

# Appendix E

## Methods for Quantification

This appendix describes in brief the methods used in quantifying the greenhouse gas (GHG) emission reductions and direct costs/cost savings associated with the policy recommendations, and provides examples of the distinction between “direct” and “indirect” costs. In addition, the combined impacts of all of the policy recommendations within and between each sector were estimated as if all of the recommendations were implemented together. This involved eliminating any overlaps in coverage of affected entities that would occur to avoid double counting of impacts. These quantification methods are based on those widely accepted among climate change mitigation policy analysts. The following general methods were used as the starting point, but were customized as needed to address the policy design features and specifications for analysis of each policy, as approved by the Arkansas Governor’s Commission on Global Warming (GCGW):

### Methods for Quantifying the Impacts of Policy Recommendations

- **Focus of Analysis: Net GHG reduction potential** in physical units of million metric tons (MMt) of carbon dioxide equivalent (CO<sub>2</sub>e) and **net cost per metric ton reduced** in units of dollars per metric ton of carbon dioxide equivalent (\$/tCO<sub>2</sub>e). Where possible, full life cycle analysis is used to evaluate the net energy (and emissions) performance of actions (taking into account all energy inputs and outputs to production). Net analysis of the effects of carbon sequestration is conducted where applicable.
- **Cost-Effectiveness:** Because monetized dollar value of GHG reduction benefits are not available, physical benefits are used instead, measured as dollars per MMtCO<sub>2</sub>e (cost or savings per ton) or “cost effectiveness” evaluation. Both positive costs and cost savings (negative costs) are estimated as a part of compliance cost.
- **Geographic Inclusion:** Measure GHG impacts of activities that occur within the state, regardless of the actual location of emissions reductions. For instance, a major benefit of recycling is the reduction in material extraction and processing (e.g., aluminum production). While a policy option may increase recycling in Arkansas, the reduction in emissions may occur where this material is produced. Where significant emissions impacts are likely to occur outside the state, this will be clearly indicated. These emissions reductions are counted towards the achievement of the state’s emission goal, since they result from actions taken by the state.
- **Direct vs. Indirect Effects:** “Direct effects” are those borne by the entities implementing the policy recommendation. For example, direct costs are net of any financial benefits or savings to the entity. “Indirect effects” are defined as those borne by the entities other than those implementing the policy recommendation. Indirect effects will be quantified on a case-by-case basis depending on magnitude, importance, time available, need and availability of data. (See additional discussion and list of examples below.)
- **Non-GHG (External) Impacts and Costs:** Include in qualitative terms where deemed important. Quantify on a case-by-case basis as needed depending on need and where data are readily available.

- **Discounting and Annualizing:** Discount a multi-year stream of net costs (or savings) to arrive at the “net present value cost” of the cost of implementing a policy option. Discount costs in constant 2005 dollars using a 5% annual real discount rate for the project period of 2009 through 2025 (unless otherwise specified for the particular policy option). Capital investments are represented in terms of annualized or amortized costs through 2025. Create an annualized cost per ton by dividing the present value cost or cost savings by the cumulative reduction in tons of GHG emissions.
- **Time Period of Analysis:** Count the impacts of actions that occur during the project time period and, using annualized emissions reduction and cost analysis, report emissions reductions and costs for specific target years of 2015 and 2025. Where additional GHG reductions or costs occur beyond the project period as a direct result of actions taken during the project period, show these for comparison and potential inclusion.
- **Aggregation of Cumulative Impacts of Policy Recommendations:** In addition to “stand alone” results for individual options, estimate cumulative impacts of all options combined. In this process we avoid simple double counting of GHG reduction potential and cost when adding emission reductions and costs associated with all of the policy recommendations. To do so we note and or estimate interactive effects between policy recommendations using analytical methods where significant overlap or equilibrium effects are likely. Documentation of how these overlaps were addressed is provided at the beginning of Appendix G for the RCI sectors, Appendix I for the TLU sectors, and Appendix J for the AFW sectors.
- **Policy Design Specifications and Other Key Assumptions:** Include explicit notation of timing, goal levels, implementing parties, the type of implementation mechanism, and other key assumptions as determined by the GCGW.
- **Transparency:** Include policy design choices (above) as well as data sources, methods, key assumptions, and key uncertainties. Use data and comments provided by GCGW to ensure best available data sources, methods, and key assumptions using their expertise and knowledge to address specific issues in Arkansas. Modifications will be made through facilitated decisions.

For additional reference see the economic analysis guidelines developed by the Science Advisory Board of the US EPA available at:

<http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html>.

## **Examples of Direct/Indirect Net Costs and Savings**

Note: These examples are meant to be illustrative.

### **Residential, Commercial, and Industrial (RCI) Sectors**

#### **Direct Costs and/or Savings**

- Net capital costs (or incremental costs relative to standard practice) of improved buildings, appliances, equipment (cost of higher-efficiency refrigerator versus refrigerator of similar features that meets standards)
- Net operation and maintenance (O&M) costs (relative to standard practice) of improved buildings, appliances, equipment, including avoided/extra labor costs for maintenance (less changing of compact fluorescent light (CFL) or light-emitting diode (LED) bulbs in lamps relative to incandescent)
- Net fuel (gas, electricity, biomass, etc.) costs (typically as avoided costs from a societal perspective)
- Cost/value of net water use/savings
- Cost/value of net materials use/savings (for example, raw materials savings via recycling, or lower/higher cost of low-global warming potential (GWP) refrigerants)
- Direct improved productivity as a result of industrial measures (measured as change in cost per unit output, for example, for an energy/GHG-saving improvement that also speeds up a production line or results in higher product yield)

#### **Indirect Costs and/or Savings**

- Re-spending effect on economy
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)
- Net embodied energy of materials used in buildings, appliances, equipment, relative to standard practice
- Improved productivity as a result of an improved working environment, such as improved office productivity through improved lighting (though the inclusion of this as indirect might be argued in some cases)

### **Energy Supply (ES) Sector**

#### **Direct Costs and/or Savings**

- Net capital costs (or incremental costs relative to reference case technologies) of renewables or other advanced technologies resulting from policies
- Net O&M costs (relative to reference case technologies) renewables or other advanced technologies resulting from policies

- Avoided or net fuel savings (gas, coal, biomass, etc.) of renewables or other advanced technologies relative to reference case technologies resulting from policies
- Total system costs (net capital + net O&M + avoided/net fuel savings + net imports/exports + net transmission and distribution (T&D) costs) relative to reference case total system costs

### **Indirect Costs and/or Savings**

- Re-spending effect on economy
- Higher cost of electricity reverberating through economy
- Energy security
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)

## **Agriculture, Forestry, and Waste Management (AFW) Sectors**

### **Direct Costs and/or Savings**

- Net capital costs (or incremental costs relative to standard practice) of facilities or equipment (e.g., manure digesters and associated infrastructure, generator; ethanol production facility)
- Net O&M costs (relative to standard practice) of equipment or facilities
- Net fuel (gas, electricity, biomass, etc.) costs or avoided costs
- Cost/value of net water use/savings

### **Indirect Costs and/or Savings**

- Net value of employment impacts
- Net value of human health benefits/impacts
- Net value of ecosystem health benefits/impacts (wildlife habitat; reduction in wildfire potential; etc.)
- Value of net environmental benefits/impacts (value of damage by air or water pollutants on structures, crops, etc.)
- Net embodied energy of water use in equipment or facilities relative to standard practice
- Reduced vehicle miles traveled (VMT) and fuel consumption associated with land use conversions (e.g., as a result of forest/rangeland/cropland protection policies)

## **Transportation and Land Use (TLU) Sector**

### **Direct Costs and/or Savings**

- Incremental cost of more efficient vehicles net of fuel savings.

- Incremental cost of implementing Smart Growth programs, net of saved infrastructure costs.
- Incremental cost of mass transit investment and operating expenses, net of any saved infrastructure costs (e.g., roads)
- Incremental cost of alternative fuel, net of any change in maintenance costs

**Indirect Costs and/or Savings**

- Health benefits of reduced air and water pollution.
- Ecosystem benefits of reduced air and water pollution.
- Value of quality-of-life improvements.
- Value of improved road safety.
- Energy security
- Net value of employment impacts