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Why are we here?

Desalination can be an expensive, polluting source of water

**Riyadh, Saudi Arabia:**
- High energy costs and carbon emissions
- Adverse local environmental impacts
- Low value uses (due to subsidized prices)
- Business as usual rather than living within means

Desalination can ALSO be a cheaper, cleaner source of water...

**Gulhi, Maldives:**
- Reduced energy costs and carbon emissions
- Improved local environmental impacts
- High value uses (even with full prices)
- Thriving within means
How are we here? Innovation!

- Water Piping
  - Heating
  - Cooling
  - Injection
  - Brine Disposal

- Steam Ducting

- Membranes or Foils
  - Steam Separation
  - Energy Recycling
  - Mass transfer
  - Energy transfer

- Collection of Product

- Degassing
Multi-membrane assembly
Heat-driven vacuum distillation

- **Steam Raiser**: Feedwater
- **Effect 1**: Membrane, Foil
- **Effect X**: Membrane, Foil
- **Condenser**: Membrane, Foil
- **Brine**: Waste Heat

- **Temperature and Pressure**:
  - **80°C**: 475mB
  - **70°C**: 315mB
  - **60°C**: 200mB
  - **30°C**: 100mB

**Vacuum**
- **Distillate**
The potential of waste heat

Total value of global waste heat:
app. 2.000 billion US$ per year

0.1% of this waste heat can desalinate drinking water for one billion people

2/3 waste heat in cooling cycle and exhausts

1/3 electricity output

Gas / Biogas

Coal

Diesel / Oil

54% 66% 68% 46% 34% 32%

Source: Guardian 06.06.2012 – numbers for UK power plants – developing world numbers are actually worse
Calculation Basis: GOR of 6 and 3 liter of drinking water per day
Symbiotic water-power generation

- Engine Cooling return
- Engine Cooling out
- Hot Water supply
- Feed + Cooling Water
- Distillate
- Brine
- Minerals
- Drinking Water
- Electricity
- Generator

Diagram elements:
- radiator
- fan
- membrane distillation
Maldives for rich and poor

Gulhi Inhabited Island
10$ per day per family

1.5 km

Anantara Resort
1.000$ per day per room
Pilot Project on Gulhi
PPP business model

Local Partner (Stelco) benefits from efficiency

Aquiva provides start-up funding to buy memsys gear

**Goal:** Repayment/self-financing for expansion via 3rd parties

Desalination plants → Project: Gulhi

Contribution:
- Waste heat
- Land
- Personnel
  (otherwise unused assets)

50/50 JV

AQUIVA FOUNDATION

UK/Maldives Charitable Foundation

3rd Party Investors?

Financing against interest

Projects are run on as profit centers
The Project on Gulhi
More than one year of operations

Robust Operation
High Uptime
Very Low Operational Expenditures

Generator with heat exchanger to harvest waste heat
Desalination plant w 10,000 liter (10m3) per day capacity
Symbiotic water-power generation (Gulhi)

Stand alone Generator with Fan and Radiator cooling

3.00 kWh/l diesel

+5% improved Cooling

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Generator with MD desalination

3.24 kWh/l diesel

-2% Desalination energy consumption

+5% shut down cooling fan

(depending on local set up, therefore omitted from the numbers on the next page example calculation)

+8% positive energy balance

Saving in the Gulhi example:
70,000 kWh per year or 20,000 liter diesel per year
Desalination: from necessity to opportunity

### Desalination using Waste Heat

**Example calculation**

All numbers in US$

<table>
<thead>
<tr>
<th>Actual average output m³ per day</th>
<th>Output 20 m³ per day</th>
<th>Output 500 m³ per day</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial cost of plant</strong></td>
<td>80,000</td>
<td>1,980,000</td>
</tr>
<tr>
<td><strong>Costs for borehole, prefiltration and tanks</strong></td>
<td>47,000</td>
<td>85,000</td>
</tr>
<tr>
<td><strong>Replacement costs over 5 years</strong></td>
<td>6,000</td>
<td>55,000</td>
</tr>
<tr>
<td><strong>Generator Interface costs</strong></td>
<td>20,000</td>
<td>240,000</td>
</tr>
<tr>
<td><strong>Consumables (including power)</strong></td>
<td>33,692</td>
<td>637,421</td>
</tr>
<tr>
<td><strong>Total Costs of operation per 5 years (including 100% plant write off)</strong></td>
<td>206,692</td>
<td>2,997,421</td>
</tr>
<tr>
<td><strong>Total costs per m³ produced</strong></td>
<td>5.67</td>
<td>3.28</td>
</tr>
<tr>
<td><strong>Savings through increase of generator efficiency over 5 years at costs per KWh of 0.35 US$</strong></td>
<td>-257,544</td>
<td>-6,438,600</td>
</tr>
<tr>
<td><strong>Total costs of operations over 5 years (including energy savings)</strong></td>
<td>-50,852</td>
<td>-3,441,179</td>
</tr>
<tr>
<td><strong>Total costs per m³ produced (including energy savings)</strong></td>
<td>-1.40</td>
<td>-3.77</td>
</tr>
</tbody>
</table>
Problem: Plastic bottles
Solution: reusable containers
Problem: Sick kids
Solution: free water for school & hospital
Complications
• New business model (Aquiva funding repaid by users/energy savings)
• Complex political environment

Advantages
• Cost effective
• Meets current needs
• Reasonable technology (local employees)
• Scalable (add modules)

But we’ve made progress, gained experience and have high hopes!