

Iraq Has an Opportunity to Become a Solar Leader

In Iraq they say “*safya dafya*,” meaning everything is fine – literally, “sunny and warm.” *Safya dafya* could also describe the forecast for solar power development in Iraq, as the nation’s abundant sunshine and flat, open land near population centers make it one of the best locations in the world for solar power.

But solar and geography are only one aspect of Iraq’s solar power opportunity. The impact of war, years of underinvestment in the power sector, and rapidly increasing electricity demand have created a shortage of—and desperate need for—reliable power. As a result, Iraq’s Ministry of Electricity, supported by international donors, is investing in rehabilitating and upgrading the electricity grid, and plans over the next five years to build 16 plants with a combined capacity of 3,500 megawatts (MW).



Solar thermal plant (parabolic trough).

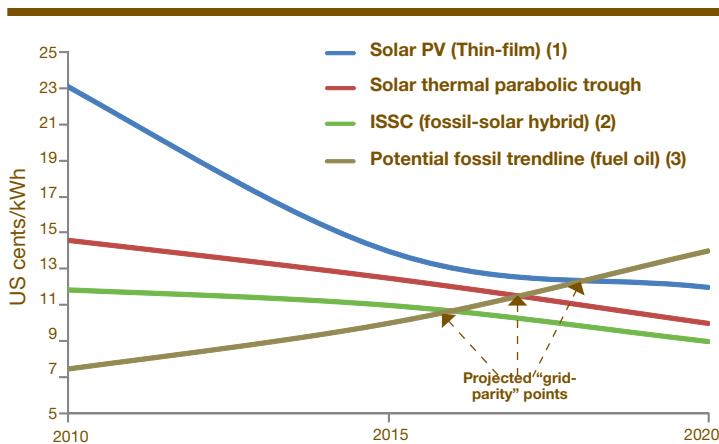
A DAI study shows there has never been a more opportune time for Iraq to take advantage of both its upcoming energy projects and vast solar resources to build a solar power plant. Specifically, our analysis shows, the country should make at least one of its new plants a large-scale, combined fossil fuel-solar thermal power plant, also called an integrated solar combined cycle (ISCC) plant. The most attractive location for such a plant would be in Al Anbar, the vast desert province in central-western Iraq, though six of Iraq’s seven planned plants have potential.

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In our efforts to tackle climate change, “step technologies” that help us transition from fossil fuel to cleaner energy will be crucial. But while global investments in solar technologies are growing, converting solar energy into power remains many times more expensive than fossil-based power. The key to bringing down the costs of solar technologies is to increase the total installed capacity worldwide by building more plants. Lessons learned through this process, and the economies of scale realized, should continue to reduce costs. In addition, rising oil and natural gas prices will likely make it easier for solar to achieve “grid parity”—the point at which solar electricity is cost-competitive with electricity from conventional sources (see Figure 1, overleaf).

This article focuses on large-scale solar thermal power in Iraq, but there are also opportunities for photovoltaic (PV) systems that use semiconductor materials to directly convert sunlight into electricity. Power from PV systems is currently more expensive than large-scale concentrating solar power, but the unreliability of Iraq’s central grid has spawned an industry of private providers of diesel-fueled power to small, distributed micro-grids. Despite the use of subsidized diesel, the costs of this fossil-fuel power are very high. In fact, the “levelized” cost of power—which takes into account all investment, fuel, operations, and disposal costs—of a small solar PV system is less than that charged by the private providers.

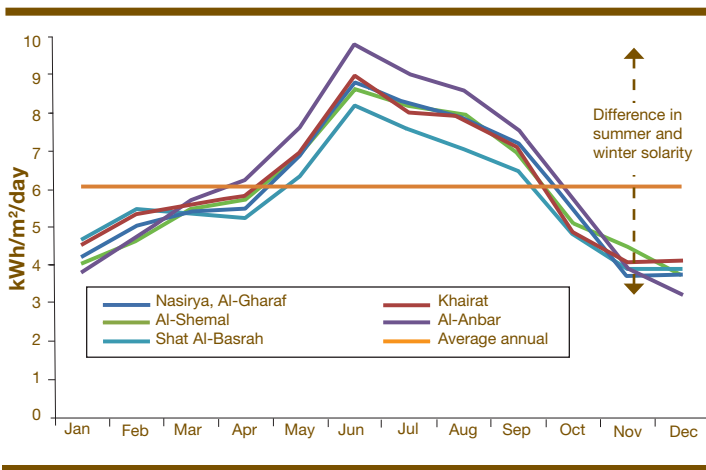
Individual Iraqis remain reluctant to make the high initial investment in solar panels. However, the market is ripe for distributed, small-scale PV as well as large-scale solar.

FIGURE 1: CURRENT AND POTENTIAL FUTURE COSTS FOR LARGE-SCALE SOLAR POWER SYSTEMS IN HIGH-RESOURCE LOCATIONS VS. FOSSIL POWER

Source: National Renewable Energy Laboratory, Energy Information Administration, International Energy Agency

Future costs based on potential cost reductions (high degree of variance in projections). Sources: NREL, EIA, IEA, DAI analysis.

- (1) Solar thin film refers to non-polycrystalline silicon technologies, such as amorphous silicon, copper indium diselenide, cadmium telluride (CdTe)
- (2) ISSC refers to a combined parabolic trough plant with a fossil fuel combined cycle plant
- (3) Trendline based on doubling of fuel oil prices from current levels

FIGURE 2: MONTHLY AVERAGE DIRECT NORMAL RADIATION FOR SELECTED SITES WITH PLANNED FOSSIL FUEL PLANTS

Source: NASA Surface Metrology and Solar Energy

The intermittency of solar power poses a challenge for electricity distribution systems. Power grid operators must account for both the daily and annual intermittency in all renewable power sources. In Iraq, for instance, though the solar resource is outstanding, output in summer is nearly double that in winter (see Figure 2). In building a power plant that compensates for the intermittency of solar power with the predict-

ability of conventional power, Iraq could become a world leader in developing large-scale, climate-friendly solar power.

Solar energy is abundant, but capturing it is not cheap, which is the primary reason that solar power contributes only a tiny fraction of global energy production. Solar remains many times more expensive than power derived from fossil fuels, even as oil and natural gas prices rise. The lowest-cost, most commercially proven large-scale solar technology is the concentrating solar parabolic trough system, which uses mirrors to heat a fluid that generates steam and in turn drives a steam turbine.

The largest solar plants in the world—the combined Solar Energy Generating Systems in California’s Mojave Desert, which have a capacity of 354 MW—use this technology. In 2007, the second largest solar plant was built in Nevada, a similar 64 MW system called Nevada Solar One. The estimated engineering procurement and construction costs for this plant—US\$4 million to \$5 million per MW—should result in power costs around \$0.17 per kilowatt-hour (kWh): several times higher than natural gas- or coal-fired generation, but lower than other solar technologies.

INTEGRATING SOLAR ENERGY AND FOSSIL FUEL

The intermittency issue could be solved by combining a solar thermal plant with a natural gas plant, enabling the solar power shortage during Iraq’s winter months to be covered by gas-generated power. Maximum solar output during Iraq’s intensely sunny summers, meanwhile, would coincide with peak demand and lessen the need for additional peaking capacity from gas. Co-locating with a gas plant would also answer the solar plant’s need for accessible transmission lines, a critical siting criterion for many renewable projects.

Most importantly, combining a solar parabolic trough plant with a gas-powered plant would reduce costs because both can utilize the same steam turbine, generator, and associated equipment. Grid interconnection costs would be reduced as well: co-location

can reduce the overall cost of the solar thermal system by 20 percent or more, depending on the cost share between the renewable and fossil plants. Using commercially proven, concentrating solar parabolic trough technology—rather than an emerging technology not proven at scale—should make lenders more comfortable with providing debt for an ISCC plant, perhaps with the financial backing of the U.S. Overseas Private Investment Corporation, the World Bank/ Global Environment Facility, or European governments.

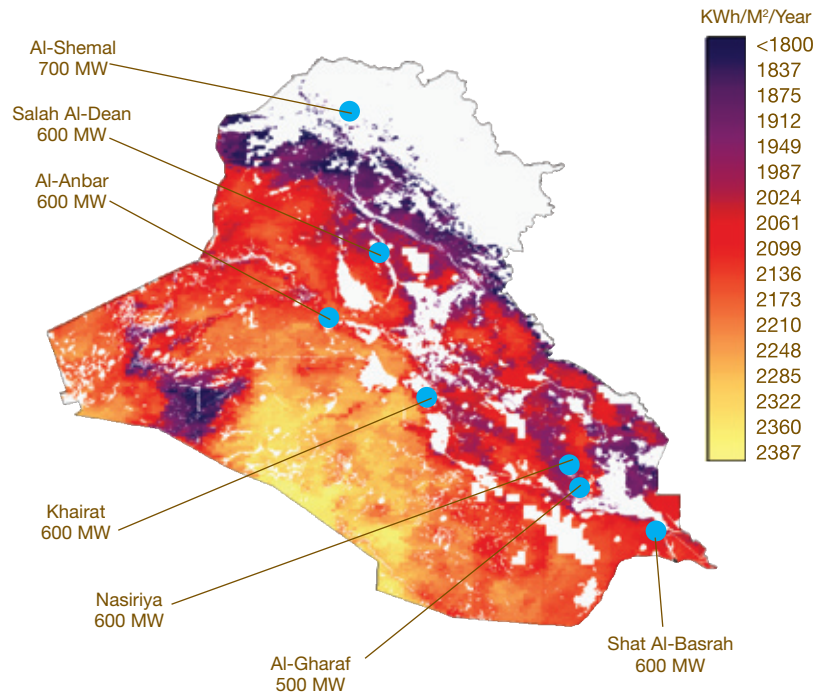
A handful of countries have announced plans to establish ISCC plants, though only Algeria—envisaging a 130 MW gas plant with an additional 25 MW of solar—has begun the design, and no country has begun construction. There is no ISCC configuration to date in a commercial plant, so no matter where the first-of-its-kind plant is built, it will face technical challenges. However, the systems are all proven independently, and overcoming the engineering challenges will provide Iraqis with competitive advantage in a technology on the verge of rapid expansion.

SELECTING THE OPTIMAL LOCATION

There are key siting requirements for large-scale solar technologies, including optimal solar resources, access to transmission lines, and five to eight acres per MW of capacity. An ISCC plant would typically require 2 million gallons of water per year per MW to cool the turbines. Accordingly, many designs, including the Algerian plant, propose using dry cooling to reduce this water requirement.

Iraq has excellent solarly, ranging from 1,800 to 2,390 kWh/m²/yr of direct normal irradiation, and much of the flat Iraqi landscape is appropriate for an ISCC plant, as shown in Figure 3. Also shown are the locations where the Ministry of Electricity plans to issue concessions for the 3,500 MW in total capacity via fossil-fuel power plants.

FIGURE 3: IRAQ'S SOLAR IRRADIATION



White areas are excluded as potential plant sites due to land cover or development.

Source: The German Aerospace Center (DLR), Iraq Ministry of Electricity

Based on an analysis of these planned plant locations, all of which receive sufficient solar radiation to be potential ISCC sites, the optimal site would be in Al-Anbar, which according to NASA data receives 2,310 kWh/m²/year. Joining even a relatively small, 50 MW concentrating solar plant to one of the planned 300 MW fossil plants would reduce carbon dioxide emissions in Iraq by nearly 40,000 metric tons per year, compared to a similar 50 MW expansion of fossil capacity.

Taking the global lead in solar technology would demonstrate that the country's technical capacity is recovering, build Iraqi skills in a promising technology with significant export potential, and position Iraq as a leader in sustainability in the Middle East.

A good reason to proclaim *safya dafya*. ■

PATRICK DOYLE LEADS DAI'S WORK IN ENERGY AND CLIMATE CHANGE. KHALIDAH JAAFAR IS AN IRAQI ENGINEER.