Transformation of Waste Management in Oman
Innovative Waste Management Technologies W.S. - Casablanca
30th September 2015
Outline

• Sultanate of Oman: Background
• Waste Management in Oman: Situation Analysis
• be’ah: Integrated Waste Management Strategy
  • Municipal Solid Waste
  • Industrial Waste
• be’ah: Waste Diversion Strategy
Sultanate of Oman
Area: 309,500 km²

Population: 4.24 million*

Density: 13.71 capita/km²

Source: National Center for Statistics and Information

*Sep 2015
Waste Management in Oman: Situation Analysis
Solid Waste Definition

Basel Convention Definition of Wastes

“Substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of the law”
Solid Waste Classification: By Source

Municipal Solid Waste (MSW)
Solid waste that is created by people, household, businesses, or institutions, such as offices, government, schools, hospitals ..etc.

Household  
Commercial  
Institutional

Non-Municipal Solid Waste
Solid waste that is created due to the production of a product.

Agricultural  
Industrial  
Construction & Demolition
### Hazardous

**Corrosive** (substances that cause damage on contact, e.g. acids)

**Ignitable** (materials that can catch fire easily like benzene)

**Toxic** (materials that can be poisonous to humans when inhaled or ingested, or come in contact with skin or mucous membranes)

**Reactive** (substances that can yield a harmful chemical if they react with other substances)

**Infectious** (substances that are capable of causing or communicating infection).

### Non-Hazardous

### Other

**Combustible** (it burns)

**Non-Combustible** (it doesn’t burn)

**Biodegradable** (it decomposes quite quickly)

**Non-Biodegradable** (it doesn’t decompose or takes very long time to do so)
Oman: Waste Management Framework Structure

Waste Management & Cleaning Services Providers

- Willayat Sohar
  - Sohar Municipality
- Muscat Governorate
  - Muscat Municipality
- Most of Oman
  - Ministry of Regional Municipalities & Water Resources
- Dhofar Governorate
  - Dhofar Municipality

Environmental Legislator & Regulator

- Ministry Of Environment & Climate Affairs
- Healthcare Waste Permits
- Ministry Of Health
Oman: Current Infrastructure

- 317 Dumpsites
- 4 Landfills
- 9 Transfer Stations
- 1 Healthcare Treatment Facility
- 6,466 Workers*
- 1,284 Pcs of Equipment*

* 2009 estimates
Oman: Other Waste Streams: Quantities in Tons

*** 2014 “ELT Feasibility Study in 2011”
***** 2009 Muscat Governorate Field estimate

- **WEEE**
  - Electrical & Electronic: 45,000*

- **Healthcare**
  - Healthcare Waste: 4,500**

- **ELT**
  - ELT: 38,000***

- **LAB**
  - Lead Acid batteries: 14,000****

- **Hazardous**
  - Hazardous Waste: 1,469,835****

- **C&D**
  - C&D: 735,341*****
Oman: Waste Treatment System

**Waste Stream**
- Municipal
- Healthcare
- Hazardous
- Others

**Collection**
- Municipal
- Healthcare
- Not Available
- Others

**Disposal**
- Municipal: LF + Dumpsites
- Healthcare: Incineration + Dumpsites
- Hazardous: Storage + Dumpsites
- Others: Dumpsites + Export
Waste Management (WM) Hierarchy

Traditional Waste Management

1. Disposal
2. Recover/Treat
3. Recycle
4. Reuse
5. Reduce

New Waste Management Paradigm

1. Disposal
2. Recover/Treat
3. Recycle
4. Reuse
5. Reduce
Oman: Waste Management Hierarchy

Current Waste Management Practice in Oman

- Reduce
- Reuse
- Recycle
- Disposal
Oman: Waste Management Challenges

Waste Management in Oman

• Done in reactive basis leading to isolated solutions
• Lack of coordination among stakeholders

Concerns

• Absence of policy and strategic master plan
• Lack of a single responsible entity
• Lack of an integrated waste management system, resources, and infrastructure
• Inadequate data and records of waste
• Inadequate laws and regulations
• Inadequate numbers of waste management experienced workforce
Collection & Disposal
Oman: Recycling Industry
1. Create an effective organizational structure and framework for waste management in Oman.

2. Establish a holding company owned by the government with subsidiaries (Geographical).

3. Implement the urgent recommended projects.

4. Lay the foundation for an Integrated Waste Management System and the overall strategy with the frame time (Long & Short terms), budgets, tariffs, and required resources.

5. Establish an independent National Authority to regulate Solid and Hazardous Waste.

6. Establish a unified law for the sector (Regulatory Framework) with separate legislations including hazardous and non-hazardous waste.

7. Implement an integrated Financial System for Solid waste Management and use this System for the tariffs.

8. Privatize with flexibility in engaging the private sector in the Waste Management Industry.
be’ah: Integrated Waste Management Strategy
Draft Strategy Report: National Solid Waste Management Project

Oman Environmental Services Holding Company “be’ah” Established

Takeover Healthcare Treatment Facility

Royal Decree 46/2009

Budget Approved by Ministry of Finance
be’ah: Responsibilities

- Restructure waste management activities across the Sultanate.
- Take over waste management responsibilities from other Municipalities and stakeholders.
- Streamline, commercialize and privatize the waste management sector
To Conserve the Environment of our Beautiful Oman for our Future Generations”
Together we *develop* the Waste Management sector in Oman by providing safe, efficient and the most economically and environmentally *sustainable* services in innovative ways—thereby contributing to the overall economy.
be’ah: Strategic Goals

1. Damage Control
2. Restructure WM Services
3. Develop WM Sector
4. Support Oman’s Economy
be’ah: Core Strategies

Phase 1

2012
• Establish required infrastructure
• Private sector participation
• Waste sector takeover

2013

2014

2015

Phase 2

2016
• Manage the sector as per sustainability principles (Environmentally, Economically, Socially, Financially)

2017
• Complete Dumpsites Closure (Q2 2017)

2018
• Rehabilitate dumsites
• Complete infrastructure (MSW and ISW)

2019
• Complete sector takeover

2020

Phase 2

2018
• Support/ develop optimal framework for the sector (Policies, Legislation, Strategies, Plans)
• Improve public awareness of waste management
• Develop & commercialize waste stream systems
• Recover lost value in waste in commercial basis
Sector Building Stages

- **Closure of Dumpsites**
- **0 CO\textsubscript{2} Emissions from Dumpsites**
- **60% Diversion Rate**
- **80% Diversion Rate**
- **Less than 1 kg/capita/day**

- **2012**: Establish Infrastructure
- **2016**: Sector Takeover
- **2020**: Rehabilitation of Dumpsites
- **2030**: Establish sustainability principles pillars
- **2040**: Establish the required recycling mechanisms and waste value recovery
- **2020**: Sustainability awareness programs designed as the services needs
- **2030**: Establish an integrated system for cost accounting and implement a tariff system

*MSW (Household excluding HW, WEEE, ELT, ELV, LAB...etc.)
be’ah: Holding Structure

Wholly owned Subsidiaries

Industrial Waste
- Hazardous Waste (HW)
- Healthcare Waste (HCW)
- Oil and Chemical Waste
- Waste of Electrical and Electronic Equipment (WEEE)
- Lead Acid Batteries (LAB)
- End of Life Vehicles (ELV)

Municipal Solid Waste
- Municipal Waste
- Green Waste
- End of Life Tires (ELT)
- Construction and Demolition (C&D)
- Others streams
be’ah: Municipal Solid Waste
<table>
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<th>2016</th>
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<td>25-34</td>
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be‘ah: Municipal Solid Waste (MSW) Infrastructure

Al-Multaqa Landfill
be‘ah: Municipal Solid Waste (MSW) Infrastructure

Tahwa Landfill
be’ah: Municipal Solid Waste (MSW) Infrastructure
be’ah: Municipal Solid Waste (MSW) Infrastructure
be‘ah: Municipal Solid Waste (MSW) Infrastructure

Thamrait Landfill
be’ah: Municipal Solid Waste (MSW) Infrastructure

Samail Transfer Station
be‘ah: Municipal Solid Waste (MSW) Infrastructure

Samail Transfer Station
be’ah: WM Sector Takeover

- Takeover in a phased manner (Governorate wise)
- Only takeover once the infrastructure becomes readily available
- Services to be outsourced to experienced waste management companies
- Outsource contract to include pre-collection, collection, transportation, treatment, and landfilling of Municipal Solid Waste (MSW)
- Outsource contract to include facility management of landfill(s) and transfer station(s)
- Outsource contract to allow for MSW diversion solutions
- Outsource contract does not include general cleaning services as they are not within be’ah’s mandate
Be’ah: Sector Takeover Outsourcing Contract

- **Collection**
  - Household
  - Commercial
  - Pre-collection

- **Transfer Stations**
  - Management

- **Transportation**
  - Recyclables

- **Landfills**
  - Management
be’ah: Industrial (Hazardous) Waste
be’ah: Healthcare Waste (HCW) Infrastructure*

- Al-Multaqa: 98% of Muscat’s HCW treated
- Thamrait: In 2015
- Barka: In 2017
- Liwa: In 2015

Remote areas

*Fully financed by be’ah
be’ah: Healthcare Waste (HCW) Operations*

*Cost recovery based fees
be‘ah: Hazardous Waste (HW) Infrastructure

Liwa
- Perfect location
- Location approved by authorities

Adam
- A tender was floated based on BOOT concept
- Bids were extremely high
- Tender was scrapped
- Plans for this location scrapped

Dujum
- No accurate data on future HW generation and needs
- Plans for this location scrapped
Integrated Industrial HW Handling & Treatment Plant

Sohar Free Zone (Liwa)

- 240 Ha
- 90% of all hazardous waste in Oman is generated in Sohar
- Good infrastructure with roads, railway, port …etc.
- Location approved by:
  - Sohar Industrial Port Company
  - Supreme Council of Planning
Central Facility

- Storage Facilities
- Pretreatment Units
- Solidification (100,000 t/annum)
- Physical / Chemical Treatment (1,000 t/annum)
- Thermal Treatment (50,000 t/annum)

Slag Reclamation
- 28 million m³

Hazardous waste landfill
- 3 million m³
be’ah: Hazardous Waste (HW) Infrastructure

Liwa
Integrated Hazardous Waste Handling & Treatment Facility:
- Slag Landfills
- Hazardous Waste Landfill
- Storage Facilities
- Pretreatment Units
- Solidification Unit
- Physical / Chemical Treatment Unit
- Thermal treatment Unit (incineration)

Dhofar
- Transfer Station
- Hazardous Waste Landfill

Duqum
- Transfer Station
- Hazardous Waste Landfill

Oil Fields
- Under Study
be‘ah: Hazardous Waste (HW) Project Timeline

**Phase 2: Floated**
- slag landfills,
- hazardous waste landfill
- solidification plant
- storage for organic solid waste

**Phase 1 Commissioned**

**Duqum HW Landfill Commissioned**

**Phase 2 Commissioned**

**Phase 3 Commissioned**

**Past**

**2015**

**2016**

**2019**

**2020**

**HW Temporary Storage Facility**

**Duqum HW Landfill: Floated**

**Phase 1 Floated**
- Temporary Slag Landfill

**Phase 3 Floated**
- incineration plant
- physical chemical treatment plant
- several pre-treatment plants
be’ah: Waste Diversion Strategy
Waste Hierarchy

Most Preferred

Reduce

Reuse

Recycle

Recover (Digestion, Composting)

Incineration (Energy Recovery)

Engineered Landfilling

Least Preferred

Waste Diversion

Waste Disposal
In today’s linear economy, we are missing opportunities to create new products and clean energy from consumed materials.
Circular Economy

In a circular economy, nothing is wasted.

Image source: Veolia UK
Recycling System: Maximum In-Country-Value

- **Imported Good**
  - Consumers
  - Recyclables
  - Collection Points

- **Collection & transportation (SME)**
  - Recyclables

- **Recycling Plants (Investment Opportunities)**
  - Recycling
  - Secondary Treatment (SME)
  - Exported Good
Waste composition*

Average energy content: 10 MJ/kg

Energy (MJ/Kg)

- Others: 0
- Textile: 18
- Wood: 13
- Metal & Glass: 0
- Plastic: 32
- Cardboard: 14
- Paper: 14
- Park & Bio: 4
- Food Waste: 1

*Waste Characterization and Quantification study, be’ah 2013
Waste to Energy

• The Waste to Energy concept has been around for over 100 years
• Over 2,000 Waste to Energy facilities around the globe
Waste to Energy: Applications

- Europe: Waste to Power & Heat, need for the heat
- Singapore: Waste to Power, scarcity of land
- United Kingdom: Waste to Power, new regulations, difficult to landfill
- Middle east: Qatar existing W2E, new W2E in Abu Dhabi, Sharjah and Kuwait, Waste to Power, minimize landfilling
Waste to Energy Implementations (Denmark)
Issy-les-Moulineaux, Paris, France
Issy-les-Moulineaux, Paris, France
Possible energy use:

• Power → relatively low cost of conventional energy production in the GCC
• Hot water or steam for industrial use → No economy of scale (small scale industrial clusters)
• District cooling → horizontal residential expansion, and high cost of logistics

All above mentioned options are not feasible
Oman: Fresh Water Shortage

- Low rainfall levels
- Dependence on sea water desalination
- Most desalination plants run on subsided gas
- Further desalination capacity is required in the near future
Waste to Energy to Water Concept

**Business Case:**
Waste to Energy with RO & MED (Thermal) based only on selling fresh water
Waste to Energy to Water Concept

Flash evaporation (MED)

Reverse Osmosis (RO)

Desalination Plant

73 mil m³ per annum
almost 30% of existing desalination capacity in Oman

Waste to Energy Plant

2,100 Tons per day
W2E2W Proposed Location (South Al-Batinah)
W2E Sustainable Benefits

• 1 Ton of waste generates 600 kw/h and replaces 1 barrel of fuel (35 gallons) or ¼ ton of coal
• Gas emissions from W2E plants are much lower than those from landfills and lower than permitted emissions as per European standards. W2E2W will eliminate the emissions of close to 337,000 tons of CO₂ per annum
• Reduces required landfill space by up to 90% (saves landfelling cost)
• Much lower environmental impacts than conventional power plants as per EPA
• Provides a sustainable mechanism in improving the environment and conserving it for a better living place
• Considered as an available alternative energy source
• Tackle potable water shortage
• Reduce government subsidy on gas (around 150 mil. m³ per annum)
W2E: Mechanical Biological Treatment (MBT)

- Municipal Solid Waste (MSW)
  - Inert Waste
    - Engineered Landfills
  - Organic Waste
    - Compost or Digestion Facilities
  - Metals
    - Recycling Facilities

- Refuse Derived Fuel (RDF)

- Industries
be’ah: Potential Waste Recovery Facilities

South Al-Batinah
2,100 T/Day
Waste to Energy to Water

North Al-Batinah
500-1,000 T/Day
Waste to Energy to Water

South Al-Sharqiyah
500-1,000 T/Day
Waste to Energy to Water

Dhofar
400-500 T/Day
MBT Facility
Conserving our Beautiful Oman

THANK YOU

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