The Transportation Climate Initiative Consortium Must Achieve Zero Greenhouse Gas Emissions by 2050

Comments on the TCI Draft Framework, by G. M. Gross

The world's climate clock is ticking toward an unstoppable global catastrophe and there is a real risk of humankind's extinction occurring within our children's lifetime. To help bring into focus the veracity of this claimed threat and the scale of societal action required to parry it, please examine Illustration 1. This graph has been copied from the United Nation's *Intergovernmental Panel on Climate Change* (IPCC) *Special Report 15 Summary for Policy Makers* [[1]]. It has been annotated with two call outs: "*You are here*" and "*Zero GHG emissions*".

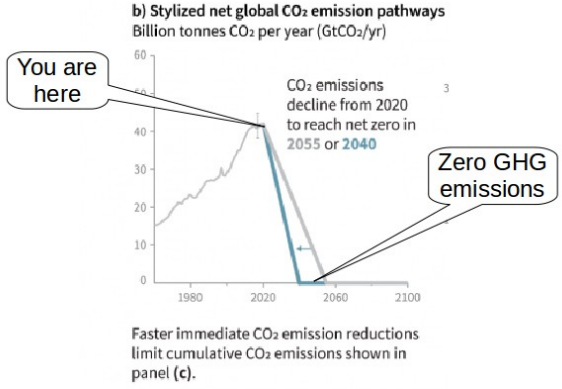

Illustration 1: IPCC Special Report 15: path to zero GHG emissions

Illustration 1 presents two critical facts. First, it shows the relentless historic global GHG emissions trend climbing upward, expressed in the Y-axis as Gigatons of annual CO2e emissions per year. As of year 2017, mankind has been emitting approximately 40 CO2e Gigatons per year. Second, the graph shows the global rate of 4% to 5% GHG emissions reductions per year that the IPCC urges all policy makers to achieve in their respective jurisdictions every year for the next 20 to 35 years. It is the consensus view of the IPCC that by year 2055, all national jurisdictions must have achieved zero GHG emissions to avert tipping our planet past 1.5 degrees Celsius of global warming. This is a far more stringent goal than those set in 2015 by the United Nation's Paris climate accord.

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1 IPCC, 2018: *Summary for Policymakers. In: Global Warming of 1.5°C*. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp, ISBN 978-92-9169-151-7

The TCI Consortium now faces a fundamental design decision: will you obey the mandates placed upon you by the immutable natural laws of climate physics? or will you instead abide by the man-made laws of economics and the unwritten laws of political risk minimization?

As a moral imperative, the TCI Consortium must embrace the IPCC Special Report 15 guidance as its guiding principle. Stated simply:

➔ **Without exception, every year the TCI Consortium must achieve a 4% to 5% reduction in the participating region's transportation GHG emissions until they realize zero GHG emissions.**

Do not under estimate the moral responsibility that you carry or deceive yourself that our society can simultaneously obey both nature's laws and mankind's artificial laws promoting profit and unchecked growth. We have reached the point in the fight against GHG emissions where we either embark on dramatic unprecedented societal change or we will fail as a species. Ultimately, the TCI Consortium participating States should embrace zero GHG emissions across all facets of our society by enacting statutory language to mandate the achievement of that goal. The TCI Consortium's operating agreement must be resolute and specifically designed to thwart the political or economically motivated compromises that would lead to our shared disaster. Our prospects for survival depend on the TCI Consortium accepting the non-negotiable laws of climate science physics as preemptive over the short-term dictates of economic modeling and the inherently selfish interests of all fossil-fuel consuming corporations, governments, and citizens.

As part of my climate change research and energy policy public advocacy at the Vermont legislature, I have evaluated the existing RGGI Carbon Trading System. Please review Appendix 1 for a critique of the RGGI carbon trading system's GHG emissions reduction performance to date. The primary findings of this investigation are that:

- The RGGI carbon allowances auction operational rules are intentionally weakened to sacrifice carbon emission allowance sales revenue in favor of minimizing the economic impacts on large electricity consuming industries and the utility's business interests. The process by which the auction rules and its threshold triggers are formulated is opaque and appears to be politically influenced by the market's participants.

- Most of the GHG emissions reductions claimed by RGGI over the last decade are in fact attributable to the utilities retiring their expensive to operate coal-fired power plants and replacing them with lower operational cost gas-fired power plants.
- RGGI does not acknowledge or include in its power plant fuel GHG emissions accounting the upstream Methane emissions from fracked gas extraction, refining, and distribution leakages. ISO-NE currently asserts its year 2017 CO2e emissions rate is 309.35 kilograms per Megawatt-hour (MW-h) [2]. When corrected for the ISO-NE gas-fired power plant fleet's heat rate, annual Megawatt-hours generated, and associated upstream GHG emissions (192 kilograms per MW-h), then ISO-NE CO2e emissions are actually 557.38 kilograms per MW-h. This is 80% higher than what is commonly represented to the public.
- Setting the RGGI carbon allowance minimum reserve pricing is subject to the influence of the ISO-NE grid utilities, some of whom are combined electrical and gas utilities who have a strong financial incentive to expand deployment and protect the continued operation of gas-fired power plants.
- The RGGI clearing price per CO2e metric ton at its December 2018 auction was only $5.35. A study done by the EIA demonstrated that this price must increase to at least $91 per metric ton to discourage the continued gas-fired power plants investments by ISO-NE utilities.

This assessment of the RGGI weaknesses informs the following recommended reforms that must be incorporated into the TCI Consortium's organization bylaws.

The draft TCI framework (version October 1st 2019) does not acknowledge these weaknesses in RGGI even exist, yet it relies heavily on the RGGI Carbon Trading System as an exemplar. Nor does the draft TCI framework identify what provisions in the TCI governance model and its associated rules would be codified in the legally binding operating agreement to avoid these weaknesses known to be present in RGGI. In the absence of such provisions, the TCI operating agreement could easily fall into the trap of inadvertently replicating those weaknesses.

This memorandum identifies a set of recommendation that if implemented would go a long way towards reforming the above cited weaknesses exhibited by RGGI. The inclusion of these

2 https://www.iso-ne.com/static-assets/documents/2019/04/2017_emissions_report.pdf

recommendations in the formal TCI consortium legal agreement (here after referred to as the "*TCI Contract*") should be the prerequisite condition for any State's legislature authorizing its participation in the Transportation and Climate Initiative Carbon Trading System:

1. Recommendation: Unless there is a legally binding and technically specific 4% per year GHG emissions reduction performance requirement placed in the TCI Contract, then the terms of the TCI Contract risk being too lenient to meet our world's transportation energy sector GHG emission reduction goals. On the other hand, if the TCI Contract was to be ratified as requiring compliance to vehicle transportation GHG emission reduction performance metrics leading to the TCI Consortium region achieving zero transportation GHG emissions by year 2040 or no later than 2050, then the recommended Carbon Trading System performance metrics would set a global referent example of a Carbon Trading System that champions a bona-fide solution to the climate crisis.

2. Recommendation: The roster of the fossil fuels legally obligated by the TCI Contract to participate in the Carbon Trading System should be expanded to include all aviation fuels [3] [4] dispensed into aircraft departing for domestic destinations at those airports within the TCI region. It is an open policy design question whether the domestic destinations subject to the TCI Consortium's agreement will include those flights destined for outside the TCI Consortium's region or only those that are intra-regional.

3. Recommendation: The TCI Contract should prohibit the individual participating States from legislating carve out exemptions benefiting specific GHG emission intensive transportation industries, such as those freight delivery companies whose truck fleet comprises Medium-Heavy Duty Vehicles.

4. Recommendation: Authorize all TCI Contract participating State legislatures to annually prescribe the CO2e emissions minimum reserve price per metric ton for the GHG emission allowances sold at the TCI auction by their State. This enables a State to assure their transportation GHG emission reduction policy programs have funding continuity, stability, and a guaranteed minimum revenue from TCI allowances. As a consequence, an adjacent State legislature shall be prohibited by the TCI Contract from setting a lower minimum reserve price for their TCI emissions allowances that they sell to those wholesale fuel

3 https://en.wikipedia.org/wiki/Environmental_impact_of_aviation#Greenhouse_gas_emissions_per_passenger_kilometre
4 https://en.wikipedia.org/wiki/Fuel_economy_in_aircraft#Regional_flights

distribution dealers who supply the retail fuel merchants near the interstate border. For example, if a State “X” legislature sets a minimum reserve price of $20 per metric ton and the adjacent State “Y” that has set a lower minimum reserve price of $10 per metric ton, then State “Y” must agree to cooperate with State “X” to avoid revenue leakage. The adjacent State “Y” would be obligated to enforce that State “X” higher minimum reserve price on all CO2e allowances sales auctioned to those transportation fuel dealers who deliver fuel to the retail fuel dealers within 10 miles of the State “X” interstate border.

5. Recommendation: The TCI Carbon Trading System must have transparent, audit-able, and accountable public governance. The TCI Carbon Trading System should be chartered as a public multi-State regional jurisdictional governing body. It should have legally binding bylaws that specify:

   a) Accountability for making poor progress towards GHG emission reduction goals in compliance to the IPCC Special Report 15 guidance. The enforcement of accountability has three components:

      - The TCI Consortium bylaws shall contain GHG emissions reduction performance metric covenants that are legally binding as promises made to the public in exchange for increasing the cost of transportation energy. If those covenants are being violated by the Consortium’s lenient Carbon Allowance pricing and auction policies then any party may file suit in the Federal court system to seek remedy. The Plaintiffs can ask the Courts to decide if the Consortium’s performance covenants have been violated, and if so then issue an order compelling the TCI Consortium’s to revise its policies to achieve compliance to the 4% to 5% GHG emissions reduction per year performance metric.

      - Levying damaging financial penalties on the after-tax income of those fossil fuel vendors within the Consortium region who have exceeded their authorized annual GHG emission quotas.

      - Decreasing a TCI Consortium participating State’s forthcoming year’s authorized Carbon Allowances quantity by whatever amount compensates for that State’s prior year of excessive GHG emissions. The amount of that Carbon Allowance ceiling

reduction shall enforce over the two year period that the overall GHG emission reduction rate is at least 8%.

b) Transparent oversight of all its accounting operations, published by an independent certified auditor as public records.

c) The full disclosure of the TCI internal decision making process. Policy making and votes by its Board of Directors are held in public. Their meetings, both in-person and through remote conferencing, are subject to public notice and public meeting access provisions similar as Vermont has enacted in its Open Meeting Law.

d) The Carbon Trading System's Board of Directors are subject to prohibitions on their participation in the decision making process where there is a conflict of interest. Members of the Board must publicly disclose their investment portfolios and they must divest from all fossil fuel industry investments, assets, and income.

e) The general public can request Carbon Trading System internal energy policy and economic study documents, meeting records, meeting recordings or transcripts, and emails between TCI participants. Ideally, all of these records are available at the TCI web site. This is similar as is already provided by Vermont's public records laws.

f) A TCI Consortium member State's legislature should retain both budgetary oversight and authority to subpoena and audit the Carbon Trading System's financial records.

6. Recommendation: Besides the Carbon Trading System floor price, the investigation has also identified several other Carbon Trading System performance metrics to specify in the TCI Contract language. They are as follows:

a) The most important performance metric would be to prohibit the Carbon Trading System's peer States from issuing extra CO2 emission allowances to the special interests of an industry within a given State. In other words, everyone plays by the same rules.

b) It has been a common failure mode in existing Carbon Trading Systems to allow the market participants to "bank" CO2 emission allowance indefinitely. This enables hoarded allowances to be used to inexpensively mask future increases in a market participant's CO2 emissions. To remedy this loophole, banked CO2 emission allowances

must decay in value over a period of three years. After a CO2 emission allowance has expired, it has no value.

c) The TCI Carbon Trading System must publish a schedule that decreases its annual CO2e emissions allowance quota by at least 5% per year until it reaches zero. If the TCI Carbon Trading System's market participants have emitted more GHG emissions in the current year than their market's CO2e emissions allowances quota, then the size of following year's quota must be reduced by more than 5%. In the following year, the Carbon Trading System must reduce its CO2e emissions allowance quota by whatever percentage compensates for the current year's excess CO2e emissions.

d) Restrict the total amount of banked CO2 emission allowances held by market participants to be no more than 10% of the market's current CO2e emissions cap.

e) Require the TCI Carbon Trading System market to annually disclose at its web site the total annual GHG emissions of all of the market's participants.

f) The TCI Carbon Trading System market must have the authority to audit and levy financial penalties to those fossil fuel dealer participants whose actual GHG emissions exceed their GHG emission allowances.

g) Carbon sequestration offsets and Renewable Energy Credit offsets should be prohibited as they can be used to mask the lack of progress by a polluter to reduce their GHG emissions.

7. Recommendation: Regardless of its past mediocre performance, the TCI Consortium should conditionally continue its support of the existing RGGI consortium. For example, expanding RGGI to encompass all of the TCI region would assure the electric power generation consumed by the TCI region's electric vehicles will trend towards zero GHG emissions. The challenge is to negotiate with RGGI to increase its electric generation carbon allowance minimum reserve pricing on an increasing schedule leading to at least $91.57 per ton by year 2040 and decrease the issued carbon allowance quota on a 5% per year schedule. The intent is to compel the ISO-NE utilities (and those of other ISO grids) to retire their gas-fired power plant fleet by year 2045. Until there is such an agreement, the

migration to electric vehicles [5] will not cause the intended benefit of zero GHG emissions. In the event that the TCI Consortium is unable to acquire these concessions then it should consider litigating against RGGI. The intent would be to compel the RGGI organization to remedy its failures and stand by its public representations of eliminating electric generation GHG emissions.

8. Recommendation: Without a statutory specified and enforced income sensitive rebate or low emissions reward mechanism and scaling formulas, all of the direct carbon pricing and Carbon Trading System options have the risk of incurring severe hardship on lower income strata households and small businesses. The TCI Contract should require the Carbon Trading System market participants pass through rebates of the GHG emission allowance costs to their retail customers on a progressive income sensitive schedule.

In conclusion, if the final TCI framework incorporates the above recommendations, then there will be a much higher likelihood our society's transportation energy consumption will become zero GHG emissions by year 2050. This step forward in combination with comparable movement by the TCI region's electric power generation fleet will go far to fulfill our obligation to become a zero GHG emissions society.

5 Society's concurrent migration to Heat Pump systems to provide building space heating and cooling faces a similar dependency on a grid implemented by a zero GHG emissions power generation fleet.

Appendix 1: A Critique of the RGGI Performance

By year 2040 or soon thereafter, the TCI Consortium may develop the EV infrastructure and sufficient zero emissions electric vehicle market penetration to satisfy its GHG emission reduction performance goals. However, there remains a huge yet often overlooked regional grid political and economics problem. In short, a large fraction of the TCI region's electrical energy comes from the ISO-NE grid and approximately half of ISO-NE grid electricity is generated by fossil gas-fired power plants. Yet there is no ISO-NE plan in place to retire those gas-fired power plants by year 2050. To the contrary, about half of ISO-NE Interconnection Request Queue [6] is occupied by proposed gas-fired power plant proposals. This section explains why RGGI may have a pivotal role in forcing their retirement.

Notwithstanding their marketing collateral, the RGGI has been only a minor factor in the CO2 emission reductions seen in the New England electric power generation sector. The vast majority of the GHG emissions reductions touted by RGGI as its achievement over the last decade were actually caused by a major utility industry shift to operate lower cost gas-fired power plants and the retirement of expensive coal-fired power plants [7].

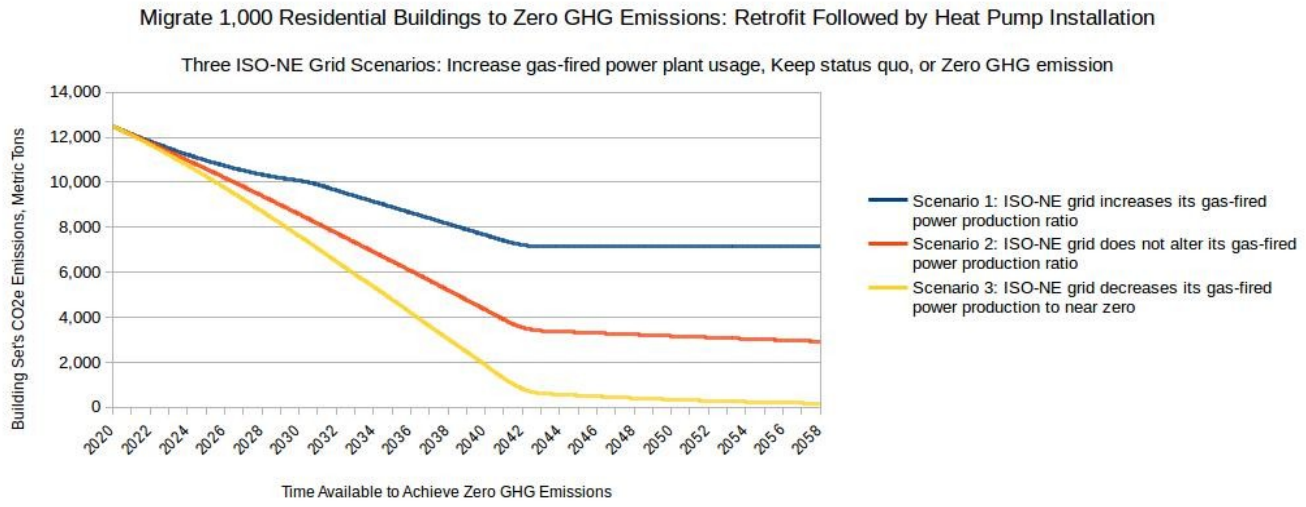

Figure 1: Graph of minimum CO2 emissions for three ISO-NE grid scenarios

The existing RGGI market has a carbon emissions allowance floor price of $2.17 per metric ton [8] and the most recent RGGI December 2018 auction had a clearing price of $5.35 per CO2

6 https://www.iso-ne.com/system-planning/transmission-planning/interconnection-request-queue/

7 https://climate-xchange.org/wp-content/uploads/2018/08/Cap-and-Trade-Report-10.03.2018-compressed.pdf

8 https://www.rggi.org/auctions/auction-results Auction 42 and also https://www.rggi.org/sites/default/files/Uploads/Auction-Materials/38/RGGI_CO2_Allowance_Auction_FAQs_Jan_10_2017.pdf question 2 regarding "Minimum reserve price".

ton. These prices are too low to achieve TCI's GHG emission reduction goals or its zero emissions policy funding objectives. At the risk of saying the obvious, so long as the ISO-NE grid is running its gas-fired power plant fleet, the TCI Consortium can not hope to achieve zero GHG emissions by 2050 or sooner as per the IPCC Special Report 15 guidance. It doesn't matter that some Vermont utilities say they are already sourcing greater than 50% renewable electricity. In 2017, the ISO-NE grid had average CO2e emissions of 550 kilograms per Megawatt-hour [9]. About half of the ISO-NE annual electric power came from gas-fired power plants [10]. A major effort in our CO2 reduction strategy will be to steer the TCI region towards Electric Vehicles and Heat Pumps. However, this migration would dramatically increase our electrical demand, on the order of 2 to 3-fold. All of it has to be satisfied with zero emissions electricity. There is no path to success if ISO-NE continues to rely on gas-fired power plants to meet this increase in demand.

Figure 1 displays the results of a thermal energy sector modeling exercise that underscores this point. The graph shows three ISO-NE grid scenarios, wherein ISO-NE either increases, holds steady, or altogether retires its gas-fired power plant fleet in response to increased demand from electrifying New England's building space heating. The latter scenario requires the extensive deployment of reliable Wintertime zero emissions renewable electricity capacity at peak heating load periods. Only that scenario achieves zero GHG emissions by year 2050.

This finding puts the weak RGGI pricing into the spotlight. Unless RGGI steeply increases its carbon emissions allowance pricing to force this movement away from gas-fired power plants, then setting a high carbon emissions allowance price at the thermal and transportation Carbon Trading Systems would cause the planned TCI regional move to electrification. However, that move won't achieve the zero GHG emissions goal at hand.

9 This value has been increased from the 310 kilograms asserted by ISO-NE 2017 Greenhouse Gas Emissions Report. Unlike the ISO-NE report, the revised value accounts for the upstream fossil gas emissions of Methane and Carbon Dioxide.

10 https://www.iso-ne.com/about/key-stats/resource-mix

Minimum CO2 emissions metric ton price to force the EIA "high gas price"

CO2 emissions mass per MCF (Kilograms)	55.15	
BTUS per MCF (BTUs per 1,000 cubic feet)	1,037,000	
EIA "high gas price" discourages gas-fired power plants	$8.62	enables solar/wind dominance
EIA "low gas price" encourages gas-fired power plants	$3.75	Status quo, gas as a false solution
CO2 emissions mass per gas MMBTU (Kilograms)	53.18	
MMBTUs per metric ton of CO2 emissions	18.80	
(18.80 MMBTU per CO2 ton) * (($8.62 high price) - ($3.75 low price)	$91.57	minimum RGGI price/CO2 metric ton

EIA Supporting References:

https://www.eia.gov/todayinenergy/detail.php?id=38252
https://www.eia.gov/tools/faqs/faq.php?id=73&t=11
https://www.eia.gov/tools/faqs/faq.php?id=45&t=8

Table 1: Calculation to Set RGGI Minimum Floor Price per Emitted CO2 Metric Ton

The Federal *Energy Information Agenc*y (EIA) has forecast that our nation's future mix of electric generation facilities will depend strongly on the price of the gas fuel sold to the utilities [11]. In this EIA study, they predict the continued low price of gas through year 2050 will drive the electric generation utility industry to primarily deploy gas-fired power plants instead of renewable wind and solar generation plants. During the period 2019 through 2050, the EIA "low price gas" scenario assumes the gas price per MMBTU starts at $3.42 and it gradually increases to near $4.00 per MMBTU by 2050. The EIA "high price gas" scenario assumes that the gas price increases to $8.62 per MMBTU by 2050. The strategic implication is clear. To force the ISO-NE grid's utilities to deploy solar/wind/hydroelectric facilities instead of gas-fired power plants, then the RGGI auction market's floor CO2 emission price must be rapidly escalated on a schedule to cause the EIA high price gas scenario. The calculation within Table 1 demonstrates why the RGGI Carbon Dioxide emissions price per metric ton must be at least $91.57.

The only alternative to raising the RGGI floor price is for every RGGI participating state to enact a stringent zero emissions electric generation *Renewable Energy Portfolio* standard.

11 "*Future U.S. Electricity Generation Mix Will Depend Largely on Natural Gas Prices*", February 6th 2019, J. Jones, L. Martin, https://www.eia.gov/todayinenergy/detail.php?id=38252

Appendix 2: Author's Curriculum Vitae

G E O R G E G R O S S

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Public Service and Advocacy

2017 to present	Town of Shoreham Planning Commission, serving as Chairperson since April 2019. Author of the Shoreham Town Energy Plan (in development). Developed the *Stored Power Integrated Renewable Energy* (SPIRE) modeling tool to forecast Shoreham's future energy loads and zero emission energy sources. Testified in September 2018 before the Public Utility Commission as the Town's witness supporting the proposed ACORN Solar project.
2017: H.396 2019: H.423	Citizen advocate testifying at the House Energy & Technology committee in support of those legislative policies promoting the deployment of community solar projects, fair Renewable Energy Credit ownership policies, and the societal benefits of net-metering over Investor Owned Utility projects.
2014-2015	Co-founder and Managing Director of the *Community Owned Solar Cooperative*, a Shoreham-based community solar project that ultimately could not find a viable site.
2015	PUC docket 7970 second remand (VGS pipeline): Developed an Addison County thermal energy market competitive analysis. Testified as an expert witness on the economic superiority of building energy efficiency retrofits, heat pumps and industrial CNG delivery over building the proposed gas pipeline.

Professional Achievements

2011 to present	Co-owner of the Solar Haven Farm LLC, an organic berry and fruit farm. Designed and built an 800 gallon per day solar powered irrigation network. The solar panels and pump are mounted on a raft floating on our irrigation pond. Designed and build our farm's barn, super-insulated berry storage cool room, and commercial kitchen.
2006 to 2010	Designed and built our Solar Haven passive solar net-zero energy home. I was the construction project's General Contractor.
2001 to 2005	President of *Secure Multicast Networks LLC*, a leader in the standardization of secure Internet multicast technology. Secure Multicast Networks developed software products and related intellectual properties for high assurance satellite based DoD secure multicast Internets. Co-author of the Internet security standards "*Group Secure Association Key Management Protocol*", RFC 4534 and the "*Multicast*

Extensions to the Security Architecture for the Internet Protocol", RFC 5374. http://www.rfc-editor.org/rfc/rfc5374.txt

1999 to 2001	Distinguished and Consulting Member of Technical Staff, the highest rung on the Lucent Technologies technical ladder. Assignments included product line strategic planning, Internet industry competitive analysis, co-authoring International Internet standards, merger and acquisition technical due diligence, and patent portfolio review. Published in the "*Bell Laboratories Technical Journal*". Co-author for the experimental IETF RFC2903, entitled "*Generic Authentication, Authorization, and Accounting Architecture*".
1984 to 1998	AT&T/Lucent Technologies Bell Laboratories, serving in numerous technical roles within the Datakit VCS product development center. Co-authored the IETF standard RFC2364 "*PPP over ATM AAL5*", an Internet communications standard widely applied across the globe in Digital Subscriber Line (DSL) access networks.
1980 to 1983	Senior Programmer for Delta Data Systems, Trevose, PA. DDS was a manufacturer of TEMPEST qualified terminals meeting the needs of high assurance government agencies.
1976 to 1980	Programmer for Sperry Univac in Blue Bell, PA

Education

Graduated with honors from Florida Institute of Technology in 1976, receiving a Bachelor of Sciences in Computer Science degree, with specialization in scientific engineering applications and system software.

Personal

- Outdoor interests include bicycling, kayaking, sailing, backpacking, and hiking.
- Have cultivated a self-taught expertise in super-insulation, passive solar, renewal energy systems, and "green build" residential home construction techniques.
- Carbon footprint: Our passive solar home gets 30% of its annual heat from the Sun streaming through the windows. We heat our home with 1 ½ cords of firewood per season. We drive a Plug-in Hybrid Electric Vehicle that for our driving profile achieves an annual average of 86 miles per gallon. Our solar PV system generates over 9,500 KW-h of solar electricity per year, which is over 80% of the power our farm and residence consumes per year. Our solar hot water system produces 2/3rds of our annual hot water needs. The remainder comes from an air source heat pump water heater.