# Magnetohydrodynamics Power Generation Workshop

**Oxycombustion/Oxygen Production**

## An Oxy-MHD Topping Cycle for Maximum Power and $CO_2$ Capture

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CO2-Global

Presented by Victor Der

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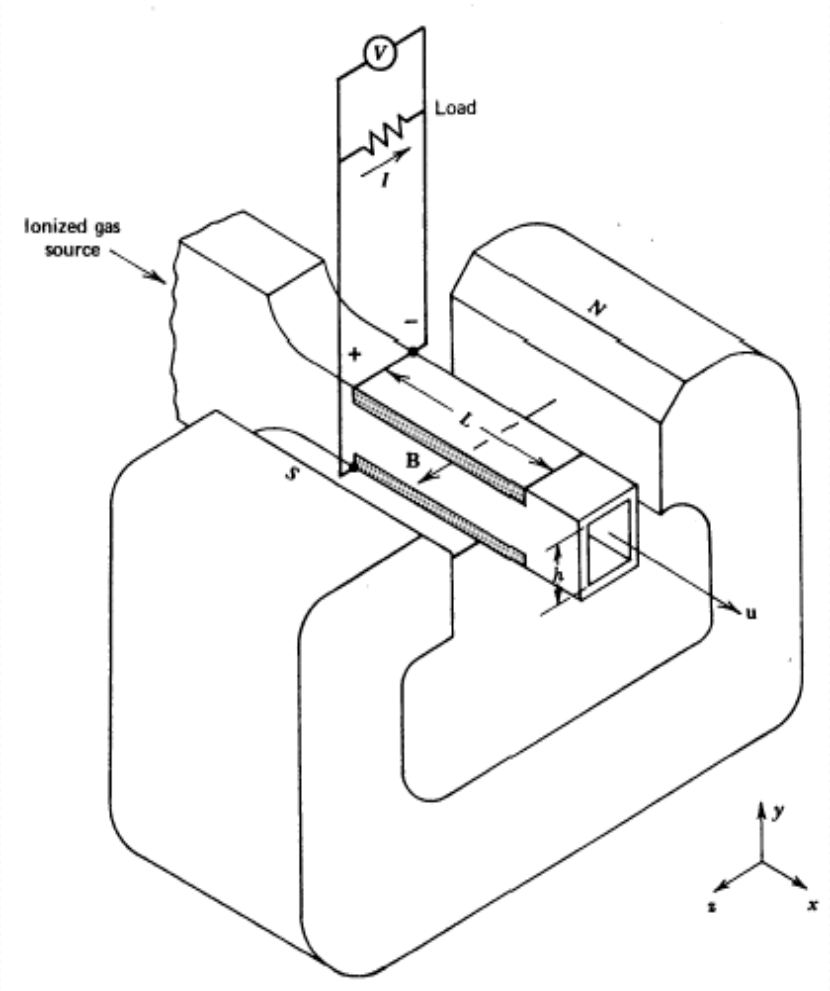
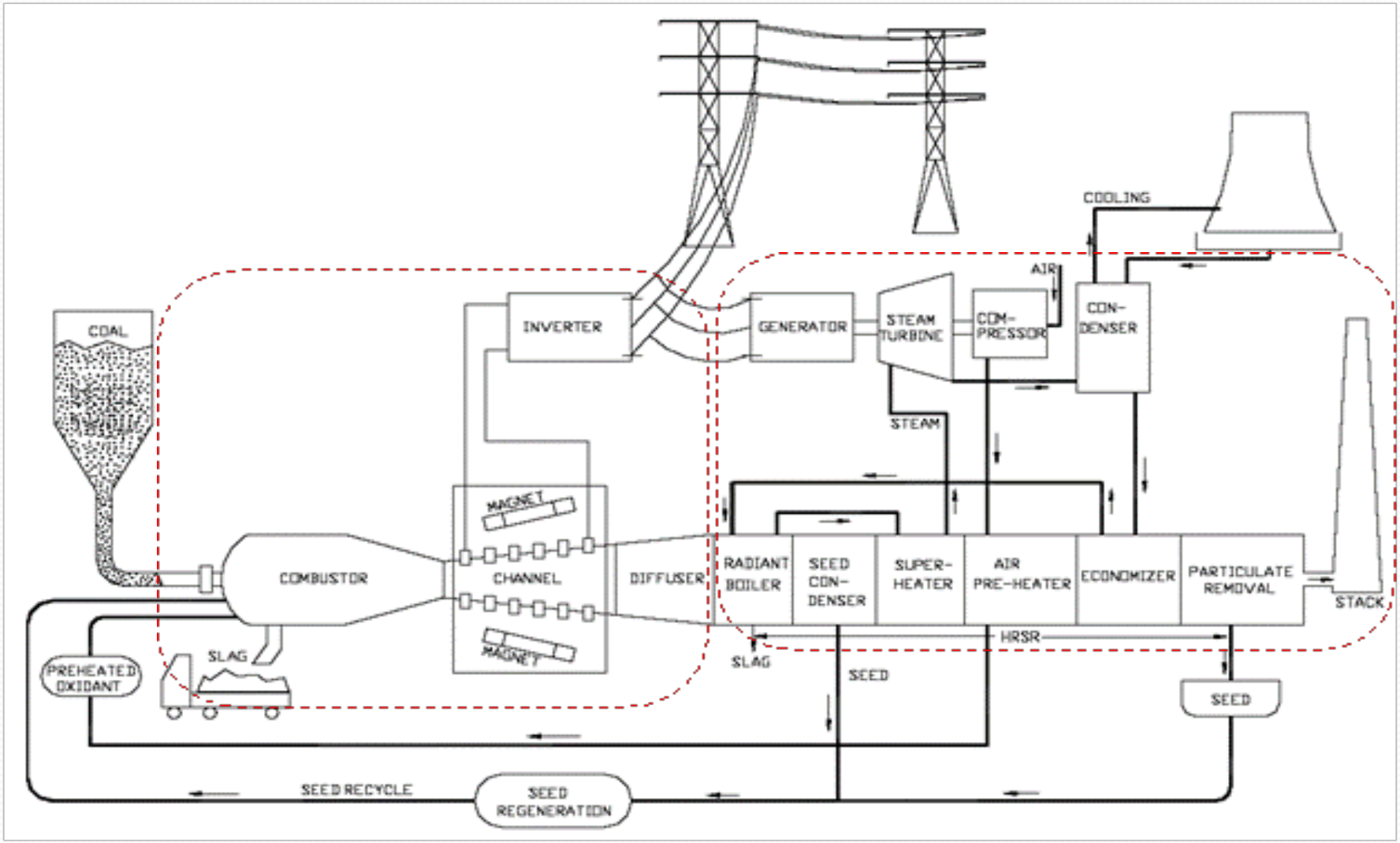
# What is MHD? - the physics

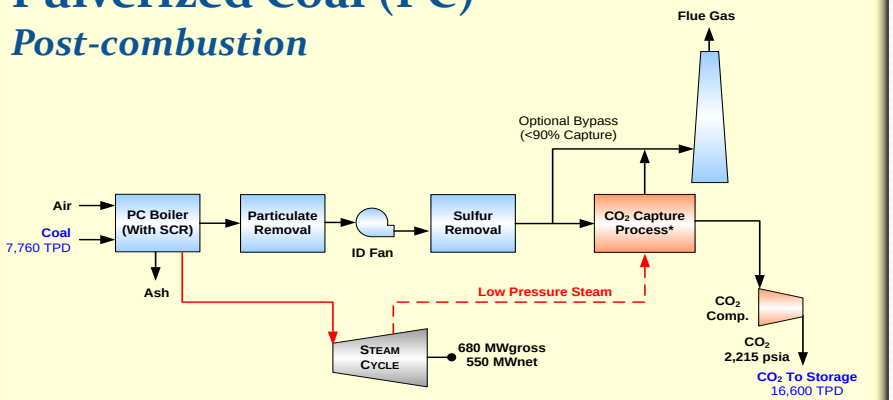


# What is MHD? - a 1980s DoE design

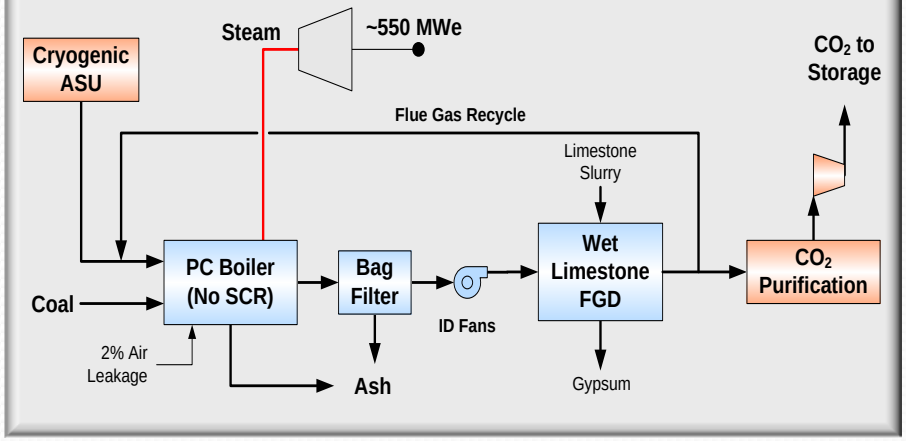


# $CO_2$ Capture Options for Fossil Energy Generators – MHD as Auxiliary Heat and Power

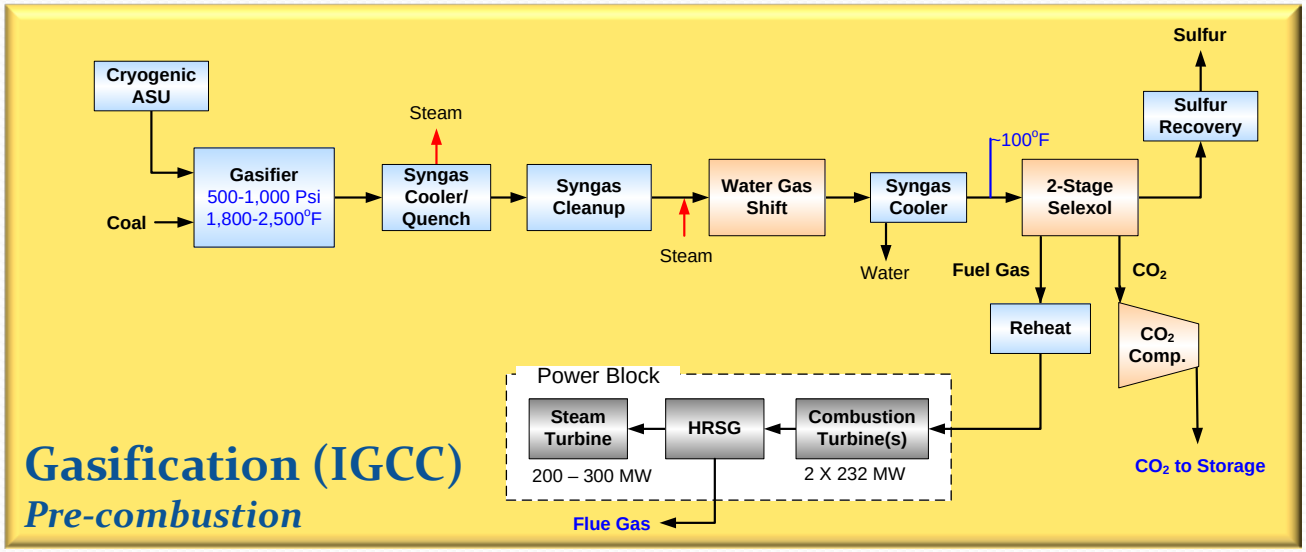
## Pulverized Coal (PC)
*Post-combustion*




## PC Oxy-combustion




## Gasification (IGCC)
*Pre-combustion*

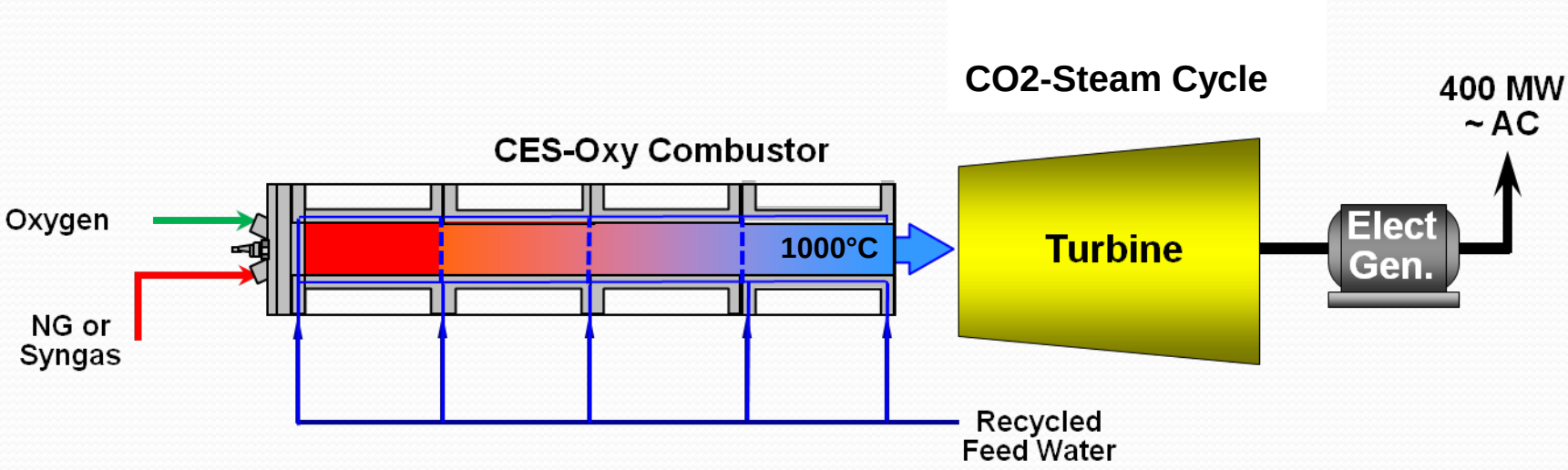



**Technologies also applicable to:**

- Industrial sources (cement, refinery, chemical…)
- NGCC power plants

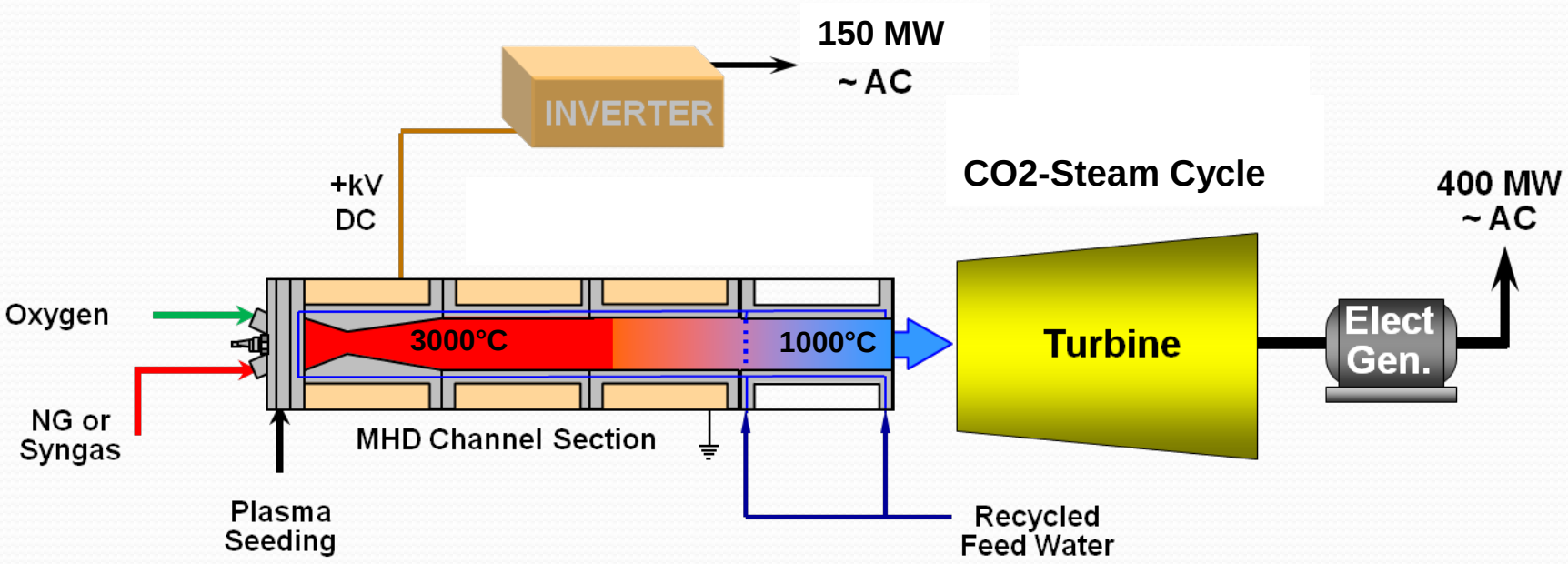
*Source: Cost and Performance Baseline for Fossil Energy Power Plants study, Volume 1: Bituminous Coal and Natural Gas to Electricity; NETL, May 2007.*

# An Oxycombustion Power Cycle without MHD



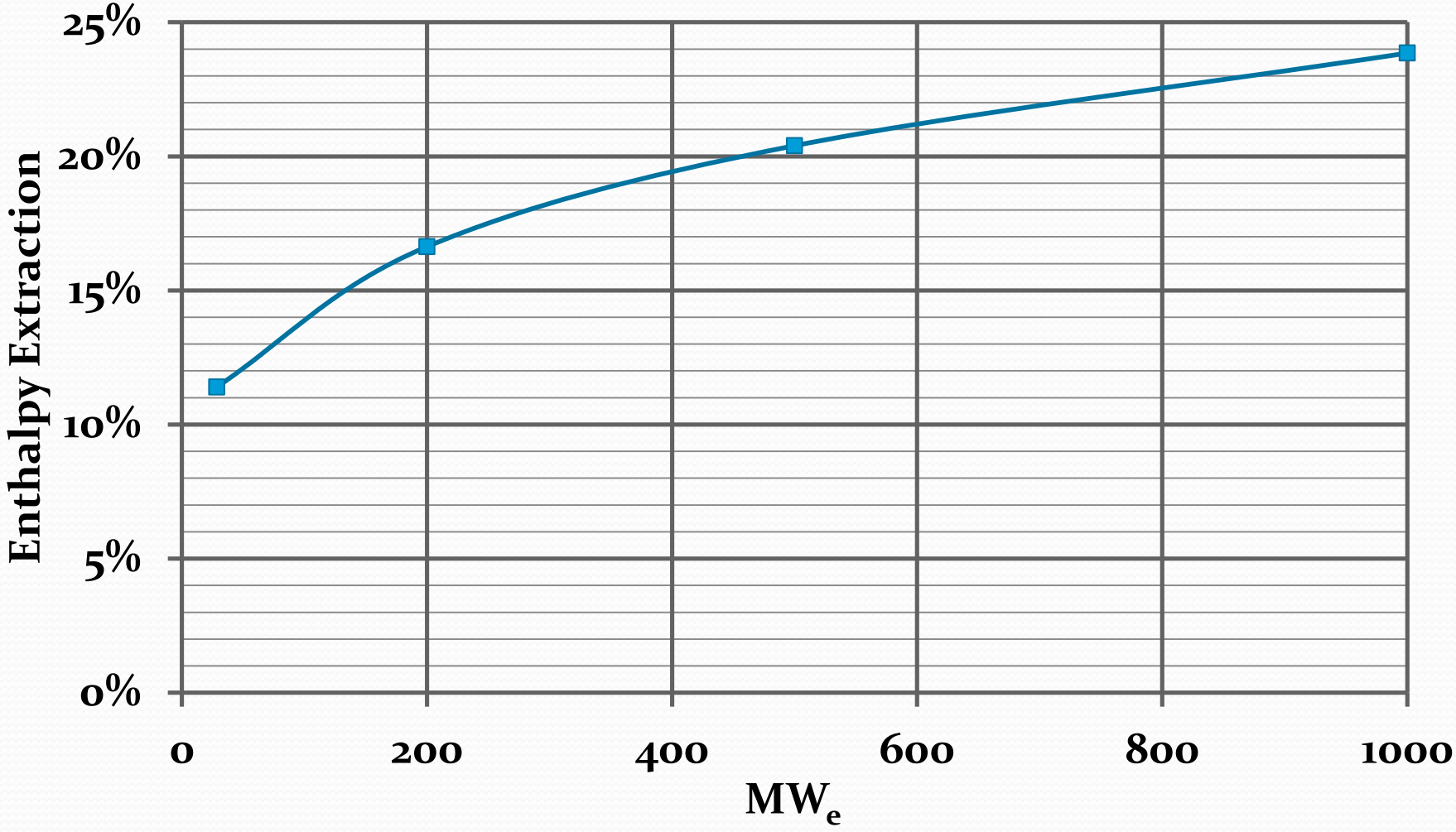

**Limits turbine-inlet temperature to 1000ºC**

# An Oxycombustion Power Cycle with MHD topping

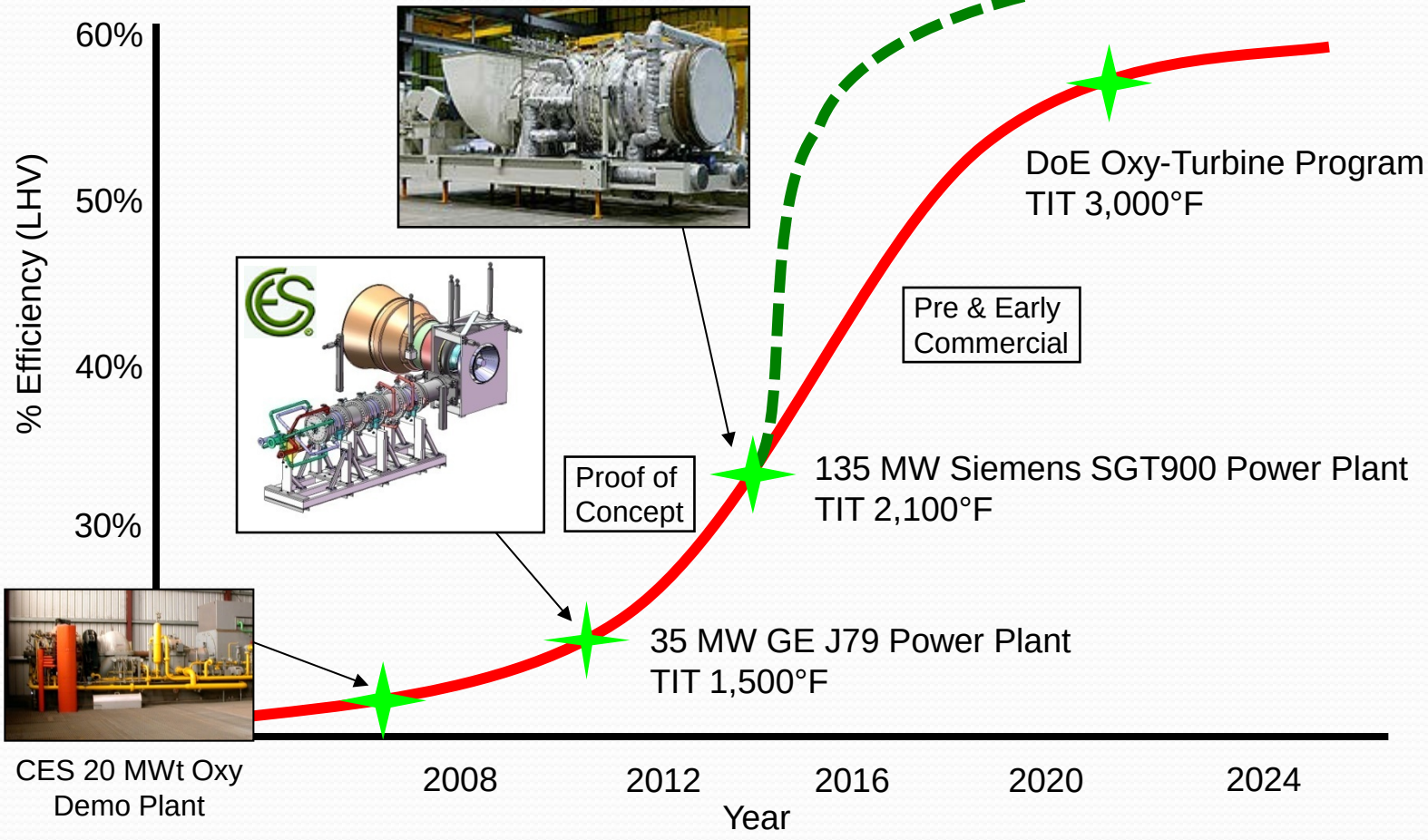



**Maximum gas temperature 3000°C**

# Added "Efficiency" *vs.* Output



# Efficiency *vs.* Time



# Possible Commercial Applications

- EOR projects with high power demand
  - smaller scale, lower efficiency
  - utilizing $CO_2$
- Utility power with no stack
  - larger scale, higher efficiency
  - storing $CO_2$

# How can we do this now?

| 1980s MHD Programs | Now |
|---|---|
| Needed more efficient, robust, stronger and cheaper magnets | High-temperature superconducting magnets |
| Needed durable insulators, electrodes, heat exchangers | Metallurgy and ceramic technology are advancing |
| Short life for ducting, nozzles, valves | Improved computational plasma fluid dynamics |
| Complex power consolidation from plasma to electrical grid | Computer systems aid in design and power conditioning |
| Electrode plasma arcing | Control technologies to enhance fault protection and mitigate arcing |
| Needed high temperatures air pre-heater or supplemental oxygen | Large-scale commercial ASU or next-generation ITM already in CES process |
| No value for $CO_2$ | Capture and use of $CO_2$, e.g. EOR |

# Progress

- Confirmed availability of workable electrodes
- Preliminary design of sized MHD channels
- Scoping design of HT superconducting magnet
- First-pass process-simulation model
- Rough economics

# Plans

- Match MHD channel design to turbine
- Improve overall cycle integration
- Work around 2000-hour electrodes
- Parallel program for 8000-hour electrodes
- Economics for demo and commercial plant
- Small demonstration unit for electrodes
- First-of-a-kind commercial plant

# Acknowledgements


- Shell GameChanger team
  - Financial support
  - Patent support
  - Commercial guidance
- Alumni of the DOE MHD program
  - Technical guidance
  - Identifying available resources