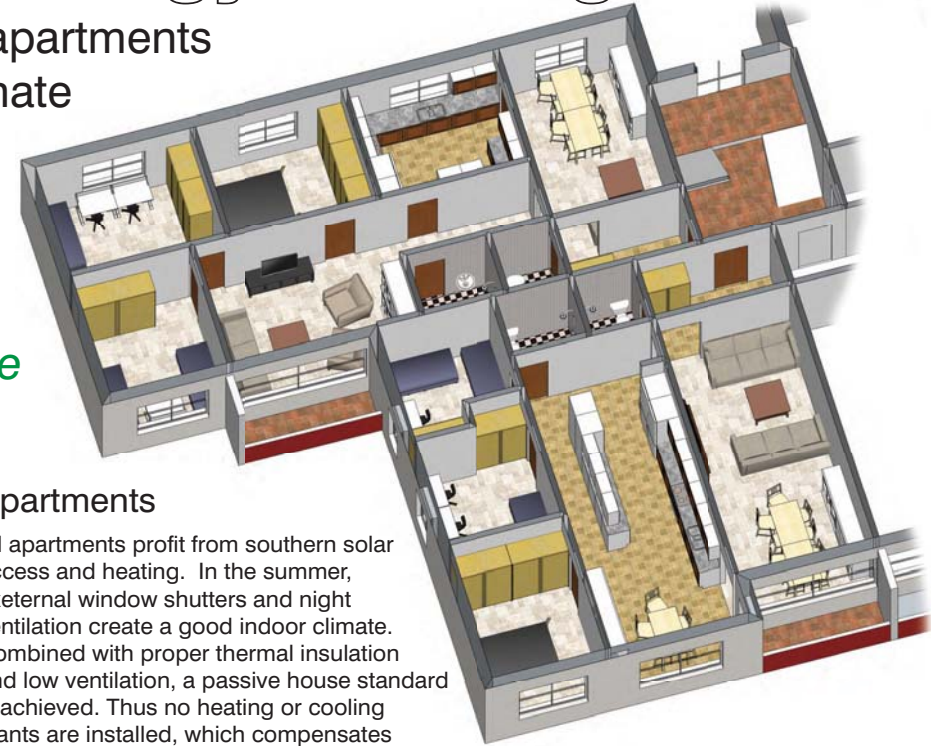


AO+ OVERVIEW

Amman Zero-/PlusEnergy Housing Model

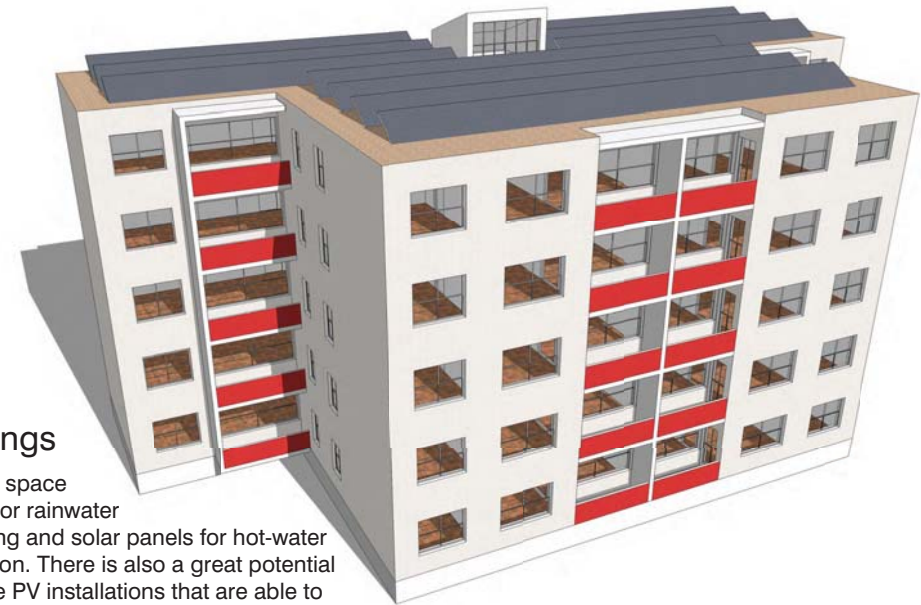
This proposal offers 168 well-planned apartments with an all-year comfortable indoor climate without *any* cost for heating/cooling, and with energy and water saving appliances – all to a normal construction cost!

*A modern, green lifestyle
in an attractive
area.*



Apartments

All apartments profit from southern solar access and heating. In the summer, external window shutters and night ventilation create a good indoor climate. Combined with proper thermal insulation and low ventilation, a passive house standard is achieved. Thus no heating or cooling plants are installed, which compensates for the extra insulation needed!



Buildings

The roof space is used for rainwater harvesting and solar panels for hot-water production. There is also a great potential for future PV installations that are able to produce enough electricity for the households' consumption – and even more!



The Area

Car access, parking and entrances are mainly from north and east, while green areas with walkways, sitting areas and children's playgrounds are towards the south and west. This creates a protected outdoor environment for the inhabitants; with sunny spaces in the winter and shading trees in the summer.

AO+

Amman Zero-/Plus Energy Housing Model

THE SITE

To assure winter solar access for all buildings, the proposed plot division was broken up. The green area is distributed along the entire plot, making a green walkway between the east access point and the north-west extreme – promoting internal communication in the whole *Abu Alanda Phase III* area. All buildings have their main facade – with larger windows – towards the south, with a maximum deviation of 15°. This direction assures optimum solar gains into the apartments in the winter and shading from the sun's higher altitude in the summer.



ELEVATION SOUTH



ELEVATION NORTH



ELEVATION EAST



ELEVATION WEST

Area Distribution

The eight buildings include totally 42 floors with an area of 493 m² each, resulting in a Floor Area Ratio, FAR=1.46 for the designated plot area. Maximum allowable is 1.76.

The public green area in the centre and north-west is about 5,200 m². There is also green space around and between the buildings. Local, low-cost and drought-resistant plants, irrigated by reused greywater, will reduce virgin water user for irrigation to zero, and guarantee a pleasant outdoor environment.

A drip irrigation system is estimated at about 3,000 JD for the entire area, which is a very marginal cost.

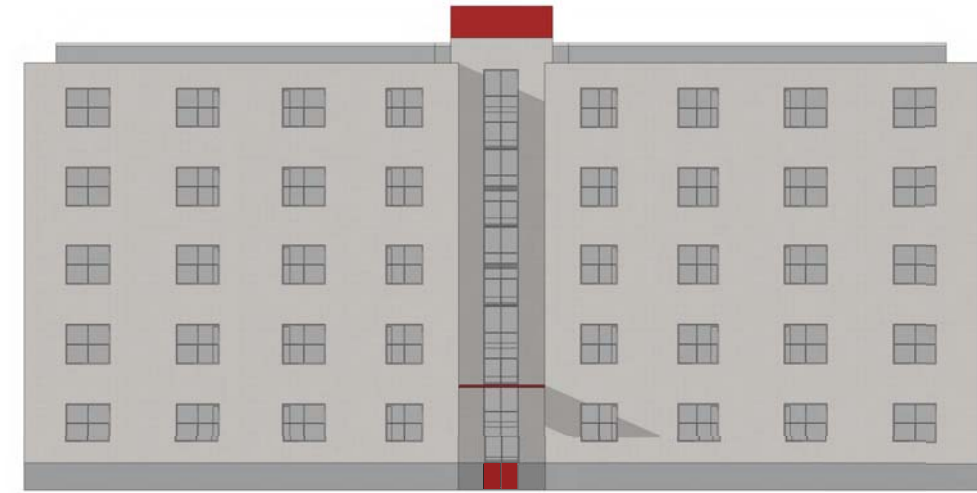
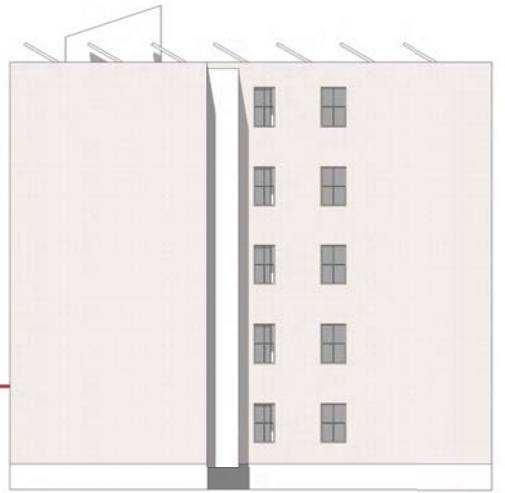
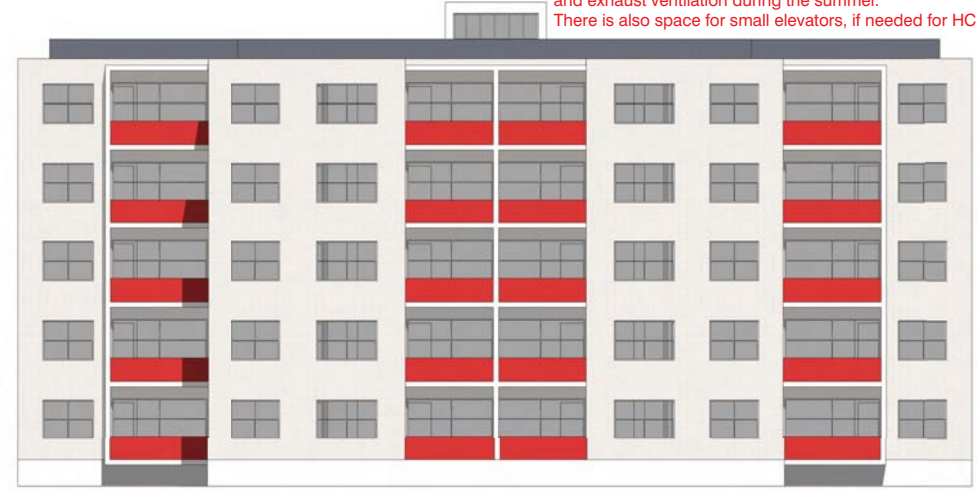
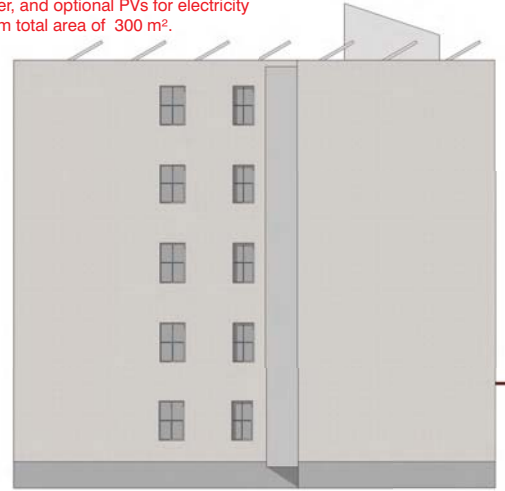
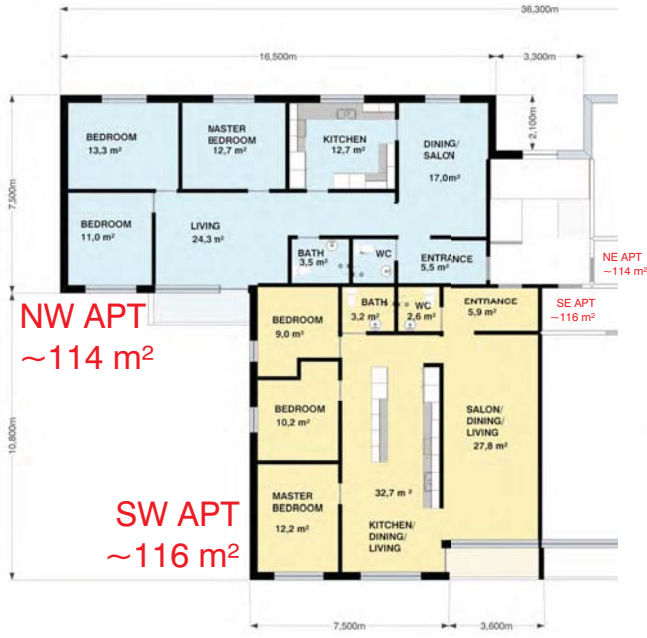
AO+ BUILDINGS

Amman Zero-/PlusEnergy Housing Model

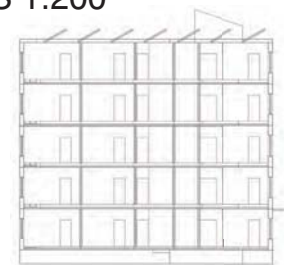
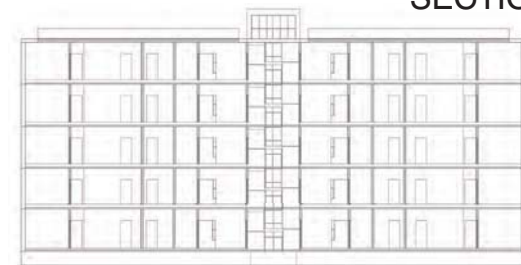
Solar panels for hot-water, and optional PVs for electricity production at a maximum total area of 300 m².

The staircase gets winter daylight and heating, and exhaust ventilation during the summer. There is also space for small elevators, if needed for HC.

SCALE 1:100



SECTIONS 1:200



The apartments have a traditional type of entrance with plenty of space for storage/wardrobes, and a direct link to the guest toilet. There is also a communication to the reception salon and further into the private living area. The kitchen is located next to the salon, which also contains a dining place. Behind is the private living area, with bedrooms and the family bathroom. The northern apartments could be considered more 'traditional', while on the south side the plan is more open, with flexibility in reception/living/dining functions. All bedrooms have plenty of storage space and workplace for school children.

See also the furnished perspective on Panel 1!

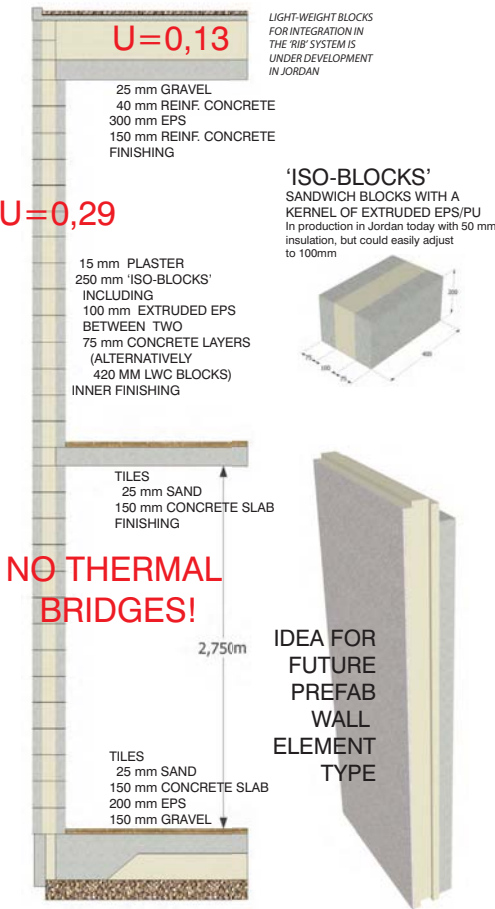
AO+ CONCEPTS

Amman Zero-/PlusEnergy Housing Model

Typical Wall Section

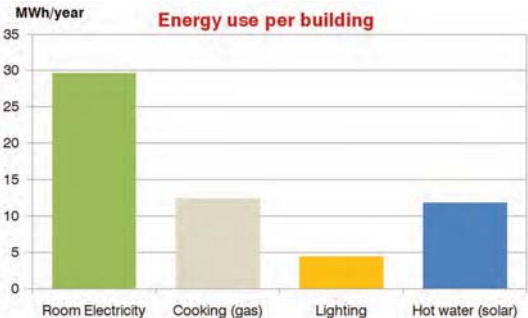
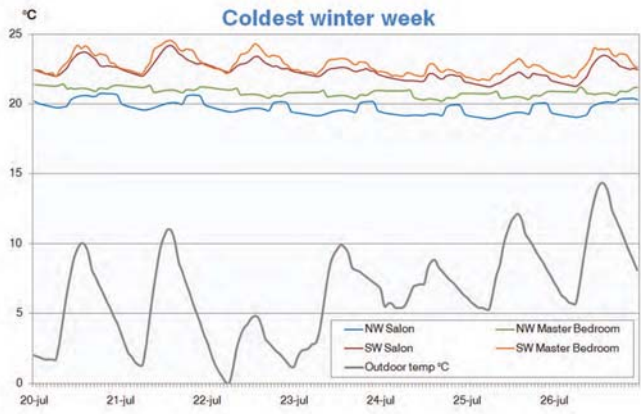
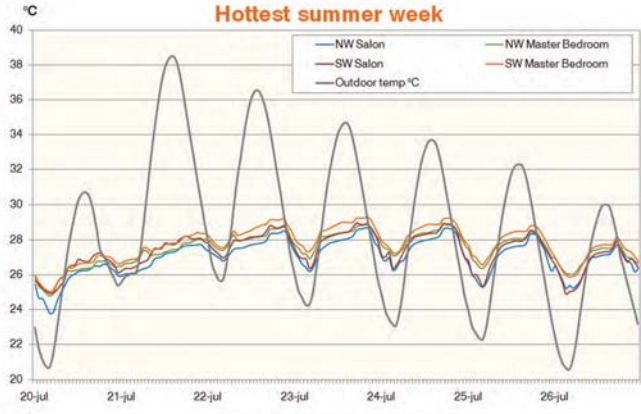
The manufacturing sector of systems for insulated envelopes is developing rapidly in Jordan today. Here, we show some alternatives fulfilling U-value requirements.

DETAIL 1:20



Energy-Efficiency and Comfort

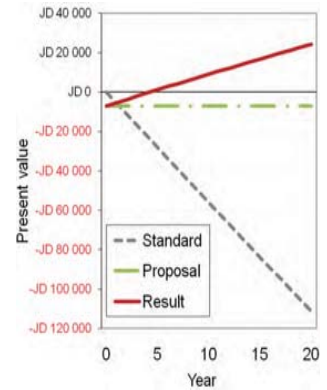
The design and material choices permit to create an acceptable indoor climate with *passive* techniques – in summer as well as in winter. The charts below show the **extremes** during the year for some rooms on the top floor (operative temperatures).



Energy balance

For a 5-storey building, lighting and room electricity add up to 35 MWh/year. This energy may be produced by 150 m² roof-top PV panels. Fully exploited, the roof area may accommodate 280 m² PV panels, producing annually 60 MWh. The site therefore has a potential of being a **PlusEnergy** housing!

Costs and Life-Cycle Assessment



The extra investment pays off in about one year

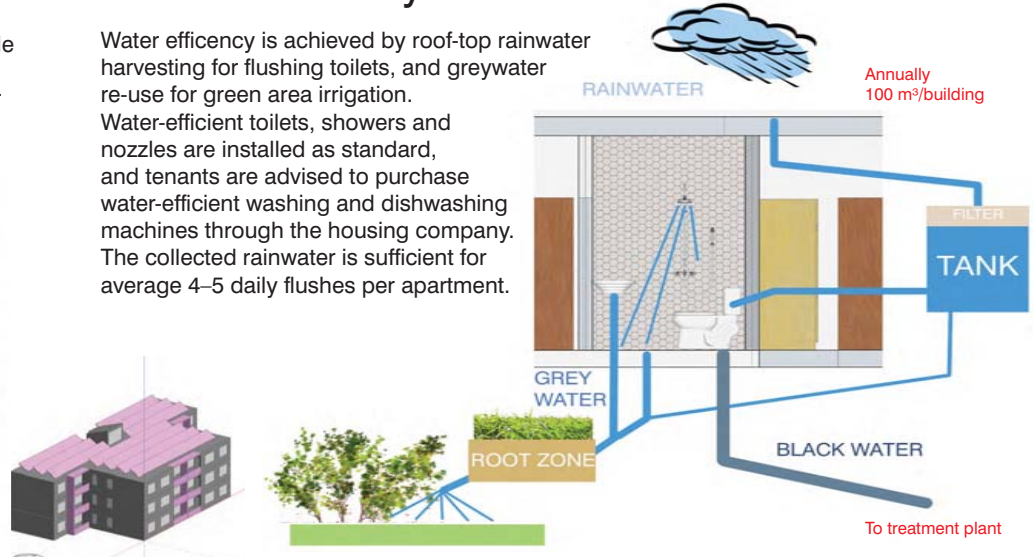
The LCCA chart above is based on 3% inflation and 5% annual increase in energy prices

This proposal can be built at normal construction cost!

A future PV panel system may be installed on the roof tops. However, today's electricity price in Jordan needs to be more than tripled to make such investment pay off within 15 years.

Water-Efficiency

Water efficiency is achieved by roof-top rainwater harvesting for flushing toilets, and greywater re-use for green area irrigation. Water-efficient toilets, showers and nozzles are installed as standard, and tenants are advised to purchase water-efficient washing and dishwashing machines through the housing company. The collected rainwater is sufficient for average 4-5 daily flushes per apartment.



A detailed whole-building model (mid-floor repeated 3 times) was simulated in EnergyPlus/DesignBuilder with full-year hourly WMO statistical climate data for Amman Airport

Investment cost differences				
Item	Standard	JD/m ²	Proposal	JD/m ²
Heating	Simple std	1500 JD/apt	None	0
Water supply	Standard	50 JD/apt	Double	100 JD/apt
Sewerage	Standard	50 JD/apt	Double	100 JD/apt
Foundations			Greywater filter	100 JD/apt
			Rainwater tanks	inst of boiler room
			Extra insulation	Ground 200 mm
Windows	1-glazed	40 JD/m ²	2-glazed	60 JD/m ²
	15%	287 m ²	32%	383 m ²
Walls	100 HCB	14 JD/m ²	150 w 100 EPS	20 JD/m ²
TOTAL		27		30
				Additional cost
Annual operation cost differences				
Item	Standard	JD/m ²	Proposal	JD/m ²
Heating	Simulated	290 JD/apt	Passive	0 JD/apt
Water cons.		0,3 JD/m ²		0,1
Tapwater, daily		160 l/apt	WE equipment	80 l/apt
Toilet flush		8 l/flush	ave (2 levels)	2,5 l/flush
Rainwater		0		-100 m ³ /bldg
TOTAL		2,7		0,1
				Saving
				2,6
Pay-back calculation				
		Interest rate not included	Additional construction cost	
			2,9	
		Annual savings		2,6
				Payback period, years
				1,1