CY 2008 CO_2 EMISSION AUDIT AND ANALYSIS OF CARBON FOOTPRINT

REPORT OF THE GREEN SEMINARY INITIATIVE GROUP
SAN FRANCISCO THEOLOGICAL SEMINARY

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CONTRIBUTORS: Douglas Olds, Evans Presley-McGowan, Carol Robb (Faculty Convener)

ABSTRACT

In 2008, San Francisco Theological Seminary (SFTS) emitted 1.6 million kilograms of carbon dioxide gas (CO_2) from its operations, a *footprint* of 436 metric tonnes of solid carbon. SFTS has a large carbon footprint for an ostensibly residential academic institution. Despite having fewer than 100 full time resident students, SFTS carbon footprint is equivalent to 278 San Francisco carbon emitter-residents. This heavy carbon footprint is due in part to substantial transportation emissions in the form of automobile and jet transportation, with staff airline travel imparting a major contribution. Life- and work-style changes in the way the readers of this report travel and heat buildings will go a long way in reducing SFTS's carbon footprint.

This study provides a baseline measurement for SFTS as it moves to join with denominational initiatives and geo-political urgencies to reduce its Greenhouse Gas emissions and carbon footprint. The planning, data collection, analysis and reporting took 110 volunteer hours to accomplish. It is hoped that this report provides a model so that future reports could take less time to perform. In addition to the preliminary general recommendations offered at the conclusion to this report, this report recommends that the Seminary take steps to repeat and refine this exercise at least every three years into the next generation, to measure performance in conservation and mitigation, thereby joining in President Barak Obama's call for the U. S. economy to reduce its carbon emissions by 80% by the year 2050.[1] We believe this is an achievable goal for reduced emissions by SFTS as it prepares for the next generation of church, community, and scholastic leadership.

[1] Schmidt, Gavin and David Archer (2009), "Climate Change: Too Much of a Bad Thing," *Nature 458:* 1117-8. Costanza, Robert (2009), "Could Climate Change Capitalism?" *Nature 458:* 1107-8.

INTRODUCTION: THE *WHY*

A. Denominational Background

Resolution paragraph h), Item 09-10 ratified by the 218th (2008) General Assembly:

> *Urges Presbyterian-related seminaries and conference centers to make environmental education on global climate change and energy a part of their curricula; to take measures to reduce energy consumption; and to encourage holistic thinking about the relationships between technology and nature.*[2]

Since at least 1981, the precursor denominations to PC(USA) have endorsed creation care and environmental stewardship as a primary church goal, and since at least 1993[3] the PC(USA) has signaled alarm regarding global climate change under the influence of industrial-emitted carbon dioxide (CO_2) and other greenhouse gases:

> *The 215th General Assembly (2003) calls on the United States government to join the world effort to reduce greenhouse gas emissions and to develop and enact a national emergency response, underwritten by law, with adequate financial support, and economic enforcement mechanism, to be fully functioning by 2005, with targeted reductions by that time. The 217th General Assembly (2006 [Item 09-22]) asked that the church ask its members to make a bold witness by aspiring to carbon neutral lives.*[4] *It was noted that "without significant changes in public policy and corporate behavior to complement actions of personal discipleship, massive and irreversible climate changes will only accelerate over the next century.*[5]

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[2] *MINUTES*, 218th GENERAL ASSEMBLY, 2008 PART I: JOURNAL, p. 935 accessed 6/23/09 at http://www.pcusa.org/ogaresources/journal2008.pdf

[3] *Minutes*, 2003, Part I, p. 617 (cited in ibid., pp. 934-57):

> *1993 The 205th General Assembly (1993) reaffirms the "Call to Restore the Creation," receives the document "World Scientists' Warning to Humanity" as a prophetic word to the church, urges President Clinton to follow new policies from the Earth Summit, and directs the Social Justice and Peacemaking Unit to advocate for policies that will reduce carbon dioxide emissions (Minutes, 1993, Part I, pp. 896−97).*
> *1998 The 210th General Assembly (1998) calls upon the United States to ratify the protocol negotiated in Kyoto and urges Presbyterian Church (U.S.A.) congregations and institutions to pursue energy efficiency and conservation in their buildings and property.*
> *1999 The 211th General Assembly (1999) again calls upon the U.S. to ratify the Kyoto Protocol; urges the United States to go beyond Kyoto targets for carbon dioxide emission reductions; directs the Presbyterian Center in Louisville and all other properties of the General Assembly to minimize fossil fuel energy (along with urging local congregations to do the same); and directs the General Assembly to promote education regarding global warming and other environmental concerns* (*Minutes*, 1999, Part I, pp. 669–70).

[4] *Minutes*, 2006, Part I, pp. 896–97.

[5] PC(USA) Memorandum; Advisory Committee on Social Witness Policy, December 4, 2006 accessed on 6/23/09 at http://www.pcusa.org/gac/business/april08/actions/b107.pdf

At the 218th General Assembly in San Jose, the *2006 Referral: Item 09-22. Commissioners' Resolution. On Calling All Presbyterians to Take Positive and Immediate Steps to Live Carbon Neutral Lives*[6] was answered by Item 09-10 of the Advisory Committee on Social Witness Policy, "The Power to Change: U.S. Energy Policy and Global Warming," and ratified by the General Assembly. This document reaffirmed the previous statements of General Assemblies, even going beyond it to affirm a covenant life of carbon neutrality to be a form of "practical discipleship."

B. Seminary Background

On April 23, 2008 a group of seminary students and professors met to discuss possible ways San Francisco Theological Seminary might become more environmentally sustainable. The following week, on April 30, Professors Charles Marks and Carol Robb convened a group[7] joined by Rev. Renee Rico, coordinator of Presbyterians for Restoring Creation. At that meeting, Rev. Rico noted that the PC(USA) denomination was calling its members and institutions to move toward carbon neutrality, defined as reducing CO_2 emissions and purchasing carbon offsets for ongoing emissions. At this meeting of the "Green Seminary Initiative Group" [GSIG], a consensus quickly developed that it would be beneficial for SFTS to determine its Carbon Footprint for purposes of establishing its baseline and with the intention toward moving to cohere with denominational policy--reducing CO_2 emissions over time and moving toward carbon neutrality.

On May 14, 2008 Heather Weidemann, Charles Marks, and Carol Robb presented a resolution to the Faculty from the Student Association Council and Community Life Committee.[8] The resolution noted the calls of the 217th and 218th General Assemblies for seminaries to witness to carbon neutral living and educating environmentally and holistically in the context of technological changes. In addition, the resolution noted that the SFTS strategic plan calls for "effectively manag[ing] maintenance and usage of facilities in San Anselmo and Southern California."

SFTS Seminarian Douglas Olds, then intern at First Presbyterian Church, San Anselmo (FPCSA), volunteered to carry out a pilot project measuring FPCA's Carbon Footprint for Calendar Year (CY) 2007. Deriving methods from Doug's academic training in Environmental Science, Policy, and Economics,[9] this analysis was completed at the beginning of August, 2008 and was delivered to FPCSA's session that month. After the conclusion of this study in September 2008, Doug informally proposed to Profs. Robb and Marks that CY 2008 would be an appropriate data set on which to perform a CO_2 emission audit of SFTS operations, a study to begin as soon after January 1, 2009 as practical. In the spring of 2009, a team of students worked with Carol Robb to collect data and formulate a report.

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[6] *Minutes,* 2006, Part I, pp. 50, 52, 895–98. Quoted at http://www.pcusa.org/ogaresources/journal2008.pdf (page 91). Accessed on 6/23/09.

[7] Also in attendance: seminarians Heather Weidemann, Douglas Olds; and Dani Holland, SFTS alumna and Elder, First Presbyterian Church, San Anselmo.

[8] *Resolution to Calculate the Carbon Footprint Of San Francisco Theological Seminary* presented to and passed by SFTS Faculty on May 14, 2008.

[9] Bachelor of Science (Biology), University of Michigan, 1980. Master of Public Policy (Environmental Policy), University of Maryland 1994. Candidate for Ph.D. in Ecological Economics, University of Maryland, 1997.

AUDIT METHODS AND RESULTS: THE *HOW* AND *WHAT*

The measurement of a carbon footprint encompasses three primary tasks: the quantification of direct emissions in the form of utilities, quantification of transportation emissions, and the assignment of indirect emissions in the form of purchased material products and outside services.

A. UTILITIES

The first task is to assemble all utilities records and convert the energy usage listed thereon into emissions of carbon dioxide (CO_2). These records are delivered monthly on the energy provider's receipts. In this case, the energy provider for SFTS was Pacific Gas and Electric. PG&E's business office facilitated this task by providing copies of the full year's receipts collated by "Service ID," the identification number for each building's energy meter. From these records, 12 months of receipts were summed on a spreadsheet in units of therms (natural gas use) and kilowatt-hours (kWh--for electricity use) and then converted into CO_2 emitted. The conversion factor for natural gas is therms multiplied by 0.1054804 gigajoules/therm times 51.56 kg CO_2 emitted per gigajoule.[10] In 2008, SFTS used 69,633 therms which convert by multiplication to 378,867 kg CO_2.

673,288 kWh of electricity was consumed by SFTS operations in 2008. Because the mix of fuel types for electricity is complicated by the sources of renewable and hydrocarbon facilities at PG&E, this report used the calculator PG&E provides for converting kWh into CO_2 emitted.[11] The calculator gives its results in average monthly pounds of CO_2 emitted, and that figure is multiplied by 12 (months) and divided by 2.2 (pounds/kg) to equal 160,364 kgs of CO_2 emitted from electricity use by SFTS in 2008.

Water use is a minor source of CO_2 emissions. Marin Municipal Water District, SFTS's water provider, provides upon request a spreadsheet of all the accounts and buildings to which water is delivered. This spreadsheet details water use in units of CCF's (centum cubic feet) of water. At Doug's request on July 23, 2008, the Marin Water District calculated the carbon footprint of water production at its facilities as 1.8 pounds CO_2 emitted per CCF. Converting to kilograms, 10,179 CCF of total water delivered to SFTS in 2008 emitted 8328 kgs CO_2.

B. **TRANSPORTATION**

The second task for measuring CO_2 emitted is to quantify vectors of transportation by surveying airline and ground transportation distances traveled during the year. Airline segments were determined from two sources: the requests for reimbursements by SFTS staff for airline flights generated back-up credit card receipts obtained from the billing office. These receipts listed airline travel by airport

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[10]S.Y. Yokoyama and K. Tahara, "A Study of Carbon Dioxide Mitigation Effect by Biomass Energy Plantation for Electricity and Methanol." In A. V. Bridgwater (ed.), *Progress in Thermochemical Biomass Conversion* (London: Wiley-Blackwell, 2001) pp. 420-5 (421). K. Tahara et al., "Lifecycle Assessment of Biomass Power Generation with Sustainable Forestry System." In Baldur Eliasson, Pierce Riemer, and Alexander Wokaun (eds.), *Greenhouse Gas Control Technologies: International Conference on Greenhouse Gas Control Technologies 1998* (Pergamon Press, 1999) pp. 1183-6 (1184).

[11] http://www.pge.com/mybusiness/environment/calculator/

itineraries for each staff-requested reimbursement. Each staff flight itinerary was quantified in terms of miles flown by feeding the itinerary into a search engine.[12] Approximately 335 itineraries (that varied as to the number of legs involved depending on the specific sites visited) generated 335,746 miles of staff travel in 2008.

The second source for airline travel segments came from the records of the home origins of participants in Trustees meetings and in the Doctor of Ministry (DMin) and Diploma in the Art of Spiritual Direction (DASD) programs. Those DASD or DMin participants who lived in campus housing and who came from outside the states of California, Oregon, Nevada, or Washington were assumed to have flown from the places given by their home address. Because of the number of DMins from far-flung world regions, 25 round trips to SFO generated 179,396 flight miles.

The same exercise was applied to participants in the January DASD program, and to Trustees who attended its meetings in 2008. From these classes of airline travel for the operations of SFTS in 2008, 633,664 flight miles were logged. 1.4455 lbs CO_2 equivalent/passenger mile was derived from the weighted average of conversion factors published by the Environmental Defense Fund and the Climate Neutral Network.[13] The figure for airline travel was thus weighted 70% domestic (@1.165) and 30% international (@2.1), roughly the proportions of staff and DMin travel[14] derived from this exercise.[15] Airline travel involved in 2008 SFTS operations thus is estimated to have generated 416,000 kgs CO_2.

The second vector for transportation is ground transportation. This vector includes staff and student commuting, ground transportation at airline destinations and commuting to originating airports, longer-distance automobile travel by staff renting cars at airports for business travel, and for DMin and DASD students coming to San Anselmo for specialized programs. In each case, assumptions had to be made regarding auto fuel economy and frequency of commuting.

Staff and students who live off-campus were surveyed by their home addresses in "Many Faces," the campus directory. Those whose addresses were unlisted were contacted by email. Some did not

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[12] http://webflyer.com/travel/milemarker/

[13] The Bonneville Environmental Foundation and the Climate Neutral Network have agreed that the appropriate approach is to double the 0.63 lbs. of CO_2, with a result of 1.26 lbs. of total CO_2 equivalent per passenger mile (CO_2 + non-CO_2 greenhouse gasses).

Burning a gallon of jet fuel produces 21.1 lbs of CO_2 (U.S. Department of Energy and the Energy Information Administration, Instructions for Form EIA 1605B, Voluntary Reporting of Greenhouse Gas Emissions, Appendix B).

The result is that each domestic passenger-mile creates about half a pound of CO2 and each international passenger-mile creates one pound of CO2.

However, the Climate Neutral Network estimates that non-CO2 greenhouse gas emissions from air travel are at least as significant as the CO2 impacts (doubling the emissions as expressed in CO2-equivalents) and upstream processes add an additional 8 percent, bringing the total to 1.1 lbs. of CO2-equivalent emissions per passenger-mile traveled domestically and 2.1 pounds of CO2-equivalent emissions per passenger-mile internationally.

--http://www.fightglobalwarming.com/content.cfm?contentid=5043 accessed June 2008.

[14] Reflecting that a minor portion of staff airline travel was international and similarly minor portion of DMin airline travel was domestic.

[15] 1.4455 pounds CO_2 emitted per mile flown is the weighted average that results.

respond, and an educated guess as to commuting miles and frequency was applied to those cases. Part-year employees were determined from information supplied by the personnel department, and the standard full-year staff employee was assumed to have taken three weeks' vacation, 13 paid holidays, and four sick days, generating the maximum staff commuting frequency of 228 days/year. The GSIG deliberated about each student who lived off campus to estimate on a case-by-case basis their yearly frequency of commuting in 2008, to their best knowledge correcting for (part-year) internships and class schedules. No attempt was made to discriminate commuting to the GTU campus other than by the SFTS shuttle vans (see below). DMins and DASD program participants who lived outside the region but did not reside on-campus were assumed to have traveled to their home address on weekends if they lived in CA, NV, or OR, while local DMin and DASD students were assumed to commute daily for the duration of their programs.

Once each party was given a frequency of commuting (which could be zero for those who had San Anselmo addresses, including most academic staff and residents of campus housing), their commuting distance was calculated using an online mapping site to find their most probable route.[16] This distance was doubled for roundtrips and divided by a selected fuel efficiency for their automobiles in the case they could be estimated. The default fuel efficiency applied to unknown vehicles was 24 mpg for local commuting and 26 mpg for long-distance commuting. From this method, it was estimated that M.Div student commuting consumed 7623 gallons of gasoline in 2008, DMins 2507, DASD 1625, Trustees 546, and Staff commuting 9352.

Added to these figures were assumptions regarding staff and student travel to and from airports. All student travel to and from airports were assumed to be on shuttle buses, as were all staff travel at peripheral sites not marked by rental car receipts on reimbursement requests. Thus for staff travel, it was assumed that staff took their own cars to SFO or OAK (or to one of the regional Los Angeles airports if based in Southern California) with a round trip of 40 miles per trip. If it was assumed that a shuttle was used, 1/10 of a shuttle trip @ 8mpg for shuttle bus for 40 miles round trip was calculated. 135 shuttle trips were quantified by this exercise.[17] At the same time, in 2008 staff originated 215 business trips, and these were sometimes accompanied with a rental car at the destination site. For these rental cars, an approximation of 100 miles of business travel was assumed.

Added to these trips, then, the actual number of gallons of gasoline for the SFTS vans and SFTS automobiles servicing sites at the Graduate Theological Union in Berkeley were determined accurately from the receipts for Shell Oil Corporation at which the vans' tanks were filled. In addition, the maintenance trucks' fuel consumption was determined by receipts from Lucky Service Station. From all these sources of gasoline consumption (seminary vehicles and stakeholder travel and commuting), it was estimated that 27,290 gallons of gasoline was consumed during SFTS operations in 2008. The conversion factor for CO_2 emitted is 19.64 pounds CO_2 per gallon of gasoline consumed, divided by 2.2 kg/pound. Thus, 27291 gallons of gasoline summed from all sources emitted 243,268 kgs CO_2.

[16] Mapquest.com and Google maps were used.
[17] 25 shuttle roundtrips estimated by DMin students, 22 by DASD program participants, and 33 by Trustees.

C. **INDIRECT EMISSIONS**

The third source of CO_2 emissions for an academic institution is the indirect emissions embedded in the acquisition of goods and offsite services. The supply chain for cement and chemicals, furniture and equipment, for example, emits CO_2, so that a given level of material consumption correlates with Greenhouse Gases emitted during production. Outside services in the form of contractors also bring their own carbon footprint that is proportionate to their contracted work at the institution. Some portion of CO_2 emitted, then, of each product or outside service that enters the institution's plant is attributable to that institution. Another way of saying this is that CO_2 emitted by material consumption is demand-driven and thus ought to be attributed in part to the purchasing institution. The question is how to attribute the embedded emissions to the institution when it has access to no data regarding the production processes of contractors and material providers. In this case, it was felt that a "top down" study of economies of production may be applied to the scale of overall material consumption of the institution.

The only source the Reporting Team found that measures indirect emissions by an academic institution comes from a Scoping Study of the British economy.[18] This "top down" study of the British economy allocated the material consumption of its economy by sector, specifically the academic sector. The Scoping Study related the academic sector's share of emissions to the total emissions of the broader economies of products and services. Indirect emissions of British academic institutions thus were determined to result from the production and application of chemicals (including paints) (5%), furniture (5%), paper (4%), other manufactured products (14%), mining and quarrying (2%) and other products and services (3%). It seems reasonable to the producers of this report to apply these proportions to SFTS operations, proportions applied to a baseline of the total direct emissions (utilities and transportation) save jet fuel, for which SFTS is an outlier and unrepresentative of the British sample of academic institutions. In this case, then, 10.3% is applied to manufactured products, 3.6% each to chemicals and furniture, 3% for paper, 1.5% for mining and quarrying, and 2.2% for other products and services (see Chart 1).

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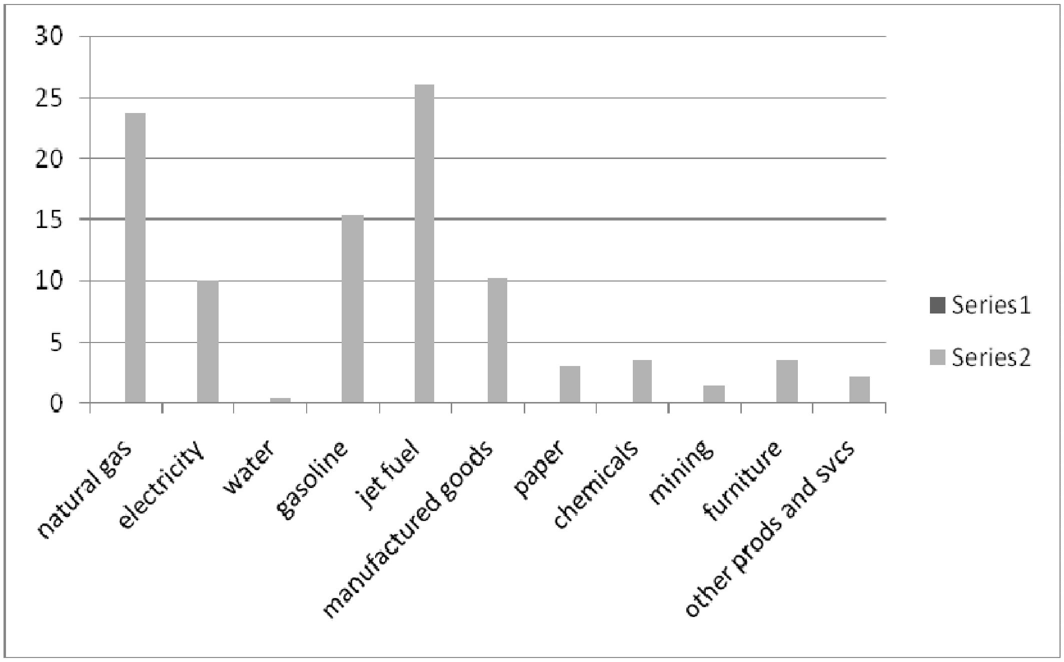
[18] UK Schools Carbon Footprint Scoping Study (2006) accessed on 7/18/08 and again on 6/17/09 at http://www.isa-research.co.uk/docs/ISA-UK_Report_07-01_carbon_footprint.pdf

CHART 1: **Proportion of 2008 SFTS CO_2 emissions by source** (in **%**)



natural gas %	23.7
electricity	10.0
water	0.5
gasoline	15.3
jet fuel	26.1
manufactured goods	10.3
paper	3.1
chemicals	3.6
mining	1.5
furniture	3.6
other products and services	2.2

Sum (due to rounding) **99.9%**

FURTHER FINDINGS

Some further points arise from the energy use audit portion of this study.

Conservative reporting: Regarding the precision of this report, it should be noted that the bias of this report has been to be conservative when estimating. Not only this, there were numerous sources of energy use that were not counted or undercounted in the course of this study. Travel by M. Div. students to and from their place of internships (some as far away as South Korea) went undetermined despite their being part of SFTS requirements and in some cases part of its internal operations. D. Min. and DASD student travel may have undercounted car use by those students. No measurement of faculty and student travel in their private cars to GTU was measured, but their use of seminary vehicles to travel to Berkeley was included. In addition, transportation to and from the various seminars and colloquia organized at and by SFTS that involved in-traveling specialists, lecturers and attendees went unmeasured.

Heating Incentives: Based on historical data collected in nearby Kentfield, California from 1902-2008,[19] CY 2008 was historically mild: 2567 heating degree days (requiring heaters, boilers, and furnaces to operate 13.3% less than an average year) while CY 2007 was significantly cooler (34% more heating degree days[20]) in the state of California compared with CY 2008. Yet SFTS consumed 2% more Natural Gas in CY 2008 than in CY 2007. **This phenomenon suggests that there may be perverse incentives in the heating of institutional buildings, supporting anecdotal reports that student residences, being unmetered, are kept unusually warm during the seasons that the boilers are running.** We conclude that because students have not directly paid the cost of heating, they lack the financial incentive to conserve energy. During the same period, electricity consumption (and thus the associated CO_2 emitted) went up even more, by 3.7%. The mechanisms for promoting and measuring energy conservation are not yet evident in the various SFTS buildings.

Surprises of this study: Items that our team did not anticipate as it embarked on this study included that 28% of the total airline transportation emissions resulted from the DMin program, and that the intentional *residential* seminary model of SFTS generated such a high proportion of emissions from automobile and airline *transport* considered together, 41.4%.

ANALYSIS AND IMPLICATIONS

1.6M kgs of CO_2 measured by the above study to be emitted by SFTS in 2008 is equal to <u>436 metric tonnes of carbon</u>.[21] This is the <u>carbon footprint</u> of the institution, equivalent to the footprints of 278 San Francisco residents.[22] 75.6% of these emissions were measured directly by this report from the records and receipts of the institution and constitute the direct emissions from operations—utilities and fuel for

[19] http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4500 accessed on 6/23/09.
[20] http://www.ncdc.noaa.gov/oa/documentlibrary/hcs/hdd.200707-200812.pdf accessed on 6/23/09.
[21] The molecular weight of CO_2 is 44, and that of elemental carbon is 12, so that the weight of emitted carbon dioxide is proportional to its carbon content by the factor of 44/12.
[22] *Per capita* footprint for San Francisco residents is 1.565 metric tonnes of carbon. -- http://www.brookings.edu/reports/2008/~/media/Files/rc/papers/2008/05_carbon_footprint_sarzynski/tables.pdf accessed in June, 2008.

transportation. An estimated 24.4% of CO_2 emissions resulted from indirect processes: emissions embedded in the supply structure and material stocks of purchased goods and contracted services that are produced or originate offsite. This 24.4% figure was derived from top-down application of an economic study of the academic sector and thus is a "pro forma" addition to the bottom-up data derived from travel records, commuting frequencies, and utilities receipts.

The amount of CO_2 gas emitted would fill approximately 1400 single-person hot air balloons.[23] 436 tonnes of elemental carbon in the form of charcoal would fill approximately 7-1/3 boxcars--or a silo with a radius of 20 feet (as in Montgomery Chapel) to the depth of 35 feet. This carbon footprint would thus be almost two "chapel-fuls" of waste carbon that would need to be buried if it could be precipitated from the atmosphere after atmospheric-carbon abatement technology becomes available.

At the midpoint of the current available mitigation "offsets" currently priced by various environmental groups ($30-$100/tonne), **the social cost to the global commons of SFTS operations from CO_2 emissions not captured by the market is $65 times 436, or $28,340.** Abatement and mitigation technologies become an issue when discussing moving toward carbon neutrality. It might be argued that the costs of offsetting climate change may be borne at lower cost in the future as technology becomes available to precipitate solid carbon from atmospheric Greenhouse gases. Alternatively, other technologies can be presumed to move human families and institutions toward carbon neutrality as a developmental ("secular") process of technological change. However, the best estimates of the costs of abatement technologies[24] have been detailed in a recent issue of the journal *Nature,*[25] technologies theorized to cost greatly in excess of the $30-100 range of "offset" technologies currently available.[26]

It thus seems prudent that developed nations and its structures move toward, at a minimum, the 80% reduction in Greenhouse gas emissions by 2050 per the climatological modeling of Schmidt and Archer (2009). Even by their scenario of industrialized nations following this path to reduction, allowing in the meanwhile for industrial "catch up" by developing nations, the probability of maintaining global temperature increase from Greenhouse gases in the atmosphere to less than 2 degrees Centigrade would be marginally less than 50%. The lower end of expected warming—beyond 0.8^{o}C already measured--is expected to have a major impact:

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[23] Taking into account that one mole of CO_2 weighs 44 grams and the volume of an ideal gas at standard temperature and pressure is 22.414 liters/mole. The volume of a single air hot air "cloudhopper" balloon is 595 cubic meters. --http://en.wikipedia.org/wiki/Hopper_balloon accessed in July 2008.

[24] Large scale geo-engineering projects to "whiten clouds" or precipitate solid carbon from the atmosphere are the two most widely discussed abatement offsets. Morton, Oliver (2009), "Great White Hope," *Nature 458:* 1097-1100. Jones, Nicola (2009), "Sucking it Up," *Nature 458:* 1094-7.

[25] Editors (2009), "[Editorial:] Time to Act," *Nature 458:* 1077-8. Monastersky, Richard (2009), "A Burden Beyond Bearing," *Nature 458:* 1091-4. Parry, Martin, Jason Lowe and Clair Hanson, "Overshoot, Adapt, and Recover." *Nature 458:* 1102-3. Schneider, Stephen (2009), "The Worst-Case Scenario," *Nature 458:* 1104-5.

[26]Jones (2009): Low-carbon energy sources and forestry and agricultural management could neutralize 2007's worldwide level of CO_2 emissions (9 Gigatonnes) for a cost of about $300/tonne, while advances in CO_2 gas extraction technology from industrial flue stacks may cost between $70-260/tonne.

> We must note that there is nothing special about 2^{o} C [rise in global temperature--a further rise of about 1.2^{o} C from today] that would make warming of less than this magnitude 'safe.'…[T]he earth would probably be warmer than it had been in millions of years, a huge change. (Ibid, 1117).

Schmidt and Archer note that the climatological models are complicated by feedback and geospheric sensitivity, so "that any temperature-based target will become progressively harder to maintain as slower feedbacks kick in" (Ibid, 1118).[27] Time is of the essence, so that an argument from prudence would indicate that institutions move rapidly to make the grosser and less technologically-complicated cuts in Greenhouse gas emissions at once, and then cohere with the resulting less than 80% trend line of reductions in future years.

The potential for mitigating global greenhouse gas emissions differs by economic sector.[28] **At the current range of $30-100 cost per tonne for "offsetting" current emissions, transportation has the least potential for technological abatement and mitigation.** That is, there are few current technologies in this economic range of costs. **Taking SFTS emissions from jet fuel and gasoline together, transport is its largest source of emissions and thus would be best addressed at the current time by conservation measures (limits)** rather than purchases of offsets or investment in technology.

On the other hand, buildings have large potentials for payoffs in emission mitigation by investment. At the $30-100 range of "offset" mitigation costs, numerous technologies exist today in the investment in energy efficiency, building design and reflective surfaces.

Macroeconomic substitutions of high carbon to low carbon emitting energy sources (e.g. eschewing coal, "oil shale" and "oil/tar sands" sources in favor of renewable sources of energy) have the potential to make an impact on every institutional and individual emitting source of CO_2. From inspection of IPCC 2007, **it appears that SFTS at present can presume that macroeconomic policy changes in the energy sector might mitigate about 40% of its current carbon footprint over time**.[29] This 40% will possibly come at a higher expense for the receipt of utilities services (gas, electric, and water) under the various "cap and reduce" economic schemes, with expenses likely higher in later years during the 40 year timeline up to 2050. Accordingly, SFTS, should it move toward institutional compliance with President Obama's goal of 80% reduction in Greenhouse gas emissions, needs to reduce the balance of 40% of carbon footprint emissions from the baseline amount being measured in this report.

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[27] See also Monastersky (2009, 1092) regarding "tipping points" from such examples as methane release from melting permafrost and change in weather patterns from melting arctic ice sheets. Monastersky also notes that abatement technologies that remove CO_2 from the atmosphere may not be able bring global temperature back down once CO_2 has stabilized or even begins to marginally decline in the improbable case that humans instantaneously ceased Greenhouse Gas emissions.

[28] IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, esp. Figure 6, p. 11.

[29] IPCC 2007, Figure 6: average potential at average cost presented for the Energy supply sector is 3.6 Gigatonnes CO_2-equivalents per year versus current world wide emissions of 9 Gigatonnes per year.

RECOMMENDATIONS

As noted in the Introduction, the 218th General Assembly approved Item 09-10 that included the following recommendations for Seminaries and Presbyterian Institutions:[30]

3. With regard to the councils, [governing bodies,] and agencies of the Presbyterian Church (U.S.A.), the 218th General Assembly (2008):

> *a. Urges synods and presbyteries to become models of energy-efficient institutions and proponents of renewable energy by*
>
> > *(5) adopting environmental education and energy conservation as high priorities at all Presbyterian camps and conference centers.*

A. Conservation. In light of the 22% cut of the expense budget of SFTS in 2009 in response to "Plan A," it seems reasonable and prudent to make the same cut in CO_2 emissions by simple conservation measures, targeting the gross emissions of heating, jet and automobile travel, and equipment purchases. Because heating emissions from Natural Gas (NG) may be more difficult to achieve an immediate 22% reduction, the other classes of emissions set for conservation cuts may initially require greater than 22% reductions.

   a. Conservation, for economic and technological reasons given in the prior section, seems most called for in the transportation sector**. Can airline travel be cut substantially** because of its very high greenhouse warming potentials? For example, a 50% cut in airline travel by the institutional staff would result in about a 6.8% reduction in total emissions of the institution.
   b. In addition, the highest source of indirect emissions is equipment. Moving toward **extending the serviceable life of business equipment** from 3- to 5-year property or from 5- to 7-year property would reduce indirect emissions from 10.3% to 7.4% of total SFTS carbon emissions.
   c. Encouraging seminary personnel to **turn down their thermostat in the winter and put on an extra layer of clothing** when indoors in offices and buildings including publicly-used ones such as Montgomery and Scott Hall, and Stuart and Montgomery Chapel.

B. Invest in global commons by investing in mitigating technologies for SFTS operations. As the non-captured social cost of carbon emissions at current rates is on the order of $28,000 (see above), it is recommended **that SFTS, in lieu of "purchasing carbon offsets," undertake internal investment in energy efficiency**. As the seminary cuts down its 436-tonne footprint, it may in coming years be obligated to less "offset" expense for investment. After the 10% cut in Recommendation A is added to macroeconomic expectations of 40% reduction in energy sector emissions over 40 years as described in the prior section, this leaves SFTS on course to join in the move toward Carbon neutrality by increasing its energy efficiency or decreasing its emissions by 30% over the next 40 years. This would require *0.89% reduction* in all sources of carbon emissions *per year* over this time frame. This investment would pay dividends in the form of reduced utility costs and commit SFTS to a path of radical reduction in its carbon footprint. $28,000 "offset investment" is 0.4% an

[30] MINUTES 218th GENERAL ASSEMBLY 2008 PART I: JOURNAL, pp. 933-5.

institutional budget of $7M after "Plan A" reductions take effect; the rate of return on investments of energy efficiency could be significant.

g. Urges presidents of Presbyterian-related colleges and universities to consider becoming a signatory of the American College and University Presidents Climate Commitment, which obligates these schools to become carbon neutral in the future and to integrate sustainability into the curriculum.

C. Commitment to emission audits on a three-year timeline. The preparation of this audit and study took the GSIG team about 110 person-hours covering 2 years of data. Thus it is recommended that a portion of the investment that the seminary commits to reducing its carbon footprint be dedicated to measuring it every three years at a cost of $3000. This would break down into 60 hours (@$10) for data collection and data entry; 30 hours (@$50) for project planning and data analysis; and 25 hours(@$40) for research and report writing

  a. on the current state of the field in carbon mitigating and abatement technologies,
  b. contextualizing the data analysis for SFTS decision makers and curriculum planners
  c. that keeps the seminary on course to its commitment to reducing its footprint,
  d. mitigating or abating its residual footprint as reputable sources for purchasing technological and natural offsets become available.

D. Education and cultural change. SFTS is located in a warm climate, and its winters are mild. Educating building residents as to the magnitude of their heating and lighting decisions on climatological warming might spur cultural changes in clothing and heating conservation. Other cultural changes that SFTS could pioneer from its innovating residential seminary model is **the design of new facilities to take into account shared high efficiency appliances and shared material goods and equipment in housing**. Trinity House may be a carbon-mitigating model of residential interactivity (though perhaps not in design) in the sharing of appliances, furniture, tools, technological equipment that can spur ideas regarding residential family sharing (rather than universal individual consumption and purchase) of high efficiency freezers, shared lawn and garden equipment, car or van pooling for the purchases of staples, etc.

h. Urges Presbyterian-related seminaries and conference centers to make environmental education on global climate change and energy a part of their curricula; to take measures to reduce energy consumption; and to encourage holistic thinking about the relationships between technology and nature.

E. Leadership, partnership and innovation. In light of item D, above, it is **recommended that this report be shared and contextualized with the full community of SFTS stakeholders for producing ideas** how SFTS may lead its program toward carbon neutrality while saving money—perhaps even serving as a pilot or leadership model for seminaries nationwide.

F. Rethinking scholastic interactivity and residence. While affirming the value of bioregionalism--maintaining the core value of a critical approach to home culture as in need of evangelization--we also recognize a possible danger of parochialism. To maintain the core

SFTS value of international and intercultural diversity and awareness, we propose that **intercultural engagement requirements, when budgeted, include the cost of carbon offsets**.

LEAD AUTHOR'S COMMENTARY: USING REFORMED PIETY TO TEACH US TO BE MORE RESPONSIBLE FOR CREATION AND THE ENVIRONMENT

The 218th General Assembly approved Item 09-10 that concluded with the following normative statement:[31]

4. Concerning the church's social responsibility regarding U.S. energy policy, the 218th General Assembly (2008):

a. Endorses and approves the following principles and stances that will guide our church's advocacy work regarding policy discussions and legislative proposals to revise energy policy in the context of global climate change:

> *With our Lord, we will stand with "the least of these" (Matt. 25:40) and advocate for the poor and oppressed in present and future generations who are often the victims of environmental injustice and who are least able to mitigate the impact of global warming that will fall disproportionately upon them. As citizens of the United States, which has historically produced more greenhouse gases than any other country, and which is currently responsible for over a fifth of the world's annual emissions, we implore our nation to accept its moral responsibility to address global warming.*

As we humans conceive of them, our self-centered obligations are narrow and often blind us to more encompassing social relationships and social responsibilities. We prioritize moral claims out of special connections—family, friends, confederates and colleagues that share our ideological and utopian ideas of the short-term. The other, the stranger, the unborn usually are thought to deserve what is left over.[32] However, our actions and social choices including the pollution of the global atmospheric commons, makes the range of persons (and animals) vulnerable much greater than markets can reduce by private discount rates and price mechanisms[33] based on promises, vows, and contracts.

The economics and science of mitigating and abating carbon emissions into the global atmosphere is complex and after twenty years of alarms regarding global warming, little has been accomplished to bring a market-based solution to the problem. The usual response—invest for the short term to build wealth that later can be applied to better technologies in the future—is problematic when the investments that could have been made with current technologies and current wealth have *not* been made. Our society continues to lack the systemic framework to recognize the intergenerational and inter-species networks of obligations and moral claims. The goal of caring for creation, as Presbyterians assert, thus

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[31] Ibid, p. 935.

[32] Robert E. Goodin, *Protecting the Vulnerable: A Re-Analysis of our Social Responsibilities* (Chicago: University of Chicago Press), 1986.

[33] Herman E. Daly and John B. Cobb, Jr. *For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future,* 2nd ed. (Boston: Beacon Press), 1994.

necessitates the church to move voluntarily to reduce future harms and vulnerabilities, even in the presence of our specific commitments to neighbor.

Again, there are no economic principles which can release us from balancing these specific and future commitments—from the neighbor here and now and for the other of a notional future. Christianity, then, must *sing to the Lord a new song*—looking to its foundations in Christian ethical virtue. Two virtues seem especially relevant: the virtue of patience and the virtue of asceticism. These virtues *praise God in a sacrifice of thanksgiving*,[34] moving us to delay immediate sensual gratification in material consumption (economic "hedonics") as a sacrifice for the benefit of others in thanksgiving for our own surfeit and blessings, thereby including others who are not part of our self-oriented moral networks.

Ethical deliberation on sacrifice outside of the realm of economic solutions seems best suited to the Church and lays the task for Christian responsibility for global warming at the foot of believers to forgo consumption voluntarily—to conserve the atmospheric commons by cutting back on global carbon emissions sooner rather than later. Church agencies and Christians themselves, then, cannot wait on governments to set up policies, facilities, and mechanisms to suitably price and cap emissions but must take the initiative now to conserve and to invest responsibly to reduce their carbon footprints. In this way, creation may continue to sing God's praise in the quickened voices of nature and future generations of humanity.

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[34] *Heidelberg Catechism* 43. –PC(USA) Book of Confessions 4.043.