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Fact Sheet

POWER SECTOR OPPORTUNITIES FOR REDUCING CARBON DIOXIDE EMISSIONS: MINNESOTA

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WHAT WILL CO_2 STANDARDS MEAN FOR MINNESOTA?

President Obama announced a national climate plan in June 2013 and directed the U.S. Environmental Protection Agency (EPA) to set carbon pollution standards for the power sector. Once EPA establishes those standards, states will implement their own plans for achieving those reductions. In this fact sheet, WRI examines existing tools Minnesota can use to reduce power plant emissions.

HOW MINNESOTA CAN REDUCE POWER SECTOR EMISSIONS

Minnesota has already made significant progress in reducing carbon dioxide (CO_2) emissions from its power sector by putting into place strong clean energy policies that will decrease the state's electricity consumption as well as increase the amount of renewable energy the state consumes. WRI analysis shows that Minnesota has many opportunities to continue to reduce carbon pollution from its power sector and is in a strong position to meet ambitious emissions standards for existing power plants in the near-term. Carbon dioxide emissions from Minnesota's power sector were 18 percent below 2005 levels in 2011 (the most recent year for which we have energy data for Minnesota).[1]

According to reference case projections based on the Energy Information Administration's (EIA) *Annual Energy Outlook 2012* (*AEO 2012*), emissions are expected to rise to 4 percent above 2011 levels by 2020 and 9 percent above

Box 1 | What's Ahead for the Power Sector?

The power sector is the leading source of carbon dioxide (CO_2) emissions in the United States, but also offers some of the most cost-effective opportunities to reduce those emissions. Despite recent decreases in power sector emissions—due to the recession, increasing competition from renewable energy and the low price of natural gas—current projections show that, absent policy action, emissions will increase in the coming decades.[2]

New Power Plants: On September 20, 2013, EPA proposed CO_2 emissions standards for new power plants.[3] These standards will provide a backstop ensuring new power plants produce significantly lower CO_2 emissions per megawatt-hour of power generation than the average existing coal plant,[4] requiring coal plants to achieve emissions rates of 1,000 – 1,100 pounds of CO_2 per megawatt-hour (lbs. per MWh), large natural gas plants to achieve 1,000 lbs. per MWh, and smaller natural gas plants to achieve 1,100 lbs. per MWh. However, because new coal plants are unlikely to be built even in the absence of the standards—due to relatively low natural gas prices, among other factors[5]—it is unlikely that the new power plant standards will have a significant impact on near-term CO_2 emissions.

Existing Power Plants: EPA also has been directed to (a) propose CO_2 emissions standards for existing power plants by June 1, 2014; (b) finalize these standards by June 1, 2015; and (c) require states to submit their proposed implementation plans by June 30, 2016. The Clean Air Act provides EPA with considerable flexibility in setting guidelines for states to meet these standards. States could be allowed to pursue a range of programs that encourage activities—such as fuel switching, dispatch of existing low-carbon power plants, increased generation by renewable sources, and energy efficiency, among other options—for meeting emissions targets. EPA also could set guidelines that allow for emissions rate averaging across power sector generation units to help meet the standard.

2011 levels by 2030.[6] This reference case includes the state's existing renewable energy standard (RES) and energy efficiency resource standard (EERS), which are both captured in the "business as usual" line in Figure 1 (see below for more detail). However, we adjust the reference case to assume that, in order to help comply with new CO_2 standards, all new renewable energy generation for compliance with the RES occurs in-state as opposed to purchasing renewable energy credits generated out of state.[7]

Minnesota can reduce power sector CO_2 emissions to 31 percent below 2011 levels in 2020 by achieving the targets in these existing state policies and taking advantage of the CO_2 reduction opportunities that use the existing infrastructure listed below.[8] This is equivalent to a 43 percent reduction in emissions from 2005 levels. Reductions of this magnitude would meet or exceed ambitious standards for existing power plants.[9]

CO_2 reduction opportunities *using existing policies* include:

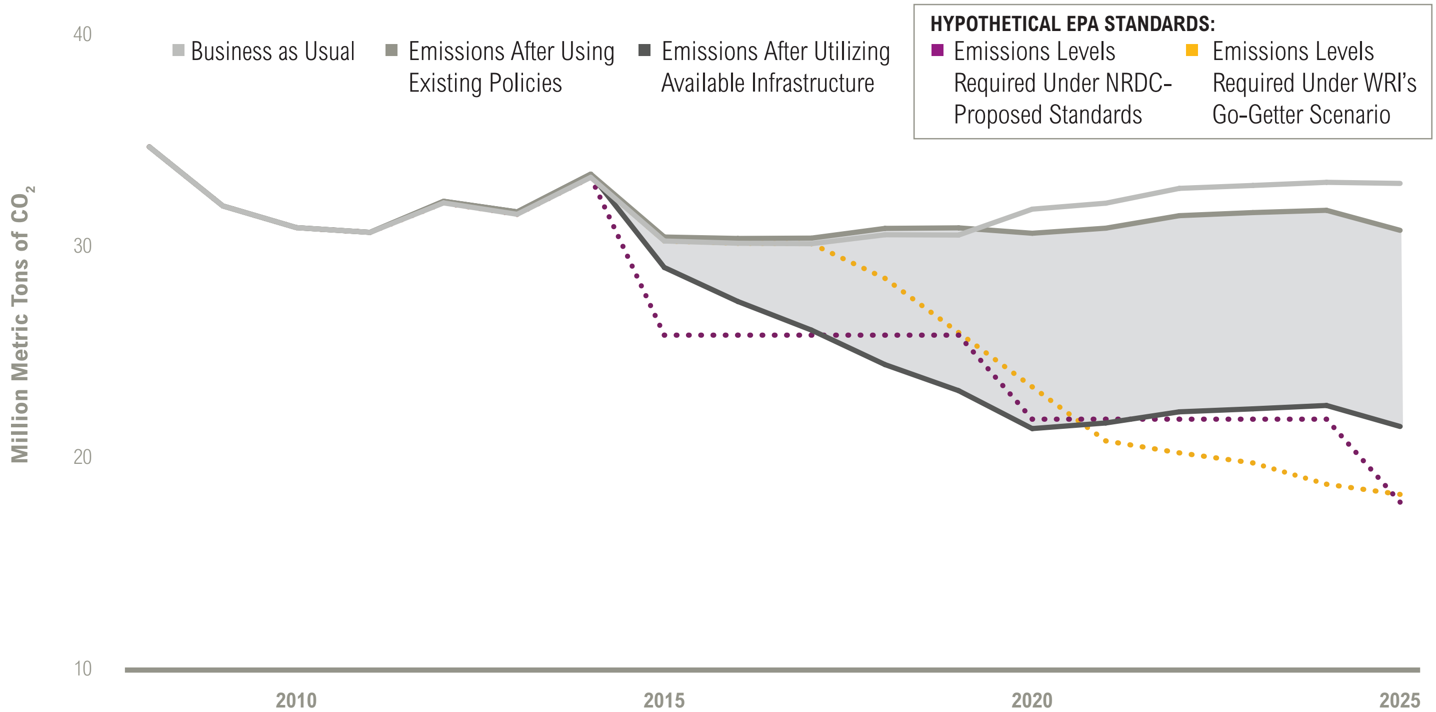
- **Meeting renewable energy targets.**[10] Minnesota has a renewable energy standard in place requiring 25 percent of the electricity sold by most utilities to come from renewables by 2025, while 30 percent of the electricity sold by the state's largest utility, Xcel Energy, must come from renewable sources by 2020. Utilities must also supply an additional 1.5 percent of their sales from solar energy by 2020. *Meeting these requirements by adding new renewable generation in Minnesota will reduce CO_2 emissions by 5 percent below 2011 levels in 2020.*

- **Meeting energy efficiency targets.** Minnesota's existing efficiency standard requires utilities to implement programs that help save energy. *Meeting this standard could lower Minnesota's CO_2 emissions by 14 percent in 2020 compared to what emissions would be in the absence of the standard.*

CO_2 reduction opportunities *using available infrastructure* include:

- **Increasing use of existing natural gas plants.** Minnesota's most efficient natural gas plants—combined cycle (NGCC) units—generated much less electricity than they were capable of producing in 2011. *Running existing NGCC plants at 75 percent can reduce CO_2 emissions by 30 percent below 2011 levels in 2020.*

Figure 1 | **Minnesota Carbon Dioxide Reduction Opportunities for Power Sector Compliance Under The Clean Air Act**



Note: EPA has not yet proposed a national emissions standard for existing power plants. For purposes of illustration, this analysis shows emissions reductions that would occur if EPA adopted the Natural Resources Defense Council's (NRDC) proposed standards for existing power plants that would require CO_2 emissions reductions in Minnesota of 30 percent below 2011 levels in 2020. We also show the emissions reductions that would occur if EPA adopted a more ambitious "go-getter" reduction schedule, which aligns with a national reduction pathway necessary to meet the Obama Administration's goal of reducing emissions 17 percent below 2005 levels by 2020.[11] National power sector emissions in the "go-getter" scenario drop 38 percent from 2005 to 2020; we show the equivalent percent reductions applied to Minnesota's power sector (24 percent from 2011 to 2020). See endnote 8 for additional explanation.

- **Increasing existing coal plant efficiency.** Existing coal plants could save energy by upgrading their equipment and making other operational improvements. *Increasing coal plant efficiency by 2.5 percent could reduce CO_2 emissions by 1 percent below 2011 levels by 2020.*

- **Using more combined heat and power (CHP).** Minnesota can build more CHP systems at existing facilities—which use waste heat to generate electricity more efficiently than the average power plant—at sites like universities, hospitals, and manufacturing facilities. *Increasing the use of CHP could help the state meet its energy efficiency targets.*

Minnesota could achieve even greater long-term emissions reductions by expanding existing policies. By taking the actions listed below, which would likely require additional legislation, Minnesota can reduce power sector CO_2 emissions to 34 percent below 2011 levels by 2020 and 40 percent below 2011 levels by 2030.[12] Taking these additional actions would provide flexibility to the state, offering various options for replacing the generation from retiring coal-burning power units as part of the state's plan to comply with EPA's standards.

- Expanding the EERS to 2 percent annual savings (additional 3 percent CO_2 emissions reductions in 2020 compared to 2011 levels)

- Expanding the RES by 1 percent per year starting in 2026 so that 33 percent of the state's generation comes from renewable sources by 2030 (additional 3 percent CO_2 emissions reductions in 2030 compared to 2011 levels)

- Further increasing CHP capacity at commercial and industrial facilities could help Minnesota meet an expanded energy efficiency standard

OPPORTUNITIES IN DETAIL

Existing and Expanded Energy Efficiency Resource Standards. Minnesota has been promoting energy efficiency since 1991, when it required utilities to spend 1.5 percent of gross revenue on energy efficiency programs.[13] In 2007, Minnesota enacted an energy efficiency resource standard, changing the efficiency target from a spending amount to an energy savings amount, requiring annual electricity savings of 1.5 percent in 2010 and each year thereafter.[14] In 2013, Minnesota passed additional legislation that defines the state's energy savings policy goal by finding cost-effective energy savings to be the preferred energy resource over all other resources, and that utilities should achieve annual energy savings of *at least* 1.5 percent.[15] To meet their targets, Minnesota's utilities offer a variety of energy saving programs to their customers including rebates, energy audits, and manufacturing process improvements.[16] The economic benefits of these measures have been shown to outweigh their costs—Xcel Energy reported that their electric savings programs will provide over $376 million in net benefits to their customers in 2012.[17]

Energy efficiency is often the lowest cost utility resource as well. The Minnesota Department of Commerce found that the average cost of reducing electricity demand through the state's Conservation Improvement Program is at least three times lower than building new generation from other energy sources,[18] allowing utilities to cost-effectively generate less energy and avoid building new power plants. For example, because of its energy efficiency programs, Xcel Energy customers have saved enough energy since 1992 to avoid building 10 medium-sized power plants.[19] Meeting the state's existing efficiency standard can reduce power sector emissions by about 14 percent in 2020 compared to what emissions would be in the absence of the standard.[20,21] If the state enacts new legislation to ramp up its annual electricity savings to 2 percent per year beginning in 2015 and continues to achieve this rate of savings through 2030, it can reduce power sector CO_2 emissions by an additional 4 percent in 2020 and 9 percent in 2030, both compared to 2011 levels.

Existing and Expanded Renewable Energy Standards. Minnesota's renewable energy standard (RES) requires Xcel Energy to generate 30 percent of its electricity sold with renewable energy sources by 2020, with at least 24 percent generated by wind resources. All other utilities must generate 25 percent of the electricity sold with renewable sources by 2025.[22] In 2013, Minnesota passed new legislation that requires investor-owned utilities to supply 1.5 percent of their sales from solar energy by 2020, beyond what is required by the state's RES.[23] To meet these standards, Minnesota must increase renewable's share of total electricity sales by about 4 percent per year between 2011 and 2025. According to EIA data, renewable generating capacity in Minnesota has grown significantly in recent years—from 1.1 gigawatts (GW) in 2005 to over 3 GW in 2011—and now comprises 21 percent of total capacity. The majority of this growth is due to an increase in wind capacity, which has actually helped drive down energy prices in the state. Xcel found that the wind sources they added caused energy prices to fall about 0.7 percent in the 2008 to 2009 timeframe compared to what prices would have been without the added wind.[24] Going forward, Xcel does not expect compliance with the state's RES to have a significant effect on energy prices. In fact, the state Public Utility Commission just approved Xcel's request to build or buy power from new wind farms in Minnesota (400 megawatts) and North Dakota (350 megawatts); Xcel is going beyond the requirements of the RES because doing so will save customers more than $225 million over the projects' lives.[25] Additionally, Otter Tail Power, serving customers in western Minnesota, has said that it would have added wind capacity even absent the state's RES since wind has been the most economical option.[26]

By meeting its renewable standard through new in-state generation going forward,[27] Minnesota can reduce its power sector emissions by an additional 5 percent in 2020 compared to 2011 levels beyond the reductions captured in the *AEO 2012* reference case.[28] If Minnesota continues to increase its renewable sales at about 1 percent per year after its target has been reached in 2025, it can reduce power sector CO_2 emissions by an additional 2 percent in 2030 compared to 2011 levels. While this is likely to require additional legislation, the Minnesota Department of Commerce is currently studying the feasibility of increasing the RES to 40 percent by 2030.[29]

Increasing CHP at Commercial and Industrial Facilities. According to ICF International, Minnesota has significant technical potential for CHP, with the potential to add around 2.5 GW of new CHP for a total technical potential of over 3.4 GW.[30] As of July 2013, Minnesota had around 0.9 GW of installed CHP capacity, about 27 percent of its technical potential.[31] Minnesota has interconnection standards for systems up to 10 MW, net metering for systems up to 40 kW for customers of municipal and cooperative utilities, net metering for systems up to 1 MW for customers of investor-owned utilities, treats renewable-fueled CHP as an eligible resource under its RPS, and allows CHP to qualify under its EERS on a case-by-case basis. However, the state has the opportunity to take additional steps to encourage additional CHP deployment, such as offering financial incentives.[32] If the state ramped up CHP capacity on a path to achieve 25 percent of additional technical potential for new CHP by 2030 (for a total of 45 percent of total technical potential), it could help the state meet its EERS.[33]

Utilizing Slack Natural Gas Capacity. According to EIA data, the capacity factor of Minnesota's existing combined cycle natural gas fleet was only 15 percent in 2011—meaning that these plants generated much less electricity than they are capable of producing.[34] Increasing the capacity factor of these existing units—including four that are proposed to be built between 2014 and 2016[35] —to 75 percent would cut power sector CO_2 emissions by 30 percent in 2020 compared to 2011 levels.[36,37] (See Box 3 for additional information on Minnesota's power sector.)

Increasing Efficiency at Existing Coal Plants. According to the National Energy Technology Laboratory (NETL) and researchers at Lehigh University, it is likely that the existing coal fleet could achieve a 5 percent increase in efficiency on average.[38] For purposes of this analysis, we conservatively assume that Minnesota's coal fleet would achieve a 2.5 percent increase in efficiency, half of these potential levels. While there are high upfront costs associated with refurbishing existing coal units, the resulting increase in unit efficiency will lead to annual fuel savings. For example, the National Energy Technology Laboratory found a payback period of less than 4 years for a refurbishment technology that achieves a 2 percent heat rate improvement.[39] Existing coal plants can increase efficiency through refurbishment and improved operation and maintenance practices, though the actual efficiency potential depends on plant age and other physical limitations.[40,41] Another option to reduce the emissions intensity of a coal plant is co-firing with natural gas using the igniters that are already built into many existing pulverized coal boilers.[42] These actions can lead to reductions in power-sector CO_2 emissions of 1 percent compared to 2011 levels in 2020.

OUTLOOK FOR MINNESOTA

Minnesota has already put measures in place that will achieve significant CO_2 emissions reductions and has the opportunity to achieve greater reductions by building off of its progress to date. By meeting the requirements of its existing renewable energy and energy efficiency standards and taking advantage of available infrastructure and underutilized resources, Minnesota is in a strong position to comply with ambitious EPA standards for existing power plants in the near-term. Through federal and state-level actions, the United States can meet its commitment to reduce emissions 17 percent below 2005 levels by 2020.

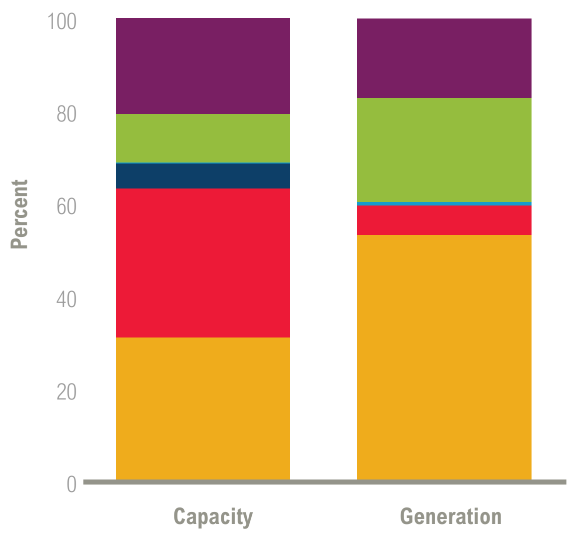
Box 2 | About This Series

In *Can The U.S. Get There From Here?*, WRI identified four key actions the Obama Administration must take in the absence of congressional action in order to meet the U.S. commitment to reducing greenhouse gas (GHG) emissions by 17 percent below 2005 levels by 2020. These actions include setting performance standards for existing power plants, reducing consumption of hydrofluorocarbons, reducing fugitive methane emissions from natural gas systems, and increasing energy efficiency. Of these four actions, the greatest opportunity for reductions comes from the power sector. In his Climate Action Plan, President Obama has directed EPA to work expeditiously to finalize carbon dioxide (CO_2) emissions standards for new power plants and adopt standards for existing power plants. As states prepare to comply with these standards, it will be necessary to understand available opportunities for reducing CO_2 emissions from the power sector. This series of fact sheets aims to shed light on these opportunities by illustrating the CO_2 emissions reduction potential from measures in a variety of states. We show how these emissions savings stack up against the reductions that could be required under forthcoming standards. This series is based on WRI analysis conducted using publicly available data. See the appendix for additional information on our methodology and modeling assumptions.[43]

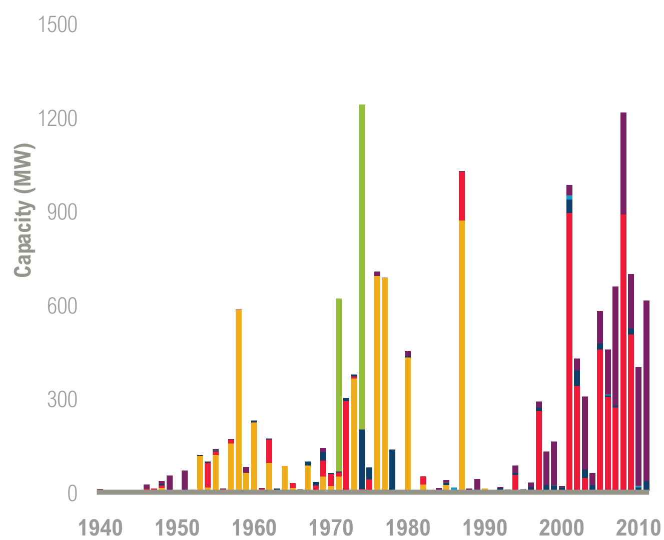
Box 3 | Minnesota Power Sector Profile

Until the 1990s, most new capacity being built in Minnesota was coal-fired or nuclear power. Since then, natural gas and renewables have comprised the bulk of new capacity additions.[44] Renewable generating capacity has grown significantly since 2005, with almost 2 GW of wind capacity added between 2005 and 2011. Coal-fired generation in the state decreased 14 percent from 2005 to 2011 as overall electricity demand increased slightly. Over the same time period, natural gas generation nearly doubled while renewable generation more than tripled. Coal comprised 53 percent of in-state generation in 2011, while nuclear and renewable sources comprised 23 percent and 17 percent, respectively. This trend of diminishing coal use may continue as the state's aging coal plants are retired. The average age of the state's coal generators with at least 50 megawatt (MW) generating capacity is over 50 years,[45] and the Minnesota Public Utility Commission requires all regulated utilities to conduct baseload diversification studies which examine the costs of retrofitting or replacing old coal-fired power plants. This has resulted in plans to retire five such units in Minnesota.[46] Furthermore, the state passed legislation in 2007 that banned the construction of new coal plants, as well as the import of electricity into the state that was generated by coal, unless 100 percent of the carbon dioxide emissions are offset.[47] In 2011, Minnesota contributed 1.4 percent of total U.S. CO_2 emissions in the power sector and 1.3 percent of electricity generation, with a state CO_2 emissions intensity of 1,292 lbs. per MWh. While this is slightly higher than the U.S. average (about 1,200 lbs. per MWh), this figure was 1,604 lbs. per MWh in 2005, so Minnesota has already made strides in reducing its emissions intensity, primarily due to fuel switching from coal to natural gas. Our analysis shows that by using existing policies and infrastructure, Minnesota could further reduce the carbon intensity of its power sector to around 1,135 lbs. per MWh by 2020.

Minnesota Generation and Generating Capacity by Fuel, 2011



New Electric Generating Capacity Additions by Fuel Type



BOTH CHARTS USE THE FOLLOWING LEGEND: Coal, Natural Gas, Oil, Other Fossil, Nuclear, Renewables

Source: U.S. Energy Information Administration Form EIA-860 and Annual Energy Review

Source: U.S. Energy Information Administration Form EIA-860, which includes existing electric generating units at plants with at least 1 MW capacity (electric utilities, independent power producers, and combined heat and power plants) that are connected to a power grid. Data represents installed summer capacity.

ENDNOTES

1. U.S. Energy Information Administration, *Annual Energy Review,* Accessible at: < http://www.eia.gov/electricity/data/state/emission_annual.xls>. Note, the Minnesota Pollution Control Agency estimated that emissions from electricity consumption (including imports) were 13 percent below 2005 levels in 2010, the last year for which the PCA supplies data. In 2010, 26 percent of the electricity consumed in-state was imported. See: <http://www.pca.state.mn.us/index.php/view-document.html?gid=18931>.
2. According to the Energy Information Administration's 2013 *Annual Energy Outlook* reference case, CO_2 emissions from the power sector will be 14 percent below 2005 levels by 2020 and only 5 percent below 2005 levels by 2035. See U.S. Department of Energy/Energy Information Administration. 2013. *Energy-Related Carbon Dioxide Emissions by Sector and Source, United States, Reference Case.* In U.S. DOE/EIA. Annual Energy Outlook 2013. Washington, D.C.: Government Printing Office. Accessible at: <http://www.eia.gov/forecasts/aeo/>.
3. For more information, see <http://www2.epa.gov/carbon-pollution-standards/2013-proposed-carbon-pollution-standard-new-power-plants>.
4. A supercritical pulverized coal unit emits about 1,768 lbs. CO_2 per MWh while a natural gas combined cycle unit emits about 804 lbs. CO_2 per MWh (National Energy Technology Laboratory, C*ost and Performance Baseline for Fossil Energy Plants Volume 1: Bituminous Coal and Natural Gas to Electricity*. Exhibit ES-17 CO_2 Emissions Normalized by Net Output, Revision 21, September 2013, Accessible at: < http://www.netl.doe.gov/energy-analyses/pubs/BitBase_FinRep_Rev2.pdf>).
5. U.S. Department of Energy/Energy Information Administration. 2013. *Electric Generating Capacity, Reference Case.* In U.S. DOE/EIA. 2013. *Annual Energy Outlook 2013*. Washington, D.C.: Government Printing Office. Accessible at: <http://www.eia.gov/forecasts/aeo/>. For more details, see also: <http://www.wri.org/publication/us-electricity-markets-increasingly-favor-alternatives-to-coal>.
6. Because EIA does not produce state-level projections, we relied on regional projections of annual electricity generation growth rates by fuel from *AEO 2012*. Because neighboring states have varying policies that will affect future in-state generation differently, these regional projections may not fully capture all the relevant trends that are expected to occur within a state's power sector.
7. The *AEO 2012* models compliance with renewable energy standards through a combination of in-state generation and purchases of renewable energy credits (RECs) from out of state. For modeling purposes, we assume that all renewable electricity generated in Minnesota is used to comply with its RES. We also assume all new renewable electricity generated after 2011 (the most recent year for which we have data) for compliance with the RES occurs in-state to help comply with new CO_2 standards, and adjust the reference case accordingly. According to data from EIA, Minnesota generated more electricity from in-state renewable sources in 2011 than was required by the RES. The National Renewable Energy Laboratory shows that Minnesota's technical potential for solar (rural and urban utility scale and rooftop) and wind resources could generate over 200 times the state's electric demand in 2011. The state could meet its RPS by harnessing about 0.1 percent of this technical potential generation in 2025.
8. The sum of reductions from the individual measures listed—along with the reductions captured in the reference case— may not match this total due to rounding. We calculated emissions reductions for existing policies using the annual reference case emissions rates for each fuel type. See the appendix for additional information on the assumptions and methodology used for this analysis (Accessible at: <http://pdf.wri.org/power_sector_opportunities_for_reducing_carbon_dioxide_emissions_methodology.pdf>).
9. EPA has not yet proposed a national emissions standard for existing power plants. To illustrate the possible stringency of the future standards, this analysis shows emissions reductions for two scenarios. Proposed standards by the Natural Resources Defense Council (Accessible at: <http://www.nrdc.org/air/pollution-standards/files/pollution-standards-report.pdf>) would result in CO_2 emissions reductions in Minnesota of 30 percent below 2011 levels in 2020. In WRI's *Can the U.S. Get There From Here?*, which focuses on reductions from 2005 levels, the most stringent scenario (the "go-getter" scenario) would achieve a 38 percent reduction from the power sector nationally between 2005 and 2020. For Minnesota, this is equivalent to a 24 percent reduction from 2011 levels. (It is unlikely that EPA standards would require identical reductions in each state, given the wide variation in emission intensities when the standards will be implemented.)
10. We assume the CO_2 savings associated with the existing energy efficiency and renewable energy standard are incorporated in the *AEO 2012* reference case. These savings are captured in the "Business as Usual" line in Figure 1. However, we adjust the reference case to assume that, in order to help comply with new CO_2 standards, all new renewable energy generation for compliance with the RES occurs in-state as opposed to purchasing renewable energy credits generated out of state. These savings are captured in the "Emissions After Using Existing Policies" line in Figure 1.
11. Nicholas Bianco, Franz Litz, Kristin Meek, and Rebecca Gasper. 2013. *Can The U.S. Get There From Here? Using Existing Federal Laws and State Action to Reduce Greenhouse Gas Emissions.* Washington, DC: World Resources Institute. Accessible at: <http://pdf.wri.org/can_us_get_there_from_here.pdf>.
12. Emissions reductions calculated using the emissions rate resulting from the adjusted reference case projection that includes Minnesota's EERS and RES policies. Reductions listed as a result of expanded policies are additional to reductions from existing policies.
13. *Conservation Improvement Programs,* Laws of Minnesota 1991, Accessible at: <https://www.revisor.leg.state.mn.us/laws/?doctype=Chapter&year=1991&type=0&id=235>.
14. *216B.241 Energy Conservation Improvement*, Minnesota Statutes, Accessible at <https://www.revisor.mn.gov/statutes/?id=216B.241>. Legislation in 2007 required 1.5 percent annual gas savings, but this was later reduced to 1.0 percent annual savings.
15. *216B.2401 Energy Savings Policy Goal,* Minnesota Statutes, Accessible at: <https://www.revisor.leg.state.mn.us/statutes/?id=216B.2401&year=2013>.
16. *How CIP Works*, Minnesota Department of Commerce, Accessible at: <http://mn.gov/commerce/energy/topics/conservation/How-CIP-Works.jsp>.
17. *Status Report & Associated Compliance Filings: Minnesota Electric and Natural Gas Conservation Improvement Program 2012,* Xcel Energy, Accessible at: <http://www.xcelenergy.com/staticfiles/xe/Regulatory/Regulatory%20PDFs/MN-DSM-CIP-2012-Status-Report.pdf>.
18. Estimates are based on the levelized average cost of the Conservation Improvement Program as calculated by the Minnesota Department of Commerce compared to the levelized average cost of other electric generating technologies as calculated by the EIA *AEO 2013*. See *Minnesota Conservation Improvement Program Energy and Carbon Dioxide Savings Report for 2010-2011,* Minnesota Department of Commerce, Division of Energy Resources, October 2013, <http://archive.leg.state.mn.us/docs/2013/mandated/131112.pdf>.
19. *Partnering for a Better Future*, Xcel Energy, Accessible at: <http://xcelenergy.com/staticfiles/xe/Corporate/Corporate%20PDFs/PartneringforaBetterEnergyFuture.pdf>, Tom Gray, *Excel Energy On Track To Surpass CO_2 Reduction Goal By 2020*, American Wind Energy Association, April 2013,

Accessible at: <http://aweablog.org/blog/post/xcel-energy-on-track-to-surpass-co2-reduction-goal-by-2020_1>.

20. We assume that all CO_2 benefits from meeting the existing energy efficiency resource standard are captured in the *AEO 2012* reference case.
21. Because states operate on a regional power grid, increased energy efficiency and renewable generation in Minnesota may reduce fossil generation and CO_2 emissions in another state rather than within Minnesota. However, all states would be operating under the new EPA standards, and other states in the region would likely be making similar efforts to reduce electricity consumption. Therefore, assuming the balance of imports and exports does not shift significantly provides a reasonable estimate of the effect of the ramp-down of regional fossil fuel generation on in-state emissions. For this reason, we assume in our analysis that all benefits of increased efficiency measures and renewable generation accrue to the state in which those measures are enacted.
22. Xcel Energy is required to meet higher standards as the result of legislative compromises related to Xcel's nuclear generation plants. See: *216B.1691 Renewable Energy Objectives*, 2013 Minnesota Statutes, <https://www.revisor.mn.gov/statutes/?id=216b.1691> and <http://www.faegrebd.com/2725>.
23. *House File 729,* 2013 session of the Minnesota Legislature, Accessible at: <https://www.revisor.mn.gov/bills/text.php?number=HF729&version=4&session=ls88&session_year=2013&session_number=0>. At the end of December, an administrative law judge (ALJ) recommended that Xcel add 100 MW of solar instead of other proposed projects, which included mostly new natural gas generators. The judge ALJ wrote that the solar project is "the most reasonable and prudent alternative to meet Xcel's near-term needs," since it has both socio-economic and environmental benefits. The MN PUC is expected to make its final decision in March. See: *Massive Minnesota Solar Project Gets Major Legal Boost,* Joanna Foster, Climate Progress, January 1, 2014. Accessible at: <http://thinkprogress.org/climate/2014/01/01/3109691/judge-says-solar-better-deal-minnesota/#>.
24. *Xcel Energy Resource Plan Update*, See: <http://www.xcelenergy.com/static-files/xe/Regulatory/Regulatory%20PDFs/2010_Resource_Plan_Update.pdf>.
25. *Xcel Energy's Wind Plan Wins Approval*, Xcel Energy News Release, October 17 2013, See: <http://www.xcelenergy.com/About_Us/Energy_News/News_Releases/Xcel_Energy%E2%80%99s_wind_plan_wins_approval>.
26. D. Haugen, *Are Renewable Standards Driving Up Utility Rates?*, Midwest Energy News, May 2011, Accessible at: <http://www.midwestenergynews.com/2011/05/17/are-renewable-standards-driving-up-utility-rates/>.
27. For purposes of this analysis, we assume that in the face of new CO_2 standards, all renewable electricity generated for compliance with the state's RES occurs within the state. See endnote 6 for additional information.
28. We assume that all benefits of increased renewable generation accrue to the state in which the generation occurs. See endnote 20 for more details.
29. Bill Grant and Matt Schuerger, *Minnesota Renewable Energy Integration and Transmission Study,* Commerce Department of Energy Resources, September 2013, Accessible at: < http://mn.gov/commerce/energy/images/MN_RE_Integration_Study_2014_pres_Stakeholder_Mtg_091313.pdf>.
30. ICF International. 2009. *Effect of a 30 Percent Investment Tax Credit on the Economic Market Potential for Combined Heat and Power.* Accessible at: <http://www.localpower.org/WADE_USCHPA_ITC_Report.pdf>.
31. I*CF CHP database.* Accessible at: < http://www.eea-inc.com/chpdata/>.
32. In 2013, Minnesota ranked 30th on ACEEE's *State Energy Efficiency Scorecard* rating based on its adoption of measures to encourage deployment of CHP systems. Other measures the state could take include offering financial incentives, financing options, technical support and guidance, and other supportive programs and policies. See: <http://www.aceee.org/sites/default/files/publications/researchreports/e13k.pdf>.
33. Under Minnesota's energy efficiency resource standard, CHP may count toward a utility's energy savings goal but is subject to approval. To remain conservative, we assume that all CHP projects will be considered eligible and thus do not generate additional savings beyond the EERS. If any CHP projects are not deemed eligible toward the EERS, there may be additional CO_2 emissions savings beyond what we present in this analysis.
34. WRI estimates based on data from U.S. Energy Information Administration, *EIA-923 Generation and Fuel Data*, <http://www.eia.gov/electricity/data/eia923/>; and *EIA-860 Annual Electric Generator Data*, <http://www.eia.gov/electricity/data/eia860/>.
35. *EIA-860 Annual Electric Generator Data,* Accessible at: <http://www.eia.gov/electricity/data/eia860/>.
36. NGCC units are designed to be operated up to 85 percent capacity (see <http://mitei.mit.edu/system/files/NaturalGas_Chapter4_Electricity.pdf>), but actual maximum capacity factors may differ among units. We assume a conservative maximum capacity factor of 75 percent. Because the majority of NGCC units are located in southern Minnesota, increasing the output from these existing units may cause transmission bottlenecks; potential transmission constraints should be studied further. The state will also need to consider both the near- and long-term potential cost differences between natural gas and coal as it weighs different options for complying with future GHG standards.
37. We did not account for the increases in methane associated with the increased production of natural gas due to a higher demand for the fuel. Going forward, industry should work with EPA to reduce methane leakage rates from natural gas systems. For additional information, see: <http://www.wri.org/publication/clearing-the-air>.
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POLICY FRAMEWORK AND INTERACTION

This analysis assumes the existing policies and other reduction opportunities listed above are fully implemented. Depending on the combination of measures actually implemented by Minnesota, each will have different impacts on the generation mix and resulting emissions. For example, increasing the efficiency of existing coal-fired power plants results in fewer emissions reductions in this analysis than would be the case if it were considered in isolation, because implementation of the EERS and RES and an increase in natural gas generation all decrease the state's coal-fired generation. The emissions reductions presented in the text are a result of each policy in combination with all other policies. We first applied the existing RES to calculate an adjusted reference case assuming the standard is met through in-state generation. Next, we increased CHP capacity and increased utilization of existing natural gas capacity compared to this adjusted reference case. Last, we increased the efficiency of any remaining coal plants. When considering the expanded policies, we applied the expanded EERS followed by increased CHP capacity, and then applied the expanded RES to the resulting adjusted demand.

Equally as important is the policy framework, which will define how each of these measures counts toward compliance under EPA's standards. We assumed that the emissions reductions from each measure would count directly toward the standard. State measures may be counted differently in the actual standards, thus actual compliance levels could potentially be greater or less than what was modeled. See the appendix for additional information on our methodology and modeling assumptions.[48]

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