Modification And Integrated Aspects Of Available Infrastructure For Water Purification In The Growing Field Of Electrical Engineering

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***Abstract*—To incorporate new infrastructure for the water purification; out of many other points, identified the energy consumptions and its associated costs to be one of the key factor in this research paper. Energy and water are interdependent because energy production needs water and making water available for drinking needs energy. So there has to be a common ground where both energy and water converge and work in synergy. So by changing the way, how and what energy we use in the system, we could improve the efficiency in water purification. By changing the energy infrastructure we can actually control the water production. Energy efficiency becomes the watchword. Electrical Engineering advances in urban water system infrastructure must include not only the reservoirs, ground water wells and aqueducts that are the sources of water supplies needed to meet the varied demands in an urban area but also the water treatment plants, the water distribution systems that transport that water and the pressures required to deliver water to the demands locations. Once used, the now-waste water needs to be collected and transported to where it can be treated and discharged back into the environment. Underlying all of these hydraulic infrastructures and plumbing is the urban storm water drainage system and everything is made possible by energy availability that is discussed in this research paper.**

Keywords— Water purification, Energy efficiency, Self-sufficiency, Urban water system modeling, Hydrologic cycle, Civil infrastructure, Optimization, Waste water

I. THE RESEARCH INTO ELECTRICITY PRODUCTION UTILIZING SMART GRIDS CONCEPTS IN A GROWING FIELD OF RESEARCH.

A. Background

Before we begin, it is imperative to looks at the current technology involved for various kinds of water treatment. Depending on place and availability of water, customized technology could be devised to handle the need at hand. Depending on the sources type, the water is classified as to be one of the following:

• Fresh Water

o Surface water

o Underground Water

• Sea Water

• Brackish Water

• Waste Water.

This site specific water purification plants needs different amount of energy for the purification process. Sea water needs more energy than fresh water purification. The energy also depends on the uses of water. That is the drinking water purification needs more energy than the water for irrigation purposes. The following figure (Fig: 1) shows the typical of energy needed for the purification of the above mentioned types of water for drinking purposes. Typically, electricity accounts for approx. 80 % of municipal water processing and distribution costs in the US [1].

	Drinking water production process	Electricity consumption in Wh /m^3
Freshwater	Conventional treatment	50 - 150
	Membrane treatment (*ultrafiltration / microfiltration*)	100 - 200
	Advanced membrane treatment	250 - 700
Seawater or brackish water	Brackish water desalination (*nanofiltration or reverse osmosis*)	600 - 1500
	Sea water desalination with energy recovery system (*reverse osmosis*)	3000 - 5000
	Sea water desalination without energy recovery system (*reverse osmosis*)	5500 - 8000
	Thermal desalination (distillation) *	> 6000
Wastewater	Wastewater recycling	25 - 1500
	Sludge treatment	5 - 15

Average electricity consumption of drinking water production, according to treatment process

Figure 1: Municipal water processing and distribution costs in the US [2]

Since all types of water purifications needs energy, we tackle our problems addressing the issues in modifying the existing energy infrastructure for efficient water purification. Also employing these technologies saves US to reduce the 45 million tons of

GHG which it would have added to the atmosphere [3].

B. Solutions:

The energy efficiency can be achieved by either one or all of the methods mentioned below.

• Increase efficiency in current energy infrastructure: This includes taking care of the conveyance of water for purification and post purification transfer. Water conveyance use majority of energy in the whole purification process. The water to be pumped from the deep aquifer also needs huge amount of energy. The efficiency is these cases can only be achieved by employing efficient motors to pump water.

• Employed efficient energy totally: This new, cheap, efficient energy comes from the Renewable energy resources. These renewable energy resources are site specific. Wind, Solar, Geo thermal, Tidal and Bio energy are used for the efficient energy generation. The smart grid can be employed to supply the energy that is curtailed to these facilities to back up on their conventional resources.

• Change in Schedule: The hour of the day production method can be employed by use of smart metering and price. The time when the total demand is low is the right time to operate the plant for water purification. This is possible in the realm of smart grid which allows flexible scheduling and price on the time of the day basis.

• Notion of saving: Not wasting purified water is same as producing the same. We have to use the smart water techniques [4] to change our usage pattern. Smart water can be realized by using stride made in other technologies. Those developments can be employed to achieve our goal. Smart water uses i) Massive data handling ii) Multi-objective optimization iii) Feedback control mechanism to fulfill its objective. It uses key features like Instrumentation technology, Control technology and Information & Communications technology to realize its goal. The overall layout of smart water system is shown below in Figure 2.

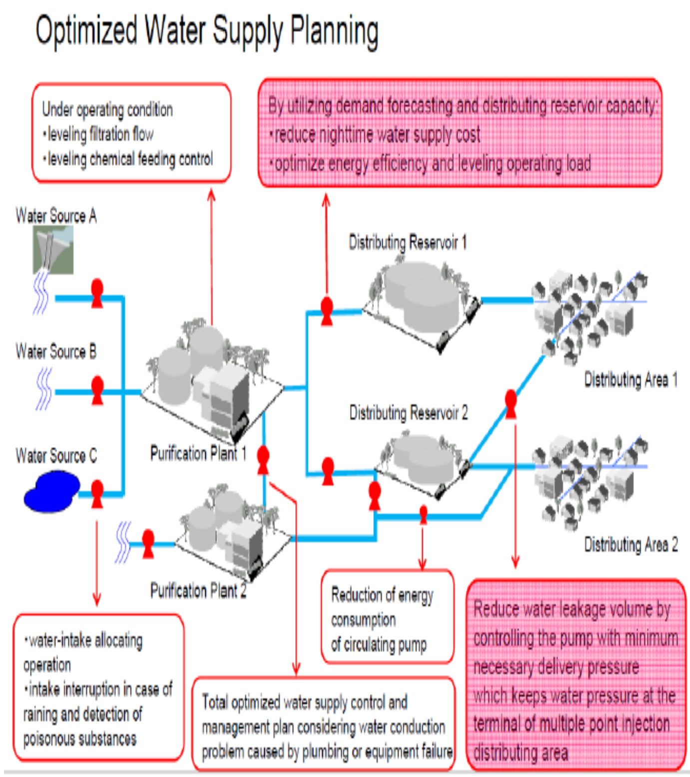

Figure 2: The overall layout of smart water system [4]

• Use Synergy on Energy Exchange: Use synergy combining desalination plant and power production plant. As for new thermal desalination projects, desalination plants are increasingly being installed in conjunction with energy production installations. The heat produced to generate electricity is used to vaporize sea water. These hybrid solutions allow optimal use of thermal power stations [2].

• Use Natural Process for treatment: Use bio technology to treat wastewater plants which is carbon neutral and saves a ton of conventional energy.

II. AN ALGORITHM TO DETERMINE THE GREATEST POPULATION DENSITY WITH THE LEAST AMOUNT OF POTABLE WATER AVAILABLE ON A GLOBAL SCALE.

The concept is to identify the the population clusters with the greatest density that has the least amount of potable water available. The engineering approach is to implement an artificial neural network algorithm to identify clusters and groupings through various data mining techniques. The results from this algorithm will be used in the planning of designing to water routes, water lines, dams aquifers, etc. The algorithm would also identify the available water sources and attempt to match the nearest population cluster. The engineering design approach would consist of the following procedure.

1. The project will need to identify and obtain a funding source. To identity and implement a plan that will solve the impending global water supply shortage will probably be humankind's greatest endeavor. The

project will require cooperation from economic and political leaders on a scale never attempted. The question is as with any project, Where is the money going to come from?"

2. Development a project plan that will identify the specific goals of the algorithm and a time table for the expected completion of the targeted objectives.

3. Conduct a literature review to identify existing research efforts and algorithm techniques. Effort should not be expended when existing research and procedure can be utilized to accomplish the goal. To identify a technique or procedure is premature at this stage of the project and is too broad for the scope of this research paper.

4. Collect data on global population and water sources. The population data can be obtained from sources such as census data and available public record. Innovative research and data gathering techniques could utilize satellite telemetry information, such as heat concentration, electricity usage and pollution levels, and global communication traffic.

5. Identify the algorithm. The selection of the algorithm that will meet the criteria of matching waters sources to population centers would be the result of making full use of the data for the inputs. This selection procedure in itself would be an analysis of test algorithms and trial outputs.

6. Implement the algorithm. The key decision would be how to implement the results of the algorithm. The results would be incorporated into the greater project plan. The algorithm would probably be the key decision making tool that would identify the critical path for the project as to where to extends resource in order to build or upgrade a water infrastructure.

III. CIVIL INFRASTRUCTURE FOR WATER, SANITATION, AND IMPROVED HEALTH

A. Methodology

Passive methods can be used to utilize the existing civil structure to provide clean water in locations that have high temperature climates. Passive devices that use the sun's heat to purify water have been created [5]. In other cases, regular plastic bottles have been used to use the sun to purify water [6]. We propose that home tubing can be used for this same process. Although aesthetically unique, exposing tubing elements from an existing home infrastructure with the addition of cheap slightly porous meshes could enable water to be heated enough to partially evaporate, leaving enough purified water for the occupants of the home to drink. An illustration of such a configuration is shown in Figure 3. The cylinder in the figure represents the tubing already used in the home. The elliptical object represents the slightly porous mesh. This mesh would allow water vapors to pass while preventing the non-evaporated water from passing. This is a similar process used by the previously mentioned methods. Many developed and developing nations have an electrical infrastructure integrated into their civil infrastructure. For these places, water treatment by electrical discharges may be possible [7]. The process of purifying water through ionization is well-established [8]; there are effective antibacterial properties with this process [9]. A system for purifying water by running a stream of water between electrodes that have an arc has been used [10]. Wood et al. describe a process that can use the existing infrastructure to produce "ultrapure" water [11].

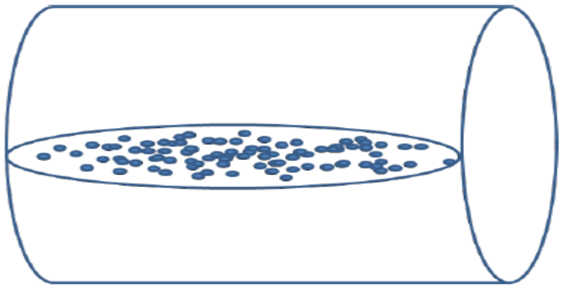

Figure 3: Illustration of existing home tubing with purification layer [6]

B. Costs

In addition to these processes, existing electrical system infrastructure could be used to power small reverse osmosis (RO) systems [12] which could easily be integrated into the existing infrastructure. The costs for these RO systems are not prohibitively expensive and could plausibly be funded through non-governmental organizations (NGOs) and from the United States Agency for International Development (USAID). USAID currently has many initiatives for providing access to clean water to people in areas in which potable water is scarse; the funds already being used could be diverted to more impactful and effective efforts.

IV. APPROACHES AND ISSUES FOR FINANCING DRINKING WATER AND WASTEWATER INFRASTRUCTURE

A. Introduction

Water is the single most important necessity in the world. Water is life. Yet 768 million people do not have access to safe, clean drinking water, and 2.5 billion people live without proper sanitation. Lack of clean water is responsible for more deaths in the world than war. It's not that the world does not possess enough water. Globally, water is available in abundance. It is just not always located where it is needed. Political and economic barriers play a major role in preventing access to clean water in areas where it is available [13]. The purpose of this research is to address the cost and finance of upgrades to aging and deteriorating drinking water and wastewater infrastructure. The issues of sewer overflows into rivers and streams, as well as water main breaks in larger cities, are the most visible manifestations of this problem. A variety of approaches have been proposed to help with these issues [14].

B. Background

The most critical point to come across is increasing the people's access to sanitation and drinking water. It is a huge benefit to the development of individual countries through the improvement in health outcomes and the economy. The impact of diarrhoeal disease on children is greater than the combined impact of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), tuberculosis and malaria. With the provision of improved sanitation the effect of diarrhoeal diseases could reduce by nearly 90%. The latest estimates indicate that improvements in sanitation and drinking-water could reduce the children who die each year by 2.2 million [15]. With this kind of benefits for human, many countries seem to allocate insufficient funding to meet the Millennium Development Goal (MDG) target for sanitation and drinking water. When comparing to other sections, the lack of funding for drinking water and wastewater infrastructure is relatively low. Figure 4 depicts the percentage for financing for sanitation and drinking water [15].

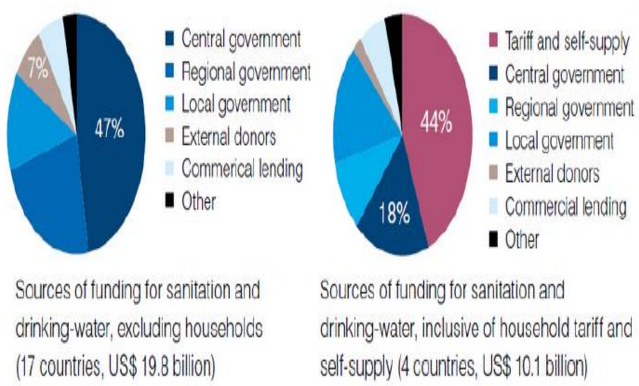

Figure 4: Funding sources for sanitation and drinking water [15]

C. Solutions for financing drink water and waste water infrastructure

A variety of approaches have been made to bridge the gap between projected infrastructure needs. Estimated by the Environmental Protection Agency (EPA), it is estimated that almost $335 billion for drinking water infrastructure and $298 billion for wastewater infrastructure. The EPA and Drinking Water State Revolving Fund (SRF) programs are the largest sources of federal and assistance to state and local communities for funding clean drinking water and wastewater infrastructure [14]. Figure 4 shows the major funding sources, with EPA accounted for 57 percent of the funding.

Agency	Funding Program	Acronym	% of Fed. Funding
EPA	Clean Water State Revolving Fund	CWSRF	57
	Drinking Water State Revolving Fund	DWSRF	
USDA	Rural Utilities Service	RUS	28
HUD	Community Development Block Grant	CDBG	10
Commerce	Economic Development Administration	EDA	3

Figure 5: Federal Drinking Water and Wastewater infrastructure Funding Sources [16]

The Government Accountability Office (GAO) has come up with three approaches to the issues for financing drinking water and wastewater infrastructure. Each of the approaches would offer a different means to fund and finance projects. They have surveyed stakeholders, including industry representatives and other government officials. They have identified the following issues with each approach [14].

• A clean water trust fund that would provide a dedicated source of funding, such as tax for wastewater infrastructure.

• A national infrastructure bank that would use public and/or private funds to finance infrastructure projects through a variety of loans.

• Public-private partnerships to encourage private investment in infrastructure projects.

Hopefully, with these approaches taken by the GAO and with the help from the EPA and other funding sources, the world will have an easier way to access clean drinking water and a more advance wastewater infrastructure that would reduce the world threats of contaminated water and provide much safer way to access cleaner water.

V. ENGINEERING THE HYDROLOGIC CYCLE FOR IMPROVED HEALTH AND WATER QUALITY PARAMETERS.

A. Background

Access to water may be restricted in several ways, e.g. by prohibitive charges, daily or seasonal fluctuations in availability or lack of supplies to remote areas, and many countries face problems. In some parts of the world where water is scarce and has to be transported over long distances by road or on foot, the cost of drinking-water may absorb a significant proportion of the average daily income. Elsewhere, seasonal, geographical and hydrological factors may conspire to deny individual households or entire communities a continuous, reliable supply of drinking-water. During dry seasons, spring sources may dwindle, reservoirs may become exhausted and excessive demands by one group of people may limit supplies to their neighbors. Such problems are not confined to poorer countries; they are also experienced with increasing frequency in industrialized countries where management of demand has failed or population growth has outpaced the development of water resources. If the performance of a community water supply system is to be properly evaluated, a number of factors must be considered [17].

B. Procedure

To take advantage of the hydrologic cycle has a lot of limitations which include location that precipitate frequently. But for countries that do not have this limitation by using the hydrologic process to clean that water and improve the controls of the clean water to maintain that water quality to a certain level. The evaporation process and condensation process acts as a filtration process which current water companies uses such as Le Bleu. Le Bleu uses a manmade process of the hydrologic process to purify water. A possible idea to help with the natural process is to have a clean environment where the water can collect and maintain a certain quality. An important component will be the analysis of the water to ensure the quality of the water. An initial investment to construct the tanks to collect the water should be the minimum to the greater good. To maintain the facility clean and in proper condition volunteers will be needed (this will depend on the population density of the area. There are 5 different key points for the process. These are:

1) Quality: The proportion of samples or supplies that comply with guideline values for drinking-water quality and minimum criteria for treatment and source protection.

2) Coverage: The percentage of the population that has a recognizable (usually public) water-supply system.

3) Quantity: The average volume of water used by consumers for domestic purposes (expressed as liters per capita per day).

4) Continuity: The percentage of the time during which water is available (daily, weekly or seasonally).

5) Cost: The tariff paid by domestic consumers. Together, these five service indicators provide the basis for setting targets for community water supplies. They serve as a quantitative guide to the comparative efficiency of water supply agencies and provide consumers with an objective measure of the quality of the overall service and thus the degree of public health protection afforded [17].

C. Consumption

Consumption of contaminated water and on average as much as one-tenth of each person’s productive time is sacrificed to water-related diseases.” The risk of acquiring a waterborne infection increases with the level of contamination by pathogenic microorganisms. Drinking-water is only one vehicle for disease transmission. Some agents may be transmitted primarily from person to person and, for bacteria capable of multiplication in food, foodborne transmission may be more important than transmission by drinking-water. The depicts the importance of water quality, though water can be purified its equally important to maintain the water clean. Water can now become a vehicle to transport disease on a large scale that can deal blow to a community. Other agents, however, such as Salmonella typhi, Vibrio cholerae, Giardia lamblia and hepatitis A virus, are frequently transmitted via contaminated drinking-water and, where this is the case, improvements in drinking-water quality may result in substantial reductions in disease prevalence. Because of this multiplicity of transmission routes, improvements in the quality and availability of water, excreta disposal, and hygiene in general are all important factors in reducing diarrhoeal morbidity and mortality. Epidemiological investigations indicate that all aspects of the quality of water supply services influence health, as do hygiene behaviors and sanitation. Experience has shown that analysis of disease incidence (epidemiological surveillance) is not a useful tool for guiding even large-scale remedial programs for community water supplies [17].

D. Method

It cannot be stressed the importance of maintain the water quality which turns into cost. There is no way around the water analysis aspect of this process. So may a method could be to have trained volunteers to maintain the quality of the water which the volunteers can cycle different days to spread the responsibility amongst the community. This method can eliminate the cost of having dedicated personnel to accomplish the task. It is expensive and yields data that are difficult to interpret. In the same way that indicators of the quality of water-supply services have been found useful in guiding remedial action, indicators of hygiene practices should also be used. Such indicators should be based on simple, standardized observations, and used to guide hygiene education programs and the selection of key messages regarding hygiene behaviors [17].

E. Electrical engineers aspects

As electrical engineers we can automate this by using pyro electric sensors as well ph sensors. This can be easily implements on a IC to gather data that can be store digitally allowing a volunteer to monitor the waters quality on a daily basis. The expected data may vary depending on the environment so data will have to gather in every area to determine the expected water quality. The cost to design the IC to automatically collect water ph levels and temperature may cost some. Additional cost will be caused by the memory to store large amounts of data gathered which will have to then be analyzed by and engineer. An engineer will have to establish what levels should be observed in the different areas. This process can used but the initial startup will incur the most cost but in the long run the cost will be minimal.

VI. CONTROL OF SMALL HYDRO TURBINES INTO EXISTING WATER INFRASTRUCTURES

A. *Introduction:*

Two questions came into mind such as

• Where are the potentials stemming from a water infrastructure?

• How (technically) can energy be recovered by a small turbine or unconventional small hydropower plant?

To answer these questions, the overall objectives were to:

• Identify potentials for non-traditional hydropower installations.

• Review main steps for development of a multipurpose project

• Provide typical recommendations for installing SHP plants into existing infrastructures.

• Summaries good practices of these technologies based on cases studies.

Main findings are based on a specific Swiss experience and the expertise of Mhylab (Mini-Hydraulics Laboratory). The SHAPES project outcome - Energy recovery in existing infrastructures with small hydropower plants (ESHA et al., 2010) is here used extensively, with some to the most relevant cases studies, collected all over the European Union and Switzerland. Moreover, a variety of information resulting from a range of publications in open sources, conference proceedings, internet resources and case studies on the application of energy recovery were collected and analyzed.

B. *Overview of small hydropower*

Hydropower plants are divided into two main areas: the “large” and the “small” ones. At present time there is no satisfying definition to determine if a hydropower plant is small or large. This differentiation depends on a multitude of criteria, such as the output of the scheme and its size or technical or economic characteristics. The criterion currently used for defining small hydropower plants is that of output, but many variants are in use. Eurelectric, the European Commission, ESHA (European Small Hydropower Association) as well as several other countries have defined a scheme of less than 10 MW as being small (Chenal et al., 2009). Here, with small hydropower plants that can operate as auxiliary installations into municipal and agricultural water systems, hydraulic structures, power plants, desalination plants, heating or cooling systems, while guarantying their primary functions.

1) Typical potential sites: These potentials, for which electricity generation is not their primary priority, but the second, are so called multipurpose schemes. This implies the integration of the power plant in the existing infrastructure while guaranteeing its primary function. For example, for a drinking water network, the primary priority is to supply in quantity and quality the needed water; whilst for a desalination plant, it is to generate drinking water from sea water. As multipurpose schemes are characterized by a wide range of water quality, from drinking water to wastewater, there is a need for an overview of different techniques

2) Drinking water network: A simple drinking-water network can be described as follows:

• a spring at altitude

• a fore bay

• a penstock

• a reservoir

• a water supply network

From the elevation of the sources, and as the pressure at the consumers cannot generally exceed 4 bars, there can be an excess of pressure in the networks to recover. The main idea here is to replace the pressure breakers, used traditionally to waste the excess pressure, by turbines so as to generate electricity. Different energy recovery possibilities can be identified and defined by the turbine positions:

• On a reservoir:

Water passes through the turbine before being accumulated in a reservoir. This method is the most flexible, as it permits disconnection of the turbine operation from the water supply network to guarantee at any time the primary function of the existing infrastructure.

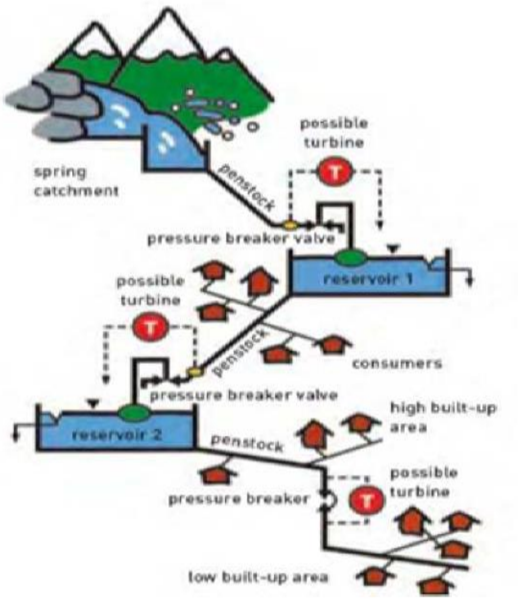

Figure 6: Layout of a drinking-water network and possible positions of the turbines

• Within the supply network: Water passes through the turbine and carries on its way through the pipe. This setting means that a pressure defined by the network requirements has to be maintained at the turbine outlet, which reaction turbines and counter pressure Pelton can achieve.

• Before restitution to the environment: Excess water that is not supplied to the consumers passes through the turbine before restitution to the environment. When the drinking water source is underground and has to be pumped to the reservoir, no turbine integration will be possible.

3) In a desalination plant: Desalination plants use reverse osmosis to separate water from dissolved salts through semipermeable

membranes under high pressures (from 40 to 80 bars). The residue of liquid water containing salt, still at high pressure can be passed through a turbine in order to recover part of the energy used for the initial compression.

• Case study Tordera, Spain: Tordera desalination plant generates drinking water for Maresme Nord and for La Selva, situated on the North coast near Barcelona. The plant takes sea water from wells, which implies that less water is taken from the aquifer and sea intrusion can be stopped. The reverse osmosis is the process used to separate water from dissolved salts through semi-permeable membranes under high pressures. Here four groups are set (cf. Photo 21 and Photo 22), each one composed of a pump, a motor and a 1-jet Pelton turbine on the same axis. The pumps are used to increase the water pressure (up to 70 bars) so that the water (without salt) can cross the membranes, while the turbines recover the energy from the concentrate outlet of the reverse osmosis, inferring smaller motors. Finally 10 to 20 hm3 of drinking water are generated per year.

Figure 7: Tordera: the four groups(left one) and a dismantled Pelton turbine(right one)

Potentials for development of hydro-powered Red Sea water desalination in Jordan are discussed [18].

4) In a coolng or heating system: Cooling or heating systems can present a pressure difference that can be recovered by hydro turbines. A system designed by Frederiksen et al. (2008) recovers excess pressure from a district heating system to direct-drive the circulation pump within the building (typically rated around 1 kW) and a small generator. This not only maintains the hot water circulation, but also provides enough power to run the electrical control system so that the heating continues to operate even when there is a fault in the electricity network. Therefore, gives a similar case of a small turbine set for energy recovery that can drive (directly or not) the circulation pumps. It is investigated the feasibility of recovering lost energy from typical bio-gas upgrading facilities by means of a hydraulic turbine, and presented analysis of different types of hydraulic power recovery turbines.

C. Main requirement: integration to the existing infrastructure

Once the feasibility study has demonstrated the project viability, the implementation project will lead to define the whole design of the SHP plant, with a focus on the integration to the existing infrastructure.

D. Flexibility and performances

The SHP plant operation must not impact on the primary function of the existing infrastructure. Thus, the turbine has to be as flexible as possible regarding the available pressures and discharges, while guaranteeing high performances on the largest operation ranges. The turbine design is based on the site flow duration curve, a crucial tool to optimize the production and the viability of the project.

E. Drinking water quality and turbines

To demonstrate that turbines can respect water quality, or in other words that drinking water can pass through the turbine before being consumed, a comparison with pumps can be achieved,

F. Conclusions

1) The equipment used for multipurpose schemes does not differ much from the traditional ones used for water streams, apart from the specific conditions of each infrastructure that have to be considered all along the projects' steps.

2) Regarding environment, as the hydropower plant has to be integrated to the existing infrastructure, the impacts are mainly due to its primary function. One can even mention that the environmental impact is positive as the SHP plant implies an energy recovery.

3) However multipurpose schemes development is just at the beginning. This is mainly due to the lack of information on the possibility to recover energy. Moreover, in some countries, one second obstacle would be the lack of administrative procedures adapted to SHP.

VII. ENGINEERING ADVANCES IN URBAN WATER SYSTEM INFRASTRUCTURE FOR WATER PURIFICATION:

A. Introduction:

As, we know in the twentieth century, simple turn of the tap provides clean water which is one of our precious resource. Water Supply Systems were constructed to deliver clean drinking water and remove sewage from urban areas in separate systems [22]. Engineering advances in managing this resource in urban areas with water treatment, supply, and distribution systems can tends to change life profoundly in the twentieth century, virtually eliminating waterborne diseases in developed nations, and providing clean and abundant water for communities, farms, and industries. In fact, populations continually move to urban areas for improved opportunities and a higher standard of living, and as cities merge to form megacities, the design and management of water supply systems serving these urban areas becomes an increasingly important part of regional integrated water resources planning and management. Localization of water cycles through neighborhood reclamation and distribution of water has several benefits including minimization of piping systems and reduced water extraction discharge of sewage to the environment [23]. We conclude that despite the challenges, self-sufficiency urban water system infrastructure for water purification in combination with conventional water resources are helping to reach this goal.

B. Urban Water System Modeling:

1) Model Selection: A wide range of models is available for the simulation of hydrodynamics and water quality in urban systems. The wastewater collection and treatment system in an urban area is modeled in three different ways. In the first approach, only the river is modeled. The discharge of effluent from a wastewater treatment plant is taken into account as a boundary condition. This is a useful approach for studying the impact of the discharge of effluent on water quality. In the second approach, a detailed water and mass balance is made for an urban area. The main routes of water and pollution are considered. Generic measures, such as the disconnection of impervious areas from the sewage system, can be evaluated with this type of model schematization. In the third, most detailed, approach, a model schematization is made for the entire sewage system and, eventually, the wastewater treatment plant. This type of model is needed when defining specific measures concerning storage in the sewage system, enhanced treatment capacity at the wastewater treatment plant and the design of storm water retention ponds.

2) Optimization Model:: The use of the storage, transport and treatment capacity of existing urban infrastructure can be optimized in many cases. Optimization of urban water systems aims at finding the technical, environmental and financial best solution, considering and balancing measures in the sewage system, the wastewater treatment plant and the surface water system at the same time. The application of optimization to master planning for complex urban water infrastructure presents a significant challenge. Using optimization methods to find the minimum-cost design of a system of several thousand pipes for a single demand at a single point in time is difficult enough on its own.

3) Simulation:: Dynamic simulation models are increasingly replacing steady-state models for analyzing water quantity, pressure and water quality in distribution and collection networks. It is practical for engineers and researchers using readily available hardware and software [19], to simulate a sequence of time periods of urban water systems driven by water use and rainfall, which by their natures are stochastic. The simulation of water quantities and qualities in urban catchments serves three general purposes i.e.

(a) Planning/Design

Engineering advances in studying to define system configurations, size or locate facilities, or define long-term operating policies under hypothetical scenarios based on representing operating conditions for urban water infrastructure system of water purification.

(b) Operations

Engineer plays an important role in this part for water purification. They handle these operations based on current system and operating conditions to be often driven by regulations.

(c) Forensics

Engineers used to link the presence of contaminants to the risk or actual occurrence of disease depending on whether the objective is cast in terms of acute or chronic exposures.

Because there are often dose–response relationships and issues of latency in the etiology of disease, explicit consideration of the spatial distribution, timing, frequency, duration and level of contamination is important to these studies [20][21].

C. Solutions

1) Spatial distribution:: The reviewed cases reveal that a variety of solutions to increased water self-sufficiency in urban areas are widely used around the world shown in Table 1. A bias towards the industrialized parts of the world is intentional since the main focus is on solutions in industrialized urban areas.

Geographical and topical distribution of the cases

Geographical distribution	Number of cases	Percentage (%)
Europe	46	41
North America	18	16
Sub-Sahara Africa	4	4
Asia	15	13
Australia	17	15
South America	2	2
Middle East	11	10
Total number of cases screened	113	100

Table 1

GEOGRAPHICAL AND TROPICAL DISTRIBUTION OF THE CASES

2) Drivers:: Five main drivers for increasing the self-sufficiency are:

(a) Direct lack of water: Direct lack of water occurs when the supply cannot meet the anthropogenic demand needed for households and irrigation. The deficit may occur as a result of decreased supply (drought), for example caused by climate change, or as a result of increased demand (population growth).

(b) Indirect lack of water: Indirect lack of water occurs where water resources are sufficient to meet anthropogenic demands, but available water resources may be allocated for other uses or the resources can be undesirable for political reasons.

(c) Constrained Infrastructure: Constrained infrastructure occurs, where bottlenecks in the water supply occur due to limited capacity of the infrastructure. Pipe systems designed decades earlier may be expensive to upgrade and restrain amounts of water to supply or remove from an area after use. Constrained infrastructure may drive a self-sufficiency trend [23] e.g. as a direct driver for the development of local wastewater treatment in some of Japan's megacities where it prevents expensive investments in up scaling of the central sewer systems [24].

(d) Demand for high quality water: Membrane processes employed in water reclamation schemes can produce water that is even purer than required for potable supply and industrial applications can create an additional demand for intensively treated wastewater [25] [26].

(e) The Sectorial System: Innovation and development occur within a sectorial or innovation system as a result of the knowledge base and interactions that exist among the system agents, i.e. firms, universities, authorities etc. [27].

D. Challenges of self-sufficiency

The main challenges of increased water self-sufficiency for water managers are:

(a) Controlling energy demands: Energy consumption has become increasingly relevant because it is linked to climate change [28]. Environmental life-cycle studies show that electricity consumption in the operation phase is generally the most important factor affecting environmental performance indicators in water treatment systems [29]. Energy consumption can contribute substantially to the total production costs [30] and global warming [31] and energy use is therefore a significant parameter to consider in decision making processes on urban water systems. Alternatives involving advanced treatment processes are more energy intensive when compared to conventional treatment shown in Figure (8) [30] [31], both in decentralized on-site applications and in centralized large scale systems. Small scale on-site reclamation systems based on membrane bioreactors are quite energy demanding (2-8 kWh/m3), depending on efficiency of scale. High energy requirements are also of concern for larger centralized systems. Potable wastewater reclamation and desalination plants typically involve membrane technologies, which require high pressures (typically 5-80 bar) to force water through the membranes [30].

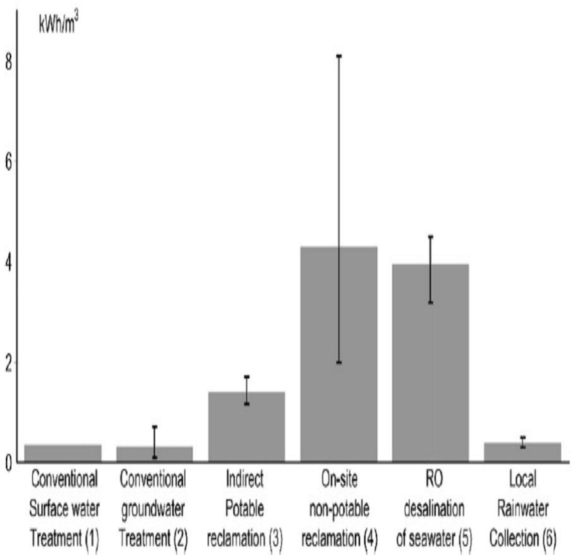

Figure 8: Electricity demand per unit water produced before distribution with minimum and maximum values indicated [30][31]

(b) Controlling environmental impacts: Life-cycle-assessment studies of water-supply technologies do not currently include environmental impacts of water abstraction and disposal of concentrate from membrane processes. For example, seawater desalination draws water from a huge resource with environmental impacts very different from inland freshwater abstraction.

(c) Ensuring high quality water and avoiding negative impacts on human health: Today's wastewater streams contain a wide range of chemical pollutants that pose risks to ecosystems and drinking water systems [33].

(d) Ensuring public trust in the water supply:

Interpreting the risk posed by mixtures of low level contamination is challenging for the scientific community, as possible combinations of compounds are numerous and the impact on public health complex [32].

(e) Ensuring cost effectiveness: Comparing the costs of different techniques is challenging as they will depend on a range of factors which may vary significantly with location and be implementation specific. It is not surprising that costs are related to treatment intensity. It is seen that the lower bounds of estimated cost are significantly higher for indirect potable reclamation, on-site treatment and desalination than for more conventional sources and simple concepts such as surface water abstraction and rainwater collection.

(f) No single concept is a panacea to urban water stress: There is unfortunately no simple panacea to urban water stress. Each type of resource has its own strengths and weaknesses shown in figure (9) [34]. Wastewater reclamation and desalination are effective ways of increasing water self- sufficiency, while reducing the impact of climate variations because such climate independent water resources can provide a steady freshwater yield in dry periods. However, wastewater reclamation and desalination becomes less optimal when considering public acceptance and treatment intensity, which reflects energy consumption and costs.

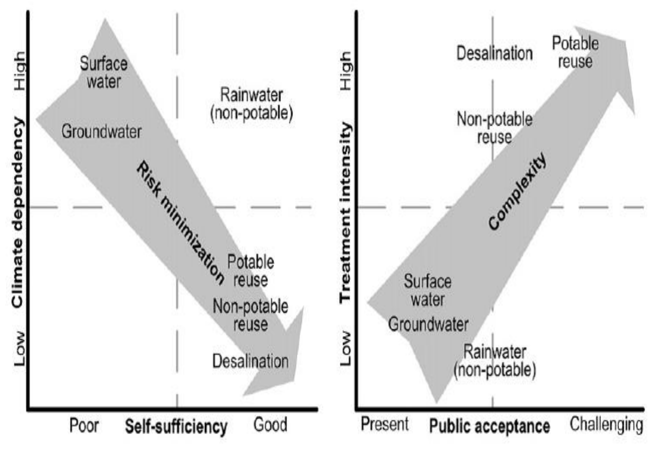

Figure 9: Properties of resources for urban water supply [34]

E. Conclusion:

Well-designed and operated urban water system is critically important for maintaining public health as well as for controlling the quality of the waters into which urban runoff is discharged. In most urban areas in developed regions, government regulations require engineers, designers and operators of urban water systems to meet three sets of standards. Pressures must be adequate for fire protection, water quality must be adequate to protect public health, and urban drainage of waste and storm waters must meet effluent and receiving water body quality standards. Therefore, Optimization and simulation models are becoming increasingly available and are used to analyze a variety of design and operation problems involving urban water systems that are incorporated within graphic user interfaces facilitate the use of the models. Moreover, it requires monitoring as well as the use of various models for detecting leaks and predicting the impacts of alternative urban water treatment and distribution, collection system designs and operating, maintenance and repair policies.

VIII. ESTIMATING COSTS FOR WASTE WATER COLLECTION AND COMPARATIVE INFRASTRUCTURE ANALYSIS FOR DRINKING WATER TREATMENT TECHNOLOGY UNDER VARIOUS GROWTH SCENARIOS IN ELECTRICAL ENGINEERING ASPECT.

Water industry authorities and analysts believe that maintaining the nation’s high-quality drinking water and wastewater services will require a substantial increase in spending over the next two decades. They point to many types of problems with existing water infrastructure, including the collapsed storm sewers in various cities, the 1.2 trillion gallons of water that overflows every year from sewer systems that commingle storm water and wastewater, and the estimated 20 percent loss from leakage in many drinking water systems. But the amount of money needed for future investment in water infrastructure is a matter of some debate, and various estimates have been developed [36]. The “needs surveys” of drinking water and wastewater systems conducted periodically by the Environmental Protection Agency (EPA) provide one measure of potential investment costs [36]. Others are offered by groups such as the Water Infrastructure Network (WIN) and the American Water Works Association. The Congressional Budget Office (CBO) has also analyzed future costs for water infrastructure and presents its estimates here as low-cost and high-cost scenarios, illustrating the large amount of uncertainty surrounding those future costs. In the debate about future investment in water systems, both the amount of money that will be needed and the source of those funds are at issue [36]. Advocates of more federal spending have argued that estimates of the difference between future costs and some measure of recent spending —the “funding gap”—justify increased federal support. However, higher future costs could be funded from many sources and are not necessarily a federal responsibility. The federal government currently supports investment in water systems through several programs [36]. They include state revolving funds (SRFs) for wastewater and drinking water, which receive capitalization grants through appropriations to EPA; loan and grant programs of the Department of Agriculture’s Rural Utilities Service; and the

Community Development Block Grants administered by the Department of Housing and Urban Development. Not with standing those and various smaller programs, the large majority of the funding for drinking water and wastewater services in the United States today comes from local ratepayers and local taxpayers. Ultimately, society as a whole pays 100 percent of the costs of water services, whether through ratepayers' bills or through federal, state, or local taxes. Federal subsidies for investment in water infrastructure can redistribute the burden of water costs from some households to others [35]. However, subsidies run the risk of undermining the incentives that managers and consumers have to make cost-effective decisions, thereby retarding beneficial change in the water industry and raising total costs to the nation as a whole.

The New Jersey Office of State Planning (OSP) has developed a spreadsheet-based computer model that allocates municipal growth projections [35], estimates future incomes and housing needs for municipalities, and then evaluates the impacts of this future growth on several infrastructure systems. It describes the sewer impact portion of the model and presents sample results.

The sewer model is based on detailed information about local conditions principally gleaned from the Annual EPA OSP also collected sewer service area maps and obtained information about water quality conditions for all streams into which treated sewerage is discharged. If the model determined the need for a new treatment plant, the cost for the new plant reflects both treatment capacity and the proper level of treatment to ensure compliance with the Clean Water Act. OSP also developed several interesting subroutines including one that calculates the likelihood for non-sewed areas to install sewers and another one that estimates future collector costs as a function of development density and pipe size [36].

Results from the model have produced interesting policy discussions. Because most municipalities are connected to retinal treatment facilities, growth elsewhere in the same sewer shed can increase cost in slower growing municipalities, or inhibit growth due to declines in treatment capacity. In the older urbanized areas, local officials are concerned that the high costs to rehabilitate existing facilities to meet Clean Water standards could inhibit revitalization efforts.

IX. CONCLUSION

No water, No life! In this research paper, the influence of modern science and technology indicates that are considerable improvements to older technologies, and subsequently standards of living can be expected to rise, especially in rural and previously less developed sectors for the modification of available infrastructure for water purification. Small hydropower plants integrated into existing infrastructures is thus a promising environment friendly market to develop. Hence, water utilities seek more secure solutions by diversifying their approaches to water supply.

To conclude, water self-sufficiency for water purification is a predictable response to urbanization and increasing water stress, and several cities are already taking advantage of low grade water resources within the city boundaries. Different proposed method use different optimization techniques but the basis for all is the optimization is sought between energy and water efficiency in Electrical engineering aspects. Therefore, then extend this principle to treat different methods of water purification and energy savings for the modification of available infrastructure.

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