Energy and Climate mitigation
Synergetic Urban landscape planning in Rotterdam
Useful examples for your own city in water, energy, densification, greening and using city data

Nico Tillie @nicotillie72
Landscape Architecture, Delft University of Technology, Director European office World Council on City Data
Part 1. Water
Innovative solutions start with understanding the system
Topo map: above (brown) and below (blue) sea level
Singelplan as an example?

What is the 21st century version of the Singelplan Rose from 1850’s?
What about precipitation and water in the city?

1. Water: Precipitation, storage capacity per district

Quality of life data per district

The data and mapping made us combine water solutions and social, economic, spatial issues.
From stand alone solutions to overall strategy (2005)

Water solutions good housing + public space + water transport
Watersquare finished in nov 2012

Study from the 'De urbanisten' Rotterdam
Watersquare finished in nov 2012
Watersquare finished in nov 2012
Water Square now

Daily Use
Protection and moving in: A dike, with shops below and a roof garden to link the waterfront very active neighborhood involvement.
Why not have this approach for Energy?
Energy costs rental homes in the Netherlands

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Energy costs home owners

- 2000: 17% energy, 83% mortgage
- 2004: 23% energy, 77% mortgage
- 2006: 27% energy, 73% mortgage
- 2008: 34% energy, 66% mortgage

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Delft University of Technology
High energy use, low income, energy too expensive

Possible solutions: smart meters, insulation, own production, lower rent, green loans

CO2 reduction and renewable energy supply

From list of solutions to a spatial inclusive strategy for Energy transition and improving Quality of life

Residential & services
- deals with corporations
- Public lighting
- Compulsory use of district heating
- Fiscal incentives
- Local laws

Transport
- Public transport, cycling
- Renewable energy
- Parking fees
- Vehicles and ships

Behaviour
- All public vehicles CO2 free
- All public buildings CO2 free
- Campagne
- Incentives

Innovation
- Innovation fund
- Knowledge cluster of new techniques
- Research connections with universities to implement

Industry & food
- Carbon captivity storage
- Deals with companies to filter
- Biofuel
- Quai electricity

.... to a vision ...from there, a tailormade plan for our specific situations, neighborhoods!

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Challenge still about how to scale up

to low carbon neighborhoods, districts, cities and regions

(Nurnberg)
Solar Decathlon 2014:
Scaling up in number: decarbon existing housing stock: 1.5 million in NL alone much more all over Europe

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Relevant theme: energetic refurbishment

Facts...

* Our job is to take our homes to a sustainable future...

* We will retrofit on different scales
  - Urban scale
  - Individual homes
  - Building parts

* We will develop a set of tools to retrofit

* We will develop a platform for tools

* We are 1 of 20 competing teams across the globe

* Our house will be seen by 300,000 visitors
Prêt-à-Loger

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Cross-section

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What it looks like
Scaling up in Approach: energy as a 'layer' in urban planning!
From ‘Trias energetica’ to new stepped strategy

Prof. Andy Van den Dobbelsteen TU Delft
1. reduction of demand
Types of result – savings potential maps are easier to read than 10 excell sheets.
2. Exchange waste flows
District heating networks

- Potential from industries 2000 MW = 1,000,000 households
- 120 MW planned for 55,000 households
- In dense cities 66% reduction in CO2 (same as passive house)
The New Stepped Strategy...and upscaling

00 standard building

01 reduce consumption
   - passive, smart and bioclimatic design

02 reuse waste energy streams
   - waste heat, waste water, waste material
   - in closed or connected cycles

By: A. Van den Dobbelsteen
1 m² of super market can heat 7 m² of appartment
1 m² of green house can heat 4 m² of appartment and produce food!!
3. Renewable Production: Energy potential maps

Energy Atlas Rotterdam online
Amsterdam Energy atlas also available.

By: A. Van den Dobbelsteen

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Basic information

Future

3000 dwellings:

Electricity: 10,5 GWhₑ
Heating: 26,5 GWhₑ (aeq)

From: Prof. Andy van den Dobbelsteen, Delft University of Technology
Energy potentials

Per house 40 m² pv or solar collectors

- DGC: PV on roofs: 12 GWh_e
- DGC: SC on roofs: 35 GWh_th

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Energy potentials

Electricity from wind 100 m (8 m/s)

10,5 GWh\textsubscript{e}
26,5 GWh\textsubscript{th}

6750 GWh\textsubscript{pr}
12 GWh\textsubscript{e}
35 GWh\textsubscript{th}

large turbines : 0.23 GWh\textsubscript{e}/ha

DGC: 0-160 GWh\textsubscript{e}

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Energy potentials

Electricity from wind at 30 m (5 m/s)

Wind at 30m:

Per Turby: 5 MWh
(DGC: 56 GWh)

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Energy potentials

Energy from waste

10,5 GWh$_e$
26,5 GWh$_{th}$
6750 GWh$_{pr}$
12 GWh$_e$
35 GWh$_{th}$
0 - 160 GWh$_e$
5 MWh$_e$/turby

Per household: 0,57 ton $\rightarrow$ 326 kWh$_e$ + 59 kWh$_{th}$

DGC: 1,2 GWh$_{(e+th)}$

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Energy potentials

waste heat

10.5 GWh\textsubscript{e}
26.5 GWh\textsubscript{th}
6750 GWh\textsubscript{pr}
12 GWh\textsubscript{e}
35 GWh\textsubscript{th}
0 - 160 GWh\textsubscript{e}
5 MWh\textsubscript{e}/turby
1.2 GWh\textsubscript{(e-th)}

Cardboard factories: 2 x 125 GWh\textsubscript{th}

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Energy potentials

biomass

- 10.5 GWh$_e$
- 26.5 GWh$_{th}$
- 6750 GWh$_{pr}$
- 12 GWh$_e$
- 35 GWh$_{th}$
- 0 - 160 GWh$_e$
- 5 MWh$_e$/turby
- 1.2 GWh$_{(e+th)}$
- 2 x 125 GWh$_{th}$

biogas

Chicken farms:
- 129,000 m$^3$ (Ae)
- 1.1 GWh$_{Ae}$

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Energy potentials

Biomass

- Biomassa-incineration:
  - from maintenance of parks: 4.7 MWh_{pr}/ha
  - and gardens: 18.9 MWh_{pr}/ha
  $\rightarrow$ DGC: 2.4 GWh_{pr}

- 10.5 GWh_{e}
- 26.5 GWh_{th}
- 6750 GWh_{pr}
- 12 GWh_{e}
- 35 GWh_{th}
- 0 - 160 GWh_{e}
- 5 MWh_{e}/turby
- 1,2 GWh_{(e-th)}
- 2 x 125 GWh_{th}
- 1,1 GWh_{ae}

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Energy potentials

**Biomass**

- 10,5 GWh\textsubscript{e}
- 26,5 GWh\textsubscript{th}
- 6750 GWh\textsubscript{pr}
- 12 GWh\textsubscript{e}
- 35 GWh\textsubscript{th}
- 0 - 160 GWh\textsubscript{e}
- 5 MWh\textsubscript{e}/turby
- 1,2 GWh\textsubscript{(e+th)}
- 2 x 125 GWh\textsubscript{th}
- 1,1 GWh\textsubscript{pr}
- 2,4 GWh\textsubscript{pr}

Biomassa-verbrandingsinstallatie:

Nature and woodland maintenance:

\[ \rightarrow \text{DGC: } 20 \text{ GWh}\textsubscript{pr} \]

Nico Tillie – **Green Building Festival**, Toronto 2\textsuperscript{nd} of October 2014
Energy potentials

Soil to 50 m. heatexchangers

10,5 GWh<sub>e</sub>
26,5 GWh<sub>th</sub>
6750 GWh<sub>pr</sub>
12 GWh<sub>e</sub>
35 GWh<sub>th</sub>
0 - 160 GWh<sub>e</sub>
5 MWh<sub>e</sub>/turby
1,2 GWh<sub>(e-th)</sub>
2 x 125 GWh<sub>th</sub>
1,1 GWh<sub>Ae</sub>
2,4 - 20 GWh<sub>pr</sub>

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Energy potentials

soil (50-500m): aquifers for heat cold storage

10,5 GWh<sub>e</sub>
26,5 GWh<sub>th</sub>

6750 GWh<sub>pr</sub>
12 GWh<sub>e</sub>
35 GWh<sub>th</sub>

0 - 160 GWh<sub>e</sub>

5 MWh<sub>e</sub>/turby

1,2 GWh<sub>(e-th)</sub>

2 x 125 GWh<sub>th</sub>

1,1 GWh<sub>ae</sub>
2,4 - 20 GWh<sub>pr</sub>

Very good
good
Not good
Restricted areas
Energy potentials

Soil(3000m): geothermal

10.5 GWh\text{e}
26.5 GWh\text{th}
6750 GWh\text{pr}
12 GWh\text{e}
35 GWh\text{th}
0 - 160 GWh\text{e}
5 MWh\text{e/turby}
1.2 GWh\text{(e-th)}
1.1 GWh\text{ae}
1.1 GWh\text{e}
2.4 - 20 GWh\text{pr}

Temperature at 3000m: 105 °C
### Energiepotenties

<table>
<thead>
<tr>
<th>Energiebron</th>
<th>Primaire Productie (MWh/ha)</th>
<th>Toegespitst (GWh)&lt;sub&gt;th&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zon</td>
<td>9640</td>
<td>6750</td>
</tr>
<tr>
<td>Wind, 100m</td>
<td>228</td>
<td>160</td>
</tr>
<tr>
<td>Wind, 30m</td>
<td>56</td>
<td>5</td>
</tr>
<tr>
<td>Afval, huishoudens</td>
<td>1,7</td>
<td>1,2</td>
</tr>
<tr>
<td>Restwarmte</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomassa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natuuronderhoud</td>
<td>4,7</td>
<td></td>
</tr>
<tr>
<td>Bosonderhoud</td>
<td>18,9</td>
<td></td>
</tr>
<tr>
<td>Bodem tot -50m verticale WW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquifers w/k opslag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geothermie, -3000m 105 °C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Toegepast

- **PV, daken**: 12 GWh<sub>th</sub>
- **Zonne-collectoren, daken**: 25 GWh<sub>th</sub>
- **Wind, grote turbines**: 160 GWh<sub>th</sub>
- **Wind, turby's**: 39 GWh<sub>th</sub>
- **Afval, verbranding**: 1,2 GWh<sub>th</sub>
- **Restwarmte**: 250 GWh<sub>th</sub>
- **Biomassa**: 2,4 GWh<sub>th</sub>
- **Onderhoud omgeving**: 20 GWh<sub>th</sub>

**Energievraag 3000 hh:**

- 10,6 GWh<sub>e</sub>
- 26,5 GWh<sub>th</sub>
Energy = Space, so we need to plan with it also spatially

<table>
<thead>
<tr>
<th>Power per unit land or water area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
</tr>
<tr>
<td>Offshore wind</td>
</tr>
<tr>
<td>Tidal pools</td>
</tr>
<tr>
<td>Tidal stream</td>
</tr>
<tr>
<td>Solar PV panels</td>
</tr>
<tr>
<td>Plants</td>
</tr>
<tr>
<td>Rain-water (highlands)</td>
</tr>
<tr>
<td>Hydroelectric facility</td>
</tr>
<tr>
<td>Geothermal</td>
</tr>
<tr>
<td>Solar chimney</td>
</tr>
<tr>
<td>Ocean thermal</td>
</tr>
<tr>
<td>Concentrating solar power (desert)</td>
</tr>
</tbody>
</table>

Table 4. Renewable facilities have to be country-sized because all renewables are so diffuse. This table lists the power per unit land-area or sea-area offered by a number of renewables.

uit David Mackay, energy without hotair
5 sustainable energy scenarios

- **Plan D**: Clean coal: 16 kWh/d, Nuclear: 16 kWh/d, Pumped heat: 12 kWh/d, Wood: 5 kWh/d, Solar HW: 1, Biofuels: 2, PV: 3, Wind: 8 kWh/d
- **Plan N**: Solar in deserts: 20 kWh/d, Nuclear: 10 kWh/d, Tide: 3.7, Wave: 2, Hydro: 0.2, Waste: 1.1
- **Plan L**: Clean coal: 16 kWh/d, Pumped heat: 12 kWh/d, Wood: 5 kWh/d, Solar HW: 1, Biofuels: 2, PV: 3, Wind: 8 kWh/d
- **Plan G**: Solar in deserts: 16 kWh/d, Tide: 3.7, Wave: 3, Hydro: 0.2, Waste: 1.1
- **Plan E**: Nuclear: 44 kWh/d, Wood: 5 kWh/d, Solar HW: 1, Biofuels: 2, PV: 3, Wind: 32

Energy inputs: 125 kWh/d

*Dutch text*:

- Domestic (alles in UK oplossen)
- NIMBY
- Liberal
- GREEN
- Economic

*David Mackay, energy without hot air*
The medium scenario was put on in a map
Different interests even within one group of stakeholders

4. Energy scenarios for existing Cities/
And that while we have energy transitions as a task ahead of us.
Scenariotool GRIP

Total energy use

Heat source

Changes in efficiency and use

Total emissions * (elec. alleen lokaal verbuik, vandaar verschil)

Changes in emissions

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Economy/demography consumption and supply see direct CO2 effects Low carbon!!
Energie scenario tools is fed by 'all the previous' and discussion from SH

Figure metrex euco2 project
240,000 dwellings in concession zones
50,000 connected
20,000 new buildings
85,000 existing rental (125,000 in these areas penetration of 80%)
Total 155,000 dwellings in 2035 (=47%)
Part 3. Improve low carbon quality of life and living

see for pdf on internet at Rotterdam 'people make the innercity'

Densification plus Green = sustainable city?
5000 trees, 80 ha of routes and green, 30000 people?

- Walkability
- childfriendly
- Energy advantages
- Cycling
- Public transport
- More program, economic input
- Lively streets
- Cleaner air and water
- Less heat island effect
People in the city had already started so we just mapped it
Klushuizen / DIY houses Rotterdam

**DENSIFICATION STRATEGY 07**

**DO-IT-YOURSELF**

De bestaande woonvoorraad niet vergeten vraagt om een verdichtingsstrategie die omgang weet te vinden met een bestand aan te kleine, bouwtechnisch matig en slecht gelokaliseerde woningen in vooral de regeertende-euwebere ring binnen de binnenstad. Hierbij gaat het niet om verdichting in vierkante meters maar het geschikt maken van bouwblokken voor meer inwoners. Waar de te kleine woningen op de huidige woonmarkt alleen aantrekkelijk zijn als studio's en maisonnettes, kan juist het vrijgeven van samengestelde kavels als kluswoningen ervoor zorgen dat grotere woningen voor gezinnen tot stand kunnen komen.

De bestaande stedelijke structuur in de oude stadsdelen wordt benut in economische en sociale zin, alsmede de bestaande groenstructuur en speelruimten. Woonconsument en coöperatie investeren samen in de verbouwkosten. Uitermate geschikt voor jonge stellen en gezinnen die een wooncarrière willen maken in een bestaande woning. Tevens biedt de aanwezigheid van bestaande scholen en levensvorm van de binnenstad een aantrekkelijk woonmilieu.

**IN PROGRESS**

?SHALL WE ADD ALL HOUSING COOPERATIONS FROM 19TH CENTURY?

POTENTIAL MAP 2040 & infographics of +houses/district
But if you densify... more green qualities needed 7 green strategies!!
Parking lot becomes green public space
Urban farming: what does the 'garden city' of the 21\textsuperscript{th} look like reusing phosphorus, producing biogas, social cohesion etc.
Childfriendly city 'woonerf revival?' sidewalks go on for kids, special circulation for cars, public transport and bikes in all suburbs since 1980's

play wilderness
Green network with more walking and biking

- Biking high ways, 1,3 bikes per capita
- Rotterdam 70% of bike use in 10 years
- Central Station 5500 Bike parking spaces
public transport 300 m from every home...and use grass!
Integrated planning with green

...in neighborhoods for heat Island, watergardens, wind, solar rights etc
Healthy Life expectancy increased with two years

Quality of Life increases mainly by introducing a green/blue network and smart transport

Question is how does Rotterdam compare to other cities?
Part 4. Using City data & WCCD comparing cities & city rankings

- Many rankings, standardization needed
- Feedback on your score
- Standardized 3rd party verified data
- Indicator evolution
- Weighing black box
- Resilience, adaptation capacity
- Governance
- Use of local potentials (renewables)
- Indirect impacts of consumption elsewhere...so footprint

...see next presentation