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San Diego County Greenhouse Gas Inventory

An Analysis of Regional Emissions and Strategies to Achieve AB 32 Targets

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For an electronic copy of this summary report and the full documentation of the San Diego Greenhouse Gas Inventory project, go to www.sandiego.edu/epic/ghginventory.

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Key Findings

- San Diego County emitted 34 million metric tons of carbon dioxide equivalent (MMT CO_2E) in 2006 – an 18% increase over 1990 levels, commensurate with population growth during the same period.
- In 2006, per-capita emissions for San Diego County were 12 metric tons CO_2E, which is slightly lower than California as a whole (13) and significantly lower than the U.S. levels (24).
- In 2006, emissions from cars and light-duty trucks represented 46% of total greenhouse gas emissions in San Diego County.
- By 2020, under a business-as-usual scenario, regional greenhouse gas emissions are expected to be 43 MMT CO_2E, an increase of 9 MMT CO_2E (26%) over 2006 levels and 14 MMT CO_2E (48%) over 1990 levels.
- To meet AB 32 emissions reduction targets (1990 levels by 2020), San Diego County would have to reduce emissions by 14 MMT CO_2E (33%) below projected business-as-usual levels in 2020.
- Nearly 60% of total regional emissions are associated with individuals (e.g., passenger vehicles, light-duty trucks, residential electricity and natural gas consumption).
- San Diego County likely can reduce its greenhouse gas emissions to 1990 levels by 2020 through a combination of reduction strategies from all sectors. This study estimates that through a combination of 21 strategies, the region could reduce its emissions by 15 MMT CO_2E by 2020, more than the quantity required to reach 1990 levels.
- In the scenario above, reductions from the on-road transportation sector (7 MMT CO_2E) and the electricity sector (5 MMT CO_2E) represent 81% of total reductions.
- Two statewide policies would account for 41% of these greenhouse gas emissions reductions. Implementing the Pavely (AB 1493) vehicle emissions standards by 2020 would reduce emissions by just over 3 MMT CO_2E, 21% of total reductions, and implementing a 33% renewable portfolio standard by 2020 would reduce emissions by 3 MMT CO_2E, 19% of total reductions.

Report Overview

This study developed a greenhouse gas inventory for San Diego County to better understand the emissions sources in the region and to serve as a resource for local and regional decision makers as they consider ways to reduce emissions at the local and regional levels. To that end, the project team calculated historical greenhouse gas emissions from 1990 to 2006 using the best available data, and then estimated future emissions to 2020 for San Diego County. Using emissions reduction targets codified in California's Global Warming Solutions Act of 2006 (AB 32) as a guide, the study also sought to establish emissions reductions targets for the region. Although AB 32 does not require individual sectors or jurisdictions (e.g., cities and counties) to reduce emissions

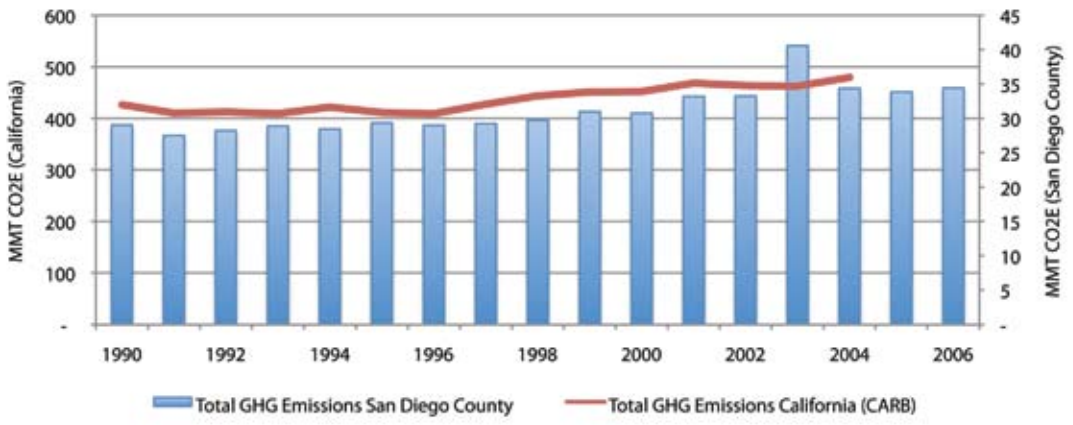
by a specific amount, the study calculated the theoretical emissions reductions necessary in each emissions category (e.g., transportation, electricity, etc.) for San Diego County to reduce emissions to 1990 levels by 2020—the statewide statutory target under AB 32. Finally, the study sought to identify and quantify potential emissions reduction strategies to determine the feasibility of reducing emissions to 1990 levels by 2020.

To the extent possible, the study followed the same calculation methodology used by the California Air Resources Board (CARB) to develop the statewide greenhouse gas inventory. In some instances, when doing so could yield a more accurate or precise result, the project modified the CARB method. This summary report is intended as an overview of the findings from the inventory, and no discussion of method is included. It provides information about the total greenhouse gas emissions for San Diego County and a summary of the highest emitting categories, including on-road transportation, electricity, and natural gas end-use consumption. It also gives an overview of the emissions reduction strategy analysis for each category of the inventory. Detailed analysis for each emissions category, including emissions levels, emissions reduction strategies (wedges), and detailed methodologies for calculating emissions are provided in eight supplemental reports available for download on the Energy Policy Initiatives Center Web site.[1]

Greenhouse Gas Emissions in San Diego County

In 2006 San Diego County emitted 34 million metric tons of carbon dioxide equivalent (MMT CO_2E), an increase of 5 MMT CO_2E (18%) over 1990 level emissions.[2] This increase is commensurate with growth in regional population, which increased at the same rate during this period. Statewide emissions grew at rate of about 12% during this same period. Though this is slightly lower, the general trends have been similar. Figure 1 shows San Diego County and California statewide greenhouse gas emissions from 1990 through 2006. Note that 2003 emissions are significantly higher due to the wildfires in San Diego County that year.

Figure 1. San Diego County and California GHG Emissisons



1. Detailed reports are available at www.sandiego.edu/epic/ghginventory.
2. Carbon dioxide equivalent includes the sum of all greenhouse gases converted to the global warming potential (GWP) of carbon dioxide. For example, the GWP for methane is 21. This means that 1 million metric tons of methane is equivalent to emissions of 21 million metric tons of carbon dioxide.

Greenhouse gas emissions in San Diego County are primarily the result of energy use, 91% of total emissions are associated with fuel use. Figure 2, compares emissions in the four principal categories established by the United Nations Intergovernmental Panel on Climate Change (IPCC).

Dividing San Diego County greenhouse gas emissions by economic sectors, as shown in Figure 3, reveals that the residential sector is responsible for more than half of all San Diego County emissions. When aggregated, the impact of individual actions on San Diego County's regional greenhouse gas levels is significant. The combination of passenger vehicles, light-duty trucks, residential electricity use, and natural gas consumption accounts for about 19 MMT CO_2E, or 56% of total emissions. These are the sectors for which residential data are readily available, and it assumes that all light-duty trucks are used by individuals rather than by the commercial or industrial sectors.[3] It is possible that a portion of passenger vehicles and light-duty trucks are used for commercial and industrial purposes, which would lower this estimate, but it is also true that the portion of civil aviation and waste attributable to individuals would increase slightly the estimated impact of individuals.[4]

Figure 2. 2006 San Diego County GHG Emissions by IPCC Category

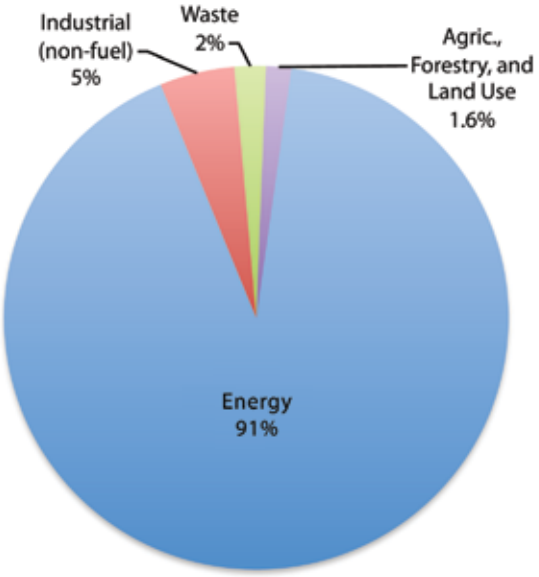
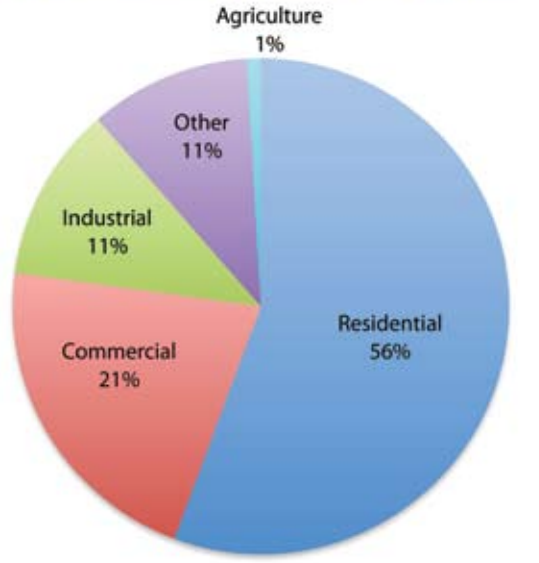


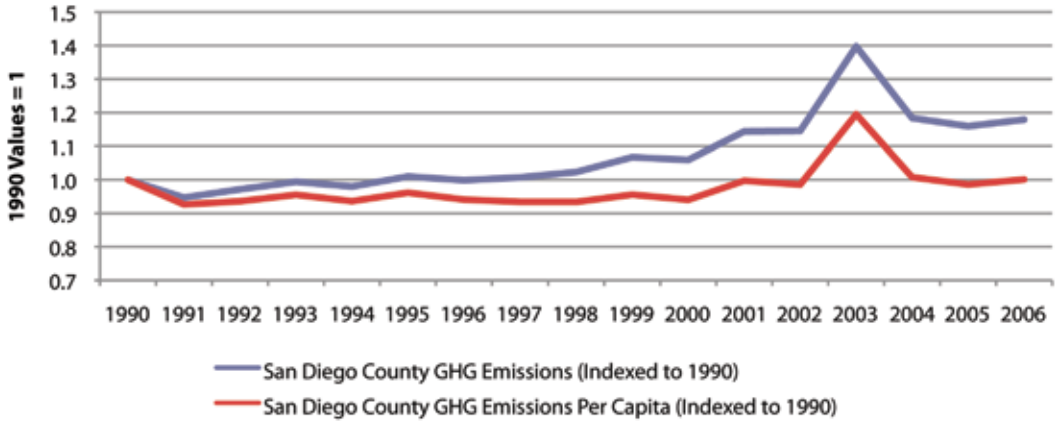
Figure 3. 2006 San Diego County GHG Emissions by Economic Sector



3. This is consistent with CARB's designation of these vehicle categories as "non-commercial."
4. Data was not available to divide emissions from civil aviation and waste into economic sectors.

Per-capita emissions for the San Diego region was 12 metric tons of CO_2E in 2006 and has been basically flat since 1990; however, total emissions increased by 18%, as shown in Figure 4. It should be noted that while per-capita metrics are useful for comparing different geographical entities, total emissions is the most important metric, since the object of AB 32 and other similar polices is to reduce the absolute amount of greenhouse gases in the atmosphere.

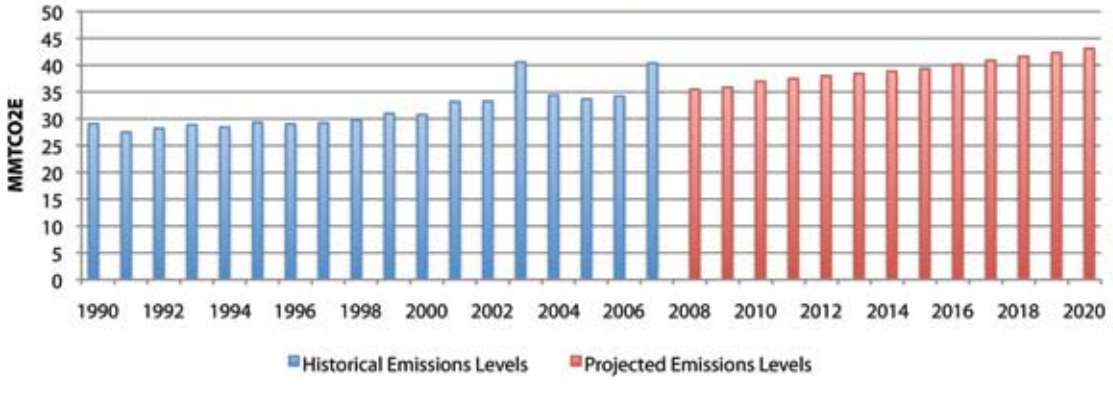
Figure 4. Comparision of Total and Per-Capita Emissions San Diego County



Emissions Projections

Given a business-as-usual trajectory, defined as no change in current trends or policies, greenhouse gas emissions from San Diego County will be approximately 43 MMT CO_2E in 2020, a 26% increase over 2006 levels and a 48% increase over 1990 levels. Figure 5 shows the projected emissions levels under the business-as-usual scenario.

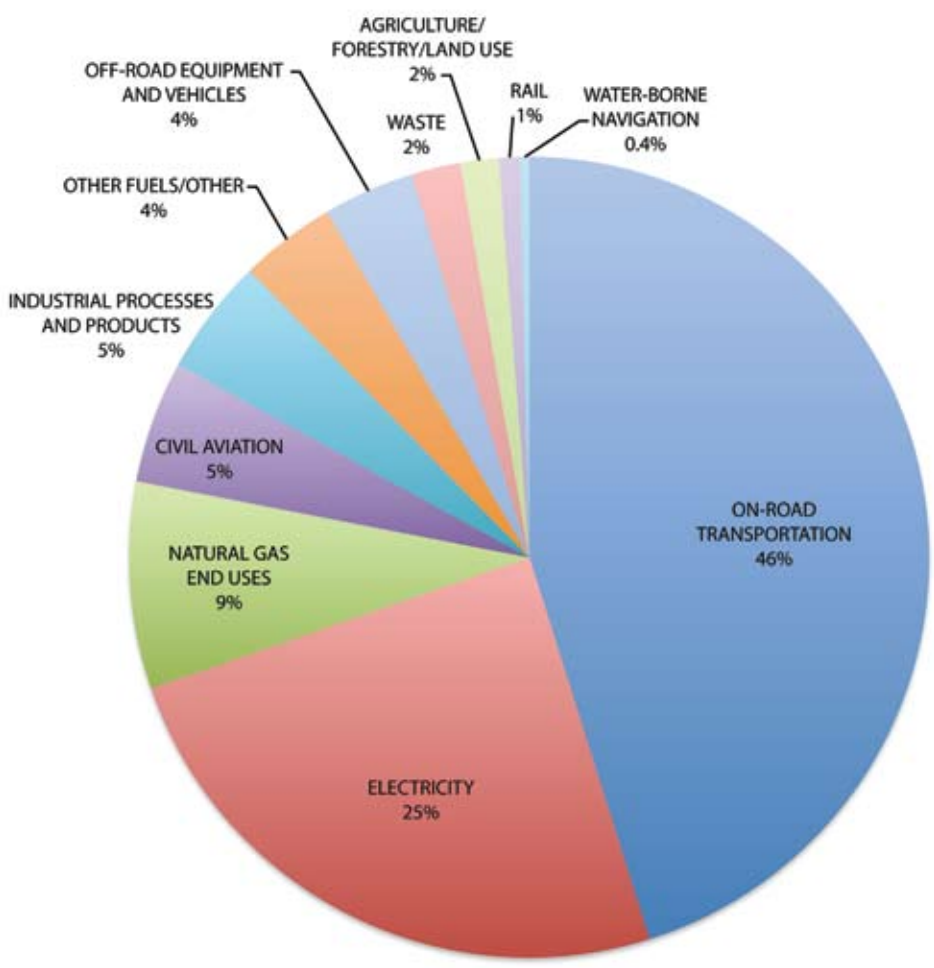
Figure 5. Total GHG Emissions for San Diego County (1990-2020)



Regional Greenhouse Gas Emissions by Category

While many different sources emit greenhouse gases in San Diego County, a few sources account for the vast majority of emissions in San Diego County. The on-road transportation category—comprising cars and trucks—is by far the largest contributor of greenhouse gas emissions in the region, accounting for 46% of the total, almost twice as much as the next largest sector. Electricity generation and natural gas combustion were the second (25%) and third (9%) highest emitting sectors. These top three categories emit 80% of total greenhouse gases in San Diego County. Civil aviation, mainly interstate flights from Lindbergh Field, is the fourth highest emitting category (5%). Given San Diego's economic make up, emissions associated with non-fuel industrial processes and product use (mainly refrigerants) are relatively small and represent just under 5% of emissions, slightly higher than the emissions from the other fuels/other category (4%), which includes the use of fuels such as propane, which are not captured in other categories of the inventory. Finally, off-road transportation and equipment activities, which include construction and mining equipment, pleasure boats, and some agricultural equipment, account for about 4% of the emissions.[5] Figure 6 shows the breakdown of emissions by source. A detailed table of inventory results can be found on page 16 of this report. (Table 3)

Figure 6. San Diego County GHG Emissions by Category (2006)



5. Emissions from industrial activities involving fuel combustion are captured mainly in the electricity and natural gas categories.

Table 1 shows the emissions categories and subcategories included in the inventory.

Table 1. Emissions Inventory Cagetories

AGRICULTURE
- Enteric Fermentation
- Manure

CIVIL AVIATION
- Interstate Flights
- Intrastate Flights

ELECTRICITY
- Residential
- Commercial
- Industrial
- Mining
- Agricultural
- Telephone, communications, utilities (TCU)
- Street Lighting

DEVELOPMENT
- Loss of farmland
- Loss of native vegetation

INDUSTRIAL PROCESSES AND PRODUCTS
- HFC refrigerants
- Sulfur hexafluoride
- Other

NATURAL GAS END USES
- Residential
- Commercial
- Industrial
- Mining
- Agricultural

OFF-ROAD EQUIPMENT AND VEHICLES
- Construction and Mining Equipment
- Pleasure Craft
- Industrial Equipment
- Agriculture Equipment
- Other

ON-ROAD TRANSPORTATION
- Passenger Vehicles
- Light-Duty Trucks
- Heavy-Duty Trucks and Vehicles
- Motorcycle

OTHER FUELS/OTHER
- Manufacturing
- Transport
- Residential
- Commercial
- Non-Specified
- Agriculture
- Cogeneration Thermal Emissions

RAIL TRANSPORTATION

SEQUESTRATION FROM LAND COVER
- Forest growth
- Woodland growth
- Chaparral, scrub, and grasslands

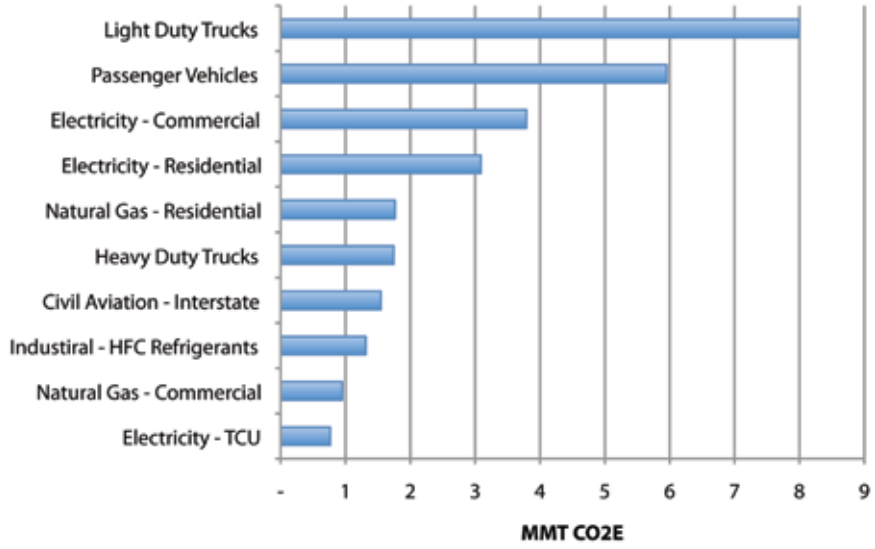
WASTE
- Landfills
- Wastewater Treatment

WATER-BORNE NAVIGATION
- Ocean Going Vessels (OGV)
- Harbor Craft

WILDFIRES
- Forest
- Woodlands
- Chaparral, scrub, and grasslands

Figure 7 shows the top 10 emitting subcategories in San Diego County in 2006. Light-duty trucks and passenger vehicles are the highest emitting subcategories by a wide margin in all years. In 2003, the year of the devastating wildfires, emissions from all fires were the single largest source of greenhouse gases in the region that year, totaling 8 MMT CO_2E (20% of total emissions).

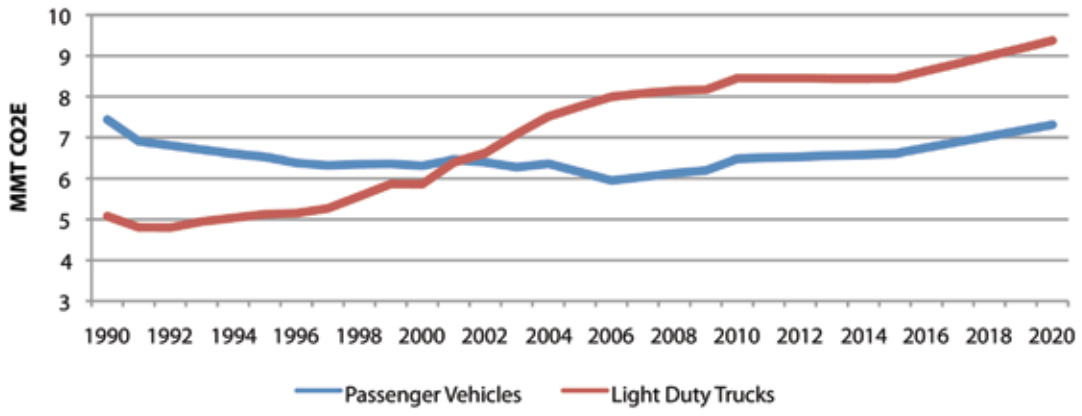
Figure 7. Top 10 GHG Emitting Subcategories San Diego County (2006)[6]



Emissions from Cars and Trucks

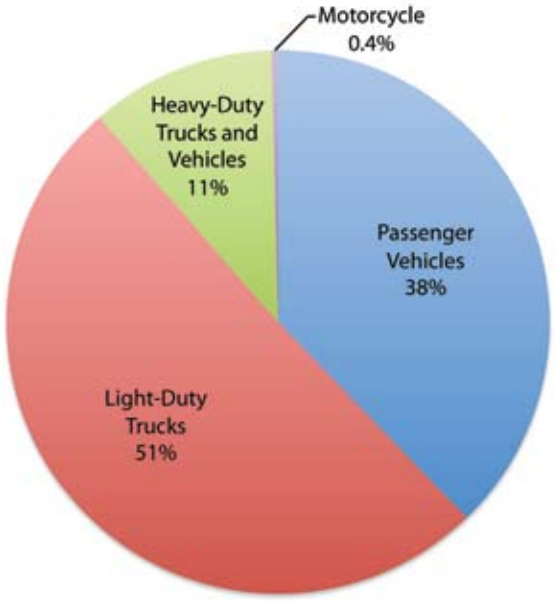
In 2006, light-duty trucks accounted for just over 50% of total on-road emissions, while passenger vehicles accounted for nearly 38%. Emissions from passenger vehicles were higher than those from light-duty trucks until 2003, when light-duty trucks became the highest emitting vehicle type in San Diego County (Figure 8). Figure 9 shows the on-road greenhouse gas emissions in 2006 by vehicle type.

Figure 8. GHG Emissions from Passenger Vehicles and Light Duty Trucks, San Diego County



6. TCU is transportation, communication, and utilities.

Figure 9. On-Road Transportation GHG Emissions by Vehicle Type, San Diego County 2006

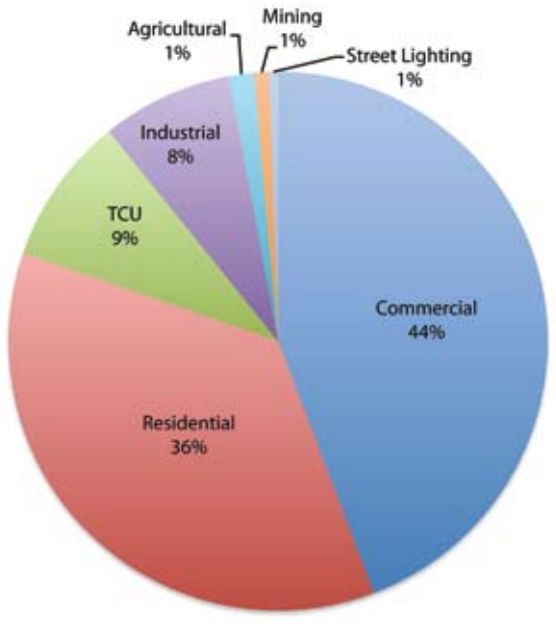


By 2020, greenhouse gas emissions from on-road vehicles are expected to reach 19 MMT CO_2E, a 21% increase over 2006 levels. Light-duty trucks are expected to continue to be the largest emitter among the vehicle classes representing nearly 50% of all emissions from the on-road transportation sector by 2020.

Emissions from Electricity Use

In 2006, electricity use accounted for 25% of total emissions in the region. About 44% of emissions from electricity came from consumption in the commercial sector. Residential sector consumption was close behind with 36%. Transportation, communication, and utilities (TCU) (9%) and the industrial sector (8%) are significantly lower than the leading subsectors. Figure 10 shows the relative breakdown of the electricity category.

Figure 10. Electricity Emissions by Subcategory San Diego County, 2006

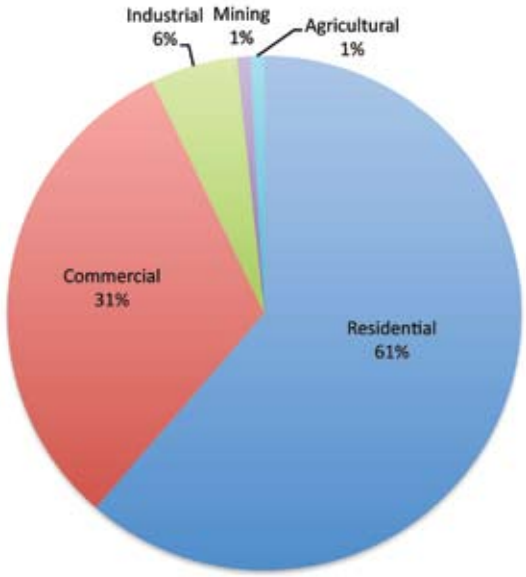


Emissions from electricity use increased by about 31% between 1990 and 2006, faster than population growth, and they are expected to increase by 28% over 2006 levels by 2020 under a business-as-usual scenario.

Emissions from Natural Gas End-use

Emissions from combustion of natural gas by end-users accounts for just under 9% of total greenhouse gas emissions in San Diego County. Of this total, the residential sector accounts for 60% of emissions, while the commercial sector emits about 33%. Figure 11 shows the contribution of each end-use sector to total natural gas emissions. Emissions associated with power generation from natural gas are accounted for in the electricity sector data.

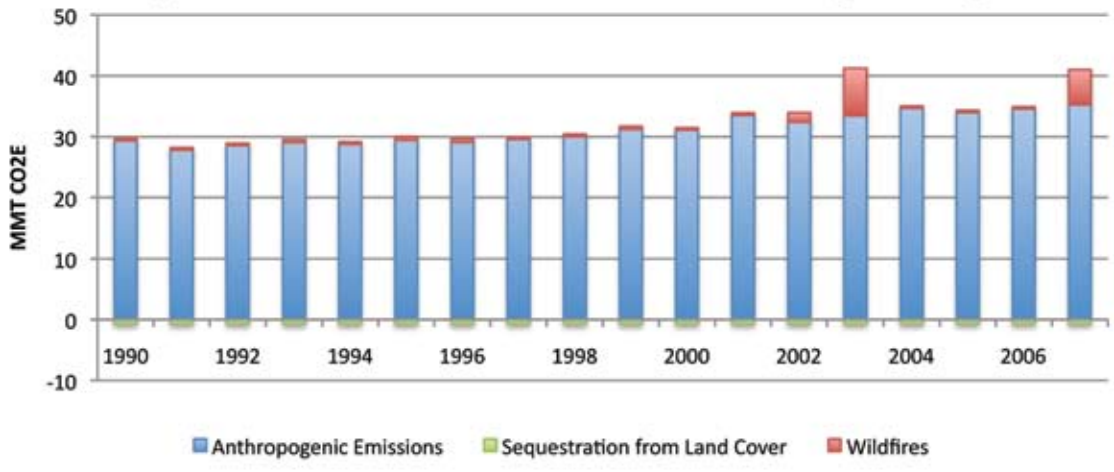
Figure 11. Natural Gas End Use Emissions By Sector, San Diego County 2006



Sequestration and Wildfires

In addition to the sources of emissions described above, this study estimated the ability of the vegetation in the county to absorb and sequester greenhouse gases. Carbon dioxide is taken up by growing plants and released again by decomposing plant matter displaced by development. During wildfires, the carbon dioxide stored in vegetation is released along with the other greenhouse gases nitrous oxide and methane. Figure 12 shows the total sources and sinks of greenhouse gas emissions for San Diego County from 1990 to 2008. The very small green bars at the bottom indicate the level of carbon dioxide sequestered by vegetation. By contrast, the red bars at the top indicate the amount of greenhouse gas emitted by wildfires. The 2003 firestorm released nearly 8 MMT CO_2E, more greenhouse gases than any other single emitting subcategory that year. These fires caused greenhouse gas emissions for that year to reach levels approximately equivalent to the projected emissions for 2017.

Figure 12. Total GHG Sources and Sinks San Diego County



Emissions Reduction Targets

In 2006, California Governor Arnold Schwarzenegger signed the Global Warming Solutions Act (AB 32), establishing statutory limits on greenhouse gas emissions in California. AB 32 seeks to reduce statewide emissions to 1990 levels by the year 2020. While AB 32 does not specify reduction targets for specific sectors or jurisdictions, this study calculated theoretical reductions targets for San Diego County. To meet the targets established by AB 32, the San Diego region would have to reduce its projected business-as-usual 2020 emissions by 14 MMT CO_2E or 33%.

In 2005, Governor Schwarzenegger signed Executive Order S-3-05, which establishes long-term targets for greenhouse gas emissions reductions to levels 80% below 1990 levels by 2050. While this reduction target is not law, it is generally accepted as the long-term target of California regulations. Like AB 32, Executive Order S-3-05 is intended to be a statewide target, but if applied hypothetically to San Diego County, total emissions would have to be reduced to 6 MMT CO_2E, 37 MMT CO_2E (87%) below the 2020 business-as-usual projection and 28 MMT CO_2E (83%) below 2006 levels. Figure 13 illustrates the magnitude of the theoretical emissions reductions necessary if San Diego County were required to meet both AB 32 and Executive Order S-3-05 targets.

Figure 13. Theoretical GHG Reduction Targets for San Diego County[7]

Reduction Strategies—Wedges

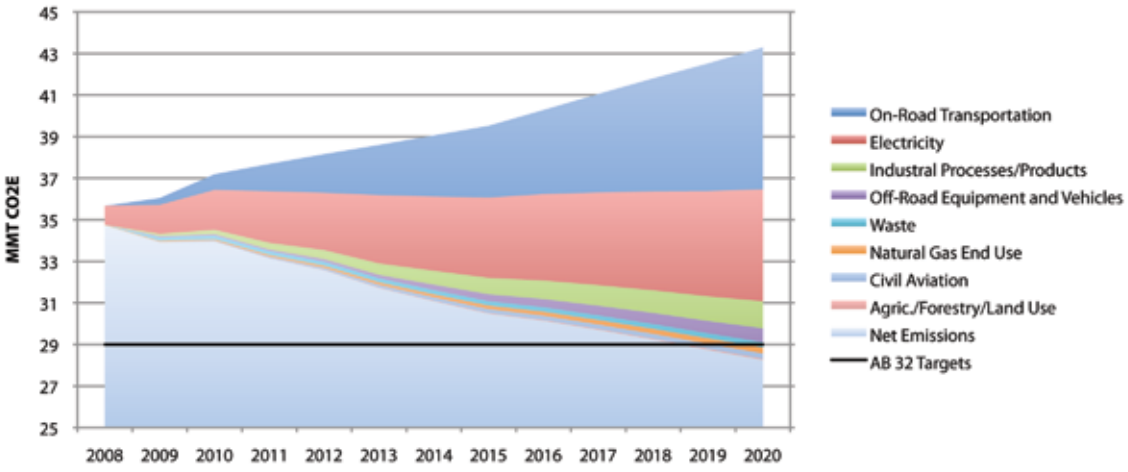
To illustrate how San Diego County could achieve the AB 32 targets and reduce emissions by 14 MMT CO_2E, the project team developed a range of strategies and calculated how much each could reduce emissions. The results were used to develop emissions reduction "wedges" illustrated in Figure 14 and Table 2. This approach was adapted from the well-known study by Pacala and Sokolow demonstrating that global emissions could be reduced to levels that would stabilize climate change using existing technologies.[8] They took the total reductions needed to stabilize emissions and split that amount into equal parts, or wedges, each wedge representing an equal reduction.

This study followed a similar approach to demonstrate how San Diego County could reduce its greenhouse gas emissions to meet AB 32 targets. Instead of making equal wedges to achieve the reduction goals, the project team developed specific wedges

7. For simplicity, the business-as-usual projection is smoothed from 1990 to 2020.
8. S. Pacala and R. Socolow, Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. Science 13 August 2004, Vol 305, pp. 968-972.

to show the effects of existing or expected policy changes. In most cases, wedges represent emissions reductions associated with existing law or regulation or are based on an authoritative source. In some cases, wedges were calculated on the basis of hypothetical but practical or realistic future policy changes. Figure 14 shows the relative greenhouse gas reduction possible from each major emissions category. The highest emitting categories also have the potential for the most emissions reduction. The on-road transportation and electricity categories account for 81% of total reductions: on-road transportation contributing 7 MMT CO_2E (45%) and electricity contributing 5 MMT CO_2E (36%) to the total. Some sectors have no emissions reduction wedge, due to their limited reduction potential.

Figure 14. Emissions Reduction Wedges by Sector, San Diego County



The study identified 21 emissions reduction wedges and calculated how much each could reduce greenhouse gas emissions by 2020. Table 2 shows each wedge, its category, and the amount of emissions that it could reduce by 2020. The combined emissions reductions of these 21 wedges are 15 MMT CO_2E, slightly more than the 14 MMT CO_2E needed to reach AB 32 emissions targets prorated for San Diego County.

The largest reductions derive from state standards for renewable energy, vehicle tailpipe emissions, and clean fuels. California's tailpipe carbon dioxide regulations (Pavley) if fully implemented would account for 21% of total emissions reductions by 2020.[9] It should be noted that the Pavley regulations would reduce emissions by just over 3 MMT CO_2E, significantly more than the new Federal corporate average fleet efficiency (CAFE) standards, adopted as part of the Federal energy legislation passed in 2007, which would reduce regional emissions by about 2 MMT CO_2E.

9. See AB 1493 (Pavley).

Table 2. Emissions Reduction Wedges to Achieve AB 32

CATEGORY	REDUCTION AMOUNT (MMT CO_2E)	PERCENTAGE OF TOTAL
ON-ROAD TRANSPORTATION	**6.8**	**46%**
2005 CAFE Standard	2.3	15%
Low-Carbon Fuel Standard	1.6	11%
Reduce Vehicle Miles Traveled by 10%	1.4	9%
Pavley Standard (Incremental to CAFE)*	0.9	6%
Light/Heavy Vehicle Efficiency/Hybridization	0.6	4%
ELECTRICITY	**5.4**	**36%**
Renewable Portfolio Standard 20%	2.0	13%
Reduce Electricity Consumption 10%	1.1	7%
Renewable Portfolio Standard 33% (Incremental)	1.0	7%
Cleaner Electricity Purchases (≤1100 lbs/MWh)	0.6	4%
Replace Boardman Contract	0.3	2%
California Solar Initiative 400 MW	0.2	1%
Increase CHP by 200 MW	0.2	1%
INDUSTRIAL PROCESSES AND PRODUCTS	**1.3**	**9%**
Phase out of HFCs	1.3	9%
OFF-ROAD EQUIPMENT AND VEHICLES	**0.7**	**4%**
Reduce Fuel Consumption by 15%	0.4	3%
Low-Carbon Fuel Standard	0.2	1%
Reduce Pleasure Craft Fuel Use by 35%	0.1	1%
NATURAL GAS END-USE	**0.3**	**2%**
Reduce Natural Gas Consumption 8%	0.3	2%
CIVIL AVIATION	**0.3**	**2%**
Civil Aviation Low-Carbon Fuel Standard	0.3	2%
WASTE	**0.3**	**2%**
Capture 80% of Landfill Gas	0.3	2%
AGRICULTURE/FORESTRY/LAND USE	**0.05**	**0.3%**
Urban Tree Planting / Preservation	0.02	0.1%
Tree Preservation during Development	0.03	0.2%
Total	**15.0**	**100%**

*The entire reduction attributable to Pavley is 3.2 MMT CO_2E (CAFE + Pavley).

Figure 15. Emissions Reduction Strategies for San Diego County to Meet Hypothetical AB 32 Targets by 2020

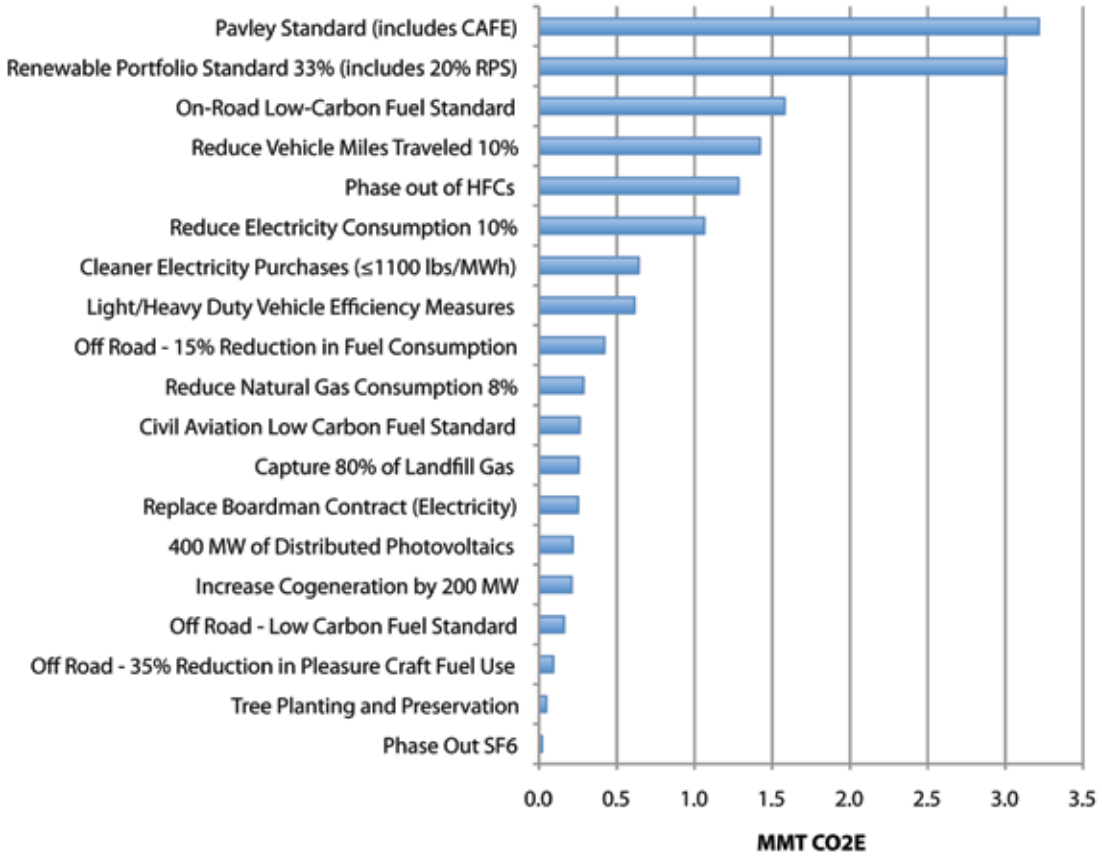


Figure 15 shows the magnitude of each individual emissions reduction wedge.

Emissions reductions from the Renewable Portfolio Standard (RPS) wedges account for 20% of total reductions. California's RPS requires the state's three investor-owned utilities to provide at least 20% of energy supplies from renewable sources by 2010.[10]

The emissions savings attributed to the 20% RPS wedge presented in Table 2 represents incremental renewable energy additions above levels already achieved by the local utility. In addition, the California Energy Commission's Integrated Energy Policy Report for 2007 recommends increasing the RPS to 33%.[11] While this increase to 33% is not law, it is very likely to be codified in the coming years. The wedge amount in Table 2 for the 33% RPS represents the incremental emissions reductions over the existing RPS requirements that would be achieved by increasing renewable energy supplies an additional 13%. A single amount for both the 20% and 33% RPS is presented in Figure 15.

The California Air Resources Board (CARB) has approved the Low-Carbon Fuel Standard as an early action measure for meeting AB 32 emissions reduction targets. This standard,

10. S. Pacala and R. Socolow, Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. Science 13 August 2004, Vol 305, pp. 968-972.
11. 007 Integrated Energy Policy Report, Commission Final Report, adopted December 5, 2007. Publication CEC-100-2007-008-CMF. Available from the CEC at http://www.energy.ca.gov/2007_energypolicy/index.html.

which was promulgated in Executive Order S-01-07, would reduce the carbon intensity of transportation fuels sold in California by 10% by 2020.[12] Applying this standard to fuels used by on-road vehicles would reduce greenhouse gas emissions by 11%. Reduction in vehicle miles traveled and increased vehicle efficiency measures make up the final transportation wedges.

While many of the strategies identified here are based in state and federal law, there is a significant role for local governments in realizing emissions reductions. While local governments can help to facilitate statewide standards like the renewable portfolio standard, they can play a more direct role in locally and regionally based strategies. Strategies include reducing vehicle miles traveled, electricity and natural gas consumption, increasing use of distributed energy resources such as cogeneration and photovoltaics, and capturing more methane gas at our region's landfills.

Conclusion

San Diego County emitted 34 million MMT CO_2E in 2006—an 18% increase over 1990 levels. This increase is commensurate with the increase in county population and statewide trends over the same period. On-road transportation, mainly cars and light-duty trucks, was responsible for 16 MMT CO_2E in 2006, 46% of total greenhouse gas emissions in San Diego County for that year, and was by far the largest emitting category of the inventory. The electricity category emitted 7 MMT CO_2E (25%) and natural gas end-use emitted 3 MMT CO_2E (9%). These top three emitting categories are significantly associated with activities by individuals (e.g., driving and home electricity and natural gas use); thus nearly 60% of total regional emissions are associated with individual activities.

By 2020, under a business-as-usual scenario, regional greenhouse gas emissions are expected to be 43 MMT CO_2E, increase of 8.52 MMT CO_2E (26%) over 2006 levels. Even though AB 32 does not specify reduction targets for counties, to achieve its emissions reduction targets (1990 levels by 2020), San Diego County would have to reduce emissions by 14 MMT CO_2E (30%) below projected business-as-usual levels in 2020. San Diego County can reduce its greenhouse gas emissions to 1990 levels by 2020 through a combination of reductions strategies from all sectors, mainly driven by renewable energy mandates, fuel efficiency standards, and a low-carbon fuel standard. This study estimates that through a combination of 21 strategies, the region could reduce its emissions by 15 MMT CO_2E by 2020, slightly more than required to reach 1990 levels.

Clearly, meeting the greenhouse gas emissions targets of AB 32 targets will involve the entire state, and actions taken on a multi-county or regional basis may well influence the contributions made by or needed from San Diego County. A detailed analysis of the local and regional policy changes necessary to achieve the potential emissions reductions presented here was beyond the purview of this report, but will be addressed in the next phase of the project.

12. Go to http://gov.ca.gov/index.php?/executive-order/5172/

Table 3. San Diego County GHG Inventory and Emissions Projections (MMT CO_2E)

					Business-as-Usual Projections		
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
ON-ROAD TRANSPORTATION	**14**	**13**	**14**	**16**	**17**	**17**	**19**
Passenger Vehicles	7.4	6.5	6.3	6.2	6.5	6.6	7.3
Light-Duty Trucks	5.1	5.1	5.9	7.8	8.5	8.4	9.4
Heavy-Duty Trucks and Vehicles	1.8	1.6	1.7	1.9	1.9	2.0	2.3
Motorcycle	0.04	0.03	0.02	0.1	0.1	0.1	0.1
ELECTRICITY	**6.5**	**7.2**	**8.0**	**8.3**	**9.4**	**10**	**11**
Residential	2.4	2.6	2.7	2.9	3.4	3.6	3.9
Commercial	2.6	2.9	3.6	3.7	4.3	4.7	5.2
Industrial	0.7	0.7	0.8	0.7	0.7	0.7	0.7
Mining	0.1	0.1	0.1	0.1	0.1	0.0	0.0
Agricultural	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TCU	0.6	0.7	0.7	0.7	0.8	0.9	0.9
Street Lighting	0.03	0.04	0.04	0.04	0.05	0.1	0.1
NATURAL GAS END USES	**3.0**	**2.8**	**2.6**	**2.9**	**3.2**	**3.4**	**3.6**
Residential	1.8	1.7	1.8	1.7	1.9	2.0	2.1
Commercial	0.7	0.7	0.5	0.9	1.0	1.1	1.2
Industrial	0.4	0.3	0.2	0.1	0.2	0.2	0.2
Mining	0.04	0.02	0.01	0.03	0.03	0.03	0.03
Agricultural	0.03	0.03	0.02	0.03	0.03	0.03	0.03
OFF-ROAD EQUIPMENT AND VEHICLES	**1.0**	**1.0**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**
Construction and Mining Equipment	0.4	0.5	0.6	0.6	0.7	0.7	0.8
Pleasure Craft	0.1	0.1	0.1	0.2	0.2	0.2	0.3
Industrial Equipment	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture Equipment	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Other	0.2	0.2	0.3	0.3	0.3	0.3	0.4
CIVIL AVIATION	**1**	**1**	**2**	**2**	**2**	**2**	**3**
Interstate	1.0	1.1	1.4	1.7	1.8	1.9	2.1
Intrastate	0.2	0.2	0.2	0.2	0.2	0.2	0.2
WASTE	**0.9**	**1.1**	**0.5**	**0.4**	**0.7**	**0.8**	**0.9**
Landfills	0.3	0.5	0.2	0.2	0.4	0.5	0.6
Wastewater Treatment	0.6	0.6	0.3	0.1	0.2	0.2	0.2
INDUSTRIAL PROCESSES AND PRODUCTS	**0.5**	**0.7**	**1.2**	**1.6**	**2.0**	**2.4**	**2.8**
HFC Refrigerants	0.003	0.3	0.8	1.2	1.6	2.0	2.5
Sulfur Hexafluoride	0.2	0.1	0.1	0.1	0.05	0.03	0.02
Other	0.3	0.2	0.3	0.3	0.3	0.3	0.3
WATER-BORNE NAVIGATION	**0.04**	**0.1**	**0.1**	**0.1**	**0.1**	**0.2**	**0.2**
Ocean Going Vessels (OGV)	0.03	0.0	0.1	0.1	0.1	0.1	0.1
Harbor Craft	0.01	0.01	0.02	0.02	0.03	0.03	0.04
RAIL TRANSPORTATION	**0.2**	**0.2**	**0.3**	**0.3**	**0.3**	**0.4**	**0.4**
OTHER/OTHER FUELS	**1.6**	**1.4**	**1.5**	**1.3**	**1.2**	**1.2**	**1.2**
Manufacturing	0.7	0.5	0.7	0.6	0.7	0.7	0.7
Transport	0.2	0.1	0.04	0.1	0.1	0.1	0.1
Non-Specified	0.04	0.04	0.1	0.1	0.1	0.2	0.2
Residential	0.2	0.1	0.2	0.1	0.1	0.1	0.1
Energy	0.02	0.02	0.02	0.03	0.03	0.03	0.03
Commercial	0.3	0.2	0.2	0.1	0.1	0.05	0.02
Cogeneration Non-Electrical	0.2	0.4	0.4	0.3	n/a	n/a	n/a
AGRICULTURE (LIVESTOCK)	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**	**0.0**
Enteric Fermentation	0.1	0.1	0.05	0.04	0.03	0.02	0.02
Manure	0.1	0.1	0.04	0.03	0.02	0.02	0.01
WILDFIRES	**0.2**	**0.6**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**
Forest	0.03	0.01	0.05	0.03	0.03	0.03	0.03
Woodland	0.01	0.1	0.04	0.02	0.02	0.02	0.02
Chaparral, Scrub, and Grasslands	0.1	0.5	0.1	0.2	0.2	0.2	0.2
DEVELOPMENT (LOSS OF VEGETATION)	**0.1**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
Loss of Farmland	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Loss of Native Vegetation	0.02	0.03	0.2	0.2	0.2	0.2	0.2
SEQUESTRATION FROM LAND COVER	**(0.7)**	**(0.7)**	**(0.7)**	**(0.7)**	**(0.7)**	**(0.7)**	**(0.7)**
Forest	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Woodland Growth	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
Chaparral, Scrub, and Grasslands	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)
TOTAL	**29**	**29**	**31**	**34**	**37**	**39**	**43**

About the Energy Policy Initiatives Center (EPIC)

The Energy Policy Initiatives Center (EPIC) is a nonprofit academic and research center of the University of San Diego School of Law that studies energy policy issues affecting the San Diego region and California. EPIC integrates research and analysis, law school study and public education. The organization also serves as a source of legal and policy expertise and information in the development of sustainable solutions that meet our future energy needs.

For more information, please visit the EPIC Web site at www.sandiego.edu/epic.

About the College of Arts and Sciences

The College of Arts and Sciences is a liberal arts college that is both historically and educationally the core of the University of San Diego. The intellectual disciplines within arts and sciences assist students in developing a coherent, integrated and rich world view. Each intellectual discipline in the college reflects a sense of community by involving students in a network of scholars.

For more information, please visit the college Web site at www.sandiego.edu/as/.

About the Department of Chemistry & Biochemistry

University of San Diego's Department of Chemistry & Biochemistry is a student-centered department offering bachelor's degrees in both chemistry and biochemistry and a research-centered curriculum. The department shares the spacious new Donald P. Shiley Center for Science and Technology with three other science departments. Aspiring to become a national leader in undergraduate education and research, the department recently received a five-year Department Development Award from Research Corporation.

For more information, please visit the department Web site at www.sandiego.edu/chemistry/.

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