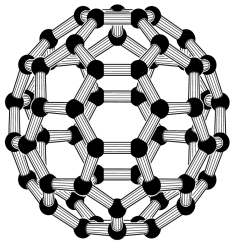


To: Members of the Senate Natural Resources and Energy Committee
From: Robert Lehmert, Carbon Negativity, LLC
Date: June 18, 2020
Re: H. 688 - Global Warming Solutions Act

Thank you for including this critical Bill during our concurrent public health and economic crises. Based my reading of the final version passed by the House, H. 688 demonstrates a great deal of thought, debate, compromise, and testimony of experts and interested parties.

Tapering off new emissions to zero by 2050, while no easy feat, will nonetheless leave us with ambient Greenhouse Gas Emissions (GHG) concentrations that are far higher than any experienced during the evolution of human species. On a global scale, a likely outcome is that, even with perfect execution, the effort will not be sufficient to avoid the worst effects of climate change.

Even if Earth were able to turn off new emissions completely and immediately, CO2e concentrations will persist "in the red zone" for many decades. And of course, no one reasonably expects a miracle of voluntary and immediate adoption of "zero net" emissions. There is growing concern that after 2100, Earth's climate will threaten the stability of many regions.

There is an oft-repeated line in the movie "Jaws" that sums up: "We're going to need a bigger boat."

That "bigger boat" is the concept of "Negative Emissions Technologies" ("NETs") — a permanent removal ("drawdown") of persistent ambient emissions in a verifiable, permanent, additional, manner. Negative emissions should be integrated in the context of H. 688.

Carbon negative practices have synergistic impacts beyond carbon removal. Some NETs make useful materials, specifically biocarbon, a form of nearly pure carbon (ie: 90% - 95% pure), which is acknowledged by the IPCC to remains stable in soils for hundreds or thousands of years. There are literally hundreds of uses for biocarbon — from cleaning up toxic waste to raising healthier farm animals, making stronger concrete, to making components for air frames and graphene.

Let's dwell on one example: replacing fossil fuel components in asphalt with biocarbon charcoal and oils. This has been in research for over decade and shows great promise compared to conventional asphalt. While it is still being researched, many studies have shown that it outperforms asphalt made with fossil fuel products because it has resistance to deterioration from UV rays — and "self-heals" micro-fractures before they grow large, which allows it to resist water penetration. No water penetration means far fewer potholes.

Conventional asphalt is a sticky, black and highly viscous liquid or semi-solid form of petroleum — bitumen — a residue from the distillation process of very low grade crude oils. In addition, most asphalt uses carbon black. Carbon black is a material produced by the incomplete combustion of heavy petroleum products such as petroleum tar, coal tar, or ethylene cracking tar.

By using biocarbon, roads become a "carbon sink", that persists even after the pavement is recycled. Many tests have been done using 10% biocarbon by volume. In effect, 528 feet of pure carbon can be sequestered into each mile of road.

The Concept of Carbon Cascades: The displacement of a fossil fuel and replacement by a carbon negative material lowers both ambient and new emissions:

- CO_2e is drawn-down from the atmosphere in the manufacture of the substitute. Without thermochemical conversion into stable carbon, most of its CO_2e would return to the atmosphere through normal decomposition. Usually, no external energy is needed for the process - the required heat is generated by volatile gases in the biomass. The thermochemical process may also generate enough excess heat so that it can be captured, used to generate electricity or thermal heat.

- The hydrocarbons that would otherwise been used to make bitumen and carbon black remain sequestered in the ground.

- Because Vermont does not produce bitumen or carbon black, the emissions associated with long-distance transportation are avoided.

Generally, H. 688 does not explicitly encourage NETs. Some references that includes NETs are present, but are not specific. For example, §590 (3) "Definitions" states "Mitigation means reduction of anthropogenic greenhouse gas emissions, and preservation and enhancement of natural systems to sequester and store carbon …"

It is easy to overlook that biocarbon asphalt fits as an "enhancement of a natural system that sequesters carbon". For this reason, convincing Vermont's Agencies to seriously consider NETs has been challenging.

H. 688 incorporates definitions which trace back to prior legislation for key terms in broad terms. For example, 10 V.S.A. § 582 (b) states: [highlights added]

> Inventory updates. To develop the Inventory under this section, the Secretary, in coordination with the Secretaries of Administration, of Transportation, of Agriculture, Food and Markets, and of Commerce and Community Development, and the Commissioner of Public Service, shall aggregate all existing statewide data on greenhouse gas emissions currently reported to State or federal entities, existing statewide data on greenhouse gas sinks, and otherwise publicly available data. Greenhouse gas emissions data that is more than 36 months old shall be updated either by statistical methods or seeking updated information from the reporting agency or department. **The information shall be standardized to reflect the emissions in tons per CO2 equivalent, shall be set out in the inventory by sources or sectors such as agriculture, manufacturing, automobile emissions, heating, and electricity production**, shall be compatible with the inventory included with the Governor's Commission on Climate Change final report and shall include, the following sources:
> (1) information collected for reporting in the National Emissions Inventory, which includes air toxics, criteria pollutants, mobile sources, point sources, and area sources; […]
> (2) in-state electricity production using RGGI and State permit information;
> (3) **vehicle miles traveled and vehicle registration data**; and
> (4) agricultural activities, including livestock and crop practices.

I do not see an obvious category that would measure and account for the GHG contribution of asphalt — unless it were included as a type of manufacturing. And, there is a split responsibility (private contractors filling contracts written by agencies). I cannot determine if GHG from the asphalt manufacturing was previously included in prior GHG inventories, which would be understandable, since at the time §582 was enacted, methods of reducing GHG from asphalt were inconsequential.

Now, companies are building plants sized to produce between 25,000 and 100,000 tonnes of biocarbon a year. Within several years, nationwide production could approach 300,000 tonnes, which represents close to 1 million tonnes of CO2e per year. Vermont is ideally suited for locating several large scale production facilities because of its proximity to forests formerly devoted to paper production. Capital is available to build plants, distributed regionally, to produce 75,000 tonnes of biocarbon annually (removing approximately 225,000 tonnes of CO2e.)

Continuing with the example involving biogenic asphalt, the Air Quality and Climate Division might be able to provide data on emissions from the appropriate sector consistent with its January 2020 report, and whether its section on Carbon Black can be expanded. Even if AQCD cannot provide data on historic emissions, a base calculation could be done now, in connection with H. 688 Rules, so that future reductions can be measured.

An expanded discussion of other carbon negative opportunities is timely, and H. 688 specified an updated amendment to 10 V.S.A. § 582, inserting the following language:

> (c) Implementation of State programs to reduce greenhouse gas emissions.
> In order to facilitate the State's compliance with the goals established in this section, **all State agencies shall consider, whenever practicable, any increase or decrease in greenhouse gas emissions** in their decision-making procedures

> **with respect to the purchase** and use of equipment and goods; the siting, **construction, and maintenance of building**s; the assignment of personnel; and the planning, design, and operation of programs, services, and **infrastructure**. [emphasis added]

Public roads are subject to this standard, even if installed by a private contractor. As roads are replaced, credit should be given for the reduction toward emissions goals. I suggest that compliance with this key provision be subject to a quinquennial audit.

As markets area key to incubating this new industry, I suggest review of the USDA's BioPreferred mandatory procurement policy, which has been in effect since 2002. Mandatory purchasing of products with a specified minimum amount of "biologically derived content" will encourage private contractors to gear up for change. **[https://tinyurl.com/y3ka8tbx]**

In the interest of brevity, I restricted my discussion to the example of replacing fossil fuels in asphalt pavement. Among dozens of additional NET "targets of opportunity" are:

- Payment for ecosystems services — increasing soil and forest carbon — through a Producers CoOp, providing technical assistance, access to low-cost equipment, analysis, and aggregation services. If purchased by the State of Vermont, the proceeds from the carbon removal would paid to the producer as a PES— with VT retaining the Carbon Offset Certificate (CORC) and controlling the carbon. Those CORCs would count against emission reductions.

- Advanced wood heating - for large commercial, industrial and public spaces in a range of sizes. These ultra-efficient, highly automated units use low-value wood (chips) and are optimized to generate hot water, steam and electricity. A modest amount of biochar is produced as a bi-product. I am working with Shelburne Farms to replace an antiquated system heating its Farm Barn.

- Advanced wood electrical generation and grid integration. These units are optimized to compete with solar and storage to produce carbon neutral base power for the grid or an off-taker. Meets CARB air standards.

- Pyrolyzation of sewage, septage, digestate and sludge — an alternative to transporting thousands of tons of wet sludge for landfill disposal. Without using external energy, sludge is dewatered to 80% solid and pyrolyzed at 800C, gasifying any volatiles. The burner operates at 1300C, which destroys pharmaceuticals, hormones, microplastics, and even PFAS. Any concentrations are retained in the residual biocarbon for safe disposal. If the sludge did not contain metals, it may be sold as a high phosphorus, high nitrogen, high carbon soil amendment. The plant's small footprint and achievement of CARB air standards makes it a "good neighbor". I recently sponsored a NEBRA webinar attracting 75 attendees, including at least one from the Vermont's Waste Management and Prevention Division

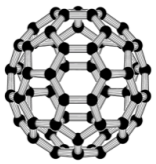
- Gasification of assorted types of less desirable solid waste to make carbon-neutral liquid fuels — A joint research and development project involving the SUNY Foundation, US Army, NYSERDA, and California's CARB, and Caribou Biofuels. Production of carbon

neutral diesel fuel from biomass is already common; this project aims for carbon neutral gasoline.

- Biocarbon has many uses in agriculture, including providing habitat for the “wee beasties” necessary for productive soil, retaining moisture in wet periods and releasing it in dry periods, permanently building to soil carbon, reducing methane emissions, aiding enteric digestion, retaining nitrogen and phosphorous, filtering water, immobilizing and capping manure lagoons. A near term objective is replacement of NPK commercial fertilizers, reducing annual additions of nutrients with gradual release.

Thank you for the opportunity to communicate with the Committee. Please note that I am not an attorney, and no references to law should be interpreted as legal advice.

Sincerely,
s/RRL
Robert Lehmert



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