Balancing equity and financial sustainability for the provision of safe water to all in small towns in Burkina Faso

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BALANCING EQUITY AND FINANCIAL SUSTAINABILITY FOR THE PROVISION OF SAFE WATER TO ALL IN SMALL TOWNS IN BURKINA FASO

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Abstract

The Agenda for Sustainable Development adopted by the United Nations in September 2015 sets the goal of achieving universal access to safe water by 2030. This article focuses on the achievement of this goal in small towns where half the population of Burkina Faso will live in 2030 by addressing the question: under which conditions could universal and equitable access to privately managed water services be financially sustainable in 2047 small towns by 2030? The article shows that the access to safe water in an equitable way and for all in small towns is submitted to the switch to solar energy and the enforcement of a consistent price-cap regulation. Under these two conditions, water tariffs could be divided by two compared to today, with 70% of small towns population being supplied on premises and 30% through stand-pipes, compared to less than 20% being supplied by stand-pipes today.

Keywords
Urban Water supply, Water Utilities, Equity, PPP, Affermage contract, Water Tariff policy, Tariff modelling, Financial Policy, Regulation, Financial sustainability

1. INTRODUCTION

The Sustainable Development Goals (SDGs) have succeeded the Millennium Development Goals (MDGs) on the international agenda for development. The MDG 7 which targeted to halve the population without access to safe water by 2015 has been achieved globally, and in Burkina Faso in 2011 (UN-Water [1]). In September 2015, heads of state from 140 countries representing 85 percent of the world's population adopted the 2030 Agenda for Sustainable Development, with 17 SDGs and 169 targets. Drinking water, sanitation, and hygiene form a central part of the clean water and sanitation goal (SDG 6) and are reflected especially in targets 6.1 and 6.2 which are (UN General Assembly [2]) :

- To achieve universal access to basic drinking water, sanitation and hygiene for households, schools and health facilities;
- To halve the proportion of the population without access at home to safely managed drinking water and sanitation services;
- To progressively eliminate inequalities in access

Cost to achieve SDG 6 has been estimated by the World Bank based on a mix of technology options (Hutton and Varughese [3]). Basic technologies include community wells for water supply, improved latrines for sanitation, and a basin with water and soap for practicing hand washing; while higher-cost options include piped water and sewerage. Safely managed water means an on-plot water supply for every household (high service), while a basic water supply includes an improved community water source within a 30-minute round-trip, including queuing. The capital financing required to supply basic water services to all those unserved in the world would cost US$ 7 billion per year, while the provision of high service to all the unserved in the world would cost US$37 billion. To halve the population without access to high water service and provide basic service to the others worldwide would cost US$ 21 billion per year, approximately three times the historical financing trend of extending access to the unserved. Urban areas account for 70 percent of the capital expenditure requirements. Interestingly, Hutton and Varughese find more cost-effective to invest straight in safely managed services than to offer first basic services then higher levels of service: "Additional investments can be well worth their cost if the

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appropriate hardware and software are chosen, and services sustainably operated." [Hutton and Varughese, [3], p.6]. In the case of Burkina Faso, the return on investment in higher service cannot be compared with basic service and the investment can well be worth if tariffs recover recurrent costs (Pezon [4]).

The purpose of the article is to identify and analyse the conditions for meeting target 6.1 for water in Burkina Faso, more specifically in small towns. The scope of the article covers 2047 small towns ranging from 2,000 to 10,000 inhabitants. In 2030, these small towns will account for 45% of the country's population (11.8 million people). Today, only 568 of these 2047 towns supply water to less than half their population (2.6 million people), with embryonic piped schemes designed to supply 2000 people each, when their average population approaches 4900 (Comité National de Recensement [5]).

Next section explains the challenge of meeting SDG 6.1 in the context of Burkina Faso. Section 3 shows that the crucial condition for providing equitable access to water while granting a fair profit to private operators is to abandon fossil energy for solar energy. Section 4 compares the capital investment required under each energy option and concludes that the higher investment in capital for solar production is largely compensated by the operating loss of fossil run services over 10 years. Section 5 explains how a sound price-cap regulation would second the adoption of solar energy to deliver universal water services. Last section concludes.

2. THE CHALLENGES OF UNIVERSAL ACCESS TO WATER IN SMALL TOWNS IN BURKINA FASO

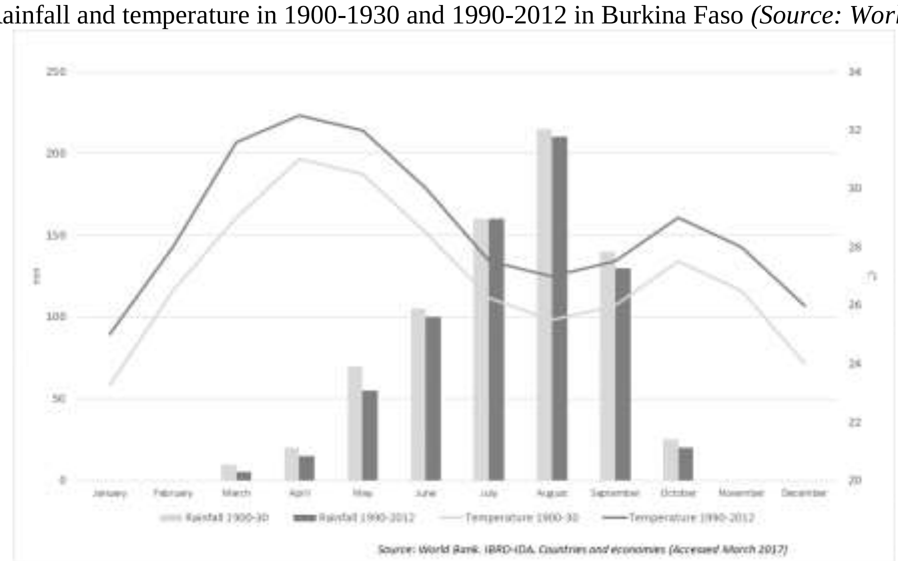
2.1. The demographic challenge

Burkina Faso is a landlocked country located in West Africa. It is ranked as the 7th most disadvantaged country in the world by the Human Development Index which combines wealth (GDP), Health (Life expectancy) and Education (UNDP [6]). Half the population lives below the poverty level and the GDP per capita stands around US$650 per year, i.e. half the average GDP per capita in Sub-Sahara Africa (World Bank [7]). The mortality rate of under-five is 98 per 1000 and a Burkinabè dies in average at 57. Three quarters of adult population is illiterate (UNICEF [8]).

Burkina Faso is a semi-arid water-stressed country characterised by a Sahelian-Soudanese climate with one short rainy season (June-September) and a dry season with average temperature over 30° Celsius (Fig. 1). Only 4 permanent rivers flow in the country (Niger, Volta, Comoé and Mouhoun rivers), and ground water is the unique resource to supply rural and semi-urban areas with drinking water; dams were built close to the capital city, Ouagadougou, and other large towns (Ouahigouya), but only to secure the provision of water to the urban population (4 million people).

Burkina Faso has a total population of 17.5 million in 2015, growing at a rate of 3% per year. Ouagadougou, the capital city, concentrates half the urban population with 2 million inhabitants. 80% of the country is rural, with "villages" counting from few dozens to 10,000 inhabitants. According to population forecasts, the demographic growth should remain at 3% per year, leading to a total population of 25 million in 2030. Though rural population should stay constant, small towns (2,000 to 10,000 inhabitants) and larger towns, will increase by 7,5 million people in the coming 15 years (Comité National du Recensement [5]).

Figure 1. Rainfall and temperature in 1900-1930 and 1990-2012 in Burkina Faso *(Source: World Bank [7])*



In 2015, more than 4 million small towns dwellers have, at best, access to a basic service through community managed water points (boreholes equipped with hand-pumps), just as the rest of the rural population.

Consequently, the challenge consists in developing safely managed water services to about 12 million people by 2030, with a large majority receiving water on premises. This ambitious objective is key to avoid a development where a metastasis capital city would be the only economic attractive centre while the other towns would develop chaotically and fail to supply urban type of water (and other) services.

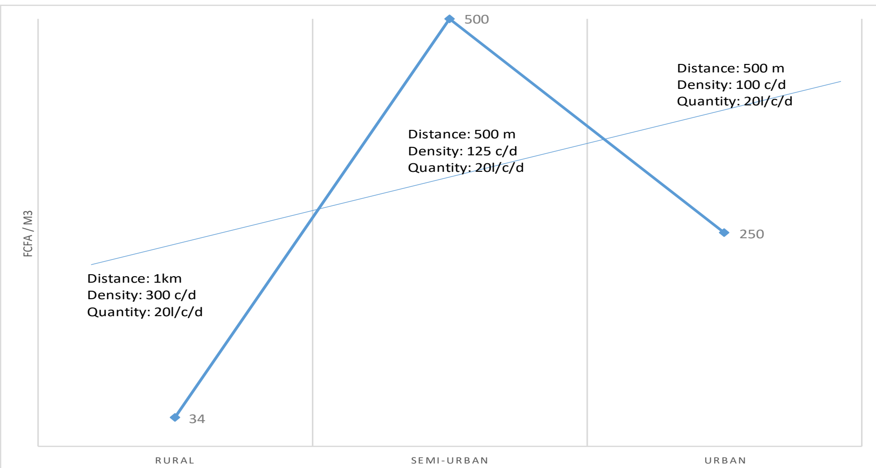
2.2. The tariff equity challenge

The organisation of water supply in Burkina Faso differentiates urban, semi-urban and rural areas. For urban areas, the public utility ONEA (Office National de l'Eau et de l'Assainissement) holds a monopoly through a concession contract with the State for the provision of drinking water to towns exceeding 10,000 inhabitants. For the provision of drinking water in semi-urban and rural areas, the National Department for Water (DGRE – Direction Générale des Ressources en Eau) remains the main stakeholder, despite the transfer of water and sanitation competencies and assets to local governments in 2009. DGRE rules that in villages (below 2000 inhabitants), population is supplied by boreholes equipped with hand pumps at a rate of 300 people per borehole. In each village, a benevolent community-based organisation is in charge of collecting water fees from users and coordinating with a technician for regular maintenance and repair in case of break-down. Small towns (2,000 to 10,000 inhabitants) should be equipped with small piped schemes supplying pressurised water to stand-pipes and private connections. These schemes are to be managed by professional operators under 10-year affermage contracts. They collect water fees from users and maintain the infrastructure, including the capital maintenance of components such as pumps and generators.

Typology of access to water includes three different service levels depending on where one leaves. In urban areas (outside Ouagadougou), the population has access to water if distant less than 500 meters away from a stand-pipe providing 20 litres of safe water per person every day to a maximum of 300 people. In small towns, one has access to water if located less than 500 meters away from a stand-pipe which supplies up to 500 people at a rate of 20 litres of safe water per capita per day. Finally, in rural areas, accessing water means walking up to 1 km to a safe water point that supplies 20 litres of water per capita to 300 people every day. In other words, the targeted level of service increases with density.

A separate tariff policy has been developed for each category of services. In urban areas, users pay a flat tariff of 250 FCFA/ m^3 to access water at stand-pipes and an average tariff of 500 FCFA/ m^3 when they receive water at home, on top of a monthly fee of 1000 FCFA. In semi-urban areas, users pay double at stand-pipe, 500 FCFA/ m^3 (US$1/m3) and for water at home (1000 FCFA/ m^3) but a similar monthly fee of 1000 FCFA as in urban areas. While the instalment of a private connection is not charged to households in urban areas, in small towns, a family must pay 200,000 FCFA (US$400) to get the best level of service. In other words, a small town dweller pays twice more than an urban one for a basic service (stand-pipe) of lower quality (higher crowding) and incomparably more to access an urban type of service e.g. water at home. In rural areas, families are expected to contribute an estimated lumpsum of 2,500 FCFA per year to access a safe water point (borehole). The tariff structure is thus not aligned with the levels of service (Fig. 2). It causes a major equity issue in a context where semi-urban population is notably poorer than urban (Institut National des Statistiques et de la Démographie [9]). This equity issue is not specific to Burkina: frequently the poor tend to pay higher price to access lower quality water services in urban areas (Banerjee and Morella [10]). In Burkina, poor pay as much as non-poor households, after considering both financial and economic expenditure (Schweitzer et al. [11]).

Figure 2. Tariffs and levels of service in rural, semi-urban and urban areas (*Source: the author)*



2.3. The regulation challenge

The economic regulation of natural monopolies pursues two objectives: make sure that operators deliver agreed services in a cost-effective way and adjust tariffs to cost (Laffont and Tirole [12]). Natural monopolies (such as network industries) are capital-intensive businesses. Cost efficiency cannot be obtained through competition, per definition, though it matters to ensure costs are the lowest possible considering the nature of the service provided (a public service recognised as a human right). However, natural monopolies benefit economies of scale that show through decreasing marginal cost with volume: for a given (production and distribution) capacity, the higher the volume of water the higher the profit margin per cubic meter of water. This is what economists call the monopoly rent, and regulation seeks to allocate this rent in favour of users through tariff adjustments to costs.

Today, in Burkina Faso, the regulation framework is poorly designed, and the monitoring mechanisms fail to capture operators' performance in service delivery and cost-efficiency (Pezon [13]). Though Burkina opted for a price-cap type of regulation by setting a fixed and national tariff for water piped schemes, the regulation frameworks does not include a mechanism to monitor operators' performance in service delivery. The monitoring of services is limited to one indicator, the functionality of the piped schemes, and is collected only once a year by DGRE. For years, it stands at 67% meaning that one third of piped schemes are broken down. The other major service indicators (the quantity of water delivered, the number of users, the quality of the water and the time spent to fetch water) remain out of reach of the national Department. However, the compliance of the service delivered should be a central piece of the price-cap regulation according to economic theory, as lowering the quality of the service delivered is a tempting way for operators to increase profits (Pezon [14]).

The regulatory framework includes no mechanism to report on operators' financial performance. In particular, there is no mechanism to ensure that the annual provisions made by operators to finance capital renewal are properly disbursed during their contracts to replace pumps and generators. When this equipment breaks down, operators explain that they cannot replace it because the provisions are insufficient to meet the replacement cost. However, at the end of the contract, operators retain the net provisions cumulated over their contracts while, according to DGRE, these provisions should be transferred to the next service providers to finance future capital replacement. While each operator is contracted for the management of a portfolio of 10 piped schemes (combining fossil and solar schemes), DGRE suspects operators to make high profit on solar piped schemes but to stop running the fossil's as soon as capital investment is required to replace generators, instead of mutualising the cost and benefit of the two types of systems.

In this context, the challenge is to design regulatory mechanisms consistent with a price-cap type of regulation and complying with the existing institutional framework, according which semi-urban services are privately operated by cluster of 10, through 10-year affermage contracts. Such contract entail that public authorities are liable for capital investment while operators are liable for the operation, maintenance and capital maintenance (pumps and generator) expenditure which they seek to recover through users' bills, hence water tariff.

3. CONTEXT, METHODOLOGY AND DATA

In November 2013, the Parliament requested to refund the water tariff policy in small towns. Two proposals were successively submitted, both rejected by DGRE, as none considered a water tariff lower than the 500 FCFA per cubic meter already enforced at stand-pipe. These proposals adopted a cost-based approach. They consider the recurrent costs for running an embryonic pipe scheme (supplying water to few stand pipes and fewer private connections) that meet a demand of about 5 litres per capita per day, and conclude that the financial sustainability of the service cannot be met with a tariff below 500 FCFA/m^3. However, the government considers that an equitable access to water means that the same services should be provided in small towns as in urban areas. In terms of tariffs, it means:

- the same payment per volume, 250 FCFA/m^3 at stand-pipe (basic service) and 500 FCFA/ m^3 at home (high service).
- the same condition to access water at home e.g. free private connection, as this major component of ONEA's tariff policy proved to be an effective pro-poor instrument (Komives et al, [15])

Moreover, considering the higher poverty level of semi-urban populations, the government would like that the monthly fee charged for the high service is half in small towns compared with urban areas (500 FCFA vs 1000 FCFA). In terms of services, the government's objective is that the same proportion of semi-urban dwellers benefit a high level of service as in urban areas by 2030: 70%.

In this article, we adopt a tariff-based methodology where the tariff does not stand as the outcome of the research but as its starting point. Subsequently, the research question becomes: under which conditions the targeted tariff to have an equitable access to water is compatible with the financial sustainability of the service? The methodology then consisted in developing a financial modelling that gives, for a set tariff, the profit margin of the operators over 10-year contracts, based on variables such as demand (demographic growth, consumption, type of service, density), investment (production and distribution of water) and operating cost. The modelling also factors macroeconomics variables such as inflation rate and tax rate. Finally, it allows for combining different sources of energy and consolidates the costs (investment and recurrent), revenues and profit or loss of 2047 small piped schemes over 15 years.

Investments are phased in three 5-year periods. In phase 1 (2016-2020), the population of the 568 small towns that are already equipped with embryonic piped schemes would be targeted. At the end of this first period, 70% of these towns would have access to a basic service and 30% to a high service. Phase 2 (2021-2025) targets 68% of the semi-urban population, located in 1308 small towns. Half receive a basic service and half a high service. In phase 3 (2026-2030), the remaining 739 small towns are equipped with piped schemes and supply a high level of service to 70% of the population -and a basic service to 30%- similarly as the other 1308 towns (Table 1).

Table 1. Targeted population with basic and high water services per investment phase *(source: author)*

	Total population	568 small towns		1479 small towns		Targeted population			
		Total population	Average population	Total population	Average population	Total	%	Basic service	High service
2016	7 810 379	2 770 542	4 878	5 039 836	3 408				
2020	8 790 650	3 118 270	5 490	5 672 380	3 835	3 118 270	35%	70%	30%
2025	10 190 773	3 614 930	6 364	6 575 843	4 570	6 902 851	68%	50%	50%
2030	11 813 899	4 190 694	7 378	7 623 204	5 298	11 813 899	100%	30%	70%

The design of schemes, the unit cost of equipment as well as the operating and maintenance cost per system were provided by the Department of planning and investments with the help of private service providers and consultants along a participatory process that lasted one year (PEZON [16]. Regarding demand, and while the Burkinabè regulation clearly targets a demand of 20 litres per capita per day, previous research demonstrated that demand at stand-pipe varies from 5 to 15 litres per capita per day, depending on season, and the proximity of the family to the stand-pipes (Pezon [13]). Assuming that in Burkina, as in other countries, people's willingness to pay increases with the level of service provided (Mahendra [17]), we assume that the target of 20 l/c/d will be reached progressively, and at different paces, depending on the type of service (basic or high), with an initial demand of 5 l/c/d in 2016 for the basic service (Table 2).

Table 2. Demand forecast per level of service 2016-2030 *(source: author)*

	2016	2020	2025	2030
Daily consumption of water at stand-pipe	8 l/c	10 l/c	12 l/c	15 l/c
Daily consumption of water at private connection	10 l/c	15 l/c	20 l/c	20 l/c
Daily consumtion of water by school, health center and others through private connection	500 l/o	500 l/o	500 l/o	500 l/o

l/c: litre per capita l/o: litre per organisation

The targeted tariffs, demand forecasts and unit costs for developing and operating water services stand as variable in the financial modelling which can be used as a decision-making tool.

4. SUSTAINABLE WATER SERVICES AT HALF PRICE WITH SOLAR ENERGY

Is it financially sustainable for operators to provide access to water to 11.8 million people at half price by 2030? Under what conditions the targeted tariffs can cover the operation, maintenance and capital maintenance expenditure for pumps and generators, and spare a decent profit to the private sector?

4.1. Comparing fossil and solar energy for the operation and maintenance of 2047 systems over 15 years

The financial sustainability of water services depends on the type of energy used to pump ground water. With carbon energy (fuel), it costs from 1,957 FCFA/m^3 to 528 FCFA/m^3 (US$3.3 to US$0.9/m^3) to provide volumes of water ranging from 10 m^3 per day to 200 m^3 per day – covering respectively a demand of 5 l/c/d by 2000 people and a demand of 20 l/c/d by 10000 people (Fig. 3). For similar volumes of water, the unit costs of a solar type of system ranges from 1,754 FCFA/m^3 to 177 FCFA/m^3 (US$3 to US$0.3/m^3) (Fig. 4).

At the targeted tariff and forecast demand, never is a carbon energy system financially sustainable (Table 3). For instance, for a town with a population of 2000 inhabitants in 2016, an operator would accumulate an operating loss of 19,5 M FCFA under a 10-year contract. The larger the town, the bigger the loss with a cumulated operating loss of 91,2 M FCFA for a town of 10000 inhabitants at the beginning of the contract. In the former case, the loss equals 21% of the cumulated revenue in 10 years. For the latter, the operating loss margin culminates at 50%.

Figure 3. Operation and maintenance expenditure on a carbon system *(source: author)*

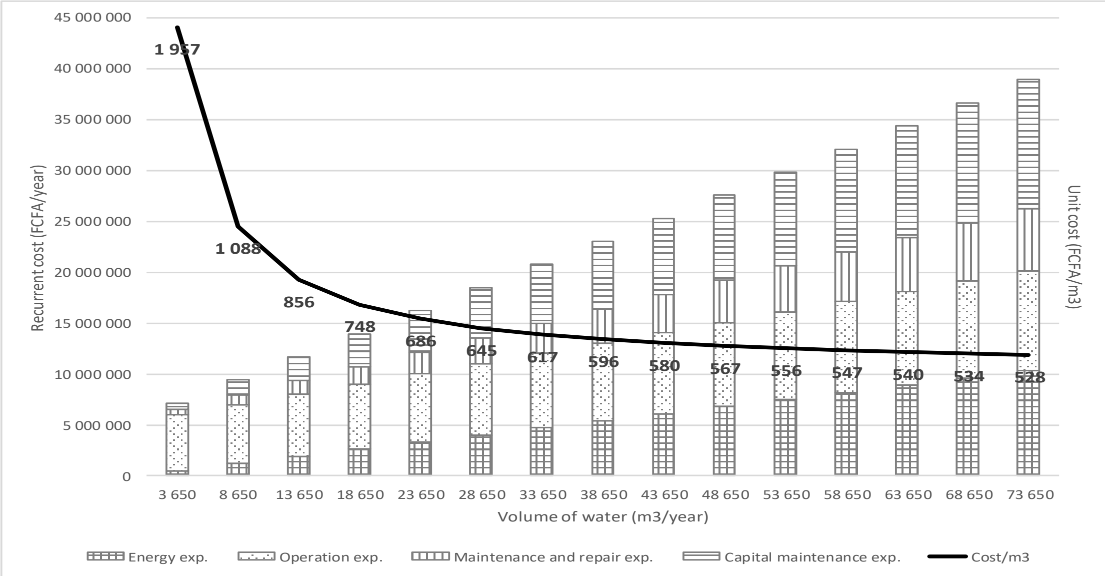
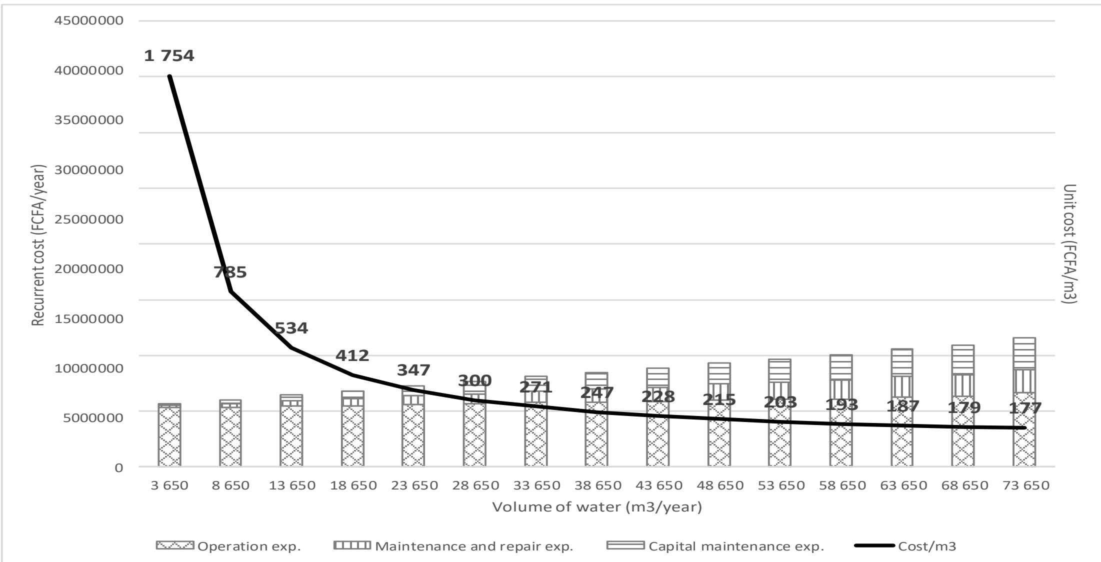


Figure 4. Operation and maintenance expenditure on a solar system *(source: author)*



A solar type of system becomes financially sustainable when the initial population is above 4000 people (Table 3). For instance, an operator supplying water in towns with population ranging from 5000 to 10000 inhabitants in 2016 cumulates, in 10 years, an operating profit ranging from 13 M to 76,5 M FCFA. The profit margin increases with the size of the service and culminates at 41%.

Looking at the 2047 small towns from 2016 to 2030, the cumulated operating result of the 2047 water services would amount to a loss of 110.9 billion FCFA (US$ 190 million) with fossil energy versus an operating profit of 83,4 billion FCFA (US$ 144 million) with solar energy (Table 4).

From a contract perspective, the 568 first systems are operated under 10-year affermage contracts from 2016 to 2025. With solar energy, these services hold a cumulated operating profit of 6,5 billion FCFA (US$ 11 M) in 10 years, representing 12% of the cumulated water sales revenue. It means that the operation of the services is financially sustainable even with a phase 1 type of demand standing at low levels (from 9 l/c/d in 2016 to 12 l/c/d in 2020). Under similar conditions but with fossil energy, the 568 systems would lose 40.5 billion FCFA (US$ 69 M) or 78% of the cumulated revenue in 10 years. Similarly, the 740 systems developed in the second phase of the investment plan are operated under 10-year contracts from 2021 to 2030. With solar energy, they hold a cumulated operating profit of 25.2 billion FCFA (US$ 43 M) in 10 years, or a margin of 30% of the total revenue. With fossil energy, the 740 systems would lose the equivalent of 48% of their revenue in 10 years.

Table 3. Operating profit and profit margin of fossil and solar systems in 10 years (FCFA) *(source: author)*

	Fossil type of system		**Solar type of system**	
Population in 2016	Operating profit in 10 years (FCFA)	Operating profit margin* in 10 years (%)	Operating profit in 10 years (FCFA)	Operating profit margin* in 10 years (%)
2000	-19 465 098	-21%	-25 101 512	-63%
2500	-23 945 912	-24%	-18 753 224	-39%
3000	-28 426 727	-27%	-12 404 936	-21%
3500	-32 907 541	-30%	-6 056 648	-9%
4000	-37 388 356	-32%	291 640	0%
4500	-41 869 170	-34%	6 639 928	8%
5000	-46 349 984	-36%	12 988 216	14%
5500	-50 830 799	-38%	19 336 504	19%
6000	-55 311 613	-40%	25 684 792	23%
6500	-59 792 428	-41%	32 033 080	26%
7000	-64 273 242	-43%	38 381 368	29%
7500	-68 754 057	-44%	44 729 656	32%
8000	-73 234 871	-45%	51 077 943	34%
8500	-77 715 686	-47%	57 426 231	36%
9000	-82 196 500	-48%	63 774 519	38%
9500	-86 677 314	-49%	70 122 807	40%
10000	-91 158 129	-50%	76 471 095	41%

* operating profit in 10 years / water sales revenue in 10 years

Table 4. Operating profit (loss) and operating profit margin of the 2047 services *(source: author)*

<table>
<tr><th></th><th></th><th>*2016*–*2020*</th><th>*2020*–*2025*</th><th>*2025*–*2030*</th></tr>
<tr><td rowspan="4">Fossil energy</td><td>568 towns</td><td colspan="2">(40,5 billion FCFA) | - 78%</td><td>(12,7 billion FCFA) | -22%</td></tr>
<tr><td>740 towns</td><td></td><td colspan="2">(40,4 billion FCFA) | -48%</td></tr>
<tr><td>739 towns</td><td></td><td></td><td>(17,4 billion FCFA) | -33%</td></tr>
<tr><td>2047 towns</td><td colspan="3">(110,9 billion FCFA) | - 45%</td></tr>
<tr><td rowspan="4">Solar energy</td><td>568 towns</td><td colspan="2">6,5 billion FCFA | 12%</td><td>29,5 billion FCFA | 52%</td></tr>
<tr><td>740 towns</td><td></td><td colspan="2">25,2 billion FCFA | 30%</td></tr>
<tr><td>739 towns</td><td></td><td></td><td>22,3 billion FCFA | 42%</td></tr>
<tr><td>2047 towns</td><td colspan="3">83,4 billion FCFA | 32%</td></tr>
</table>

For the 739 systems developed in phase 3, as well as for the 568 systems whose 10-year contracts expire in 2025, we have considered operating profits and margins over 5 years, from 2026 to 2030. In both cases, the operating profits reach outrageous levels, respectively 42% and 52%. According to demand forecasts, the majority of semi-urban population receives a high level of service (private connection) from 2025 and consumes a minimum of 17 l/c/d. Under such conditions, the provision of service becomes a cash cow type of activity. Conversely, the same services ran with fossil energy lose a fifth or a third of their revenue in 5 years.

4.2. Higher capital investment in solar but overall better cost-effectiveness

Important capital investments are required to provide 18.5 litres of water per capita per day to 11,8 million people in 2030. Our estimation includes the capital investment in development and extension, be it to increase the production capacity (pump, generator or solar panel) or the distribution capacity (network, stand-pipes and private connections) over 15 years. The cost to replace short-life equipment (pump and generator) is part of the recurrent cost that operators recover through tariff.

The cost drivers of capital investment are twofold. The level of service drives the investment in water distribution, and the source of energy drives the investment in water production.

In distribution, a capital investment of 445 billion FCFA (US$ 768 million) or 37,700 FCFA per capita (US$ 65) is estimated to distribute safely managed water to 11.8 million people by 2030, after factoring the demographic growth and an inflation rate of 2.5% per year. It includes the extension of the 568 existing distribution systems and the development and extension of the 1479 new schemes over 15 years. The capital investment in distribution is divided almost equally in networks and the instalment of stand-pipes and private connections (Table 5).

Table 5. Capital investment in distribution & production per source of energy in FCFA *(source: author)*

	Distribution			Production		TOTAL Solar systems	TOTAL Thermic systems
	Network	SP & PC	Total	Solar	Thermic		
Phase 1 (2016-2020)	48 294 007 937	23 516 460 875	71 810 468 812	21 079 142 409	3 494 683 413	92 889 611 221	75 305 152 225
Phase 2 (2021-2025)	66 739 912 422	66 456 697 625	133 196 610 047	138 600 623 639	75 636 479 095	271 797 233 686	208 833 089 141
Phase 3 (2026-2030)	100 397 475 555	139 872 679 934	240 270 155 489	186 224 650 503	95 978 848 676	426 494 805 992	336 249 004 164
TOTAL FCFA	215 431 395 913	229 845 838 434	445 277 234 347	345 904 416 552	175 110 011 183	791 181 650 899	620 387 245 530
TOTAL US$	*371 433 441*	*396 285 928*	*767 719 370*	*596 386 925*	*301 913 812*	*1 364 106 295*	*1 069 633 182*

In production, the source of energy is the driver of the capital investment: it costs twice more to invest in the production of water with solar panels than with generators (346 billion FCFA vs 175 billion FCFA). Consolidating capital investments in both distribution and production, it costs 27,5% more to establish water systems running on solar energy than on fossil fuels (791 billion FCFA vs 620 billion FCFA). This additional investment amounts for 14,500 FCFA per capita, i.e. roughly a supplement of 1000 FCFA per capita per year during 15 years (US$ 1,6/c/y).

This additional investment is justified financially and from a risk perspective. Financially, investment must be compared with the wealth they generate. 2047 fossil type of systems require both capital investment and permanent subsidy for the recovery of most operational expenditure. In 15 years, the combination of capital investment and operational expenditure to be subsidised amounts to 731 billion FCFA. With solar energy, a capital investment of 791 billion FCFA generates a wealth of 83 billion FCFA: the net investment after 15 years is 708 billion FCFA, hence below the one with the fossil option. A risk perspective favours the solar option too. Private operators are unlikely to enter a business that relies more on subsidy than on water sales revenues. Besides, donors are reluctant to finance operational costs, even against interest: they reserve development aid (grant and loans) to capital investment and sector strengthening (policy and strategy) (UN Water, [1]). It would thus leave the sole State of Burkina with the responsibility to contribute each year as much as users to the operation and maintenance of *de facto* no profit water services. Which donor would take the risk of investing massively in services the delivery of which is suspended to annual contributions of the ministry of finance for 15 years? Debates around tariff levels would sooner than later arise, and increased tariffs would again appear as the way to solve the lack of financing.

The fossil option is simply not sustainable considering the equitable and universal access to water that stakeholders have defined. The solar option, on the other side, turns the provision of the water service into a wealthy activity that benefits users, and the development of a bankable private sector. By 2025 / 2030, a technical and political reflexion can be engaged to discuss the allocation of the financial rent of water services between stakeholders (operators, users, public authorities). As suggested previously, solar services would become extremely profitable after 10 years and the threshold of half population with high service reached. This profit is a collective surplus, and though operators should take their share, they cannot be granted the full return on investments that have been financed by others (donors and the State) to deliver a public service listed as a human right. The economic surplus of water services can be partially allocated to users through a reduction of tariffs or to the service authorities to finance further investment or develop their capacities.

The capital investment to universalise an equitable access to water to 11,8 million people by 2030, costs 791,2 billion FCFA or 67,000 FCFA per capita (resp. US$ 1,36 billion and US$ 115). These figures stand within the range of investments reported in Africa to supply higher level service (US$ 80 to 130 per capita, WASHCost [18]) and are coherent with the estimated investment required to provide safely managed water by 2030 (Hutton and al. [3]).

5. SOUND REGULATION OF SOLAR WATER SERVICES

Universal and equitable access to safe water requires the development of regulatory capacities to enforce contracts, monitor operators' performance and service delivery, including to the poor (Marson and Van Dijk [19]; Nyarko et al. [20]). Development of capacities comes at a cost, and development projects usually include a budget for capacity building equal to 3% of the investment in capital. The financial model factors this ratio and allows for an average budget of 1,5 billion FCFA per year over 15 years to finance local and national authorities' capacities.

Regulatory mechanisms and capacities must be coherent with the regulatory regime adopted for the water services. In Burkina Faso, the regulation of water services falls under the price-cap regulation regime, when the tariff is fixed for the duration of the contract and cannot be modified whatever cost changing during the contract. This regulation provides a high level of incentives for performance to operators: a cost reduction means an additional profit for operators (a kind of bonus for their out-performance) but an uncontrolled cost increase turns into a loss for which operators are liable. For the regulator, the downside of price-cap regulation is that operators may be tempted to deliver a sub-standard service in order to reduce their costs and increase their profits. Hence, the regulator should focus its attention to the conformity of the service delivered, and build on regulatory mechanisms to capture service level indicators.

Compared to fossil energy, the solar option facilitates the design and the enforcement of a sound regulation, adapted to capacities at local and national levels. First-of-all, it is possible to define fixed tariffs under the solar option, while the fossil option does not allow enforcing a simple price-cap regulation. With solar systems, the operators have control over all recurrent costs. The change in cost during their contract is attributable to their relative performance in delivering water services. Fossil systems introduce a recurrent cost on energy, the price of which is beyond the scope of operators' control. This risk is usually handled by indexing the tariff of water on energy price. However, indexed tariffs would annihilate the equity of tariff. As there is neither a national price nor an index for fuel, tariffs would differ from place to place, and in semi-urban areas compared with urban areas. In the case of Burkina Faso, where equality of tariffs in all urban areas is considered as the first criteria in search for equity, the indexation of tariffs to energy is particularly irrelevant (Calder and Schmitt [21]). From a capacity perspective, the adjustment of tariff on energy expenditure implies financial reporting and validation processes that are unlikely to develop soon in the 2047 small towns and are too heavy to handle at national level.

Under the solar option, local authorities can focus on the monitoring of service delivery, which is both the heart of price-cap regulatory functions, and within reach of their capabilities. Indicators such as the number of stand-pipes, the number of private connections, the volume of water supplied to basic and high services are easy to monitor since water is metered at each distribution point (stand-pipes, private connections). It is thus possible to compare the development of each service with annual objectives, and to use local indicators to trigger new investment in capital (extension of production and/or distribution) to support further development and reach full access by 2030.

In order to improve the accountability of operators with regard to provisioning for capital maintenance and avoiding litigation on the allocation of these provisions at the end of the contracts, it is proposed to pool them into a regional or national fund. All operators would have to transfer the provisions made every year to renew short-term capital to this fund. By mutualising the financing of capital maintenance, the pooling mechanism also helps mitigate the risk that operators face in case of premature break-down, when the replacement cost exceeds the accumulated provision.

Though a price-cap regulation does not rely on the monitoring of costs, it is still recommended to develop a cost national monitoring in order to benchmark operators against each other, analyse the impact of contract size on performance and update the unit costs that serve as sector references to adjust tariff for next generation contracts. Therefore, operators would report their income statements to DGRE whose capacities allow for the development and the management of a national database. This database would not only be accessible by local authorities and operators but more broadly to everyone interested in operators' relative performances. This "sunshine" regulatory mechanism reinforces the incentives for a good and performing provision of water services (Murungi and Blokland [22]).

6. CONCLUSION

Sustainability of water services is often seen as pursuing conflicting goals as far as equity and cost recovery are concerned: equity calls for lowest possible tariff while recurrent expenditures are best recovered through water sales revenue. In Burkina Faso, the government considers that the water tariff policy for small towns should align on larger towns' policy to be equitable for users. This requires to halve current tariffs for basic service (stand-pipe) and high service (on-plot) and to subsidy fully the instalment of private connections.

The financial sustainability of water services depends on the type of energy used to pump ground water. At the targeted tariffs, never is a carbon energy system financially sustainable no matter the population and demand. At the scale of the 2047 small towns and in 15 years, the carbon option turns into an operating loss of 110.9 billion FCFA (US$ 190 million) versus an operating profit of 83,4 billion FCFA (US$ 144 million) with solar energy. The sustainable development of an equitable access to water relies on the paradigm shift in energy (Omri et al. [23]).

A tariff policy is embedded in a regulatory framework whose objective is to make sure that services are delivered cost-effectively and to adjust tariffs to cost. In Burkina Faso, a sound price-cap regulation can be designed and enforced with solar energy while fossil energy requires adjustment of water tariff to energy price altering equity and exceeding by far monitoring capacities.

Renewable energy is the corner stone for equity, financial sustainability and regulation of water services. The contribution of solar energy to sustainable economy is a long pending question (King and Slesser [24]) and the capital investment still perceived as a limiting factors. In our study, it costs 1000 FCFA more per person per year to invest in solar than in carbon systems (US$1.6). However, in 15 years the operating loss of fossil systems fully compensates this supplemental investment, disqualifying the carbon option even from an investment perspective.

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