Kraftanlagen München

Kraftanlagen München's Concentrated Solar Power (CSP) Technology – an Economic and Highly Flexible Solution, Designed for Full Market Integration

- Solar-thermal power generation with a superior thermal storage system: Configurable from dispatchable peaking power plant to base load unit - designed for full integration into electricity markets
- Proven cutting edge efficiency and robust operation, also under unstable solar irradiation conditions
- Rigorously designed according to standards and market expectations of conventional power plants
- Capable of supporting a variety of additional applications, including hybridized thermal power generation and solar desalination

Executive Summary

CSP has the unique advantage over wind and solar PV that primary energy storage can be directly integrated into the power plant. This is an energy efficient and economic method to turn a CSP unit into a flexible power plant. When properly scaled and located, CSP with storage will offer dispatchable, CO2-free energy at LCOE competitive with conventional flexible generation, in particular if CO2 prices establish at a politically desired level around 30 EUR/ton. Furthermore, for example through hybridization with combined cycle gas turbines (CCGT), solar CSP can significantly reduce the carbon footprint of conventional generation.

The increasing challenge of conventional, undispatched RES generation

Intense R&D and industrial scaling has led to substantial technological improvements and massive cost reductions of wind turbines and solar PV equipment. As a result, at attractive wind and solar sites, the levelized cost of electricity (LCOE) of these renewable sources (RES) has dropped down to the level of conventional thermal generation. However, wind and solar PV suffer from their low capacity factors and their uncontrollable feed-in. Thus, large installed RES capacities stress the electricity supply system: Most notably, to keep demand and generation in balance, the integration of large quantities of wind and solar PV

requires an increased number of very flexible, dispatchable power plants (for instance, gas turbines). Furthermore, heavy investments into transmission capacity are needed to transport electricity from remote generation sites to the consumption centres. Both of these needs lead to a very significant increase of total electricity supply cost. An additional complication lies in the fact that the wide-spread political and public resistance against new high voltage transmission corridors makes it virtually impossible to upgrade the transmission system in due time. The inevitable consequences are frequent regional electricity supply-demand mismatches, causing wild electricity price hikes in both directions. This not only impedes the proper functioning of the regular energy markets, the coincidence of low prices and high RES infeed also makes it difficult to fully integrate wind and solar PV into the energy markets.

Complete RES Market Integration is the only Sustainable Solution

Nevertheless, the only sustainable cure to these issues still lies in the full integration of RES into the energy markets. This will lead to a very high pressure to turn RES feed-in dispatchable, either directly or indirectly. Energy prices should then re-establish at a (higher) level where dispatch costs are properly factored in, and where critical balancing technologies like gas turbines can operate economically.

Concentrated Solar Power (CSP) with integrated thermal storage: An increasingly attractive alternative to wind and solar PV

The need for RES dispatchability requires that RES generation can be buffered or stored, enabling the release of electricity to the grid according to the demand curve. In order to effectively unload the transmission capacity, these storage/buffer functions must be located in close proximity to the generation sites. Unfortunately, viable local storage solutions for wind electricity and solar PV are relatively expensive and/or inefficient. The main reason lies in the fact that electricity storage requires its conversion into a different form of energy and back (e.g. chemical energy in the cases of batteries and power to gas). This disadvantage of wind and solar PV may provide Concentrated Solar Power (CSP) a major boost: CSP power plants are ideally suited to integrate storage of the primary energy (heat), i.e., no expensive and inefficient energy conversion takes place. In fact, a well-designed storage technology like the one of Kraftanlagen München (KAM) may even reduce the plant's LCOE, because expensive electricity generation components (boiler, steam turbine, generator, substation) do not need to be designed for the plant's peak thermal capacity.

A pioneer in the field of solar thermal power plants, Kraftanlagen München is one of few companies worldwide that have developed and implemented plants of its kind.

KAM CSP Technology – Rigorously Designed for the Market's Needs

Kraftanlagen München (KAM) offers a CSP technology, which is very well adapted to the emerging energy market requirements. The type of the technology is a central receiver CSP (tower CSP). The main differentiator to the other CSP technologies lies in the fact that the primary heat transfer fluid (HTF) is not steam, oil, or molten salt, but air at atmospheric pressure. The technology is referred to by the name "Open Volumetric Receiver" (OVR). OVR CSP has been successfully demonstrated in a 9 MWth pilot/demonstration plant in Jülich (Germany), which has been in operation since 2009. The technology has several key advantages:

(a) In contrast to the conventional HTF, air can be heated to much higher temperatures. The HTF temperature limit of 680 °C is mainly determined by state-of-the-art power plant materials and -technologies, lending the OVR CSP technology a cutting-edge Carnot efficiency.

(b) Air as HTF is perfectly suited for solid state thermal energy storage, since no additional expensive and inefficient heat exchangers are required. KAM uses Silicon Carbide (SiC) as storage medium, which has a unique set of attractive properties:

   a. No risk of freezing, cracking, or chemical reaction, and thus, virtually no plant dispatch constraints and no operational risks;
   b. Good thermal conductivity, requiring only a low internal heat exchange surface area;
   c. A good combination of material density and heat capacity;
   d. A very high melting point, enabling storage at very high temperature;
   e. non-toxic, non-hazardous, environmentally friendly material, can be easily recycled or disposed of;
   f. SiC is inexpensive, enabling large storage capacities;
   g. Raw materials are abundant, and the SiC production process does not involve environmentally critical materials;

(c) The very low thermal inertia of the primary HTF circuit enables the system to adapt almost instantly to changing irradiation conditions. Hence, stable and efficient plant operation is possible even under unfavourable, volatile solar irradiation conditions, for instance during partially clouded skies.

KAM's OVR CSP technology is rigorously designed for a high life expectation, high reliability, availability, and low maintenance cost. This is accomplished by consequent use of state-of-the art power plant materials and design principles. KAM has broad experience with the design of power plants and is committed to meet with its CSP technology the industry's standards and expectations in terms of reliability and availability.

KAM's OVR CSP technology and the usage of air as HTF is also well suited for many other CSP applications, i.e., Integrated Solar Combined Cycle (ISCC), Solar Augmentation, Solar Desalination, and Enhanced Oil Recovery. Hence, the technology will be an attractive, economic, and sustainable choice for many applications, markets, and locations.

Jülich solar thermal power plant

For more information about Kraftanlagen München go to www.kraftanlagen.com

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