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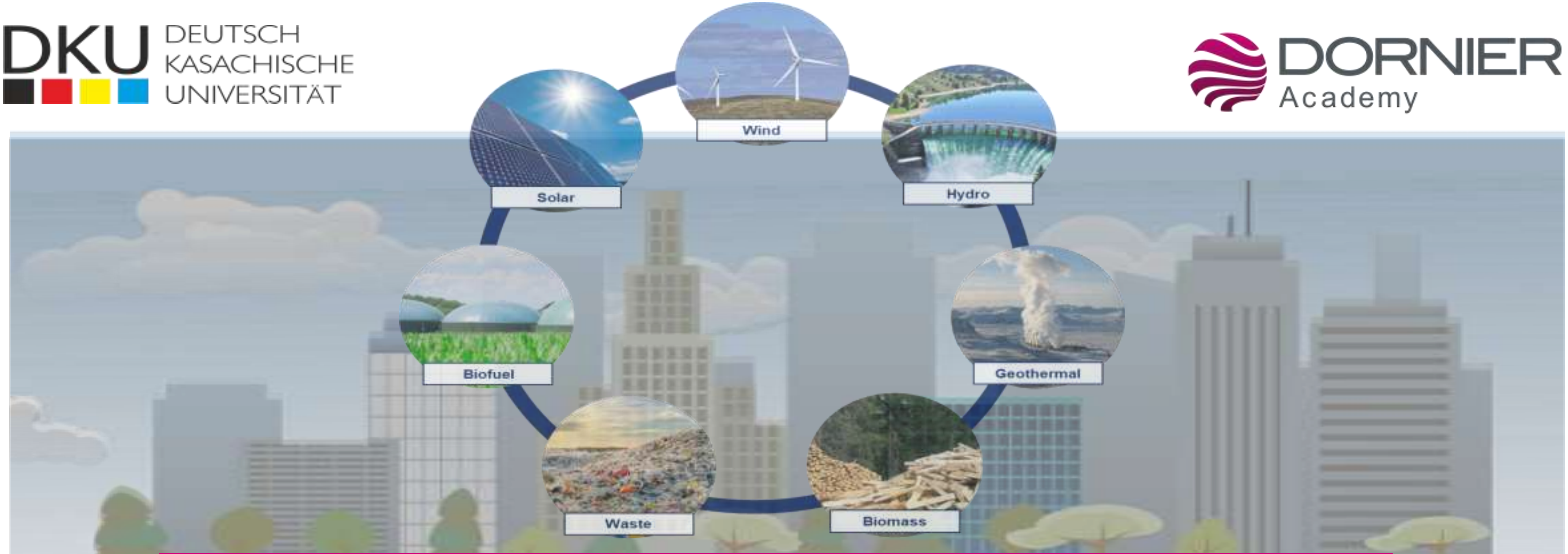


# 1.2 Heat distribution (temperature control, system design, loss reduction, repairs and maintenance regimes)

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**Modern heating sector - international trends and challenges for the Republic of Kazakhstan. Webinar Course in connection with the preparation of the “Law on Heating”**

ADB

Supporting Renewable Technology Inclusive Heat Supply Legislation – Technical and Legal Consultancy ADB. TA 6564 KAZ

VPC

# What is district heating (heating energy)
# What is district heating. What does district heating consist of?

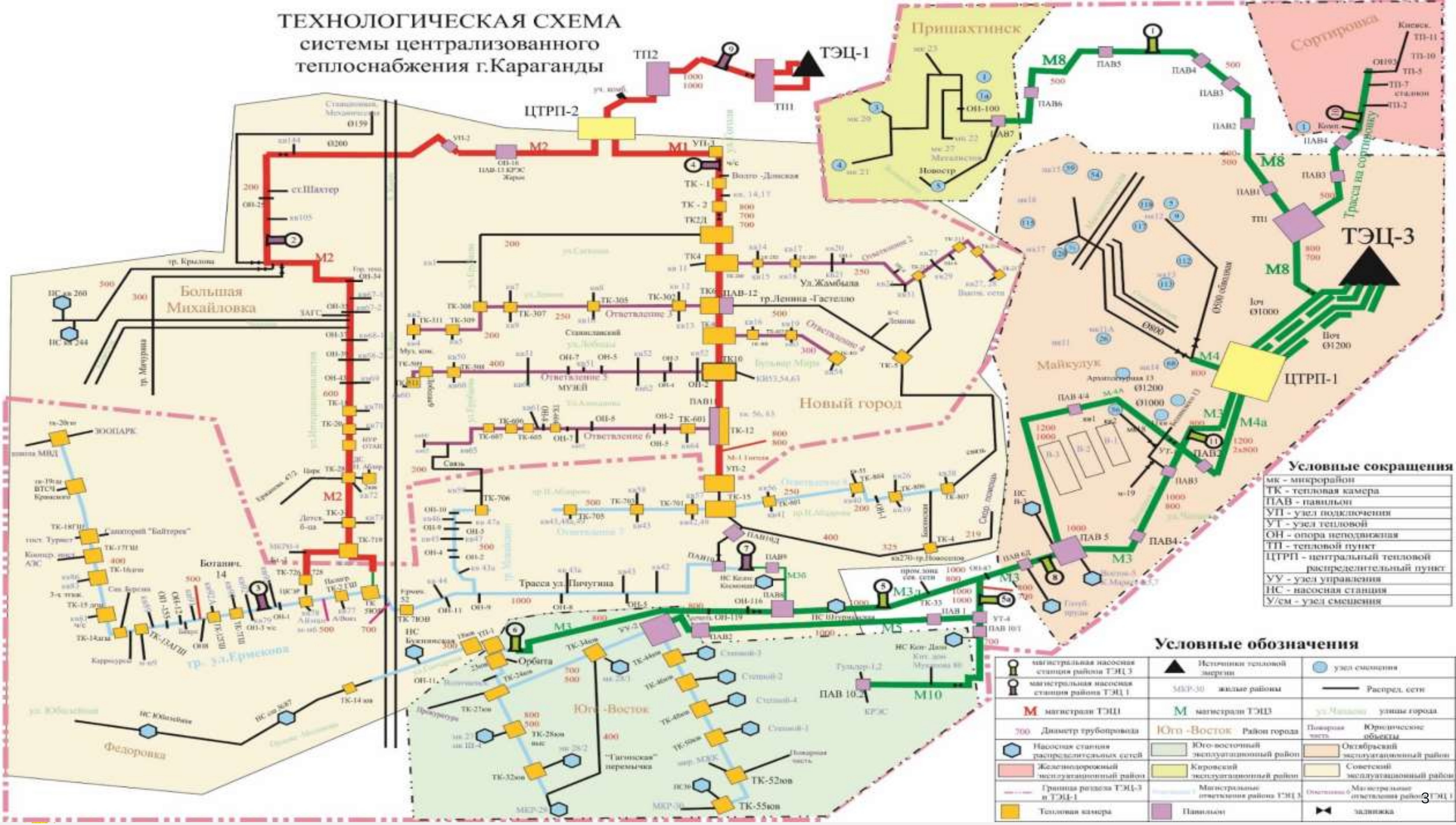
**Heat supply** - provision of heat to buildings and structures

**District heating** - system of heat supply from one or more heat sources with transfer of heat carrier via public heating networks

## Transit of heat energy:

- **Heat networks** - a system of pipelines (heat pipelines) through which heat carrier is transported from the source to the consumers and back to the source.
- **Pumping stations** (mixing and booster stations) - designed to increase the available head, increase the flow of the heat carrier and change the pressure in the heat network pipelines;
- **District heating substations** are designed to connect district heating systems (groups of buildings) to the distribution network of the city heating network.

# ТЕХНОЛОГИЧЕСКАЯ СХЕМА системы централизованного теплоснабжения г.Караганды



# What district heating systems are like

Single source / Multiple sources

**By connection type of the system:**

- Dependent connection scheme - a system in which the heat carrier is supplied directly to the heating system of the consumers
- Independent connection scheme - the heat transfer fluid circulating through the heating networks heats the heat transfer fluid in the heat exchanger, which circulates in the heating system

**By connection method of the system:**

- Open hot water connection scheme - the water circulating in the heating network is partially or fully withdrawn from the network by the heat consumers
- Closed hot water connection scheme - the water circulating in the heating network is used only as a heat carrier and is not withdrawn from the network

**By the method of regulation:**

- Qualitative - change in the temperature of water in the supply pipeline (without regulation of water flow);
- Quantitative - by changing the water flow rate while maintaining a constant water temperature in the supply pipeline.

# Advantages and disadvantages of systems

| | Advantages | Disadvantages |
|---|---|---|
| **Open** | ❑ Easy installation;<br>❑ Easy maintenance. | ❑ The presence of harmful chemical impurities in hot water: can dry the skin, cause irritation, hot water is not of drinking water quality;<br>❑ High cost of preparing water in centralised conditions;<br>❑ Hot water occasionally gives off an unpleasant odour;<br>❑ Water occasionally has an orange tinge due to rust;<br>❑ More expensive, chemically desalinated water has to be paid for;<br>❑ If the system is used incorrectly, water can flow over 100 degrees Celsius for short periods from the taps, which can cause burns. |
| **Closed** | ❑ No unpleasant odour from the water;<br>❑ Hot water of the same quality as potable water;<br>❑ Lower cost of water preparation;<br>❑ Savings by not having to pay for chemically desalinated water.<br>❑ Water will flow from the tap at a maximum temperature of 60 degrees, which prevents severe scalding.<br>❑ The **main advantage** is that harder water can be supplied, which extends the life of the heating networks. | ❑ The use of expensive equipment, resulting in higher capital costs during the construction phase;<br>❑ More expensive maintenance (compared to open heating system). |

# Advantages and disadvantages of quality regulation

**Advantage**
Stable hydraulic operation of the heating network.

**Disadvantages**

1. Low reliability of peak heat capacity sources.
2. Necessity of application of expensive methods of treatment of make-up water of a heating network at high temperatures of the heat carrier.
3. Increased temperature schedule for compensation of water intake for hot water supply and related reduction of power generation for heat consumption.
4. Large transport lag (heat retention) of heat load regulation of heat supply system.
5. High intensity of corrosion of pipelines
6. Fluctuations of indoor air temperature due to the influence of hot water load on the operation of heating systems, as well as different ratio of hot water and heating loads at the customers.
7. Reduced quality of heat supply when regulating the coolant temperature according to the average (in a few hours) outside temperature, which leads to fluctuations in indoor air temperature.
8. Variable network water temperature significantly complicates the operation of compensators

# Advantages and disadvantages of quantitative regulation

**Advantages**

1. Increase electricity generation at the heat demand by lowering the return temperature of the network water.
2. Possibility to use inexpensive methods of treatment of heating system make-up water at t <110 °C.
3. Operation of a heat supply system for the most part of the heating season with reduced consumption of heating water and considerable saving of electric power for the transportation of heat carrier.
4. Less retention of heat load regulation as the heat supply system reacts more quickly to pressure changes than to changes in the temperature of heating water.
5. Constant temperature of heat carrier in the heat supply line which contributes to reduction of corrosion damage of pipelines of the heating system.
6. Possibility of additional saving of electric power for circulating pump drive due to increase of natural circulating pressure.
7. The possibility of using long-lasting non-metallic pipelines in local systems and district heating networks at t < 110 ºC.
8. Keeping the temperature of network water constant has a favourable effect on the operation of expansion joints.
9. There is no need for mixing devices in the customer's inlets.

**Disadvantage**

Переменный гидравлический режим работы тепловых сетей

# General information

- **The length of heating networks** in the country is about 11.5 thousand km, of which:
  - main – 30%;
  - distribution networks – 70%.
- **Lifetime of the existing heat networks**

| | |
|---|---|
| **up to 10 years** | **6%** |
| **10-15 years** | **24%** |
| **15-20 years** | **27%** |
| **more than 20 years** | **43%** |

Why, when the norm is 25 years, the networks have been in operation for more than 40 years?

When the networks were laid, a Soviet safety margin was built, but it is ***not infinite***.

*The cost of replacing all networks is around $15 billion.*

**In fact, more than 50% of the networks have been in operation for more than 40 years!**

# Network length by region

| | Length of two-pipe networks, km | dilapidated networks | | need to be replaced | |
|---|---|---|---|---|---|
| | | total, km | in % of total length | total, km | in % of total length |
| Republic of Kazakhstan | 11440,9 | 3104,5 | 27,1 | 3219,3 | 28,1 |
| Akmola | 927,6 | 231,1 | 24,9 | 228,8 | 24,7 |
| Aktobe region | 566,9 | 153,1 | 27 | 125,3 | 22,1 |
| Almaty region | 671,1 | 155,1 | 23,1 | 148,2 | 22,1 |
| Atyrau region | 288,8 | 108 | 37,4 | 95,3 | 33 |
| West Kazakhstan | 345,2 | 28,3 | 8,2 | 28,3 | 8,2 |
| Zhambyl | 413,3 | 98,2 | 23,8 | 22,9 | 5,5 |
| Karaganda region | 1563 | 217,6 | 13,9 | 224,4 | 14,4 |
| Kostanai region | 824,5 | 91 | 11 | 138,4 | 16,8 |
| Kyzylorda region | 241,5 | 75,7 | 31,4 | 75 | 31,1 |
| Mangystau | 582,7 | 44 | 7,6 | 203,4 | 34,9 |
| Pavlodar region | 879,7 | 314,6 | 35,8 | 322,5 | 36,7 |
| North Kazakhstan | 367,9 | 185,5 | 50,4 | 126,8 | 34,5 |
| Turkestan region | 191,2 | 54,7 | 28,6 | 31,6 | 16,5 |
| East Kazakhstan | 1075 | 288 | 26,8 | 389,5 | 36,2 |
| Astana | 882,6 | 200,1 | 22,7 | 199,5 | 22,6 |
| Almaty | 1411,4 | 821 | 58,2 | 821 | 58,2 |
| Shymkent | 208,4 | 38,4 | 18,4 | 38,4 | 18,4 |

about
US$4 billion

required
260 000 000 $
earnings for
2020
6 000 $

# Heat losses in surveyed cities of Kazakhstan

| City | Losses (GWh) | Losses (%) |
|---|---|---|
| Aksai | 7 | 11% |
| Aktobe | 311 | 18% |
| Almaty | 1 567 | 26% |
| Atyrau | 187 | 23% |
| Karaganda | 487 | 18% |
| Kostanai | 140 | 18% |
| Astana | 1 018 | 12% |
| Petropavl | 548 | 26% |
| Saran | NA | NA |
| Semei | 625 | 36% |
| Shakhtinsk | 53 | 22% |
| Shymkent | 189 | 33% |
| Uralsk | 151 | 13% |
| Oskemen | 485 | 19% |
| **Total** | **5 768** | **19%** |

Heat losses are a big problem in Kazakhstan. Almost all loss figures are estimates.In the table, losses are calculated based on production and sales data obtained mainly from our questionnaires. These losses range from 11-33%, with a weighted average value of 19%

# Current problems in the regions (excluding Astana)

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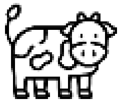
- high accident rate (1 to 10 damages per 1 km of pipeline annually, up to 20 accidents per hour);
- increased corrosion of heat networks;
- overheating of return flow;
- high heat energy losses (up to 40%);
- high electricity consumption for heat carrier pumping (whereas in Astana the unit cost is 10 kWh/1Gcal, in Karaganda and Kokshetau - 60 kWh/1Gcal);
- insufficient carrying capacity of networks, and as a consequence, inability to connect new consumers;
- lack of a unified strategy for development of heating networks in the regions, which leads to irrational use of heating networks;
- **LOSSES!!!**

while new consumers are willing to connect (new demanders) **DO EXIST!!!!**

# What is the source of the problems?

- high wear and tear on the networks;
- high oxygen content in the heat carrier (open heat supply system);
- technological and physical deterioration of main and auxiliary equipment in heat networks (63%);
- non-compliance with the temperature schedule (overheating of the return, and the consumer is a "sacred cow"); 
- tariffs are only current costs;
- no economic sense to invest in heat networks.

# Solution

## Technical

- optimal selection of pumping equipment;
- transition to a closed, independent heat supply system;
- regulation of heat extraction at the consumer and observance of the temperature schedule (installation and proper adjustment of the heating substation);
- Modernisation of heat networks with pre-insulated pipes and restoration of the quality of heat insulation where possible;

## Regulatory

- compliance with the temperature schedule;
- possibility of introducing a multi-rate tariff (Q, P, G, K).

## Institutional

- administrative liability of consumers;
- PPP for heat networks.

# multipart tariff

(Q)
payment for consumed heat energy

(P)
payment for declared (reserved) capacity

(G)
payment for heat circulation

(K)
consumption imbalance factor

**Fee for heat energy services =** $(Q + P + G) \cdot K$

# Results

- reduction of heat losses (about 5 million Gcal/year); → more than 1 mln t of coal/year, about 2 mln $tCO_2$ eq/year
- reduction of electricity consumption for heat carrier pumping (about 1 billion kWh/year);
- reduction of $CO_2$-eq emissions (more than 3 mln $tCO_2$-eq/year); → more than 300k t of coal/year, about 1 mln $tCO_2$-eq/year

- connection of additional consumers to the heat supply system (reduction of emissions, no more coal-burning stoves);
- increasing the useful supply of heat energy;
- increasing the profitability of heat supply and heat transmission organisations;
- reliable heat supply.

## Questions for discussion

1. How much does it cost to build new networks in Kazakhstan?
2. How many percent of the population in Kazakhstan use district heating?
3. What are the benefits of district heating?

# Methods and logic for determining the optimal mix of different heating systems in the regions

# Thank you for your attention!

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