ENERGY EFFICICNECY CHALLENGES
IN HEATING SUPPLY SYSTEM OF TURKMENISTAN AND POTENTIAL SOLUTIONS

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ABSTRACT

The poor condition and inefficient operation of the existing heat and hot water supply system in Turkmenistan is causing serious economic, social and environmental problems. Yet, the situation may very well change to the worse as increase of energy consumption is projected for near future. The country's commitment to reduce greenhouse gases emissions faces the challenge of ensuring that both the short- and long-term environmental impacts can be minimized while service levels of heat and hot water supply to the population are simultaneously improved.

Despite the energy, economic, and environmental benefits of energy efficiency in Turkmenistan, little has been done to eliminate energy waste. Due historic legacy, there is a limited institutional capacity to increase energy efficiency. Achieving energy and environmental goals will require a basic institutional transformation. Gaps in polices and legislation in the area of energy efficiency and the lack capacity and institutional expertise in managing local, regional and national energy efficiency programs have to be addressed.

INTRODUCTION

Despite the foreseen environmental, social and national economic benefits of improving the energy efficiency of the heat and hot water supply systems, there are some key barriers that currently prevent or slow down this development from taking place. These barriers are listed below.

Information and capacity barriers

- Lack of information on the modern, energy efficient heat and hot water supply technologies;
- Lack of local capacity to prepare feasibility studies and master plans taking fully into account the energy efficiency and GHG reduction aspects (on which the decisions to invest on energy efficiency could be based);
- Lack of experience and information on the applicability and the costs of different technical solutions to improve the energy efficiency of the heat and hot water supply systems in Turkmenistan; and
- Lack of information on and awareness of the national economic benefits of improving the energy efficiency of the heat and hot water supply systems.

Institutional and financial barriers

- Lack of enabling mechanisms to implement the agreed energy saving policies and strategies;
- Lack of incentives and appropriate institutional structures (e.g., co-operatives, home-owner association etc.) to improve the demand side energy efficiency within the buildings;
- A complex cost-sharing and subsidy system between the end users, local municipalities and the federal government, which in its current form does not encourage and facilitate the investments in energy efficiency.

The aim of the research is to remove the existing barriers to the improvement of the heat and hot water supply systems in Turkmenistan, thereby reducing their energy consumption and the associated greenhouse gas emissions. Some key components of the research include:

- Facilitating the preparation of feasibility studies and master plans for the participating municipalities, providing a basis for the long term development of the heat and hot water services according to sustainable development principles.
- Assisting the Government in the establishment of a supportive institutional and financial framework for energy efficiency investments.

The heating system of Turkmenistan was mostly formed in the 1950"s/1960 on basis of the ideas of centralized supply and minimization of expenses. Design principles are characterized by standardization with a low range of variations in the technical solutions. Standard types of boiler houses have been implemented. Staged capacity in standard type of boiler houses has resulted in over capacities in several cases, leading to low efficient operation. The implementation of the heating systems was determined by the lack of high efficient equipment and high quality material. A low level of automation has to be recognized. The current problems of heat supply in Turkmenistan can be solved only by a long term strategy. Therefore, a master plan has to indicate the development for the next 10-20 years.

The saving potential can be estimated by 40-50% for both domestic hot water and heating supply system.

PRINCIPLES OF REHABILITATION PLANNING OF DISTRICT HEATING SYSTEMS

It is important to recognize that District Heating reconstruction starts at the demand side, at the customers. Since they are paying for the services- irrespective of whether this is directly through the tariffs or indirectly through taxes and subsides- the customers' demand and consumption necessarily has to lead the activities of the whole sector. The necessity of the different steps can be explained by the following figure 1.

Figure 1: Principle course of DH refurbishment in Turkmenistan

Step 1 IV Building systems

- Rehabilitation of internal installations in buildings.
- Installation of cold and hot water meters for each flat, in order to decrease the hot and cold water consumption.
- Installation of thermostatic valves and cost allocators.

Step 2. III. Substations.

- Installation of heat meters.
- Replacement of old, worn out substations by new substations with heat exchangers.
- Installation of automatic control (priority switching)
- Renovation of heat insulation.

Introduction of consumption – based rates and tariff system

Step 3. II. Distribution network

- Stop leaks
- Hydraulic calculations of network, optimization
- Renovation of pipe insulation
- Replacement of old, wet mineral wool insulated pipes with PJP
- Replacement of other worn-out pipes with PJP

Step 4. I. Generation and transmission

- Variable- speed control for DH pumps.
- Rehabilitation of water treatment facilities if necessary.
- Clarifying electricity demand and prices in CHP.
- Development of generation concept.
- Improvement of CHP for basic loads.
- Improvement of HOB for peak loads.

The basic strategy is rehabilitation or better renewal of the whole DH chain starting at the customer and ending at the generation facilities. This approach means a strong orientation towards customer needs. Without satisfied customers, there will be no secure payments for DH heat supply in future when the population has more financial means available and will therefore have a choice between different options.

ECONOMIC EFFECTS OF DH SYSTEM MODERNIZATION

The overall economics of modernizing a DH system depend on the necessary expenses (investments costs etc) and resultant energy savings, improved heat supply reliability, and other advantages resulting in lower heat supply costs. The economic effect of reduced environmental pollution is more important from a national perspective, but when it is established emission trading may benefit DH companies. The main economic benefit for the DH Company and its customers is lower heat supply costs by implementing the least cost principle in the following ways:

- flexible fuel use - ability to use various fuels and use the cheapest
- utilization of various waste heat sources
- economic load division between heat sources supplying DH network
- elimination of redundant capacity in heat sources and DH network
- elimination of low efficiency heat sources
- development of heat and electricity cogeneration
- reduction of heat losses in DH network
- reduction of electricity consumption for water pumping and other needs
- economy of scale by producing heat in larger central plants.

The financial security of the DH Company is very important for making sure the modernization programme is sustained. This involves taking forward the most appropriate measures, in a planned sequence, which is affordable. Usually the main aims of 'generation driven' DH system rehabilitation in CIS countries are improvement of the total energy efficiency of heat supply and rationalization of heat utilization by consumers. Generally DH system modernization results in:

- considerable decrease of fuel and electricity consumption in heat sources,
- reduction of heat losses in DH networks,
- improvement of heat control on the supply side,
- reduction of heat consumption following demand side management (DSM) measures for energy conservation in buildings.

It means that rehabilitation of a DH system leads to considerable energy savings giving lower heat supply costs and improved environmental protection (reduction of emissions). Simultaneously the transformation from generation-driven to demand-driven encourages customers to consume less, increasing the unit cost of heat supply (fixed costs are divided into a smaller amount of sold heat). Thus economic aspects are very important for planning the DH system modernization.

The starting point for the DH system modernization planning should be:

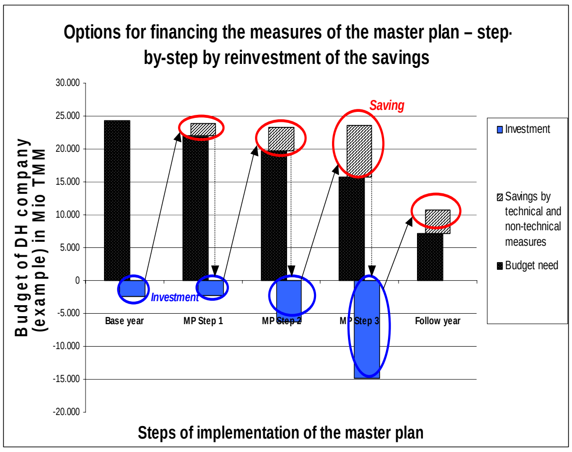
- To define the scope of modernization together with an evaluation of expected costs and economic effects (decrease or increase of heat supply unit costs) for particular DH system elements,
- evaluation of available financial sources

If available financial sources are not sufficient to cover all costs of planned DH system modernization the plan should be divided into affordable stages.

The DH system rehabilitation should be considered in this way: its first stages should include measures which can be realized without or almost without investment costs (e.g. organizational changes, improvement of operation quality etc.), but giving savings and resulting in reduction of heat supply unit costs. This means that some improvements can be made quite quickly. More expensive improvements can be carried out when resources allow:

→ realization of small investments by own resources or government support → refinancing by savings within the DH company → than investment into the next step (see figure 2).

Figure 2: Options for financing the measures of the master plan –step –by-step by reinvestment of the savings.



Both the DH Company's own and outside financial sources can be used. It is necessary to stress that the economic effects of DH system rehabilitation affect heat supply unit costs and DH Company pricing policy, as well as the competitiveness of DH systems with other systems of heat supply (e.g. decentralized gas or oil fired boilers).

In order to allow the functioning of this financing pproach the flexibility and own responsibility of the DH Companies on the use of their budget has to be given, as out-lined above.

Due to the fact that the entire energy sector is state controlled and substituted, the macroeconomic approach for the assessment of investment and modernization shall be applied. This means gas saving result into higher gas export capacity, for which the export price can be considered. To determine the costs reductions as result of reached energy savings (mainly gas) the gas export price of approx. 65 US$ shall be applied.

It is obvious that on a macroeconomic scale (export of natural gas saved) the budget savings are about 30 times higher than the savings on a microeconomic scale. This is due to the export price being considerably above the natural gas purchase price for domestic consumption.

The evaluation of the economic efficiency at project level (so called microeconomic level) will not be leading to results, because of the above explained reasons of insufficient income by sales tariffs to refinance the investments.

COMMON MEASURES OF MASTER PLANS

The figure 3 provides an overview on the proposed measures. The codes of the figure 3 are used for the detailed description of the measure and for the compilation of measures for the master plans for each city. Not all indicated measures, shall be realized in each city.

According to the target of the measure, there are 9 packages of measures identified and proposed.

Package of measures (see annex 1):

1. Measuring of real energy consumption for heat generation.
2. Increase of boiler efficiency.
3. Reduction of water losses in DH system.
4. Reduction of heat losses in transmission system.
5. Processing of feed water.
6. Reduction of energy demand for heat transfer.
7. Optimization of heat supply structure.
8. Improvement of heat supply of apartments by better balancing.
9. Reduction in the heat consumption of buildings.

RESULTS

The results of the calculation of the saving effects by the implementation of the master plans in the 9 cities are quite impressive.

The overall annual savings of natural gas would be 123 million m³ , starting in the 1st year after implementation if the 1st priority packages of measures; up to annual 150-190 million m³ for the years following the 2nd and 3rd priority measures.

This is an important result on the background of the Presidential decree to increase the export capacity of Turkmenistan over the planning period until 2030.

Error! Reference source not found. compares the total gas saving options for each city. Naturally the cities with the larger DH system have a higher saving potential for gas. This total gas saving figures shall not be the basis for a decision for the implementation of the master plan, because the conditions in the cities (like number of customers, technical conditions and other) are not comparable. The specific figures provide a clearer picture on the effectiveness of the implementation of the master plan phases for each city.

In addition, not only the economic results shall be the basis for decision, there are also “soft”, but important factors to be considered, such as stabilization of heat supply to residents and public buildings.

In the **Error! Reference source not found.** the ratio of state support per 1000 m³ gas saved per city and phase of master plan implementation is compared with the gas export prices, which can be received, when exporting this gas.

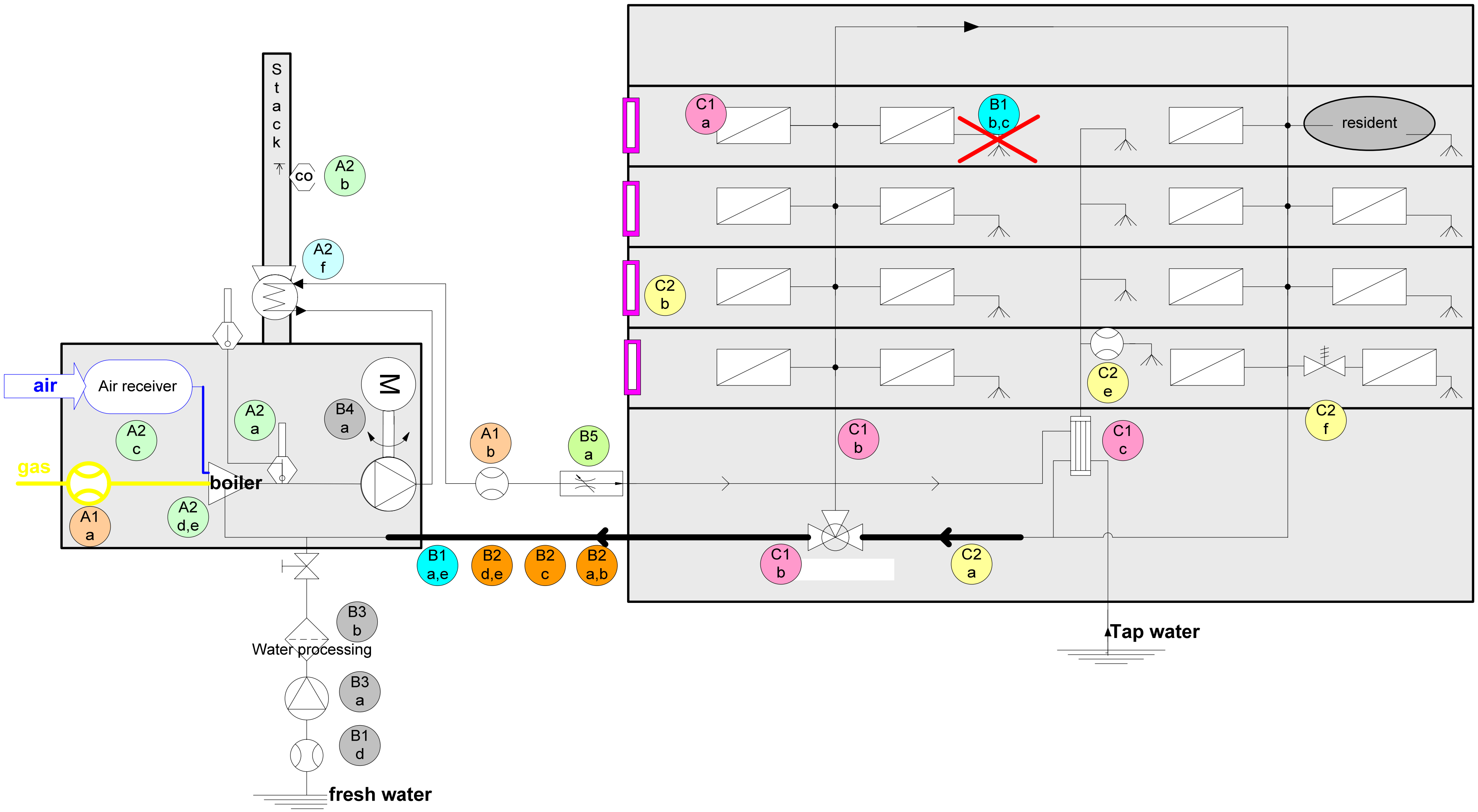
It can be seen, that the specific costs per gas saving are quite low for smaller cities, in which relatively low investments (in one implementation phase only) can generate high gas savings over the entire period of the analysis (15 years). For larger cities, respectively larger DH systems more complex and comprehensive packages of measures are foreseen, which generates slightly higher specific costs per gas saving. The figures between the cities shall not be directly compared, because the conditions in the cities (like density of heat supply, number of customers, technical conditions and other) are not comparable.

The specific costs for the realization of the first phase (priority 1 measures) is in the range between 6 to 12 US$ per 1000 m³ gas saved, which is 10-20% of the gas export price, which could be gained already in 2006. The difference would be income for the state budget.

The measures of priority phase 2 and 3 have are naturally more expensive (20 to 100 US$ per 1000 m³ gas saved), because the measures which are bringing the best economic results are realized in phase 1. Anyhow, if a further increase of the gas export price can be realized, the measures of at least priority 2 are economic, because their specific costs would be still below 50% of the gas export price.

The calculation of the macroeconomic budget saldo for implementation of master plan for 9 cities, results into 106 million US$ (PROFIT) in which the investment of 56.4 million US$ is considered. The so-called break-event point is reached in the 4th year of implementation that means that from this year the investment brings profit (Figure 9).

Figure 3: Schematic overview on the central heating system with indication of sites for the proposed measures (generation, transmission, distribution and consumptions site)



ANNEX 1:

1. ***Measuring of real energy consumption for heat generation.***

Measures of priority 1:

CODE:	**A1a**
Title:	**Metering of gas consumption**
Type:	Technical
Characteristic	Installation of gas consumption meters
Investments:	Gas meter, 3-valves, manometers and thermometers.
Average	average size 3 000 US$ per unit
Effects:	Measuring of real consumption, proof of savings (if any) DH companies pay only for the really gas consumed
Assumptions:	none

CODE:	**A1b**
Title:	**Metering of heat production**
Type:	Technical
Characteristic:	Installation of heat meters at the outlet of the BH Measuring of real production, possibility to calculate real efficiency of the boilers
Investments:	1 unit: Heat meter, 2 ball valves, flanges
Average	average size 3000 US$ per unit
Effects:	Capacities at the DH company to assess the real efficiency of the boilers based on concrete measuring
Assumptions:	This package shall be accompanied by a non-technical measure: The development of capacities at the DH company to assess the results of the measuring. This will allow the assessment of the real consumption and effects of technical and non-technical activities. Operator staff in the boiler house shall be trained on handling of the measuring equipment, compilation and documentation of data. This shall comprise the maintenance of the installations, e.g. cleaning of gas filters. Engineers of the DH company shall be trained on analyzing the data and developing recommendations for technical improvements, e.g. improvement of combustion process, adjustment of the temperature/ operation mode of the boilers.

2. ***Increase of boiler efficiency.***

Measures of priority 1:

CODE:	**A2a**
Title:	**Justification of operation mode according to temperatures**
Type:	Technical
Characteristic:	Renew outside air thermometer and thermometers at supply and return pipe
Investments:	Thermometers + installation
Average	100 US$ per unit
Effects:	Operation of boiler according real heating demand and saving of gas, when mild temperatures. Increase of ~ 1-2% of the efficiency of the boiler
Assumptions:	Trained and instructed operator of the boiler

CODE:	**A2b**
Title:	**Analyzing of exhaust flue gas and adjustment of combustion**
Type:	Non-technical
Characteristic:	Analyzing of exhaust flue gas for measurement of CO, CO2 content, and calculation of fuel utilization rate.
Investments:	Is low, equipment is available, costs to travel and service.
average	Up to 50 US$ per service at one boiler
Effects:	Optimization /adjustment combustion process (except the new boilers). Increase of ~ 3-5 % of the efficiency of the boiler
Assumptions:	Measuring equipment available. Willingness and understanding of boiler operator Adjustment at least once a heating period (at the beginning)

CODE:	**A2c**
Title:	**Training of boiler operator staff**
Type:	Non-technical
Characteristic	Training of boiler operator staff (water processing, boiler operation, installers, plumbers). On operation according to demand, installation improvements
Investments:	Is low. Fee to travel and service.
average	**20 US$ per training unit (1 day)**
Effects:	Operation of boilers according to optimal parameters. Increase of ~ 1-2

	% of the efficiency of the boiler
Assumptions:	In combination with A2a

Measures of priority 2:

CODE:	**A2d**
Title:	**Replacement of burners, installation of automatic combustion control**
Type:	Technical
Characteristic:	Optimization of combustion process by adjustment of air and gas input
Investments:	Replacement of burners, installation of automatic combustion control
average	3 500 US$ per burner of capacity 1.6 Gcal/h, 2 000 US$ per burner of capacity 0.6 Gcal/h
Effects:	Gas saving due to higher efficiency of the burning process up to 15%, especially for boilers with lower capacity in addition to measures of priority 1
Assumptions:	none

CODE:	**A2f**
Title:	**Installation of economizer to increase supply temperature**
Type:	Technical
Characteristic:	Installation of simple heat exchanger (welded cast iron) in flue gas channel of boiler house (average 5 boilers=1 unit), only for medium and large size boilers, >30 000 Gcal/yr
Investments:	Heat exchanger (welded cast iron) in flue gas channel of boiler house
average	4 000 US$ per unit
Effects:	Utilization of exhaust gas energy for superheating of supply water, ~ 5% higher boiler efficiency in addition to measures of priority 1
Assumptions:	Condition is the availability of capacities and materials for installation

Measures of priority 3:

CODE:	**A2e**
Title:	**Replacement of inefficient boilers**
Type:	Technical
Characteristic:	Replacement of inefficient boilers, especially of type HP 18, which have exceeded the lifetime
Investments:	Installation of new boilers, specifically small-scale boilers
average	6000 US$ for boiler of capacity 0,7 Gcal/h
Effects:	Higher efficiency of burners, burners with lower capacity up to 30% gas saving
Assumptions:	avoid overlapping with measure A2d - Replacement of burners, installation of automatic combustion control, means only replacement of boilers, which not got new burners

CODE:	**A2g**
Title:	**Installation of medium size gas-turbine CHP at the premises of existing large boiler houses**
Type:	Technical
Characteristic:	Reconstruction of large district boiler houses with regard to the installation of gas turbine (small GT) for cogeneration of power and heat in a capacity share of 40/60%. The capacity of such GT CHP could be 30 MWth/20 Mwelt.
Investments:	Combined Heat and power generation plant with Gas Turbine
average	Investment costs would be about 1 200 US$ per kW power capacity.
Effects:	Combined heat and power production is cheaper; heat is waste product of the power production. This leads to saving of approx. 50% of the current heat production costs for this amount of heat. The simple payback period of the investment would 9-10 years under the assumption of export gas price.
Assumptions:	The investment into medium sized CHP with gas turbine technology seems viable only under the following conditions in Turkmenistan: - existing large boiler house with existing district heating system. - demand for the replacement of the existing heat only boilers. - the heat load of the connected customers shall be as stable as possible, there shall be DHW supply in summer time as well.

	- In order to allow high annual operation hours of the CHP (most effective operation mode) the capacity of the heat production shall be designed to meet the minimum heat load of the connected customers. Installation of CHP only as priority 3 measure after exploitation of the main energy saving potentials at heat distribution and consumption in buildings sites in order to avoid over-dimensioning of the heat supply by the CHP. Considering the potential for the introduction of cogeneration plants within the district heating companies as the most efficient generation facilities, the idea of closing all boiler houses and removing the district heating networks in order to install small boilers everywhere should not be followed. One could come to the conclusion that it is necessary to give everybody the choice for the selection of type of heat supply depending on what could be installed. This is a wrong understanding of freedom of choice. It is in the interests of everybody to save resources for future generations and to generate energy with the lowest environmental impact. The existing district heating networks offer a chance to introduce this very recommendable technology. If the networks were dissolved, and a tendency to individual generation preferred, this large potential would be lost with little opposition. Therefore, the district heating sector should be protected and developed to ensure efficient operation. Its existence is opportune for the energy sector.

CODE:	**A2h**
Title:	**Solar hot water production**
Type:	Technical
Characteristic:	Application of solar collectors (heating of feed water and hot water supply in selected boiler houses)
Investments:	Solar collector system (1 000 m² capacity of 0,8 Gcal/h~4 000 Gcal)
average	280 US$ per m² (production in Central Asia, e.g. Uzbekistan)
Effects:	2-4 Gcal/m² collector area and year --> Gas saving. Substitution of respective energy demand for heating of feed water

Assumptions:	Precondition is the availability of materials, and space at the boiler house

3. ***Reduction of water losses in DH system***

Measures of priority 1:

CODE:	**B1a**
Title:	**Repair leaks in DH network at pumps, pipelines and valves**
Type:	Technical and Non-technical
Characteristic:	Development of a preventive and emergency repair plan, organization of equipment and material supply. In addition DH systems with open system DHW supply, e.g. hotels, clinics the poor condition of hot water installations (leaking taps) are not allowing a respectful handling or saving of the hot water
Investments:	Efforts shall be undertaken with the repair brigades of the respective operator of the buildings to repair the taps, opening on demand and seal when closed tap. Investment for material and repair tools for the brigades only
average	12 000 US$/year as lump sum
Effects:	Reduction of up to 50% of the water losses in the network. Leads to reduction of ~ 7% energy demand to heat up the feed water
Assumptions:	Capacities for repair. Availability of materials. Cooperation between operators of buildings and DH company and water company. Metering of the feed water

CODE:	**B1b and c**
Title:	**Stop the unauthorized discharge of DH water at radiators**
Type:	Technical
Characteristic:	Dismantling of existing taps at radiators at residential buildings
Investments:	Installation, pipelines, welding
average	5 US$ per radiator, 4 radiators per apartment
Effects:	Two effects: b) Reduction of up to 50% of the water losses in the network c) Leads to reduction of ~ 25% energy demand to heat up the feed water
Assumptions:	Only in combination with measure C1a: Rehabilitation of internal heating system in apartment houses: Inside cleaning of the heating system parts of the building, Balancing of heat supply in buildings

CODE:	**B1d**
Title:	**Metering of feed water in each boiler house**
Type:	Technical
Characteristic:	Installation of water meter of feed water in each boiler house
Investments:	One unit comprises: water meter, 2 flanges, 2 ball valves.
average	120 US$ per unit
Effects:	No direct savings , only valuation of the saving of feed water. In order to prove the real water consumption and reduce the water bill from the water supply company
Assumptions:	none

Measures of priority 3:

CODE:	**B1e**
Title:	**Replacement of leaking transmission pipes**
Type:	Technical
Characteristic:	Replacement of leaking transmission pipes
Investments:	Replacement of distribution/ transmission pipelines, Installation of new pre-insulated pipelines
average	Costs are covered, when implementing measure B2e
Effects:	Reduction of the water losses in the network. Leads to reduction of ~ 7% energy demand to heat up the feed water
Assumptions:	Only in combination with B2e - Replacement of distribution/ transmission pipelines, Installation of new pre-insulated pipelines

4. REDUCTION OF HEAT LOSSES IN TRANSMISSION SYSTEM

Measures of priority 1:

CODE:	**B2a**
Title:	Reinsulation of distribution pipelines
Type:	Technical
Characteristic:	Reinsulation of over-ground distribution pipelines according to western standard
Investments:	Reinsulation of over-ground distribution
average	3 US$ per m
Effects:	Reduction of up to 50% heat losses in this network part (average of total 20%)
Assumptions:	12% of total produced heat is lost in distribution pipes, availability of materials

CODE:	**B2b**
Title:	Reinsulation of transmission pipelines
Type:	Technical
Characteristic:	Reinsulation of all underground transmission pipelines according to western standard and sealing of ducts
Investments:	Reinsulation of transmission pipelines
average	10 US$ per m
Effects:	Reduction of up to 50% heat losses in this network part (average of total 20%)
Assumptions:	12% of total produced heat is lost in transmission pipes, availability of materials

CODE:	**B2c**
Title:	Insulate valves and related pipeline equipment
Type:	Technical
Characteristic:	Simple repair with local material
Investments:	Simple repair, insulation, sealing with local material and labour forces
average	10 US$ per valve
Effects:	Reduction of up to 50% heat losses in this network part (average of total 1%)
Assumptions:	4% of total produced heat is lost at valves and related pipeline equipment, availability of materials

Measures of priority 3:

CODE:	**B2d**
Title:	**Replacement of transmission pipelines**
Type:	Technical
Characteristic:	Replacement of transmission pipelines
Investments:	Installation of new pre-insulated plastic jacked pipelines
average	300 US$ per m
Effects:	Reduction of up to 30% additional heat losses in this network part (average of total 20%)
Assumptions:	8% of total produced heat is lost in transmission pipes, availability of materials;

	Consider and overlapping with B2b - Re-insulation of transmission pipelines That means only this pipelines shall be replaced, which really exceeded the lifetime and cannot be repaired, may be 10% of all pipelines

CODE:	**B2e**
Title:	**Replacement of distribution pipelines**
Type:	Technical
Characteristic:	Replacement of distribution pipelines, Installation of new pre-insulated pipelines
Investments:	Installation of new pre-insulated plastic jacked pipelines
average	200 US$ per m
Effects:	Reduction of up to 30% additional heat losses in this network part (average of total 20%)
Assumptions:	8% of total produced heat is lost in transmission pipes, availability of materials; consider and overlapping with B2a - Re-insulation of distribution pipelines That means only this pipelines shall be replaced, which really exceeded the lifetime and can not be repaired, may be 10% of all pipelines

5. PROCESSING OF FEED WATER

Measures of priority 1:

CODE:	**B3a**
Title:	**Maintenance respectively installation of fresh water filters**
Type:	Technical
Characteristic:	Fresh water filter before feed in the DH system, one per boiler house
Investments:	Fresh water filter before feed in the DH system, one per boiler house
average	100 US$ as lump sum per boiler house
Effects:	Mechanical treatment, reduction of deposits, Reduction of ~ 0,5% of the annual maintenance costs for network
Assumptions:	none

Measures of priority 2:

CODE:	**B3b**
Title:	**Processing of feed water to the DH system**
Type:	Technical
Characteristic:	Install feed water processing equipment for the water which has to feed to the DH system in order to compensate the water losses Only in medium to large scale boiler houses, not for small and individual boilers
Investments:	Filtering, Decarbonisation, softening
average	3 500 US$ per unit in one medium sized boiler house
Effects:	Slower inside corrosion of pipelines, reduction of deposits, reduction of network /pipeline maintenance costs and extension of life time, Reduction of ~ 10% of the annual maintenance costs for network
Assumptions:	Design the capacity of the equipment after water saving measures of priority 1 in order to avoid over dimensioning

6. REDUCTION OF ENERGY DEMAND OF HEAT TRANSFER.

Measures of priority 2:

CODE:	**B4a**
Title:	**Reduction of power consumption for pumping**
Type:	Technical
Characteristic:	Installation of variable speed drives (VSD) at network pumps
Investments:	Equip pump with variable control according to network flow demand, in average 2 per heating network. Check before if the variable speed drive system can be adapted to the existing pumps, if necessary, replace pumps.
average	9000 US$ for one unit of variable speed drive
Effects:	Reduction of ~ 20% of the power consumption of the network pumps, reduction Reduction of the power bill of the DH company
Assumptions:	Existence of meter for power consumption

7. *Optimization of heat supply structure*

Measures of priority 1:

CODE:	B5a
Title:	**Hydraulic balancing of the heat flow to customers**
Type:	Technical
Characteristic:	Balancing of heat flow in the parts of the DH system, hydraulic balancing
Investments:	Flow limiters (valves) at parts of the DH system, e.g. at buildings (30% of the building stock), mainly those, which are located next to the boiler house
average	100 US$ per building = 4 US$ per riser
Effects:	Balanced heat supply to all connected buildings, avoided over heating → improvement of heating comfort reduction of up to 4%heat demand in buildings
Assumptions:	Previous analysis of demand of the measure, on real overheating of near BH buildings

Measures of priority 3:

CODE:	B5b
Title:	**Heat Load Analysis and economic load dispatch**
Type:	Non-technical
Characteristic:	Long-term analysis of heat demand Extension of central heat supply Acquisition of new (paying) customers, such as industry or public buildings, Extend services (e.g. steam and hot water supply, external repair services)
Investments:	Connection of new customers according to savings (overcapacity) achieved by other measures
average	investment into new distribution pipeline average 250 US$/m
Effects:	Long-term savings, substitution of saved energy with new customers The simple payback time of this measure is approx. 20 years
Assumptions:	Assumption 240 Gcal/yr for 1 new building of 3000m², connection length 0,2 km average. Tariff for new customer minimum 4 500 TMM/m² heated area per year

CODE:	B5c
Title:	**Decentralization of heat supply - Closure of boiler houses and central heat systems**
Type:	Technical
Characteristic:	Closure of boiler houses and DH systems in low load areas, installation of individual gas boilers in residential areas
Investments:	Close central heating plant, Installation of individual (small, high efficient) boilers for the supply (of 2 buildings in average 2*3000m²)
average	8000 US$ for individual boiler of capacity 0,6 Gcal/h
Effects:	Reduction of ~ 95% of distribution losses. Increase boiler efficiency to 90%
Assumptions:	In areas with low heat density and load In some smaller cities, this shall be the main measure with priority 1

CODE:	B5d
Title:	**Staged complete modernization of the heating networks**
Type:	Technical
Characteristic/ description:	Staged transition of heating networks and heat consumption systems under reconstruction to **closed cycle** and application of modern technologies of pipelining, and individual temperature control for each customer ensuring minimum losses of heat energy and continuous control of heat insulation conditions.
Investments:	Application of modern technologies of pipelining, and individual temperature control for each customer ensuring minimum losses of heat energy and continuous control of heat insulation conditions.
average	10 US$ per m² heated area
Effects:	Long-term savings, In addition to measures A and B 1 and 2 priority , reduction of energy demand up to 30% of all
Assumptions:	Is not economic under Conditions in Turkmenistan Avoid overlapping with measure C2i Detailed analysis of the individual installations of this measure is necessary considering the achieved saving by phase 1 and 2

8. IMPROVING OF HEAT SUPPLY OF APPARTMENTS BY BETTER BALANCING

Measures of priority 1:

CODE:	**C1a**
Title:	**Rehabilitation of internal heating system**
Type:	Technical
Characteristic/ description:	Rehabilitation of internal heating system in apartment houses: Inside cleaning of the heating system parts of the building, Balancing of heat supply in buildings (50% of building stock) Washing of pipelines and radiator, Installation of **balancing valves** with differential pressure control and weather compensator, valves;
Investments:	One unit comprises 1 riser, ~100 m² heated area (average building with 60 apartments à 50 m², 30 risers)
average	40 US$ per riser = 0,4 US$ per m² heated area
Effects:	Increase of flow through the radiators and by that better heating comfort Up to 30% reduction of heat water losses, Gas saving at boiler house for feed water preheating In addition to measure B1c - Stop the unauthorized discharge of DH water at radiators
Assumptions:	This measure shall be implemented in cooperation between DH company, housing Association and Residents (building users) Implementation at approx. 50% of the building stock

Measures of priority 2:

CODE:	**C1b**
Title:	**Renewal of internal piping in apartment buildings**
Type:	Technical
Characteristic:	Renewal of internal piping in apartment buildings (50% of building stock)
Investments:	New pipelines, balancing valves, valves, other material,
average	55 US$ per riser = 0,55 US$ per m² heated area
Effects:	reduction of up to 20%of heat water losses, in addition to measure B1c- Stop the unauthorized discharge of DH water at radiators
Assumptions:	This measure shall be implemented in cooperation between DH company, housing association and residents (building users) Implementation at approx. 50% of the building stock Avoid overlapping with C1a - Rehabilitation of internal heating system

Measures of priority 3:

CODE:	**C1c**
Title:	**Heat exchangers for hot water supply**
Type:	Technical
Characteristic:	Installation of heat exchanger for domestic hot water only
Investments:	Installation of heat exchanger for domestic hot water only
average	2 000 US$ per riser = 20 US$ per m² heated area
Effects:	Improvement of reliability of DHW supply Reduction of network water losses Reduction of 15% of energy for heating feed water
Assumptions:	This depends on the general policy of the heat and hot water supply services, the capacities of the boilers houses after the implementation of measures of phase 1 and 2 (there shall be capacity available) Implementation at ~50% of apartment buildings

9. REDUCTION IN THE HEAT CONSUMPTION OF BUILDING.

Measures of priority 1:

CODE:	**C2a**
Title:	**Insulation of heating pipelines in the building**
Type:	Technical
Characteristic:	Insulation of heating pipelines in the building
Investments:	Insulate all internal pipes in the open cellars under the buildings, risers and in the basement with local material
average	20 US$ per riser = 0,2 US$ per m² heated area
Effects:	Better heating comfort in the apartments, Reduction of 5% of the heat demand in (all) buildings
Assumptions:	Availability of insulation material

CODE:	**C2b**

Title:	**Low-cost thermal upgrade of the building**
Type:	Technical
Characteristic:	Low-cost thermal upgrade of the building comprising:
Investments:	Improvement of window sealing, installation of 'heat reflector - insulation' between radiator and wall in rooms, replacing or tightening of old radiator valves, automatic closing mechanisms for closing existing front doors, Repair of windows in stair and basement rooms, Automatic closing mechanisms for closing existing front doors, New front doors with closing mechanisms, when missing, Repair of windows in stair rooms, Insulate **all** internal pipes in the open cellars under the buildings, Tighten windows, Complete glazing on balconies
average	2 US$ per m² heated area
Effects:	Reduction of ~ 15% heat demand in apartment buildings Improvement of living comfort by reduction of draught
Assumptions:	This measure shall be implemented in cooperation between DH company, Housing Association and Residents (building users)

CODE:	**C2c**
Title:	**Information package customers**
Type:	Non-technical
Characteristic:	Development and implementation of comprehensive information package customers on changing of user behaviour, energy saving issues, self-help for insulation of windows, doors , etc. Organisation of "subbotnics" for rehabilitation of installations in the apartments
Investments:	Into low cost materials and tools only
average	Approx. 10 000 US$ per year as lump sum (depends on the size of the city)
Effects:	Reduction of heat demand in buildings, in combination with C2b- Low-cost thermal upgrade of the building Reduction of ~1% of the heating demand in buildings
Assumptions:	Provision of guidance, tools and materials

CODE:	**C2d**
Title:	Organisation of intensive cooperation between the DH company and the housing association
Type:	Non-technical
Characteristic:	Housing Associations have a lack of technical capacity for maintaining the building installations: insulation, water, Training of operation staff (installers, plumbers)
Investments:	No
average	No
Effects:	Increasing repair capacities
Assumptions:	Measure under the supervision of the city administration

<u>Measures of priority 2:</u>

CODE:	**C2e**
Title:	**Installation of cold and hot water meter in each apartment/ customer**
Type:	Technical
Characteristic:	Metering of cold and hot water supply, metering of heat water flow Implementation of consumption based billing for water/ cold and DHW
Investments:	meters for hot and cold water meters
average	49 US$ per apartment = ~ 1 US$ per m² heated area
Effects:	Reduction of water consumption up to 40% 40% reduction of energy demand for heating of feed water to in the DH system
Assumptions:	Implementation in cooperation with the Hosing Association This measure is a precondition for consumption based billing, which stimulates energy and waster saving at the consumer site

CODE:	**C2f**
Title:	**Regulation of heating in the apartments**
Type:	Technical
Characteristic:	In the current system the only way for inhabitants to regulate the temperature in their apartments is to open the window. This means unnecessary heat losses and, as the radiators are connected by a one-string system without bypass, it could

	lead to insufficient heat supply for the last apartments on the string. Therefore, it is suggested that thermostatic valves and bypasses be installed at each radiator.
Investments:	implementation of thermostatic radiator valves, 3 valves per apartment
average	~ 75 US$ per apartment= 1,5 US$ per m²
Effects:	Improvement of heating comfort, no overheating Reduction of 5% of heat demand in buildings (could be even higher → 20%, if heat supply is effective and danger of overheating of the rooms)
Assumptions:	This is very necessary, if due to measures of the 1st phase the heat supply of the apartments is increased.

Measures of priority 3:

CODE:	**C2g**
Title:	**High-cost modernisation of apartment buildings**
Type:	Technical
Characteristic/ description:	High-cost building modernisation Replacement of old windows with high heat losses, additional thermal insulation to walls and roofs, better insulation internal pipelines, replacement of space heating and domestic hot water installations (pipelines, radiators), completion of glazing of balconies
Investments:	
average	7US$ per m² heated area
Effects:	Improvement of living comfort by reduction of draught Reduction of ~ 30 % heat demand in apartment buildings
Assumptions:	Consider overlapping effects with measure C2b - Low-cost thermal upgrade of the building

CODE:	**C2h**
Title:	**Introduction of metering**
Type:	Non-technical
Characteristic/ description:	Introduction meter reading programme (consumption of heat energy and hot water supply, water) and subsequent billing mechanism. To encourage proper use of the thermostatic valves and heat savings, it is suggested that simple evaporation heat meters (or heat allocaters) be installed on each radiator. Billing based on metered consumption is essentially for changing users' behavior to an energy saving approach. Therefore, it is required to change tariffs from the billing related to number of tenants of a flat and the area heated to the approach of consumption-related billing. At the time being, there are no incentives for consumers to save energy. In order to keep costs low, the heat consumed in one building could be metered as a first step. Then, consumption could be calculated for the flats depending on their size. As a condition for anticipated savings from metering, regulation equipment, such as the installation of thermostatic valves, must be done before or together with the installation of meters. The installation of hot water meters should be carried out for each flat. The introduction of the measures described requires huge efforts and can only be carried out step-by-step. In order to convince tenants of the advantages of this system, some pilot demonstrations should be installed and accompanying measures are required.
Investments:	heat cost allocators & individual billing system for flat users, Installation of vaporisation tubes (measuring the share of the respective radiator of the total heat for supplied to entire building) Implementation of consumption based billing for heat
average	0,5 US$ per m² heated area
Effects:	Save 10% of energy demand in buildings by changing user behaviour via the price
Assumptions:	Pre-condition: review of tariff system towards stimulation of savings

CODE:	**C2i**
Title:	**Staged modernisation of the entire heating system**
Type:	Technical
Characteristic/ description:	Staged transition of the heating system of residential houses and buildings to connection by an **independent scheme**

	using compact transmission thermal nodes (house substations), including organization of their joint production (JV).
Investments:	Complete rehabilitation of the DH system, closing the network, installation of substations with heat exchangers (at least for) hot water supply
average	80 US$ per m² heated area
Effects:	Reduction of ~ 20% of the overall heat demand in heating system at building site Increase of the comfort of heat and DHW supply
Assumptions:	Considering that, at the time being, no sufficient heat supply is guaranteed overall, heat consumption can increase following the introduction of the improvement of the substations and the house systems as a result of better hydraulic conditions. However, in these cases the use of the heat will be more useful than it is today and the supply will be paid for.

PURPOSE OF THE MASTER PLANS IN INDIVIDUAL CITIES.

Every city has to co-ordinate the long-term development of the land use pattern and consequently of the necessary supply infrastructure. A general plan for the future development of residential, commercial, administrative and industrial areas in a city is therefore basis and pre-requisite for a consequent sound planning of the local energy supply infrastructure.

The purpose of this master plan for heat energy supply is to provide a clear long-term orientation for the development of the DH network system under the specific conditions in Turkmenistan. Since DH systems are expensive and have a long lifetime, the master plan will have to pay attention to possible developments which might occur during the operation the systems in future. DH systems can be operated economically only over a very long period of time (25 years and more) until the initial investment is reimbursed. Most capital is “buried” in form of pipelines underground, so the system is economically very inflexible towards a change in heat energy demand, especially in a reduction of the connected capacity and consequent consumption. The DH supply approach was developed during a time when natural gas networks and efficient gas technologies were not available. This situation has changed. Therefore, an isolated plan for DH only without taking into account the potentials of natural gas would not reflect today’s real conditions.

In difference to the situation when DH started to develop, today natural gas networks are available. Natural gas technologies often provide the same heating comfort as DH systems at lower costs or, taken the same cost level, provide a higher comfort level than DH. This situation requires a careful consideration where DH should be applied and where natural gas-based individual heating is more appropriate.

The basic difference between natural gas-based and DH systems can be explained that in DH systems the product is transported to the customer while in natural gas networks the fuel is transported and the required product, heat energy, is generated at the customer. Heat energy requires a carrier (water) that needs to be transported and causes corrosion of the pipes. Consequently DH systems need careful installation, operation and maintenance. If the costs for installation, operation and maintenance of a DH system are higher than those for a natural gas network and individual boilers the DH system is not competitive. Looking at the energy efficiency in heat generation it has to be said that individual natural gas-based heat generators have today the same efficiency as central boiler plants. An exception is represented by those heat sources which have considerably higher energy efficiency than boilers. Another exception are heat sources that can provide heat energy at very low costs compared to boiler houses. In these cases the saved costs for heat energy are available for the installation, operation and maintenance of a DH system in addition to the costs of its major competitor, the natural gas network. However, the losses in natural gas transport which are usually smaller than in hot water transport should also be taken into account.

Usually the density of land use, combined with other factors like availability and prices of fuel and equipment today and in future (this framework of prices can substantially change) is the key for the kind of energy supply infrastructure which can be applied with acceptable economic feasibility. District heating (DH) systems with – compared to other supply options - high requirements for capital investments have a chance for economic operation only in very densely used areas with high heat energy consumption today and in future. Such areas are usually the city centre and other densely populated areas with buildings of five or more stories. A second pre-requisite for the application of DH supply is the availability of sufficient financial means for the necessary investment both from budgets and from a long-term investment capital market at low interest rates. The third requirement is the availability of a cheap heat source which can be a CHP-plant.

Compared to DH networks, gas distribution networks can be operated most efficiently also in densely used areas, but due to their lower costs they are competitive to other supply options in less densely used areas with smaller houses as well. Due to the lower installation costs, there is a lower economic risk of a gas distribution system.

Consequently, in densely used city areas there is a competition between DH and gas suppliers. In principle, competition is good, but a parallel installation of both DH and gas networks in the same area reduces the economic efficiency of each option since the supply density and consequently revenues from heat respectively gas sales are lower on the one hand while fixed costs of the supply systems stay at the same level on the other.

In the following the concerned cities are analyzed separately. After a short analysis of the cities infrastructures and current barriers of DH efficiency, in the conceptual part packages of recommendations for technical and non-technical measures are recommended.
As an example: Master Plan of the Ashgabat city.

Master plan of Ashgabat city

Table 1: **Basic figures of the DH system of Ashgabat city (on information of the DH company)**

Gas consumption	**160.888.321**	**m³**
Gas consumption	**1.367.551**	**Gcal**
Efficiency of boilers	69%	
Boiler capacity	777	Gcal/h
Heat production	**943.610**	**Gcal**
Heat losses total	**253.866**	**Gcal**
a) Heat losses network	113.233	Gcal
b) Heat loss own consumption	47.181	Gcal
c) Heat losses hot water	27.400	Gcal
d) Heat losses discharge	66.053	Gcal
Real delivered heat	**689.744**	**Gcal**
a) residential sector	402.396	Gcal
b) public building sector	273.552	Gcal
c) commercial (other) sector	13.795	Gcal
Energy for domestic hot water	0	Gcal
Total water use	11.000.000	m³
Feed water use	6.050.000	m³
Energy for heating of feed water	27.225	Gcal
Power consumption for pumping	19.000.000	kWh
Costs for maintenance	450.605	US$
Length of transmission pipeline system	31	km
Length of distribution pipeline system	147	km
Number of valves in transmission or distribution network	496	pcs
Number of boiler houses	110	pcs
Number of operationable boilers	249	pcs
Average duration of the heating periode	3600	hours

Financial figures:

45.461.459.000	annual state support in TMM
47.764.159.000	total operation costs in TMM
2.302.700.000	Income by heat sales in TMM

Identified problems of the heat supply and issues to focus

- High water losses in the heating system (~11 million m³/yr)
- High gas consumption (~190 million m³/yr, 2004)
- Building heat supply is not regulated
- Operation of many small inefficient boilers: 95% of all boilers have been commissioned in soviet times. They exceeded the designed life time two to three times already. Due to limited capacities for major overhaul during the last decade the real efficiency is not higher than 50%. Only 9 new boilers were commissioned over the period of the last 14 years.
- During the last 3 years it was not possible to renew any pipeline due non existing capacities or no access to materials (new pipelines).
- Insufficient capacity of existing boilers to connect new customers
- Insufficient capacity of water make-up for DH system → high corrosion ; Water processing only for boilers, which are producing steam.
- No metering of heat and gas consumption. The gas consumption is measured at a few boilers only (30%).
- Generally the performance of pumps within the DH company (feed water and circulation pumps) is very poor, due to insufficient resources for overhaul.
- The repair capacities of Ashgabatenergo are fully bound by emergency repairs of pipelines and boilers.
- The housing associations lost almost all capacities for maintenance and repair of buildings. Almost all specialist are gone.
- Limited access to locally produced and imports of materials and equipment for rehabilitation and repair measures
- Limited flexibility and own-responsibility of the DH companies on the use of their budget
- The capacities of the municipal decision makers seems not sufficient to overview the demand of the DH company. They don't trust the argumentation of the specialists of the DH company to change framework conditions and to provide financial flexibility to improve the operation.
- According to estimations of economists of the DH company an increase of the heat tariff will decrease the payment capacities (moral) of the customers, resulting overall into lower revenues.
- According to recommendations of the management of the DH company, the best solution would be to create a separate private company in order to implement the measures of the master plan with financial repayment options.

- Options for CHP: New large CHP Gas turbine is planned, outsourcing of heat is possible, but not discussed now with DH company, completion in 5 years, but too fare from the existing central heated areas (8-9 km)

Master plan measures proposed

The measures are described in the above chapter in detail.

Further details of the calculation of the effects per measure are given in the annexed EXCEL table 2.

Implementation plan:

The master plan follows the approach of step-by-step implementation of technical and non-technical measures to overcome the problems/ "unsolved issues" according to the identified priority.

This approach was discussed and agreed with the key-representatives of the city administration and the DH company.

It is recommended to implement the packages of the master plan in 3 steps according to the given priority – 1, 2 or 3. The year 2006 and 2007 shall be used for a more detailed planning and preparation of the measures. The first investment phase (Priority 1 measures) shall start in 2008, with a 1-2 year installation period. Investments of the next phase (Priority 2 measures) shall be implemented in 2012, with a 1-2 year installation period. Measures of priority 3 shall be implemented not earlier than 2016, after an analysis of the real effects and review of the measures of the last phase according to real demands and effects.

Package of measures: Measuring of real energy consumption for heat generation

Measures of priority 1:

A1a Metering of gas consumption

A1b Metering of heat production

Package of measures: Increase of boiler efficiency

Measures of priority 1:

A2a Justification of operation mode according to temperatures

A2b Analyzing of exhaust flue gas and adjustment of combustion

A2c Training of boiler operator staff

Measures of priority 2:

A2d Replacement of burners, installation of automatic combustion control

A2f Installation of economizer to increase supply temperature

Measures of priority 3:

A2e Replacement of inefficient boilers

A2g Installation of medium size gas-turbine CHP at the premises of existing large boiler houses

A2h Solar hot water production

Package of measures: Reduction of water losses in DH system

Measures of priority 1:

B1a Repair leaks in DH network at pumps, pipelines and valves

B1b and c Stop the unauthorized discharge of DH water at radiators

B1d Metering of feed water in each boiler house

Package of measures: Reduction of heat losses in transmission system

Measures of priority 1:

B2a Re-insulation of distribution pipelines

B2b Re-insulation of transmission pipelines

B2c Insulate valves and related pipeline equipment

Package of measures: Processing of feed water

Measures of priority 1:

B3a Maintenance respectively installation of fresh water filters

Measures of priority 2:

B3b Processing of feed water to the DH system

Package of measures: Reduction of energy demand for heat transfer

Measures of priority 2:

B4a Reduction of power consumption for pumping

Package of measures: Optimization of heat supply structure

Measures of priority 1:

B5a Hydraulic balancing of the heat flow to customers

B5d Staged complete modernization of the heating networks

Package of measures: Improvement of heat supply of apartments by better balancing.

Measures of priority 1:

C1a Rehabilitation of internal heating system

Measures of priority 2:

C1b Renewal of internal piping in apartment buildings

Package of measures: Reduction in the heat consumption of buildings

Measures of priority 1:

C2a Insulation of heating pipelines in the building

C2b Low-cost thermal upgrade of the building

C2c Information package customers

C2d Organisation of intensive cooperation between the DH company and the housing association

Measures of priority 2:

C2e Installation of cold and hot water meter in each apartment/ customer

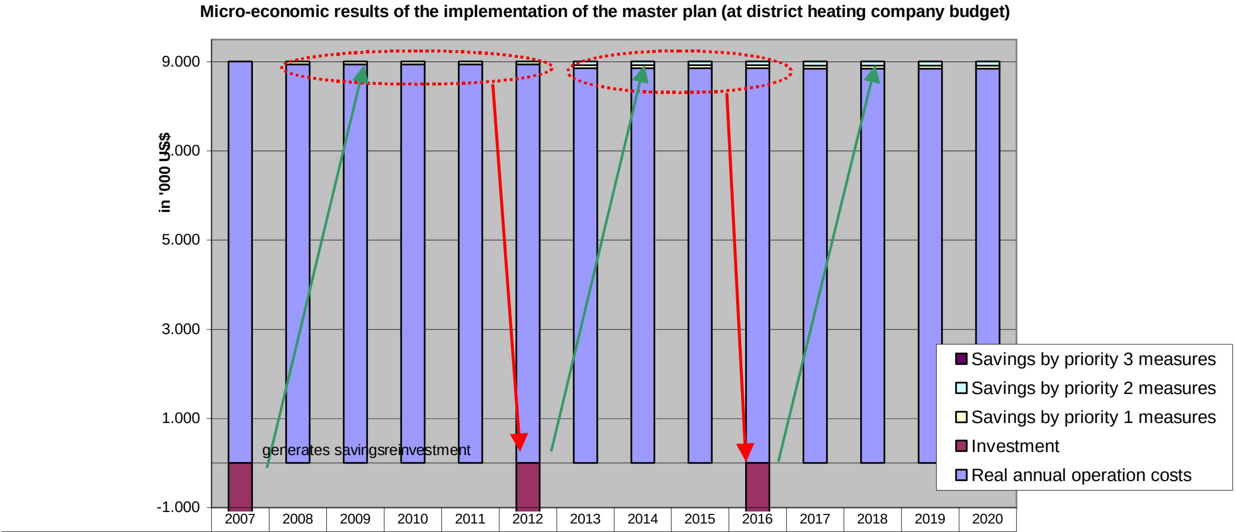
C2f Regulation of heating in the apartments

Table 2: Legend and explanations of the list ,easures.

Ifd №	site	№	measure	priority	Title of measures	Type of measure	specification	Effects of the measures	In%
1	2	3	4	5	6	7	8	9	10
	Site (A,B,C), where the measure shall be implemented (A- at heat generation facilities. (B- -at heat transmission/distribution system) (C- at heat consumer site)	№- of package (1,2,3..) at site (A,B,C) (this defines the code of the measure and can be found in related graph of measures.)	№- of measure (a,b,c….) in package (1,2,3…) at site (A,B,C)	Priority of measure (1,2,3) Measures of priority 1. Measures of priority 2. Measures of priority 3.		Technical measure: requires investment. Non technical measures: Requires organization and own resources of man-power.			Percent of savings of the

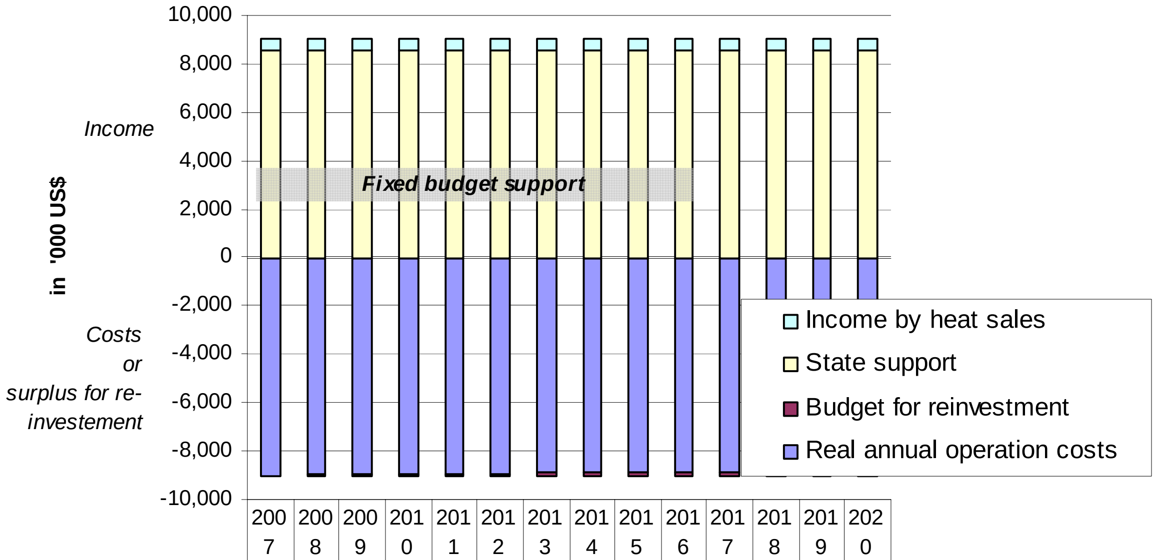
Of the base figure	Specific investment excluding installation	Number of installations	Specific costs in US$	Total costs in US$	Base figure for saving	Total savings at site (Gcal)	Total gas savings (Gcal)	Total savings in US$	Simple playback in years.
11	12	13	14	15	16	17	18	19	20
Base figure for savings (efficiency of boiler, heat demand, heat loss, etc.)	Estimated investment costs per unit with explanation Source: "Index of investment costs in energy sector Germany 2004+expert estimations"	Recommended installations in city (for example Ashgabat)		Total investment costs for this measure (once)	Figure of explained figure in column 11	Energy/water/power savings at the site	Gas savings before the boiler influences of previous measures are considered	Based on Macroeconomic prices e.g. for gas 49$/1000m3, power 20 $/MWh	Of the measures

Figure 4. Micro-economic results of the implementation of the master plan (at district heating company budget of the Ashgabat city)



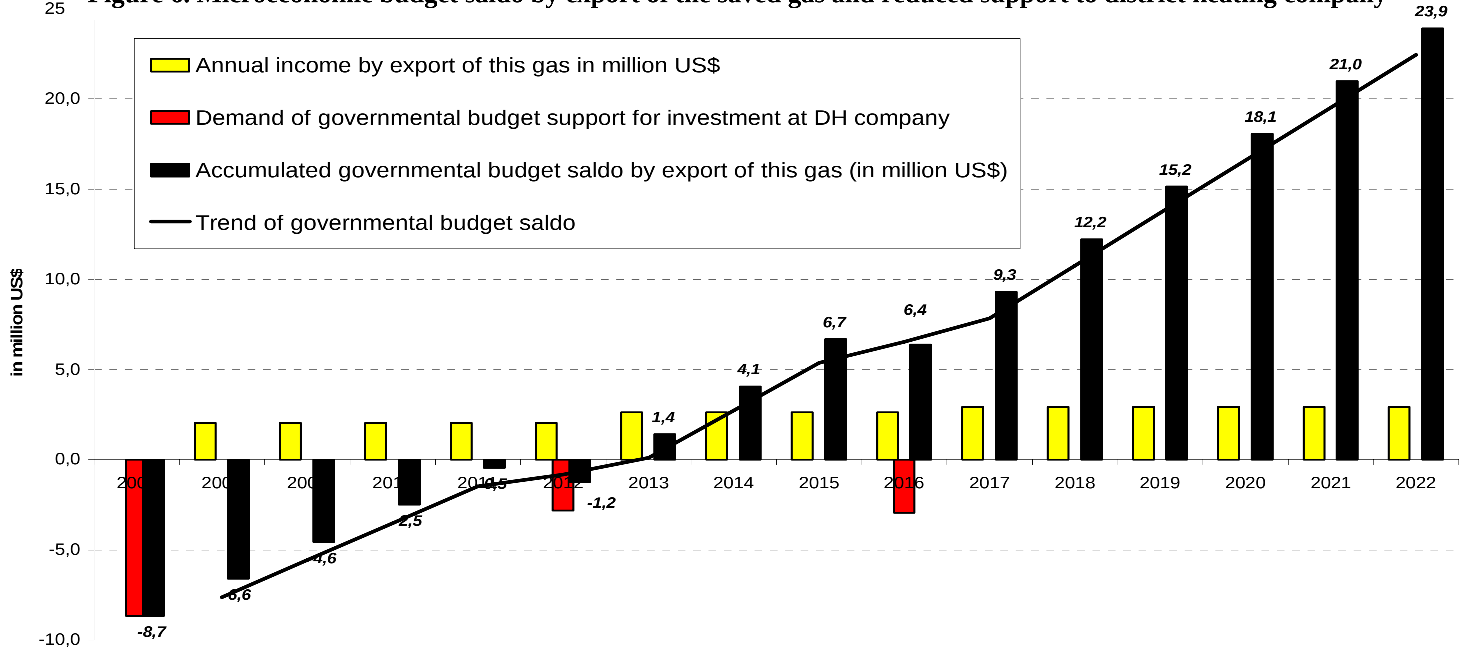
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Savings by priority 3 measures	0	0	0	0	0	0	0	0	0	0	8	8	8	8
Savings by priority 2 measures	0	0	0	0	0	0	90	90	90	90	90	90	90	90
Savings by priority 1 measures	0	67	67	67	67	67	67	67	67	67	67	67	67	67
Investment	-8.653	0	0	0	0	-3.090	0	0	0	-3.568	0	0	0	0
Real annual operation costs	9.012	8.945	8.945	8.945	8.945	8.945	8.855	8.855	8.855	8.855	8.846	8.846	8.846	8.846

Figure 5. Use of the income to cover costs and reinvestment (at district heating company budget level of Ashgabat city.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Income by heat sales	434	434	434	434	434	434	434	434	434	434	434	434	434	434
State support	8,57	8,57	8,57	8,57	8,57	8,57	8,57	8,57	8,57	8,57	8,57	8,57	8,57	8,57
Budget for reinvestment	0	-67	-67	-67	-67	-67	-158	-158	-158	-158	-166	-166	-166	-166
Real annual operation costs	-9,0	-8,9	-8,9	-8,9	-8,9	-8,9	-8,8	-8,8	-8,8	-8,8	-8,8	-8,8	-8,8	-8,8

Figure 6. Microeconomic budget saldo by export of the saved gas and reduced support to district heating company



Over an implementation period of 15 years a total of 590 million m3 gas can be saved, which can generate additional income for the state budget through export. The accumulated budget savings (income by gas savings +reduction of state support demand to DH company- investment support demand in 3 steps) results into million US$ of 23.9.

Figure 7. Total gas savings over 15 years in million m3

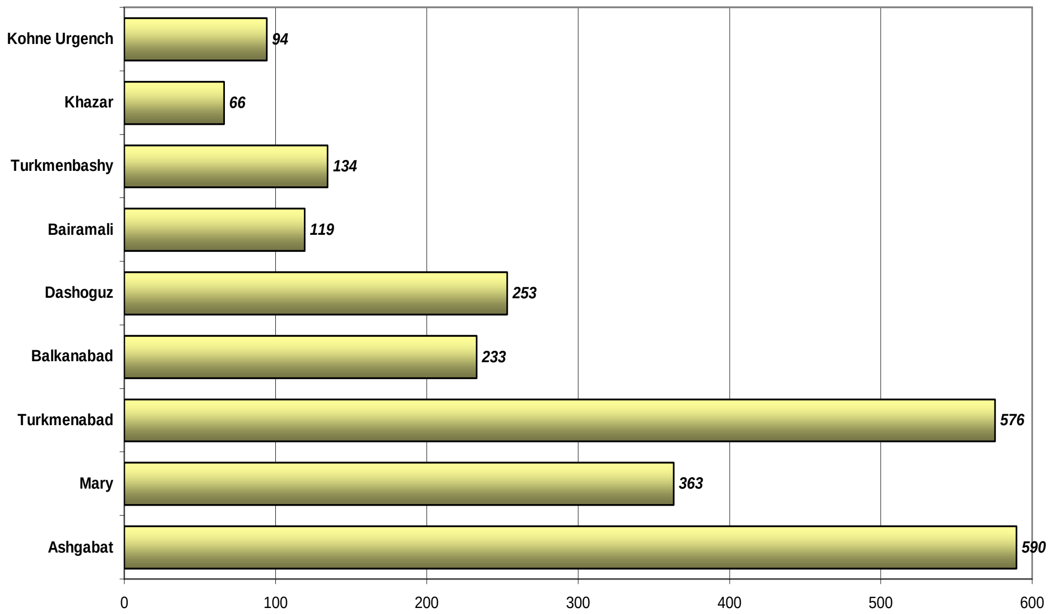
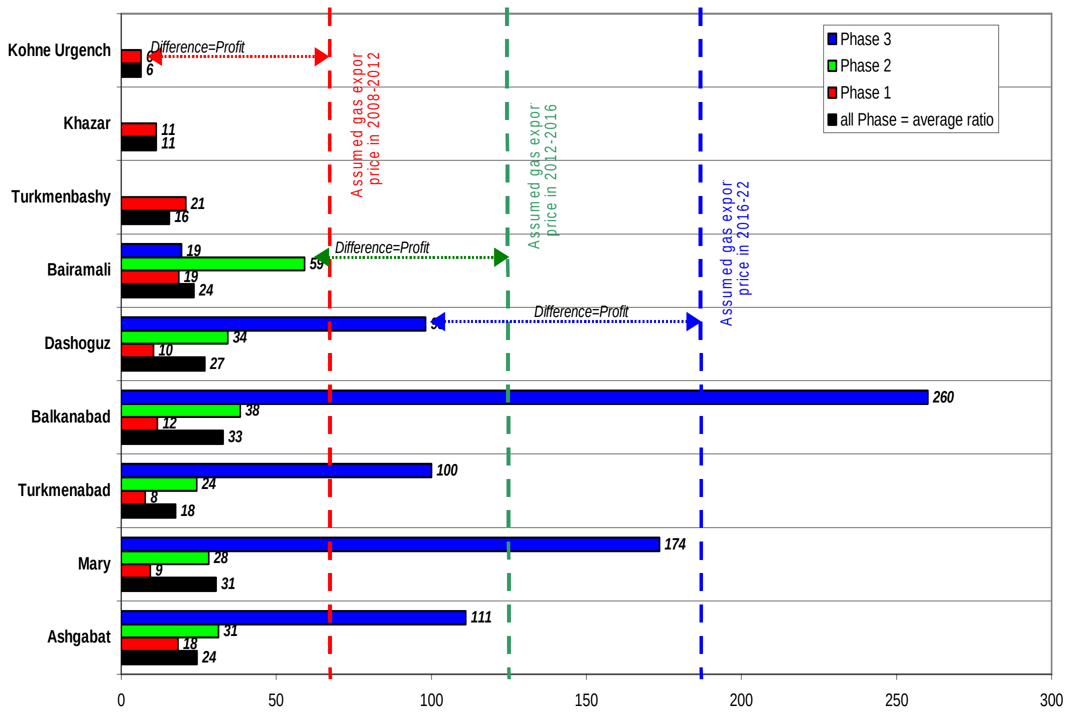
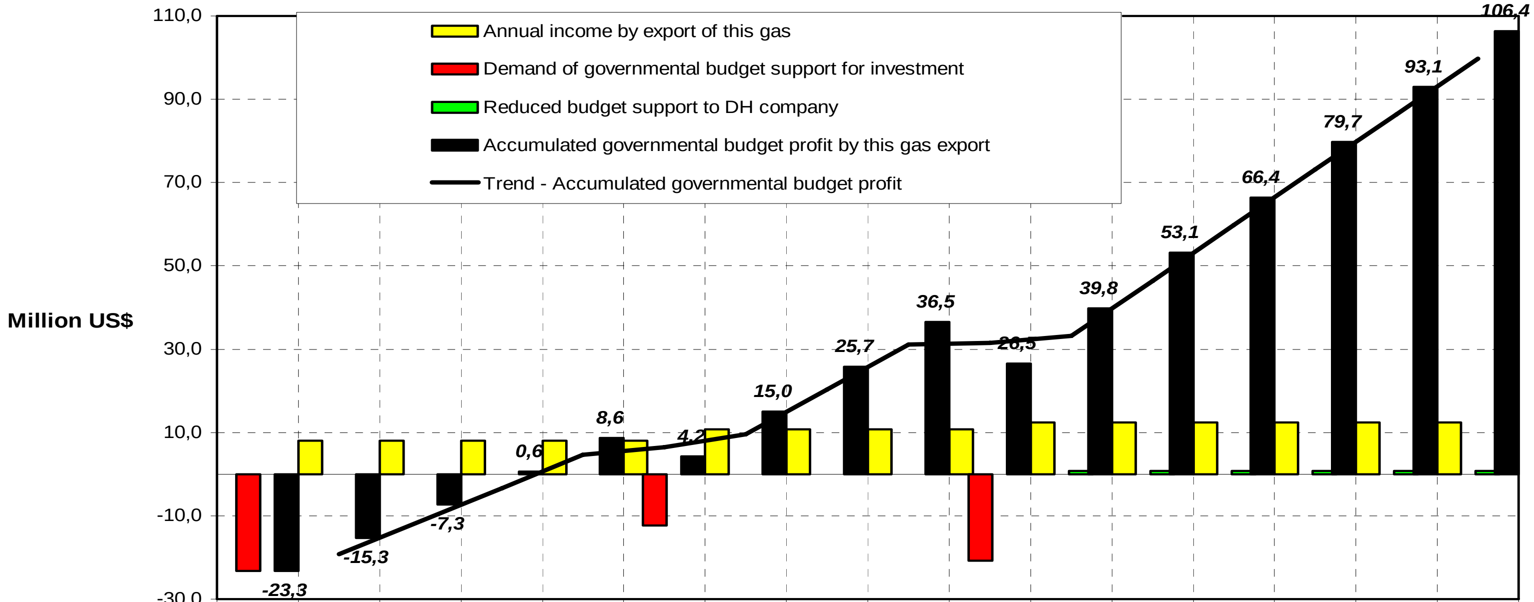


Figure 8. Ration: state support gas saved in US$/1000m3



The calculation of the macroeconomic budget saldo for implementation of master plan for 9 cites an implementation period of 15 years a total of 2428 million m3 gas can be saved, which can generate additional income for the state budget through export. The accumulated budget savings (income by gas savings +reduction of state support demand to DH company-investment support demand in 3 steps) results into of 106 billon.

Figure 9. Microeconomic budget saldo for implementation of master plan for 9 cities.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Annual income by export of this gas	0,0	8,0	8,0	8,0	8,0	8,0	10,8	10,8	10,8	10,8	12,5	12,5	12,5	12,5	12,5	12,5
Demand of governmental budget support for investment	-23,3	0,0	0,0	0,0	0,0	-12,4	0,0	0,0	0,0	-20,7	0,0	0,0	0,0	0,0	0,0	0,0
Reduced budget support to DH company	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,8	0,8	0,8	0,8	0,8	0,8
Accumulated governmental budget profit by this gas export	-23,3	-15,3	-7,3	0,6	8,6	4,2	15,0	25,7	36,5	26,5	39,8	53,1	66,4	79,7	93,1	106,4

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