

## On-Site Application of ATP's CRBBP Process to Reduce the Adverse Environmental Impacts of Power Plants

ATP's CRBBP Process Cost-Effectively:

- Captures Substantial Amounts of Flue Gas CO<sub>2</sub>
- Reuses Captured Carbon as "Cost-Advantaged" Bio-Coal, Compliant With EPA's ACE Program
- Makes Other "Cost-Advantaged" Bio-Products,
- May Perform Additional Beneficial Tasks, like Remediating Coal Ash, as it is Produced

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## Challenges & Opportunities

### Challenges:

- **Global Warming:** We need timely and cost-effective CO<sub>2</sub> capture, carbon re-use & sequestration mechanisms.
- **Cleaner Coal:** We need cost-effective ways to reduce the environmental impacts of burning coal.
- **Coal Ash:** We need cost-effective ways to remediate toxic coal ash, as it is produced, rather than store it in sites.

### Opportunities:

- **Our CRBBP Process:** Can cost-effectively reduce the environmental impacts of coal, gas and biomass-fired power plants, while converting captured carbon into cost-advantaged Bio-Coal and other cost-advantaged and environmentally beneficial Bio-Products.



## ATP's CRBBP Process

We plant and then multi-task bio-crops and their resulting biomass, to do good things, for people and the planet, less expensively.



## Bio-Crops Are Bred to Grow Fast, Big and to Do Good Things!!!



Standard Sorghum



Biomass Sorghum



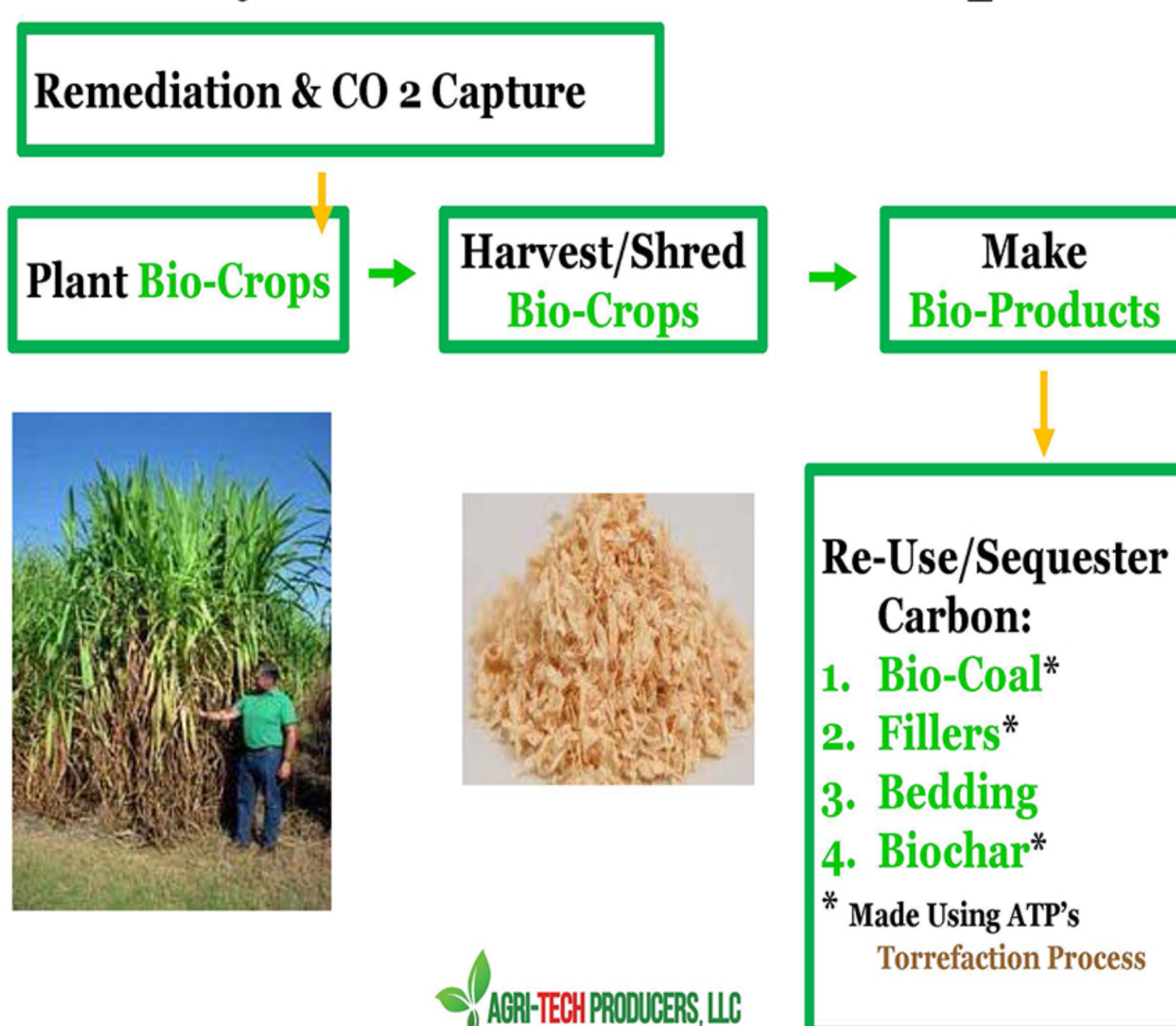
## CRBBP Process: Two, Key Biological Processes

**Photosynthesis:** A process by which plants and trees absorb atmospheric carbon dioxide (CO<sub>2</sub>) and converts it, along with water, nutrients and sunlight, into plant and tree material.

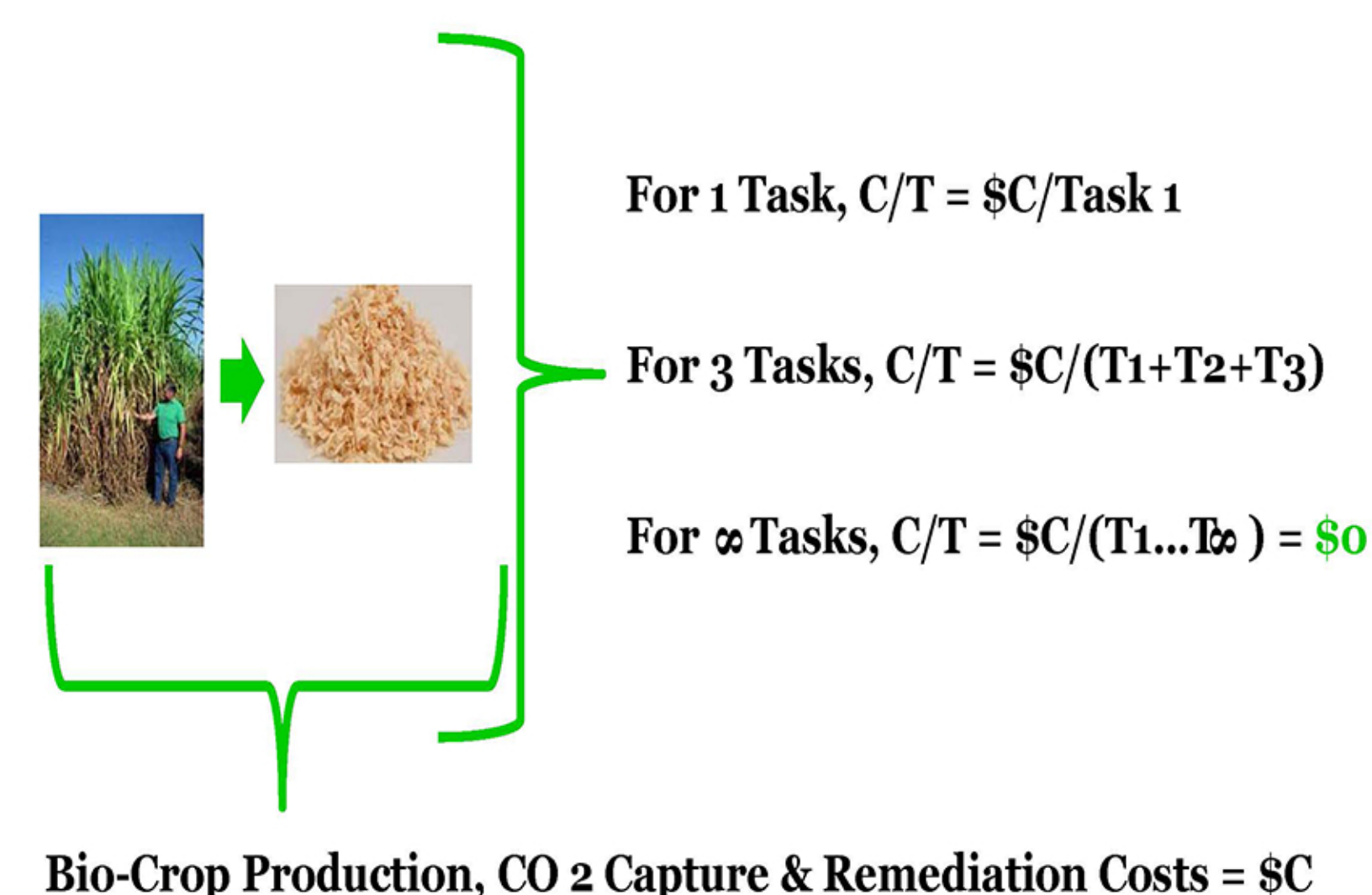
**Phytoremediation:** A process by which plants and trees uptake problematic substances, from air, soil and water.



## Key CRBBP Process Steps



## CRBBP Process: Multi-Tasking Reduces Costs Per Task (\$C/T)



Bio-Crop Production, CO<sub>2</sub> Capture & Remediation Costs = \$C



## The Superior CO<sub>2</sub> Capture Capabilities of Biomass Sorghum

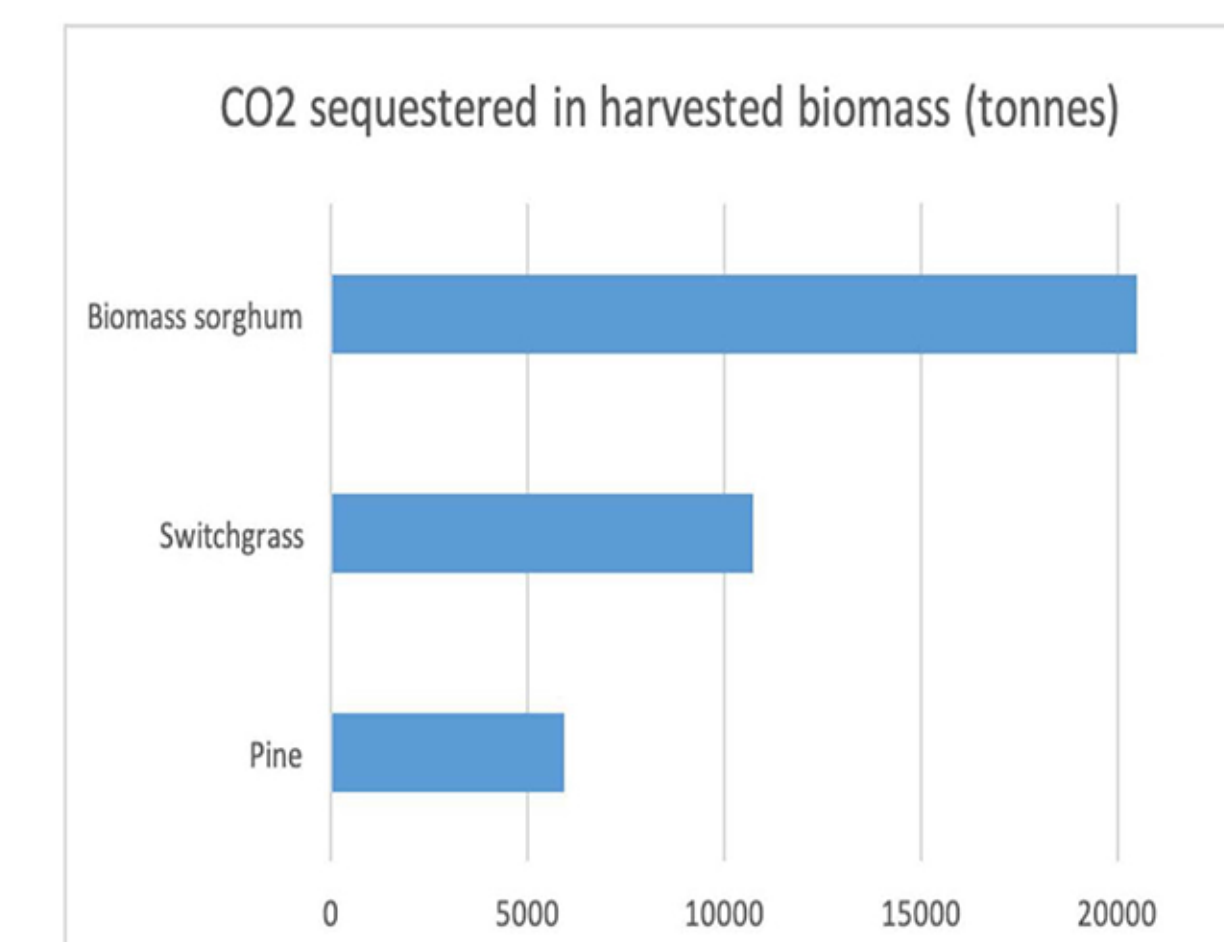


Figure 2. Relative amounts of CO<sub>2</sub> captured over 15-year period from 100-acre plot of forage sorghum, switchgrass, and pine. Credit: Dr. Daniel Sanchez, University of California-Berkeley.



## Vertical Bio-Crop Farms (VBF's) Can Capture Power Plant CO<sub>2</sub> & Treat New Coal Ash Residues



## VBF's: May More Than Double Biomass Sorghum Yields!!!

- The **REGULAR** Biomass Sorghum Growing Season is 6 months, **ONCE**, a year.
- However, our climate-controlled **VBF's**, using artificial lighting, may allow us to host **TWO** Growing Seasons, a year, thereby **Doubling** the CRBBP Process benefits offered by **REGULAR** farming.
- And, **High-CO<sub>2</sub> Environments** stimulate plant growth, further **INCREASING** yields.



## VBF's: Can Cost-Effectively Capture CO<sub>2</sub> at Various Point-Sources

- Coal-Fired Power Plants
- Gas/Oil-Fired Power Plants
- Biomass-Fired Power Plants
- Other, Large, Industrial Point-Source Emitters & CO<sub>2</sub> "Collectors"



## Our Cost-Effective & Patented Torrefaction Process

- Our **Torrefaction Process**, **Heats** plant or wood material (**Biomass**), in a **low-oxygen** environment, which evaporates away the water and much of the organic compounds, resulting in a carbon and energy-rich, charred material.
- The organic gases are **Captured** and **Burned** by our **Torrefaction Units**, to cost-effectively and with minimal environmental impact, generate **all** required **Process Heat**.
- **Torrefied Biomass** can be used to make a variety of **Bio-Products**: e.g. a clean and renewable **Bio-Coal**, co-fire fuel; **Fillers**, used to make better-performing, circular economy **Plastics**; and **Biochar**, to make poor soils more productive.



## CRBBP Process Bio-Products

- **Bio-Coal:** A clean/renewable, co-fire fuel, which can be made, in part, from power plant flue gas.  
**Value:** \$200/ton
- **Torrefied Biomass Fillers:** Help make stronger, lighter and more heat & water-resistant plastics.  
**Value:** \$400-\$600/ton
- **Poultry House Bedding:** Locally-produced, cost-advantaged, and better-performing bedding.  
**Value:** \$75 - \$95/ton.
- **Biochar Soil Amendments:** Increase the productivity and water-efficiency of poor soils.  
**Value:** \$250-\$500/ton



## Size of Bio-Product Markets

- **Bio-Coal:** The **9+ billion** TPY, global coal market
- **Torrefied Biomass Fillers:** The **\$380 billion** US plastics market
- **Poultry House Bedding:** The **\$48.3 billion** US poultry market
- **Biochar:** The **\$8 billion** US garden consumables market



## ATP's Collaborators

**Industry:** Electric Power Research Inst. (EPRI), Bio-Crop Seed Companies, Farmers, Manufacturers, Etc.

**US Government:** EPA, USDA: NRCS, Rural Development, USCP

**Universities:** Univ. of Akron, Clemson, NC State, Penn State, South Carolina State, UMD, UMES, VA Tech



## Key Milestones Achieved

- Our **CRBBP Process** was invented in 2016 and patented in 2018, while, our **Torrefaction Process** was patented, in 2012.
- In collaboration with the Electric Power Research Institute (EPRI), we have demonstrated our **Bio-Coal** as a superior, clean and renewable fuel, easy to co-fire in coal-fired power plants.
- We have planted our **CRBBP Process** bio-crops in Chesapeake Bay watershed farm soils, in Maryland, Pennsylvania and now Virginia, to extract excess nitrogen and phosphorus, to protect fish and other aquatic life in the Bay.
- And, we plan to conduct new bio-crop plantings in Lake Erie's Western Ohio watershed, to protect the lake, and in rural, wastewater treatment plant spray fields, to keep their operating and capital costs low, while improving water quality.
- We have demonstrated the superiority of and are creating markets for our **Bedding** and **Bio-Based Filler Powders**.

