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Research Report

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Bringing Air Quality Home

Reducing Residential Emissions

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The mission of Utah Foundation is to promote a thriving economy, a well-prepared workforce, and a high quality of life for Utahns by performing thorough, well-supported research that helps policymakers, business and community leaders, and citizens better understand complex issues and providing practical, well-reasoned recommendations for policy change.

Bringing Air Quality Home

Reducing Residential Emissions

Many Utahns consider air quality an important factor in determining quality of life and would support actions to improve air quality. Oil refineries and other industrial polluters, as well as passenger vehicles, have been the focus of federal, state, and local government regulation, yet there has been little focus in Utah about reducing pollution generated from commercial and residential buildings. Emissions from buildings contribute substantially to Utah's pollution, particularly during the winter when they produce as much as 60% of certain pollutants. As planned regulations on vehicles come into effect, residential buildings will emit a greater share of the pollution. This report summarizes some actions that could reduce the pollution generated from buildings.

KEY FINDINGS

- **Updating Utah's building code will save buyers of newly built homes an estimated $3,750 over the course of 30 years.**
- **Were ultra-low NOx water heaters the standard between 2012 and 2014 there would have been 10 fewer instances of PM2.5 exceeding federal guidelines, a 20% reduction.**
- **Up to 70% of the ambient levels of woodsmoke from your neighborhood can wind up in your home.**

What Can Be Done to Reduce Residential Pollution?

	Action	Participant	Timeframe	Impact	Summary
	**Update building codes**	State	Long term	Large	Most of Utah's thermodynamic standards have not been updated since 2006. Updating these requirements would make new homes more energy efficient, reducing the amount of energy used and natural gas combusted to heat them. This is especially important as Utah's population will double over the next 40 years and much of that growth will occur in areas already having trouble meeting federal pollution guidelines.
	**Require ultra-low NOx water heaters**	State and homeowners	Medium term	Medium	Ultra-low NOx water heaters would reduce the amount of pollution emitted by water heaters by 75%. The full effect is estimated to reduce the amount of pollution from buildings by nearly 5%.
	**Reduce woodburning**	State, local municipalities, and homeowners	Immediate and medium term	Medium	By fully enforcing woodburning bans during inversions, state and local municipalities could reduce the amount of pollution accumulated by 5%. Homeowners can simply refrain from having fires immediately before and during inversions.
	**Turn down thermostats**	Homeowners	Immediate	Low	Although the impact of a single individual would be small, it is an action that each household has complete control over. Moreover, the impact is immediate and will help when it matters most during inversions.

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INTRODUCTION

A recent survey by Utah Foundation found that "air and water quality" was the third most important factor for determining quality of life in Utah. Moreover, when asked to identify what would most improve Utah as a place to live, the third most common response was air quality.[1] This is a pressing issue for many Utahns. They worry about the effect bad air will have on their health, their life enjoyment, and even Utah's future economic development.

NONATTAINMENT

Utah's air pollution exceeds federal standards in some areas. As a result, the Environmental Protection Agency (EPA) has assigned these areas a "nonattainment" status. This forces Utah to create a State Implementation Plan (SIP), which outlines actions the state will take to bring Utah's level of pollution back in compliance with federal air quality standards. If Utah failed to create a SIP in response to the nonattainment assignation, or if the SIP failed to reduce emissions to federal standards, the EPA would create a Federal Implementation Plan (FIP). A FIP could restrict federal transportation funding and even hamper economic development by enforcing stricter requirements for new or expanding business (e.g., requiring the installation of additional emission control equipment).[2]

Figure 1: Glossary

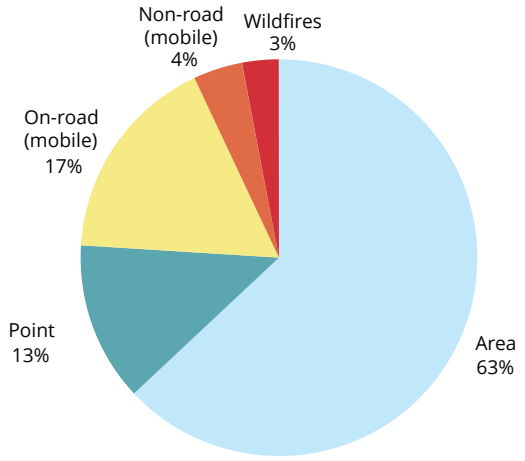
Term	Definition	Example
Criteria Pollutants	Pollutants monitored by the EPA	Carbon monoxide, lead, sulfur dioxide, nitrogen oxides, ozone, and particulate matter
Mobile source	Mobile sources of pollution	Commercial & private vehicles, backhoes, chainsaws, etc.
Point source	Sources of large scale pollution	Power plants, oil refineries, large universities, etc.
Area source	Smaller, localized sources	Smaller businesses, homes, water heaters, biogenic, etc.
Biogenics	Emissions from wildfires and vegetation	Smoke from wildfires and natural off-gassing from vegetation
Nonattainment	When levels of pollution fail to comply with federal standards	Wasatch Front for PM2.5, Salt Lake County for sulfur dioxide, and Salt lake and Utah counties for PM10
Particulate matter (PM)	Small particles, often associated with a number denoting size (in micrometers)	Chemical combinations, dust, dirt, soot, smoke, etc., often referred to as PM2.5, PM10
Ozone	A chemical variation of oxygen that is harmful to breathe	What we see as smog in the summer. Ozone is also an issue during the winter in the Unitah Basin)
Volatile Organic Compounds (VOC)	Volatile organic compounds, gasses, or aerosol liquids that are highly reactive	Emissions from paint, varnish, gasoline cleaning products and plant matter

Several counties in northern Utah, specifically Cache, Box Elder, Weber, Davis, Salt Lake, Tooele and Utah counties, are considered in nonattainment for fine particulate matter (PM2.5). Salt Lake, Weber and Utah counties are considered in nonattainment for "inhalable coarse particles" (PM10).[3] Particulate matter consists of specks of dust and other particles. Particulate matter can either be emitted directly from sources such as dirt roads, construction sites, and wood smoke, or can be created from chemical reactions of certain gases powered by sunlight in the lower atmosphere. It not only causes respiratory problems as particles enter deep into the lungs, but particles can also enter the blood stream and create heart problems.[4] Salt Lake County is also considered in nonattainment for sulfur dioxide, which is a precursor to particulate matter as well as acid rain.[5]

While ozone is not currently a nonattainment issue in Utah, it will likely be in the near future. In October 2015, the EPA set new rules reducing the limit on ozone levels across the nation. Already, locations in Utah have reached levels "well above the ozone standard."[6] Ozone can also be a problem in the Uintah Basin with its mix of high elevation and oil and gas development. The state will submit its preliminary attainment status in October 2016, and the EPA will make its final attainment designations by October 2017.

Ozone is "good up high, bad nearby."[7] Ozone naturally occurs in the stratosphere (15 miles above ground) and protects the earth from ultraviolet radiation, which can cause cancer, cataracts, and can harm immune systems. However, breathing ozone causes health problems, particularly for the young, elderly, and those with lung diseases such as asthma. Ozone is not directly emitted from any source, but typically results from a chemical reaction between high concentrations of nitrous oxide (NOx) and volatile organic compounds (VOCs) in high temperatures with sunlight. As a result, ozone is usually only a problem during the hottest parts of the day in summer.[8]

Figure 2: Sources of PM2.5 Emissions in Utah



Source: Utah Division of Air Quality.

GOVERNMENT ACTION

Governments on several levels have taken actions to improve air quality. The federal government has enacted several laws regarding pollution created by mobile sources (cars, trucks, trains, and even lawn-mowers). Historically this had been done by requiring the removal of lead from gasoline, and more recently by seeking to reduce the sulfur content and evaporative emissions from passenger vehicles with Tier III vehicle and fuel standards.[9] It is noteworthy that the seven counties in the United States that will benefit most from the implementation of Tier III vehicle and fuel standards are all in Utah (the seven counties of PM2.5 nonattainment).[10]

State governmental officials have also taken several actions to reduce the pollution by point sources (power plants, refineries, and large campuses like universities), but until recently under SIP requirements, very little has been done to improve emissions from area sources (commercial and residential buildings).[11] Moreover, as Tier III gasoline and cars begin phasing into the market (starting around 2017) and mobile sources emit less pollution, area sources such as residential and commercial buildings will emit a greater share of the pollution along the Wasatch Front.

ADDRESSING POLLUTION FROM AREA SOURCES

Adopting 2015 IECC Standards

Governor Herbert's Energy Efficiency and Conservation Plan outlines a number of priorities to help improve energy efficiency and conservation across the state.[12] One of these items is updating Utah's building code to reflect the latest standards in energy-efficient buildings, also known as the 2015 International Efficiency Conservation Code (2015 IECC). The code is updated every three years, and 2015 IECC standards would require home builders to use updated building materials and processes. Accordingly, these materials and processes would create a better thermal envelope around both commercial and residential buildings reducing the amount of electricity or natural gas needed to heat or cool the buildings. Pollution emitted statewide would decrease from the reduction in energy generated, and a local reduction of emissions would result as less natural gas is combusted.

From a local standpoint, the cleanest form of heating homes is with electrical heating systems. However, this merely exports pollution to the power plants, and in Utah these power plants use either coal or natural

gas.[13] Overall, heating homes using electrical heating systems is less efficient and more expensive than using natural gas, but the natural gas combustion produces NOx in residential areas. NOx is one of the gases that reacts with other chemicals in the atmosphere to generate both PM2.5 pollution and ozone. In highly urbanized areas, home heating and water heating accounts for substantial amounts of NOx pollution. In 2011 (the latest data available), residential natural gas combustion generated nearly 1,400 pounds of NOx in Salt Lake County, accounting for 40% of all the NOx generated in the county by area sources.[14]

Updating building codes is one action Utah can take that will have a lasting effect. Utah's population is expected to double by 2050. Most of that growth will happen in areas that have already reached nonattainment status.[15] While it does cost more to build homes in accordance with 2015 IECC standards, it costs much less than retrofitting existing homes to fit those standards.[16] In the large majority of cases, homes pollute at the same rate over the natural life of the home (50-100 years). Updating building codes to reflect higher standards of energy efficiency will not have a large immediate effect because standards will only apply to new homes. However, the long-term effect would be significant as the new homes built to support Utah's large population growth would pollute at much lower levels. If these standards were implemented, Utah's direct and secondary pollutants would be reduced by 1,500 tons per year by 2050.[17]

The last major update of the Utah building code was in 2013 using some of the 2012 IECC standards as a basis.[18] Had Utah completely adopted the 2012 IECC standards, updating to 2015 standards would have only a moderate impact. In a U.S. Department of Energy (DOE) study of the 77 changes from the 2012 IECC standards to the 2015 IECC standards for residential buildings, only six were considered beneficial to energy savings. Of the remaining 71 amendments, 62 were considered energy neutral, five were negligible, one was unquantifiable, and one was actually detrimental to energy efficiency, although it only applied to a small number of cases.[19]

However, when Utah updated its building code in 2013, legislators made a number of specific amendments reducing the standards to the equivalent of 2009 standards and even 2006 standards. Indeed, the only insulation (efficiency dealing with heat through walls and ceilings) and fenestration (efficiency dealing with light and heat through windows) standards that met 2012 IECC standards were those that remained unchanged from 2006.[20] Implementing the 2015 IECC standards could actually result in a cost savings for homeowners. In a report commissioned by the DOE, the Pacific Northwest National Laboratory found that if Utah updated from the 2009 IECC standards to 2015 IECC standards, the average house price would increase by $2,200. As a result, down payments on new homes would increase by $236, and annual mortgage payments would increase by $128. However, the lower energy costs of the more energy-efficient home would save homeowners $297 a year, meaning an overall cost savings after just two years. Over the course of a 30-year mortgage, increased energy efficiency would save the average homeowner $3,759.[21]

While there might be cost savings updating building code to 2015 IECC standards, cost savings are not guaranteed when adopting future standards. However, even adopting standards that might ultimately make it more expensive for the consumer still might be advisable if it helps reduce harmful pollution across the state.

Why might Utah not want to update its building code? The affordability of new homes is a major concern for both homebuilders and realtors, and of course, consumers. Although consumers would end up saving money by purchasing homes that met 2015 IECC standards over comparable homes at Utah's current standards, it might be difficult for consumers to understand the difference in energy savings. For example, would consumers purchase a more costly fuel-efficient car if no one bothered to rate the miles-per-gallon each car received? Although standards exist to rank the energy efficiency of homes – most notably the Home Energy Rating System (HERS) index – this information is difficult to obtain. Moreover, despite a commitment to create some sort of energy rating index field available on the Multiple Listing Service (the database that aggregates what homes are for sale), nearly a year later the Utah Association of Realtors has failed to do so.[22]

The additional cost of building a more energy efficient single family home is estimated at just under $2,400.[23] When the median price of a new single family home in Utah is $305,000, this represents only a small price increase (less than 1%), most of which is made even less acute by being broken up and absorbed in 360 monthly payments.[24] While the majority of potential homeowners who are searching for new houses will likely not be forced out of the market, there certainly will be some on the margin who cannot afford those extra costs. These individuals can likely find suitable homes in the used housing market. However, homebuilders loose potential customers because of government mandates that force them to create a higher quality product. Additionally, homebuilders and realtors, and policymakers sensitive to their needs, worry that each enhancement of code and its subsequent increase in cost might cumulatively drive more and more individuals out of the new-home market. Adopting higher standards of energy efficiency in residential buildings will certainly benefit the community as a whole, but such a policy change would doubtlessly carry a detrimental effect on some individuals and industries in Utah.

Ultra-low NOx Water Heaters and Furnaces

The requirement to use ultra-low NOx water heaters has seen widespread implementation across several areas in California. Utah's Department of Air Quality (DAQ) has undertaken careful study of the prospects of ultra-low NOx water heaters, and the results show that a switch to ultra-low NOx water heaters across the Wasatch Front (water heaters have a replacement cycle of seven years) would result in 1,918 fewer tons of NOx released in the non-attainment area. That is more NOx than Salt Lake County commercial and residential buildings produced from natural gas furnaces and water heaters in 2011.[25] This would greatly affect Utah's air pollution problem, because NOx is one of the airborne gases that reacts with other chemicals in the atmosphere to create PM2.5 and ozone. DAQ estimates that a reduction in NOx emissions would result in the reduction of 1 $\mu g/m^3$ (one microgram per cubic meter) in PM2.5. Had this policy already been fully in place from 2012 to 2014, Utah would have had more than 20% fewer instances of a daily average of PM2.5 exceeding federal standards.[26]

In September 2015, Utah's Air Quality Board passed a requirement to use ultra-low NOx water heaters. However, the rule was held up in the Utah Legislature. The argument from representatives of the Utah Homebuilders Association and the Utah Association of Realtors to the Administrative Rules Review Committee was that while Utah's Air Quality Board could make rules regarding emissions, administrative rules could not supersede state statute (law implemented by the legislature). The committee ultimately agreed, with some expressing concern that the Air Quality Board was reaching beyond its mandate in making rules regarding residential appliances. As a result, the rule was placed on a sunset list.[27] However, during the 2016 General Session, House Bill 250 and House Bill 316 are both designed to enable the rule created by the board.[28]

Another concern was how effective these appliances would be at high altitudes (a problem affecting water heaters in general) and with a different natural gas mix (which varies by location). However, the Air Quality Board had already addressed this concern by delaying implementation to late 2017 so that natural gas providers and any other entities concerned would have time to prepare for the rule change.

Additionally, these water heaters are less energy efficient because the process they use to reduce the NOx production also uses more energy.[29] Although still less energy efficient than their counterparts, manufacturers have created some ways of dealing with the technological problems, and Energy Star-rated ultra-low NOx water heaters are available.[30] Beyond just costing more to operate, opponents point out these types of water heaters heat less efficiently. As a result, they might burn longer (while polluting at a lower rate) to generate the same amount of hot water. This is similar to the counter-intuitive way that low-flush toilets might sometimes be less efficient than their counterparts because consumers might flush multiple times where previously they only needed to flush once.

Additionally, because the ultra-low NOx water heaters combust gas less efficiently, carbon dioxide (CO2) is produced at a higher rate.[31] While additional CO2 emissions might add slightly to the larger problem of climate change, the reduction in NOx emitted would have a significant impact on local pollution and help the state meet federal standards for both PM2.5 and ozone emissions.

One of the principle reasons for opposition to ultra-low NOx water heaters is the additional cost. As outlined above, Utah Home Builders Association and the Utah Association of Realtors are both sensitive to any change that might increase the cost of purchasing homes. Questar also pointed out that if ultra-low NOx water heaters were significantly more expensive it might induce consumers to switch out their gas water heater for an electric water heater.[32] This would not only reduce demand for Questar's product, but increase the amount of pollution generated statewide, although that pollution would be outsourced to power plants.

Consequently, the projected extra cost of ultra-low NOx water heaters is a subject of intense debate. Estimates range from a Utah Division of Air Quality survey estimating a $10 price increase to the Utah Homebuilders Association estimating an increase of $450.[33] Some of the price discrepancy lies in the difficulty of obtaining ultra-low NOx water heaters because they are primarily available in California and Texas which have ultra-low NOx regulations. Even the Utah Homebuilders Association admits that the price will likely trend downward as suppliers adjust their inventory to meet Utah's future demand for ultra-low NOx water heaters.[34] However, there is still some debate as to how much more expensive ultra-low NOx water heaters will actually be.

With the identical strategy as ultra-low NOx water heaters, area in California are pushing low NOx furnaces. While ultra-low NOx water heaters have existed for years, low NOx furnaces are still under development. Reports show they work well in test conditions, but they have yet to be tested in the less sterile environments of homeowners.[35] Engineers at the Utah Division of Air Quality are closely watching the development of low NOx furnaces in California. If the furnaces prove their effectiveness, the Division will consider encouraging their implementation in Utah. The state's propensity toward winter inversions is one of the primary causes of Utah exceeding federal PM2.5 standards. During these inversions, secondary PM2.5 (the particulate matter

that results from chemical reactions between NOx and other chemicals in the atmosphere) is an even larger part of the problem.[36] Accordingly, because furnaces are used most in the winter when inversions happen, there is great potential in low NOx furnaces to decrease the amount of PM2.5 in Utah's atmosphere just when the state needs it most.

Reduce Wood Burning

Wood smoke is one of the single largest contributors to PM2.5 along the Wasatch Front; some research indicates that the pollution from the thousands of homes that are heated by burning wood is equal to the pollution of the hundreds of thousands of cars driving Utah's streets.[37]

Aside from being the source of approximately 5% of the PM2.5 buildup during inversions, there are additional health concerns associated with wood smoke.[38] During inversions, the air remains extremely stagnant and the smoke that exits fireplaces ends up seeping back into the surrounding houses. Studies in Washington and Idaho have reported that as much as 50%, and even 70%, of the outdoor levels of wood smoke were found inside nearby houses, even those homes not burning wood.[39] Opponents to the wood-burning ban often cite the fact that wood smoke only accounts for 5% of the problem during inversions, and that policy makers should be focused on the other 95%. While wood smoke only produces 5% of the PM2.5 particles in the atmosphere, a Vancouver study found that a PM2.5 particle from wood smoke is seven times more likely to end up in your lungs than the average PM2.5 particle.[40] Studies also show that wood smoke tends to remain in the locality it was produced, so a neighborhood with one house burning wood could see levels of PM2.5 that are many times higher than those being recorded at an air quality monitoring station.[41] In conclusion, PM2.5 not only contributes to the general air quality problem, it is also a direct public health problem.

A complete ban on wood burning from November 1st to March 15th was proposed early in 2015 for counties which were categorized as nonattainment. With the possibility of a complete wood-burning ban during the winter months – which would have been the most stringent ban on wood burning in the country – strong opposition arose. Wood stove owners protested the additional heating costs they would bear and pointed out how such a ban would seriously devalue the thousands of dollars invested in installing wood stoves in their homes. Those with EPA-certified wood-burning stoves pointed out that such stoves emit much less pollution than noncompliant wood stoves or fireplaces. Critics pointed out the ramifications such a ban might have on several industries. Woodstove manufacturers, distributors, and contractors would lose a substantial amount of their business. The Forest Service might lose an estimated $50,000 in revenue levied from wood-cutting permits as well as be left with the dead timber not removed – the result of a pine beetle infestation. One opponent made the comparison of the intermittent ban of 18-wheel trucks on freeways during periods of high wind; just as you would not impose a blanket ban disallowing 18-wheel trucks on freeways for several months due to a few weeks of windy days, policymakers should not impose a blanket ban on wood burning when the inversion only sets for a few weeks of the year.[42]

In the face of such opposition, the Utah Division of Air Quality backed off their proposal for a complete ban on wood burning during the winter months, and Governor Herbert actually signed legislation making it illegal to implement a complete ban on wood burning.[43] While many of the arguments against a complete wood-burning ban are valid, many of them only address the contribution of wood smoke to inversions and ignore the localized health hazard of wood smoke itself.

Currently, Utah prohibits wood burning during periods the Division of Air Quality determines as "mandatory no burn days." Two counties in Utah have implemented additional rules. Salt Lake County has restricted burning even on voluntary no burn days.[44] Additionally, Summit County recently prohibited the installation of wood stoves in new buildings and only allowed EPA-certified wood-burning stoves in remodels where the stove already exists.[45] Parts of Washington State take that concept a step farther and prohibit the ownership and use of non-EPA certified stoves. If residents have existing woodburning stoves in their homes, they must remove them, replace them, or render them inoperable.[46]

Several options, however, remain open should the state again try to reduce the amount of pollution generated by wood burning. One option is to fully enforce the rule. "Compliance officers monitor neighborhoods using infrared cameras that can detect heat plumes even when there is no visible smoke [and] assess fines of up to $299."[47] However, without a sufficient budget for enforcement, most violators go unpunished. Utah lawmakers could increase the budget for compliance of wood burning or increase fines to cover the cost of regulating compliance.

Policy makers could also overturn the Utah Code disallowing a complete woodburning ban and then impose a complete ban on woodburning during winter months. As noted previously, this would be the most stringent standards on woodburning in the nation. However, since Utah has unique geographical problems seriously hindering the state's ability to bring down PM2.5 levels, a unique solution might be the appropriate response.

Whatever the level of restriction policymakers might ultimately enact, wood burning remains a single action that would make a large difference in both the immediate and long term. There are several programs both at the state and local levels that assist households that rely on wood burning as a source for heating their homes to transfer over to a cleaner form of heat.[48]

CONCLUSION

Federal and local policymakers have made large strides in improving air quality in Utah. As large changes phase in across the state, Utahns can expect to continue to see improvements and reduced emissions from point and mobile sources. However, there is still much that policymakers can do to reduce pollution emitted by commercial and residential buildings as outlined above. All of these policies have their associated costs, from the restricted liberty of not being allowed to warm your home with wood-burning stoves to the increased costs of more efficient appliances and more efficient building materials. Current building code upgrades might provide increased cost savings, though this might not always be the case. Beyond a certain point, increased efficiencies will both have a smaller impact and be more expensive, but that might have to be the cost of cleaner air.

Utahns will have to decide which of these options makes sense, and what other actions the state can take to reduce its emissions to meet federal standards. Should Utahns fail to take substantial enough actions, the federal government could step in with mandates misaligned with Utah's best interests.

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