SPATIAL PLANNING FOR THE ENERGY TRANSITION

The role of spatial planning in facilitating the energy transition in Dubai

Karishma Asarpota

Mentors

Vincent Nadin
Carola Hein
Daniela Maiullari

DEWA Energy and Desalination Plant in Jabel Ali, Dubai.
Photo source: Luca Locatelli, Institute for National Geographic

Mohammed Bin Rashid Al Maktoum Solar Park
Photo source: Luca Locatelli, Institute for National Geographic

1 WHAT IS THE LINK BETWEEN URBAN PLANNING AND ENERGY SYSTEMS IN DUBAI?

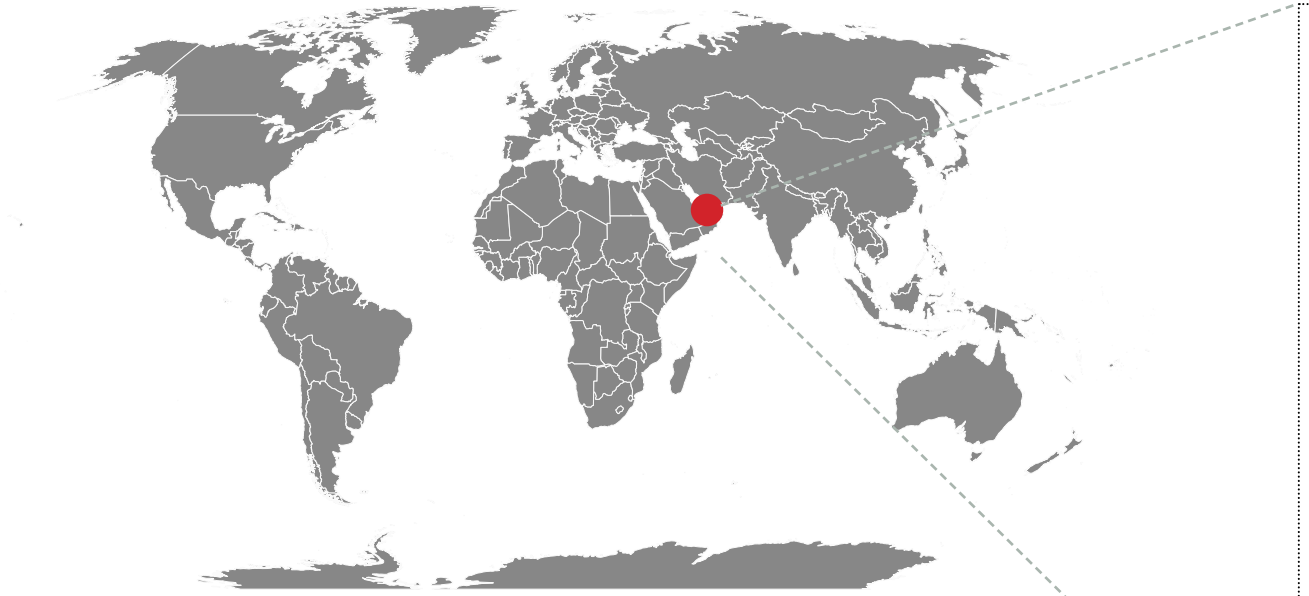
Street in Deira
Photo source: https://www.flickr.com/photos/31357475@N08/11190908373

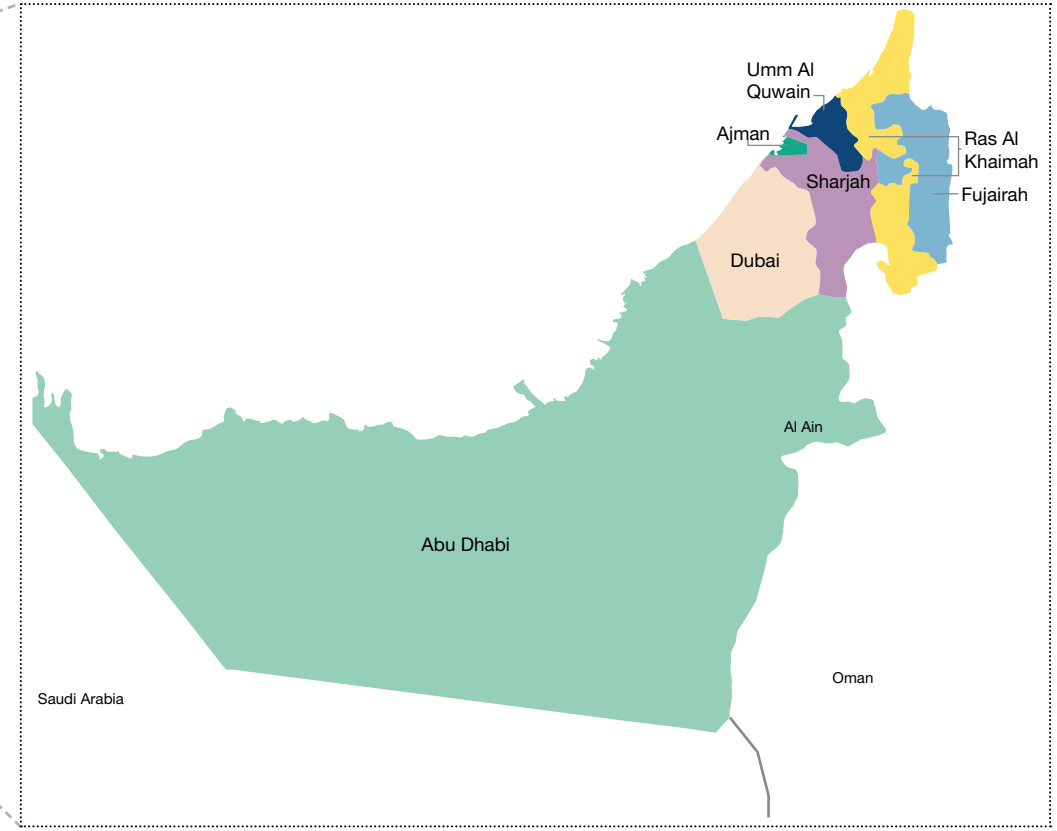
2 HOW DOES URBAN AND SPATIAL FORM CONTRIBUTE TO ENERGY CONSUMPTION?

3 WHAT SHOULD PLANNING DELIVER FOR THE ENERGY TRANSITION IN DUBAI?

4 WHAT CAN OTHER CITIES LEARN FROM THIS RESEARCH?

THE SEVEN EMIRATES IN UNITED ARAB EMIRATES (UAE)





- Capital: Abu Dhabi
- Most populous city: Dubai (2.85 mil)
- Extreme desert climate
- On top of the list of the world's most water stressed countries

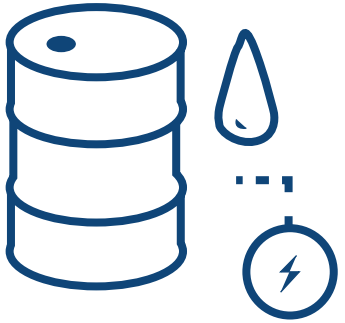
Sources: OPEC, 2017 and http://www.wri.org/blog/2015/08/ranking-world%E2%80%99s-most-water-stressed-countries-2040

URGENCY OF THE PROBLEM

Global warming

70% of cities are facing the impact of climate change

Source:C40 Cities



Energy Security

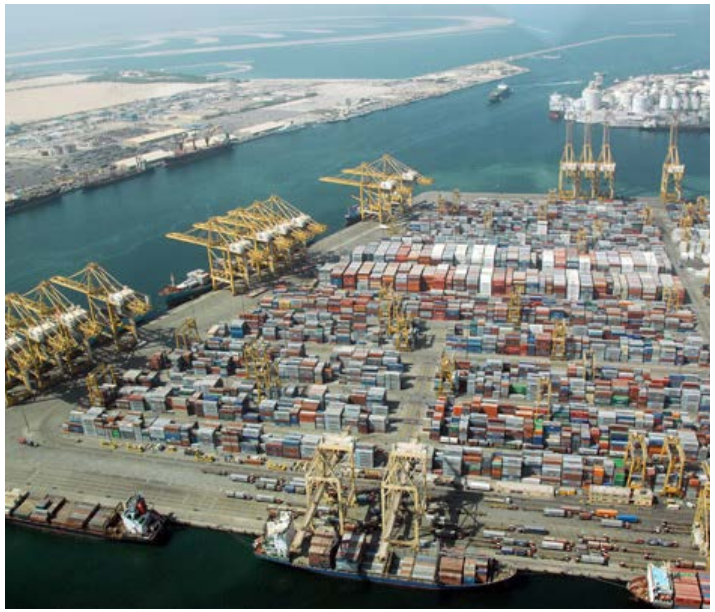
Energy (in)justice

Source for icons: The Noun Project

ENERGY SECURITY IN THE UAE

Energy Security : 'Uninterrupted availability of energy sources at an affordable price.' IEA, 2018

ECONOMIC DEPENDENCE ON OIL AND GAS



Jabel Ali Port

- 50% of exports from petroluem products
- 65% of global oil reserves in the Middle East

7th HIGHEST CONSUMER OF ENERGY WORLDWIDE

Ski Dubai, Mall of the Emirates

- 60-70% of total energy is needed for cooling
- 30% of total energy is needed for desalination

NET IMPORTER OF NATURAL GAS

Dolphin Pipeline between Qatar and UAE

- Expensive to extract
- 26% injeccted back for EOR

Source: S. Sgouris, A. Abdullah, S. Griffiths, D. Saygin, N. Wagner, D. Gielen, H. Reinisch & D. McQueen, 2015. Re-mapping the UAE's energy transition: An economy-wide assessment of renewable energy options and their policy implications. Elsevier.

M. Jamil, F. A., Y.J.Jeon. (2014). Renewable energy technologies adopted by the UAE: Prospects and challengs - A comprehensive overview. Renewable and Sustainable Energy reviews, 55, 1181-1194.

MAIN RESEARCH QUESTION

How can spatial planning help Dubai government to advance the energy transition?

1 WHAT IS THE LINK BETWEEN URBAN PLANNING AND ENERGY SYSTEMS IN DUBAI?

Street in Deira
Photo source: https://www.flickr.com/photos/31357475@N08/11190908373

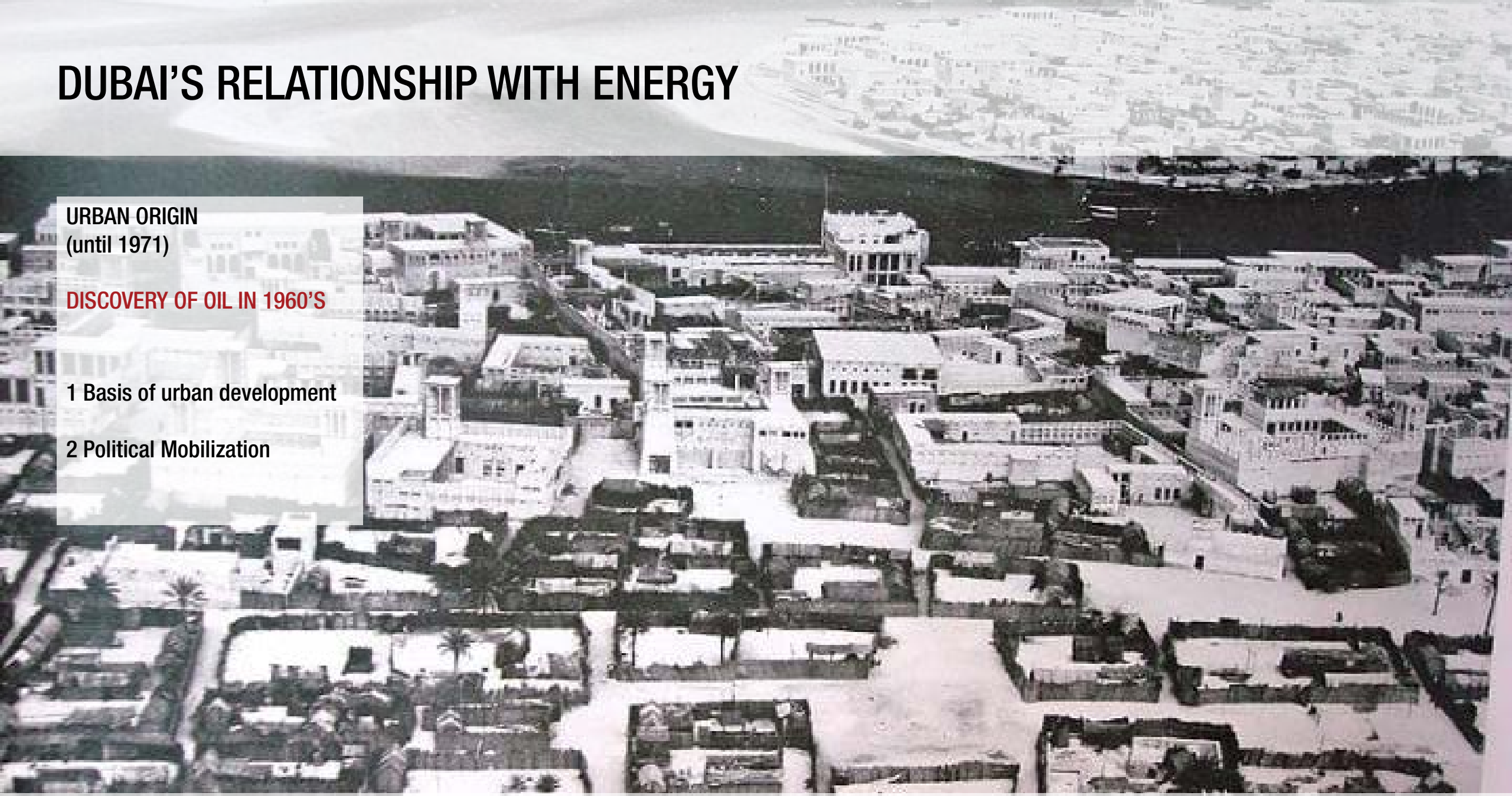
DUBAI'S RELATIONSHIP WITH ENERGY

URBAN ORIGIN
(until 1971)

DISCOVERY OF OIL IN 1960'S

1 Basis of urban development

2 Political Mobilization



Dubai in the 1950's

Photo source: The Telegraph (https://www.telegraph.co.uk/travel/destinations/middle-east/united-arab-emirates/dubai/galleries/Dubai-old-and-new-incredible-pictures-of-the-changing-skyline/)

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PLANNED SUBURBAN GROWTH (1971-1984)

LARGER QUANTITIES OF OIL WERE DISCOVERED

1 Dubai' economic and global success

2 Beginning of an energy intensive urban development and travel pattern which was fuelled by the discovery of oil

Deira Clocktower in 1964
Photo source: Sheikh Mohammed Centre for Cultural Understanding

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MODERNIZATION (1984-2003)

DECLINE OF OIL AND ITS CONTRIBUTION TO THE GDP

1 Change in Dubai' vision

2 Economic diversification promoted real estate development among other industries

View from the Burj Khalifa

Photo source: Luca Locatelli, Institute for National Geographic

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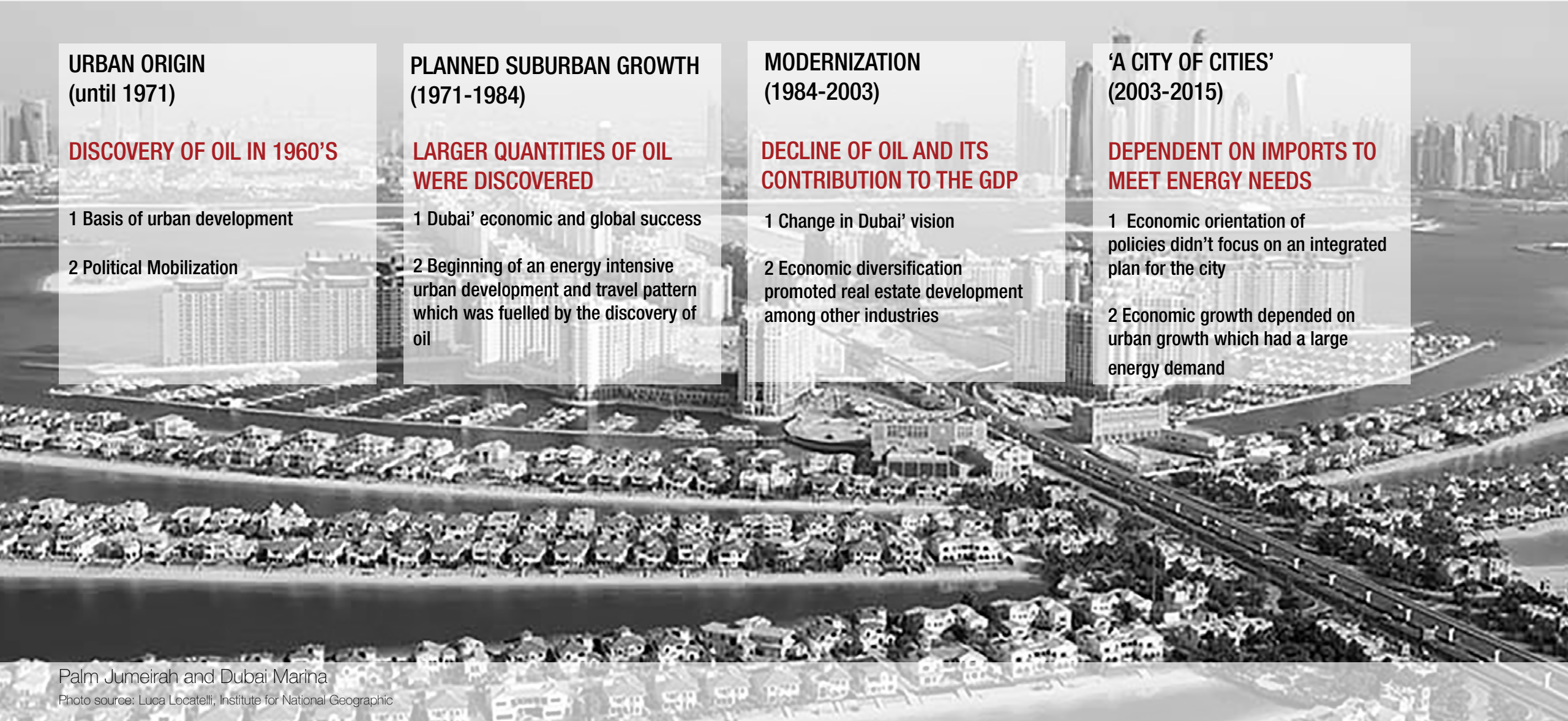
'A CITY OF CITIES' (2003-2015)

DEPENDENT ON IMPORTS TO MEET ENERGY NEEDS

1 Economic orientation of policies didn't focus on an integrated plan for the city

2 Economic growth depended on urban growth which had a large energy demand

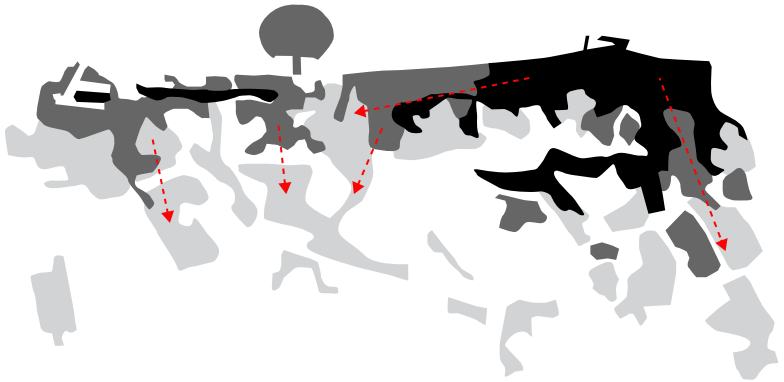


Palm Jumeirah and Dubai Marina

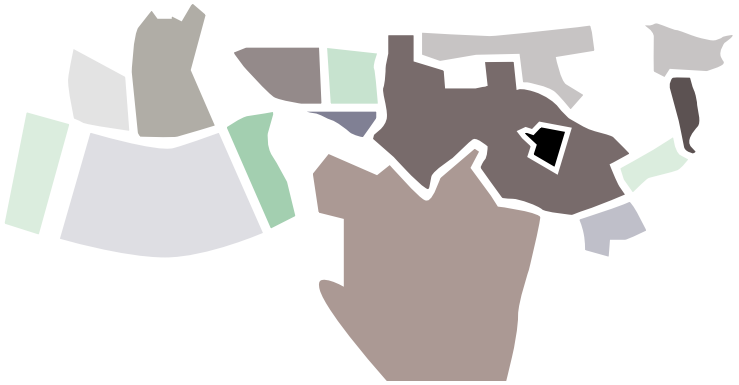
Photo source: Luca Locatelli, Institute for National Geographic

WHAT IS CONTRIBUTING TO ENERGY INEFFICIENCY IN DUBAI?

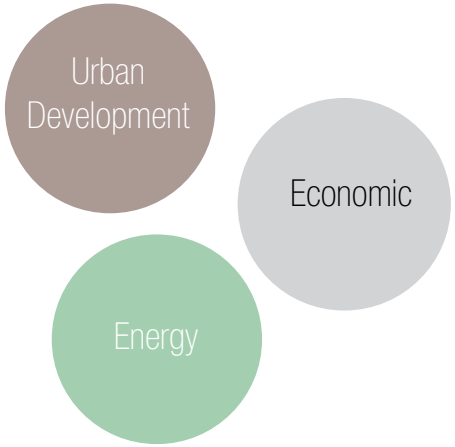
FAST GROWTH



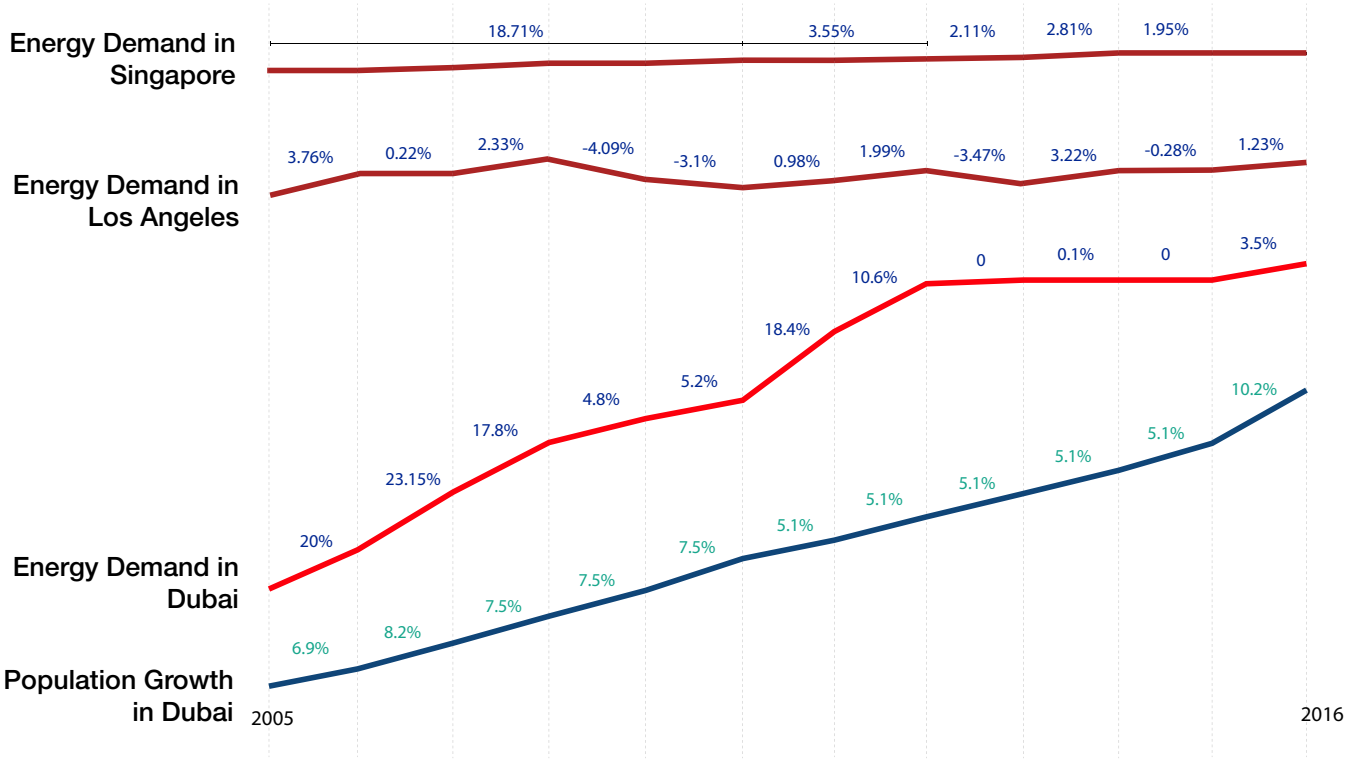
PLANNING PROCESSES

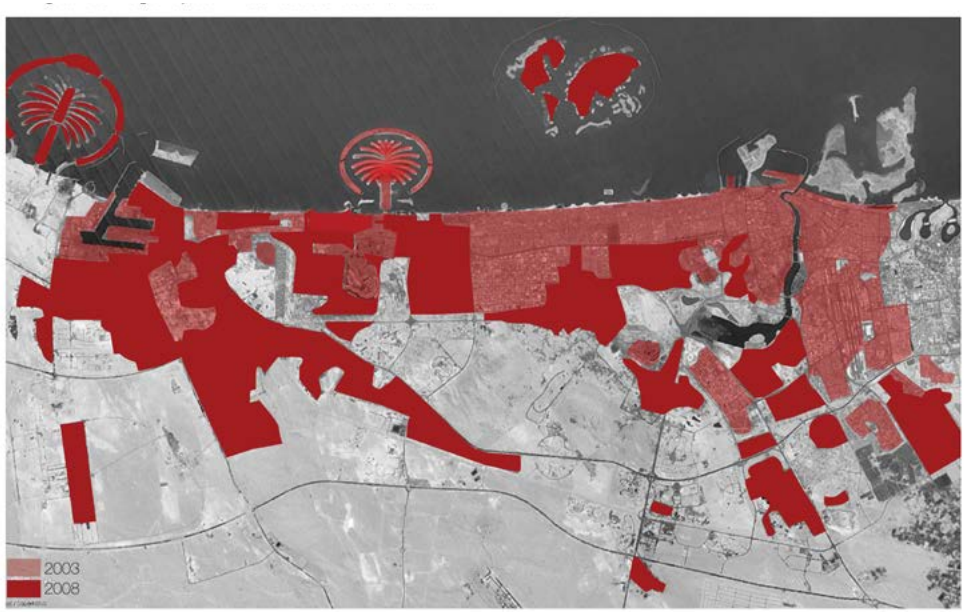


LACK OF INTEGRATIVE POLICIES



FAST GROWTH

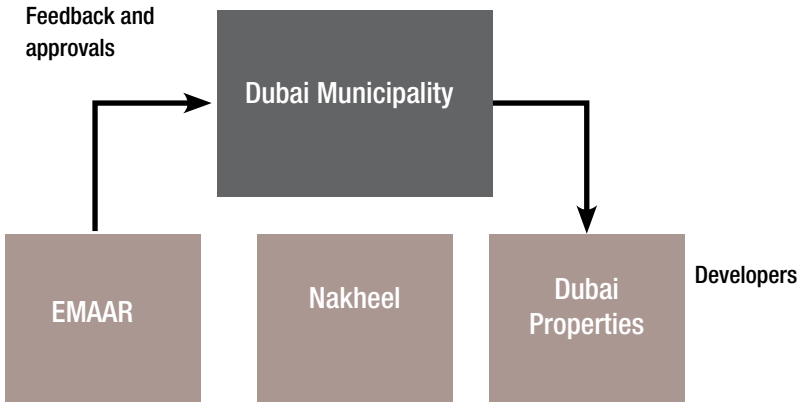




Source: Dubai Statistics Centre
Source: California Energy Commission, http://ecdms.energy.ca.gov/elecbyplan.aspxtion
Source:Singapore Energy Statistics, https://www.ema.gov.sg/cmsmedia/Publications_and_Statistics/Publications/SES%202016/Publication_Singapore_Energy_Statistics_2016.pd

CHANGE IN PLANNING PROCESSES

Free-zones in Dubal



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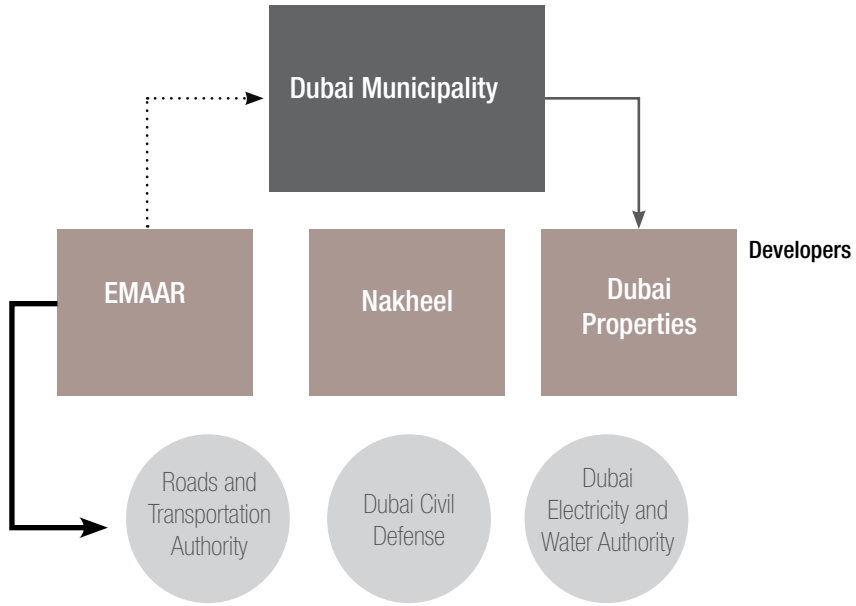
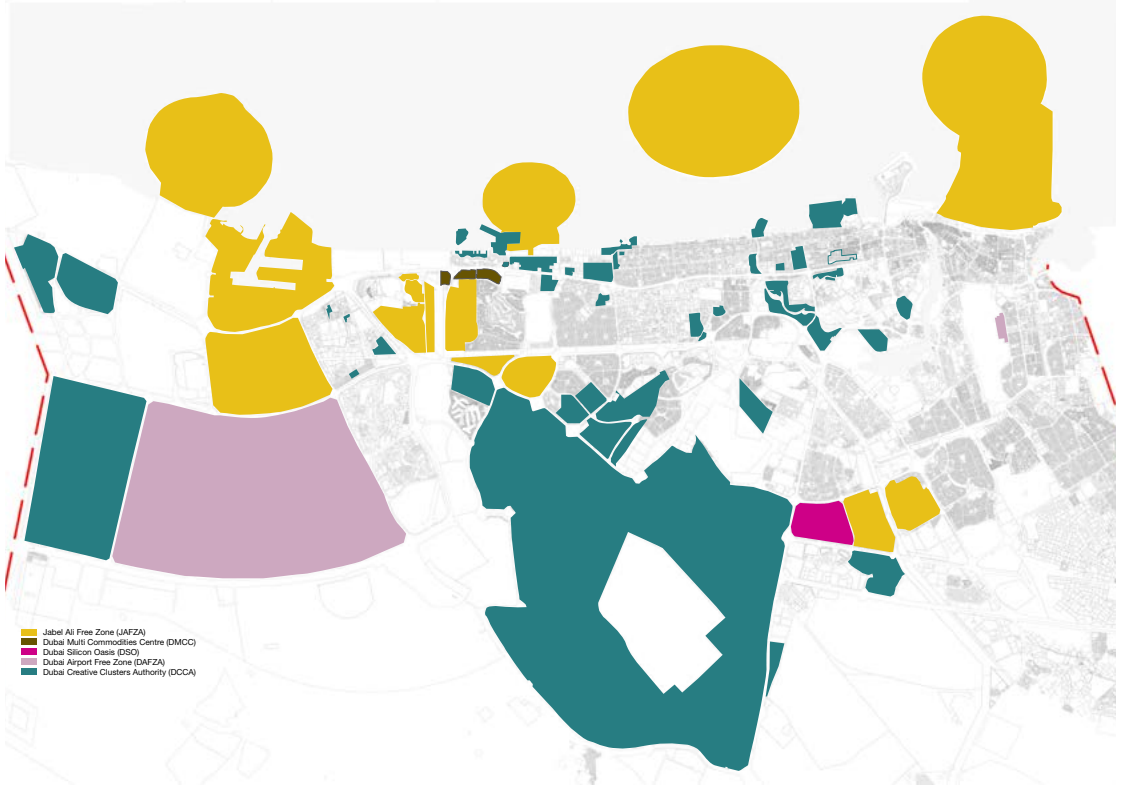
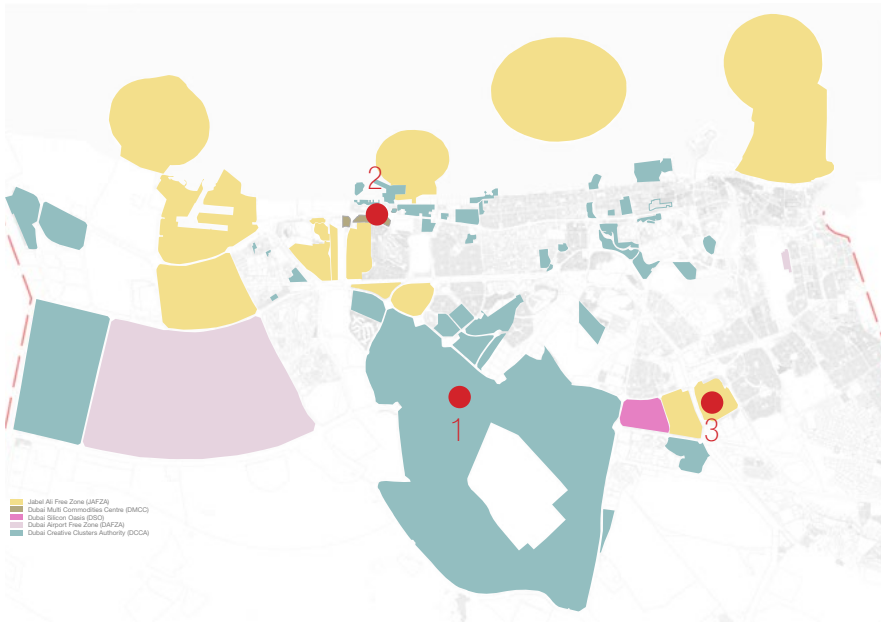




Regulatory Authorities in Dubai

1 Dubai Sustainable City

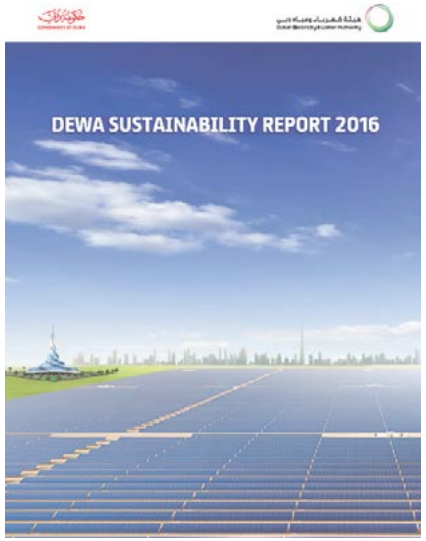


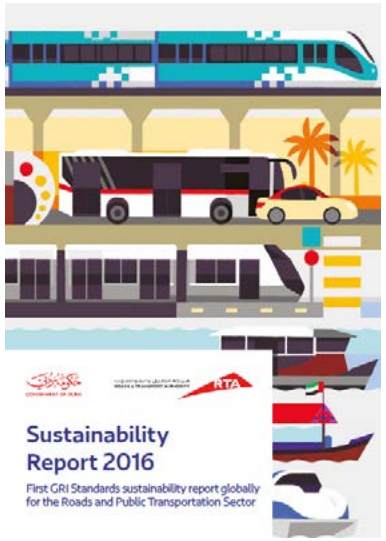
2 Dubai Marina

3 Dubai International City

LACK OF INTEGRATIVE POLICIES

GOVERNMENT AUTHORITIES





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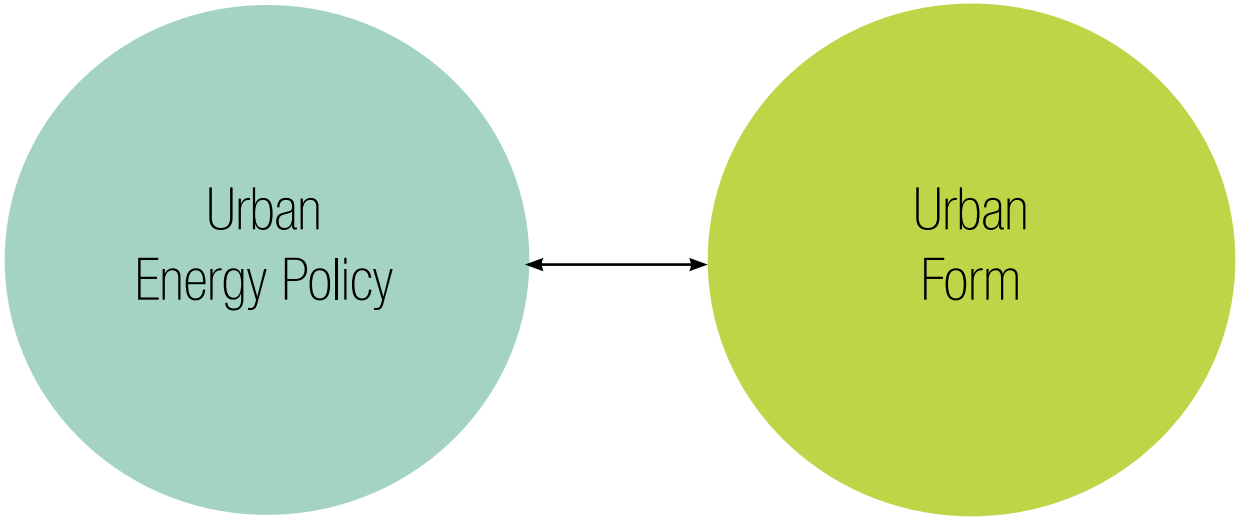
RESEARCH APPROACH

HOW DOES URBAN AND SPATIAL FORM CONTRIBUTE TO ENERGY CONSUMPTION?

Masdar City, Abu Dhabi
Photo source: Luca Locatelli, Institute for the National Geographic

SPATIAL PLANNING FOR ENERGY EFFICIENCY



URBAN ENERGY POLICY

Interplay of planning policy and carbon emissions

- Transport policies
- Urban form and location policies
- Development layout and design

Barton, 2017

LEED neighbourhood development categories

- Smart location and linkage
- Neighbourhood pattern and design
- Green building and infrastructure

LEED ND Reference Guide, 2014

Spatial planning measures for energy transitions

- Transport policy and technology
- Regional planning and agricultural reform
- Institutional change

Droege, 2008

Measures for sustainable development in cities

- Urban form and urban design
- Landscape and building
- Traffic planning

Lehmann, 2008

Energy criterion for a resourceful city

- Land use management
- Efficient building
- Mobility and accessibility
- Waste management

Mega, 2008

Impact of urban planning on energy consumption and production

- Energy consumption Residential, Industrial, Transportation
- Urban energy generation

PLEEC, 2015

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URBAN FORM

Barton, 2017

- Transport
- Jobs and services
- Housing
- Greenspace
- Density

Jabareen, 2006

- Compactness
- Sustainable transport
- Density
- Mixed land use
- Diversity
- Passive solar design
- Greening

Dempsey et. al, 2010

- Density
- Transportation infrastructure
- Building typology
- Layout
- Land use

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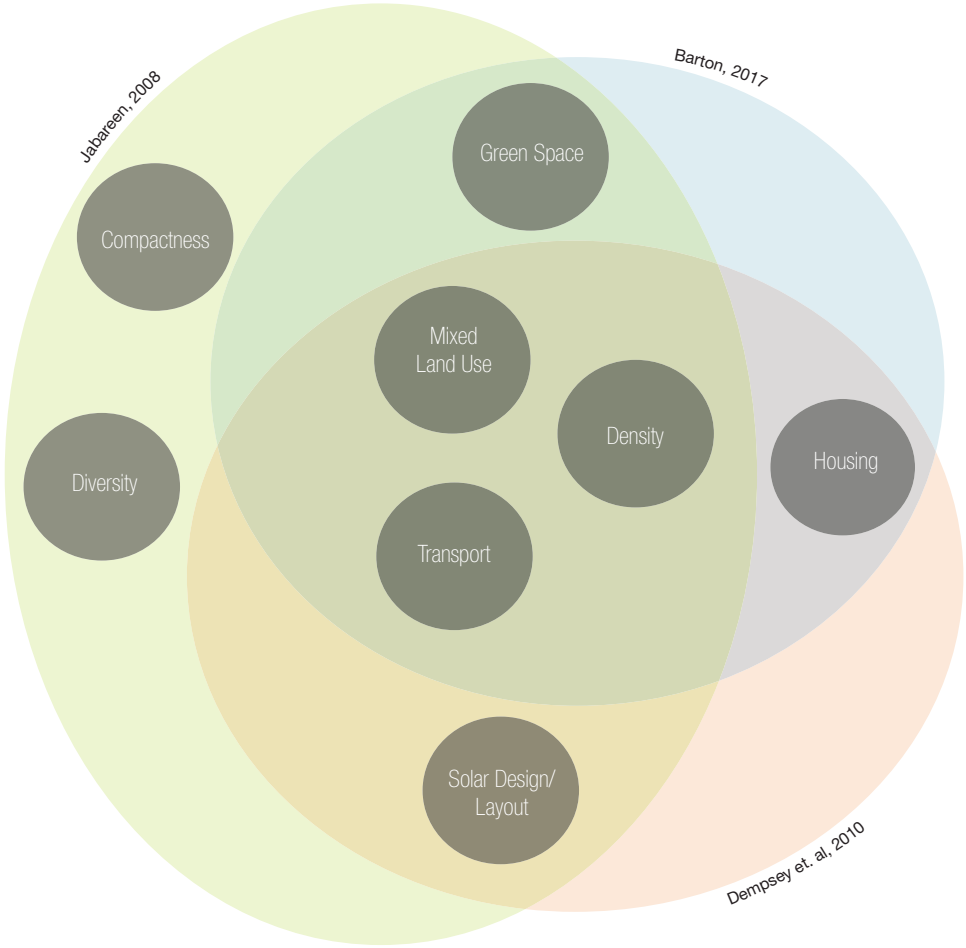
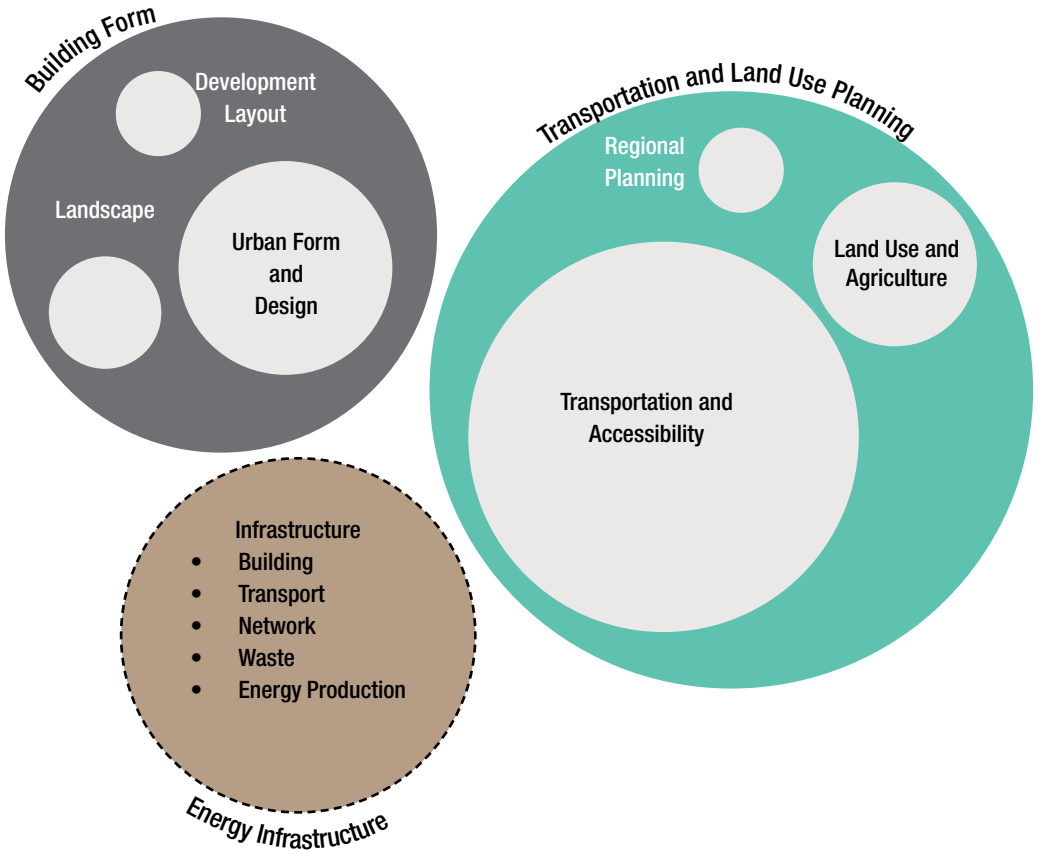
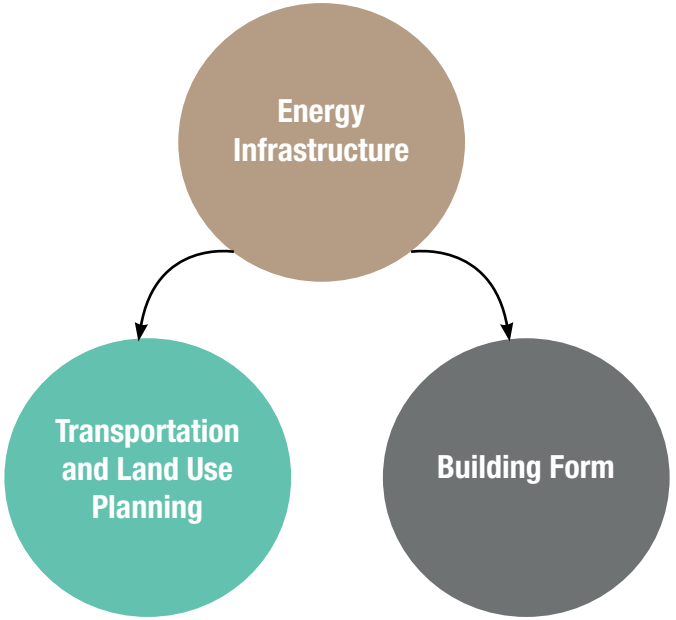


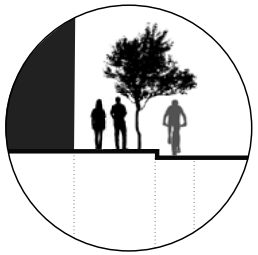
THE COMPONENTS OF ENERGY SYSTEMS



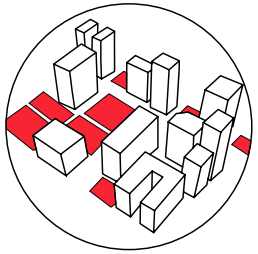


SPATIAL PLANNING MEASURES FOR ENERGY EFFICIENCY

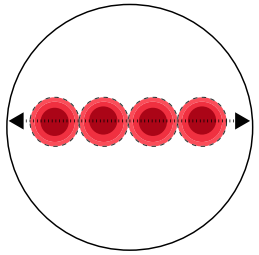
TRANSPORTATION AND LAND USE PLANNING



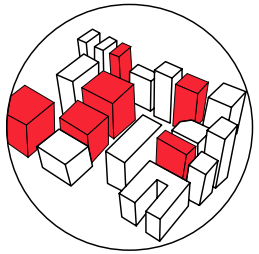
Promote active travel



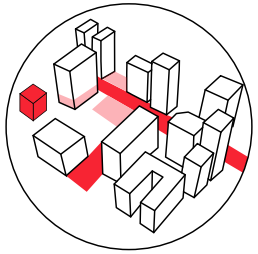
Encourage infill developement



Promote transport oriented development

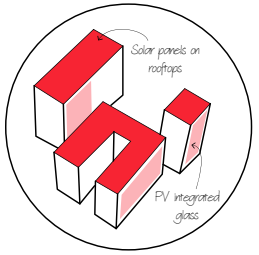


Promote compact development

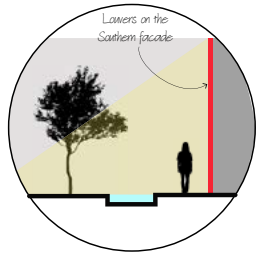


Transport Demand Management

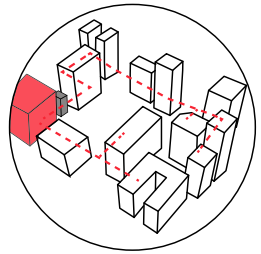
BUILDING FORM



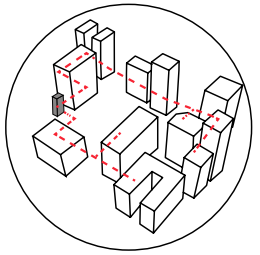
Increase renewable energy production



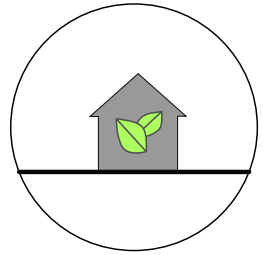
Design with the urban microclimatic



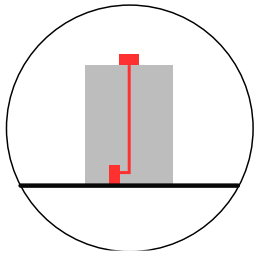
Implement district energy systems



Implement smart grids and metres



Use building rating systems to improve environmental performance



Retrofit existing building stock

SUMMARY TABLE ON PAGES 19-22 OF THE REPORT

WHAT CAN WE LEARN FROM OTHER CITIES?

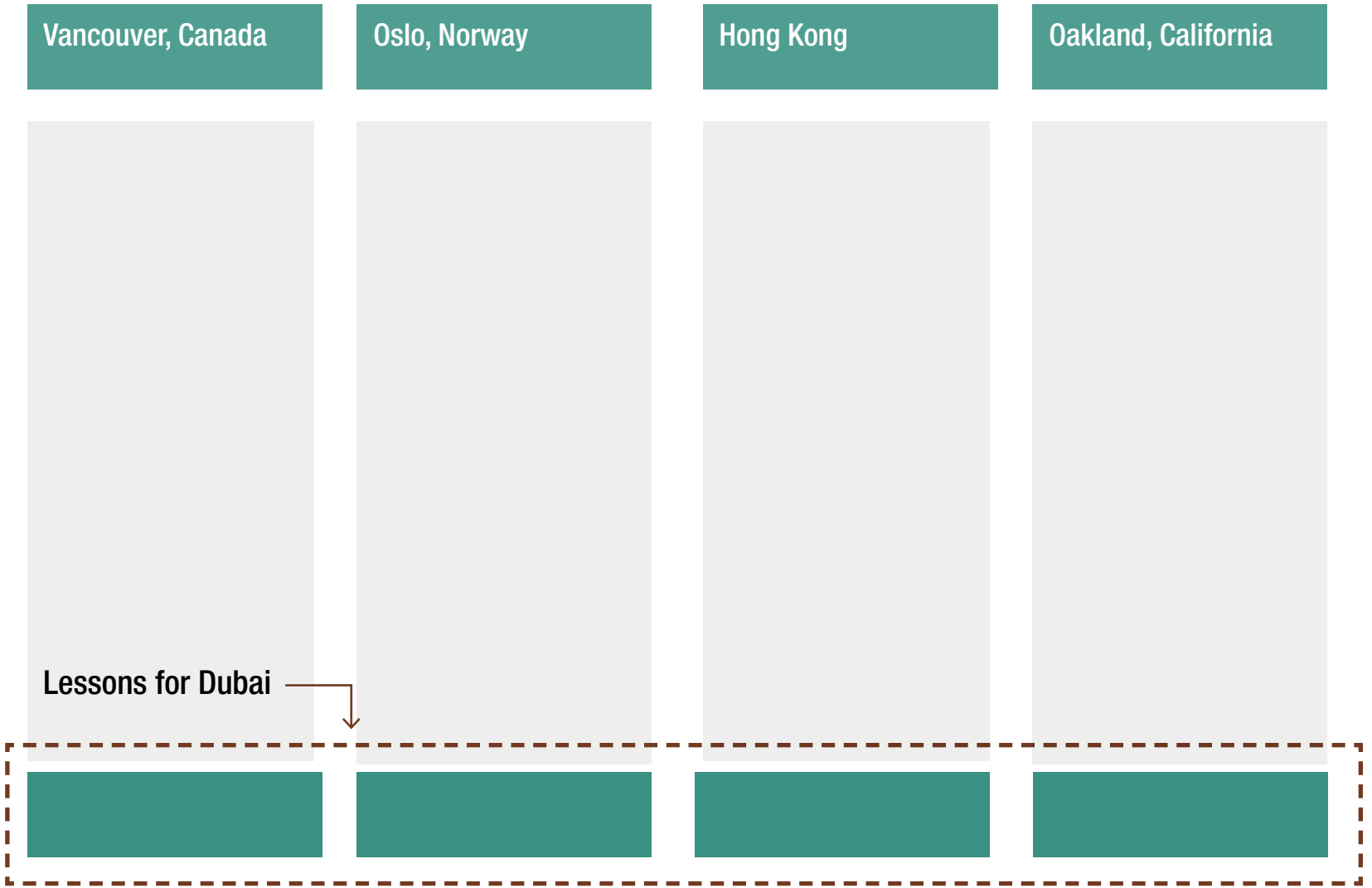
Evaluation Framework

Transport and Land Use Planning

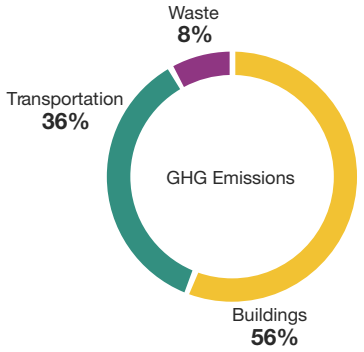
- Promote active travel
- Encourage infill development
- Promote transport oriented development
- Promote compact development
- Transport demand management

Building Form

- Increase renewable energy supply
- Designing with the urban microclimate
- Implement district cooling system
- Implement a smart gird and metres
- Use rating systems to improve environmental performance
- Retrofit existing building stock

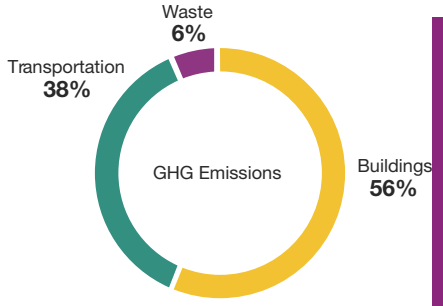


THE 4 CITIES



Vancouver, Canada

Population **647,540 (2014)**
Area **115 sq. km**
National per capita energy consumption in kWh
14,930
Energy strategy Renewable City Strategy 2015-2050

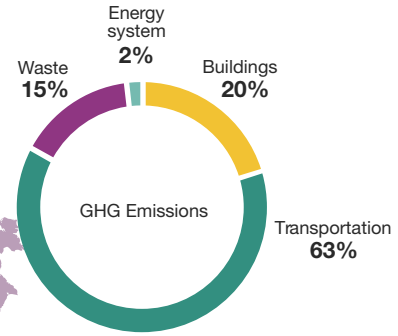


Oakland, United States

Population **420,005 (2016)**
Area **201.7 sq. km**
National per capita energy consumption in kWh
12,071
Energy strategy City of Oakland Energy and Climate Action Plan (2012)

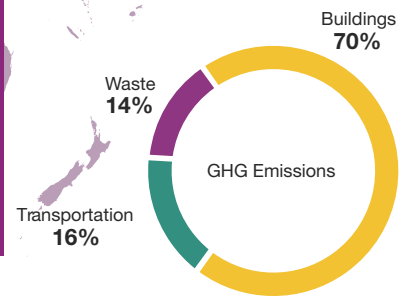
Oslo, Norway

Population **634,293 (2014)**
Area **454 sq. km**
National per capita energy consumption in kWh **24,006**
Energy strategy Climate and Energy Strategy for Oslo (2016)

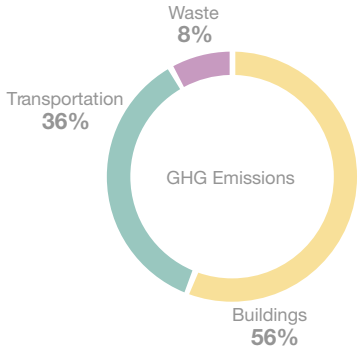


Hong Kong

Population **7.35 million (2016)**
Area **1,104 sq. km**
National per capita energy consumption in kWh **5,859**
Energy strategy Energy Saving Plan for Hong Kong's Built Environment 2015-2025+ & Hong Kong's Climate Action Plan 2030+ (2017)



GOALS OF THE ENERGY STRATEGIES



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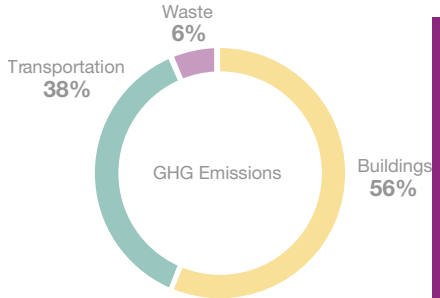
80%
reduction in GHG emissions by 2050



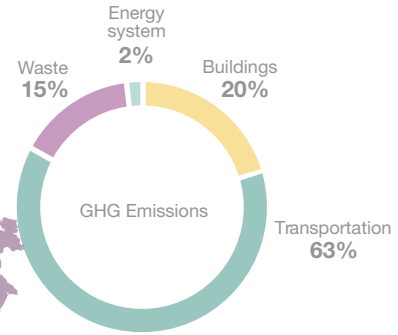
36%
reduction in GHG emissions by 2020

Oakland, United States

Population **420,005 (2016)**
Area **201.7 sq. km**
National per capita energy consumption in kWh
12,071
Energy strategy City of Oakland Energy and Climate Action Plan (2012)

Oslo, Norway

Population **634,293 (2014)**
Area **454 sq. km**
National per capita energy consumption in kWh **24,006**
Energy strategy Climate and Energy Strategy for Oslo (2016)

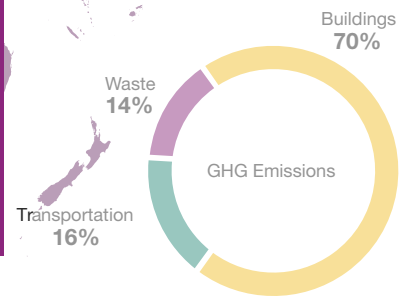


95%
reduction in GHG emissions by 2030

Hong Kong

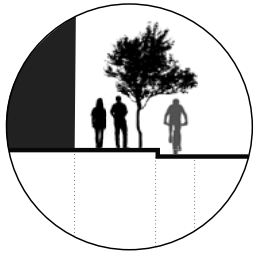
Population **7.35 million (2016)**
Area **1,104 sq. km**
National per capita energy consumption in kWh **5,859**
Energy strategy Energy Saving Plan for Hong Kong's Built Environment 2015-2025+ & Hong Kong's Climate Action Plan 2030+ (2017)

36%
reduction in GHG emissions by 2030

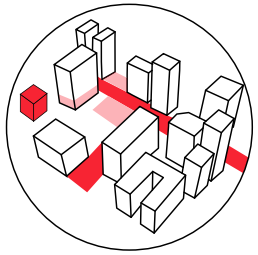


COMMON ACTIONS IN ALL 4 STRATEGIES

TRANSPORTATION AND LAND USE PLANNING

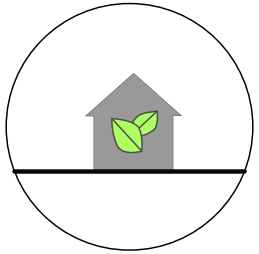


Promote active travel

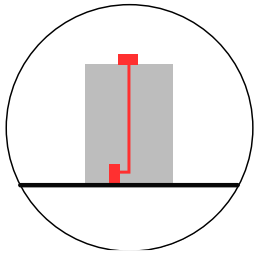


Transport demand management

BUILDING FORM

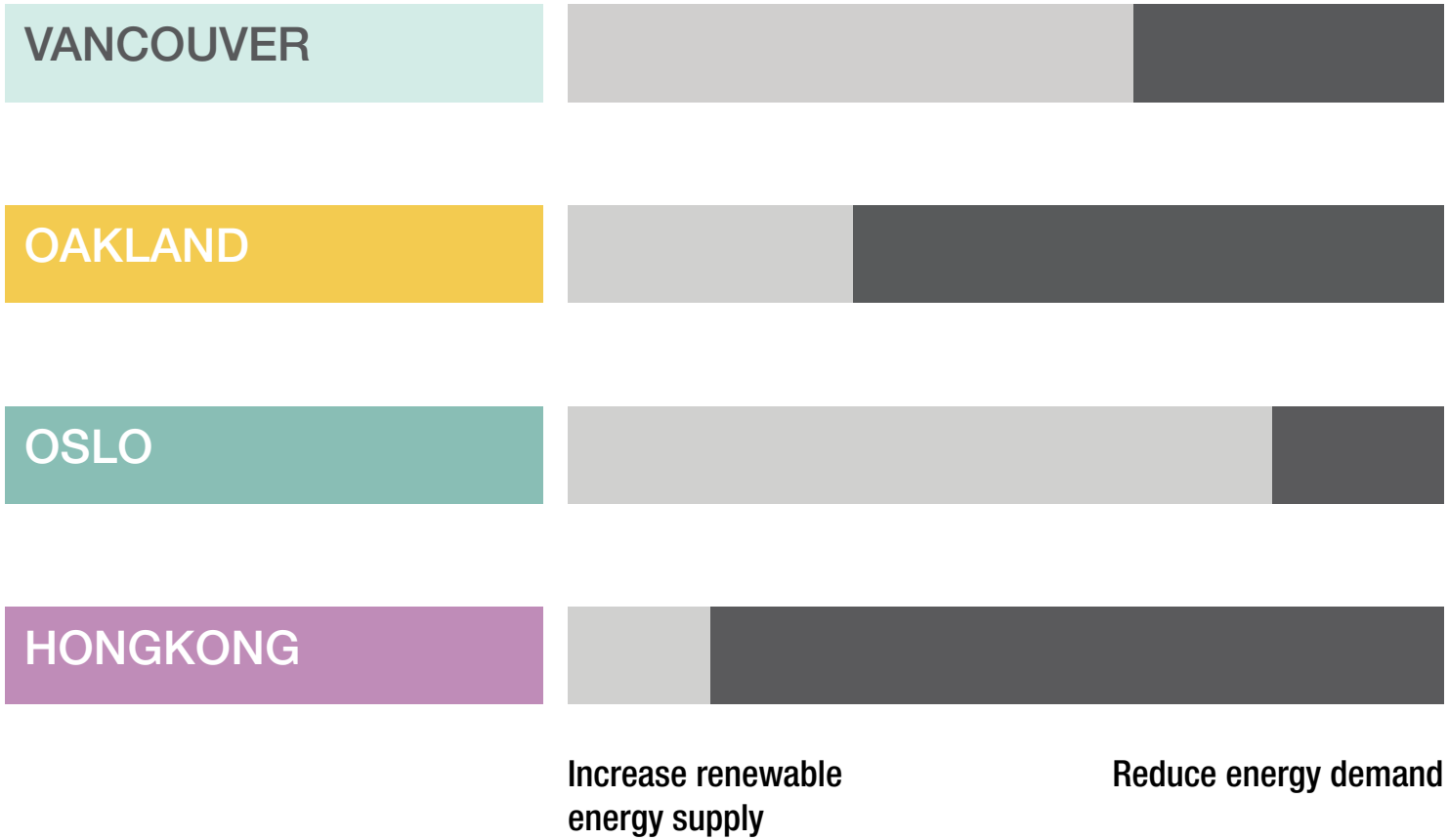


Building rating systems or benchmarking



Upgrade existing building stock

REDUCE DEMAND OR INCREASE RENEWABLE ENERGY SUPPLY?



WHAT IS THE LINK TO URBAN DEVELOPMENT PLANS?

HONG KONG

VANCOUVER

15 ENERGY AND CLIMATE CHANGE

Introduction

Vancouver has the goal of being the greenest city in the world by 2020. This includes aspirations to reduce dependence on fossil fuels and lead the world in green building design and construction. To achieve this, all communities must start taking a more aggressive approach to reducing energy consumption and the production of greenhouse gases (GHGs). The West End will help contribute to this goal by using strategies relating to land use, neighbourhood energy, and green building design.

At the same time, Vancouver is preparing for the impacts we are very likely to experience from the changing climate and exploring the opportunities this may provide. Scientists anticipate we will experience an increased frequency and intensity of rain and wind storms; hotter, drier summers; a longer growing season; and flooding from sea level rise. Building resilience means looking at the ways we design and maintain infrastructure and enhancing connections among people and groups in the community to improve our ability to respond to and recover from events.

CRITICISMS OF THE ENERGY STRATEGIES

1 The potential to reduce energy consumption in the **urban development** plans is not emphasized

2 None of the strategies mention adopting **passive solar design** as a mandatory action to reduce energy consumption

'Passive solar design can reduce demand for energy and provide the best use of passive energy.'
Jabareen, 2006

Bio-climatic design enhances energy efficiency of buildings.
Yeang, 2008

'Designing with microclimatic conditions reduces the need for internal space heating or cooling by conventional mechanical systems.'
Owens, 1992

3 None of the strategies are able to say if they will achieve their **goals** through adopting the proposed measures

WHAT SHOULD PLANNING DELIVER FOR THE ENERGY TRANSITION IN DUBAI?

Dubai's skyline
Photo source: Zuhair Lokhandwala

GOALS OF THE ENERGY STRATEGY

UAE ratifies Paris Climate Agreement

Paris Climate Agreement aims to mitigate and limit climate change

Image Credit: WAM

Dr Thani Ahmad Al Zeyoudi with Ban Ki Moon after the UAE ratified the Paris Climate Agreement in New York.

Published: 13:47 September 22, 2016
Staff Report

GULF NEWS

September 2016

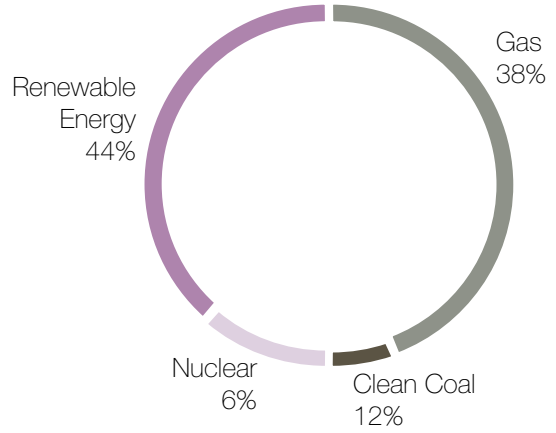
HH Sheikh Mohammed
@HHShkMohd
Following

Our 2050 goals for energy mix are to utilize 44% renewable, 38% gas, 12% clean fossil and 6% nuclear energy.

5:14 AM - 10 Jan 2017

January 2017

INCREASE RENEWABLE ENERGY PRODUCTION

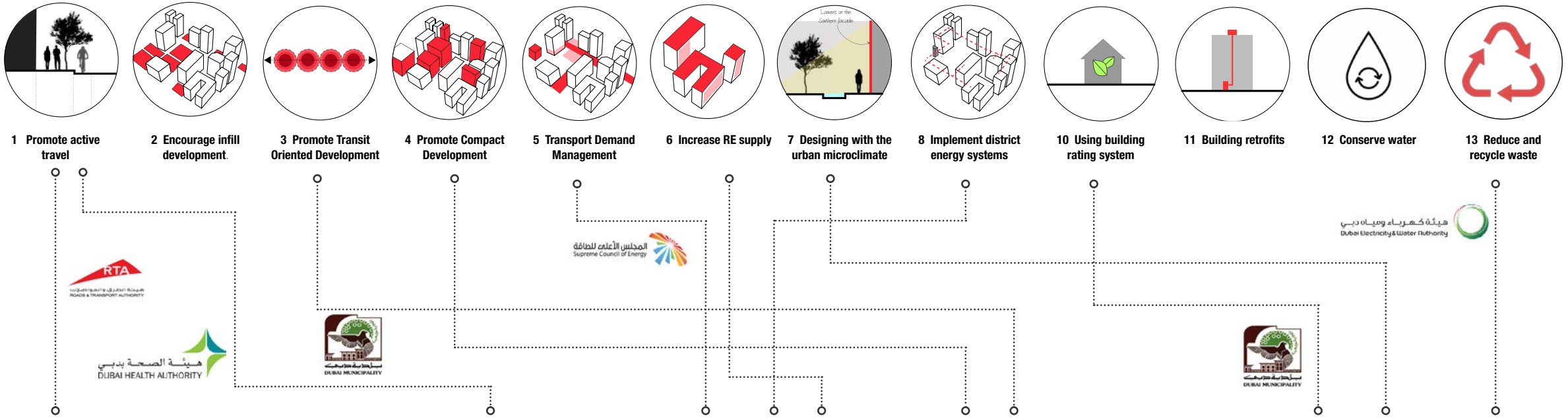


DECREASE ENERGY DEMAND

30%

reduction in energy demand

FRAGMENTATION OF POLICIES



DUBAI BICYCLE MASTER PLAN

DUBAI'S UNIVERSAL DESIGN CODE

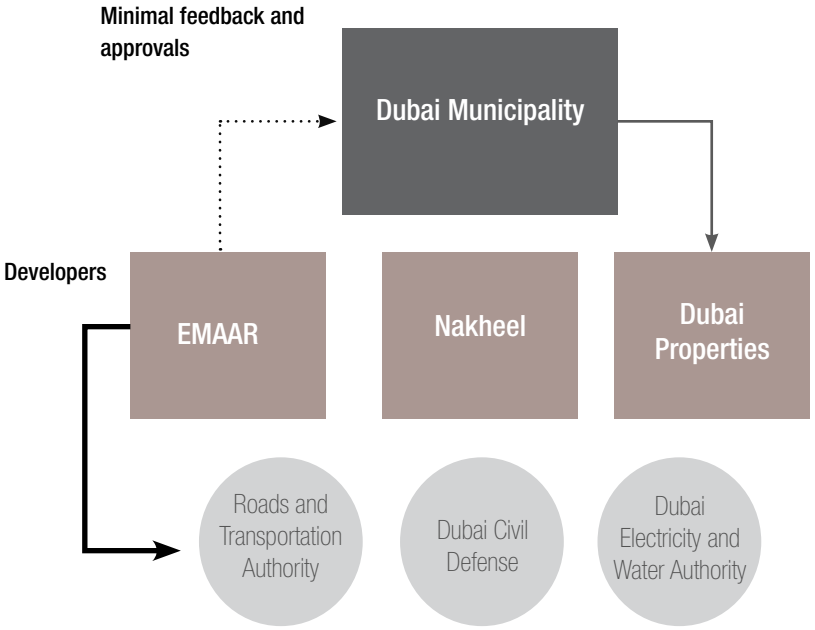
DUBAI'S INTEGRATED ENERGY STRATEGY

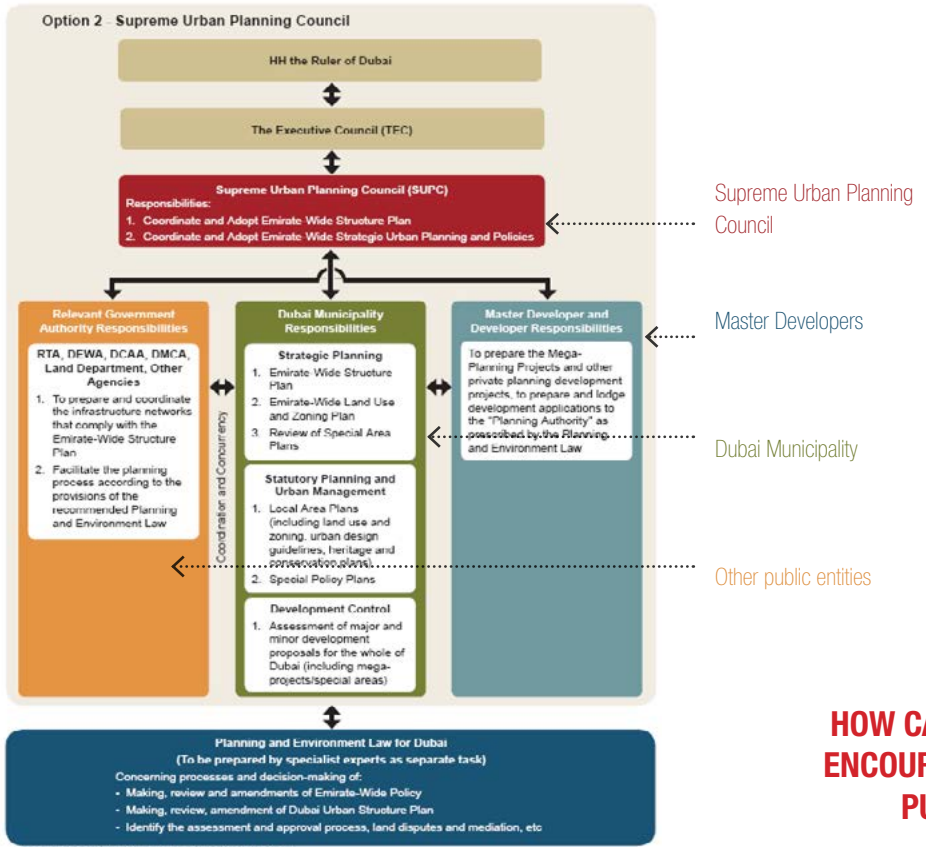
DUBAI'S 2020 URBAN MASTER PLAN

AL SAFAT GREEN BUILDING REGULATIONS

CHALLENGES FOR DUBAI

THE PLANNING PROCESS





HOW CAN DEVELOPERS BE ENCOURAGED TO INVEST IN PUBLIC GOODS?

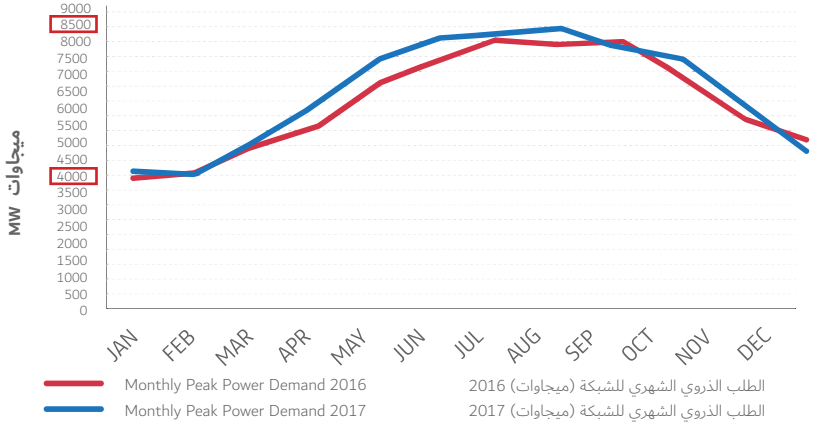
CHALLENGES FOR DUBAI

EXTREME CLIMATE

Air Conditioned bus stops

Air Conditioned Pedestrian Crossings

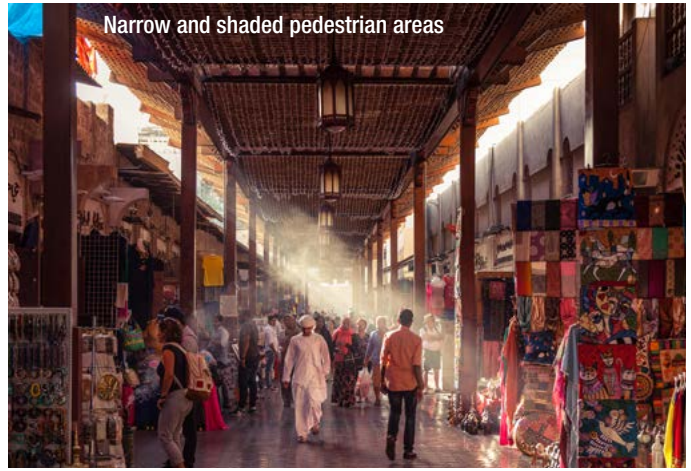
Raised pedestrian walkways proposed for Dubai Health Care City by ARUP



Energy Demand per month in Dubai

Microclimate Design Solutions

Retractable Ground Floor



Narrow and shaded pedestrian areas

Source: http://manonthelam.com/dubai-land-of-air-conditioned-bus-stops/, https://www.arup.com/projects/dubai-pedways-development-strategy, https://www.arup.com/projects/dubai-pedways-development-strategy, https://www.thenational.ae/uae/transport/dubai-plans-10-new-pedestrian-bridges-to-cut-risk-of-being-run-over-1.280807,https://www.thenational.ae/arts-culture/native-plants-make-a-welcome-comeback-to-abu-dhabi, DEWA (Dubai Electricity and Water Authority) Annual Statistics for 2017

WHAT DOES PLANNING NEED TO DELIVER FOR DUBAI'S ENERGY TRANSITION?

1. MORE COLLABORATION BETWEEN DIFFERENT PUBLIC ENTITIES

2. INTEGRATED POLICY FRAMEWORK

3. A COMMON GOAL TO PROMOTE LONG TERM ENVIRONMENTAL SUSTAINABILITY

NEIGHBOURHOODS

TECOM

DUBAI CREATIVE CLUSTERS AUTHORITY

MIZHAR

DUBAI MUNICIPALITY

Dubai Media City

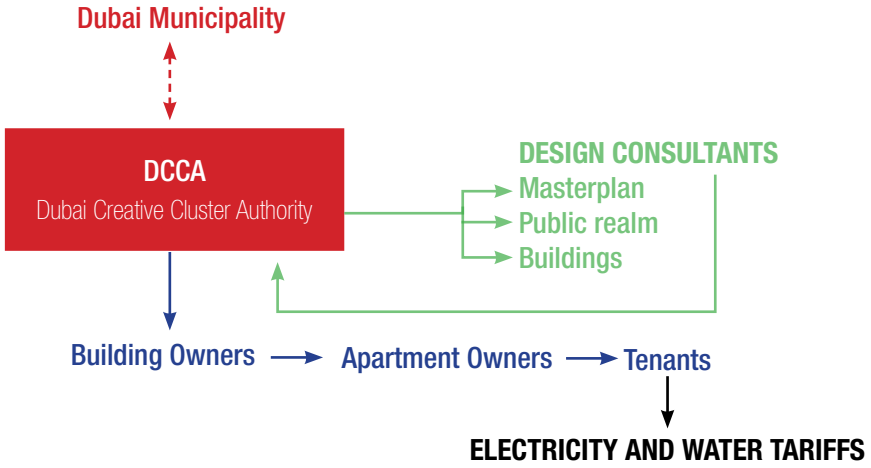
Knowledge Village

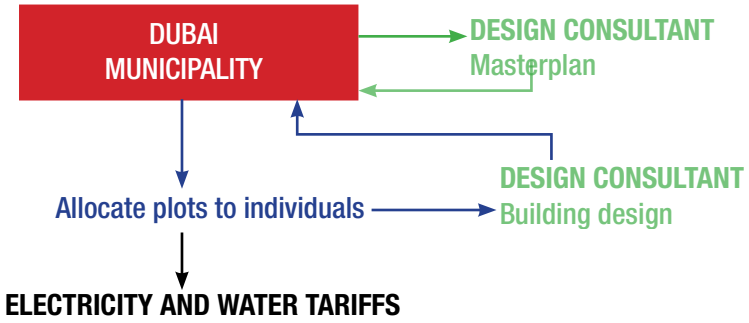
Sheikh Zayed Road

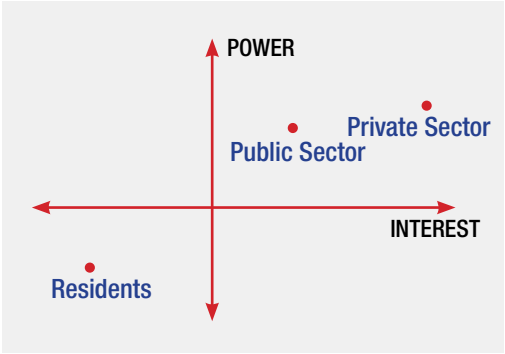
TECOM C

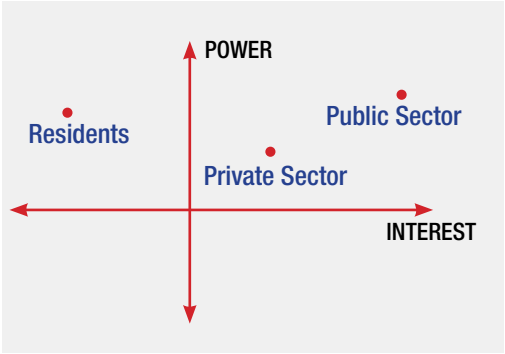

MIZHAR

URBAN DECISION MAKING







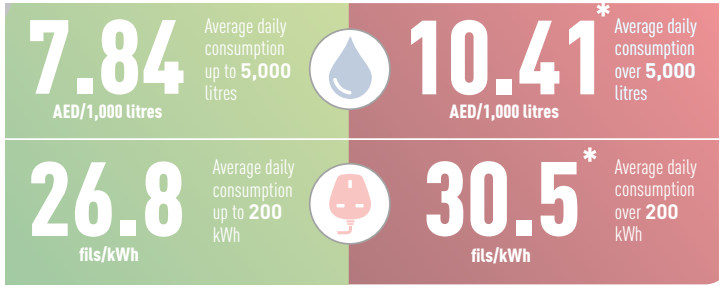


TECOM

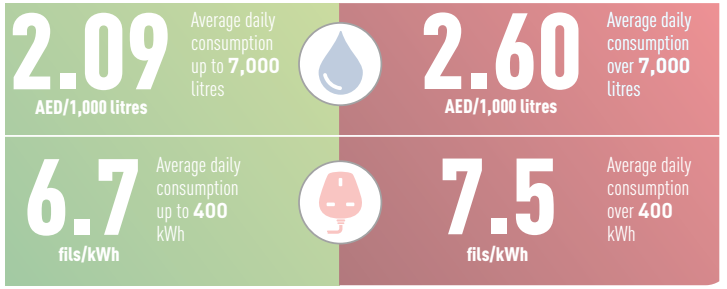
Mizhar

ENERGY TARIFF'S AND ENERGY DEMAND

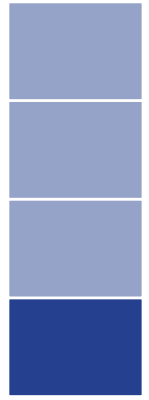
ENERGY TARIFF



EXPATS



NATIONALS



ENERGY DEMAND

Average daily electricity consumption

Major land uses
- High rise residential
- Commercial
- Hotels
- Low rise residential

Average daily electricity consumption

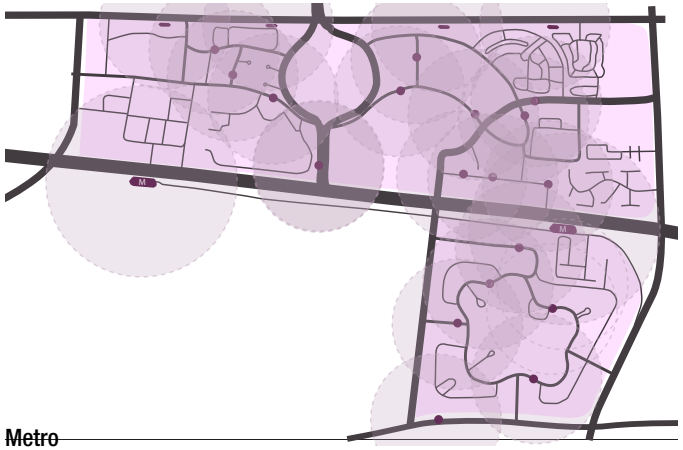
Major land uses
- Low rise residential
- Commercial

DETAILS ON PAGE 74 OF THE REPORT

TECOM

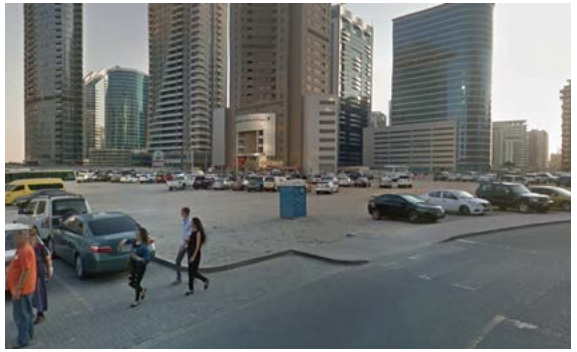
Mizhar

ACCESSIBILITY AND WALKABILITY



Metro
Tram
Bus

Bus



TECOM

Mizhar

NEIGHBOURHOOD ENERGY STRATEGY

1 POLICY FRAMEWORK

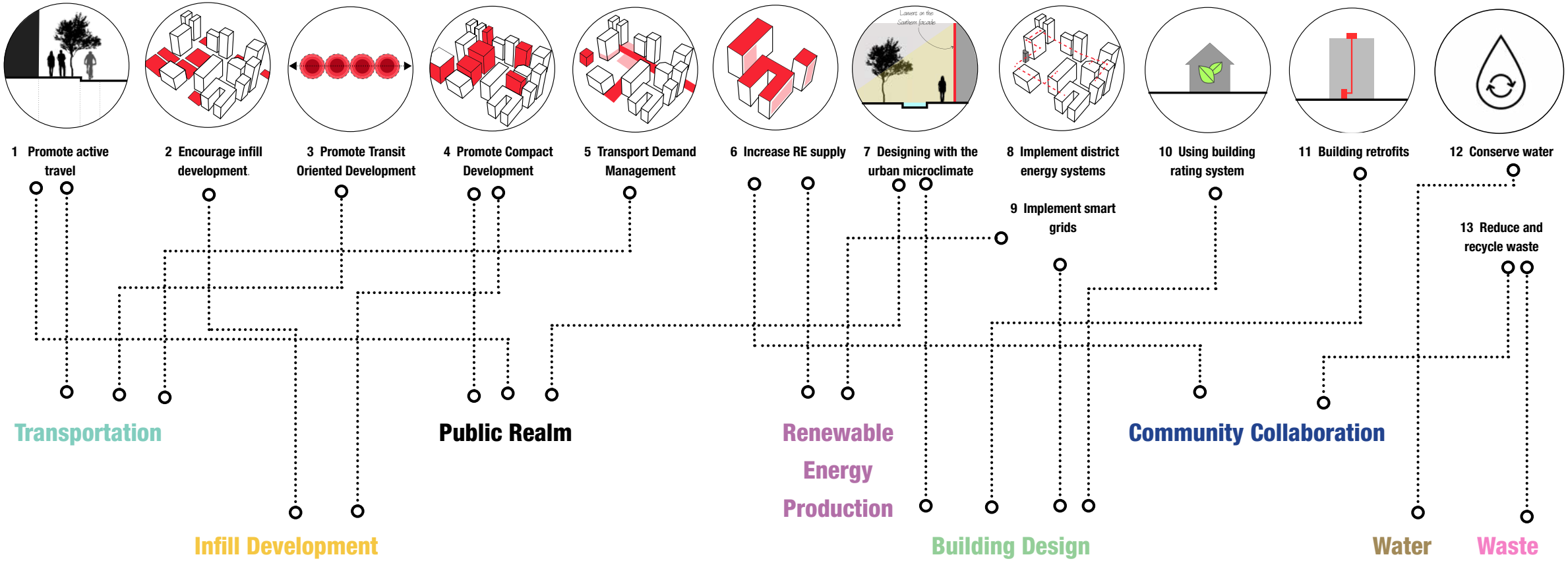
2 DESIGN GUIDELINES

3 URBAN RETROFIT PLAN

4 IMPLEMENTATION

POLICY FRAMEWORK

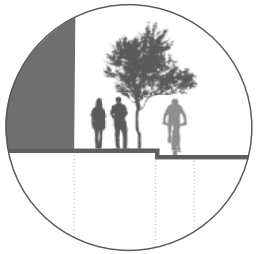
DESIGN PRINCIPLES



POLICY THEMES

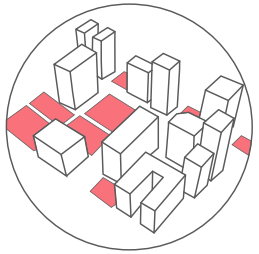
DETAILS ON PAGE 91-128 OF THE REPORT

POLICY OVERVIEW FOR MIZHAR



A Transportation

- Increase the accessibility to the metro line and number of bus stops.
- Upgrade street infrastructure to increase safety for pedestrians and cyclists.
- Decrease the amount of space taken up by roads to discourage the rise in the number of cars, increase compactness and the possibility of increased shadow density to reduce heat gain.
- Increase the importance of pedestrian pathways in the housing block by transforming existing ‘sikkas’ or utility corridors to pedestrianized pathways.
- Increase incentives to switch to electric cars powered by renewable fuels of energy.



B Infill Development

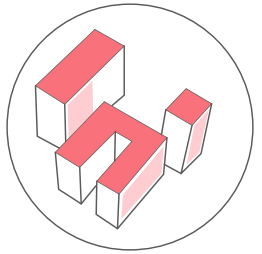
- Encourage infill development to increase efficiency of land consumption and reduce the environmental and economic costs of providing transport infrastructure.

CASE 1- Freehold property market
CASE 2 - Areas around mosques
CASE 3- Encourage property extensions within street right-of-way and the creation of shared courtyards between houses.

C Renewable Energy Production

- A minimum of 60% of energy demand of individual homes should be met by renewable energy sources.

CASE 1 - Individual households
CASE 2 - Community collaboration



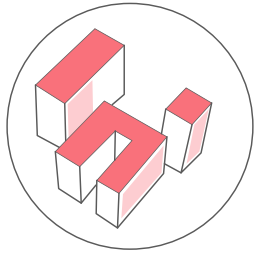
D Building Design

- All buildings should reduce their energy demand by 30%.

CASE 1 - New constructions
CASE 2 - Existing buildings

E Community Collaboration

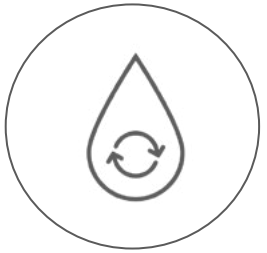
- Provide strong incentives to encourage community led projects that can benefit a larger part of the neighbourhood.



F Water

- Outdoor and indoor water use should be decreased by 30%.

CASE 1 - Outdoor landscaping
CASE 2 - Indoor water use



STREET RIGHT OF WAY

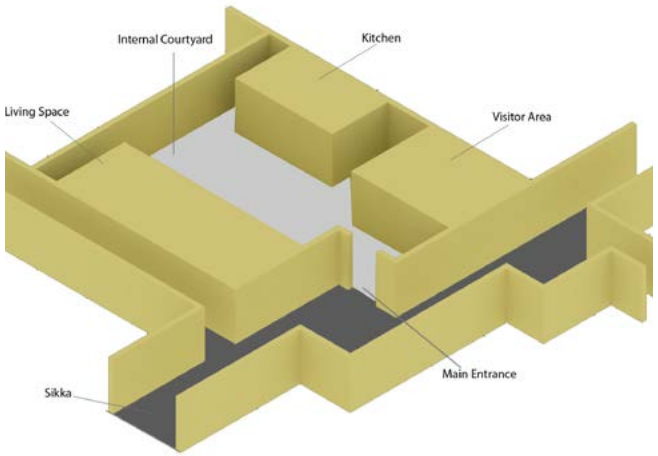
Frontyard

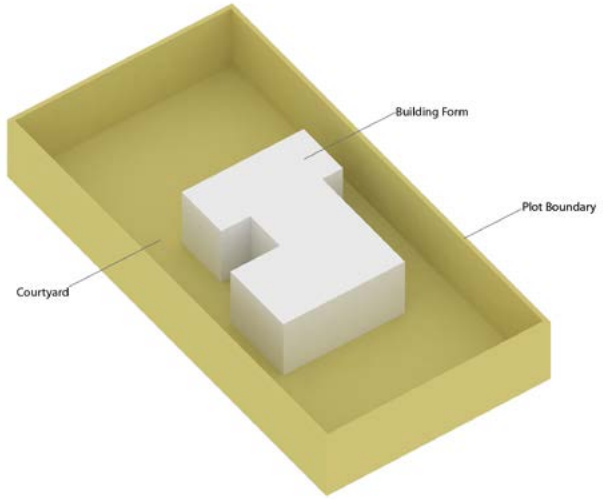
Backyard

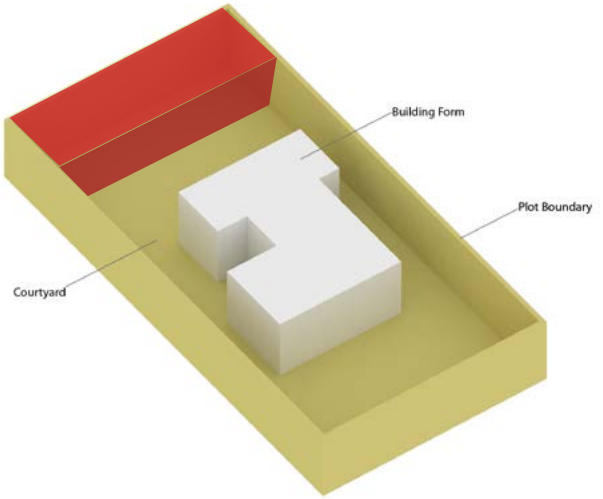
Added shadow on the street

Courtyard

Evolution of national housing







STREETS

Permeable Boundary Wall

Boundary walls are usually built quite high (2.75-3m) for privacy. To add to spatial quality and allow for social spaces to emerge, 'mashrabiya' styled permeable walls should be encouraged instead of concrete brick walls.

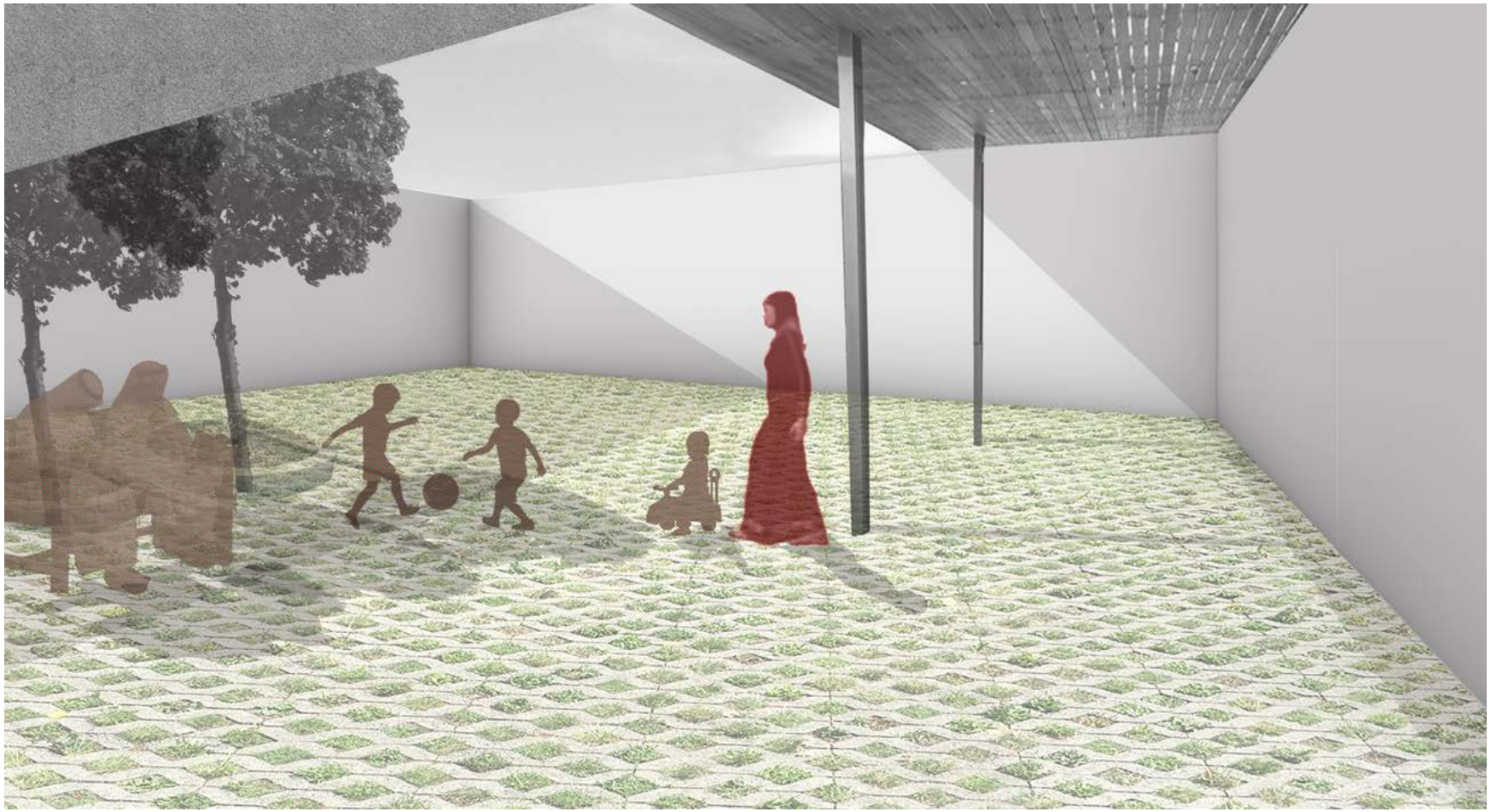
Pedestrian Pathway

Dedicated path for pedestrians along the side of the road.

'Street Park'

Landscaped space open to public maintained by residents. Only native species for vegetation. No concrete paving or parking is allowed. Benches, children play area, shading and other street furniture is permitted.

COURTYARDS



Shading

Light shading devices made of wood or cloth can be used to improve urban micro-climate to make it comfortable for outdoor use.

Flooring

Permeable flooring or low maintenance vegetation instead of concrete bricks.

Vegetation

Trees or large plants can be used for shading and to reduce urban heat island effect.

MOSQUES

MOSQUES

Vegetation

Vegetation using native species that consume less water and are easy to maintain.

Flooring

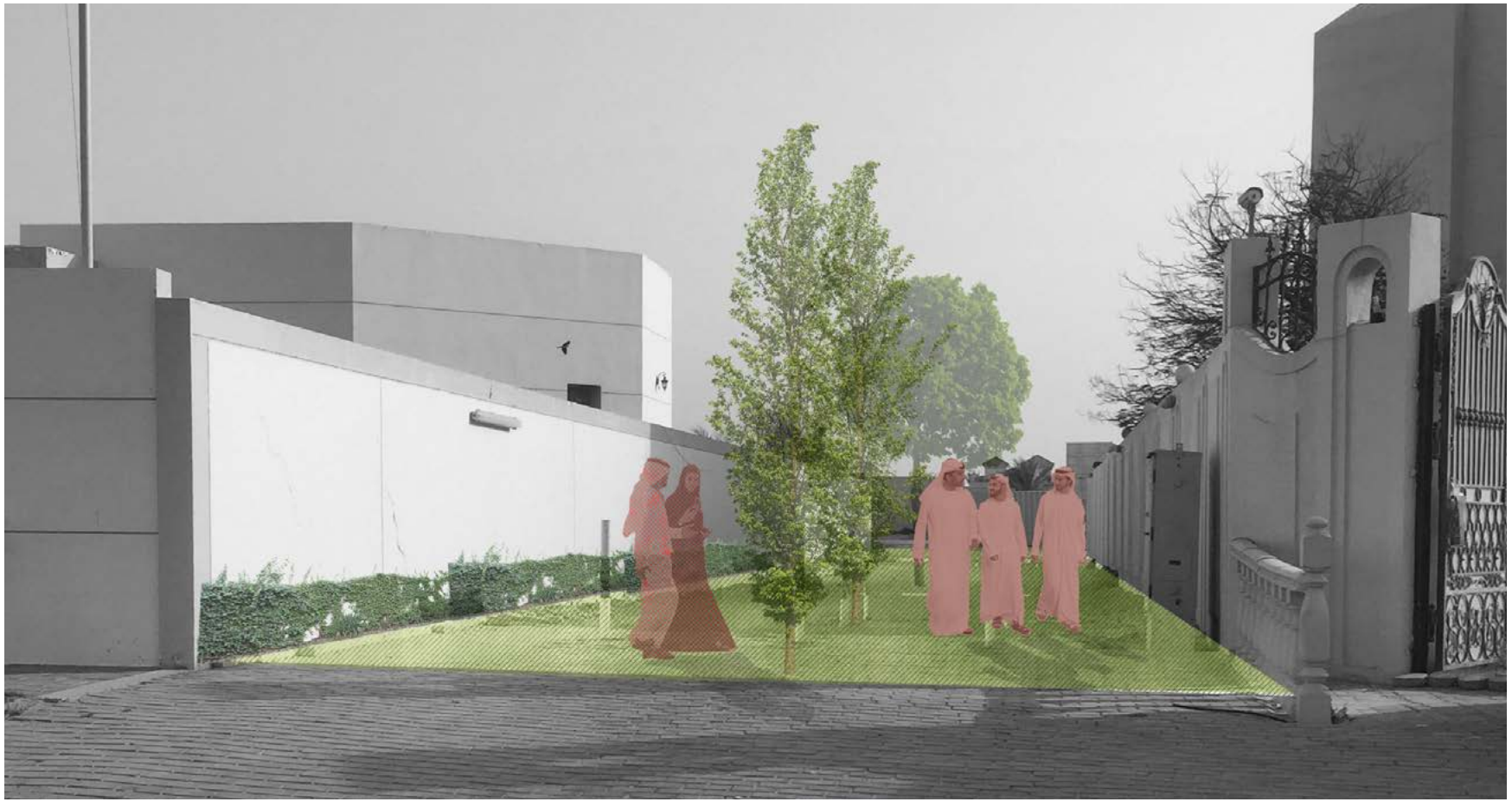
Permeable flooring instead of concrete bricks.

Solar powered electric car charing point

Renewably powered car charging point with floor solar panels for minimum maintenance.

SIKKAS

SIKKAS



Vegetation

Vegetation on walls and within the sikka using native species that consume less water and are easy to maintain.

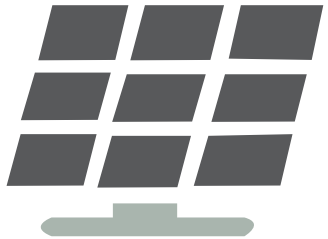
Flooring

Permeable flooring instead of concrete bricks.

Openings from houses

Residents can have the option to have an opening into the sikka from private property plots.

INVESTMENT IN RENEWABLE ENERGY PRODUCTION



Benefits

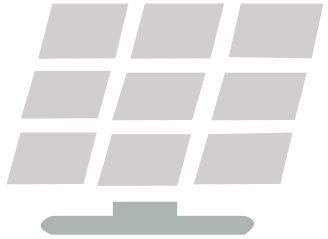
- Increase in RE power
- Encourage long term investment
- Benefits stay in the community

Investment

Individuals can make a larger investment and make a return

- Increase in RE power
- Encourage long term investment and community collaboration

Community collectively invests in solar power and makes a return



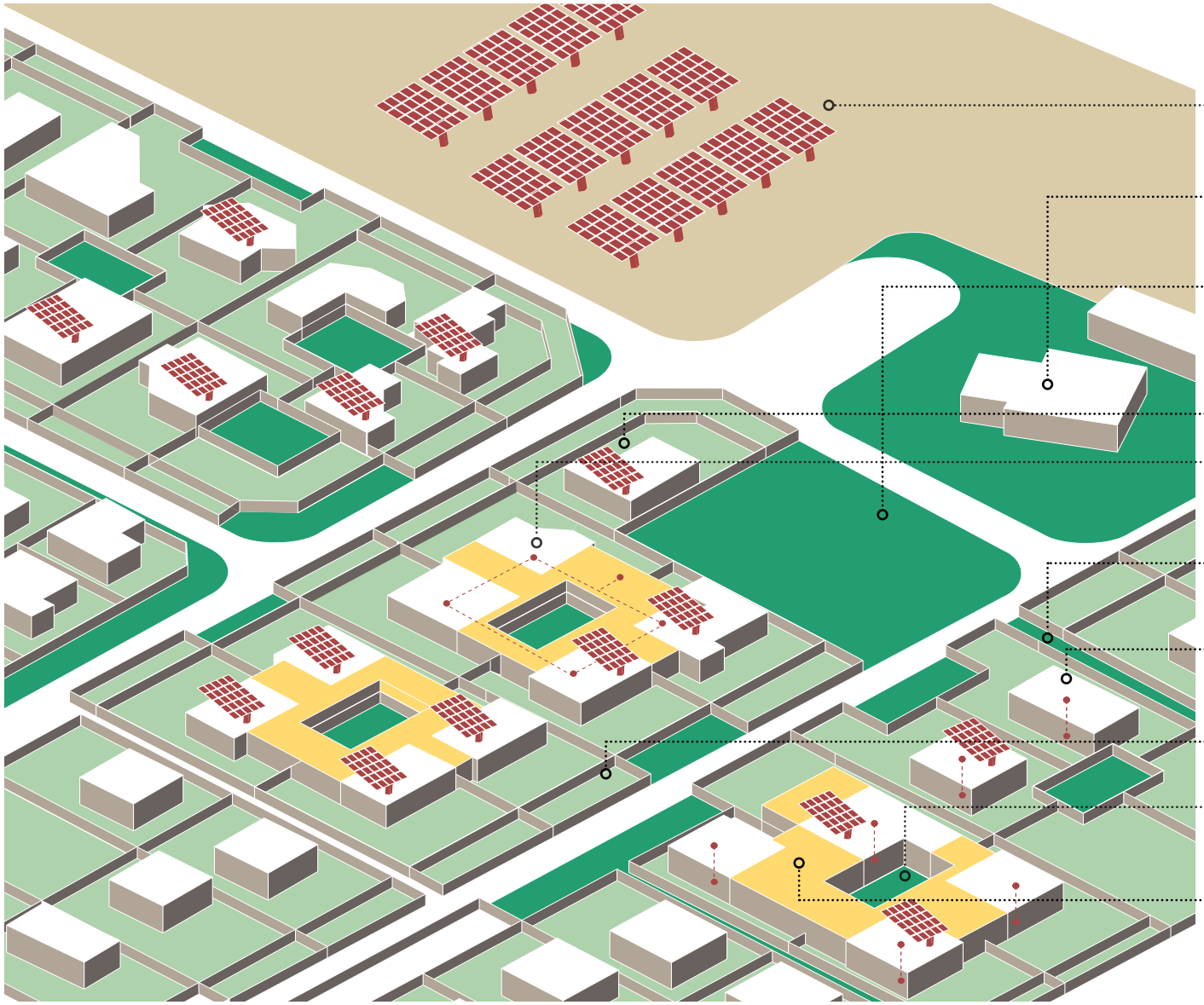
- Increase in RE power

Government invests in installing solar panels

Decentralized energy production

Centralized energy production

URBAN RETROFIT PLAN DETAIL



Solar Panel Farm

Mosques

Pocket parks

Rooftop Solar Panels

VRF System

Sikka

Geothermal Cooling System

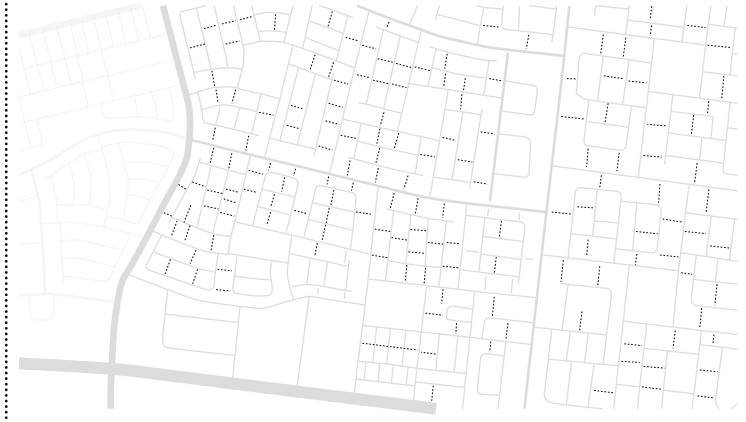
Private Property Extensions

Semi-Private Courtyards

Permitted Building Extensions

WHO NEEDS TO TAKE THE LEAD?

Awaqf (Department of Islamic Affairs)



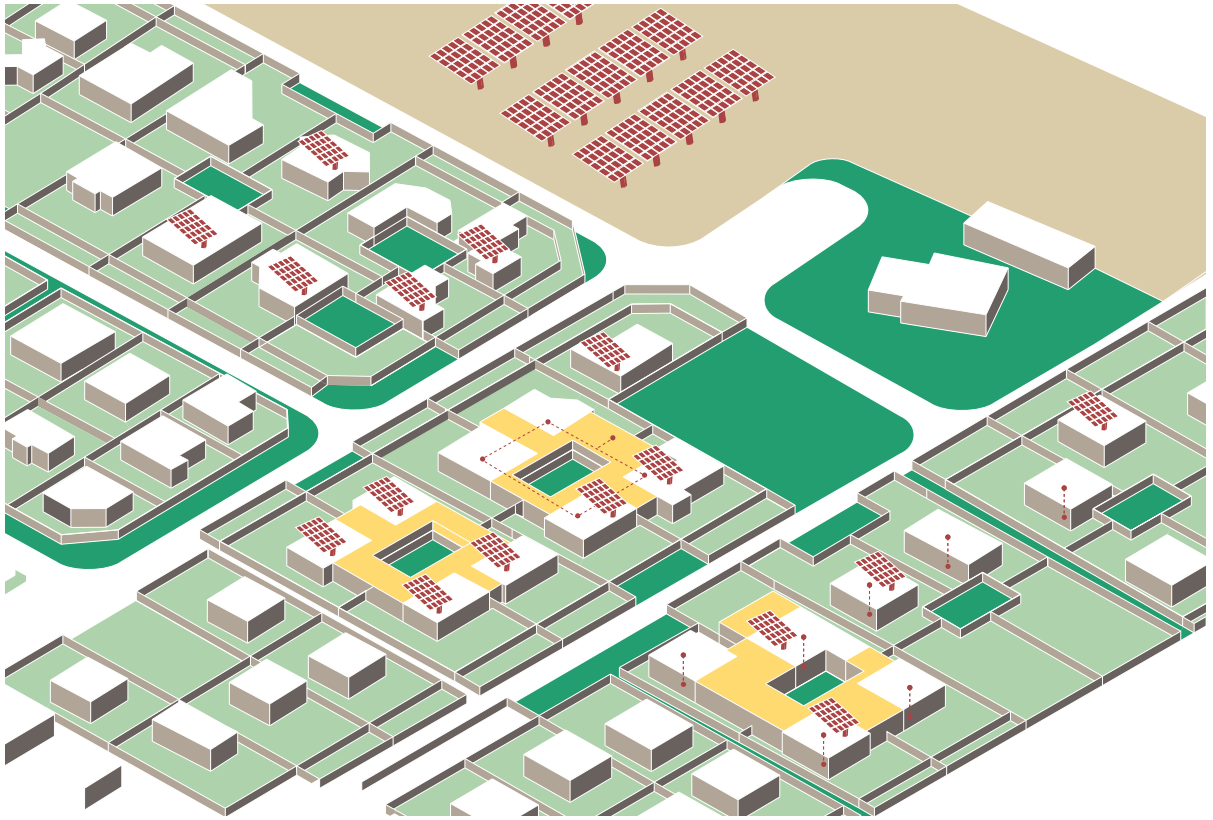
Roads and Transportation Authority

Dubai Municipality
Roads and Transportation Authority

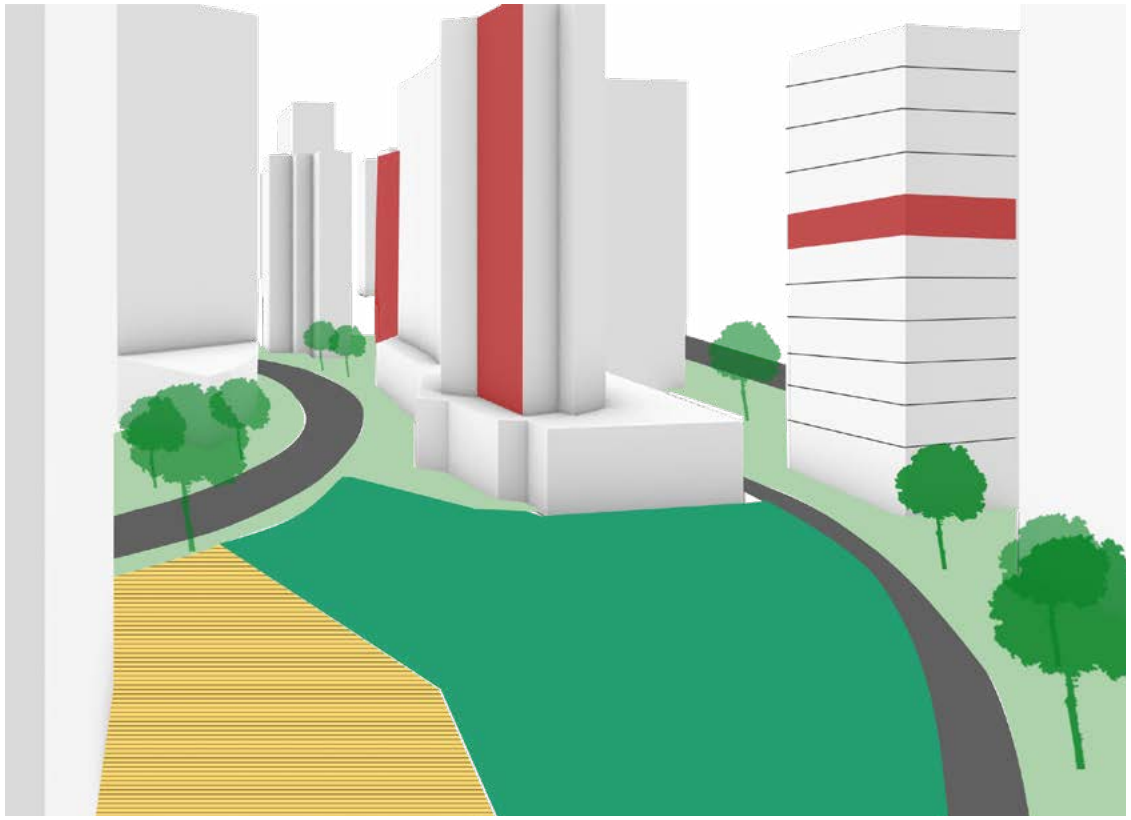
MIZHAR URBAN RETROFIT PLAN

- Increase public transport accessibility by increasing the number of bus stops
- Upgrade street infrastructure to increase safety for pedestrians and cyclists
- Transforming existing ‘sikkas’ or utility corridors to pedestrianized pathways
- Encourage property extensions within the street right-of-way
- Encourage shared courtyard between houses
- Prioritize housing development
- Plots for the freehold market
- Existing mosques
- Develop pocket parks or open public space
- Areas for community led projects that can benefit a larger part of the neighbourhood

MIZHAR URBAN RETROFIT PLAN DETAIL



TECOM URBAN RETROFIT PLAN DETAIL



Common Challenges
Differences

WHAT CAN OTHER CITIES LEARN FROM THIS RESEARCH?

Dubai Canal
Photo source: Luca Locatelli, Institute for the National Geographic

WHAT IS THE ROLE OF SPATIAL PLANNING IN THE ENERGY TRANSITION?

1. CHALLENGE NORMS THAT DON'T PROMOTE ENERGY EFFICIENCY
2. PROMOTE A COLLECTIVE INVESTMENT IN PUBLIC GOODS
3. PLAN FOR LONG TERM BENEFITS TO CHANGE THE PERCEPTION OF SPACE

SPATIAL PLANNING MEASURES FOR THE ENERGY TRANSITION

TRANSPORTATION AND LAND USE PLANNING

1. PROMOTE ACTIVE TRAVEL
2. INTEGRATE INEFFICIENT SITES
3. PROMOTE TOD AREAS
4. COMPACT DEVELOPMENT
5. TRANSPORT DEMAND MANAGEMENT

BUILDING FORM

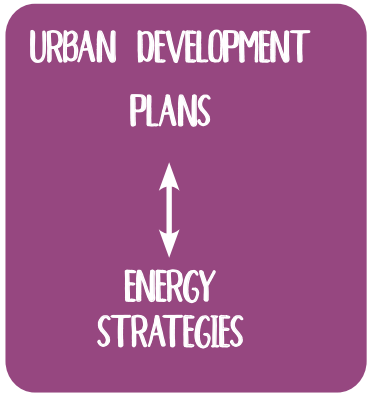
6. MICRO CLIMATE DESIGN
7. INCREASE RE SUPPLY
8. DISTRICT ENERGY SYSTEM
9. RETROFIT BUILDINGS
10. MINIMIZE WATER USE
11. REDUCE WASTE

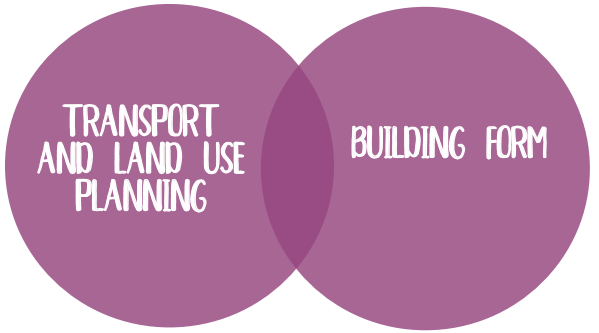
WHY IS THE SPATIAL ANALYSIS IMPORTANT?

1. BRIDGE THE GAP BETWEEN URBAN DEVELOPMENT PLANS AND ENERGY STRATEGIES

2. ADDRESSES THE SPACES BETWEEN BUILDINGS

3. INTEGRATES TRANSPORT PLANNING AND BUILDING DESIGN





HOW CAN CITIES DEVELOP THIS?

WHAT SHOULD ENERGY STRATEGIES AIM TO ACHIEVE?

1. REDUCE GHG EMISSIONS
2. INCREASE SPATIAL QUALITY
3. PROMOTE LONG TERM ENVIRONMENTAL SUSTAINABILITY

SPATIAL ANALYSIS

- TRANSPORTATION AND LAND USE
- BUILDING FORM
- ENERGY INFRASTRUCTURE

+

GOVERNANCE MODEL

- STAKEHOLDERS
- PLANNING PROCESS
- PLANNING INSTRUMENTS
- ECONOMIC FEASIBILITY

+

SOCIETAL VALUES

- LOCAL CULTURE
- BEHAVIORAL NORMS
- COMMUNITY ASPIRATIONS

THANK YOU