

# Solar Augmented Steam Cycles for Coal Plants

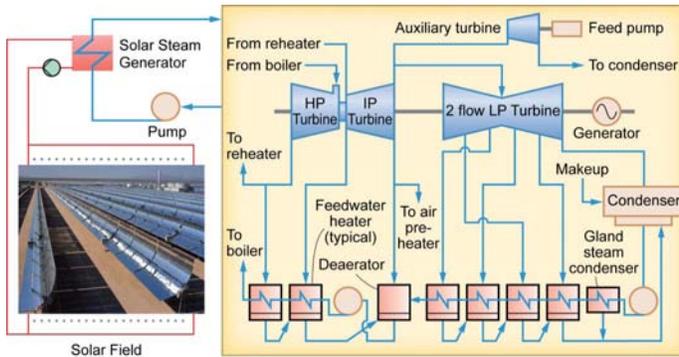


Illustration of a possible steam cycle in which a solar field supplies steam to a pulverized coal plant.

- Stay abreast of the latest solar augmented steam cycle developments
- Collaborate on innovative concepts for utility scale hybrid applications
- Reduce emissions
- Avoid fuel costs
- Participate in renewable energy credit markets
- Meet renewable energy goals

## Background

As fossil fuel prices rise and emission allowances are implemented, solar augmented steam cycles might be an attractive option for energy companies. The system utilizes steam generated by a solar field in a conventional coal-powered steam cycle, offsetting some of the fuel required to generate power. Many energy companies are interested in adding solar power to their generating mix, but today most solar applications are not cost-competitive with other power generating options. Solar thermal augmentation potentially is the lowest cost option for adding solar power to the generation fleet. The highest intensity solar energy typically is within a few hours of peak summer loads, making it a particularly attractive renewable option.

This project will be conducted in parallel with the Solar Augmented Steam Cycles for Natural Gas Plants project (SPN #1016979), addressing natural gas technologies. EPRI will employ expertise in solar technologies, steam cycles, and plant operation, as well as past EPRI solar and fossil plant studies. A solar technology assessment in New Mexico (EPRI Report No. 1016344), completed in January 2008, evaluated the development status, cost and performance of central solar plant designs. The results of that study and relationships with technology providers will be used to identify suitable technology options for the current study. EPRI currently holds two patents in solar steam cycle optimization.

## Value

Solar augmented steam cycle facilities can offer a variety of values to energy companies:

- Adds utility-scale solar power generation without the significant challenges of siting a new plant and developing a new power block;
- Utilizes existing plant assets, improving performance and increasing longevity;
- Contributes to green power programs and reduces CO<sub>2</sub> footprint;
- Develops experience with solar thermal technologies to assess future potential in generation mix.

## Drivers and Trends

Utilities need to develop solar energy projects to meet state renewable portfolio standards (RPS), demonstrate corporate leadership in mitigating climate change, and avoid fuel costs and emissions while developing a diverse generation portfolio.

By April 2008, 26 states in the U.S. and Washington, D.C. had enacted RPS policies. Some states have specific mandates that a percentage of the requirement be met with solar energy. At the same time, limits on CO<sub>2</sub> emissions are expected to impact coal plant economics. The impacts of these requirements and initiatives on electricity generation, transmission, and distribution are likely to be significant. Solar energy, although currently not the lowest-cost option, in the long run is the most abundant, widespread, and publicly acceptable clean-energy resource.

## Project Summary

The project provides a conceptual design study and two detailed case studies to evaluate solar augmented steam cycles for coal plant applications. Design options for existing plants will be analyzed using thermodynamic modeling tools. New plant design options that would be amenable to future solar augmentation also will be identified. The technical criteria and requirements will be addressed for several solar augmented steam cycles, solar technologies, and plant configurations.

The key augmentation issues are:

- Heat balance
- Water consumption
- Point-of-steam addition
- Steam take-off options
- Metallurgy constraints
- Control, ramping, and integration impacts on O&M
- Strategies for introducing solar heating into the cycle
- Operation strategies during times of solar variability

The current statement of work considers only coal plant technologies (pulverized coal and integrated gasification combined cycle). A separate project, Solar Augmented Steam Cycles for Gas Plants (SPN #1016979) will address natural gas plant technologies. In the current study, two pulverized coal plant case studies will include site assessments, integration analyses, and development of generic plant layouts with workable drawings and schematics. A project development manual will be provided for each case study. To the extent possible, the host sites will be treated as generic plants, so that the results will be applicable to a large number of plants.

A pro forma model will be used to estimate the cost of electricity for various operating scenarios and financial incentives. In addition, the savings due to avoided fuel costs for select cycles, technologies, and plant configurations will be quantified. Avoided emissions also will be calculated. The model will include scaling factors and clearly labeled user inputs, so that project participants can run the model using parameters for their own coal plants.

## Deliverables

- Mid-term presentation covering conceptual design results, including solar technology options, steam cycle evaluations, and assessment of plant designs
- Final EPRI Technical Report: Solar Augmented Steam Cycles for Coal Plants
- Two Final EPRI Technical Reports: Development guideline manuals for case studies
- Economic pro forma model
- Final presentation covering all project results

## Cost of Project

The estimated cost to complete this project is \$640,000. The price to participate is \$125,000. The price for case study hosts is \$250,000. Companies that fund any EPRI program can use Tailored Collaboration (TC) funds for up to half of their contribution.

## Note

Companies that join the Solar Augmented Steam Cycles for Natural Gas Plants project (SPN #1016979) may participate in this project for \$75,000 or serve as case study host for \$200,000. This represents a reduction of \$50,000 for participating in both Solar Augmented Steam Cycle Projects – Coal and Natural Gas.

## Project Status and Schedule

The project is expected to begin in the first quarter of 2009 and continue through the fourth quarter of 2010.

## Who Should Join

The results of this project will be beneficial to any energy company or project developer that is examining options for adding renewable generation capacity and has existing coal plants.

## Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 ([askepri@epri.com](mailto:askepri@epri.com)).

## Technical Contact

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