Abu Alanda Housing Competition

Conceptual approach for
water and energy efficient
low-income apartments
in Abu Alanda district
Amman-Jordan

Report

0. Introduction

0.1 Objectives

The project aims to achieve 3 main objectives:

Environment: Creation of an answer for the site; considering its location in a semi-arid environment with significant slope lots, providing new urban spaces independent yet easily linked in the future with the new expanding urban tissue.

Function: Recognize residential use of the building over its form, providing quality in both internal and external spaces. Efficient use of materials and elements considering always the reality of low-income housing.

Bioclimatic architecture: The building as the base of adapting to sustainable criteria, using passive strategies, control of water and energy consumption, as well as active strategies, taking advantage of climatic conditions.

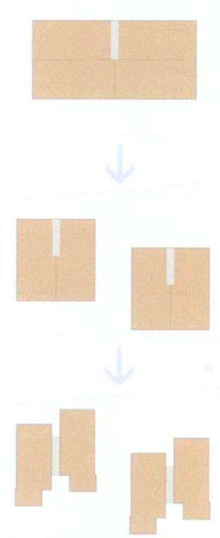
The proposal shows that sustainability is treated on different levels of architectural actions, with optimization of resources with adapted design and appropriate maintenance. Although it requires a higher investment initially, payback period is short especially for apartments units.

1. The proposal

1.1 Conceptual approach

Implementation of the buildings is result of 2 main ideas:

Connect disconnecting



The proposal considers that achievement of project goals of residential density and site slope requirements, urges to provide an integrated proposal able to achieve minimum impacts on site

Defragmentation and displacement of building to adapt on site topography, starting from the compact composition of a whole block, provides creation of intermediate private and communal spaces more integrated in the landscape. The result is 2 separated bodies that contain 19 dwellings (result of application of proportional floor area ratio over the whole plots to achieve 168 housing units).

To understand both blocks as one building, in this special condition, flow of accesses are related in such a way that both blocks depend on each other when accessing from opposite levels. Energy system strategy must be also considered as one to achieve more efficiency.

Another degree of defragmentation is within each body itself, around its stairs core, this provides added values for each flat allowing more privacy spaces and appropriate southern orientation.

Use as a group

Communal spaces created between buildings will assure social areas of relation and internal safe playground for children and families; this is believed to be a measure of improvement for external spaces.

Again, there is another level of connection between plots, using intermediate spaces between buildings as a whole longitudinal chain of communal spaces of similar levels that reach to the central public park.

1.2 Uses program

Residential

Provide both indoor and outdoor living spaces, the proposal suggests a meeting point between social requirements of apartment distribution and efficient distribution of indoor spaces, the result is to assure south facing living room with appropriate terrace dimensions to provide a private leisure area and shadow in summer, and dormitories oriented to north and east/west.

1.3 Definition of urban space

Urban works in the project focuses to create spaces rather than provide high quality materials of finishing. Local materials (from site) are supposed to be re-used for creating landscape works such as gabion walls and dry stone walls, remaining areas are adapted to provide spaces with minimum intervention, and use of local trees and xerophilous plants in appropriate places to provide shadow and wind blockage

2. Bioclimatic architecture

2.1 Energy strategy

The proposal suggests working on 2 axes when dealing with energy requirements of the apartments. From one side, to reduce the demand of energy of the families to a reasonable level, less demand at the end means less consumption. This is meant to be achieved by **passive measures** of design, mainly with the following applied ideas:

1-Reduce overall wall and roofs thermal transmissions by introducing isolation materials in wall and roof section, as well as wall composition allowing ventilation with industrial systems of ventilated facades, this supposes also less water consumption during construction phase of the building.

The following table compares common cases of construction with this proposal, and shows the reduced percentage of thermal demand that reaches 40%.

	Skin 1- Walls- U value W/m2K and composition		Skin 2-Roofs- U value W/m2K and composition		Skin 3-Windows- U value W/m2K and composition		Heat demand average/m2 for ΔT of 20°C
Common building	1.2	Un-insolated hollow brick wall	1.4	Un-insolated roof	5.4	Single glazed windows	95W/m2
Proposed	0.5	Insolated & ventilated façade	0.5	Insolated roof	2.8	Double glazed windows	45W/m2

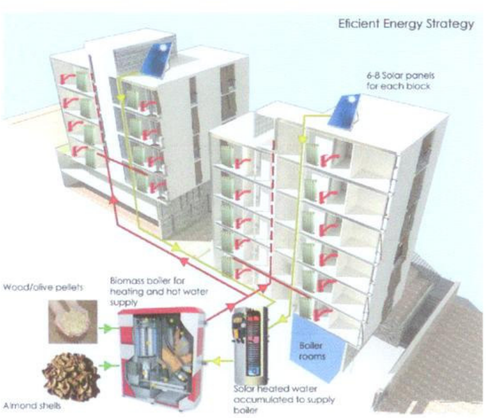
2- Appropriate building orientation, as a result, each flat has the living area is oriented to south providing clear distance between buildings to provide enough direct sunshine during the day which also reduces heat demand in winter.

3- Outside solar protection, using exterior "roll up" shades from a recycled material (palm leaves or bamboo).

4- Cross ventilation. This proposal doesn't consider air conditioning systems, yet the building's displacement around the stair case allows cross ventilation of each apartment, especially for the cool western summer breeze in Amman.

Active measures for energy strategy are the other axis that should deal with the demands of energy in the apartments.

The starting point of the strategy is to centralize production of energy; this means less costs of implementation of energy production systems as well as its maintenance. Energy would be produced centrally for the 19 apartments (2 proposed blocks), so each apartment would be billed according to its consumption from this "central generator".



The strategy of energy generation can be summarized in the following steps:

1-Solar energy for water heating, as has been a common practice for long time, Amman is an appropriate to use its 4.5 KWh/m2 average solar radiation energy per day. This is achieved by 6 to 8 solar panels located over each block roof, oriented to south with an inclination of 60° to avoid overheating in summer, and a good optimization of solar angel in winter.

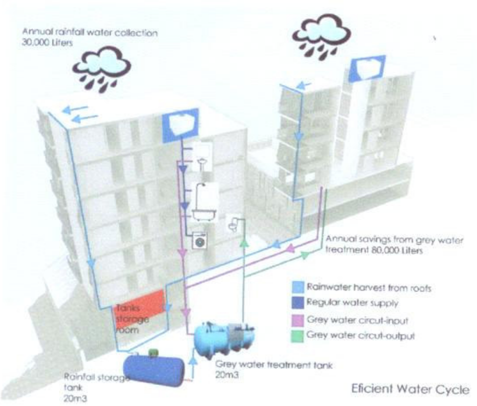
Hot water generated with solar panels of each block will be first accumulated in a water tank. Once hot water is demanded, it will circulate to its next stage which is the central boiler.

2- Central biomass boiler will be used as the source of water heating production for apartments, since it has the support of solar panels, the incoming water will require less energy to be pumped at 60°C from the boiler.

The boiler requires a deposit of biomass fuel that can be provided with many surrounding agricultural productions available around Amman, such as olive pellets and many agricultural wastes.

Biomass boilers are very efficient specially if used for central energy generation, and depending also on the kind of fuel used. As a reference; it is needed 2 Kg of compressed olive pits to produce the same energy of 1 L. of diesel

2.2 Water efficient cycle



Eficient Water Cycle

As energy efficiency of the apartments, water efficiency also works on 2 axes, reduction of demand and efficient water supply.

Reduction of demand should be achieved using simple practices of water saving at homes such installing faucets with aerators to reduce water consumption and toilets with dual flush. These simple measurements would save up to 20% consumption of water at homes.

For water supply it is also formed of 2 systems, one of roof rain water collection that will support a grey water reuse system. Rain water collection is justified for regions with more of 200mm rainfall per year, considering the 400m2 of roof available, and a period of 45 days of deposit of rainfall frequency, it is calculated that approximately 30,000 liters can be collected per year using a tank of 20m3 (2x2x5) despite this means a low percentage of overall water consumption, it means a support for the whole water supply system.

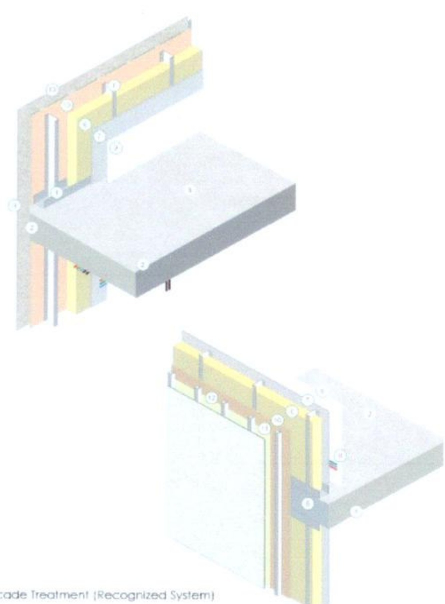
Collected water from rainfall would supply the grey water network after collecting the closed network of grey water to provide after that water for toilet tanks in the apartments.

Grey water use is justified considering a network for 19 apartments (2 blocks), size of grey water tank is again 20m3 and it is expected to save 800,000 liters of water per year for 19 apartments.

2.3 Construction system

Construction system is proposed to be of a mix system of common construction of structural elements and pre-industrialized system of façade and internal walls, this system not only provides appropriate insulation of the wall and structural joints of slabs and columns as it allows to create a ventilated façade, but also allows ecological and practical advantages such as:

- Dry construction of façade and internal walls which means less use of water during construction
- Optimization of construction periods reducing time needed by 25%
- Allows to be combined with different interior and exterior finishing
- Minimizes waste materials during construction



Facade Treatment (Recognized System)

01. Frame of 105 mm cold-rolled galvanized steel beams
02. Floor of 250 mm reinforced concret
03. Fixings: Self-taping bolt for joining metal components
04. Layer of neoprene
05. Cold-rolled galvanized steel beam
06. 100 mm Mineral wool sheet in light gauge steel framework
07. Internal sheet of standard 13 mm laminated plasterboard
08. Electrical installations (with 36 mm cladding)
09. Standard 15 mm laminated plasterboard
10. 10 mm OSB/3
11. Impermeable hdpe sheet. Water vapor resistant
12. 40 mm Airway in ventilated exterior wall
13. Exterior lining

3. Tables of costs and LCCA

3.1 Table of costs

General budget		Built area (m2)	ratio: cost / m2 built dwelling (JD/m2)	Total cost (JD)
I. CONSTRUCTION				
	Dwellings (19 apartments)	2.735	235	642.749
	Total Residential	2.735	235	642.749
	Parking (underground)	1.192	118	140.089
	Techinical areas	189	118	22.237
	TOTAL CONSTRUCTION	4.117		805.075
II. ORIENTATIVE INCREASE FOR ADOPTED MEASURES OF EFFICIENT ENERGY STRATEGIES				
	Pasive measures	3,0%	7	19.146
	Active measures			
	Centralized energy generation	2,1%	5	13.676
	Grey water and rainfall efficient water cycles	1,7%	4	10.940
	Total of energy measures	6,8%	16	43.762
	TOTAL OF CONSTRUCTION AND ENERGY MEASURES			848.836
III. URBAN WORKS				
	Urban works on plot	1.121	25	28.025
	TOTAL			876.861
	AVERAGE TOTAL COST OF CONSTRUCTION (JD/m2 constructed)		213	

3.2 Table and diagrams of Life Cycle Cost Analysis for 20 years

From detailing table below it can be seen that project's objectives are adapted to reality of low-income houses, all measures of bioclimatic architecture mean to save costs (up to 33%) for final users throughout time as well as achieving more sustainable environment compared with a common construction practice. (Costs are calculated not considering financial costs and inflation)

Costs analysis
20 years period

EFFICIENT PROJECT

	Total community cost (JD)	Total cost per apartment (JD)	Annual cost per apartment (JD)	Monthly cost per apartment (JD)
CONSTRUCTION	**833.100**	**43.847**	**2.192**	**183**
IMPLAMENTATION OF ENERGY STRATEGY	**43.762**	**2.303**	**115**	**10**
Passive measures	19.146	1.008	50	4
Active measures				
Centralization of energy production	13.676	720	36	3
Water efficient cycle (Grey water and rainfall circuits)	10.940	576	29	2
OPERATION	**166.234**	**8.749**	**437**	**36**
Maintenance & Conservation (Building, Centralized Plumbing, Urban areas)	81.850	4.308	215	18
Consumes				
Heating of apartments (radiators)	45.000	2.368	118	10
Hot water supply	21.880	1.152	58	5
Water	17.504	921	46	4
TOTAL JD	**1.043.095**	**54.900**	**2.745**	**229**

COMMON CONSTRUCTION

	Total community cost (JD)	Total cost per apartment (JD)	Annual cost per apartment (JD)	Monthly cost per apartment (JD)
CONSTRUCTION	**833.100**	**43.847**	**2.192**	**183**
IMPLAMENTATION OF ENERGY STRATEGY	**20.513**	**1.080**	**54**	**4**
Passive measures				
Active measures				
Centralization of energy production	20.513	1.080	54	4
Water efficient cycle (Grey water and rainfall circuits)				
OPERATION	**286.738**	**15.091**	**755**	**63**
Maintenance & Conservation (Building, Decentralized plumbing, Urban areas)	98.220	3.877	194	16
Consumes				
Heating of apartments (radiators)	108.000	5.684	284	24
Hot water supply	52.512	2.764	138	12
Water	28.006	1.474	74	6
TOTAL	**1.140.351**	**60.018**	**3.001**	**250**

Note: Financial costs not included