al-qadisiya, kuwait city
sustainable urban retrofit and design

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growth in the desert

- growing population
  - 1.25 million citizens
  - 2.25 million non-citizens
- housing waiting list
  - 110,000 currently waiting
  - growing by 8000/year
- planned expansion
  - 5 new cities in the next 10 years
  - partnership through Kuwait-MIT Center for Natural Resources and the Environment

source: Third Kuwait Master Plan, 2005
desert climate

temperature ranges

wind: temperature, velocity and direction
al-qadisiya

- low-density residential neighborhood
  - 1 central service core
  - 8 residential blocks
- near Kuwait city center
  - accessible by car
  - separated by busy roads
- population 20,893
- area 1,745,000 m²
- density 0.012 pp/m²
al-qadisiya block 8

- smaller service locations within this block
  - park
  - youth center
  - mosque
  - cooperative store
- varying degrees of affluence in this block

- 200 villas
- area 202,440 m²
- population >2000
## Housing Typologies

<table>
<thead>
<tr>
<th>government housing</th>
<th>retrofit</th>
<th>replacement</th>
<th>private villas</th>
</tr>
</thead>
<tbody>
<tr>
<td>constructed in the 1950’s and 60’s for limited income families</td>
<td>renovated government villas</td>
<td>detached modern construction</td>
<td>expansive, luxurious villas constructed privately with government loans</td>
</tr>
<tr>
<td>abuts neighbors</td>
<td>usually include new windows and façade treatments</td>
<td>redevelopment of government lots after demolition of older villas</td>
<td>large lots, detached structures</td>
</tr>
<tr>
<td>include internal courtyard</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
goals

provide luxury → promote walkability → outdoor comfort → daylight autonomy → energy intensity → increase density
proposed typologies

provide luxury ← increase density

type I
detached
FAR 1.4

type II
overhang
FAR 1.4

type III
highrise
FAR 5.5
model

block 5

block 8
promote walkability
outdoor comfort
daylight autonomy
energy intensity
walkability

800 m walkable radius
walkability

- 200 m walkable radius
- block 5 amenities unreachable from block 8
- crosswalks help

without crosswalks

with crosswalks
walkability

- block lengths must be shorter than walkable radius
- pedestrian paths within blocks for comfortable movement
- accompany increased density with additional amenities
walkability

without crosswalks

with crosswalks
promote walkability
outdoor comfort
daylight autonomy
energy intensity
outdoor comfort

- **base**: street too hot, smaller courtyards remain comfortable
- **type I**: street too hot, courtyards remain comfortable
- **type II**: overhangs keep street comfortable, courtyards overheat
- **type III**: outdoor area remains cool, urban heat island?
outdoor comfort

uncomfortable hours per year

- **base**
  - max overheating
  - mean overheating
  - max overcooling
  - mean overcooling

- **type I detached**
  - max overheating
  - mean overheating
  - max overcooling
  - mean overcooling

- **type II overhang**
  - max overheating
  - mean overheating
  - max overcooling
  - mean overcooling

- **type III highrise**
  - max overheating
  - mean overheating
  - max overcooling
  - mean overcooling
promote walkability
outdoor comfort
daylight autonomy
energy intensity
daylight autonomy

- **base**
  - highly variable self-shading
  - common

- **type I**
  - courtyards expose lower floors
  - reduced self-shading

- **type II**
  - shaded exterior areas
  - skylighting potential

- **type III**
  - significant self-shading
  - limited view to sky
daylight autonomy

Average cDA

interior daylighting potential

- base
- type I detached
- type II overhang
- type III highrise
promote walkability
outdoor comfort
daylight autonomy
energy intensity
Energy use templates

- **original**
  - mass produced government constructed villas
  - poor construction
  - no insulation
  - single pane glazing

- **retrofit**
  - improvements made on the original homes, often by the homeowners
  - cosmetic renovations to the façade
  - generic double pane glazing
energy use templates

- modern
  - privately built new construction
  - insulated
  - double pane glazing

- revised
  - based on 2010 Building Code
  - not yet applied to villas in the neighborhood
  - increased insulation
  - coated windows
energy use

- original
- retrofit
- modern

revised
energy use

Operational energy use

Embodied energy
promote walkability
outdoor comfort
daylight autonomy
energy intensity
<table>
<thead>
<tr>
<th>Summary</th>
<th>Energy Use kWh/m²/yr</th>
<th>Walkability min - max</th>
<th>Outdoor Comfortable Hours</th>
<th>Daylight Average cDA</th>
<th>Embodied kWh/m²/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base</strong></td>
<td>488</td>
<td>3 – 21%</td>
<td>78%</td>
<td>55%</td>
<td>25</td>
</tr>
<tr>
<td><strong>Type I</strong></td>
<td><strong>Detached</strong></td>
<td>321</td>
<td>7 – 37%</td>
<td>79%</td>
<td>69%</td>
</tr>
<tr>
<td><strong>Type II</strong></td>
<td><strong>Overhang</strong></td>
<td>333</td>
<td>7 – 37%</td>
<td>84%</td>
<td>68%</td>
</tr>
<tr>
<td><strong>Type III</strong></td>
<td><strong>Highrise</strong></td>
<td>298</td>
<td>20 – 45%</td>
<td>89%</td>
<td>26%</td>
</tr>
</tbody>
</table>
thank you