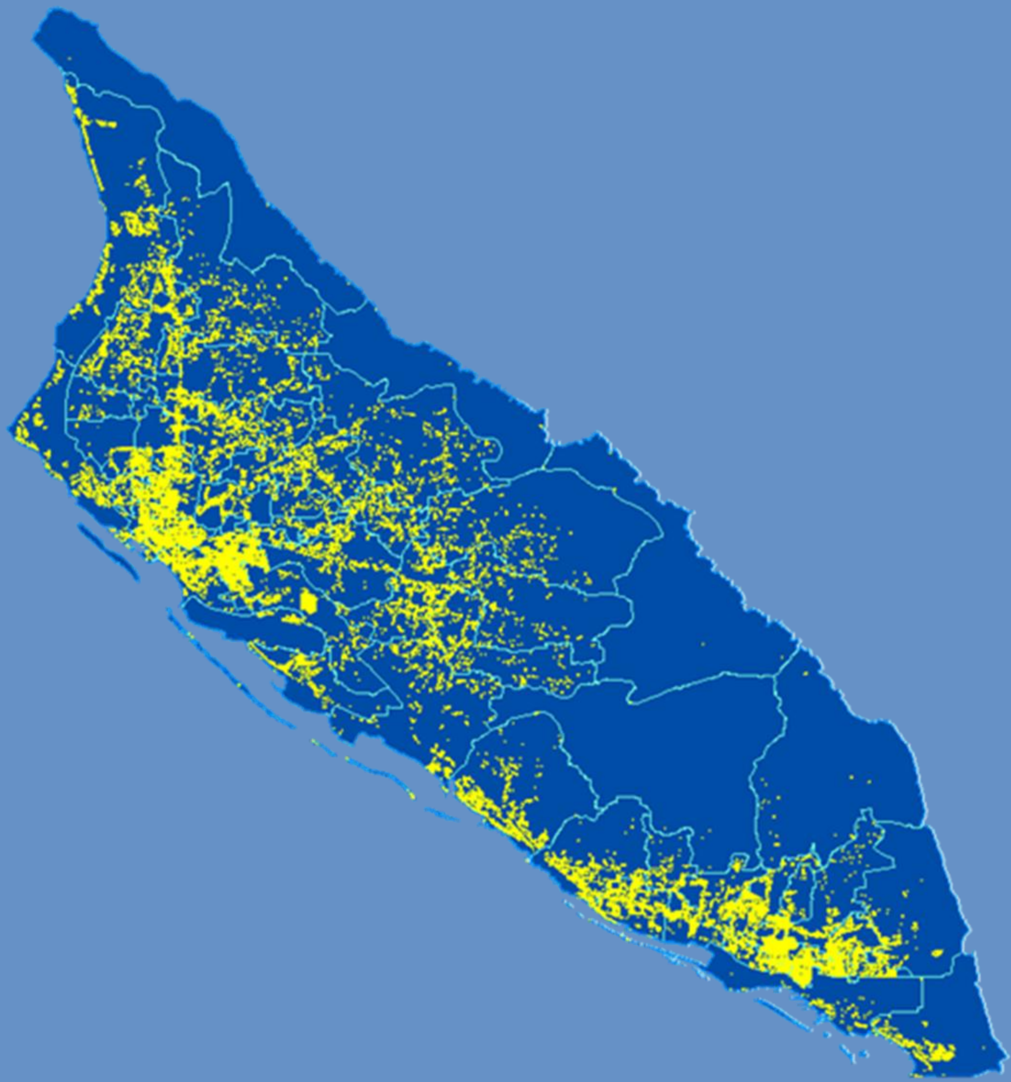
GAS, WATER AND ELECTRICITY EXPENSES BY ARUBAN HOUSEHOLDS 2010

central bureau of statistics

The role of utilities in Aruban households is a topic of public discussion. How much does a household spend on gas, water and electricity? Why have prices of water and electricity risen so rapidly in recent years? Is there a pattern in the expenditures on utilities by Aruban households, and by what factors is the consumption of utilities influenced? These are some of the important questions that have been tackled in the present study.

Based on a collection of data from the Income and Expenditure surveys in 1993, 1998 and 2006



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Acknowledgement: Thanks are due to Martijn Balkestein and Monique Plaza-Maduro for their discussion on this paper. I would like to mention my roommate Frank Eelens for his statistical support and valuable comments throughout the writing of this paper. I am indebted many thanks to Herbie Kock and Leo Da Silva for their readiness to provide some of the data.

Contents

Introduction

For Aruba, and the Caribbean Islands in more general, limited information is available on household consumption and expenditures of utilities. In a recent press release WEB Aruba NV states, that on Aruba, households tend to live rather sumptuously with regard to the consumption of water and electricity[1]. On Aruba, the availability of utilities is implicit to the economic development. However, worldwide the way we consume gas, water and electricity resources has become a topic of public debate[2,3,4]. Oil dependence is vast and there is a basis for concern. It is foresighted that oil-based natural energy resources will increasingly become a scarce commodity and that utility prices are likely to rise in the future[5]. What is more, the environment is undergoing irreversible and dramatic changes, due to the prolonged negative impact of the burning of fossil fuels and the production of waste. The idea of an unconstrained water and energy usage has indisputably come under pressure[6]. Households will have to adapt their consumption pattern, and in the process policy makers will need to gain insights in how to facilitate these changes.

In this paper, we provide relevant information about several aspects of utility prices, consumption and expenditure patterns of households on Aruba. We have examined the Aruban tariff structure and compared utility prices with our neighbor Curacao. We were able to describe, based on a linear regression model, the local price of water and electricity as a simple function of international crude oil prices. Also, in this paper, we present information on the influences and changes that define household utility consumption and expenditures during the past 5 years. We reveal an interesting seasonality in consumption patterns based on changes in average daily temperatures and number of rainy days, but effects from around Christmas have been suggested as well. A comparative analysis of household utility expenditures and a number of household characteristics reveals further information about what factors influence the consumptive behavior of Aruban households. Characteristics, such as the household's financial situation, presence of a swimming pool, or, demographic background are related to the expenditures on gas, water and electricity. Information is based on data from the utility companies and from household expenditure surveys in 1993, 1998 and 2006.

A short history of Aruban utilities[7]

Aruba has a remarkable history and struggle for an independent freshwater and energy supply. The access to freshwater lies on the basis of economic developments on Aruba. Already in early seventeenth century, the 'West-Indische Compagnie' developed additional water holes to cover growing needs. Freshwater was not readily available to everyone and everywhere and at that time drinking water came from wells, simple cisterns, or man-made water holes. Driven by wood-framed windmills, water was pumped over large distances to the cattle and the small-scale agricultural developments. Households had to use stone filters filled with carbon and pebble stones to purify the available water. In late nineteenth century, with the growing gold- and phosphate industry, a serious shortage in drinking water was at hand. Thanks to new techniques of the exploitation and discovery of more abundant wells, such as near Baby Beach, large scale water exploitation became a possibility. After the start of the Lago refinery, in 1928, the very first water supply system on Aruba was a fact.

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[1] WEB Aruba NV, Press release, September 2008
[2] The EU Strategic energy review. Driving investment in clean and Secure Energy. E3G, 2007. www.e3g.org
[3] On the economics of electricity consumption in small Island developing states. D. Weisser, Energy policy 32, vol. 1, 2004
[4] Sustainable consumption and production. Promoting climate-friendly household consumption patterns. UN | Desa, April 2007.
[5] Carilec position paper on energy policy, pp.10 , January 2008
[6] Jaarverslag 2007- EnergieNed. www.energiened.nl
[7] Sources in this section were cited in: " Bouwen op de wind – Architectuur en Cultuur op Aruba, Olga van der Klooster and Michel Bakker, 2007".

Water was pumped by small metal-framed windmills and via a network of pipes and water tanks led to San Nicolas, where most of the workers lived. However, the economic development, the expansion of the oil industry and the rapid population growth required even larger amounts of water. Water became once more a scarce and expensive commodity and the production of household water was to be organized more thoroughly. In street-trade, water was sold for up to 5-15 cents for an 18 liter canister; a large amount at that time. Churches and local government became involved and created large public water cisterns, and at some locations even a municipal bath was built to offer sanitary facilities. At one point Lago Oil Company was urged to employ oil tankers for the import of freshwater from abroad. The taste of the water from these oil tankers however was substandard and the claim for freshwater continued. The solution was found in 1933. Instead to continue with the exploitation of ground and rain water, the decision was made to build a freshwater production facility. Based on new discoveries and the process of distillation of sea water, for the first time water was now made available for households as well as for industrial use in essentially unlimited quantities. Step by step, all Aruban households got access to a central water supply system. Problems from the past were soon forgotten and the public became used to the readily available water supply, particularly because of the low oil fuel costs. Only during the years of WW II, water production stayed behind as the troops that resided on the island increased demands and at that time there was a stagnation in fuel oil provision. The government was forced to exploit its natural groundwater resources once more and many of the man-made wells that still exist today are from this period. Finally, in 1964, the production of water became integrated with the production of electricity. Once more, following new discoveries, the process of 'seawater reverse osmosis' in combination with the employment of steam driven turbine generators, enabled the simultaneous production of energy as well as freshwater. For the first time in Aruban history, for the entire Aruban population likewise, a steady supply of drinking tap water as well as electricity was guaranteed.

From the beginning of the twentieth century until today, the Aruba Government, has remained in control of the provision and the pricing regime of utility sources, even after WEB Aruba NV (production facility of water and electricity) and Elmar NV (responsible for the distribution of electricity) were privatized more recently. Today, as both companies are brought under the umbrella of Utilities NV, the Aruban Government still acts as the major stake holder.

The production and distribution of gas, on the other hand, is by a private company, Arugas NV (Aruba Gas Voorzieningsmaatschappij). Propane gas, as a by-product of the oil refinery process, was filled at the local refinery and sold in cylinders. This distribution was temporarily halted after the closure of the Lago refinery. Subsequently, gas was imported from abroad and purchased from a variety of countries, such as the US Gulf Coast, Trinidad and Venezuela. However, as of June 2004, gas is bought once more directly from the Oil Refinery on Aruba (Valero). Gas soon became a welcome alternative to kerosene as the more common fuel source in the first half of last century. Nowadays, most of the gas that is consumed by households is used as fuel to cook and, to a lesser extent, as fuel for the gas burners in some household dryers.

Present challenges

Today, once more the Aruban energy policy is challenged due to the volatility of recent oil prices. On the Caribbean Islands, oil is readily available and can often be bought from nearby refineries. But, this opportunity is at the same time a burden, as it makes for a very high dependency on oil. There is cause for serious concern for the single use of oil for local power generation (Carilec Position Paper on Energy, 2008). From a short-term economic perspective, oil is considered the best option, but disadvantages are linked to oil. First, an oil-based economy is more disposed to the continuous international oil price changes by which many causal factors from abroad find their way to influence local economics. Accordingly, the prices for local utilities are perceived as instable and volatile and may thus prevent further economic development. To safeguard economic growth and to be able to compete with other countries, local utility companies therefore need to provide power (and water) not just to supply local consumption but against internationally competitive prices as well. Utility companies find themselves in a difficult position; in particular, as local utility companies are confronted with a growing international pressure to comply with higher standards of environmental protection. Fortunately, there is a growing understanding of the urgency to explore alternative power generation, but, realization is slowed down by many internal factors. In the worldwide search for new alternative energy sources, it is argued that smaller islands may have less potential to do so, but, then again, some of the Caribbean islands have found the ways to overcome these problems. Islands like Aruba are surrounded by favorable circumstances such as wind, sun, and power by the sea, and because of its stable economy, on Aruba, prospects to make the transition to alternative forms of energy production are favorable.

Methodology

In the present study, we used data from the CBS, gathered during a number of surveys, together with information from WEB Aruba NV[8], ELMAR NV[9], and ARUGAS NV[10].

Analyses of the Aruban household expenditures on gas, water and electricity were based primarily on Information from the Income and Expenditure Survey in 2006[11], which took place between April and May. The results have been depicted against the findings of earlier surveys that were held between October 1998 and December 1999[12] and between October and November in 1993[13]. Thus, given the limited means to conduct a full scale population research, our information was based on household samples, i.e., were based on 519 households in 1993, 498 households in 1998 and 817 households in 2006. Unfortunately, not all households provided the full insight in their income and expenditures. Thus, our findings were based on data from less households then originally planned. With regard to some aspects of our investigation, this may have introduced a bias in our results. We did use however the data from the censuses in 1991[14] and 2000[15] to validate certain aspects of the survey data. For a more specific explanation of the chosen survey methodology and the validation of our data, we refer to appendix 1 and to earlier reports about the mentioned income and expenditure surveys[11,12,13].

Due to the complex tariff structure, it was difficult to discuss utility prices and not refer to the different tariff units and levels of consumption. In order to study changes in the utilities price relative to external factors, we were inclined to use one single price for water, for gas and for electricity. As for gas, we could simply use the monthly unit tariff since the gas price was a fixed price without different tariffs and independent of changes in total household consumption. With regard to water and electricity, however, we had to calculate a standard price in terms of the average monthly household consumption, which we named the Dc price (price of a standard domestic consumption). In some analyses though, when comparisons were made on a monthly scale, it was optional to simply use the tariff of the highly variable monthly 'electricity clause' or 'fuel surcharge price'. This was the case when we compared price changes in electricity with international oil prices. The 'fuel clause' is independent of the quantity of household consumption. Unfortunately, with regard to the price of water, no quantity independent price tariff did exist. Thus, we were forced to calculate the standard Dc price of water for a number of typical consumption levels. An average monthly household consumption of 22.4 m^3 was used primarily, as this volume was described in previous models such as the Consumption Price Index[16]. We refer to the next section for a more elaborate description of the different utility tariffs.

To complete the study on Aruban household utilities, it would have been interesting to add some information about the frequency of occurrence or length of interruptions in the electricity and water distribution on Aruba, but unfortunately, such data was not available.

As some readers will have limited knowledge on statistics, we will elucidate on the type of statistics we have utilized, next.

We have used linear regression analysis[17] on a number of occasions, to explore the relationship between characteristics. In fact, with linear regression analysis, a model is proposed, that describes

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[8] Water- en Energiebedrijf Aruba (WEB) N.V refers to the Aruban electricity and water production facility. www.webaruba.com
[9] Electriciteit Maatschappij Aruba (ELMAR) NV refers to the electricity distributor and service provider. www.elmar.aw
[10] Aruba Gas Supply company Ltd. (ARUGAS NV) refers to the gas distribution company. www.arugas.com
[11] Income and Expenditure Survey 2006 – Selected Tables, CBS Aruba, 2008
[12] Income and Expenditure Survey 1998, CBS Aruba, 1999
[13] Budgetonderzoek 1993 Aruba, CBS Aruba, 1994
[14] Censo 1991, CBS Aruba, 1992.
[15] Population and Housing Census 2000, CBS Aruba, 2001
[16] Aruba Consumer Price Index. CBS Aruba, 2008
[17] SPSS Regression Models™ 16.0. www.spss.com. 2007.

the variation in a number of data points in an optimal manner and by a straight line. I.e., the summed (squared) vertical distances from that line to all the data points is minimized. In our case, the data points concern the values in a scatter gram, where each point is the two-dimensional representation of two different characteristics. The regression line can thus be used as a prediction for the data points (the best fit would be when all data points fall on the line). Data points that do not fall on the line, attribute to an error term. [“Y= a + b*X + error term”, in which ‘a’ is called the intercept and ‘b’ is called the slope or regression coefficient]. The Pearson product-moment correlation coefficient (R) describes ‘the Goodness of fit’ of the regression line by the data points. A value of close to 0.0 means a poor fit, whereas a value closer to +1.0 or -1.0 denotes a mere perfect fit (and the two variables are respectively inversely or positively related). The R squared (R^2) value is also used as a measure of association (it ranges from 0.0 to 1.0) and denotes the proportion of variance of one variable ‘explained’ by the other. In fact, what this all means is, that we have used a method to determine the extent to which variation in one variable is linked to variation in the other, and we used a measure that describes the strength of the relationship.

Also, we have used Multiple Classification Analysis (MCA) statistics[18] to study the effects of some factors on a criterion variable, in our case the effect of a number of household characteristics on the household utility expenditure. These household characteristics are introduced in the analysis as categorical variables. In our analysis, we assumed that the height of utility expenditure is also determined by an interval variable, namely the number of persons in the household. This variable has been incorporated in the analysis as a covariate. Similarly, we assumed that the height of income might influence the expenditures. The MCA analysis is based on the ANOVA technique to study the variance in a dataset, i.e., it calculates the association between variables on the basis of deviations of the (adjusted) means (i.e., by incorporating the influence of other factors or covariates) from the unadjusted means (i.e., the grand mean from all its occurrences). ANOVA analysis is a suitable method because the approach allows variables (factors) to be categorical and cell frequencies to be unequal or even empty (user-defined missing or system-missing). In our example, some household characteristics may have had a direct effect on the expenditure of a utility, such as for instance the usage of air-conditioners, but not all participants may have filled in how many air conditioning systems they possess. Other characteristics are expected to act more as a covariate factor, such as the level of income or the number of persons in the household. We have set up the analysis accordingly, and assumed no interaction between the factors under examination, besides the influence of household income and number of persons in a household. Independent factors that have been investigated are number of air conditioning systems, area of living quarter, presence of a swimming pool, and a number of physical characteristics of the housing unit, demographics of the residents, etc.

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[18] Multiple Classification Analysis, MCA, An unfortunately, nearly forgotten method for doing linear regression with categorical variables, H. Lolle, ECPR Conference Paper, Pisa, September 2007

Utility Prices

Consequences of the tariff structure

On Aruba, households pay a monthly fee for water and electricity. Prices vary on a monthly basis. Table 1 presents the tariff structure of gas, water, and electricity at two distinct moments in time, September 2008 (when due to high oil prices, rates had become very high) and February 2009 (when oil prices had dropped). In the table, we compare the tariff structure of electricity, water and gas on Aruba and Curacao.

The fee for gas is simple and based on one single price, 44.10 Afl per 100 lb cylinder. For water and electricity the monthly fee is not so straightforward and calculated on the basis of a complex tariff structure. For instance, for the private consumer the electricity price is based on a fixed charge and a variable charge, called the ‘fuel clause’ or ‘fuel surcharge’. The name ‘variable’ refers to the fact that the charge may change every month. The ‘fixed’ charge remains constant but differs per volume of consumption. Both parts contribute to the calculation on the basis of units of consumption (in kWh). In contrast, the price for the private customer of water is calculated stepwise on the basis of volume of water consumption (in m^3) and does not include a fixed part. It is noteworthy that since May 1995, the rate for a consumption up to 12 m^3 per month hasn’t changed, and we might call these tariffs fixed.

Table 1 Domestic Utility tariff in Aruba and Curacao as of September 2008

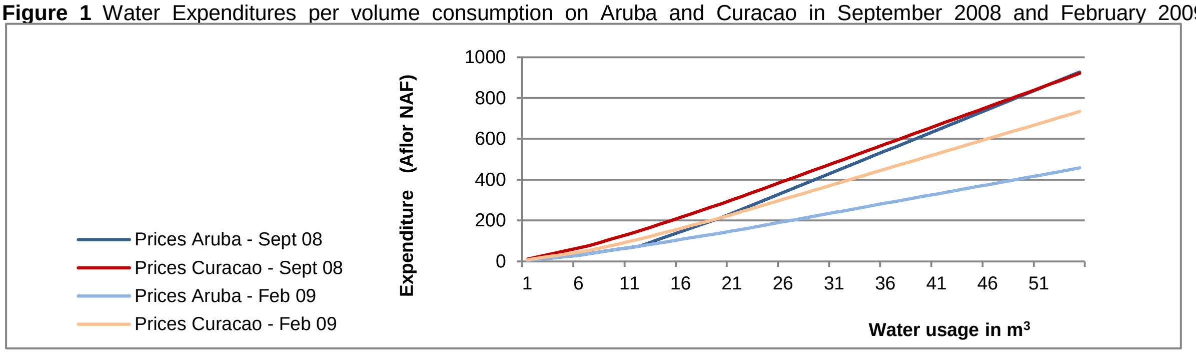
Aruba	Sept. 08	Feb. 09	**Curacao**	Sept. 08	Feb. 09
Electricity	Price / kWh (Afl)		Electricity	Price/ kWh (Naf)	
≤250 kWh	0.1850	0.1850	≤150 kWh	0.5930	0.5357
250 kWh < x ≤ 500 kWh	0.1450	0.1450	150 kWh < x ≤ 350 kWh	0.6700	0.6127
> 500 kWh	0.1400	0.1400	> 350 kWh	0.7106	0.6533
Fuel clause surcharge	0.3652	0.1420	No Fuel clause surcharge	-	-
Water	Price / m^3 (Afl)		Water	Price / m^3 (Naf)	
≤ $3m^3$	4.55	4.55			
$3m^3 < x \le 6m^3$	5.40	5.40	≤ $7m^3$	10.85	7.46
$6m^3 < x \le 12m^3$	7.55	7.55	$7m^3 < x \le 12m^3$	14.80	11.41
$12m^3 < x \le 20m^3$	19.15	7.95	$12m^3 < x \le 20m^3$	16.51	13.12
> $20m^3$	22.15	9.10	> $20m^3$	18.24	14.85
Gas	Price / lbs (Afl)		gas	Price / lbs (Naf)	
> lbs	0.441	0.441		0.643	0.479

Source: Central Bureau of Statistics, Aruba and Web-based information Web Aruba NV and Aqualectra NV, Curacao.

On Aruba, electricity tariffs and prices change on a monthly basis. On Curacao there were only two tariff changes, in 2007 and more recently in 2009. The price for electricity generally is much higher on Curaçao than on Aruba.

If we compare the tariff structure of water on Aruba and Curacao, for instance as in September 2008, we see significant differences in prices per unit of water. Obviously, there exists an overall different price calculation to the private customer (see Table 1 and Figure 1). Based on the prices of September 2008, water consumption up to 52 m^3 per month costs less on Aruba than on Curacao. Above 52 m^3 one pays effectively less on Curacao. At a consumption of 12 m^3 the difference between what is to be paid on Aruba and on Curacao is at its maximum value. This suggests that for small users the purchase of water is more economical on Aruba whereas for large users the price on Curacao is less. As of February 2009, after oil prices have dropped worldwide and Curacao introduced a new price tariff, overall, the customer pays less for water on Aruba than on Curacao.

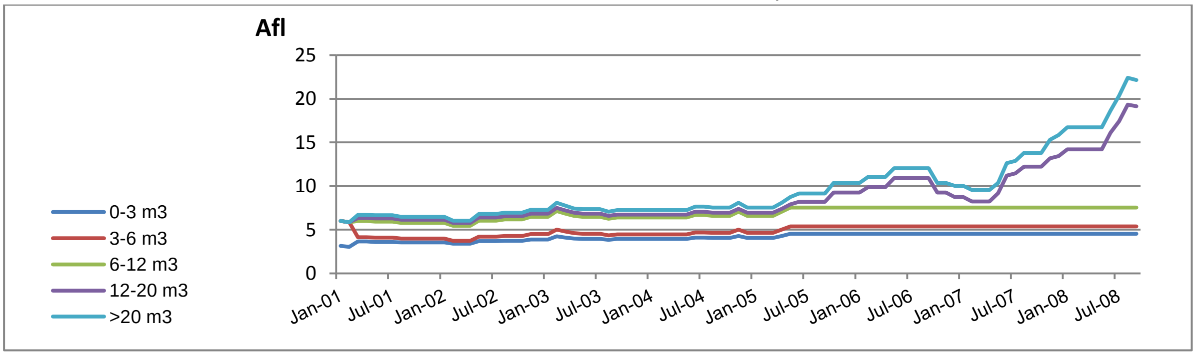
Figure 1 Water Expenditures per volume consumption on Aruba and Curacao in September 2008 and February 2009



Source: WEB Aruba NV (www.webaruba.com) and AQUALECTRA,Curacao; (www.aqualectra.an)

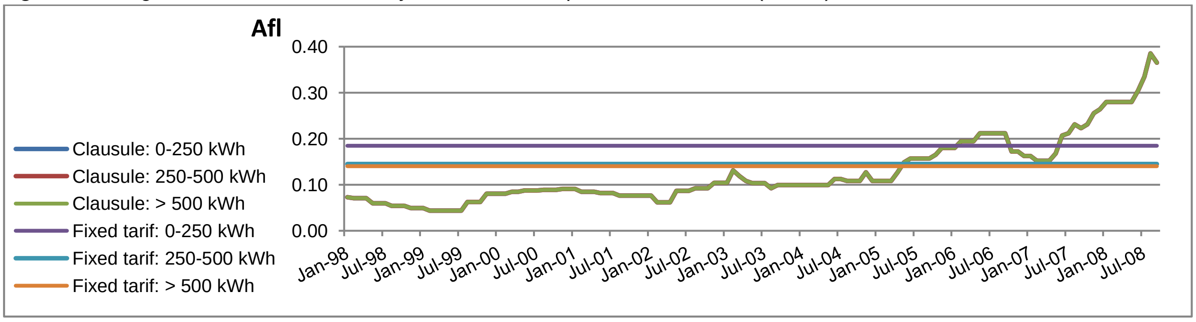
In contrast to the situation in Curacao, water and electricity prices on Aruba are subject to constant change. Figure 2 shows the dimension of changes in water tariffs over the last 8 years on Aruba. The variable tariff rates of electricity are fluctuating likewise (Figure 3). The graphs clearly reveal the strong temporal dynamics of the electricity clause charge (similar to the water charges), particularly during recent years. Remarkably, in comparison to water and electricity, the gas price was influenced only little by changing oil prices and was adapted only three times during the last decade (figure 4).

Figure 2 Changes in the tariffs of water on Aruba in the period 2001 – 2008 (Afl/ m³)



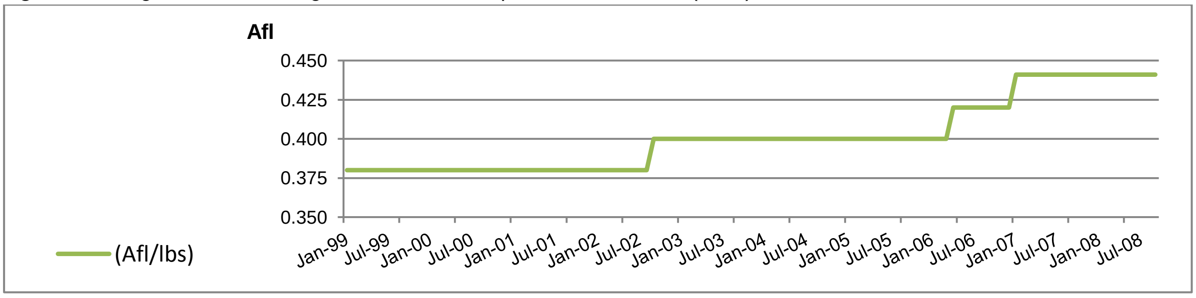
Source: WEB Aruba NV

Figure 3 Changes in the tariffs of electricity on Aruba in the period 1998 – 2008 (Afl/kWh)



Source: ELMAR NV

Figure 4 Changes in the tariff of gas on Aruba in the period 1999 – 2008 (Afl/lbs)



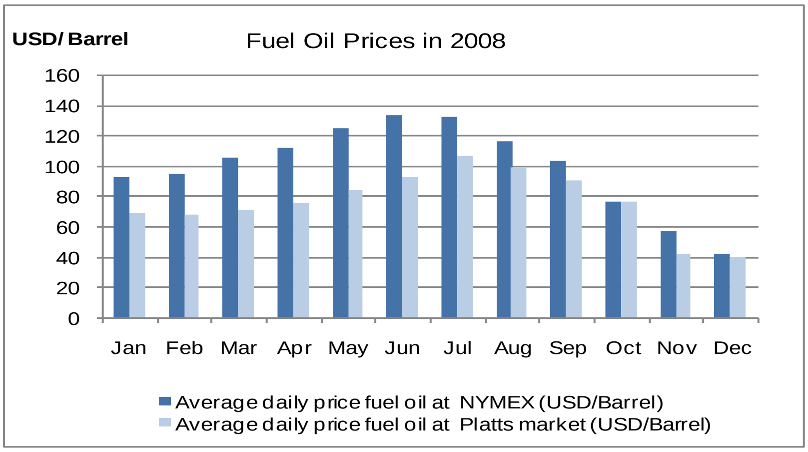
Source: Arugas NV

The influence of international oil prices on the price of water and electricity on Aruba

The influence of changing oil prices on the dynamics of Aruban utility prices is well-known, but there has never been clear insight in the exact formula or the level of the relationship. As depicted earlier, the continuous price changes cause much debate about the pricing of water and electricity on Aruba. Although it might be interesting to know how WEB NV and ELMAR NV attribute their benefits and costs to the final price calculation, their company policy and financial calculations lie far beyond the scope of this study. Anyway, it would also be unfeasible to determine and include the exact cost calculation of the production process, such as the contribution of the heating of boilers, power to turbines, pumps, etc.., and, next to the burning of crude oil, additional fuel sources like diesel are required in the production process. On some occasions, even electric power is to be bought back from customers. So, the simple price of crude oil alone, we thought, would probably be a very unreliable determinant for the price of water and electricity anyway. Yet, nothing seemed more untrue. Our analysis revealed that electricity and water prices were highly and directly dependent on the price of oil.

Worldwide, oil prices followed a similar pattern of ups and downs, but there was still some difference between different areas. As reference for the oil price we used the price of crude oil on the nearest stock exchange market, i.e. the New York Stock Exchange. More specifically, we chose for the NYMEX Light Sweet Crude, Future Contract 1 [19]. The reason for doing so, was because this type of crude oil was used in a previous study[20] already, and also, because the price information from NYMEX Light Sweet Crude was on a monthly basis readily available on the Internet. We were informed that WEB NV paid a price based on Platt's Oilgram price Report quotation[21]. To be sure that the fluctuations in barrel oil price on both Oil Markets were comparable, we included a comparison of the prices of Platt's oil, as accounted by WEB Aruba NV[22], and the NYMEX crude oil prices, as used in this study (Figure 5). The results show that the fluctuation in oil price for the crude oil that WEB Aruba NV purchased, though in height consistently less than the price that we used for our analysis, overall is the same.

Figure 5 Oil price from the NYMEX stock Exchange[19], and price paid by WEB NV, based on Platt's Oil Market[22].



Source: NYMEX and WEB NV

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19 www.nymex.com and www.eia.doe.gov/emeu/international/crude2.html

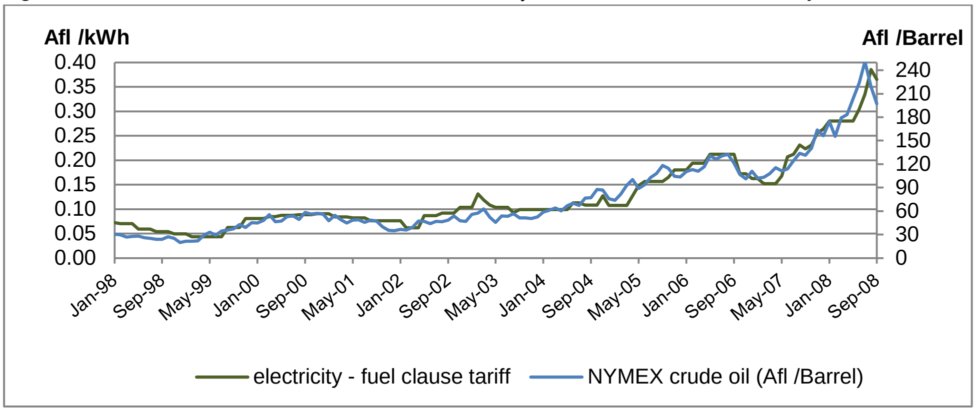
20 Use of NYMEX Crude Oil Contract Prices as an indicator of Market Pricing Changes. Michael M, Ye et al. Q21-1 (2203). Economics of Natural Resources. Rome, March 2009.

21 WEB Aruba NV, Clarification Publication Valero, 2 Feb 2009

22 WEB Aruba NV, Press Release, April 2009. www.webaruba.com

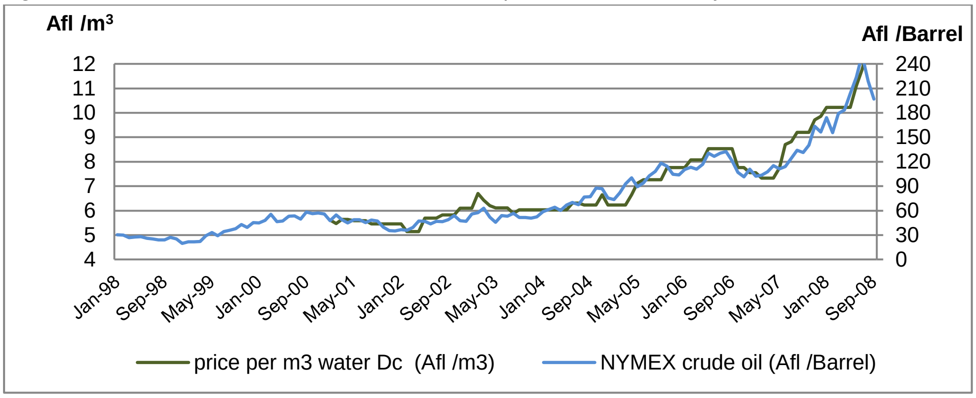
Figure 6 and 7 present the monthly NYMEX oil prices versus respectively the monthly kWh electricity fuel clause and the m³ water Dc price (i.e. for standard domestic consumption of 22.4 m³). Oil prices have been listed in local currency against a USD exchange rate of 1.75 Afl.

Figure 6 Price of NYMEX crude oil and of the 'electricity fuel clause' over the last ten years on Aruba.



Source: NYMEX (see foot note 19) and ELMAR NV (via Web Aruba NV)

Figure 7 Price of NYMEX crude oil and the water Dc price over the last ten years on Aruba.

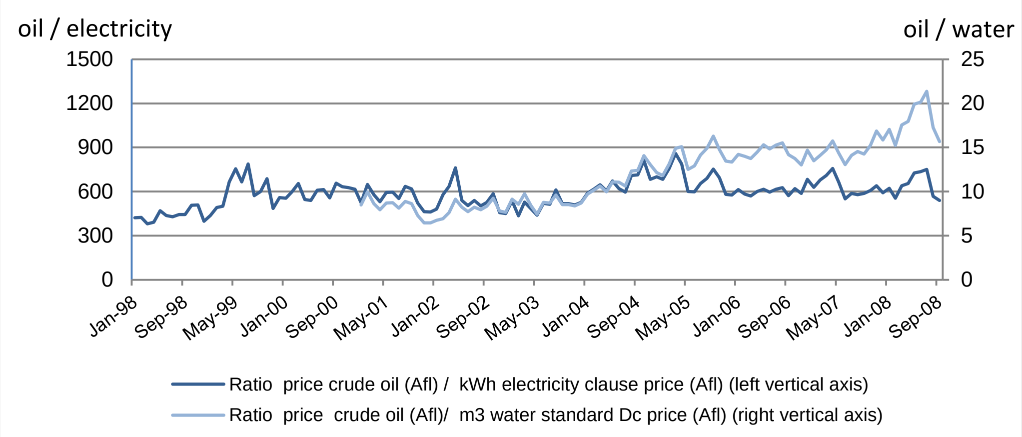


Source: NYMEX (see foot note 19) and WEB Aruba NV
Note: Monthly water consumption was available only from 2001 onwards. The water Dc price is calculated on the basis of a standard household consumption of 22.4 m^3.

We like to note that in the figurers above, the oil price is presented by the right vertical axis whereas the water and respectively electricity prices by the left vertical axis. Thus, the magnitudes of the left and right axis are totally different. However, on a monthly basis, prices seem to follow each other with the same irregular pattern of ups and downs quite well. The relationship between the crude oil price and the price for electricity and water was investigated in more detail, next.

First, the relationship was expressed as a ratio of crude oil price and electricity or respectively water price (see figure 8). The ratio crude oil by 'fuel clause' price remains fairly constant over the years (608 on average, left axis), despite minor fluctuations. Only, during the period up to April 1999 the ratio was clearly less (446 on average). Seemingly, changes in the crude oil price, even after many years, remained fairly well in equal balance with changes in the price of electricity. A similar pattern revealed for the price ratio between crude oil and water Dc (9.4 on average, right axis) up to the first half of 2005. Around May 2005, after a year of increasing prices, the ratio for water in contrast to electricity seemed to have re-established at the higher level (15.2 on average). At the same time the water tariff became fixed for consumption below 12 m³. In 2008, the high peak for the oil/water ratio was remarkable; the mere the peak for oil/electricity did not fall beyond the normal range. These data suggest that there was a change in the price policy and/or conditions for water. We lack, the information to investigate this phenomenon in more detail. The relative constant ratio over the years indicates the strong dependency on oil. More than electricity, water is the end result of an industrial process that requires more than one energy resource. Whether this was the reason for the different pricing policy is unknown, and many other factors may have played a role.

Figure 8 Ratio between crude oil price and respectively the standard Dc water price and the 'fuel clause' electricity price.



Source: NYMEX and WEB ARUBA NV and ELMAR NV
Note: Monthly water consumption was available only from 2001 onwards.

We performed a linear regression analysis to investigate the relationships in further detail. The results are shown in Table 2. The model describes the water price per m³ and the electricity price per kWh as a function of the price of a barrel of crude oil[19]. The table lists the linear regression model equations for the electricity fuel clause, as well as for a number of different household situations, i.e., with a standard electricity Dc of 700 kWh as well as a standard water Dc of respectively 22.4 m³, 19.1 m³, and, 16.2 m³. N represents the number of data points (monthly averages) on which the regression equation is based.

Table 2 Linear regression model equations for a number of different electricity and water prices.

Standard Dc	Model	Regression Coefficients		N	R square
all	electricity clause price/ kWh (AFL) = a + b* price/ barrel Nymex Crude Oil (AFL)	a=0.0146	b=0.0015	129	0.9483
700 kWh	electricity price/ kWh (AFL) = a + b* price/ barrel Nymex Crude Oil (AFL)	a=0.1725	b=0.0015	129	0.9483
22.4 m³	water price/ m³ (AFL) = a + b* price/ barrel Nymex Crude Oil (AFL)	a=3.9963	b=0.0348	93	0.9376
19.1 m³	water price/ m³ (AFL) = a + b* price/ barrel Nymex Crude Oil (AFL)	a=4.1796	b=0.0287	93	0.9387
16.2 m³	water price/ m³ (AFL) = a + b* price/ barrel Nymex Crude Oil (AFL)	a=4.3674	b=0.0228	93	0.9328

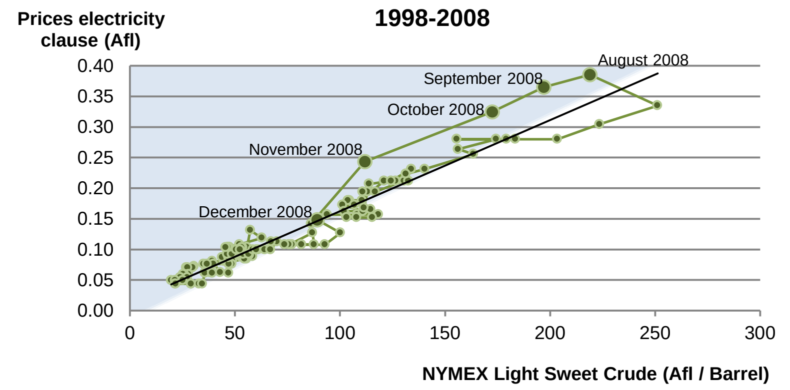
Source: Central Bureau of Statistics, Aruba.
Note: the price of NYMEX sweet crude oil, future contract 1, is expressed in local currency

The results in Table 2 clearly show that over the last ten years, the monthly price of electricity did indeed correlate strongly to the price of crude oil [19]. (high R^2 values). The variation in observed prices was explained quite well by a linear regression model. For instance, with a given price of crude oil it was easy to determine a price of the 'fuel clause' that, following the equation [*'fuel clause' price in* AFL = 0.*0146 + 0.0015 * crude oil price*[19] *in* Afl], came very close to the real price. In other words, the model also had strong predictive power. According to the model, a change in the price of crude oil per barrel by 1 Afl corresponded to a change in the fuel clause price of 0.0015 Afl.

Likewise, water prices were equally well explained by a linear regression model. For instance, for an average household consumption with a standard Dc of 22.4 m^3, the values for respectively the intercept were 3.996 and for the regression coefficient were 0.0348. In other words, a change in the price of oil per barrel by 1 Afl corresponded with a change in m^3 water price of 0.0348 Afl.

The relationship between oil price and respectively water and electricity prices were presented in Figure 9 and 10. When the ‘electricity’ price or the standard Dc water price fell in the blue area (above the regression line) a relative disadvantage existed for the customer, as he had to pay a higher price as one might expect on the basis of the modeled relationship with crude oil prices. In contrast, electricity prices or water prices in the white area indicated a corresponding advantage to the customer. The figures show a continuous adjustment over time in order to balance the wins and losses of previous month. More recently, in late 2008, the electricity price became highly volatile as crude oil prices increased unpredictably. As figure 9 shows, large changes in the oil price were followed by large adjustments in the price of the electricity fuel clause. Remarkably, when the oil prices dropped (after August 2008; see figure 9), the drop in fuel clause prices followed along the line of expectations (i.e. the regression equation), but remained for several months in a row higher (blue area) than we might expect (straight line).

Figure 9 Average electricity clause prices versus oil prices (in Afl), from 1998 to 2008.

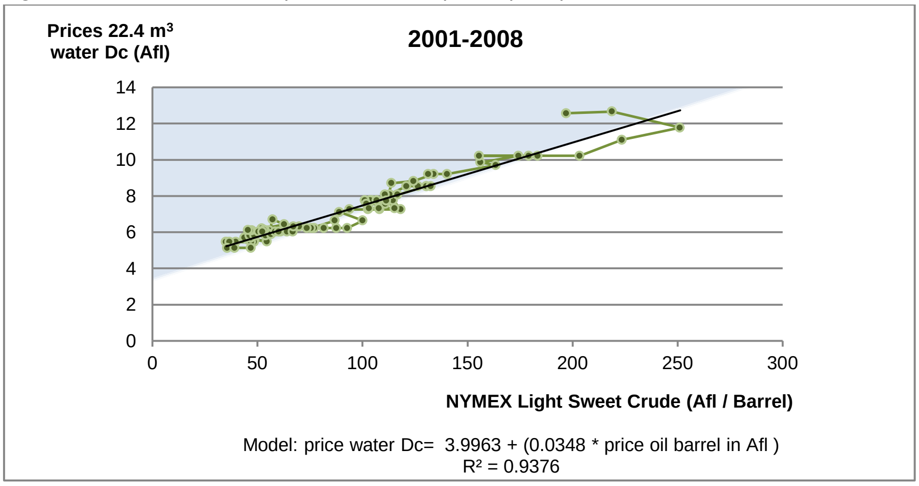


Model: price electricity clause = 0.0146 + (0.0015 * price oil barrel in Afl)
$R^2 = 0.9483$

Source: NYMEX and ELMAR NV

Note: The regression model equation is represented by the straight line. Monthly values of the electricity fuel clause are represented by dots which are interconnected by a thin line to link the monthly values that follow each other. To stress the monthly fuel clause prices of August 2008 up to including December 2008, their values were represented by somewhat bigger dots and accompanied by their month label.

Figure 10 Standard water Dc prices versus oil prices (in Afl), from 2001 to 2008.



Source: NYMEX and WEB ARUBA NV

Note: The regression model equation is represented by the straight line. Monthly values of the water Dc price are represented by dots and these are interconnected by a thin line to link the monthly values that follow each other. Prices refer to an Aruban household with a Dc of 22.4 m^3

It was noted earlier in this report, that the continuous adjustments in price of utilities and the subsequent delays until new prices were announced to the public, had a negative impact on the image of the electricity facility. Public debates took place about the correctness of price calculations[23]. Conflicts like these may be the direct consequence of the high oil dependency and as explained in the introduction still is a matter of general concern (Carilec report, 2008). The phenomenon has been described on other Caribbean islands as well.

In summary, our data revealed a strong linear relationship between oil price and utility price. Once the new crude oil price is known, in fact, we may estimate fairly well the new price for utilities of next month. But such an approach is only realistic as long as the model provides explanatory power and as long as we have no concern with the wins and losses of the production facility. In other words, we have no insight in the actual benefit and cost calculations of the utility facilities and we do not know the degree to which costs have to be covered by managing water or electricity prices in relation to expected sale volumes.

[23] WEB Aruba NV press releases and corresponding discussions in relation to international oil prices. October 2008 and February 2009

Aruban electricity and water prices compared to prices elsewhere.

As the price of electricity and water is based on oil prices, it is interesting to compare Aruban utility prices with surrounding countries and also with prices in Europe and the US (Table 3). The main question is of course to know, whether prices in Aruba are high, compared to other countries. Some considerations are however to be noticed, first.

First, larger countries are less prone to oil price changes. They are able to purchase larger bulks of oil and gain better prices, and besides, they may switch more easily to alternative power resources (natural gas, coal, biomass, wind, nuclear power, etc.), or they may interconnect their power grid with grids in neighboring countries in order to comply with sudden need changes.

Other factors have an effect on prices. Worth noticing is the way in which water and electricity are produced on Aruba and Curacao. The process of reverse osmosis of sea water[24] is uncommon in countries in Europe and the US and is quite expensive. Also, on Aruba, instead of posing an energy tax or VAT on utility prices such as in the Netherlands (CBS NL, 2006), the government receives dividends from profits by the production and distribution companies. Thirdly, economic well-being and purchasing power may differ substantially between countries. To correct for those factors, one should compare prices on the basis of a common reference or standardization. The use of a so-called Purchasing Power Parity Standard (PPS)[25] is a suggested approach in these cases. The complex process of translation of prices into PPS, however, not only lies beyond the scope of this research, but this translation has also come into discussion and was described as a quite tricky conversion as well[26]. Given these considerations, we decided to present the prices simply in their local currency. With respect to a standardization of units of consumption, however, we found it meaningful to convert these units into one common unit (for instance lb., BTU, GJ or ft^3 of gas was converted into m^3 of gas). But by doing so, we may have introduced a small error term as these conversion factors are temperature and pressure dependent, and this respective information is generally not listed in reports. Also the gas composition itself may differ in different areas (Propane, Butane, etc.). Finally, as country specific information about household energy consumption and pricing was lacking, we were forced to use data on whatever was available in literature and compare the data from different years.

Consequently, although the information in Table 3 may not be rock-solid, we thought that the comparison of Aruban consumption levels and prices in an international perspective, would still be valuable to present.

Compared to the Netherlands, electricity prices on Aruba were less high. The costs of household electricity in 1998 was a comparable 0.11 €/kWh[27] (0.22 Afl/kWh) on Aruba and 0.10 €/kWh in the Netherlands. However, in 2006, electricity prices in the Netherlands had mounted to an estimated 0.21 €/kWh[28] against 0.16 €/kWh[27] on Aruba. The Netherlands is recognized as one of more expensive countries in Europe with regard to energy prices[28,29,30]. Aruban electricity prices in 2006 are somewhat higher than the average price of the EU 15 countries. Also, in comparison to the US, Aruban electricity prices were quite high, but in regard to energy prices, the US may be more an exception.

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24 Energy Recovery in Caribbean Seawater Reverse osmosis, R.Stover and I.Cameron, International Desalination Conference 2007, WEB Aruba NV

25 Note: The PPS value is a calculated artificial value that corrects for price level differences between countries, and is commonly used as a reference currency.

26 The measure of GDP per Capita in purchasing Power Standards (PPS): A statistical indicator tricky to interpret, F. Magnien, INSEE. 2002.

27 Note: Currency rates in 1998 were 1€ = 2.20 NLG, and, 1 NLG=0.88 Afl. Central Bank Aruba, Year Report 1998.

28 Dutch gas and electricity prices among the highest in Europe, May 2007, CBS the Netherlands. www.cbs.nl

29 Household Electricity prices rose by 5% in 2005. Eurostat News. 2006

30 Households spending more on energy, CBS the Netherlands, 2002

Table 3 Average monthly household consumption and price of gas, water and electricity in different countries.

		electricity		water		gas	
		Consumption	Price/ kWh	Consumption	Price / m^3	Consumption	Price / GJ
Aruba	2006	747 kWh [31]	0.35 Afl [31]	18.80 m^3 [31]	7.64 Afl [31]	14 m^3 [32]	18.52 Afl [31]
Curacao	2007	400 kWh [33]	-	8.5 -10.9 m^3 [34]	11.54 -12.25 Naf [35]	-	28.35 Naf [35]
US	2001	888 kWh [36]	0.09 us$ [38]	40.00 m^3 [37]	0.66 us$ [39]	196 m^3	9.98 us$ [38]
EU15	2005	292 kWh [38]	0.14 € [40]	-	-	188 m^3 [40]	11.90 € [40]
NL	2006	284 kWh [39]	0.21 € [29]	8.42 m^3 [40]	1.36 € [41]	123 m^3 [42]	16.25 € [29]

Source: see footnotes
Note: The unit of volume was not always similar between countries. We converted the figures by the following conversion measures: 1 lb liquid propane gas = approx 21.500 BTU = approx 0.0227 GJ = approx 0.88 dm^3. 1000 cubic feet natural gas =1,000,000 BTU = 1.05 GJ = 28.3 m^3. EU15 refers to the average of the 15 original countries within the European Union.

The average household electricity consumption in Aruba is nearly as much as in the US, (please note that in Aruba the average consumption in 2006 was similar to 2001; see also Figure 11), and clearly much higher than in Europe (2005). Also, in comparison to Curacao (2007), Aruban households consume clearly more electricity. This suggests that electricity consumption due to for instance air conditioning is not the only explanatory factor for the high consumption rate on Aruba.

With regard to water, the consumption on Aruba is high in contrast to the Netherlands. There may be a direct effect of the higher ambient temperatures and the consequential higher water requirements on Aruba, but again, the consumption on Aruba is also higher than the consumption on Curacao whilst the circumstances are the same. Consumption in the US is extremely high.

As might be expected, gas consumption on Aruba is low in comparison to the more Northern countries. In Europe and the US there is an obvious need of gas for water and room heating. Unfortunately, we had no figures from Curacao. Compared to Curacao, gas prices on Aruba are fairly low.

31 CBS, Aruba. 2006. This report. Original data by WEB Aruba NV and AruGas NV.
32 Note: Gas volume refers to natural gas volume (i.e. recalculated volume of liquid gas in cylinders into gaseous volume).
33 WEB Aruba NV, Press Release, 2006
34 Armoede; Water_en_elektriciteitsverbruik. Ned. Antillen. 1999. www.central-bureau-of-statistics.an
35 Note: Verbal information provided by Aqualectra NV, Curacao. 2008
36 Energy Information Administration (EIA); Residential Energy Consumption Survey, 2001
37 Earth Policy Institute. Water prices rising worldwide. 2007. www.earth-policy.org
38 Gas and Electricity Market Statistics. EuroStat report. 2005
39 Gemiddeld energiegebruik per huishouden. Energie in Nederland. 2007. www.energie.nl
40 Dutch use less water. CBS, The Netherlands. Sept 2008, www.cbs.nl
41 Drinkwater Huishoudelijk verbruik; tarieven. CBS-StatLine, NL. www.cbs.nl.
42 Natural gas Consumption nearly reduced by half over the past three decades. CBS, The Netherlands. 2008. www.cbs.nl.

Consumption of gas, water and electricity.

Based on information from WEB Aruba NV and ARUGAS NV on the sales to households, we calculated the average monthly household consumption. Table 4 summarizes all information about the utility price, the monthly consumption, and, the monthly expenditures during the years 2003 – 2008 for Aruban households.

Table 4 Monthly averages of Gas, Water and Electricity on Aruba

	Water				Electricity				Gas			
	Premises (N)	price (/m^3)	usage (m^3)	expense (AFL)	Premises (N)	price (/kWh)	usage (kWh)	expense (AFL)	Premises (N)	price[43] (/lbs)	usage (lbs)	expense (AFL)
2003	28,786	6.08	21.2	**129**	30,139	0.26	747	**196**	28,786	0.40	21.2	**8.50**
2004	29,595	6.05	20.2	**122**	30,996	0.26	759	**200**	29,595	0.40	20.8	**8.33**
2005	30,521	6.82	19.6	**134**	31,770	0.30	783	**236**	30,521	0.40	20.2	**8.08**
2006	31,553	7.64	18.8	**143**	32,631	0.35	747	**262**	31,553	0.42	19.5	**8.09**
2007	32,539	7.77	18.1	**140**	33,369	0.36	730	**261**	32,539	0.44	18.8	**8.30**
2008	33,521	8.77	16.8	**148**	34,096	0.45	680	**306**	33,521	0.44	18.5	**8.15**
5 years change	*16%*	*44%*	*-21%*	*15%*	*13%*	*72%*	*-9%*	*56%*	*16%*	*10%*	*-13%*	*-4%*

Source: WEB NV and ARUGAS NV
Note 1: Since we had no prior information about the number of households that used gas, we assumed these to be equal to the number of premises that were connected to the water grid. There was no underlying reason for this, except that we assumed that households were equally inclined to use gas as they were to use water, which we assumed would not necessarily be true between gas and electricity users.
Note 2: WE were unable to retrieve figures about the number of premises connected to the water grid for the last quarter of 2008. In order to be able to complete our analyses we have made an extrapolation based on previous month.

Over a period from 2003 to 2008, the average water, electricity and gas consumption was respectively 19.1 m³, 741 kWh and 19.8 lbs.

The number of *premises* that were connected to water and electricity increased by respectively 16% and 13% over the years 2003 - 2008. However, the difference in the number of connections is not well understood (see also figure 12). From the population census in 2000, it follows that 26.807 *housing units* were connected to electricity and 26.458 housing units to water. These figures are close to the data provided by ELMAR NV (27.799 connections) and WEB NV (26.040 households) at the time of the census in October 2000. But clearly, there was a distinction between definitions used (housing units, premises or connections). As the differences are small and we have no decisive information about how to correct for these differences, we have used the figures as such and without correction.

The findings revealed that gas consumption decreased steadily by 13% during the last five years, from a monthly average household consumption of 21.2 lbs. to 18.5 lbs. gas. One standard household gas cylinder contains 100 lbs. As such, on average, about 1/5 of a cylinder is used per month per household. The household costs of an average gas consumption in 2008 were about 8.15 Afl/month. This is a decrease of 4% with respect to 2003. However, as we choose the number of premises connected to the water grid as a good guess to the number of gas users, we may have introduced a small bias in our results. The price of gas increased by 10% in the same period (0.40 to 0.44 Afl /lbs.).

The average price of water and electricity over the last five years increased with respectively 44% and 72% (respectively from 6.08 to 8.77 Afl/m^3 for water and 0.26 to 0.45 Afl/kWh for electricity).

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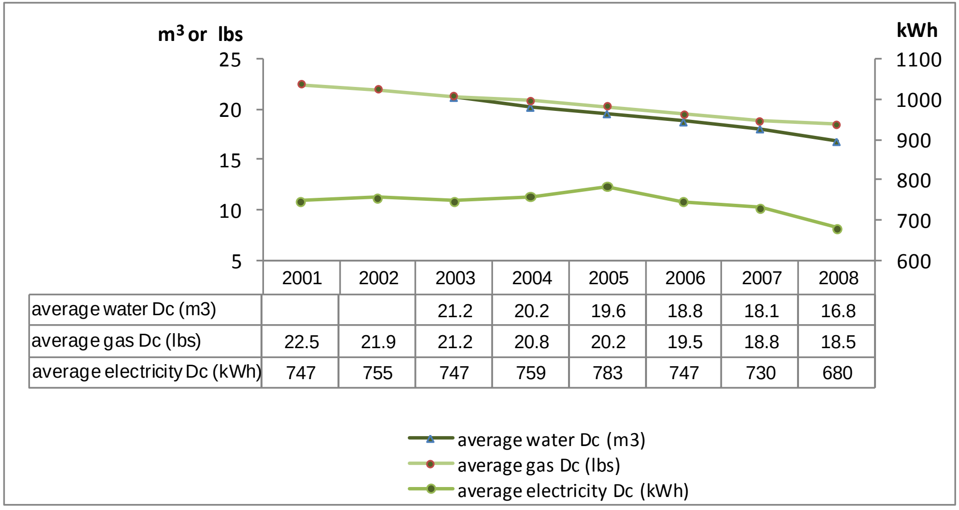
[43] The Household tariff (in contrast to the commercial tariff) is maintained artificially low. Communication with Arugas Supply company, Ltd. 2009.

Interestingly, at the same time, the average consumption of water decreased steadily by 21% (from 21.2 to 16.8 m^3/month) whilst the average consumption of electricity changed by a mere -9% (747 to 680 kWh/month) of which the majority can be explained by a decrease during the year 2008. When left 2008 outside the analysis, no change in average consumption of electricity was noticeable (see also Figure 11).

The household costs of an average water consumption in 2008 were about 148 Afl/month. This is an increase of 15% with respect to 2003 (from a 129 to 148 Afl/month). Even more strong (56%) was the change in costs of an average household electricity consumption (an increase from 196 to 306 Afl/month) during these years.

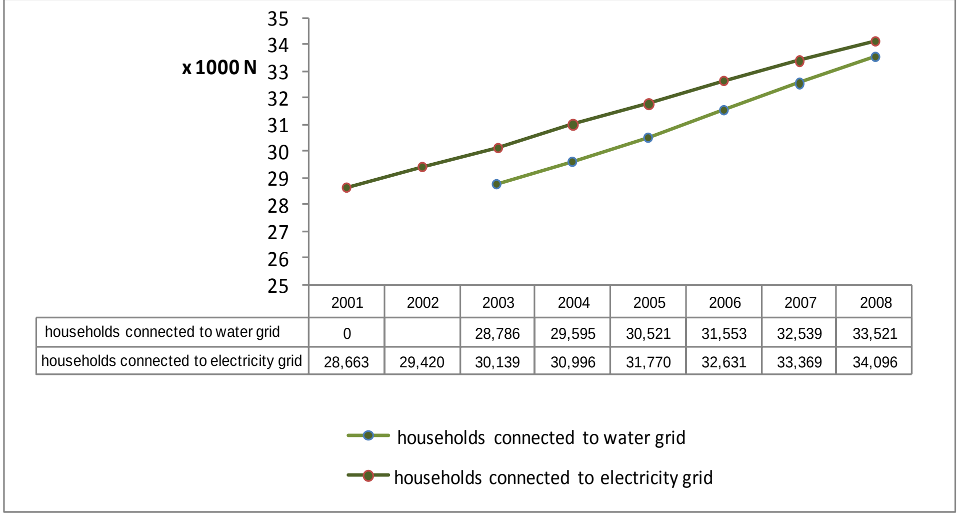
Figure 11 The average monthly domestic consumption (Dc) of water, electricity and gas on Aruba for 2001 until 2008.



	2001	2002	2003	2004	2005	2006	2007	2008
average water Dc (m3)			21.2	20.2	19.6	18.8	18.1	16.8
average gas Dc (lbs)	22.5	21.9	21.2	20.8	20.2	19.5	18.8	18.5
average electricity Dc (kWh)	747	755	747	759	783	747	730	680

Source: WEB Aruba NV, ARUGAS NV and ELMAR NV.

Figure 12 The number of households connected to the water and electricity grid on Aruba from 2001 to 2008.



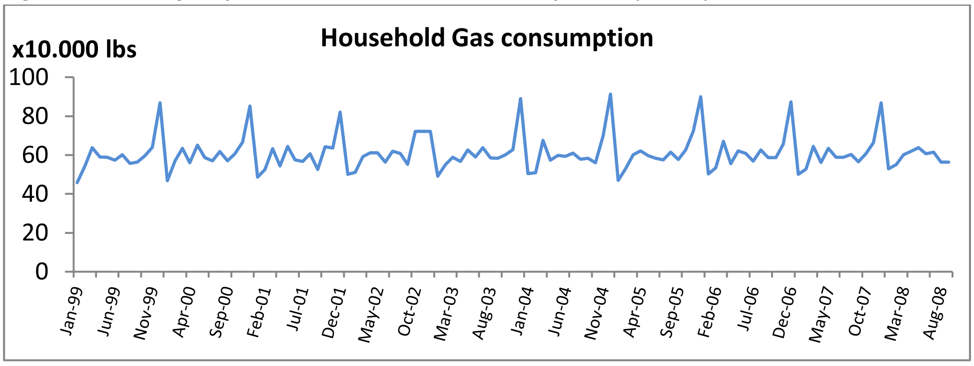
	2001	2002	2003	2004	2005	2006	2007	2008
households connected to water grid	0		28,786	29,595	30,521	31,553	32,539	33,521
households connected to electricity grid	28,663	29,420	30,139	30,996	31,770	32,631	33,369	34,096

Source: WEB Aruba NV and ELMAR NV.

The influence of Christmas

On Aruba, an interesting phenomena takes place around Christmas as there is an increased purchase of gas during the month of December. We have no certainty but assume that the high figures presented by Arugas NV are not the result of some accountancy action during year's end. Otherwise, a likely reason might be that the gas expenditures are due to the Christmas Season food preparations. As people prepare for Christmas, they probably take care that the gas cylinders are well-filled at years' end (see Figure 13). Following the holidays, during the month of January, we observe a drop of gas purchases. Probably, there was sufficient gas left from previous month. The yearly reoccurring pattern, which we like to call the '*Christmas gas bell'* has remained fairly constant, whereas over the years the average monthly volumes decreased consistently. In October up to December 2002, one may observe a cut-off peak, but this was a direct consequence of our imputation procedure during these months (because only the quarterly value had been available for the period October).

Figure 13 Sale of gas by ARUGAS NV on Aruba in January 2000 up to September 2008.



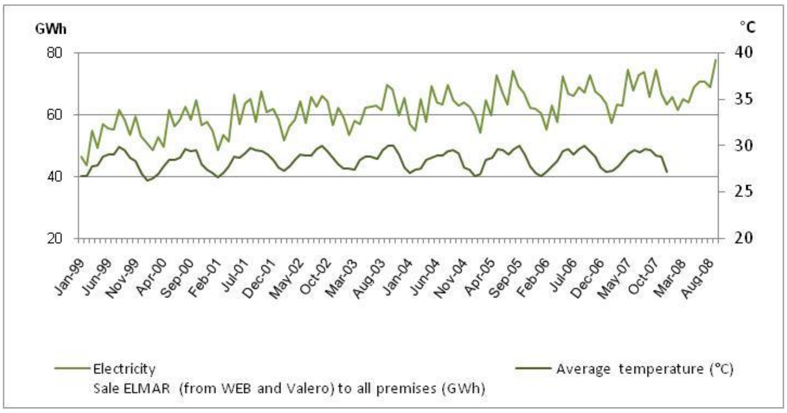
Source: ARUGAS NV and WEB NV and www.meteo.an. Gas quantity sold is indicated at the left vertical axis and calculated domestic consumption on the right vertical axis.

The influence of climate

One would expect climate factors, such as high air temperatures and precipitation, to have a strong influence on water and electricity consumption. For instance, one would expect that air conditioning, watering the garden plants, or the swimming pool, and maybe also the inclination during the warmer month to shower more often, will increase water and electricity consumption during the 'hot' season. As most households have no running hot water the opposite could be true during the rainy season, when water is a few degrees colder.

A. *Temperature and consumption of water and electricity*: The total sales of electricity (in GWh) by ELMAR NV, i.e., including sales to households, hotels, government, industry and trade, etc., indeed clearly reveals a seasonal pattern of ups and downs in concordance with the monthly average air temperatures (Figure 14).

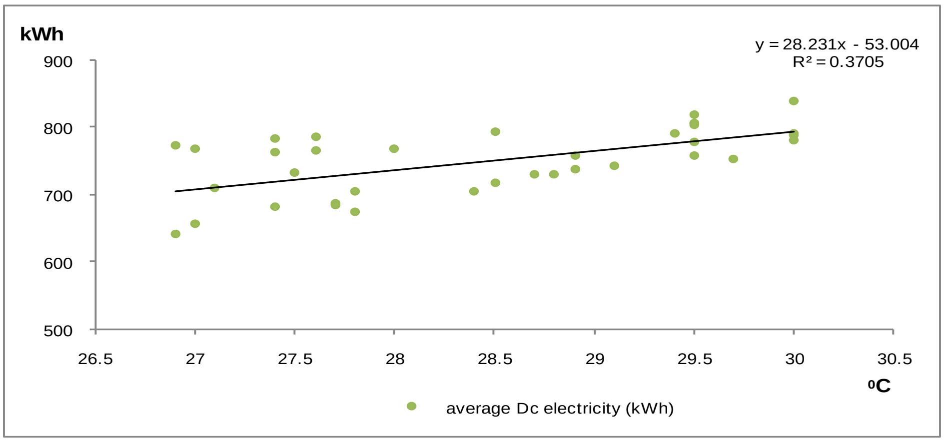
Figure 14 Monthly average air temperatures and total monthly sale of electricity by ELMAR



Source: WEB Aruba NV and ELMAR NV and www.meteo.an.

The relationship between electricity consumption and temperature was analyzed through a linear regression analysis. The dependent variable in the equation was kWh of average household electricity consumption per month. The explanatory variable was the average air temperature per month. Given the many factors that influence the consumption of electricity, an R^2 of 0.3705 can be considered quite high (N=36 quarterly values). This means that about 37% of the variation in consumption of electricity, can be explained by the variation in air temperature. The results of the linear regression are presented in Figure 15. The figure represents the relationship between average monthly temperature and monthly electricity sale volumes to the average household by WEB NV via ELMAR NV (1999 –2008). The linear regression model of best fit is represented by the straight line. Our analysis showed that an increase of 1 degree Celsius in a given month leads to an increase of monthly household electricity consumption by 28 kWh,

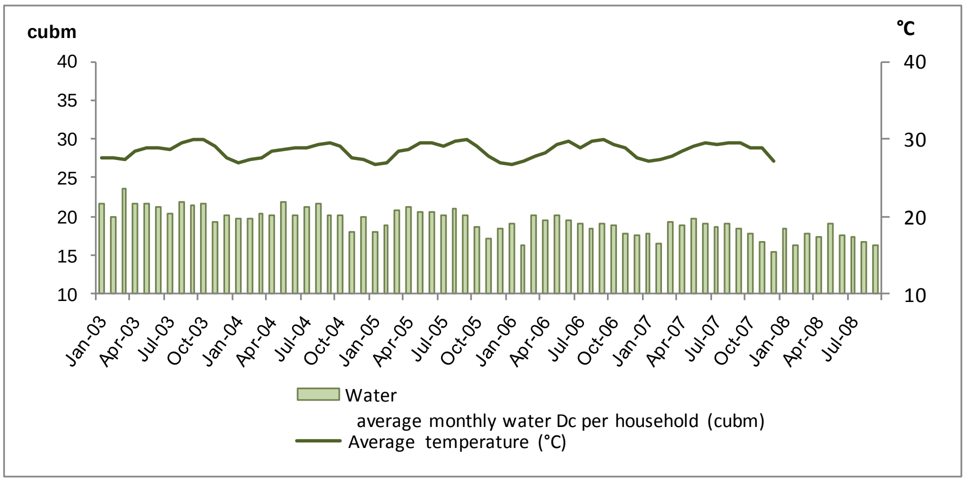
Figure 15 Average monthly household electricity consumption (kWh) by average air temperature.



Source: WEB Aruba NV and ELMAR NV and www.meteo.an.

The average monthly sales of water by WEB NV to Aruban households (in m³), also shows some seasonal pattern. (see Figure 16).

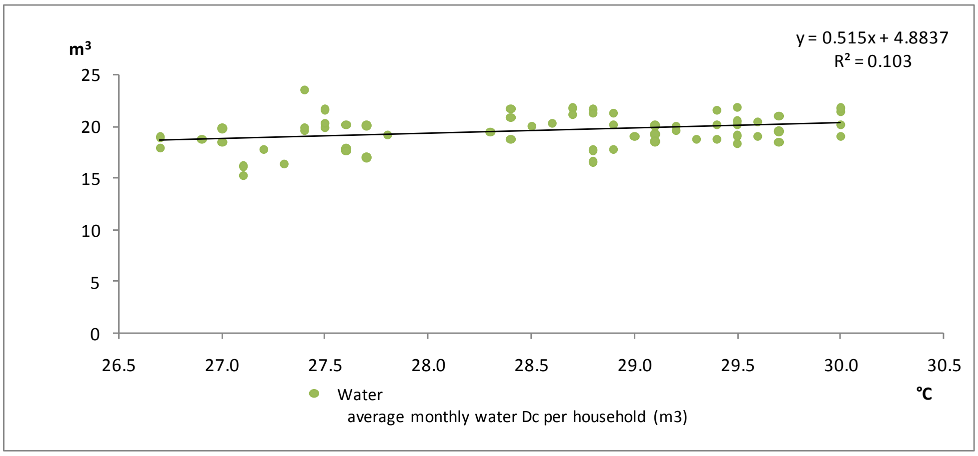
Figure 16 Monthly average air temperatures and monthly sale of water by WEB NV to the average household.



Source: WEB Aruba NV and www.meteo.an.

Similar to the above, we present a regression model to examine the relationship between air temperature and the quantity of water sold by WEB NV to the average household. These data based on sales to the average household, first have been recalculated to fit calendar dates (the original sales period did not correspond to the exact calender month). An R^2 of 0.103 suggested, that air temperature did have some influence on water consumption but not as strongly as in relation to electricity (Figure 17 shows the relationship between average monthly temperature and monthly water sale volumes by WEB NV to the average households during January 2003 – September 2008). Thus, about 10% of the variation in water consumption can be explained by changes in air temprature. The linear regression model of best fit, is given by the straight line. Our analysis showed that on average an increase of 1 degree Celsius in a given month leads to an increase of household water consumption by 0.5 m^3.

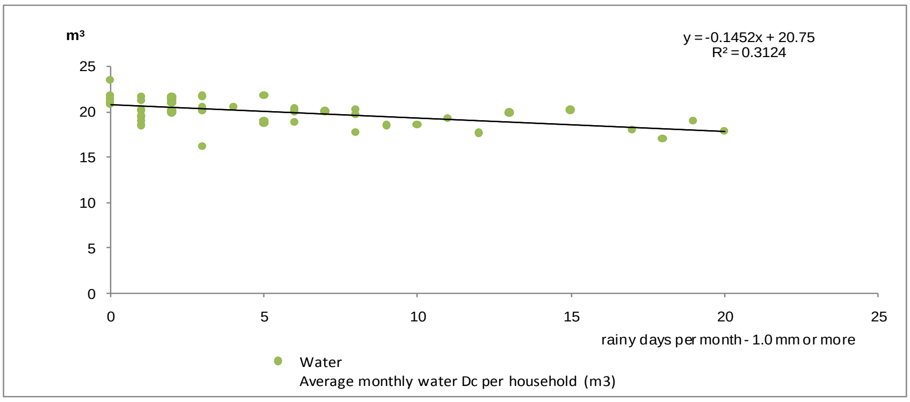
Figure 17 Average household water consumption (m^3) per month by average air temperature.



Source: WEB Aruba NV and www.meteo.an.

B. Rainy days and consumption of water and electricity: A similar comparison between the 'number of rainy days' per month and the consumption of water by Aruban households revealed quite a strong inverse relationship (R^2 of 0.3124). The results are shown in figure 18 and were based too on the data from January 2003 – September 2008. The more rainy days in a given month, the less water was consumed. Our analysis showed that on average an increase of one rainy day (defined as 1 mm or more precipitation) in a given month leads to a decrease of household water consumption by 0.15 m^3. About 31% of the variation in water consumption can be explained by changes in number of rainy days per month. The effect of an increase in number of rainy days by one, is small compared to the effect of a temperature increase of one degree. This is due to the fact that the spread in number of rainy days is much larger than in temperature. On other words, a small change in temperature, will explain already a lot of the total variation, even if the explanatory power of temperature is small (to explain water consumption).

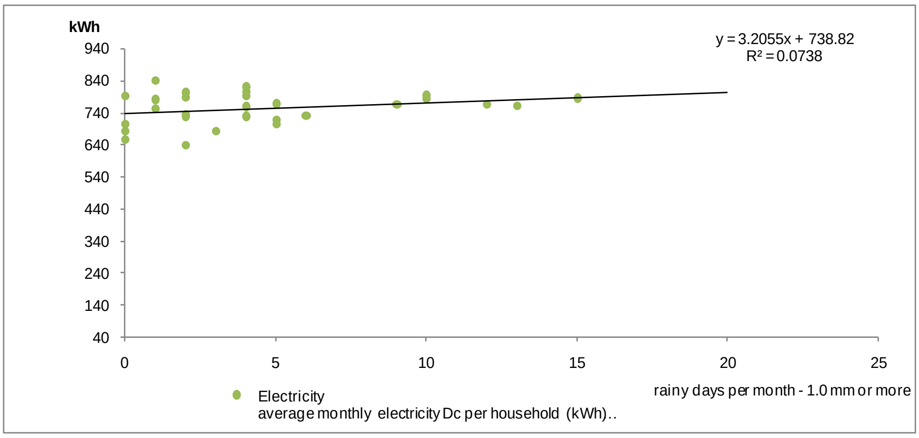
Figure 18 Average household water consumption (m^3) per month by number of rainy days (days with a precipitation of at least 1.0 mm)



Source: WEB Aruba NV and www.meteo.an.

No significant relationship was observed between 'number of rainy days' and average household electricity consumption (Figure 19; R^2 of 0.0738) during the period January 1998 – September 2008.

Figure 19 Average monthly household electricity consumption (kWh) by number of rainy days (days with a precipitation of at least 1.0 mm).



Source: WEB Aruba NV and ELMAR NV and www.meteo.an.

Total precipitation per month would have been an alternative measure to analyze against the total water or electricity consumption. Likewise, given the localized pattern of rain showers, it would have been interesting to perform these analyses on a smaller scale area. But unfortunately, we were unable to retrieve sufficient relevant data to perform such analyses.

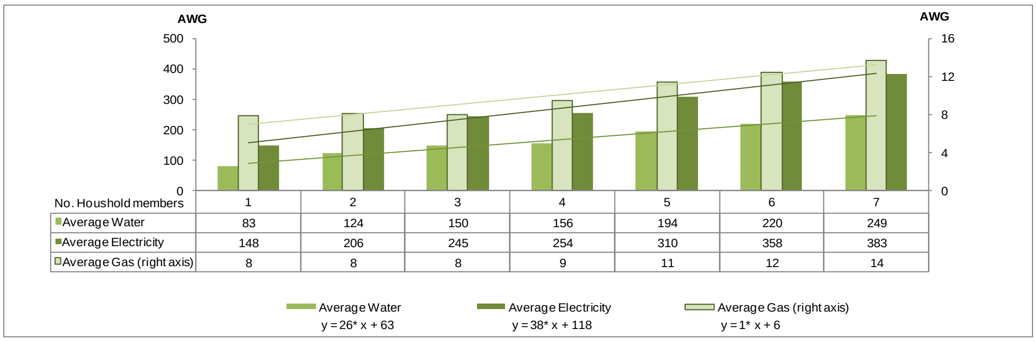
Characteristic Household expenditures

From the monthly sales for water, electricity and gas (data received from Web NV and ARUGAS NV), we were able to get insight in the changes of household consumption over the years, but we were unable to retrieve detailed information up to the level of a specific household characteristic. We have used the data from the Income and Expenditure Surveys of 1993, 1998 and 2006 to relate household consumption with household specific characteristics (see Appendix 1 for a validation to use these surveys as a representation of Aruban households).

Between 1993, 1998 and 2006, the population size increased from 77.973, to 93.428 and 103.484 persons). During the same period, the average household size decreased; respectively from 3.5, to 3.2 and 2.8 persons per household. Generally it is thought, that smaller households consume relatively more on energy per person. However, this was only partially confirmed to be true.

According to the 2006 Income and Expenditure Survey, a single-person household paid on average monthly Afl 148,- on electricity, Afl 83,- per month on water and Afl 8,- on gas. Our results revealed that an additional household member costs per month on average an aditional Afl 38.- on electricity and Afl 26,- on water (Figure 20). Children, adolescents, adults, and pensioners are all counted as equal consumers. An additional member of 1 or 2 did not significantly cost more on gas. In households with more than 3 members, an additional member costs on average Afl 1,40 more on gas expenditure.

Figure 20 Average utility expenditures for households with different number of household members.

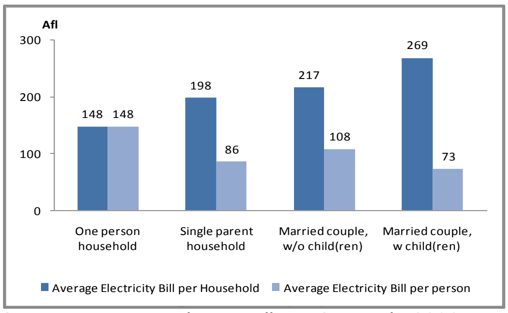


No. Houshold members	1	2	3	4	5	6	7
Average Water	83	124	150	156	194	220	249
Average Electricity	148	206	245	254	310	358	383
Average Gas (right axis)	8	8	8	9	11	12	14

Source: Income and Expenditure Survey in 2006.

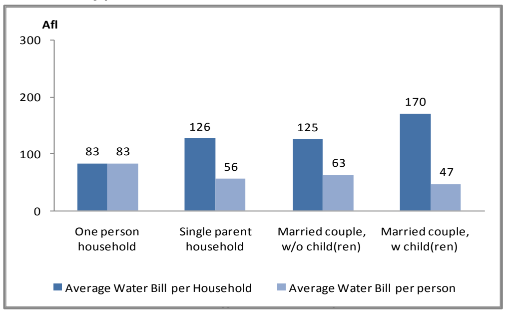
We have analyzed the data of 2006 in relation to the type of household. The results show that the per person expenditures on electricity and water were highest in a one-person household as compared to a multi-person household (Figure 21 and 22). In a multi-person household, married couples without children spend per person more than single parents or married couples with children. This is easily explained, as several individuals in a household may enjoy same resources which have to be spent only once (for instance, light, air-conditioning, swimming pool or watering plants, etc). Married couples with children clearly spent most on total household expenditures.

Figure 21 Average monthly electricity expenditures for different types of households



Source: Income and Expenditure Survey in 2006.

Figure 22 Average monthly water expenditures for different types of households.



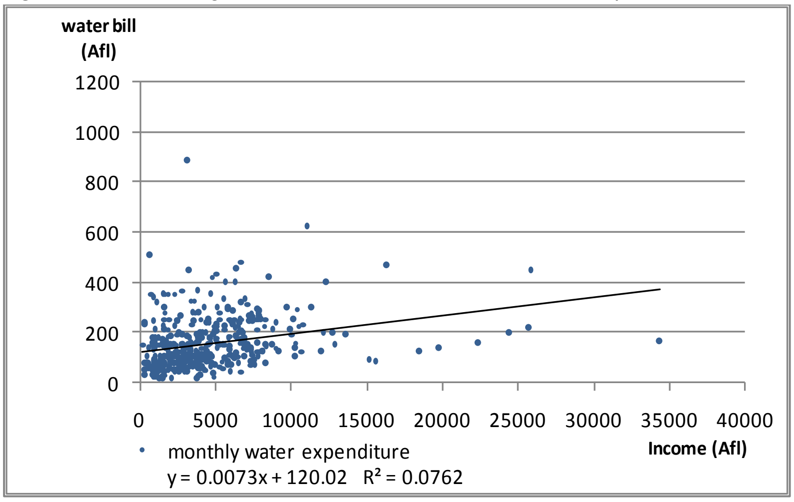
Source: Income and Expenditure Survey in 2006.

We have analyzed the influence of a number of characteristics on the utilities expenditure pattern, such as the physical housing conditions, some demographic aspects, the presence of a number of appliances that were encountered, and the financial situation. We used the data from the income and expenditure surveys of 1993, 1998 and 2006. The relationships were analyzed with a Multiple Classification Analysis (MCA). The results are shown in the next sections.

Factors that influence water consumption:

An initial analysis showed that the number of household members (see previous section: figure 22) and the height of the household income[44] (figure 23), both, had a positive relationship on the height of the household water expenditure ($p < 0.001$). The variation in water expenditure explained by household income is however small (7.6%). One could easily reason that higher income households have more money to spend and are likely to spend more on water. However, although this may partly be true, there is another factor which has to be taken into account. A high household income may be the result of the contribution by several household members to that income. As larger households are more likely to have more contributors, their total income will be higher. In order to avoid that size underlies the results of income, we corrected total household income, by dividing the household income by the number of household members. As such we obtained a more balanced measure of the household income position than by just taking the overall income. We then analyzed the relationship between water expenditure relative to 'income per household member'. Interestingly, the 'per person household income' still did not reveal a significant relationship ($p>0.05$). From this we can conclude, that the influence of income on changes in the expenditure or consumption of water on Aruba was less as previously thought.

Figure 23 Scatter diagram of household income versus water expenditure, in 2006



Source: Income and Expenditure Survey in 2006.

Furthermore, it is quite obvious - and our results confirm this - that water expenditure depends on a number of other factors, some of which involve direct water requirements. We tested those intervening factors which we suspected would have an effect on water consumption.

In the income and expenditure survey of 2006, we have collected, amongst others, information about features of the living quarters, such as 'the number of showers' and the 'presence of a swimming pool'. We found that the presence of a swimming pool is indeed very strong related to a high water expenditure ($p<0.001$). The frequency of occurrence is small (N=5), but the predicted average expenditure for water by households with a swimming pool is Afl 265 against Afl 143 for those without (N=536).

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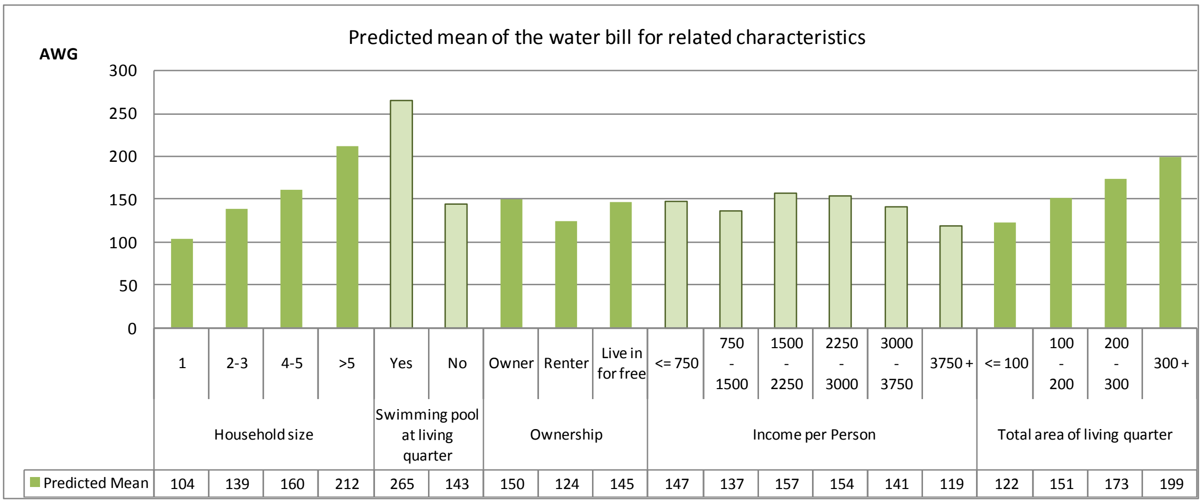
[44] Note: Results that follow on the basis of differences in household income have to be interpreted with care, as, in particular lower income groups are expected to have additional means to make ends meet. The discrepancy between their expenditures and incomes cannot be explained satisfactory. In a few instances, the costs of the energy bill alone were as high as the income that was provided in the survey. It is clear, that these participants did not report their income completely. Also, on a number of occasions, the amount of data was insufficient for proper analysis of the household income.

In contrast, the number of showers in a living quarter notably, was not directly correlated with water expenditure ($p > 0.05$). More showers did not cause higher water expenditure, particularly, this was observed after we controlled for the number of household members. Factors that have an effect on overall water expenditures are shown in figure 24[45].

Furthermore, owners of housing units were observed to spend more on water than tenants (a predicted Afl 150 against Afl 124), even after data were corrected for household size and income per person. Interestingly, those who ‘lived in for free’ were found to spend clearly more on water than those who rented (N=37; Afl 148). After, we redefined home ownership situation, and left those households with for free living-in out of the analysis, we observed a significant correlation between home ownership (owner or renter) and the degree of water expenditure. Between the characteristics home ownership and respectively income, type of the living unit (house, apartment, room, cuarto/shack), household composition (single, parent with or without children, etc.), or, number of persons in a household, we observed no significant two-way interactions. Thus, the results suggest that the fact that household members live in their owned housing unit, is sufficient to explain higher water consumption when compared to the situation with tenants. These is findings are similar to what is observed in The Netherlands in 2000 with regard to differences in electricity consumption[46].

Finally, a large living area did correlate not only with a high water consumption but also with a high per person household income. Clearly, households that possess a larger living area, have significantly more money to spend for water consumption than those with smaller living areas.

Figure 24 Factors that influence household water expenditures[47].



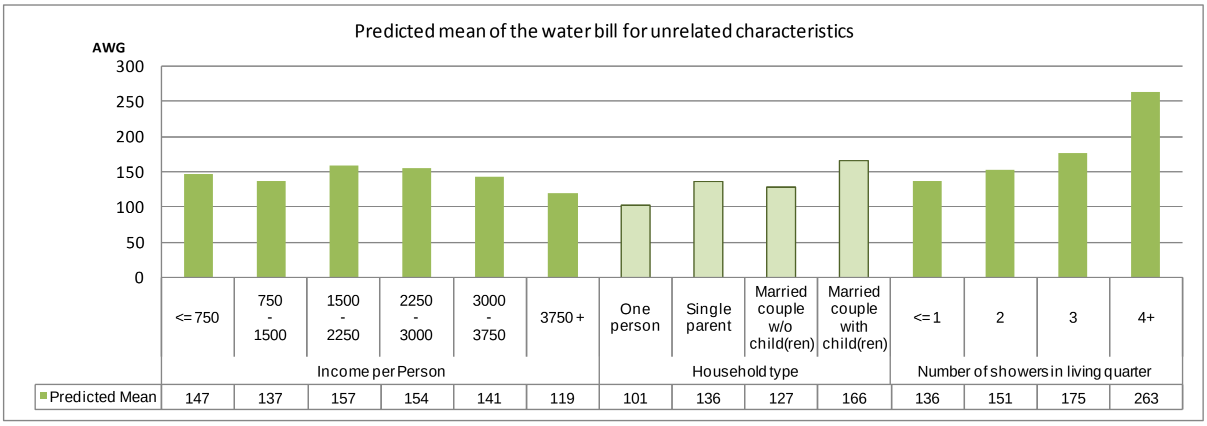
Source: Income and Expenditure Survey in 2006.

For a number of household characteristics, no relationship with household water expenditures revealed. These were: ‘number of years that household members live on Aruba’, ‘type of housing unit’, and, ‘type of household’. Beforehand, we had reasoned that immigrants may need some time to adapt their expenditures to the Aruban conditions with relatively high water prices and that they may have been inclined to consume more heavily during their first year after arrival. Likewise, we argued, that the ‘type of housing unit’ (house, apartment, room, trailer or container, cuarto/shack) might have an influence on the water consumption pattern, as the construction and physical condition of these

[45] Note: These values were adjusted averages and were corrected for the influence of co-varying factors and the ‘per person’ income or the number of household members.
[46] Households spending more on electricity. Tenants versus owners. CBS the Netherlands, September 2002, www.cbs.nl
[47] Note: Frequencies are expressed as (adjusted) mean water expenditures. We call these adjusted values approximations or estimates, because their height depend to a small degree on what other factors were involved in the analyses.

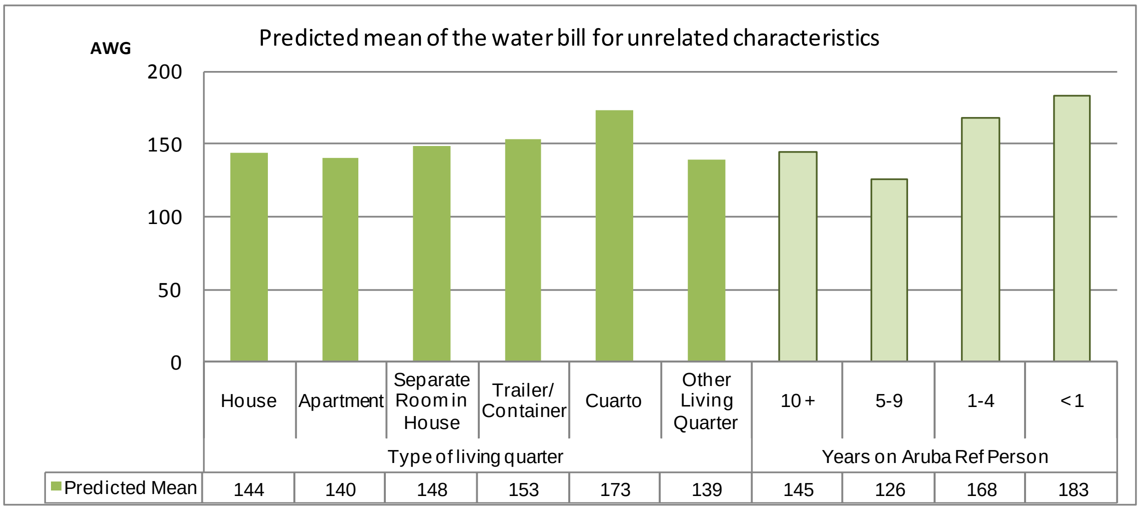
unit's differed considerably. But, none of the above was confirmed by our results. The adjusted values are presented in figure 25 and 26.

Figure 25 Factors that did not influence household water expenditures[47].



Source: Income and Expenditure Survey in 2006.

Figure 26 Factors that did not influence household water expenditures[47]



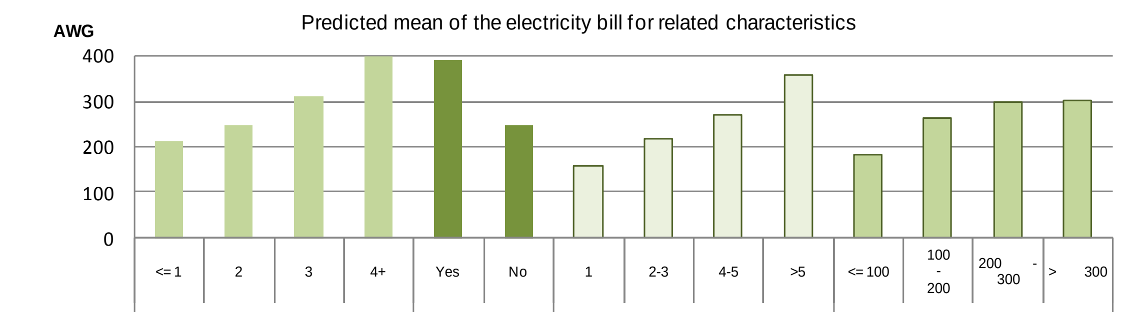
Source: Income and Expenditure Survey in 2006.

Other characteristics would have been interesting to compare, but unfortunately our data sets were insufficient to investigate all the relationships that seemed obvious in the first place.

Factors that influence electricity consumption:

The variation between households' electricity expenditure was made a function of the 'number of air-conditioning systems' ($p<0.001$), 'area of living unit' ($p<0.001$), 'number of persons in household' ($p>0.001$), and 'presence of a swimming pool' ($p<0.001$). So, these factors were observed to influence the expenditure of electricity significantly. Figure 27 shows the expected electricity expenditures under a given condition of household characteristic.

Figure 27 Factors that influence household electricity expenditures[47]

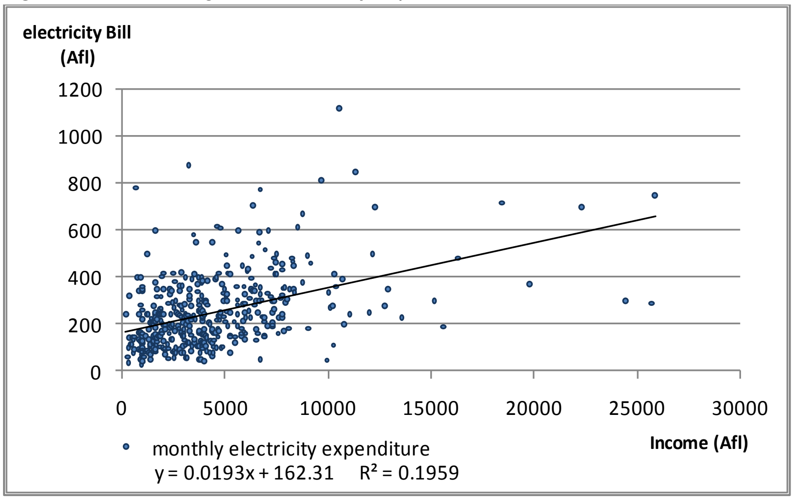


	Nr. of aircond. Units				Swimming pool at living quarter		Household size				Total area of living unit			
	<= 1	2	3	4+	Yes	No	1	2-3	4-5	>5	<= 100	100 - 200	200 - 300	> 300
Predicted Mean	213	246	308	398	390	247	159	218	271	358	182	262	299	301

Source: Income and Expenditure Survey in 2006.

A correlation between electricity expenditures and household income was observed as well. However, the relationship was defined by a relatively few number of outliers (figure 28), while the variance was still considerable. An increase of the income by for instance Afl 1000, was predicted to correspond to an increase of Afl 19.-. in the electricity bill.

Figure 28 Scatter diagram of electricity expenditures versus household incomes, in 2006.



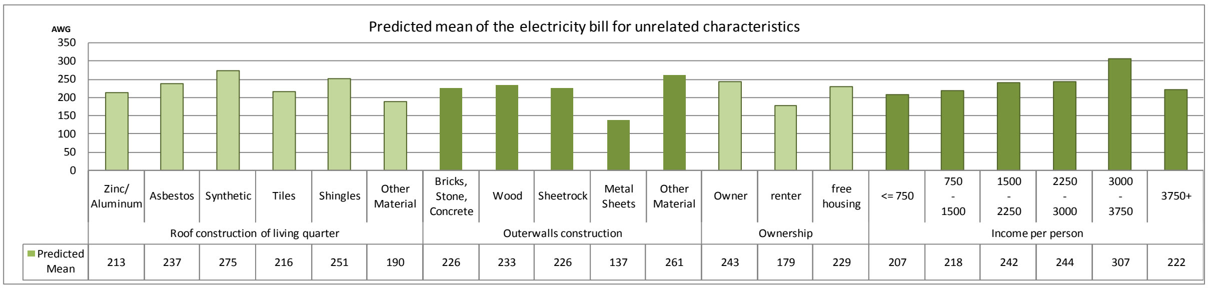
Source: Income and Expenditure Survey in 2006.

The data also revealed that 'area of living unit' and 'height of income' were inter-correlated, i.e., a larger living area is more likely to be occupied by a household with relatively higher spending power. Again, as we had done in the analysis of water expenditure, we used the 'per person household income'. Interestingly, a relationship between electricity expenditure and per person income existed, but only up to a certain level of income (figure 29). In households with a quite high level of averaged income per person (income > 3.750,00 Afl), relatively less was spent on electricity (see Fig 29).

Type of outer wall construction' and 'type of roof construction' did not reveal a causal relationship with the level of electricity expenditure. These factors had been worth investigating, as a relationship of above mentioned factors with electricity expenditure might indicate an effect of (insufficient) isolation and thus higher air conditioning costs. We found that, although 'type of roof construction' was significantly related to the height of the total 'household income' ($p>0.001$), it was not related to electricity expenditures.

Regarding a possible effect of 'home ownership', again we observed a clear difference between owners and tenants in the level of electricity expenditure. Households with living-in for free members showed an intermediate height of electricity expenditure.

Figure 29 Factors that did not influence household electricity expenditures[34]

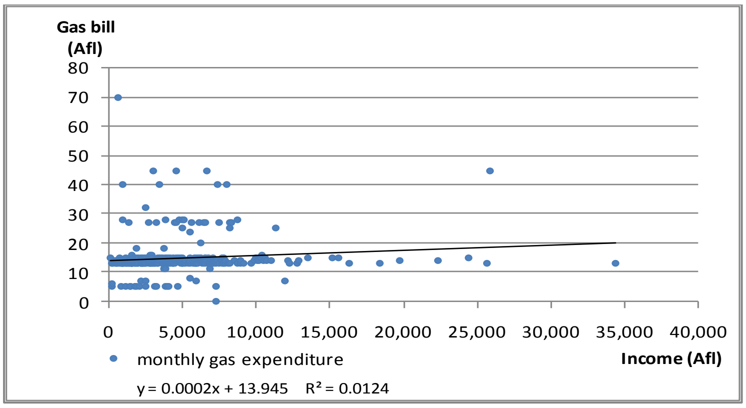


Source: Income and Expenditure Survey in 2006.

Factors that influence gas consumption

Figure 30 presents the relationship between household income and gas expenditures. The strength (in this case it is an absence) of a relationship is indicated by the R^2 value (0.0124). According to the regression model, an increase in household income by Afl 1000 corresponds to an increase of Afl 0.20 in gas expenditures. In other words, higher income households pay a similar total amount for gas consumption as lower income households.

Figure 30 Monthly gas expenditures versus household incomes, in 2006.



Source: Income and Expenditure Survey in 2006.

Thus, given a few exceptions, the gas expenditures are not influenced by the level of income. Most probably, the extreme outliers (high gas bill) concern households that have some kind of activity in the informal sector. Out of 817 households in 2006 that were investigated, 32 (3.9%) provided no further information about their income, 29 (3.5%) provided no information about their electricity bill, and 38 (4.7%) told nothing about their water bill. However, only a total of 480 households reported any gas expenses (58.8%). This low percentage is certainly due to the fact that a gas cylinder is bought only once every few months. In fact, the figure reveals at least three distinct levels of consumption, indicative for the frequency of buying a new gas cylinder (costs of a regular gas cylinder is Afl 42,-).

Out of door consumption and energy costs

Interestingly, our data reveal, that local citizen indeed, more and more, tend to dine out, instead of preparing their meals at home (Table 5). In 1998, 46% of households went to a fast-food or restaurant at a median frequency of 2 times a month paying an average bill of Afl 154. In 2006, 68% of households went 8.7 times a month to a fast-food or restaurant paying a bill of Afl 91.05[48].

Thus, there is indirect evidence that suggested that the decrease of gas consumption by 17% during the period 2003 to 2008 (see Table 4) from 21.2 to 17.6 lbs., was at least partly caused by a shift in cooking habits.

Table 5 Characteristics of households dining outdoors.

Monthly consumption outdoors	1998	2006
Number of households in total(N)	496	817
Number of households consuming outdoors (N)	228	552
% households that dine outdoors	46%	68%
Outdoor visits per household (average)	4.7	12.8
Outdoor visits per household (median)	2.0	8.7
Consumption outdoors (average in AFL)	259.73	171.79
Consumption outdoors (median amount in AFL)	154.00	91.05
Source: Income and Expenditure Survey in 1998 and 2006.		

48 Note: Figures are median values because the frequency distributions were skewed towards the lower values

Average monthly household utility expenditure

The values of the average expenditures on gas, water and electricity, are also presented based on the income and expenditure surveys of 1993, 1998 and 2006 (CBS reports; Table 6). The results from 2006 can be compared with the data we received from the utility companies. The calculated average expenditures based on the survey in 2006 were observed to be in reasonable agreement with the figures we received from WEB NV and ARUGAS NV (Table 4). The total household expenditure for utilities per month increased from Afl 238 and Afl 291 up to Afl 374,- on average, in respectively 1993, 1998 and 2006.

Unlike water and electricity, average household gas consumption decreased over the survey years 1993 till 2006. In fact, the decrease in gas consumption was more rapidly than the increase in price, resulting in low total gas expenditures. The decrease of gas consumption might be explained by a shift from gas-based appliances to electrical appliances (i.e., for cooking, cloth drying or water heating, etc.). A shift like this has been described in The Netherlands[49]. Lower gas consumption may also be the result of less cooking, as has been described in the US[50] (we refer also to "Characteristic Household Expenditures", this report, pp27).

Table 6 Average monthly gas, water and electricity expenditure from Income and Expenditure Surveys in 1993, 1998 and 2006

	Premises (N)	Water expense (Afl)	Electricity expense (Afl)	Gas expense (Afl)	Total (Afl)
1993	519	94	132	12	238
1998	498	119	172	36 [51]	291
2006	817	138	227	9	374

Source: Income and expenditure surveys 1993, 1998 and 2006. From: Statistical yearbook
Note: Gas expense is expressed as a monthly average, in contrast to the year values in the Statistical Yearbook.

Important to notice is a slight difference in the way the survey was conducted in 1998 and in 2006. This may have consequences on how the results have to be interpreted. For instance, in 1998 the exact number of households to be surveyed was exactly as planned. In 1998 respondents who refused or who were absent, were simply excluded from the survey and another sample households was chosen until the total amount of households to be surveyed was reached. As a consequence, a bias in this respective year may have become introduced. Some typical household categories for instance, like elderly people, were most likely over-represented because they will have been at home more frequently than others. Also, the higher gas expenditures at the end of the year, as has been discussed in this paper, might have biased the results in 1998 (see note below).

[49] CBS, The Netherlands: Households spending more on Energy, Sept 2002

[50] Cooking Trends in the United States. Energy Information Administration, US.. 2002, www.eia.doe.gov

[51] Note: The high gas expenses in 1998 are most probably due to the fact that the survey is conducted in the period October – December 1998. As discussed earlier in this report, this period is known for a typical high gas consumption due to probably the Christmas preparations.

The costs of household appliances

As the primary focus of the income and expenditure surveys was to provide information on the general consumption patterns of people on Aruba and not on the consumption of utilities in particular, a number of interesting aspects have not been recorded. We have no detailed data about the electricity consumption per type of electrical appliance, such as for instance the usage of air conditioning, refrigerator or the fan. To be able to retrieve such data, one would need to investigate the average energy consumption and frequency of 'on-switching' of preferably all possible household aplliances that are present in the housing unit. This was beyond the scope of this study. But, it is interesting to have at least some knowledge of the energy consumption for some of the more common household appliances on Aruba in order to understand the high utility expenses. Table 7 presents some information on the power consumption and the daily costs of some common household appliances.

Table 7 Electricity costs of a number of typical household appliances on Aruba, based on an estimated average usage.

	estimated electricity consumption per hour (kWh)		estimated usage per day (hrs)	calculated costs per day (Afl)		calculated costs per month (Afl)	
	low	**high**		**low**	**high**	**low**	**high**
Incandescent bulb 60W - 75W	0.06	0.075	5	0.16	0.20	5	6
TV (tube - plasma)	0.10	0.30	5	0.26	0.78	8	24
Stereo-Hi-fi	0.01	0.02	5	0.03	0.05	1	2
Laptop/PC	0.02	0.20	2	0.02	0.21	1	6
Electric Kettle	0.30	2.00	0.6	0.09	0.62	3	19
Electric Iron	1.00	1.00	1	0.52	0.52	16	16
Electric oven	1.00	1.40	1	0.52	0.73	16	22
Airco (Window - Split unit)*[52]	1.00	1.20	4	2.08	2.50	63	76
Electric fan	0.05	0.08	5	0.13	0.20	4	6
Refrigerator (250 l - 500 l)*	0.16	0.30	4	0.33	0.62	10	19
Refrigerator with freezer*	0.30	0.90	4	0.62	1.87	19	57
Swimming Pool Pump	0.85	2.00	6	2.65	6.24	81	190
Washing machine	0.60	1.70	4	0.31	0.88	5	16
Dryer	1.75	5.50	4	0.91	2.86	16	50
Dishwasher	0.60	1.60	4	0.31	0.83	5	15
Microwave oven	0.10	0.20	5	0.05	0.10	1	2

Source: Information based on various Internet sources, mainly with a focus on consumer behaviour or the environment. Electricity costs are calculated on the basis of an average electricity price of 0.52 Afl/kWh, as from september 2008

Information from abroad, such as from the Netherlands or the US, indicate that heating or cooling appliances and pumps, consume the largest amounts of household energy. Also, replacing a gas oven by an electricial one does not only add to the total electrical consumption but is more costly as a whole. On Aruba, room heating is to be considered irrelevant, but air conditioning and pumps for the swimming pool will cost a lot on energy.

Between appliances of a similar kind variation exists in respect to energy consumption. In contrast to the power absorbing older models, newer products tend to be more energy efficient. Likewise, for instance, LED lights produce a similar light but consume only a fraction of the energy of a candescelent bulb. And not only the type, but also the circumstances may have an influence on energy consumption. An air conditioning system, for instance, consumes more when room insulation is bad, and a refrigerator consumes considerably more when it is placed in a tight area with its back to a sun-heated outerwall or when heat ventilation is bad. Also, the fact that an appliance needlessly remains in a stand-by position adds up to the power consumption.

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[52] Note: Peak time is less than total time of operation. Appliance only needs to keep the temperature at a certain level, once the required temperature is reached.

It is interesting to notice, that in many households the dishes are done with running tap water. In ten minutes time, this will cost about 40 liters of water, while dishwashing in a tub would cost only 10-15 liters per dish wash. In a month time, this may add to 800-1000 liters of water. Thus, approx. 1 m^3 water or Afl 20,- is wasted down the sink each month. The use of a dishwasher would even be worse, as it consumes about 25 liters of water for a normal dish wash and consumes an additional amount of electricity as well.

Although, the information in table 7 is meant to be informative, the listing reveals that some appliances cause unexpected high monthly energy costs. A plasma TV consumes considerably more energy than an old-fashioned tube TV. More recent, so-called OLED TV's are brought onto the market and are supposed to consume considerably less energy. Swimming pools are not only costly because they consume a lot of electricity, but also because of evaporation the pool needs to be constantly refilled with water. Likewise, air conditioning units, electrical dryers, and refrigerators consume lots of energy. The figures have taught us that it may be worth to exchange older models by more energy efficient newer ones or to check at least the local heating conditions of some of our appliances.

Appendices

Appendix 1.

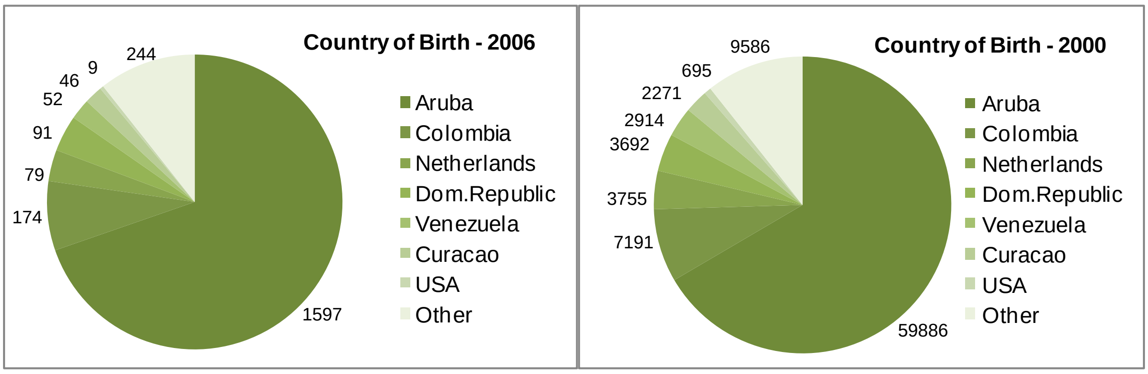
Validation of the Income and Expenditure Surveys in 1993, 1998 and 2006 to be used as a representation of a number of population characteristics.

The surveys in 1993, 1998 and 2006 reveal information about individual household expenditures on electricity and water for each of several characteristics, such as owned appliances, physical housing conditions, financial situation and demographic characteristics. We were interested to know whether these household surveys are to be considered a good representation of the total Aruban population. We have made a comparison between the data sets on the basis of male and female numbers, country of birth of the household members, as well as age distribution (see figure 31, 32 and 33).

A comparison between frequency distribution of household incomes in 1993, 1998 and 2006 and from the population census data revealed a good conformity (see: Income and Expenditure Tables, CBS, 2006 and 1993). The Gini-coefficient from the income and expenditure survey in 1993 (0.39) matched the coefficient on the basis of data from the census in 1991 (0.41) quite well. Likewise, the Gini-coefficients from the income and expenditure surveys in 1998 and 2006 (0.41 respectively 0.40) were in close agreement with the coefficient of data from the population census in 2000 (0.40). These Gini-coefficients indicate a strong similarity of the frequency distributions of household incomes during these years.

Another factor that we consider important for a correct interpretation of the Income and Expenditure Survey results, is country of origin of household members. As an example, we show the similarity between the census 2000 and the Income & Expenditure Survey 2006 with regard to the measured characteristic ‘country of birth’ of household members (see figure 31). The results revealed a good agreement of relative frequency distributions between the sample survey in 2006 and the populationsurvey in 2000.

Figure 31 Frequency distribution of country of origin of household members in 2000 and 2006 [53]



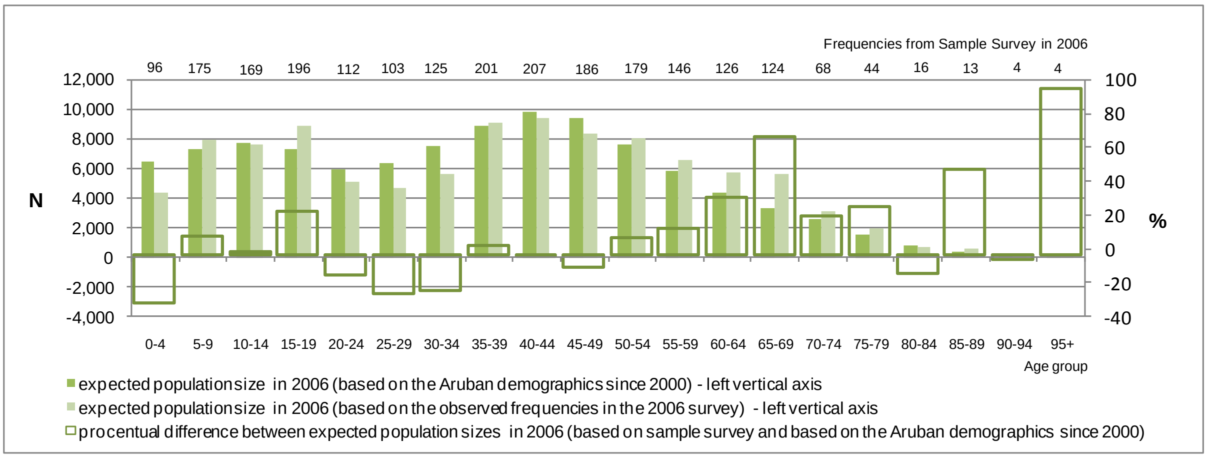
Source: CBS, Income and Expenditure Survey 2006 and census 2000

Also, we present the age distributions of household members from the income and expenditure survey in 2006 versus the population estimate in 2006, based on the observed frequencies in the sample survey and the demographic changes[54] since the population census in 2000 (figure 32).

[53] Note: In the census total population size N= 89.990 and in the Income and Expenditure survey sampled number of households N=817.

[54] Note: In the six year period between the census of 2000 and the survey in 2006, the age distribution will have shifted by 6 years due to the effect of aging. This is irrespective of factors such as immigration, emigration, birth, and death.

Figure 32 Frequency distributions of household members by age group.

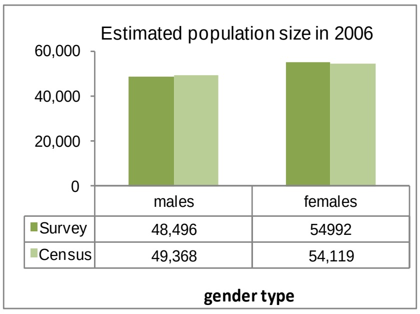


Source: CBS, Income and Expenditure Survey 2006 and census 2000
Note: The horizontal axis on top presents the observed frequencies from the sample survey of 2006

The analysis revealed a partial fit of the observed age groups in the Income and Expenditure Survey of 2006 with the distribution of age groups based on the census. Ages above 60 years are generally over-represented in the sample survey of 2006; in particular those between 65 and 69. Likewise the age group of adolescents, between 15 and 19 years of age, were over-represented. The likelihood that household members in these age groups were at home during the fieldwork and their willingness to participate, led to an over-representation in the sample survey of 2006. On the other hand, ages between 0 and 4 years, and 20 and 34 years were clearly under-represented. These concerned most probably households where the members were working or otherwise from home. Most logically, they concerned those household members that had also the children below 5 years of age which were absent in the survey. However, in general, with respect to our research questions, we saw insufficient cause to correct and weigh our data. Where necessary, we have mentioned some cause in the interpretation of our results.

Finally, we investigated whether both sexes were properly represented in the Income and Expenditure Survey in 2006. The frequencies we observed during the survey were incremented at the population level, i.e. multiplied by the sampling fraction, in order to compare with the population census. Also, as the survey was in 2006, we corrected for demographic changes since 2000 (figure 33).

Figure 33 Comparison of estimated male and female population numbers in 2006.



Source: CBS, Income and Expenditure Survey 2006 and based on demographic changes since census 2000

The results showed, that in the Income and Expense Survey of 2006, females were only slightly over represented (1.6 %) to males. This difference, however, is very small and supports our general findings that the Aruban population is also well represented in the income and expenditure survey in 2006.

Summary

The role of utilities in Aruban households is a topic of recent public discussion. How much does a household spend on gas, water and electricity? Why have prices of water and electricity risen so rapidly in recent years? Is there a pattern in the expenditures on utilities by Aruban households, and by what factors is the consumption of utilities influenced? These are some of the important questions that have been tackled in the present study.

The results are based on data provided by the Aruban utility companies (WEB Aruba NV, ELMAR NV and ARUGAS NV) and the Income and Expenditure Surveys in 1993, 1998 and 2006 (CBS Aruba). The effect of a number of variables on the expenditures of household utility resources was analyzed using linear regression techniques and Multiple Classification Analysis (MCA).
The tariff structures for water and electricity on Aruba and Curacao reveals a different approach (based on data from 2008). For small users, the purchase of water is more advantageous on Aruba than on Curacao. Also the price for electricity on Curacao is higher than on Aruba.
Our analysis confirmed that electricity and water tariffs were highly dependent on small changes in the international crude oil price. Data from the last decennium reveal, that the price we pay for electricity and water correlates strongly with the price of crude oil. We were able to describe the relation between oil and utility price by a simple mathematical function on the basis of which we were able to make short term predictions.

From 2001 to 2006, the unit price for gas, water and electricity, as well as the number of consumers, has increased steadily. However, household consumption for gas and water decreased, and remained roughly the same for electricity. All over, total household expenditures for water and electricity increased. Such increase was not observed for gas. The average household gas expenditures decreased slightly over these years.

While gas consumption decreased over the years, during the month of December, a so-called, 'Christmas bell' occurred for the total sale of gas when the household gas consumption peaked drastically. In this context, it is noteworthy, that our findings suggest that Arubans tend to dine out more as before.

In comparison with The Netherlands, we observe high electricity consumption and low consumption of gas on Aruba. The underlying factor may well be the total absence of gas consumption for room heating and the presence of electricity consumption for room cooling instead. Specific data to analyze the consumption by typical appliances was however not available on Aruba. About 43% of the variation in total sale of electricity, could be explained by variation in air temperature, and, as one may expect, the variation in household air conditioning systems was positvely related to higher household electricity expenses. Too, air temperature influenced water consumption but not very strong. Furthermore, the more rainy days in a given month, the less water was consumed. No such relationship was observed between number of rainy days and electricity consumption.

Our analyses revealed, that the expenditures on electricity as well as on water was relatively high in one-person households (singles) compared to multi-person households. In a multi-person household, married couples without children paid relatively more than single parents or than married couples with children. A single person household paid on average monthly Afl 148,- on electricity, Afl 83,- on water and Afl 8,- on gas. Our results showed that an extra household member costs on average an additional Afl 38,- on electricity and Afl 26,- on water. In households with more than 3 members, an additional member caused on average Afl 1,40 more on gas expenditure. In smaller households, the extra costs were negligible.

The variation between households' electricity expenditure was a function of the 'number of air-conditioning systems', 'area of living unit', 'number of persons in household', and 'per person household income'.
The frequency of occurrence of households with a swimming pool was small (N=5), but the predicted average expenditure of water by households with a swimming pool is Afl 265,- against Afl 143,- for those without a swimming pool (N=536). Furthermore, house owners were thought to spend more on water than tenants (a predicted Afl 150,- against Afl 124,-). Interestingly, those who 'live in for free' were found to spend clearly more on water then those who rented.

In contrast to the variation in household electricity expenditures, the expenditures on water were unrelated to the level of income, and, given a few exceptions, the gas expenditures were un-influenced by income as well.

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