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The Weight of The Domestic Energy Demand In The Solar Field

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ABSTRACT
The satisfaction of the household energy demand requires a good knowledge of the consumption from the quantitative and qualitative point of view. Thus, a study of the structure of the demand both in urban and rural environment is necessary, while taking into account the socio-professional category of the subscribers. In urban environment, one distinguishes at first residential housing that the average power does not exceed 1 kVA, afterwards there are residences and villas that the average power is about 3 kVA, and finally luxurious villas with an average Power of 5 kVA. In rural environment, the average power do not exceed 500 W. Thus, the study of the consumption segmentation allows satisfying the energy demand while respecting the constraint of energy saving in the solar field.
Keywords: Average power, consumption, domestic energy demand, energy saving, solar energy

I. INTRODUCTION

The utilization of the solar energy, in particular for the functioning of electric households appliances, requires the knowledge of a certain number of essential data source, conditioning to a large extent on the expected energy saving. Thus, the satisfaction of the needs passes notably by a good knowledge of the used active elements, their respective consumption and the duration of their use. So, we propose in this paper to study a typology of the structure of the energy demand in Madagascar in urban and rural environments.

II. BASIC DATA

This study concerns only domestic uses of the electricity, so we will not take into account industrial uses, tertiary sector needs (commerce and services) and collective needs (public services, …). In quantitative terms, the data that we will use are those generally allowed in any evaluation of an energy nature.

Thus, we carried our choice on the publication of the “Energy Consumption Chart”, a directive coming from the energy commission in California on July 1984. We added there data concerning new devices and equipments which result from the technological evolution, recut by the averages of measurements taken in situ with the consometer during our frequent displacements for their installation.

Moreover, these data place us in the way of security towards of the devices overload during their functioning, limiting any risk of damage towards the users. One can see in the appendices an energy consumption chart example.

III. LEVEL OF SATISFACTION

It is necessary to review the case of the urban and the countryside environments. Generally and in the interest of consumers towards the increase of the price of the electricity in Madagascar, we recommend and retain for the continuation of the study the systematic use of LED lamps. They offer two main advantages compared to incandescent lamps, low energy consumption for a same lighting level and long lifespan.

3.1 Urban environment.

At the domestic level, energy consumption is intended mainly into inhabited-houses that use high power devices (electric stove, electric oven, refrigerator, iron…) and sometimes swimming pool. So we have the following model presented in the form of tables including:

- Column 1: gives the number of electric household appliances used.
- Column 2: gives the nature of the appliance.
- Column 3: indicates the power in Watt of the appliance.
- Column 4: gives the total of the power of the appliance.
- Column 5: shows the average duration of the daily use of the appliance.
- Column 6: indicates the total value of the average energy consumed per day.
- Column 7: gives the total value of the average energy consumed per year.
- Column 8: indicates the total number of days of use of the appliance in the year.

TABLE 1. Standard habitation

Number of appliances	Appliances	Unity power [W]	Total power [W]	Duration [h]	Energy [Wh/day]	Energy [Wh/year]	Days of use
1	Fluorescent lamp	5	5	10	50	18,250	365
2	LED lamp	5	10	5	50	18,250	365
4	Compact fluo lamp	4	16	3	48	17,520	365
1	TV	90	90	3	270	98,550	365
1	Laptop	54	54	3	162	41,634	257
2	Smartphone	10	20	1.5	30	10,950	365
1	Refrigerator 200 L	105	105	12	1,260	459,900	365
0	Iron	1,000	0	0.36	0	0	365
1	Hi-fi	105	105	3	315	66,150	210
1	DVD player	35	35	1	35	5,425	155
1	Mixer	150	150	0.03	4.5	1,6425	365
			P = 590	Q = 2,225		Q = 738,272	

Through the TABLE 1, one can have Q = 2,023 Wh/day. It is the average of the daily consumption, with the utilization of usual electric domestic appliances, except the laptop which operates on average 257 days per year or 5 days per week, the Hi-fi 210 days per year or 4 days per week and the DVD player 155 days per year or 3 days per week. It is noted that a lamp 5 W is planned for external lighting.

The power concerned in this category of consumer does not exceed 1 kVA.

TABLE 2. Villas and residences

Number of appliances	Appliances	Unity power [W]	Total power [W]	Duration [h]	Energy [Wh/day]	Energy [Wh/year]	Days of use
1	Fluorescent lamp ext	8	8	10	80	29,200	365
1	Refrigerator 200 L	150	150	12	1,800	657,000	365
4	Compact fluo lamp	8	32	4	128	46,720	365
2	Compact fluo lamp	6	12	5	60	21,900	365
2	Compact fluo lamp	4	8	3	24	8,760	365
2	TV LED 42’’	90	180	3	540	197,100	365
1	Decoder	25	25	2	50	18,250	365
1	Hi - Fi	105	105	4	420	88,200	210
1	DVD player	35	35	1	35	7,350	210
1	Laptop	54	54	3	162	51,192	316
2	Smartphone	10	20	1.5	30	10,950	365
1	Iron	1,000	1,000	0.36	360	131,400	365
1	Coffee maker	800	800	0.1	80	29,200	365
			P = 2,429		Q = 3,769	Q = 1,297,222	

In the TABLE 2, most of the electric household appliances are also used every day except the Hi-fi and the DVD player which function 4 days per week or 210 days per year, as well as laptop for 316 days per year or 6 days per week. External lighting is sometimes ensured by a lamp of 8 W.

This category of consumer corresponds to the middle-class. It distinguishes from the precedent category by the fact of a use of a greater number of appliances having high power such as iron, toaster or coffee maker.

The concerned average power is about 3 kVA.

TABLE 3. Luxurious villas

Number of appliances	Appliances	Unity power [W]	Total power [W]	Duration [h]	Energy [Wh/day]	Energy [Wh/year]	Days of use
2	Fluorescent lamp ext	10	20	10	200	73,000	365
4	Safety Compact fluo lamp	6	24	10	240	87,600	365
2	Compact fluo lamp bedroom	8	16	4	64	23,360	365
2	Compact fluo lamp bedroom	6	12	5	60	21,900	365
4	Compact fluo lamp bedroom	4	16	3	48	17,520	365
2	TV LED	200	400	3	1,200	438,000	365
2	Decoder	25	50	2	100	36,500	365
1	Hi - Fi	105	105	4	420	88,200	210
1	DVD player	35	35	1	35	7,350	210
1	Laptop	54	54	3	162	51,192	316
2	Smartphone	10	20	1.5	30	10,950	365
1	Refrigerator 25 L	200	200	12	2,400	876,000	365
1	Iron	1,000	1,000	0.36	360	131,400	365
1	Microwave	1,000	1,000	0.15	150	54,750	365
1	Vacuum cleaner	800	800	0.3	240	87,600	365
1	Hair dryer	500	500	0.09	45	16,425	365
			P = 4,252		Q = 5,754	Q = 2, 021,747	

In this third category of consumers, one can find high-tech appliances and other electric equipment which used every day. Hence, the difference concerns the quality of the material which has too much power. Moreover, in these houses, electric household appliances are numerous and diversify like microwave oven, hair dryer, vacuum cleaner…

Thus, external lighting relates to all the extent of the property. For some privileged people, there is also swimming pool. Internal lighting serves the entire house such as living room, bedroom, corridors, shower room, garage… Hence, the average power observed in this category of habitation is about 5 kVA.

1.1. Rural environment

In the rural environment, the global needs are clearly weaker. They are generally limited in lighting and multimedia, for more than 70 % of the population in the rural environment. Thus, the portable kit is there privileged. It is not requiring any fixed structure for the installation of solar panels.

To define the concept as well as possible, we will give hereafter a standard model of the average consumption observed. The average of the daily consumption is about Q = 812 Wh/day.

It is noticed that for this category of habitation, external lighting does not essential. Thus, in rural environment, the average power observed do not exceeds 500 W.

TABLE 4. Rural environment

Number of appliances	Appliances	Unity power [W]	Total power [W]	Duration [h]	Energy [Wh/day]	Energy [Wh/year]	Days of use
1	Compact fluo lamp living room	9	9	5	45	16,425	365
2	Compact fluo lamp bedroom	7	14	4	56	20,440	365
2	Compact fluo lamp bedroom	6	12	5	60	21,900	365
1	Fluo lamp shower room	4	4	3	12	4,380	365
1	TV	90	90	4	360	131,400	365
0	Decoder	25	0	2	0	0	365
1	Hi - Fi	90	90	2	180	37,800	210
1	DVD player	35	35	1	35	7,350	210
1	Laptop	54	54	3	162	51,192	316
1	Smartphone	10	10	1.5	15	5,475	365
0	Refrigerator 200 L	150	0	12	0	0	365
			P = 318		Q = 925	Q = 296,362	

IV. CONCLUSION

One could see in this work a detailed structure of the global demand of the electricity in Madagascar, in rural and urban environment. For this last, the energy needs was studied according to the socio-professional category of the subscribers. Thus, the necessary average power lies between 1 kVA for standard habitation and 5 kVA for luxurious villas. This approach will allow thereafter the development of the type of equipment which can satisfy the energy demand while taking into account of the constraints of the search for energy saving.

APPENDICES: ENERGY CONSUMPTION CHART EXAMPLE

	LOADS	WATTS	ANNUAL kWh
HOUSEHOLD APPLIANCES	Baby Food Warmer	165	22
	Blanket (Electric)	170	147-150
	Blender	290-385	1.5
	Broiler	375-6700	85-100
	Can Opener	100	0.3
	Carving Knife	92	0.8
	Clothes Dryer	4856	840-1397
	Coffee Maker	575	106
	Cooker-Fryer/Dutch Oven	1200	23
	Corn Popper	575	9
	Deep Fryer	1380-1667	83
	Dishwasher	1190-1250	182-363
	Egg Cooker	500-550	13
	Floor Polisher	312-350	15
	Fondue/Chafing Dish	800	9
	Freezer (15 cu. ft.)	341	700-1450
	Freezer (Frostless 15 cu. ft.)	440	1195-2150
	Fruit Juicer	100	0.5
	Frying Pan	1100-1250	100-186
	Griddle	1200	46
	Grill (Sandwich)	1050-1250	20-33
	Heating Pad	6	12-36
	Hot Plate	1256	90
	Ice Cream Freezer	130	0.7
	Ice Crusher	100	0.5
	Iron	1000-1100	60-144
	Kettle	1500	75
	Knife Sharpener	40	0.2
	Microwave Oven	1450	190
	Mixer (Hand)	80	1
	Mixer (Stand)	150	2
	Oven (With Range)	12,200	750-1200
	Oven (Self Cleaning)	12,200	750-1205
	Refrigerator (12 cu. ft.)	240	725-1200
	Refrigerator (Frostless 12 cu. ft.)	330	1200-2100
	Refrigerator/Freezer (14 cu. ft.)	325	1135
	Refrigerator/Freezer (Frostless 14 cu. ft.)	425-615	1830
	Roaster	1333-1425	60-205
	Rotisserie	1400	73
	Sewing Machine	75	11
	Slow Cooker	200	139
	Table Range	1100	112
	Table Clothes Washer	95	4
	Toaster	1100-1250	39
	Toaster Oven	1500	
	Trash Compactor	400	50
	Vacuum Cleaner	540-630	46
	Waffle Iron	1080-1116	22
	Warming Tray	140	7
	Washing Machine (Auto)	375-515	103
	Washing Machine (Manual)	286	76
	Waste Disposal	420-445	30
	Water Heater		
	Standard	3000	4050
	Quick Recovery	4500	4500

	LOADS	WATTS	ANNUAL kWh
CLIMATE CONTROL	Air Cleaner		216
	Air Conditioner		
	Central		2000-3600
	Room	1300	1275-1350
	Dehumidifier	240	377-559
	Fans		
	Attic	375	312
	Circulating	85	36
	Furnace	270	360
	Roll-About	205	108
	Window	190	144
	Heater (Radiant)	130	156
	Humidifier	70	150-260
LIGHTING	Bathroom	50	18-30
	Bedroom	50	20-50
	Dining/Den	100	144
	Hall	75	54
	Kitchen	100	75-100
	Living Room	75	108
	Porch	100	30-70
ENTERTAINMENT	Car Stereo	15	
	CB Radio	12	
	Movie Projector	600	
	Radio	71-80	86
	Slide Projector	300	
	Stereo/Phonograph	105	108
	Television (B&W)	75-250	120-400
	Television (Color)	200-300	320-660
PERSONAL CARE	Curling Iron	40	1.6
	Hair Clipper	10	0.3
	Hair Dryer		
	Hand Held	500-1000	15-40
	Hard Bonnet	1000	45-60
	Soft Bonnet	400	30
	Heat Lamp	250	13
	Mirror (Lighted)	20	2
	Shaver	14	2
	Shaving Cream Dispenser	60	0.4
	Sun Lamp	280	12-16
	Toothbrush	1.1	0.10
SHOP TOOLS	Drill		
	Portable (3/8")	264	
	Press	660	
	Lathe (12")	660	
	Router	720	
	Sander		
	Orbital	300	
	Polisher	1080	
	Saw		
	Circular	800-1080	
	Saber	288	
	Table	800-950	
	Soldering Iron	125	

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