



GEODYN
SOLUTIONS

**ADVANCED CELLULOSIC BIOMASS,
ORGANIC WASTE, AND KENAF
ETHANOL FACILITY WITH AMMONIA
AND HYDROGEN PRODUCTION
AND 500 MW POWER PLANT IN THE
DOMINICAN REPUBLIC**

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INTRODUCTION

Geodyn Solutions proposes the development of a cutting-edge ethanol production facility utilizing cellulosic biomass (e.g., sugarcane bagasse, crop residues), organic waste (e.g., municipal solid waste, food waste), and kenaf to fuel a 500 MW combined-cycle power plant in the Dominican Republic. The power generated will be used to produce ammonia (via electrolysis and Haber-Bosch) and hydrogen (via electrolysis), leveraging advanced technologies to surpass sugarcane's yield and sustainability. The facility will produce 200 million gallons of ethanol annually to power the plant, with surplus ethanol and byproducts sold locally. The power plant incorporates Organic Rankine Cycle (ORC) and heat recovery turbines for enhanced efficiency. This project aligns with the Dominican Republic's National Energy Plan (2022–2036), targeting 25% renewable energy by 2025, and leverages Law 57-07 incentives. By producing green ammonia and hydrogen, the project will deliver significant economic, social, and environmental benefits, including job creation, reduced greenhouse gas (GHG) emissions, and support for global decarbonization.

PROJECT OVERVIEW

CELLULOSIC BIOMASS, ORGANIC WASTE, AND KENAF ETHANOL FACILITY

Location: Haina, Dominican Republic, due to proximity to agricultural zones, waste collection networks, and industrial infrastructure.

Feedstock:

- **Cellulosic Biomass: 1,000,000 tons/year**, primarily sugarcane bagasse and crop residues (e.g., rice straw, corn stover) from local farms.
- **Organic Waste: 500,000 tons/year**, including municipal solid waste (MSW) and food waste from urban centers like Santo Domingo.
- **Kenaf: 500,000 tons/year**, cultivated on 50,000 hectares of marginal land.
- **Production Capacity: 200 million gallons/year** (757 million liters) of ethanol, sufficient to fuel the 500 MW power plant with surplus for local markets.

Technology:

- **Cellulosic Biomass and Kenaf:** Advanced pretreatment (e.g., steam explosion, dilute acid) and enzymatic hydrolysis using Microbebio's proprietary enzymes to break down cellulose into fermentable sugars, followed by fermentation with engineered *Saccharomyces cerevisiae*.
- **Organic Waste:** Anaerobic digestion to produce biogas, followed by conversion to ethanol via syngas fermentation using *Clostridium* species. Advanced sorting removes non-fermentable materials.
- **Advancements:** Microbebio's enzymes and genetically modified microbes increase cellulose-to-ethanol conversion by 20% over sugarcane's sucrose fermentation. Integrated biorefinery with IoT monitoring optimizes waste-to-ethanol processes, surpassing sugarcane's efficiency (70–80% sugar conversion vs. 65–70% for cellulosic/organic feedstocks).

PROJECT OBJECTIVES

500 MW POWER PLANT WITH AMMONIA AND HYDROGEN PRODUCTION

Type

Combined-cycle power plant with flex-fuel turbines optimized for ethanol (natural gas or diesel as backups), augmented by ORC and heat recovery steam turbines.

Output

500 MW, including 450 MW from combined-cycle turbines and 50 MW from ORC and heat recovery systems. Power is used internally for:

- **Ammonia Production:** 200,000 tons/year via electrolysis (producing hydrogen) and Haber-Bosch synthesis using nitrogen from air separation units.
- **Hydrogen Production:** 50,000 tons/year via electrolysis, stored as liquid hydrogen or compressed gas.

Location

Adjacent to the ethanol facility to minimize transportation and emissions.

Efficiency Enhancements

- **ORC Turbines:** Utilize low-grade waste heat (100–200°C) from fermentation, syngas production, and power plant exhaust to generate ~30 MW.
- **Heat Recovery Steam Turbines:** Capture high-grade waste heat to produce steam, generating ~20 MW.
- **Combined efficiency:** ~65% (vs. 60% without ORC/heat recovery), reducing fuel consumption by ~8%.

Electrolysis and Ammonia Synthesis

- **Electrolysis:** Alkaline electrolyzers (50 MW capacity) produce hydrogen at 4.5 kWh/kg H₂, consuming 225,000 MWh/year for 50,000 tons H₂.
- **Ammonia Synthesis:** Haber-Bosch process uses 1.5 tons H₂ per ton NH₃, with nitrogen from air separation units. Total **power consumption:** 1,600,000 MWh/year for 200,000 tons NH₃.
- Remaining power supports facility operations and grid stability.

PROJECT COSTS

Cellulosic Biomass, Organic Waste, and Kenaf Ethanol Facility



Capital Costs

- Land acquisition (100 hectares for biorefinery and kenaf processing): **\$5 million**
- Biorefinery construction (fermentation tanks, pretreatment, distillation): **\$250 million**
- Equipment (enzymatic hydrolysis systems, waste sorting, syngas fermenters, IoT sensors, ORC integration): **\$150 million**
- Kenaf cultivation infrastructure (irrigation, planting systems): **\$30 million**
- Waste collection and preprocessing systems: **\$40 million**
- Engineering, procurement, and construction (EPC) services: **\$60 million**
- Subtotal: **\$535 million**
- Contingency (25%): **\$133.75 million**
- Total Capital Cost: **\$668.75 million**

Source Reference

Based on cellulosic ethanol plants (e.g., DuPont's 30 million gallon facility at \$225 million) and waste-to-ethanol projects (e.g., Enerkem's MSW ethanol), scaled to 200 million gallons/year, with ORC costs (~\$15 million) from Turboden projects.

PROJECT COSTS

500 MW Power Plant with Ammonia and Hydrogen Production



Capital Costs

- Turbine and generator systems (flex-fuel combined-cycle, ORC, heat recovery turbines): **\$380 million**
- Infrastructure (cooling systems, grid connection, control systems): **\$160 million**
- Electrolysis units (50 MW alkaline electrolyzers): **\$50 million**
- Ammonia synthesis plant (Haber-Bosch and air separation units): **\$100 million**
- Hydrogen storage and compression systems: **\$30 million**
- Construction and site preparation: **\$120 million**
- EPC services: **\$70 million**
- Subtotal: **\$910 million**
- Contingency (25%): **\$227.5 million**
- Total Capital Cost: **\$1,137.5 million**

Source Reference

Based on Quisqueya I & II (\$700 million for 430 MW), adjusted for ORC (\$30 million), heat recovery (\$20 million), electrolysis (\$1,000/kW), and ammonia plant costs (\$500/ton annual capacity).

TOTAL PROJECT COST



ETHANOL FACILITY:
\$668.75 MILLION

POWER PLANT AND AMMONIA/
HYDROGEN PRODUCTION:
\$1,137.5 MILLION

GRAND TOTAL:
\$1,806.25 MILLION

OPERATIONAL COSTS

Cellulosic Biomass, Organic Waste, and Kenaf Ethanol Facility

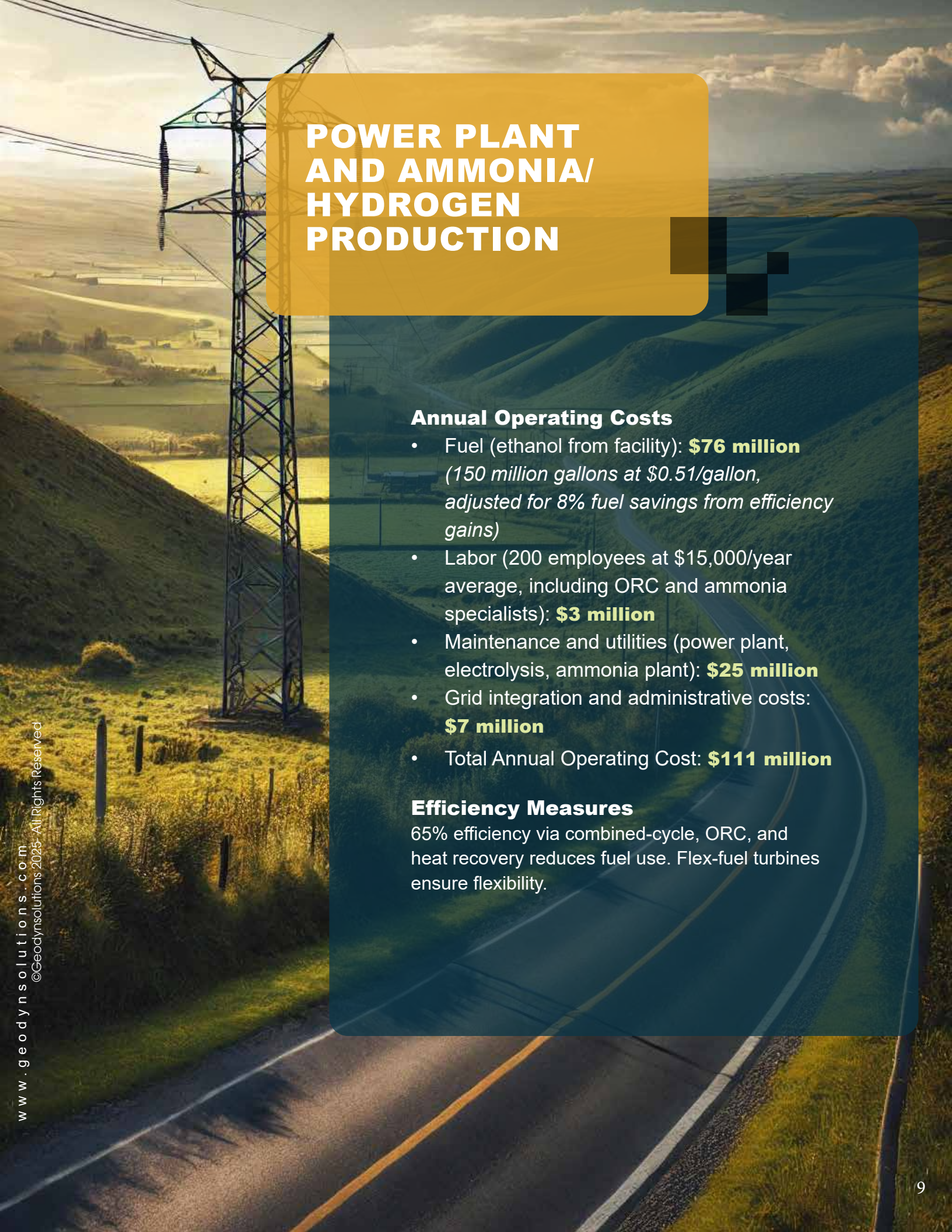
Annual Operating Costs:

- Feedstock (biomass: \$10/ton, organic waste: \$5/ton, kenaf: \$15/ton): **\$22.5 million**
- Labor (700 employees at \$12,000/year average, including waste processing specialists): **\$8.4 million**
- Maintenance and utilities (biorefinery, waste sorting, electricity, water recycling): **\$35 million**
- Administrative and overhead: **\$12 million**
- Total Annual Operating Cost: **\$77.9 million**

Efficiency Measures:

Biogas from organic waste reduces external energy needs by 15%. ORC recycles waste heat, cutting energy costs by 10%. IoT optimizes feedstock processing and fermentation.





POWER PLANT AND AMMONIA/ HYDROGEN PRODUCTION

Annual Operating Costs

- Fuel (ethanol from facility): **\$76 million**
*(150 million gallons at \$0.51/gallon,
adjusted for 8% fuel savings from efficiency
gains)*
- Labor (200 employees at \$15,000/year
average, including ORC and ammonia
specialists): **\$3 million**
- Maintenance and utilities (power plant,
electrolysis, ammonia plant): **\$25 million**
- Grid integration and administrative costs:
\$7 million
- Total Annual Operating Cost: **\$111 million**

Efficiency Measures

65% efficiency via combined-cycle, ORC, and heat recovery reduces fuel use. Flex-fuel turbines ensure flexibility.



TOTAL ANNUAL OPERATIONAL COST

ETHANOL FACILITY:
\$77.9 MILLION

POWER PLANT AND AMMONIA/
HYDROGEN PRODUCTION:
\$111 MILLION

GRAND TOTAL:
\$188.9 MILLION



REVENUE AND RETURN ON INVESTMENT (ROI)

Ammonia Sales:

- **Output: 200,000 tons/year**
- **Price: \$600/ton** (global green ammonia market price, 2025 estimate)
- **Annual revenue:** 200,000 tons × \$600 = **\$120 million**

Hydrogen Sales:

- **Output: 50,000 tons/year**
- **Price: \$3,000/ton** (green hydrogen market price, 2025 estimate)
- **Annual revenue:** 50,000 tons × \$3,000 = **\$150 million**

Ethanol Surplus Sales:

- **Surplus ethanol: 50 million gallons**
- **Price: \$2/gallon** (local market price for E85 blend)
- **Annual revenue:** 50 million gallons × \$2 = **\$100 million**

Byproduct Sales (Biochar and Digestate):

- **Output: 100,000 tons/year of biochar** (from pyrolysis of non-fermentable waste) and digestate (from anaerobic digestion)
- **Price: \$100/ton**
- **Annual revenue:** 100,000 tons × \$100 = **\$10 million**

Carbon Credits:

- **Estimated CO₂ reduction: 1.9 million tons/year** (see Environmental Benefits)
- **Carbon credit price: \$50/ton** (conservative estimate)
- **Annual revenue:** 1.9 million tons × \$50 = **\$95 million**

Total Annual Revenue:

- \$120 million + \$150 million + \$100 million + \$10 million + \$95 million = **\$475 million**

ROI CALCULATION

NET ANNUAL PROFIT

- *Revenue:* **\$475 million**
- *Operational Costs:* **\$188.9 million**
- *Net Profit:* \$475 million - \$188.9 million = **\$286.1 million**

PAYBACK PERIOD

- *Total Investment:* **\$1,806.25 million**
- *Payback:* \$1,806.25 million ÷ \$286.1 million ≈ **6.31 years**

ROI

- *Annual ROI:* (\$286.1 million ÷ \$1,806.25 million) × 100 ≈ **15.8%**
- *10-Year Net Present Value (NPV) at 8% discount rate:*
 - $NPV = \sum (\text{Net Profit} \div (1 + 0.08)^t) - \text{Initial Investment}$
 - NPV ≈ \$680 million (indicating positive financial viability)

The background of the slide is a close-up photograph of a woven bamboo basket. The bamboo strips are light brown and tan, with some darker, charred-looking sections. The weaving pattern is a complex diagonal twill, creating a textured, three-dimensional appearance. The lighting is warm, highlighting the natural grain and texture of the bamboo.

COMPARISON TO PREVIOUS PROPOSAL

The previous proposal, which sold electricity at \$0.17/kWh, yielded an annual ROI of 45.4% and a payback period of 2.20 years due to higher revenue (\$875 million vs. \$475 million). Converting electricity to ammonia and hydrogen reduces ROI because of lower market prices for these products compared to electricity in the Dominican Republic's high-tariff market. However, ammonia and hydrogen offer strategic benefits, including export potential and alignment with global decarbonization trends.

JOB CREATION



Construction Phase (2–3 years):

- Ethanol Facility: **2,000 direct jobs** (construction workers, engineers, waste processing specialists)
- Power Plant and Ammonia/Hydrogen Production: **1,500 direct jobs** (includes ORC, electrolysis, and ammonia plant integration)
- Indirect jobs (supply chain, logistics, kenaf cultivation): **2,700**
- Total: **~6,200 jobs**

Operational Phase:

- Ethanol Facility: **700 direct jobs** (biorefinery operators, waste sorters, kenaf farmers)
- Power Plant and Ammonia/Hydrogen Production: **200 direct jobs** (engineers, maintenance, ORC, ammonia specialists)
- Indirect jobs (feedstock supply, distribution, hydrogen logistics): **1,400**
- Total: **~2,300 permanent jobs**

Community Impact: Local hiring prioritized, with training programs for cellulosic ethanol production, waste management, kenaf farming, and ammonia/hydrogen technologies. Partnerships with universities (e.g., UASD) will foster renewable energy education.

ENVIRONMENTAL BENEFITS



GHG Emissions Reduction:

- Ethanol-based power and green ammonia/hydrogen production reduce CO₂ emissions by ~1.9 million tons/year (lifecycle analysis of cellulosic/organic ethanol and green H₂/NH₃ vs. fossil-based alternatives, enhanced by ORC efficiency).
- Avoids 400,000 barrels of oil imports annually, enhancing energy security.

Waste Reduction:

- Processes 500,000 tons/year of organic waste, reducing landfill methane emissions by ~100,000 tons CO₂e/year.
- Biochar sequesters carbon in soils, enhancing long-term CO₂ storage.

Land and Soil Benefits:

- Kenaf cultivation on marginal land (50,000 hectares) improves soil health and sequesters 5–10 tons CO₂/acre/year.
- Commitment to reforest 500 hectares with native species to enhance biodiversity.

ENVIRONMENTAL BENEFITS



Pollution Control:

- ORC and heat recovery reduce fuel use, lowering NOx and SOx emissions by ~10%.
- Advanced waste sorting and enclosed systems minimize air and water pollution.
- Water recycling reduces freshwater use by 20%.

Compliance with Regulations:

- Adheres to Dominican Republic's environmental laws and UNFCCC commitments (27% GHG reduction by 2030).
- Environmental impact assessments completed, with mitigation for land and water impacts.

Community Fund:

5% of carbon credit revenue allocated to soil restoration and community-led environmental projects.

INCENTIVES AND POLICY SUPPORT



LAW 57-07 (RENEWABLE ENERGY INCENTIVES):

- 100% tariff exemption on imported equipment (*biorefinery systems, ORC, electrolysis units*).
- Tax exemptions on profits (*up to 2020, with extensions possible as of 2023*).



NATIONAL ENERGY PLAN:

Supports renewable energy expansion to 25% by 2025, aligning with project goals.

CARBON MARKET:

Eligibility for CDM and Gold Standard certification, enhancing financial stability.



TECHNOLOGICAL ADVANCEMENTS TO SURPASS SUGARCANE



Yield Improvements

- Cellulosic Biomass and Kenaf: **500–700 gallons/acre** (vs. sugarcane's 600–800) via optimized pretreatment and high-yield kenaf varieties. Biomass availability (10–20 tons/acre) ensures scalability.
- Organic Waste: **100–150 gallons/ton** via syngas fermentation, leveraging abundant MSW.

Sustainability Enhancements

- No food crop competition, unlike sugarcane's land-intensive cultivation.
- Utilizes waste and marginal land, reducing environmental footprint.
- Biochar and digestate improve soil health, unlike sugarcane's soil degradation.

Efficiency Gains

- Microbebio's proprietary enzymes and genetically modified microbes increase cellulose conversion by 15–20% over sugarcane's sucrose fermentation.
- Integrated biorefinery recycles biogas and waste heat, reducing energy use by 15%.
- IoT and AI optimize feedstock processing and fermentation, cutting costs by 10%.

Scalability

Abundant biomass (e.g., 10 million tons/year bagasse in the Dominican Republic) and waste (1.5 million tons/year MSW) ensure feedstock security, surpassing sugarcane's land constraints.

IMPLEMENTATION PLAN

PHASE 1 (YEAR 1)

- Feasibility studies, environmental impact assessments, and permitting.
- Land acquisition and financing (green bonds, IDB loans).

PHASE 2 (YEARS 2-3)

- Construction of ethanol facility, kenaf farms, waste collection systems, power plant, and ammonia/hydrogen production units with ORC/heat recovery.
- Establish feedstock supply chains with farmers and municipalities.

PHASE 3 (YEAR 4)

- Commissioning and testing of facilities.
- Initial ethanol, ammonia, and hydrogen production.

PHASE 4 (YEAR 5 ONWARD)

- Full-scale operations, surplus ethanol and byproduct sales, and carbon credit monetization.

RISKS AND MITIGATION

Risk: Feedstock supply disruptions.

Mitigation: Diversify biomass sources and secure long-term waste contracts; scale kenaf cultivation as needed.

Risk: High pretreatment costs.

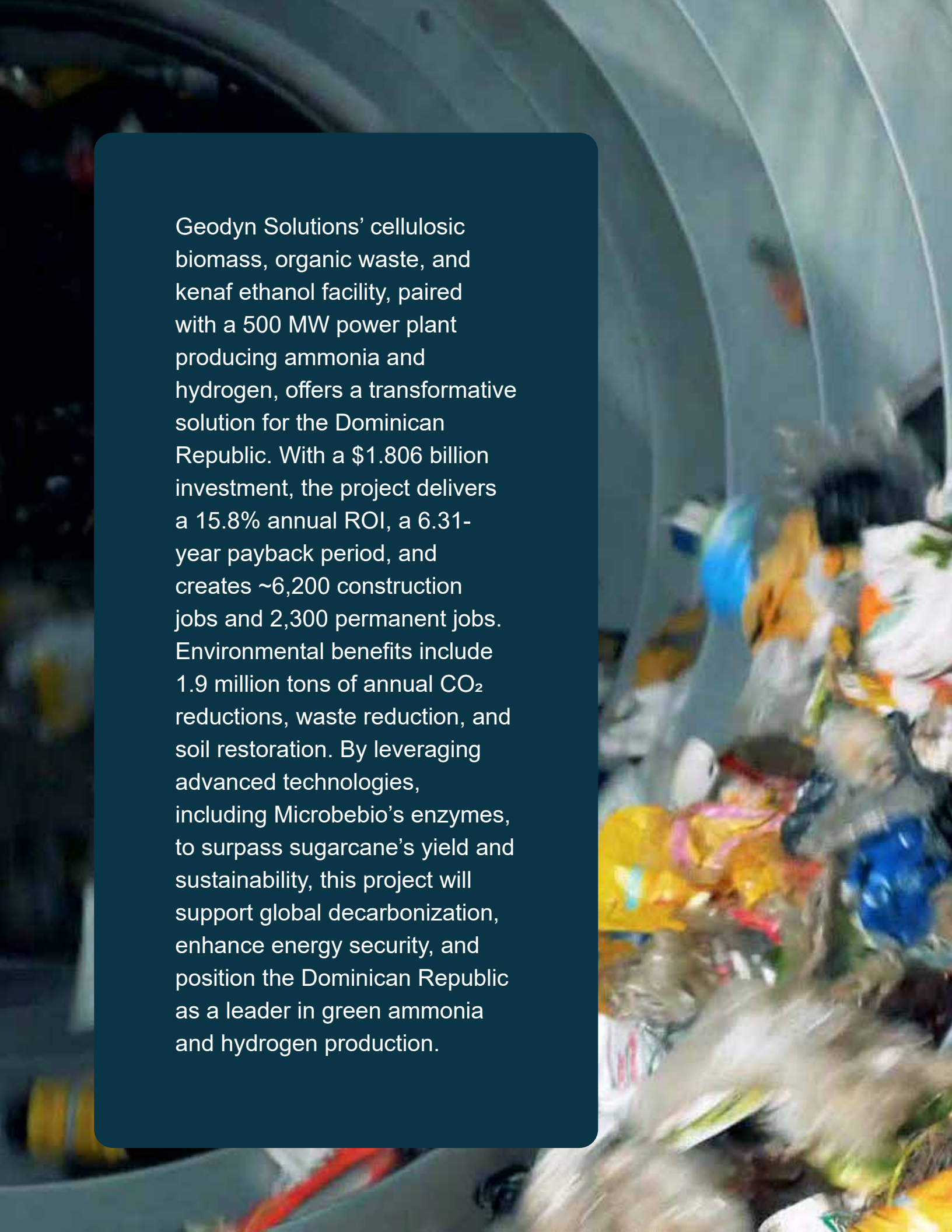
Mitigation: Partner with Microbebio for cost-effective enzymes and optimize processes in Phase 1.

Risk: Ammonia/hydrogen market volatility.

Mitigation: Secure long-term offtake agreements with fertilizer and energy sectors; diversify revenue with ethanol sales.

Risk: Construction delays.

Mitigation: Experienced EPC contractors and 25% contingency budget.



Geodyn Solutions' cellulosic biomass, organic waste, and kenaf ethanol facility, paired with a 500 MW power plant producing ammonia and hydrogen, offers a transformative solution for the Dominican Republic. With a \$1.806 billion investment, the project delivers a 15.8% annual ROI, a 6.31-year payback period, and creates ~6,200 construction jobs and 2,300 permanent jobs. Environmental benefits include 1.9 million tons of annual CO₂ reductions, waste reduction, and soil restoration. By leveraging advanced technologies, including Microbebio's enzymes, to surpass sugarcane's yield and sustainability, this project will support global decarbonization, enhance energy security, and position the Dominican Republic as a leader in green ammonia and hydrogen production.



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