Solar Thermal Advanced Reactor System (STARS)

Battelle Number(s): 17135-E, 12190-B, 12672-E

Patent(s) Issued
Available for licensing in all fields

SUMMARY

The Solar Thermochemical Advanced Reactor System, or STARS, converts natural gas and sunlight into a more energy-rich fuel called syngas, which power plants can burn to make electricity. STARS uses a mirrored parabolic dish to concentrate sunlight on a pod about four feet long and two feet wide. The device contains a chemical reactor and several heat exchangers. The reactor and heat exchangers have narrow channels that are only as wide as six dimes stacked on top of each other. Concentrated sunlight heats up the natural gas flowing through the reactor’s channels, which hold a catalyst that helps turn natural gas into syngas. The heat exchangers’ channels help recycle heat left over from the chemical reaction gas. By reusing the heat, solar energy is used more efficiently to convert natural gas into syngas. STARS has set a world record with 69% of the solar energy that hit the system's mirrored dish converted into chemical energy contained in the syngas.
ADVANTAGES

- Dual-purpose system. Using natural gas or biomethane as a feedstock, STARS produces syngas that can be used to make electricity and, potentially, to produce synthetic transportation fuels, such as hydrogen, synthetic crude oil, or methanol.

- Low cost. When operating commercially in a hybrid, solar/natural gas-fired combined-cycle power plant, STARS will be economically competitive at a levelized cost of 6 cents per kWh or less. In contrast, the total system levelized cost for other solar generation systems exceeds 14 cents per kWh.

- Modular. STARS can be installed at virtually any scale (one unit or thousands). Thus, large up-front capital costs do not necessarily need to be incurred.

- Efficiency. By using the most efficient type of solar concentrator, the mirrored parabolic dish, STARS offers nearly 70% solar-to-chemical energy conversion. By converting solar energy into chemical energy rather than thermal energy, the system can be coupled with highly efficient, low-cost, combined-cycle power generation technology and obtain higher levels of efficiency in producing electricity than either solar or natural gas plants alone.

- Reduced carbon dioxide emissions. Because power plants equipped with the system can make electricity while using approximately 20% less feedstock when solar energy is available, the system reduces greenhouse gas emissions compared to conventional natural gas-fired plants.

- Around-the-clock operation. STARS does not require power plants to cease operations when the sun sets or clouds cover the sky. Power plants can bypass the system and burn natural gas directly. In essence, the system turns natural gas power plants into hybrid solar-gas power plants capable of operating around the clock.

PATENTS & INTELLECTUAL PROPERTY

- 7,125,540
- 7,270,905
- 9,950,305

TECHNOLOGY PORTFOLIO(S)

- Microtechnology

POTENTIAL INDUSTRY APPLICATION(S)

- Energy & Utilities

CONTACT

Sara M. Hunt
Pacific Northwest National Laboratory
(509) 375-6555
sara.hunt@pnnl.gov
https://availabletechnologies.pnnl.gov