THEME 5

RESOURCE OPTIMIZATION

Investigation on Energy Conservation Potentials and Benchmarking for Drinking Water Supply Schemes

Lalith Wijesinghe[1], Chettiyappan Visvanathan[2]
1. National Water Supply and Drainage Board
2. Asian Institute of Technology, Pathumthani, Thailand

INTRODUCTION

Water pumping stations and treatment facilities are significant energy consumers representing approximately between 2 to 3 percent of the world's energy consumption. Water Supply schemes are among the largest energy consumers for many electricity providers around the world. Energy consumption in most water systems worldwide could be reduced by at least 25 percent through cost-effective efficiency actions. The overall cost of energy consumption in NWSDB Sri Lanka in 2011 was 22% of the total cost incurred. Therefore energy conservation efforts in water treatment will reduce the burden on the environment and increase the financial sustainability of the organization. This study aimed to benchmark energy consumption in each unit process of drinking water treatment in Sri Lanka and Thailand and to investigate the potential for reduction of energy in water supply schemes

HIGHLIGHTS

- Four WSS from Sri Lanka and one WSS from Thailand were selected
- Preliminary energy audits carried out for benchmarking energy consumption
- Detailed energy audits carried out to investigate conservation potentials
- Chemical feeding and filtration are major energy consuming processes
- Energy conservation potential of improving efficiency of pumps: 1% - 14%

METHODOLOGY

The study comprised two major activities to achieve the objectives stated in the introduction. One activity is to develop benchmarks for energy consumption in water supply schemes using primary and secondary data collected from Sri Lanka and Thailand. The other direction is to assess the potential for energy conservation by carrying out energy audits in selected water supply schemes in Sri Lanka and Thailand. Four water supply schemes from Sri Lanka and one water supply scheme from PWA Region 10 in Thailand were selected for the study. Both technical and management aspects were considered when selecting these water supply schemes for the study.

Both primary and secondary data were collected by carrying out energy audits in selected water supply schemes to evaluate the specific energy consumption and to identify and quantify energy conservation potentials. The energy audits were carried out in two stages; preliminary auditing stage and detailed auditing stage. The detailed audit was carried out to check the potential for increased plant efficiency. Data required for evaluation of performance of the pumps and other energy utilizing equipment in the plants were collected at this stage. In addition quantifying the potential energy savings from reduction of leakage was also collected.

Benchmarking was carried out using the following performance indicator; the energy consumption per unit volume of treated water produced in kWh/m^3. Benchmarking was done on individual unit process level. Using the results of benchmarking study and energy audit, opportunities for energy conservation using several technical options were assessed.

RESULTS

The conventional surface water treatment process consists of coarse screening, fine screening, aeration, chemical feeding, rapid mixing, slow mixing, sedimentation, filtration and disinfection. Chemical feeding is the highest energy consuming unit process in Mawanella and Kandy South water treatment plant and second largest in Kandy South and Nakhon Sawan water treatment plant. Slow mixing is the largest energy consuming unit process for Kandy South water treatment plant. For Nakhon Sawan and Morontota water treatment plants the largest energy consuming unit processes respectively are sedimentation and filtration. Benchmarks for energy consumption in drinking water treatment unit processes for surface water sources in Sri Lanka and Thailand context are shown in Table 1.

Modification of chlorinator by removing the chlorinator booster pump reduces the total energy consumption by 1%. Constant head chemical feeding arrangements reduces the energy consumption by removing the energy required for chemical feeding pumps. Reducing the backwashing frequency reduces total energy consumption by 0.06%. The energy conservation potential of filter backwash water recovery at Nakhon Sawan WSS was 0.05%. Improving the overall pump and motor efficiency up to 70% provides energy conservation potentials ranging from 1% to 14%. Reduction of Non-Revenue Water provides energy conservation potentials ranging from 5% to 12%. Percentage of total energy conversation potential in audited water supply schemes are illustrated in Figure 1 and Figure 2 illustrates the annual total energy conversation potential for audited water supply schemes. Figure 3 illustrates annual total cost saving potential for audited water supply schemes. Table 2 presents a comparison of the effect of identified energy conservation potentials in audited water supply schemes.

CONCLUSION

The cost of energy is the second highest cost component in water utilities and it is around 25% of the total cost of operation and maintenance. Total specific energy consumption for surface water supply schemes varies from 0.234 to 0.851 kWh/m^3 in the Sri Lankan and Thailand context. Benchmarks were created for each unit process of surface water treatment.

Modification of chlorinator by removing the chlorinator booster pump, constant head chemical feeding arrangements, reducing the backwashing frequency, recovery of filter backwash water, improving the overall pump and motor efficiency and reduction of Non-Revenue Water are potential options for energy conservation in water supply schemes.

Table 1: Benchmarks for Energy Consumption in Drinking Water Treatment Unit Processes for Surface Water Sources in Sri Lanka and Thailand Context

Unit Process	Observed Specific Energy Consumption Range (kWh/ m^3) x 10^{-3}
Fine screening	0.2
Chemical feeding	0.03 - 5.5
Rapid mixing	-
Flocculation	8.2
Sedimentation	0.6 - 4.7
Filtration	0.3 - 2.2
Chlorination	0.9 4.5
Backwash recovery	1 - 1.6

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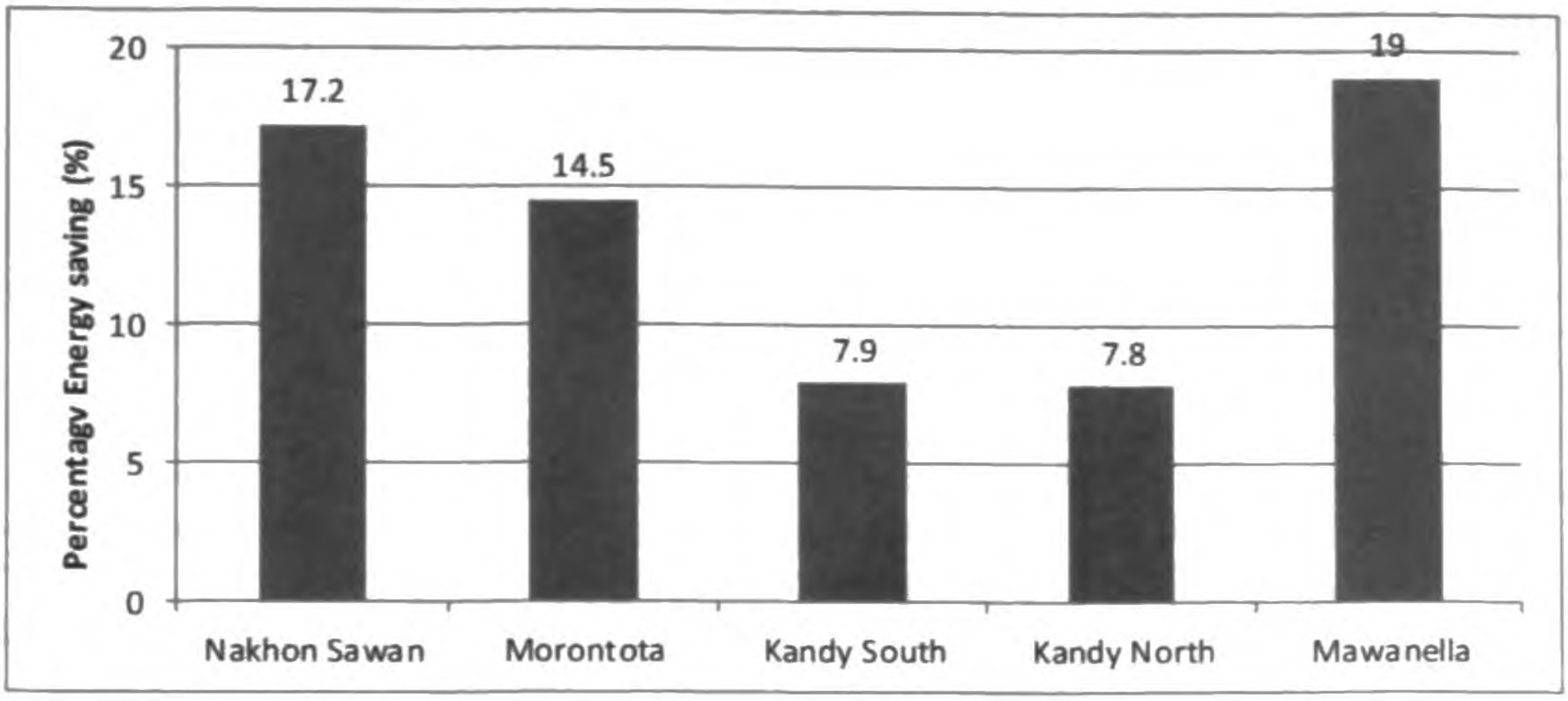

Figure 1: Percentage of total energy conversation potential in audited water supply schemes

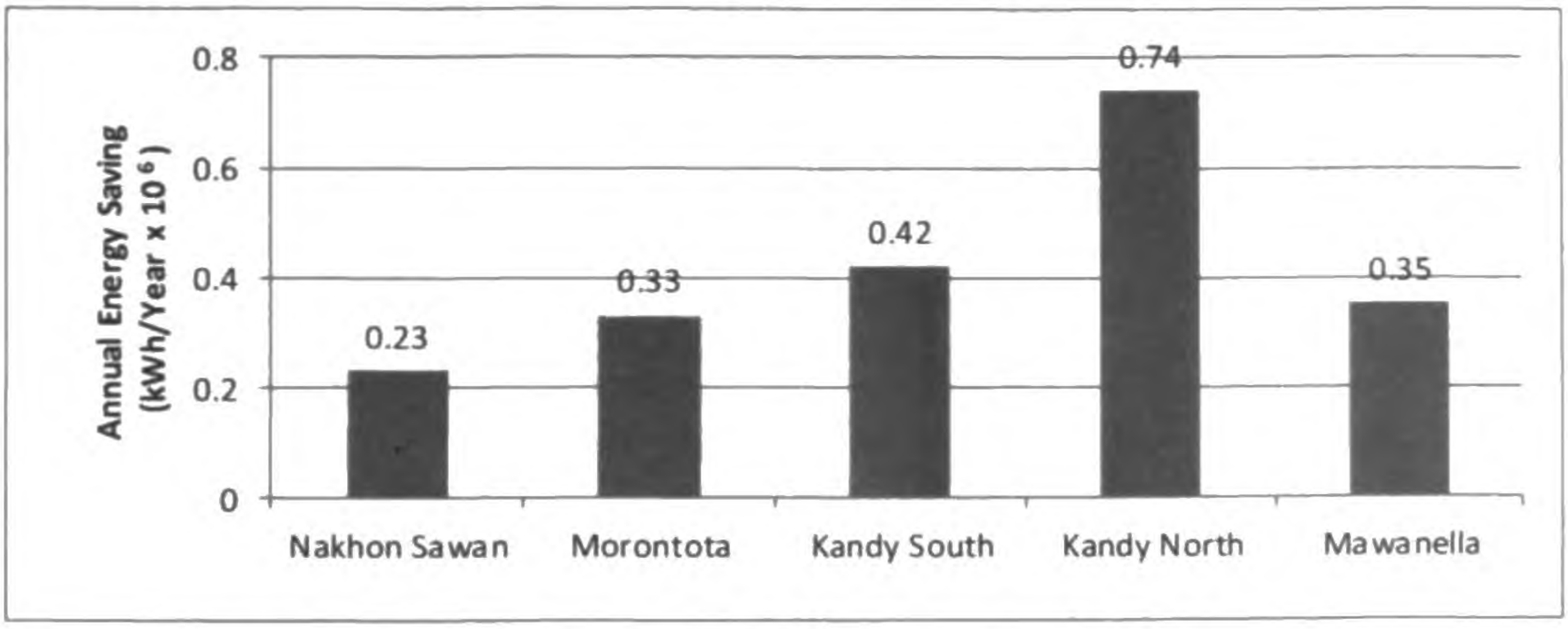

Figure 2: Annual total energy conversation potential for audited water supply schemes

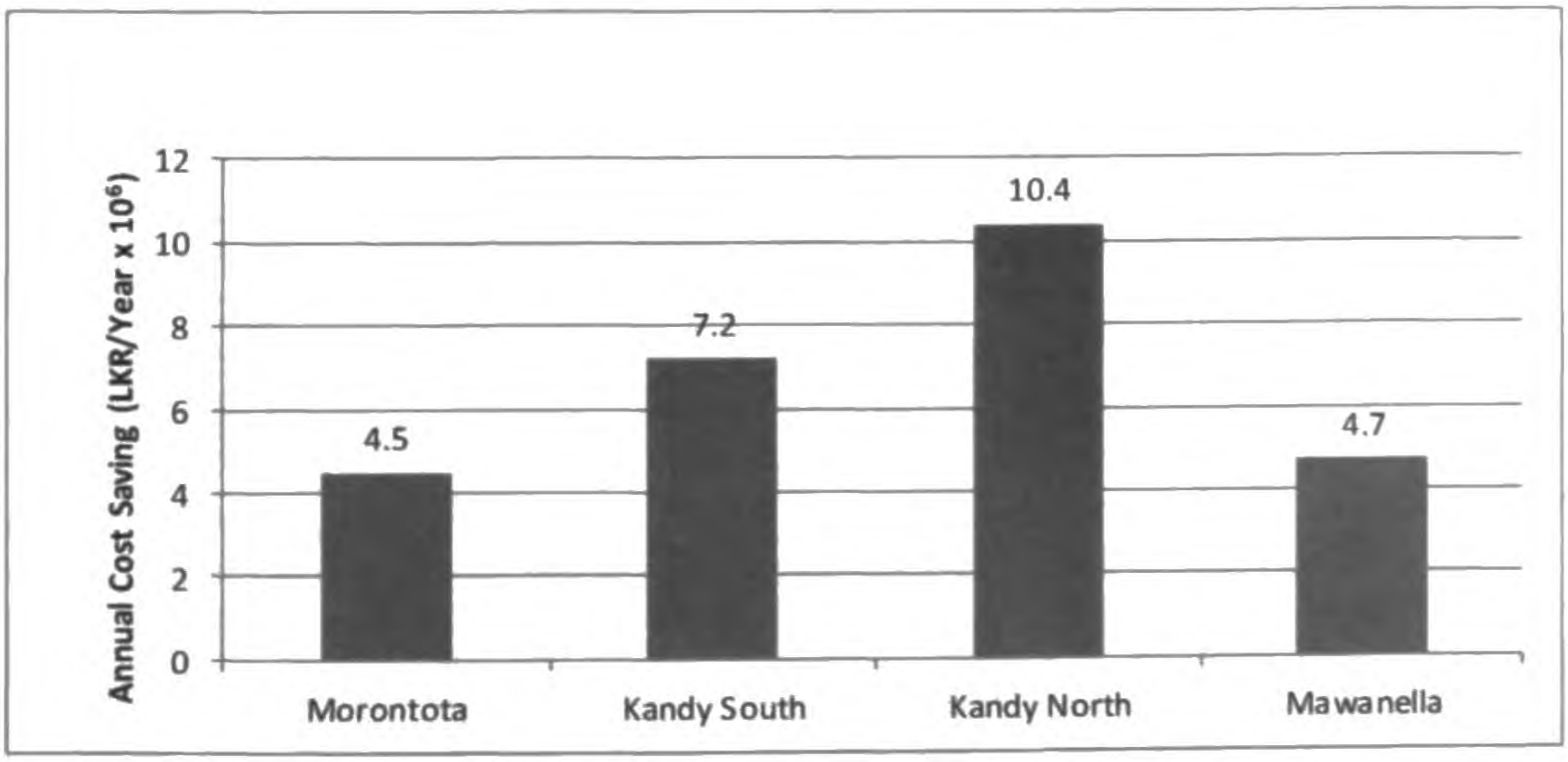

Figure 3: Annual total cost saving potential for audited water supply schemes

Table 2: Comparison of the Effect of Identified Energy Conservation Potentials in Audited Water Supply Schemes

Description	Specific Energy Saving and Percentage Energy Saving Potential									
	Nakhon Sawan		Morontota		Kandy South		Kandy North		Mawanella	
	kWh/m³	%	kWh/m³	%	kWh/m³	%	kWh/m³	%	kWh/m³	%
Total Specific Energy Consumption	0.397		0.851		0.766		0.622		0.48	
Energy Saving Potentials										
Removing chlorinator booster pump	0.0038	1	-	-	-	-	-	-	-	-
Adjusting filter backwash frequency	-	-	0.0003	0.04	-	-	-	-	-	-
Backwash water recovery	0.002	0.5	-	-	-	-	-	-	-	-
Improving overall pump and motor efficiency	0.0624	15.7	0.0212	2.5	0.0146	1.9	0.0047	0.8	0.0684	14
Reduction of NRW	-	-	0.1021	12	0.0459	6	0.0435	7	0.024	5
Total specific energy saving	**0.0682**	**17.2**	**0.1236**	**14.5**	**0.0605**	**7.9**	**0.0482**	**7.8**	**0.0924**	**19**