Permanente's Solutions for Sustainable, Industrial-Scale Green Energy from Cellulosic Biomass

Products and Patented Technologies

Permanente Corporation ("Permanente"), based in Houston, delivers a family of patented and proprietary processing technologies that convert abundant, sustainable, low-cost waste cellulosic biomass into competitively priced green-energy products at industrial scale. Outputs in millions of tons per year are achieved through continuous processing in oxygen-free PIPE™ reactors that obsolete every other carbonizing process available today, allowing Permanente's products to compete with conventional petroleum hydrocarbons and fossil fuels — *without subsidy* — while also qualifying, where applicable, for federal carbon-removal incentives such as the Section 45Q Carbon Oxide Sequestration Credit.[1]

The PIPE™ Reactor

The patented PIPE™ reactor[2] operates as a horizontal version of a refinery cracking tower, configured as a pipe-in-pipe radiator that gives feedstock the extended process path and dwell time required for clean, complete conversion. Recycling heat-transfer fluids propel, torrefy, and pyrolyze biomass at controlled temperatures ranging from 350°C to 850°C.[3] With very few moving parts, the reactor enables continuous, precisely controlled time, temperature, and feedstock flow, drawing its process heat from perpetually self-generating syngas produced inside the reactor itself. The result is industrial-scale throughput — measured in millions of tons per year — from a platform that obsoletes every legacy carbonization technology against which it competes.

The Permanente Green-Energy Product Family

From a single PIPE™ platform, Permanente produces a coordinated family of green-energy and carbon-negative products:

- **Biocoal** — A clean, drop-in solid fuel that blends or burns seamlessly with coal. Permanente biocoal is hydrophobic, low-moisture, and low-ash, with a heating value of approximately 12,500 BTU/lb — delivering roughly 33% to 62% greater energy density than Powder River Basin (PRB) coal across its published range,[4] yet containing no

[1] Internal Revenue Code § 45Q (Credit for Carbon Oxide Sequestration). See 26 U.S.C. § 45Q (Cornell Legal Information Institute) and IRS Form 8933 instructions, Carbon Oxide Sequestration Credit.

[2] U.S. Patent No. 9,758,738 B2, *Green Renewable Liquid Fuel*, assigned to Permanente Corporation. Available at: https://patents.google.com/patent/US9758738B2/en. The PIPE™ reactor technology and related processing methods are further protected under additional U.S. and foreign patents in the Permanente portfolio, including U.S. Patent Nos. 10,961,459, 11,345,860, 11,674,086, and 12,595,340 B1.

[3] Torrefaction is conventionally conducted at 200–300°C, with pyrolysis stages extending to 500–850°C. See A. Ohlemüller et al., Ohio State University Extension, *Torrefaction: Upgrading Biomass to "Green Coal"*, available at https://ohioline.osu.edu/factsheet/fabe-6603.

[4] Wyoming State Geological Survey, *Wyoming's Coal Geology*, reporting that Powder River Basin (PRB) subbituminous coals range from 7,710 BTU/lb to 9,410 BTU/lb, averaging 8,580 BTU/lb. Available at: https://main.wsgs.wyo.gov/energy/coal/coal-geology. Permanente biocoal heating value of approximately 12,500 BTU/lb is supported by Permanente Corporation internal product testing. At 12,500 BTU/lb, Permanente biocoal delivers approximately 33% greater energy density than PRB coal at its high end (9,410 BTU/lb), and approximately 62% greater than PRB coal at its low end (7,710 BTU/lb).

PERMANENTE CORPORATION
4265 San Felipe Street • Suite 1100 • Houston, Texas 77027 • USA
Tel: 1-713-485-0970 • Fax: 1-713-486-0599 • Email: info@permanentecorp.com

sulfur, no heavy metals, and no toxics. With its greater heat value, biocoal competes with fossil coal on an energy basis, requires no special-purpose machinery or equipment, and provides a carbon-neutral energy solution for existing power and industrial boilers.

- **Biocoke** — Produced through a newly patented process that first highly densifies woody biomass and then carbonizes it, biocoke yields a strong, high-fixed-carbon, low-ash shaped fuel that is a green alternative to coked fossil metallurgical coal. It substitutes directly for, or blends with, metallurgical coal in blast furnaces for pig-iron smelting and supports electric-arc-furnace (EAF) production of green steel.
- **Biochar** — Refined from a soil-amendment tradition more than a thousand years old, Permanente biochar is a rich, low-cost soil amendment that enhances nutrient and moisture retention, rebuilds depleted soils, and increases crop yields by as much as 20%.[5] Each ton of biochar applied to the soil sequesters approximately 2.8 tons of CO_2 — effectively forever.[6] Fresh from the PIPE™ reactor, pristine biochar additionally provides modest direct-air-capture sorption of CO_2 — approximately 6% of its mass under typical conditions — contributing further to its negative-emissions profile prior to soil application.[7]
- **Bio-oil and GRC88®** — Slow-pyrolysis catalyzed syngas from the PIPE™ reactor is condensed into bio-oil suitable for further refinement into higher-grade liquid green fuels and chemical feedstocks. Bio-oil is the primary ingredient of GRC88®, Permanente's patented low-cost marine fuel: a carbon-neutral viscous colloidal suspension of bio-oil, pyrolysis oil, and nano-particle-sized energy-rich biocarbon. GRC88® contains no sulfur, no heavy metals, and no toxics; it is engineered for use in heat-and-power boilers and in low-speed two-cycle marine diesels, and it delivers energy density on par with No. 6 Residual Fuel Oil and Bunker C.[8]

A Foundation of Three Generations

Three generations of global, entrepreneurial, value-added forest-products expertise stand behind Permanente's technology platform. That heritage — carried forward by the Seidner family of inventors — enabled the vision, engineering discipline, and persistence required to invent, validate, and commercialize a sustainable, low-carbon alternative to fossil fuels and conventional carbonization. The result is a family of new bioenergy products produced from abundant, low-cost, waste woody biomass and waste agribusiness by-products — collectively, cellulosic biomass — secured by multiple U.S. and foreign patents and ready for industrial deployment today.

---

[5] S. Jeffery et al., meta-analyses of global biochar field trials report average crop-yield increases of approximately 13–25%, with higher responses in acidic and tropical soils. See K. Schmidt et al., *Biochar in Agriculture — A Systematic Review of 26 Global Meta-Analyses*, GCB Bioenergy (2021), available at https://onlinelibrary.wiley.com/doi/10.1111/gcbb.12889.

[6] International Biochar Initiative, *Why Biochar*, available at https://biochar-international.org/why-biochar/. The IPCC AR6 (2022) recognizes biochar as a carbon-dioxide-removal pathway with a global potential of approximately 2.6 $GtCO_2$ per year. Industry consensus places sequestration at roughly 2–3 tons CO_2 per ton of biochar applied.

[7] Pristine biochar exhibits measurable CO_2 adsorption capacity attributable to its high surface area and microporous structure. Reported pristine-biochar CO_2 uptake is on the order of 68 mg CO_2 per gram of biochar (≈ 6% by mass) under controlled conditions. See "Biochar-based materials in environmental pollutant elimination, H_2 production and CO_2 capture applications," Biochar (Springer, 2023).

[8] Energy density of No. 6 Residual Fuel Oil (Bunker C) is approximately 17,400 BTU/lb (lower heating value) and 124,000–150,000 BTU/gallon. See U.S. Forest Products Laboratory, Fuel Value Calculator.

PERMANENTE CORPORATION
4265 San Felipe Street • Suite 1100 • Houston, Texas 77027 • USA
Tel: 1-713-485-0970 • Fax: 1-713-486-0599 • Email: info@permanentecorp.com