental Protection Agency (Sepa.) "Ethylene dichloride." Available at <http://apps.sepa.org.uk/spripa/Pages/SubstanceInformation.aspx?pid=55>. Accessed February 2017.
- 71 European Pollutant Release and Transfer Register. Ineos Chemicals Grangemouth Ltd. 2014. Accessed February 2017.
- 72 European Chemicals Agency. "Member State Committee support document for Identification of 1,2-dichloroethane as a substance of very high concern because of its CMR properties." November 24, 2011 at i and 1; Agency for Toxic Substances and Disease Registry. "1,2-Dichloroethane." Last updated March 3, 2011; Harrison, Henrietta. Health Protection Agency. "Vinyl Chloride. General Information." 2008 at 2; European Chemicals Agency. "Carbon tetrachloride." Available at <https://echa.europa.eu/brief-profile/-/briefprofile/100.000.239>. Accessed March 2017; Ozturk, B. and D. Yilmaz. "Absorptive removal of volatile organic compounds from flue gas streams." *Process Safety and Environmental Protection*. Vol. 84, Iss. 5. September 2006 at Abstract; Agency for Toxic Substances & Disease Registry (2011).
- 73 "Revealed: the catalogue of health and safety." *Glasgow Herald*. March 14, 2015.
- 74 *Ibid*.
- 75 O'Brien, Flora. Scottish Parliament Information Centre (SPICe). "Air Quality in Scotland." May 10, 2016 at 16.
- 76 Cusick, Marie. Pennsylvania StateImpact. "Whose gas is it anyway?" National Public Radio (NPR). August 4, 2016; Brice. "A collaborative effort" (2016) at 6.
- 77 Pennsylvania Office of the Governor. 2010-11 Executive Budget Facts. "Booming Natural Gas Industry Should Pay Its Fair Share." February 2010; Pennsylvania Department of Environmental Protection (DEP). Interactive Reports, Wells Drilled by County. January 1, 2005 to December 31, 2016. Available at http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/Wells_Drilled_By_County. Accessed March 2017; Arthur et al. (2008) at 7.
- 78 DEP. Interactive Reports, Wells Drilled by County. Data sets for wells drilled between: January 1, 2005 to December 31, 2005 (Conventional and Unconventional); January 1, 2011 to December 31, 2011 (Conventional and Unconventional); January 1, 2016 to December 31, 2016 (Conventional and Unconventional). Accessed March 2017.
- 79 Loris, Nicolas D. Heritage Foundation. "U.S. Natural Gas Exports: Lift Restrictions and Empower the States." Backgrounder No. 2767. February 11, 2013 at 1 and 3; American Petroleum Institute. "Understanding Natural Gas Markets." 2014 at 15.
- 80 Colborn et al. (2011) at 1042.
- 81 *Ibid*.
- 82 Jackson, Robert B. et al. Duke University. Center on Global Change. "Research and Policy Recommendations for Hydraulic Fracturing and Shale-Gas Extraction." 2011 at 2.
- 83 Jackson, Robert B. et al. "Natural gas pipeline leaks across Washington, DC." *Environmental Science & Technology*. Vol. 48, Iss. 3. January 2014 at 2051.
- 84 Kort, E.A. et al. "Fugitive emissions from the Bakken shale illustrate role of shale production in global ethane shift." *Geophysical Research Letters*. May 7, 2016 at 4617, 4618 and 4620; University of Michigan. [Press Release]. "One oil field a key culprit in global ethane gas increase." April 26, 2016.
- 85 See McDermott-Levy (2013).
- 86 Brice. "A collaborative effort" (2016) at 6; Arthur et al. (2008) at 7.
- 87 Gottlieb, Barbara. "From Flint to fracking, EPA can learn from its mistakes." *The Hill*. March 23, 2016.
- 88 Range Resources Corporation. SEC 10-K filing. February 25, 2016 at 7 and 33; DEP. Oil and Gas Reports, Oil and Gas Compliance Report. Range Resources Appalachia LLC. January 1, 2005 to December 31, 2016. Available at www.dep.pa.gov/DataandTools/Reports/Oil%20and%20Gas%20Reports/Pages/default.aspx. Accessed May 2017
- 89 *Ibid*.
- 90 CONSOL Energy (2014).
- 91 Brewer, Reuben Gregg. "Will CONSOL Energy Inc. sink or swim?" *The Motley Fool*. February 24, 2017; Moore, Daniel. "Consol Energy plans to sell or spin out coal business." *Pittsburgh Post-Gazette*. January 31, 2017.
- 92 DEP. Oil and Gas Reports, Oil and Gas Compliance Report. CONSOL Gas. January 1, 2005 to December 31, 2016. Accessed May 2017; DEP. CONSOL Coal PA LLC (259457). January 1, 2005 to December 31, 2016. Accessed May 2017; DEP. CONSOL Coal PA LLC (73190). January 1, 2005 to December 31, 2016. Accessed May 2017.

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- 93 Acker, Joe Van. "Consol Energy Coal unit faces new W.VA. pollution suit." *Law360*. February 3, 2015; Mandak, Joe. "Feds, Pennsylvania settle Consol Energy water pollution suit." *Associated Press*. August 4, 2016.
- 94 Brice. "A collaborative effort" (2016) at 2, 3 and 6.
- 95 *Ibid.* at 6.
- 96 Sunoco Logistics Partners L.P. SEC 10-K filing. February 26, 2016 at 2, 9 and 46; "Rick Perry is a board member of the company behind the Dakota Access Pipeline." *Associated Press*. December 13, 2016.
- 97 *Associated Press* (December 13, 2016); Penman, Maggie. "Rick Perry sworn in as Energy Secretary." NPR. March 2, 2017; Trabish, Herman K. "How will Rick Perry run the Department of Energy?" *Utility Dive*. January 3, 2017; Svitek, Patrick. "Rick Perry resigns from board of Dallas company building Dakota Access Pipeline." *Texas Tribune*. January 5, 2017.
- 98 Trabish (2017)
- 99 Hampton, Liz. "Sunoco, behind protested Dakota pipeline, tops U.S. crude spill charts." *Reuters*. September 23, 2016.
- 100 US Department of Transportation. Pipeline & Hazardous Materials Safety Administration. Operator Information. Incident and Mileage Data. Sunoco Pipeline L.P. Available at https://primis-stage.phmsa.dot.gov/comm/reports/operator/OperatorIM_opid_18718.html?nocache=3734#_OuterPanel_tab_2. Accessed March 2017.
- 101 DEP. "Environmental Justice Areas — Southeast Regional Office." September 2014.
- 102 Earthjustice. "Public Comment Submission for Petroleum Refinery Sector Risk and Technology Review and New Source Performance Standards, EPA-HQ-OAR-2010-0682. Addendum A: Community Impact Report: The Toll of Refineries on Fenceline Communities." October 28, 2014 at 12.
- 103 Sunoco Logistics. [PowerPoint]. "The Mariner East Story. Rebirth of an Industrial Facility: The Second Act." At Slides 3 to 6 and 13.
- 104 Council for Growth. Greater Philadelphia Chamber of Commerce, and Select Greater Philadelphia. "A Pipeline for Growth. Fueling Economic Revitalization with Marcellus and Utica Shale Gas." March 30, 2016 at 19 and 40; Corkhill (2016).
- 105 "World's first ethane-powered marine vessels." *Wärtsilä Technical Journal*. October 27, 2016.
- 106 Sunoco Logistics [PowerPoint] at Slide 14.
- 107 Sunoco Logistics. "About Sunoco Logistics and the Mariner East Project." Available at <http://www.landscapes2.org/pipeline/pdf/ME1-ME2DetailedDescription.pdf>. Accessed January 2017; Cerilli, Richard. "Closer look: Notable pipeline projects." *Pittsburgh Business Times*. February 1, 2017.
- 108 Sunoco Logistics. "About Sunoco Logistics and the Mariner East Project;" Phillips, Susan. *StateImpact Pennsylvania*. "DEP gives Sunoco long to-do list on Mariner East 2 pipeline plan." NPR. September 15, 2016; Maykuth, Andrew. "Permits in hand, Sunoco plans to build two new pipelines, not one." *Philadelphia Inquirer*. February 23, 2017.
- 109 Maykuth, Andrew. "PA grants final permits for \$2.5B Mariner East pipeline." *Philadelphia Inquirer*. February 13, 2017.
- 110 Council for Growth (2016) at 40; Natural Gas Intelligence. "Information on the Marcellus Shale." Available at <http://www.naturalgasintel.com/marcellusinfo>. Accessed March 2017.
- 111 Carey, Kathleen E. "Environmental groups appeal Pa.'s approval of Mariner East 2 pipeline." *West Chester (PA) Daily Local*. February 15, 2017; Hurdle, Jon and Susan Phillips. *StateImpact Pennsylvania*. "DEP approved Mariner East 2 permits despite deficiencies, documents show." NPR. March 10, 2017.
- 112 Carey (2017).
- 113 Frazier, Reid. "Pennsylvania confirms first fracking-related earthquakes." *The Allegheny Front*. February 18, 2017; Troutman, Melissa A. et al. "Hidden data suggests fracking created widespread, systemic impact in Pennsylvania." *Public Herald*. January 23, 2017; Schafft, Kai A. et al. "The relationship between Marcellus Shale gas development in Pennsylvania and local perceptions of risk and opportunity." *Rural Sociology*. Vol. 78, Iss. 2. June 2013 at 18; Przybycian, Jason. "Mansfield police were busy in 2011, especially with DUI." *The Wellsboro/Mansfield (PA) Gazette*. January 23, 2012; Clarke, Cheryl R. "More people, more crime. Tioga County copes with more vehicles, people and more stress on its police." *Williamsport (PA) Sun Gazette*. March 4, 2012; Gleiter, Sue. "Protesters share anti-fracking message at 2016 PA Farm Show." *Harrisburg (PA) Patriot-News*. January 9, 2016; Ingraffea, Anthony R. et al. "Assessment and risk analysis of casing and cement impairment in oil and gas wells in Pennsylvania, 2000-2012." *Proceedings of the National Academy of Sciences*. Vol. 111, No. 30. July 29, 2014 at 10955, 10958 and 10959.
- 114 Burger, Michael. "Fracking and Federalism Choice." *University of Pennsylvania Law Review*. Vol. 161, Iss. 150. 2013 at 159, 162 and 163.

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