CityZEN Strategy Plan # 4: Menorca


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ISLA
SOSTENIBLE ‘MENORCA’
ROADSHOW

Monday 24th April to Friday 28th April 2017
Hosted by IME – Institut Menorquí d’Estudis

Dr Craig Martin, TU Delft NL.
THE AIM

• Through group working and interactive sessions, the Roadshow team and Menorca’s stakeholders co-created a ‘Sustainable Island Vision’ owned by your Island and you!

• To define realisable solutions all Roadshow activities dealt with innovative & impactful concepts, strategies and technologies at all scales of island life….
Mira Menorca
El Maó més autosuficient

Alumnes de la Delft University of Technology han plantejat propostes per que la ciutat sigui més sostenible.

3 MONTHS

MENORCA ‘SWAT’ Studio (Feb 2017)
Día 1

INTRO

MENORCA 'trazos'

EXCURSIÓN EN BUS y BARCO

DAY 1 (MON)

Mira Menorca
Otro estilo de vida para cero emisiones

Tras Amsterdám, Belgrado, Estocolmo y Dublín, el sello menorquín de la UC City-Zen ha llegado mientras está todavía en la fase para reducir el consumo energético.

CONTRIBUCIÓN
El hecho de que el menorquín esté cada vez más relacionado con nuestra vida cotidiana, no significa que deba ser un fin en sí mismo. En este sentido, el menorquín es un espejo que refleja en las personas.

Un juego interactivo para ver cómo se descarboniza la energía y economía

52
del 84

CITY zen
New urban energy

52
del 84
Día 2: ‘MAPA DE FUTUROS’ TALLERES PARALELOS COMENZAN
Día 3: SERIOUS GAME
Día 3: MENORCA SMART ISLAND

'DISEÑO'

'39%'

56% of the energy is used to produce power and 40% for local means of transportation.
Día 3: TOUR PERSONAS Y TECNOLOGÍA
Día 4: ‘EVALUAR’ - CONTABILIDAD DEL CARBONO EXPLICADA

<table>
<thead>
<tr>
<th>Mobility</th>
<th>km/day</th>
<th>AVG Menorca</th>
<th>km/yr</th>
<th>use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td></td>
<td>10</td>
<td>365</td>
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</tr>
<tr>
<td>Jose</td>
<td>15</td>
<td></td>
<td>365</td>
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</tr>
<tr>
<td>Begonja</td>
<td>10</td>
<td></td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>Agnes</td>
<td>10</td>
<td></td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>David</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

EVALUAR

Contabilidad del Carbono Explicada

Day 4 (Thurs)

MOBILITY IN MY HOUSE

CITY  zen
New urban energy
Día 5: ‘VIE’ - ISLA SOSTENIBLE – LA VISIÓN
Día 5: ‘VIE’ - ISLA SOSTENIBLE – LA VISIÓN

MAPA DE FUTUROS
EXCURSIÓN EN BUS y BARCO
'ESTILOS DE VIDA DEL FUTURO'
'LA ENERGÍA DE LA ISLA'
'TOUR PERSONAS Y TECNOLOGÍA'
'GO2ZERO'

CONTABILIDAD DEL CARBONO
EXPLICADA
'MENORCA SMART ISLAND'

Día 5: ‘VIE’ – ISLA SOSTENIBLE – LA VISIÓN

3 MONTHS
DAY 1 (MON)
DAY 2 (TUES)
DAY 3 (WED)
DAY 4 (THURS)
DAY 5 (FRI)

Pre-Roadshow Analysis
Ricardo Pulselli, University of Siena
Ecological Footprint of Menorca is roughly 7 times its area.

Most of this is comprised of

**Food**
- Generally sourced from elsewhere.
- High levels of waste/foodmiles

**Materials**
- Poor recycling and re-use
- Non local sources.

**Energy**
- Mainly Fossil fuels

**Transport**
- Low public transport
- Little cycling/walking
- High car use

**Water**
- Limited local supply
MENORCA ELECTRICAL GRID

Electricity demand 479 GWh
Electricity production 411 GWh

NET IMPORT (14.3%) 69 GWh
Coal (70%); Nat gas (14%); Oil (4%)

THERMO-ELECTRICITY (82.9%) 397 GWh
Oil (82.9%) 397 GWh/yr

RENEWABLE (3%) 13 GWh
PV (1.6%) 8 GWh/yr
Wind (1.1%) 5 GWh/yr

ELECTRICITY EMISSION FACTOR
0.761 kg CO₂eq/kWh
# Residential Energy

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>CO₂eq/yr</th>
<th>MWh/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>166,122</td>
<td>198,270</td>
</tr>
<tr>
<td>Petroleum</td>
<td></td>
<td>33,773</td>
</tr>
<tr>
<td>LPG</td>
<td></td>
<td>27,256</td>
</tr>
<tr>
<td>Biomass</td>
<td></td>
<td>7,670</td>
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# Commercial Energy

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<thead>
<tr>
<th>Energy Source</th>
<th>CO₂eq/yr</th>
<th>MWh/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>178,218</td>
<td>210,371</td>
</tr>
<tr>
<td>Petroleum</td>
<td></td>
<td>43,422</td>
</tr>
<tr>
<td>LPG</td>
<td></td>
<td>28,581</td>
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# Industrial Energy

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>CO₂eq/yr</th>
<th>MWh/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>26,105</td>
<td>24,267</td>
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<tr>
<td>Petroleum</td>
<td></td>
<td>19,299</td>
</tr>
<tr>
<td>Liquified Natural Gas</td>
<td></td>
<td>3519</td>
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# Agriculture

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>CO₂eq/yr</th>
<th>MWh/yr</th>
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</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>16,187</td>
<td>7692</td>
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<tr>
<td>Petroleum</td>
<td></td>
<td>38,556</td>
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<tr>
<td>Biomass</td>
<td></td>
<td>0.005</td>
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# Mobility

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>CO₂eq/yr</th>
<th>MWh/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>129,647</td>
<td>478,401</td>
</tr>
<tr>
<td>Petroleum</td>
<td></td>
<td>444,798</td>
</tr>
</tbody>
</table>

# Maritime & Air transport

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>CO₂eq/yr</th>
<th>MWh/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum</td>
<td>120,540</td>
<td>444,798</td>
</tr>
</tbody>
</table>

# Water Management

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>CO₂eq/yr</th>
<th>m³/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water use</td>
<td>6319</td>
<td>10,800,000</td>
</tr>
</tbody>
</table>
CARBON FOOTPRINT OF MENORCA

ENERGY
28,640 ha

MOBILITY
18,530 ha

WATER
470 ha

WASTE
3800 ha

CF OFFSET 51,448 ha

694,551 t CO₂eq/yr

MENORCA
92,348 inhabitants
111230 inhab. + tourists
69,400 m²

CITY-ZEN ROADSHOW @ MENORCA – CARBON ACCOUNTING – RICCARDO M PULSELLI – UNIVERSITY OF SIENA
CARBON FOOTPRINT OFFSET OF MENORCA

CITY-ZEN ROADSHOW @ MENORCA – CARBON ACCOUNTING – RICCARDO M PULSELLI – UNIVERSITY OF SIENA
CARBON FOOTPRINT OFFSET OF MENORCA

C FOOTPRINT 51,448 ha
C UPTAKE 43,750 ha
694,551 t CO₂eq/yr
-590,636 t CO₂eq/yr
### MENORCA HOUSEHOLD PROFILING

#### ENERGY DEMAND

<table>
<thead>
<tr>
<th>Category</th>
<th>Demand</th>
<th>CO₂eq</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling electricity</td>
<td>619 kWh/yr</td>
<td></td>
<td>55%</td>
</tr>
<tr>
<td>Lighting &amp; appliances</td>
<td>3713 kWh/yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating &amp; DHW (electr)</td>
<td>1857 kWh/yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating &amp; DHW (butane)</td>
<td>253 kWh/yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking (butane)</td>
<td>591 kWh/yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating &amp; DHW (oil)</td>
<td>1063 kWh/yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating (biomass)</td>
<td>250 kWh/yr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### MOBILITY

<table>
<thead>
<tr>
<th>Category</th>
<th>Demand</th>
<th>CO₂eq</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance by car</td>
<td>8094 km/yr</td>
<td></td>
<td>31%</td>
</tr>
</tbody>
</table>

#### WASTE MANAGEMENT

<table>
<thead>
<tr>
<th>Category</th>
<th>Demand</th>
<th>CO₂eq</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collected quantity</td>
<td>496 kg/yr</td>
<td></td>
<td>12%</td>
</tr>
<tr>
<td>Recycled</td>
<td>20 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste to landfill</td>
<td>0.8 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### WATER MANAGEMENT

<table>
<thead>
<tr>
<th>Category</th>
<th>Demand</th>
<th>CO₂eq</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water use per inhabitant</td>
<td>97.1 m³/yr</td>
<td></td>
<td>2%</td>
</tr>
</tbody>
</table>

---

**Total CO₂eq per household:** 9.40 t CO₂eq/yr
The carbon footprint of one household is equivalent to 26,000 km driven by car.

The carbon footprint offset of one household is equivalent to 0.70 ha forestland.
MAHON NEIGHBOURHOOD
3000 inhabitants
1125 households

CARBON FOOTPRINT 10,570 t CO₂eq
CF OFFSET 783 ha forestland
CARBON FOOTPRINT of the NEIGHBOURHOOD

ENERGY 432 ha

WATER 12 ha

MOBILITY 244 ha

WASTE 96 ha

MAHON NEIGHBOURHOOD
3000 inhabitants
1125 households

CARBON FOOTPRINT 10,570 t CO₂ eq
CF OFFSET 783 ha forestland
CARBON FOOTPRINT of the NEIGHBOURHOOD

ENERGY
432 ha

MOBILITY
244 ha

WASTE
96 ha
Building shadowing systems and passive ventilation
- applied to 30% households (-50% cooling energy)
- avoided 80 tCO2eq = 6ha
### CARBON FOOTPRINT of the NEIGHBOURHOOD

#### ENERGY

**403 ha**

1. Building shadowing systems and passive ventilation
   - applied to 30% households (-50% cooling energy)
   - avoided 80 tCO2eq = 6 ha

2. Envelope insulation
   - applied to 60% households (-35% heat; -10% cooling)
   - avoided 310tCO2eq = 23 ha

#### MOBILITY

**244 ha**

#### WASTE

**96 ha**
CITY- ZEN ROADSHOW @ MENORCA – CARBON ACCOUNTING – RICCARDO M PULSELLI – UNIVERSITY OF SIENA

CARBON FOOTPRINT of the NEIGHBOURHOOD

ENERGY
403 ha

public transport
- +30% public transport instead of car
- avoided tCO2eq

MOBILITY
122 ha

WASTE
96 ha
CITY-ZEN ROADSHOW @ MENORCA – CARBON ACCOUNTING – RICCARDO M PULSELLI – UNIVERSITY OF SIENA

CARBON FOOTPRINT of the NEIGHBOURHOOD

ENERGY
403 ha

3 public transport
   - +30% public transport instead of car
   - avoided tCO2eq

4 Electric bike sharing
   - Avoided tCO2eq

MOBILITY
94 ha

WASTE
96 ha
### CARBON FOOTPRINT of the NEIGHBOURHOOD

**CARBON ACCOUNTING**

<table>
<thead>
<tr>
<th><strong>ENERGY</strong></th>
<th><strong>403 ha</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WASTE</strong></td>
<td><strong>46 ha</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MOBILITY</strong></td>
<td><strong>94 ha</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Waste decrease; differentiated waste**
- -50% landfill
- avoided tCO2eq

CITY-ZEN ROADSHOW @ MENORCA – CARBON ACCOUNTING – RICCARDO M PULSELLI – UNIVERSITY OF SIENA
## CARBON FOOTPRINT of the NEIGHBOURHOOD

### CARBON ACCOUNTING

<table>
<thead>
<tr>
<th>Energy</th>
<th>403 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste decrease; differentiated waste</td>
<td></td>
</tr>
<tr>
<td>- -50% landfill</td>
<td></td>
</tr>
<tr>
<td>- avoided tCO2eq</td>
<td></td>
</tr>
<tr>
<td>Waste to energy; Waste to compost</td>
<td></td>
</tr>
<tr>
<td>- -90% landfill</td>
<td></td>
</tr>
<tr>
<td>- avoided tCO2eq</td>
<td></td>
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</tbody>
</table>

### Mobility
- 94 ha

### Waste
- 24 ha
<table>
<thead>
<tr>
<th>Carbon Footprint of the Neighbourhood</th>
<th>Carbon Accounting</th>
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</thead>
</table>

TO BE CONTINUED......
Energy interventions

Siebe Broersma TU Delft

The current energy system, demand & potentials
The current energy system & energy use
## DEFINING THE REAL ENERGY DEMAND

### RESIDENTIAL ENERGY USE AND DEMAND

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Total (MWh)</th>
<th>Demand for</th>
<th>per hh (kWh)</th>
<th>Electricity (appl)</th>
<th>Cooling</th>
<th>Heating</th>
<th>DHW</th>
<th>Cooking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>198000</td>
<td>6188</td>
<td>3713</td>
<td>619</td>
<td>1238</td>
<td>619</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butane etc</td>
<td>27000</td>
<td>844</td>
<td>3713</td>
<td>169</td>
<td>84</td>
<td>84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petroleum</td>
<td>34000</td>
<td>1063</td>
<td>3713</td>
<td>744</td>
<td>319</td>
<td>319</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass</td>
<td>8000</td>
<td>250</td>
<td></td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>267000</td>
<td>8344</td>
<td>3713</td>
<td>619</td>
<td>2400</td>
<td>1022</td>
<td></td>
<td>591</td>
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</table>

### AVERAGE HOUSEHOLD DEMAND FOR:

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Total (MWh)</th>
<th>Demand for</th>
<th>per hh (kWh)</th>
<th>Electricity (appl)</th>
<th>Cooling</th>
<th>Heating</th>
<th>DHW</th>
<th>Cooking</th>
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</thead>
<tbody>
<tr>
<td>COP Airco</td>
<td>118800</td>
<td>49500</td>
<td>3713</td>
<td>1547</td>
<td>2400</td>
<td>1022</td>
<td></td>
<td>591</td>
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</table>

### TOTAL RESIDENTIAL ENERGY DEMAND:

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Total (MWh)</th>
<th>Demand for</th>
<th>per hh (kWh)</th>
<th>Electricity (appl)</th>
<th>Cooling</th>
<th>Heating</th>
<th>DHW</th>
<th>Cooking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>286600</td>
<td>96100</td>
<td>49500</td>
<td>3713</td>
<td>2400</td>
<td></td>
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<td>591</td>
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</table>

### ENERGY USE AND DEMAND SERVICES

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Total (MWh)</th>
<th>Demand for</th>
<th>per hh (kWh)</th>
<th>Electricity (appl)</th>
<th>Cooling</th>
<th>Heating</th>
<th>DHW</th>
<th>Cooking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>21000</td>
<td>84000</td>
<td>3713</td>
<td>250</td>
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<td>319</td>
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<td></td>
</tr>
<tr>
<td>Petroleum</td>
<td>28000</td>
<td>14000</td>
<td>3713</td>
<td>169</td>
<td>84</td>
<td>319</td>
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<td>Total</td>
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<td>3713</td>
<td>250</td>
<td>84</td>
<td>319</td>
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### ENERGY DEMAND FROM SERVICES:

<table>
<thead>
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<th>Energy Source</th>
<th>Total (MWh)</th>
<th>Demand for</th>
<th>per hh (kWh)</th>
<th>Electricity (appl)</th>
<th>Cooling</th>
<th>Heating</th>
<th>DHW</th>
<th>Cooking</th>
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<tbody>
<tr>
<td>Total</td>
<td>286600</td>
<td>96100</td>
<td>49500</td>
<td>3713</td>
<td>2400</td>
<td></td>
<td></td>
<td>591</td>
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### ENERGY USE AND DEMAND INDUSTRIAL

<table>
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<th>Demand for</th>
<th>per hh (kWh)</th>
<th>Electricity (appl)</th>
<th>Cooling</th>
<th>Heating</th>
<th>DHW</th>
<th>Cooking</th>
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</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>24000</td>
<td>0</td>
<td>3713</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petroleum</td>
<td>31000</td>
<td>0</td>
<td>3713</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>Total</td>
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<td>3713</td>
<td>0</td>
<td>0</td>
<td>0</td>
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### ENERGY USE AND DEMAND FOR VEHICLES AND AGRICULTURE

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Total (MWh)</th>
<th>Demand for</th>
<th>per hh (kWh)</th>
<th>Electricity (appl)</th>
<th>Cooling</th>
<th>Heating</th>
<th>DHW</th>
<th>Cooking</th>
</tr>
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<tbody>
<tr>
<td>Airplanes</td>
<td>23100</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>8000</td>
<td>8000</td>
<td>8000</td>
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<td></td>
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### 1ST STEP TOWARDS A ZERO ENERGY ISLAND: PROPER ENERGY ACCOUNTING!

**Know your energy demand!**
### Starting point: the current demand

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>electricity (appl)</th>
<th>cooling</th>
<th>heating</th>
<th>DHW</th>
<th>cooking</th>
<th>fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESIDENTIAL</td>
<td>119</td>
<td>50</td>
<td>77</td>
<td>33</td>
<td>19</td>
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<tr>
<td>SERVICES</td>
<td>105</td>
<td>84</td>
<td>38</td>
<td>46</td>
<td>14</td>
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</tr>
<tr>
<td>INDUSTRIAL + AGRIC</td>
<td>32</td>
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<tr>
<td>VEHICLES LAND</td>
<td></td>
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<td></td>
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<td>516</td>
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<tr>
<td>BOATS</td>
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<td></td>
<td>214</td>
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<tr>
<td>AIRPLANES</td>
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<td></td>
<td>231</td>
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<tr>
<td><strong>TOTAL (GWh)</strong></td>
<td><strong>256</strong></td>
<td><strong>134</strong></td>
<td><strong>114</strong></td>
<td><strong>110</strong></td>
<td><strong>33</strong></td>
<td><strong>961</strong></td>
</tr>
</tbody>
</table>

Total current energy demand (GWh)
### Energy potential analyses

**How much – where – barriers - solutions**

<table>
<thead>
<tr>
<th>Energy Analysis</th>
<th>How Much</th>
<th>Potential</th>
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<tbody>
<tr>
<td>Sun</td>
<td></td>
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<tr>
<td>Wind</td>
<td></td>
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<tr>
<td>Underground</td>
<td></td>
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<tr>
<td>Biomass</td>
<td></td>
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<tr>
<td>Water</td>
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</table>

- **Efficiency/Reduction**
- **Electrification**
- **Vehicles**
- **Other**

**What are the local energy potentials...and barriers?**
Solar power potential

- Green = suitable location solar parks
- Small blue = existing solar park
- 5 km² for current electricity demand
- = 60x existing PV plant (west) for current electricity demand
Wind potential

- Green = suitable location
- 3MW turbine = 7.5 GWh at Menorca
- 71 potential locations
- 60 needed for current electricity demand
Taking energy measures in a smart way

Our New Stepped Strategy (for different scale levels)

1. **Reduce** the energy demand
   - Urban planning & design
   - Architectural design
   - Passive, smart & bioclimatic design
   - Using local characteristics, vernacularity

2. **Reuse** waste energy
   - Attune supply and demand
   - Exchange surpluses with shortages
   - Cascade heat
   - Store energy

3. **Produce** renewable energy
   - Sun
   - Wind
   - Water
   - Air
   - Soil
   - Biomass
Horas equivalentes de producción renovable 2013

For steady electricity production: 50% wind - 50% sun
### Energy efficiency & sustainable production

#### Total current energy demand (GWh)

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>electricity (appl)</th>
<th>cooling</th>
<th>heating</th>
<th>DHW</th>
<th>cooking</th>
<th>fuel</th>
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</tbody>
</table>

#### Energy efficiency measures for Menorca (GWh)

<table>
<thead>
<tr>
<th>ENERGY MEASURE</th>
<th>electricity (appl)</th>
<th>cooling</th>
<th>heating</th>
<th>DHW</th>
<th>cooking</th>
<th>fuel</th>
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<tbody>
<tr>
<td>electricity reduction for appliances (-25%)</td>
<td>64</td>
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<td>modal shift (more public transport and bikes)</td>
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<tr>
<td>switch to 50% electric cars/busses/trucks</td>
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<tr>
<td>switch to 50% electric bikes</td>
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<tr>
<td>building retrofit measures ave. 43% red</td>
<td>-71.3</td>
<td>57</td>
<td>49</td>
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<tr>
<td>switch to electric boats 100%</td>
<td>-13.8</td>
<td>55</td>
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<tr>
<td>heat pump for heating (COP 4)</td>
<td>-10.5</td>
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<td>heat pumps for DHW (COP 2)</td>
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<td>electric cooking (80%)</td>
<td>-26</td>
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<tr>
<td>heat pump systems for cooling (COP 5)</td>
<td>-15.2</td>
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<tr>
<td>remaining energy demand</td>
<td><strong>373</strong></td>
<td><strong>0</strong></td>
<td><strong>10</strong></td>
<td><strong>89</strong></td>
<td><strong>7</strong></td>
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#### Energy PRODUCTION measures for Menorca (GWh)

<table>
<thead>
<tr>
<th>ENERGY MEASURE</th>
<th>electricity (appl)</th>
<th>cooling</th>
<th>heating</th>
<th>DHW</th>
<th>cooking</th>
<th>fuel</th>
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</thead>
<tbody>
<tr>
<td>Wind turbines Mahon (replace 4) (7x3MW)</td>
<td>50</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Wind turbines Ciutadella (7x3MW)</td>
<td>50</td>
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<tr>
<td>PV-roof canopy 30 km (amorpheus, 15m)</td>
<td>67</td>
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<td></td>
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<tr>
<td>solar boilers 75% of DHW</td>
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<tr>
<td>CHP on biomass for heating city centres + el.</td>
<td>10</td>
<td>10</td>
<td>6</td>
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<tr>
<td>biogas from foodwaste</td>
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<tr>
<td>PV on roofs (20% all roofs)</td>
<td>120</td>
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</tr>
<tr>
<td>10 3MW windturbines</td>
<td>76</td>
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</tr>
<tr>
<td><strong>total energy balance with measures</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>231</strong></td>
</tr>
</tbody>
</table>
Large scale energy production

- 7 (3M)W turbines Mahón
- 10 turbines Ciutadella
- 30 km PV canopy
- 7 turbines north coast
CARBON FOOTPRINT OF MENORCA

ENERGY
28,640 ha

MOBILITY
18,530 ha

WATER
470 ha

WASTE
3800 ha

MENORCA
92,348 inhabitants
111,230 inhab. + tourists
69,400 m2

CARBON FOOTPRINT
694,551 t CO₂eq/yr

CF OFFSET 51,448 ha

CITY-ZEN ROADSHOW @ MENORCA – CARBON ACCOUNTING – RICCARDO M PULSELLI – UNIVERSITY OF SIENA
Electricity reduction for appliances and lighting
- Applied to 100% buildings: -25% electricity for appl.
- Saved energy: 64 GWh electricity
- Avoided emission: 48,666 (-7%)
Modal shift (more public transport & bikes)
- Saved energy: 258 GWh fuel
- Avoided emission: 69,918 (-10%)
Switch to 50% electric cars / buses / tracks
- Saved energy: 129 GWh fuel (+43 GWh electricity)
- Avoided emission: 2236 (-0.3%)

Switch to 50% electric bikes
- Saved energy: 129 GWh fuel (+1.3 GWh electricity)
- Avoided emission: 33,977 (-5%)
CARBON FOOTPRINT OF MENORCA
CARBON ACCOUNTING

Building retrofit measures
- Applied to 100% buildings: -43% heating & cooling
- Saved energy: 57GWh cooling; 49GWh heating
- Avoided emission: 68,921 (-10%)

Switch to electric boats
- Applied to 100% boats
- Saved energy: 214 GWh fuel (+71GWh electricity)
- Avoided emission: 3709 (-0.5%)
Heat pump for heating (CoP4)
- Saved energy: 55Wh heating (+14GWh electricity)
- Avoided emission: 17,751 (-2.5%)

Heat pumps for DHW (CoP2)
- Saved energy: 21 GWh DHW (+10GWh electricity)
- Avoided emission: 2783 (-0.4%)
CARBON FOOTPRINT OF MENORCA

CARBON ACCOUNTING

Electric Cooking (80%)
- Saved energy: 26 Wh cooking (+26 GWh electricity)
- Avoided emission: 13,884 (-2%)

Heat pump systems for cooling (COP5)
- Saved energy: 76 GWh DHW (+15 GWh electricity)
- Avoided emission: 46,269 (-7%)
Waste differentiated collection
- 40% recycling; 30% organic to compost; 30% landfill
- Avoided emission: 30,676 (-60%)
Waste to energy plant
- 25% waste to energy; 30% organic to compost; 45% recycling
- Avoided emission: 10,200 (-20%)
Wind turbines Mahon (replace 4) (7x3 MW)
- Produced energy: 50 GWh
- Avoided emission: 38,050 (5.5%)
Wind turbines Ciutadella (7x3 MW)
- Produced energy: 50 GWh
- Avoided emission: 38,050 (5.5%)
PV-roof canopy 30km (amorpheus, 15m)
- Produced energy: 67 GWh
- Avoided emission: 50987 (7,3%)
Solar boilers 75% of DHW
- Produced energy: 82 GWh DHW
- Avoided emission: 42207 (6.1%)
**CHP on biomass for heating city-centres**
- Produced energy: 10GWh electricity; 10GWh heating; 6GWh DHW
- Avoided emission: 15,818 (2.3%)

**Biogas from food-waste**
- Produced energy: 7 GWh cooking
- Avoided emission: 1589 (0.2%)
CARBON FOOTPRINT OF MENORCA

CARBON ACCOUNTING

PV on roofs (20% all roofs)
- Produced energy: 120 GWh electricity
- Avoided emission: 91,320 (13%)
10 wind turbines 3MW
- Produced energy: 76 GWh electricity
- Avoided emission: 57,836 (8%)
Trust yourselves

GO TO ZERO!
The vision

This needs to be

Positive
Shared
Clear
Sustainable
Futuristic
Unique
Ambitious
Active
Re-active
Holistic
Locally-focussed

Fun
The Road to ZEN

Speed of Implementation

- Current trajectory
- Planned descent 20% reduction per 5 years
- Ambitious descent 33% reduction
The vision

This needs to be
Positive
Shared
Clear
Sustainable
Futuristic
Unique
Ambitious
Active
Re-active
Holistic
Locally-focussed

Fun
The city vision:

Mahon a slow city,

Confident in its future

Connected to its environment.

Car free

Sustainably powered

Locally focused

Child-friendly

A destination for sustainable tourism
Mahon: Historic and projected city growth

1. City as fortress
2. City expands
3. Ringroad becomes new divide
4. City today expands beyond ring
5. Future expansion creates second ring
6. City is disconnected from country
Long term vision - city

(Re) Connect the city with the rural landscape

Create and Protect green corridors.

Remove cars from city centre

Create green and shaded routes inside the city for bicycles and pedestrians.

De-engineer the ring road

Allow city to grow in a structured way

new public spaces created with car parking under.
Rural space directly accessed from the city
Car domination
Bicycle routes for the city
Energy strategy Mahón south
• Insulation of roofs/walls/glazing
  • Reduction of heating demand: 50%
  • Reduction of cooling demand: 25%

• Tropical roof & greening the building
  • Reduction of cooling demand: 20%

• Solar boilers for hot water
  • Reduction of DHW: 80%

• Installation of low-temperature radiators + heat pumps
  • Reduction heating 75%
  • Reduction cooling 60%

• PV-thermal roof
  • Reduction electricity 35%
  • Reduction of heating 20%
Energy measures

- Connection to low temperature heat-cold grid with seasonal storage (boreholes)
  - Reduction of heating demand: 35%
  - Reduction of cooling demand: 90%

- Total reduction energy consumption neighbourhood
  - 70%
Passive cooling strategy for apartment blocks using ground cooling and solar chimneys

Option 2b. Ground cooling with solar assisted extract
Electric mobility
Not all vehicles are equal

Required Energy [kWh/km]
- Car
- E-Car
- E-Scooter
- E-Bike
Issues & Solutions

Cars are used for short distances
Use E-Bikes / E-Scooters

High EV Investment cost
Use Leasing (incl. fuel)
Electric mobility

Every year: replace 10% of cars by electric vehicles

50% E-Bikes & 50% E-Cars
Electric Mobility

Vehicle CO2 & Cost Reduction

<table>
<thead>
<tr>
<th>Year</th>
<th>CO2 Emission [ton CO2]</th>
<th>Total Costs [k€]</th>
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<td>2017</td>
<td>120000</td>
<td>140000</td>
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<td>2018</td>
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<td>2019</td>
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<tr>
<td>2027</td>
<td>10000</td>
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</tbody>
</table>
Cost of Retrofit – orders of magnitude.

Each household pays 1000 Euro per year for energy.

Energy retrofit operation on all permanent residential units in Menorca
In **historic centres**, allowing **20%** of reduction in energy use
In all other places **deeper retrofit** allowing **50%** reduction in energy use.

We estimate *average* retrofitting costs as follows:
- 10.000 Euro for an apartment;
- 25.000 Euro for a terraced house;
- 30.000 Euro for a freestanding house.

Total Cost for 600 million Euro
Saving each household €420 pa

**Payback 27 years if 5% fuel inflation**

The payback time is very **sensitive** to rising energy prices, behaviour of occupants and other factors influencing energy use & costs.
Cost of Retrofit – orders of magnitude.

Residential PV Installation (< 10kWp) : 1,012 € / kWh
   = Revenue for local installers

Industrial PV Installation (> 10kWp) : 0,812 € / kWh

E-Cars (leased): 0,32 € / km

E-Bikes (leased): 0,04 € / km

Wind turbines

Large scale 1,230 € /kWh
Conclusions

Shared vision for the island
  Holistic
  Ambitious
  Confident

Be pro-active
  Begin today
  Have a development plan for the city re urban design

Local focus.
  Use the expertise you have
  Invest in local businesses

No more Fossil fuel investment
  Spend monies on energy conservation
  Develop expertise in passive heating and cooling
  Invest in renewables
  Develop smart grids

If in doubt, cover roofs with Photovoltaics!!
Zero energy Menorca

Set yourselves up as living laboratory as soon as you can.

Make your own Roadmap

Start immediately

You can do it!!
Muchas gracias!

For more information please contact:
Dr Craig L. Martin (c.l.martin@tudelft.nl) Roadshow Leader
Jesús Cardona (jcardona@nontropia.com) Menorca Roadshow Coordinator