High temperature solar thermal generator

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Commercial Status of HTST The United States and Spain are the world leaders in HTST for power generation. Each currently has 6 operational plants (see Table 1), with a total capacity of 430 MW and 182 MW respectively(8).

Spain has 20 plants under construction, which account for 1617 MW of the 1757 MW (92%) of capacity under construction worldwide(8). All of the plants under construction in Spain are expected to come online by the end of 2010, and all will use parabolic trough technology, except for one 17 MW plant, which will use the power tower arrangement. Spain also has another 19 plants announced, totalling 1080 MW. Of these, 15 will be parabolic trough, with 5 of those 15 using energy storage(8).

The USA has 29 plants announced, totalling 8546 MW(8). Of these, 15 will be parabolic trough, 8 will be power tower, 2 will be parabolic dish, and 2 will be linear Fresnel. So although parabolic troughs remain the favourite HTST technology, power towers are becoming increasingly attractive, as are parabolic dishes, at least in the USA.

The CSIRO’s National Solar Energy Centre (NSEC), launched in 2006, is the only multi-collector installation of its type in Australia(12). It consists of a power tower with a capacity of 0.5 MW, and a linear Fresnel system.

In 2003, Solar Heat & Power Pty. Ltd. begun the construction of a 40 MW compact linear Fresnel plant, located adjacent to the 2000 MW coal-fired power station in Liddell(13). The company is now designing a stand-alone 240 MW system.

The Australian National University’s ‘Big Dish’ (Figure 5) is the world’s largest parabolic dish technology, with an aperture of 400m2(14). The ANU and Wizard Power Pty. Ltd. have entered into a partnership to commercialise the Big Dish, with plans to construct a demonstration plant consisting of up to 20 dishes, each with an electrical generation capacity of 100 kW.

HTST is a renewable energy technology, however this does not mean that it is necessarily an environmentally sustainable technology in all instances. The environmental impact of HTST depends on how it is implemented. Here we look at several environmental issues associated with HTST technology.

Land use: HTST requires large areas of cleared flat land. The amount of land required of course varies depending on the size of the plant, the chosen HTST design, and whether energy storage is employed. A typical parabolic trough plant requires about 5 to 10 acres of land per MW of capacity(16), and the land required for a typical parabolic dish plant is at the lower end of this range(17). For comparison, a typical coal-fired plant requires about 1 acre per MW of capacity(18), but this does not include the land area required

for mining coal.

Aesthetic impacts: due to the sheer size of HTST installations, some people might consider them to be visually offensive. This of course depends on where installations are sited, and who is looking at them. In HTST hotspots, such as the Mojave Desert, “nearby residents and national park visitors will (also) face the burden of increased traffic, pollution, noise, and infrastructure…”(26). All of these things diminish the aesthetic quality of the immediate environment, and can thus result in decreased well-being for some people.

Remote Area Power Supply (RAPS): currently, many remote communities do not have access to a reliable power supply, and this is a social inequality. Some remote communities use stand-alone photovoltaic systems (or small wind turbines) with a diesel generator for backup, and a battery bank for energy storage. HTST has so far proven best suited to large-scale applications, and thus has not been deployed for RAPS. As a result, the benefits of HTST are not yet realised by those who most in need of a reliable power supply.

Energy Security: for HTST to be viable, a certain amount of solar irradiation must be available for harnessing at the site. As Figure 6 shows, solar resources are abundant in the USA, Mexico, northern and southern Africa, the Middle East, and Australia. These regions / countries can utilise HTST, and thus obtain a larger proportion of domestic power from an indigenous energy resource. This would necessarily increase energy security, and therefore contribute to a reduction in social and political tensions associated with energy insecurity.

The cost of HTST power depends on system design and power plant siting. As we have seen, the parabolic trough is the most utilised design, followed by the power tower and linear Fresnel, with the parabolic dish seldom being utilized so far. This is indicative of the current cost of each design relative to the others. With regard to power plant siting, energy will be cheaper to produce where solar resources are plentiful.