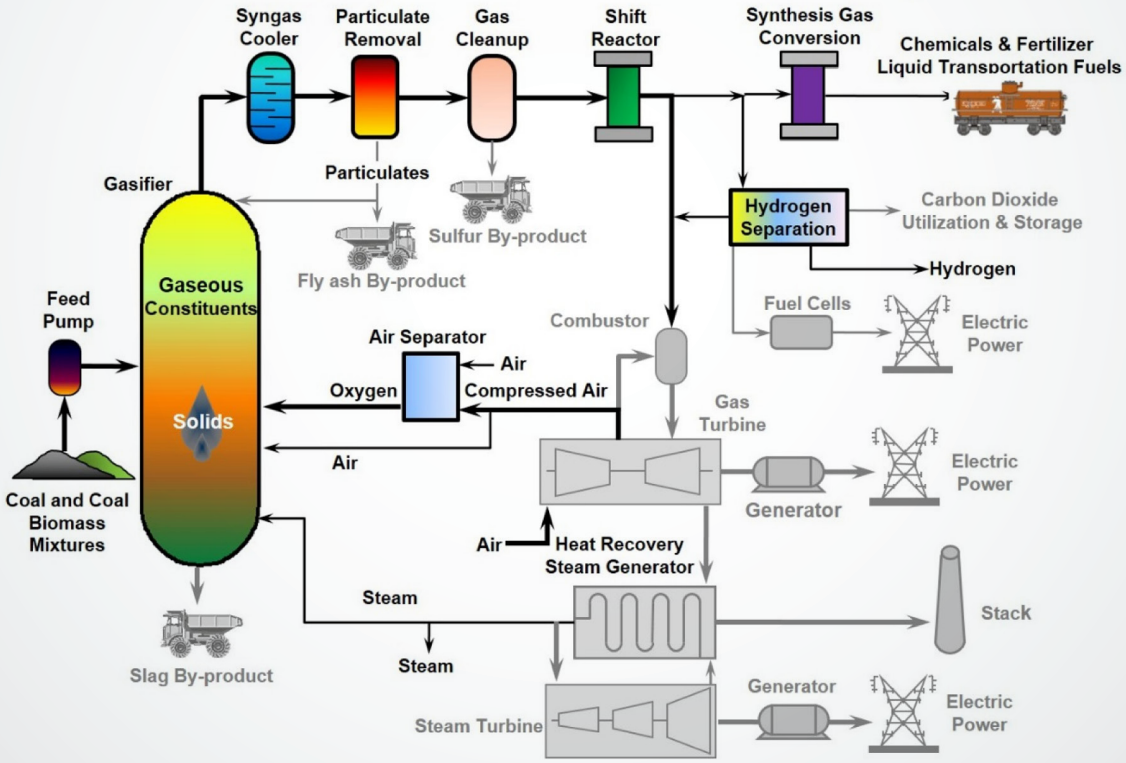
GASIFICATION SYSTEMS AND C&CBTL PROGRAM



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NATIONAL ENERGY TECHNOLOGY LABORATORY

OVERVIEW

The Department of Energy (DOE) leads the nation in transformational research, development, and demonstration (RD&D) of an extensive range of clean and efficient technologies supporting an "all of the above" energy strategy. Ensuring that we can continue to rely on clean, affordable energy from abundant domestic fossil fuel resources is the primary mission of DOE's Office of Fossil Energy (FE) research programs.

The DOE Gasification Systems and Coal and Coal-Biomass to Liquids (C&CBTL) programs are conducted under the DOE Clean Coal and Carbon Management Research Program (CCCMRP). CCCMRP is pursuing RD&D of advanced technologies to improve the efficiency and cost of advanced coal power systems while minimizing the cost and energy penalty of CO_2 capture, and carbon storage efforts designed to address the technical challenges of future commercial-scale projects. Achieving these RD&D goals will enable advanced power generation technologies to be competitive in both domestic and international markets.

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INTRODUCTION

The Gasification Systems and C&CBTL Programs have historically developed advanced technologies that lower the cost of producing electricity and liquid transportation fuels in large coal conversion plants with minimal environmental impact. The technologies are often expected to be integrated with other advanced energy systems technologies and rely on carbon emission reductions through advances in carbon dioxide (CO2) capture and sequestration technologies. This has been reflected via a major programmatic focus on efficient and low-emissions integrated gasification combined cycle (IGCC) plants. These plants facilitate relatively efficient carbon capture at the 90 percent level, consistent with the need to provide clean power under conditions including significantly higher natural gas prices, strong greenhouse gas (GHG) legislation, and a resurgent U.S. economy that will demand more power than currently available.

However, recent and projected low natural gas and oil prices, plus the reality that coal-based power must compete with other fossil fuels with lower carbon footprints, make it difficult for conventional coal conversion technologies to compete effectively in the U.S. marketplace. It is obvious that incremental improvements in state-of-the-art technologies for coal conversion technologies to create electricity and fuels will not be sufficient for a major role in U.S. markets or GHG reduction.

Both Gasification Systems and C&CBTL programs are undergoing a major redirection in planning, with important projects completed, ongoing projects being transitioned, and new work aligned with new approaches. The programs will focus exclusively on new directions—designated radically engineered modular systems (REMS).

The new focus is on revolutionary changes in the science, engineering, design, and construction of coal conversion plants leading to smaller, lower cost, profitable plants that support a significant reduction in GHG emissions from coal in the United States and abroad. Note that REMS will continue to take advantage of programmatic synergy between Gasification Systems and C&CBTL, in which advances in coal gasification will not only improve the efficiency and cost of creating electricity, but could also reduce the cost of creating liquid transportation fuels.

PROGRAM RESEARCH AND DEVELOPMENT

GASIFICATION SYSTEMS PROGRAM — The Gasification Systems Program develops advanced technologies that lower the cost of producing ultraclean, high-hydrogen syngas; increase the efficiency of coal conversion systems; and facilitate the reduction of greenhouse gas emissions. The key technologies of the Gasification Systems Program include:

- **Air Separation**—Gasification plants run more efficiently and can be configured to more economically capture CO2 if the oxidant is oxygen rather than air. However, creating oxygen is expensive. The cryogenic air separation unit used in state-of-the-art gasification plants typically accounts for 12–15 percent of the overall capital cost of the IGCC plant, and also consumes a large quantity of parasitic power for operation. Accordingly, this key technology addresses reduction of cost and increases efficiency, with focus on identification of new concepts and technologies for production of oxygen for feed to gasifiers.
- **Reactor Engineering Design**—This a newly devised key technology addressing control of chemical reactions with unprecedented precision in increasingly modular and efficient reactors, allowing for smaller reactors and streamlined processes to convert coal into valuable products at low cost and with high energy efficiency.
- **Site-Specific Coal Conversion**—Many coal producing regions in the United States are economically depressed because of the reduction in U.S. coal use. There is a general trend on the part of coal owners to export U.S. coal. This key technology is intended to reverse both so that the populations at specific sites, such as near coal mines, will increase in value. The site-specific coal conversion key technology is currently addressing bio-conversion technologies development to encourage native microbial communities present in different coals to significantly increase the rate at which they convert coal into methane. Techniques may include the addition of inexpensive nutrients that may be limiting for the microorganisms to produce natural gas more quickly.
- **Novel Technologies to Advance Conventional Gasification**—The key technology targets increased availability and efficiency, and reducing the capital and operating costs of the major cost elements of large-scale IGCC power plants. Such plants are still an important part the technology portfolio that the nation may need for affordable power from coal, particularly in a future with higher natural gas costs and stringent carbon dioxide emission control. The high-hydrogen, ultraclean syngas needed for IGCC with CO2 capture would also be ideal for fuels or chemicals production and polygeneration applications in general.

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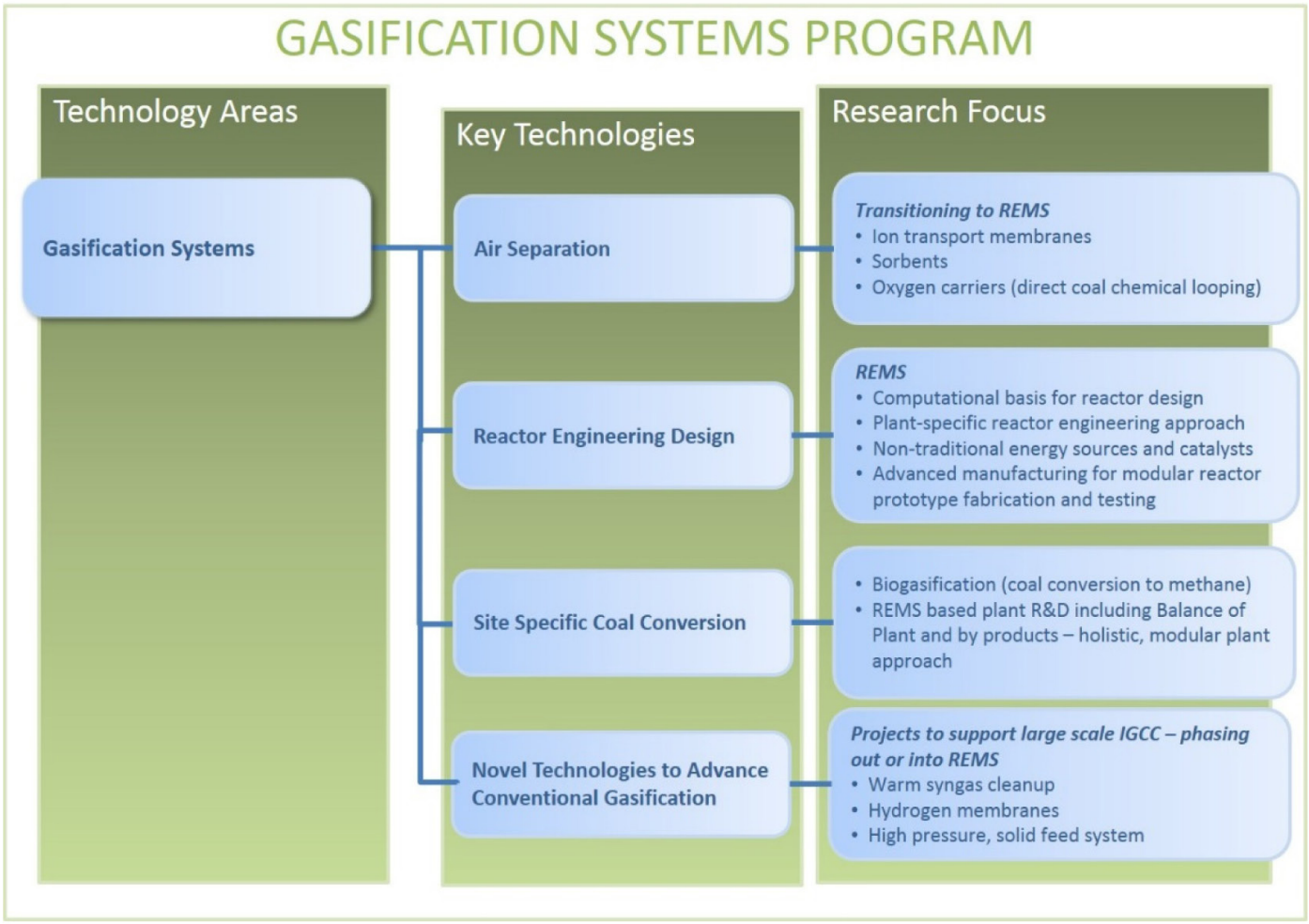


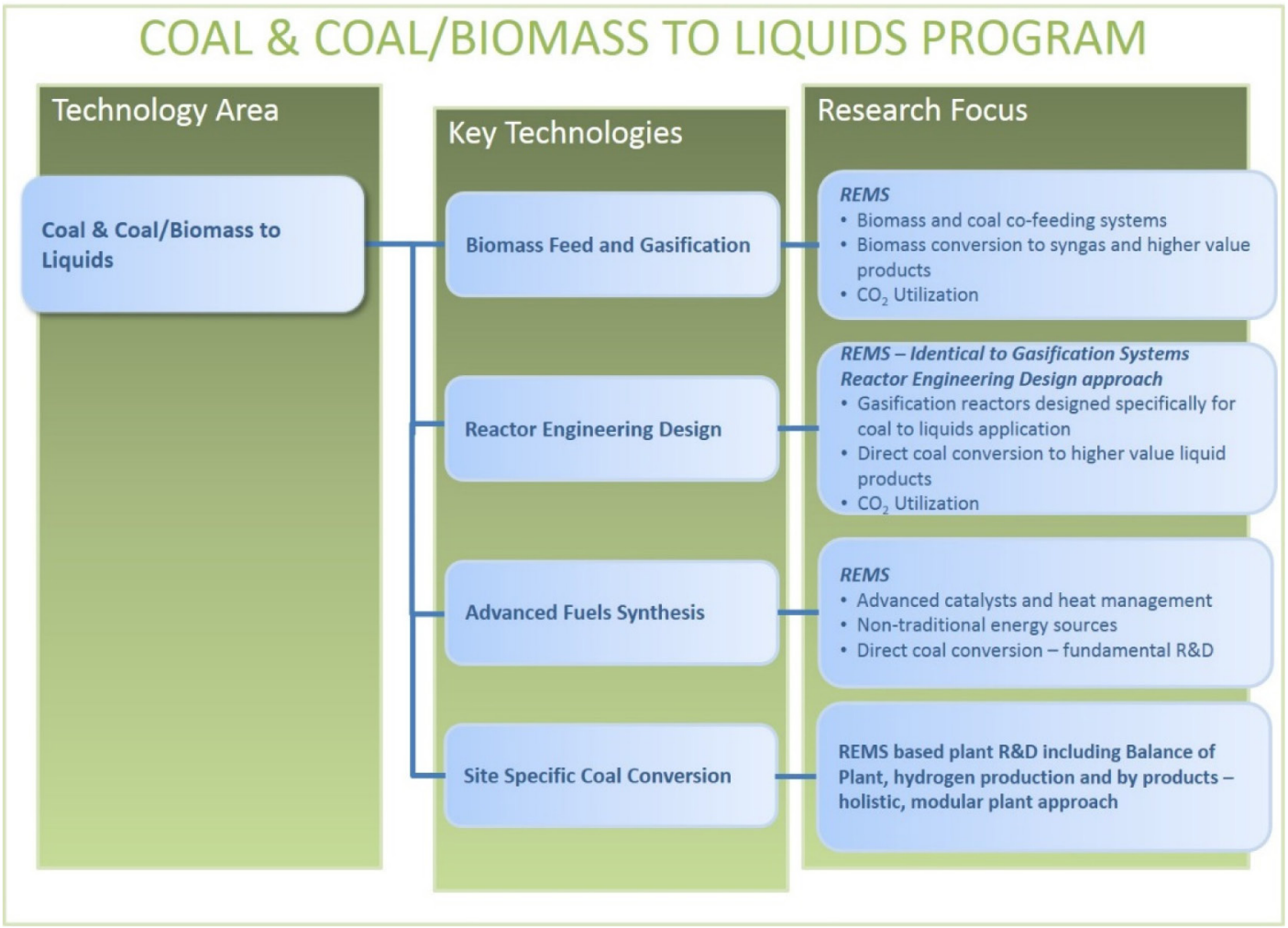
COAL AND COAL-BIOMASS TO LIQUIDS PROGRAM — The Coal and Coal-Biomass to Liquids Program is developing technologies to foster the commercial adoption of coal-biomass gasification and downstream production of affordable liquid fuels and hydrogen with excellent environmental performance. The key technologies of the C&CBTL program include:

- **Biomass Feed and Gasification**—The key technology advances scientific knowledge of the feeding and conversion of biomass and coal-biomass mixtures as essential upstream steps in production of liquid hydrocarbon fuels. With biomass use, which is considered carbon-neutral, coupled with carbon capture and storage, gasification can be considered carbon-negative technology. Activities support research for handling and processing of coal-biomass mixtures, ensuring those mixtures are compatible with feed delivery systems, identifying potential impacts on downstream components, and conversion optimization.
- **Reactor Engineering Design**—In the C&CBTL program, reactor engineering design will similarly focus on control of chemical reactions with unprecedented precision in increasingly modular and efficient reactors, allowing for smaller reactors and streamlined processes that will convert coal into valuable products at low cost and with high energy efficiency. Here, the specific emphasis will be reactors that enable conversion of coal-biomass to liquid fuels. Emphasis will also be placed on designing reactors with CO2 as a co-feed as a possible method of carbon utilization.
- **Advanced Fuels Synthesis**—The key technology is focused on catalyst and reactor optimization for producing liquid hydrocarbon fuels and valuable byproducts from coal/coal-biomass mixtures. The current focus is on making significant improvements in

fuels synthesis product distribution, i.e., by developing catalysts that are not bound by the Anderson-Shultz-Flory distributions characteristic of conventional silica-, alumina-, or zeolite-supported iron or cobalt Fischer-Tropsch (F-T) synthesis catalysts. Future work in this area may include direct coal conversion to higher value products and solid carbon product byproducts. Reducing the costs to produce liquid fuels will result in higher profits from the high value products that could be used to offset the additional cost of CO2 capture.

- **Site-Specific Coal Conversion**—In the C&CBTL program, the site-specific coal conversion technology area will include less mature R&D and case-specific engineering and construction and balance of plant R&D to most effectively deploy advanced C&CBTL systems in a certain location, with a certain feed, infrastructure, and environment for fuels production.

The level of technology R&D conducted by the program ranges from laboratory- to bench-scale activities, spanning projects at various stages of technology readiness.Body text



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