

## Heat Pumps for Different World Regions - Now and in the Future

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### Abstract

Heat pumps offer the possibility of reducing energy consumption significantly, mainly in the building sector, but also in industry. Basic second law thermodynamics show the advantages: while a condensing boiler can reach a primary energy ratio (PER) of 105 % (the theoretical maximum would be 110 % based on the lower calorific value), heat pumps achieve 200 % and more. The majority of heat pumps is in operation in Japan and in the US, most commonly air-to-air dual-mode units for both heating and cooling, China has already the largest industry for producing air conditioners, and in South East Asia the trend to this technology is rising rapidly. Europe has been concentrated on heating-only hydronic heat pumps and heat recovery systems, but sales of dual-mode units are growing.

The drive energy is most commonly electricity, and for the future improved power generation systems based on renewables and fossil fuels have to be taken into consideration. The efficiency of gas-fired combined-cycle power plants available on the market is about 58 %, with oil as fuel similar values are possible. Ground-source heat pumps combined with low-temperature heat distribution systems achieve seasonal performance factors (SPFs) of 4 and higher, which means PERs of 220 to 280 %. However, improvements up to PERs of 400 % are possible in the future.

Presently more than 100 million heat pumps with a thermal output of 700 TWh/a are in operation world-wide, reducing CO<sub>2</sub> emission by 0.12 Gt/a. The potential for reducing CO<sub>2</sub> emissions assuming a 30 % share in the building sector using technology presently available is about 6 % of the total world-wide CO<sub>2</sub> emission of 20 Gt/a. Therefore, heat pumps are one of the key technologies for energy conservation and reducing CO<sub>2</sub> emission.