Testimony of
MICHAEL T. GOERGEN
VICE PRESIDENT, INNOVATION AND DIRECTOR, P3NANO
U.S. ENDOWMENT FOR FORESTRY AND COMMUNITIES

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"Innovative Wood Products: Promoting Rural Economies and Healthy Forests"

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Chair Spanberger, Ranking Member LaMalfa, and Members of the Committee, thank you for the opportunity to testify on this issue of importance to all Americans – Innovation in sustainable forest products that promote rural economies and forest health.

I have been with the U.S. Endowment for Forestry and Communities (the Endowment) for more than six years where I have focused on bringing innovation to the forest sector and accelerating the commercialization of those innovations. Prior to that, I served as the CEO of the Society of American Foresters, the professional society representing foresters in the United States.

While each organization is unique, we find few organizations with roots that compare to those of the Endowment. We are a not-for-profit, public charity chartered at the requests of the governments of the U.S. and Canada as a result of the Softwood Lumber Agreement of 2006. That long-running dispute over softwood lumber production and its export/import, in this instance, led to what we believe is the only time in the world when a not-for-profit was created and funded as a result of a trade settlement between two sovereign governments.

The Endowment was granted a one-time $200 million perpetual endowment with interest and earnings to be dedicated to sustainable management of forests and economic vibrancy of the rural communities nested within or adjacent to those forests. We are a catalyst for innovation that invigorates forest-rich, rural communities by keeping working forests as forests for all their environmental, societal, and economic benefits and values. The Endowment works collaboratively with partners in the public and private sectors to advance systemic, transformative and sustainable change for the health and vitality of the nation's working forests and forest-reliant communities.

The forest sector represents a $300 billion/year economic impact in the U.S. and directly employs nearly one million people. As this Committee is aware, many of the forests that sustain this sector are in trouble. Almost a quarter of a billion acres – fully 1/3 of our forestland is at risk of catastrophic wildfire. Forests are also under threat from insects and diseases. Invasive species infest almost 40 percent of forested acres. Therefore, we focus on creating markets. When there is demand for forest products, the costs of restoring forest health is significantly less as we can conduct management actions that improve forest health and pay for that work by selling the byproducts of those efforts for various uses. Markets bring value to forests, and we keep things we value.

Some people think that harvesting trees is inherently a bad thing, but that is just not true. If we sustainably manage our forests, we all benefit. A recent study of forests in the Southern U.S. concluded that as demand for forest products increased over the past 50 years, landowners responded by keeping their land and more than doubling their forests' productivity. The ability to build wealth from forestlands encourages investment in forests resulting in multiple benefits to all stakeholders and constituents. By demonstrating economic value creation, we reduce the incentive to convert our forests to other uses. Markets, old and new, are vitally important to sustaining forests.

Developing new markets, displacing current technology, getting people to think differently about forest products, these are daunting challenges for the forest sector. While we have solutions to many of today's environmental challenges, getting them to market requires overcoming many obstacles. At the Endowment, we are finding opportunities to bring together government scientists, university researchers and the private sector to accelerate the commercial readiness of a number of innovative forest products including mass timber construction, low value products that utilize forest restoration materials, and one of the most exciting opportunities, cellulosic nanomaterials (CN).

The Potential of Cellulosic Nanomaterials

We are finding incredible applications for cellulosic nanomaterials made from the tiniest parts of trees. These materials will play a vital role in solving challenges facing the planet. Cellulosic nanomaterials (CN) are a new class of materials valued for their mechanical properties, sustainability, large-scale production potential, and low cost. At the nano scale – about 1/100,000th the width of a human hair – cellulose has novel properties. To give context the head of a pin is one million nanometers wide, and we can make crystals of CN that are just 6 nanometers wide. When we get to the nano scale for many materials, strange things start to happen. For example, nano gold is no longer a golden color, it can be red or pink. In the case of cellulose, these nanomaterials are as strong as steel with only a fifth of the weight. Making these materials is like making paper, yet more refined. Once we have the CN, they can be used in numerous material applications previously closed to forest products.

Some other nanomaterials have incredibly exciting properties but are just not ready for commercialization as they have only been produced at very small scales. That is not a challenge for cellulosic nanomaterials. While some nanomaterials are talked about in gram quantities, we can produce tons of cellulosic nanomaterials. Safety has also been a primary concern. Researchers at Virginia Tech, American University, Oregon State University, Rice University and others are studying the environmental and human health impacts of these materials and have many encouraging findings. In fact, the Endowment led a consortium that pooled together the resources of several industrial partners to conduct the research necessary to obtain Food and Drug Administration (FDA) reviewed generally regarded as safe status (GRAS). We submitted the necessary notification to FDA earlier this month.

Adding cellulosic nanomaterials to auto parts will make them stronger yet lighter resulting in improved gas mileage and reducing greenhouse gas emissions. A researcher at Georgia Tech is working on reinforcing fiberglass-based auto parts with cellulosic nanomaterials achieving 18-20 percent weight reductions with minimal additions of CN. Researchers at Michigan State University are making packaging that behaves like plastic but is a 100 percent biobased material that is fully biodegradable. Researchers at Purdue University can make lighter-weight bullet-proof glass from CN. Flexible microchips are being made at the University of Wisconsin and are projected to be much lower cost than competing materials.

Researchers at the University of Maine are working on several innovative products. One scientist and his team are developing a replacement for gypsum board that would be made from saw dust and CN fibers that act as the biding agent. This new type of board will be lighter weight, will not have chemical additives associated with negative human health, and will have greenhouse gas emission profiles significantly lower than products currently on the market. Another researcher at Maine is developing a replacement snack package that would be fully recyclable and biodegradable. Imagine no more potato chip bags by the side of the road, in our forests, or our streams.

CN can be used in 3D printers, reducing the use of plastics and opening new applications in the biomedical field as these materials are biocompatible. CN materials have the power to block the sun. Using these findings researchers are exploring topical sunscreen applications that will not absorb into the human body. Since CN is benign in the environment, a sunscreen produced from these materials can eliminate a known impact to marine eco-systems. Researchers are investigating improvements to lithium ion battery technology that could theoretically double storage capacity. Imagine doubling the range of current electric vehicles using a sustainable, renewable forest product.

Another interesting application for cellulosic nanomaterials involves concrete. Gravel, sand and cement are the basic ingredients of concrete. We use it everywhere. Four trillion tons worldwide, in fact. But concrete is the source of five to eight percent of the world's greenhouse gas emissions because it takes a lot of energy to make cement. To make cement, one must first heat limestone to more than 2,600 degrees Fahrenheit, which takes a lot of energy, which produces greenhouse gas emissions. That hot rock itself releases even more emissions from the carbon stored within. Since the world uses so much concrete, even a small reduction in greenhouse gas emissions can go a long way. That is where cellulosic nanomaterials can help. When we add a tiny amount of this material to the mix, we can reduce emissions from concrete production by 18 to 20 percent.

Concrete requires near complete hydration, without going too far. If concrete is made with too much water, it will crack; not enough water and it won't be strong enough. Adding just 1 percent cellulosic nanomaterials increases the hydration of concrete. The CN acts like a straw and carries water more completely through the concrete mixture. Think about pancake batter. Pancake mix often has dry lumps even after adding liquids. One might expect after adding milk and eggs the dry ingredients would mix in easily. But, for some reason they don't. Something similar happens in concrete; yet, by adding CN we get better hydration. This increased hydration makes the mix 18 to 20 percent stronger. We can have stronger concrete, and since cement is the largest source of CO2 emissions from concrete, we can reduce the amount of cement by about 18 to 20 percent and we significantly reduce CO2 emissions.

Public Private Partnerships

Listening to all these exciting end use applications for CN, you may be wondering is there anything you can't make from CN? There may be some things we cannot make as cost effectively, but we truly can make almost anything from forest products. At the Endowment we are overcoming the obstacles to commercialization by bringing together a public private partnership to advance this technology. Absolutely none of the progress mentioned would be possible without the financial, technical and scientific contributions provided by the men and women of the USDA Forest Service, and more specifically, the agency's Forest Products Laboratory (FPL). Together with FPL we have formed a public private partnership known as P3Nano that is combining the strengths of the premier federal laboratory working on forest products with leading researchers and the companies that are making these products. Together we are exploring ways to ensure safety, reduce the costs of production and explore end use

applications that leverage the unique properties of CN. The advances made would not be possible without the contributions of the Forest Service.

Government research is critical at so many stages of the scientific process, but it is even more critical when it comes time to overcome what is known as the valley of death. When scientists make new discoveries that hold great promise there is often initial interest in funding that explores the potential of the discovery. There is often funding available when that product is ready for commercialization. The valley of death in between is often short of resources to take that initial discovery to successful commercial products. P3Nano is working hard to bridge that valley, trying to ensure that the most promising of these applications make it to your home to improve your life. It is incredibly hard work and would not be possible without the contributions of the USDA Forest Service and their Research and State & Private Forestry programs.

Mass Timber

Mass timber is another area where the Endowment is collaborating with partners to build the market for these innovative forest products. In December 2018, the International Code Council voted to allow wood structures as tall as 18-stories from the current six-story limit. What makes these buildings possible—and safe—is cross-laminated timber (CLT) and its kin: nail- and dowel-laminated timber, mass plywood panels, and laminated veneer lumber. All these mass timber engineered wood products use the same principle as plywood. Laminating layers of wood with the fibers at right angles creates a strong material with good acoustic, seismic, thermal, and fire performance.

Getting a code change that allows for 18-stories took a concerted effort by, among others, the USDA Forest Service (through collaborative efforts of its State & Private Forestry as well as Research and Development divisions), the American Wood Council (which promotes the use of wood through regulatory and public policy efforts), the Softwood Lumber Board (a "commodity check-off" research and promotion program initially envisions by the Endowment), WoodWorks (a nonprofit industry program focused on education and project support) and the U.S. Endowment for Forestry and Communities as well as a host of others. Building more and taller buildings from wood has numerous benefits. Tall wood buildings sequester carbon. Steel and concrete based buildings have significant CO2 emissions. More use of forest products brings more value to those products and the forests that grow them. More value in the forest provides landowners with incentives to keep their forests as forests and sustainably manage them. More value for forest products makes it easier for the USDA Forest Service to reduce forest health threats as the management activities often produce lower value material needing a market. Innovation in forest products will help create the markets we need to more fully restore forest health across all our forest lands.

Torrefaction

At the Endowment we are constantly on the search for innovation in forest products. Torrefied wood is an innovation that allows for the lowest value material to find a home in markets that will make a difference. Torrefied wood is a process where wood is roasted at relatively low temperature in a low oxygen environment. The resulting material has significant advantages over the raw biomass used in the process. Torrefaction reduces moisture, increases energy density and develops a product that stores and transports far better than untreated biomass eliminating some of the logistical hurdles that make low value biomass from restoration efforts a little more valuable.

The Endowment's Restoration Fuels project in John Day, Oregon is the first, commercial scale torrefaction facility in the U.S. and the last stage in the Endowment's and its collaborators' efforts to commercialize this technology. In addition to proving the technology, this effort is designed to help open a large-scale market for forest restoration residuals and open the door to development of additional carbon products that can be produced from thermo-chemical treatment of biomass. This facility will not only serve to help develop the utility market for an advanced renewable fuel, it will serve as a test bed for other companies through our collaboration with the Forest Products Laboratory, the National Renewable Energy Lab and over a dozen research institutions around the country.

Summary

We are collaborating in Yreka, a small town in northern California at the foot of Mount Shasta. Wildfire is a real threat there, so the community wants to remove some of the small, dying and dead trees that are choking the forest, but that is expensive to do. These trees have little to no commercial value, so they cannot "pay their way" out of the woods. Cellulosic nanomaterials are emerging as a new market for low value wood, a market that will make it economical to improve forest health, protect the town, and create jobs. The people of Yreka see the possibilities, so they plan to install the first bridge deck in the world reinforced with cellulosic nanomaterials. Later this spring, community volunteers will conduct a test of this reinforced concrete. We will bring the concrete truck, they will pour the concrete, and all of us will be working together to build not just better infrastructure and a better community but a better, cleaner, greener world. To show our commitment to these efforts the Endowment conducted the largest commercial application of cellulosic-infused concrete when we replaced a more than 40-year-old asphalt parking lot at our headquarters in Greenville, SC. The results are real.

Cellulosic nanomaterials, and other innovative forest products are going to make an impact. They will be part of flexible electronics, 3D printing, more sustainable packaging, new-age composites for everything from tennis rackets to rockets. We will build tall buildings with wood, provide markets for the byproducts of forest restoration, and reduce CO2 emissions from several industries. Forest products are going to contribute to a sustainable future, and it all comes back to trees and the forest. Markets like cellulosic nanomaterials, mass timber and others can help us demonstrate the known value of forests. When we value forests, we keep them instead of converting them for development, and we are encouraged to promote long term stewardship of those forests. Good stewardship reduces risks from catastrophic wildfire, insects and diseases. It promotes the health of our watersheds and the sustainability of our planet. Even the tiniest bits of them can make a giant contribution. Thank you for the opportunity to testify before the Committee.