

Heat pump innovations and its role in 2060 China Carbon Neutral Strategies

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Abstract

The world is facing carbon neutral in the middle of this century, carbon neutral does not mean zero carbon emission, it means carbon emission could be absorbed by carbon sink. It is clear that the world will be more powered by renewable energy (50% or more in 2050), electrification would be affordable and accessible and could be extended its applications. Fossil fuel should be treated for less CO₂ emission by increasing energy conversion efficiency, and wide uses of heat recovery devices to use low grade heat both from waste heat or solar heat or even from the ambient becomes vital. Heating and cooling are the most demanded energy for end users, such as buildings, industries and also transportations, heat pump is truly the most effective equipment for decarbonization.

This report will present 1. Heat pumps based on electric vapor compression systems: air source heat pump water heater, air source heat pump heating and cooling for residential and commercial buildings, other various low grade heat source heat pump (such as ground source, water source and etc..), waste heat recovery heat pump for industry heating; 2. Heat pump based on thermal driven systems: LiBr-water and water-ammonia absorption heat pumps for efficient waste heat recovery for industry application, and solar cooling; 3. Chemical heat pumps based on thermal energy for heating, cooling, thermal energy upgrading, and thermal storage; 4. Next generation heat pumps for air conditioning with coupled sensible and latent thermal load handling, its doubled efficiency for heating and cooling could be applied in residential/commercial/transportation heating and cooling; 5. Air source heat pump or waste heat recovery heat pump for steam generation, which may bring a new feasible way to use electrified heat pump to replace small to medium scale fossil fuel based or electric heated boilers.

Heating/cooling decarbonization is a major challenge for China to meet its 2060 carbon neutral commitment, heat pump represents a promising solution for heat/cold supply in various building and industry applications. Our results reveal that the decarbonization potential from heat pump in a carbon neutral China future could reach around 1400Mton and 600Mton for residential and industrial heating respectively, which add to 20% current carbon

emission in China. It is also shown that achieving such deep decarbonization of heat pump requires ad-hoc interventions that balance technology advancement, techno economics, policy incentive, and integrated short-term and long-term decision making. This research has shown that heat pump could play a key role in carbon neutral target.

Keywords: Heat pump, decarbonization, carbon neutral, heating and cooling, innovation