ANALYSIS OF THE CONDITIONS FOR LARGE-SCALE USE OF RENEWABLE ENERGY IN THE RESIDENTIAL AND MUNICIPAL SECTORS

Director, Doctor of Engineering, Professor

Vadim Olegovich Kitikov
Breakdown of the final consumption of fuel and energy resources in the residential sector

- Liquefied hydrocarbon gases: 44.87%
- Natural gas: 30.47%
- Electrical energy: 11.37%
- Peat briquettes: 2.33%
- Coal: 0.37%
- Wood: 0.01%
- Thermal energy: 9.58%
- Other fuel types: 1.01%
Upgrading housing facilities
(including individuals' housing facilities; percent)
District heating systems in the housing and utilities sector, operational features

The average energy efficiency ratio in the energy balance of the boiler house - heating network - heating system of a building (or process heating) is no more than 40%.

Closed district heating system
Main factors affecting the efficiency of district heating systems

- a high proportion of physically obsolete equipment;
- different balance sheet attribution of heat supply system elements;
- a large branching of heat networks from a single heat source and high heat losses in them;
- the separation of process control systems for heat supply and heat consumption.
Current requirements for district heating systems

1. Minimum network losses

2. Interoperation with smart energy systems

3. Interoperation with renewable heat sources (integration through intelligent information and communication management systems);

4. Participation in digital processes through information and communication technology.
Modernisation and upgrading of the energy efficiency of heating networks and housing and communal facilities

Optimisation of district heating schemes and decentralisation of heat supply systems for housing and public facilities

Modernisation of systems and transition to low-carbon technologies for the heat supply of housing and public facilities using electricity and renewable energy sources (RES)

Modernisation of district heating systems and boiler houses in the housing and utilities sector, based on the integrated use of local fuel types, electricity and RES

DEVELOPMENTS IN IMPROVING THE EFFICIENCY OF HEAT SUPPLY TO HOUSING AND PUBLIC FACILITIES IN THE REPUBLIC OF BELARUS
OPTIONS FOR THE EFFICIENT USE OF RENEWABLE ENERGY SOURCES IN THE HEAT SUPPLY OF HOUSING AND PUBLIC FACILITIES
Classification of housing and public services

- Housing and public facilities
  - Housing sector facilities
    - Multi-storey apartment buildings
    - Low-rise apartment buildings
    - Individual residential buildings
  - Social sector facilities
    - Educational facilities
    - Service sector facilities
    - Healthcare facilities
  - Production facilities
    - Housing and public sector business facilities
    - Housing and public sector heat supply facilities
    - Wastewater disposal facilities
An integrated approach to the use of RES in the heat supply of the housing sector

Structural diagram of the integrated use of heat sources for heating hot water in a multi-storey residential building
250 solar collectors are installed on the roof.
Preparations for the transition of the district heating systems of multi-storey residential buildings to a new technological level

View of the solar power plant panels: total area of the solar panels - 250 m², output - 74 kW.
There are three heat pumps for the whole house. Two of them are powered by the collector. The other receives heat from the ground beneath the foundation. Inside the 34 piles of the house there is a heat pump heat exchanger.

A view of the greywater recycler

View of heat pumps and storage tank
The actual heating energy costs for this house are 60-70% lower than for similar buildings in this series.
The district heating system for low-rise residential buildings is integrated with the use of low-temperature energy sources.

Multiple-dwelling low-rise residential building in the centre of Grodno

The district heating supply integrates a hot water system using low-temperature energy sources.

The hot water supply of the residential building in the off-heating period is provided by two air-to-water heat pumps and a set of storage tanks.
District heating supply for low-rise residential buildings using local fuel and energy resources and solar energy

Orsha district, Vitebsk region

Modernisation of hot water supply system with installation of solar water heater on the roof of a 5-storey residential building in Obukhovo village, 8 Svyazistov st.

Installed solar collectors for the provision of hot water in two residential buildings 1 and 2 in the village of Zvezdnaya, Internatovskaya st. 24 SCH30 solar panels, consisting of vacuum tubes, are placed outdoors near building number 2. The rest of the heating equipment is situated in the basement of the apartment building.
The air-to-water heat pump used in an individual home heating system consists of the following equipment:

- the outdoor unit, which is an outdoor inverter unit. It is similar to a standard unit used for space conditioning. To protect the unit from precipitation, a canopy can be fit over it;

- indoor unit - hydraulic module. The design is ultra-stable with a built-in, predictor-corrector regulator. It allows the supply of hydraulic fluid to be changed automatically depending on the actual hydraulic demand in real time, without changing the phase shift.
Heating a private home with an air-to-water heat pump

Sebezh
Heating and cooling using an air-to-water heat pump, the cost of the equipment, together with the commissioning work, was 13,860 roubles. Operating costs in the form of electricity bills have decreased fourfold.
Heat supply systems for wastewater disposal facilities using RES
Molodechnovodokanal District Heating Company
wastewater pump system in the city of Maladzyechna

A geothermal heat pump has been installed.

A spiral heat exchanger was installed in the wastewater inlet of the sewage pumping station, which made it possible to eliminate drilling work and reduce the cost of the equipment with installation to 15,492 roubles. The design of the heat exchanger in the form of a tubular coil to the heat pump has reduced the cost of the equipment by up to 40%.

The average heat consumption in the existing system was 180 kW per day, the heat pump wastes 55 kW per day. Monetary savings over the heating season amounted to 6,100 roubles, which indicates a return on investment of 2.5 years excluding hot water.
Novopolotskvodokanal branch of the Vitebskolvodokanal District Heating Company Deferrization plant
City of Verkhnyadzvinsk

the area of the room
221.5 m²

hydrothermal heat pump with a heat output of 24 kW

water heat source extracted; after water treatment, the heat pump is connected to the water supply
Conclusions

1. Ensuring savings of 10% or more of heat energy for heating the housing sector, based on the use of renewable energy sources, can provide an energy effect of 300,000 or more tonnes of oil equivalent per year of final consumption of fuel and energy resources for thermal energy production.

2. In the short term, the following is required:
   — development and implementation of comprehensive research projects on the use of hybrid systems based on district heating and renewable energy sources for the heating and hot water supply of public utilities;
   — creation of a systems management infrastructure for the effective implementation of these schemes;
   — interoperation with renewable heat sources (integration through intelligent information and communication management systems);
   — participation in digital processes through information and communication technology;

3. In the reconstruction, design and construction of new facilities, a group of housing units, the use of RES as part of hybrid heat supply systems should be envisaged in addition to a decentralised heat supply.
State Scientific Institution - Institute of the Housing and Utilities Sector of the National Academy of Sciences of Belarus
220024, Republic of Belarus, Minsk, 10 Akademika Kuprevicha st.
Email: institut-gkh@tut.by
Front desk: Tel./fax: (017) 360-38-35; mob.: (033) 392-45-09