

Hybrid Technologies in District Heating Systems

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Abstract

This paper describes methods of improving district heating systems based on hybrid technologies and presents results of best-performing structure of district heating systems.

1. Introduction

Enhancement of energy efficiency and resource saving are pressing issues worldwide. This issue develops new technologies and critical solutions. Hybrid energy systems, where conventional sources of heat and electrical energy are combined with such non-conventional renewable sources as solar collectors and panels along with the use of alternative fuels, are becoming more common. Such solutions became a best frequent practice, which has a sizeable effect on the economy [1].

Hybrid technologies contribute to the reduction in consumption of conventional fuel and energy resources such as coal, fuel oil, natural gas. External consumption of these resources is reduced thanks to own production of energy and heat that, apart from economic benefits, supports in removing environmental issues, in part or in whole, e.g. reduction in carbon dioxide emissions to the atmosphere [2].

Currently existing hybrid energy systems and their control algorithms are inefficient to meet the requirements of cost effectiveness. They are still behind the conventional systems, particularly, when the prices for natural energy resources drop. However, this solution became popular because these systems have an attractive associated perception. Especially since sophisticated engineering of alternative energy forms is backed at governmental level in the economically developed countries of Europe, Asia and America.

This support resulted in hybrid devices and technologies of their application, which succeeded to combine wide functional requirements. They include hybrid solar collectors, which simultaneously produce electrical energy and heat as they compose a single unit of a solar battery and a solar collector. Unlike the conventional solar batteries, the hybrid devices remove the issue of overheating the photocell. It is known that an overheated photocell stops producing electrical energy [3], while hybrid devices supply the whole excess heat through the heat collector for heating and hot water supply to the buildings. If that is the case, the amount of electrical energy produces highly exceeds the productivity of regular solar batteries.

As compared with the heat collectors, the hybrid solar collector serves longer, produces a low-cost energy unit, requires less operational expenses and has a high thermoelectric performance. In addition, the hybrid collector requires much less area for installation in contrast to the system with separate installation of solar battery array and collectors [4]. This makes such solution suitable for the buildings with limited installation area.



Another type of hybrid sources is the boiler house that uses both the conventional and alternative fuels (fig. 1) illustrates a typical flow chart of the boiler house.

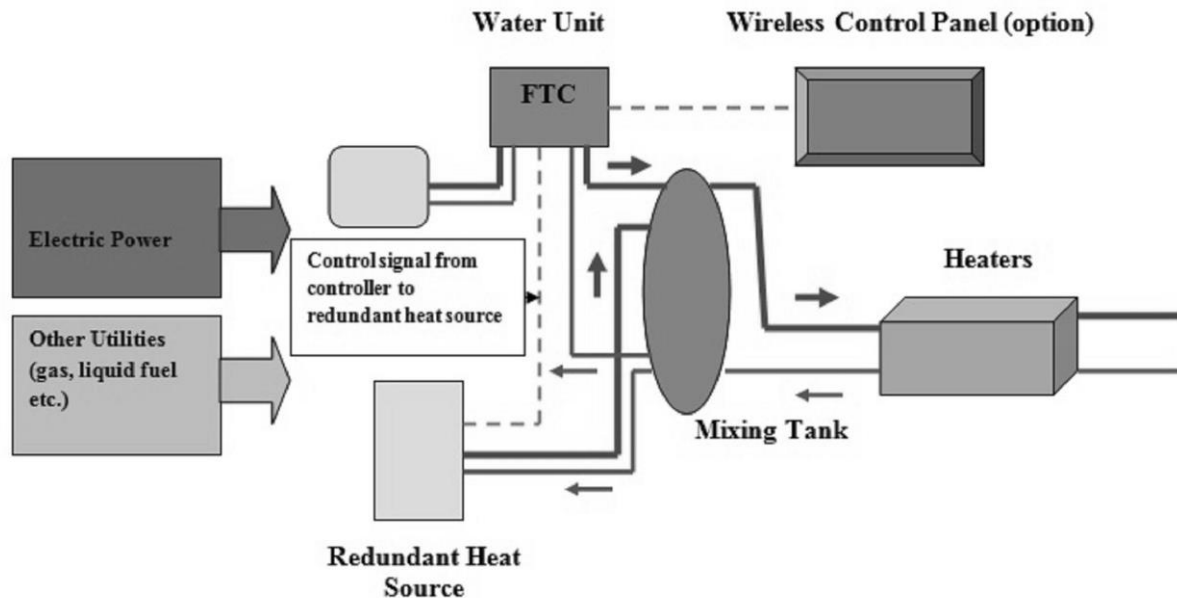


Fig. 1. The hybrid boiler house

The main heat generator of the boiler house is the water-air heat pump, which is so selected that to facilitate the heating requirements of the building or a consumer as well as requirements to hot water supply at ambient temperature ranged -10 to -15°C . If the ambient temperature drops below these values, this will run a fuel or electrical boiler in addition to the heat pump (fig. 2).

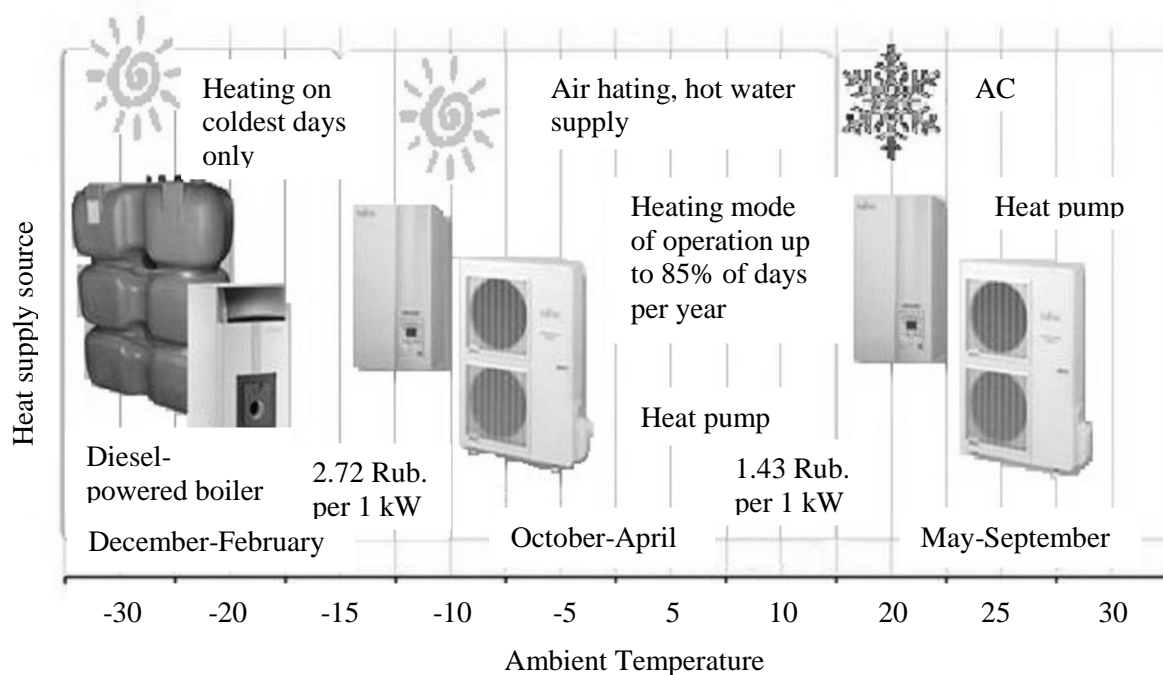


Fig. 2. A heat pump based hybrid heating system with a diesel-powered boiler

The hybrid boiler houses are cost effective due to inverter heat pumps and reliable as they employ two independent heat generators [4].

This technology is widely used in individual heating systems, and can be installed in the district heat supply systems.

The comparative analysis of engineering solutions provided a preferred version of hybrid boiler house layout that includes a few options of how to use several alternative sources of energy:

- Water-air heat pump
- Fuel or electric floor- or wall-mounted boiler with weather-dependent automatics
- Fuel burner feed system (if a fuel boiler is used)
- Flue system
- Boiler safety group
- Valved circuit
- Expansion tank
- Indirect-heating hot water tank
- Distribution header with pumps
- Heating circuit makeup
- Hybrid solar collector
- Electric power storage battery
- Secondary equipment

Energy resources can be saved in a district heating system due to the following processes:

- Displacement of external power consumption
- Replacement of thermal load with raw water pre-heating and, partially, with chemically treated water pre-heating
- Displacement of heating load produced by the boiler house and other buildings tied in with the source
- Removal of energy losses associated with the irregularity of installed load due to accumulation of energy resources

3. Conclusions

Optimisation of the hybrid boiler house including more components requires mathematical modelling as well as analysis, synthesis and optimisation of complex heat-power facilities [5].

References

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