

IEA Heat Pump Centre

# The Rotterdam sustainable energy port and industry transition

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## Outline

- Current position Rotterdam PIC (Port & Industry Complex)
- Developments and macro trends
- Options for the future
- Sustainable energy transition
- Transition routes, pathways and experiments
- Barriers and challenges
- Summary

## Rotterdam PIC characteristics

- National economy – 7% GDP
  - Port: 328 million tons import & export of goods (2003)
  - Industry: energy use > 477 PJ (2002); > 758 PJ (2020)
- Carbon-based port and (process) industry (oil, coal, refineries, petro/chemical etc.)
- Coherent cluster of carbon-based clean and efficient activities: *Rotterdam Energy Port*

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## Rotterdam PIC



<http://takeoff.to/rotterdam>

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## Rotterdam PIC activities

- Industrial processing and production
- Logistics
- Energy production and consumption
- Living and working
- Governmental tasks
- Transport

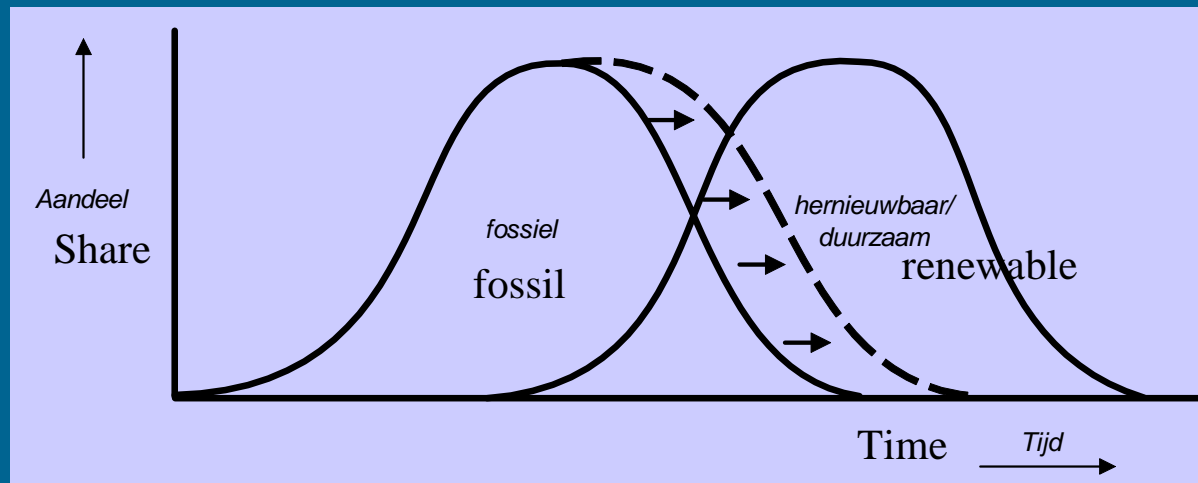
## Developments since 1996

- Analysis of energy infrastructure, supply and demand
- Assessment of residual process heat and low-temperature heat demand across PIC
- Focus on process improvement and heat exchange between companies
- Study supply of residual heat for nearby housing and greenhouses
- Extending Rotterdam PIC area (land reclaim - Maasvlakte 2)
- *Three related energy initiatives merged into the new R3-initiative (Common goal: integrated space use and environment)*

## Macro trends

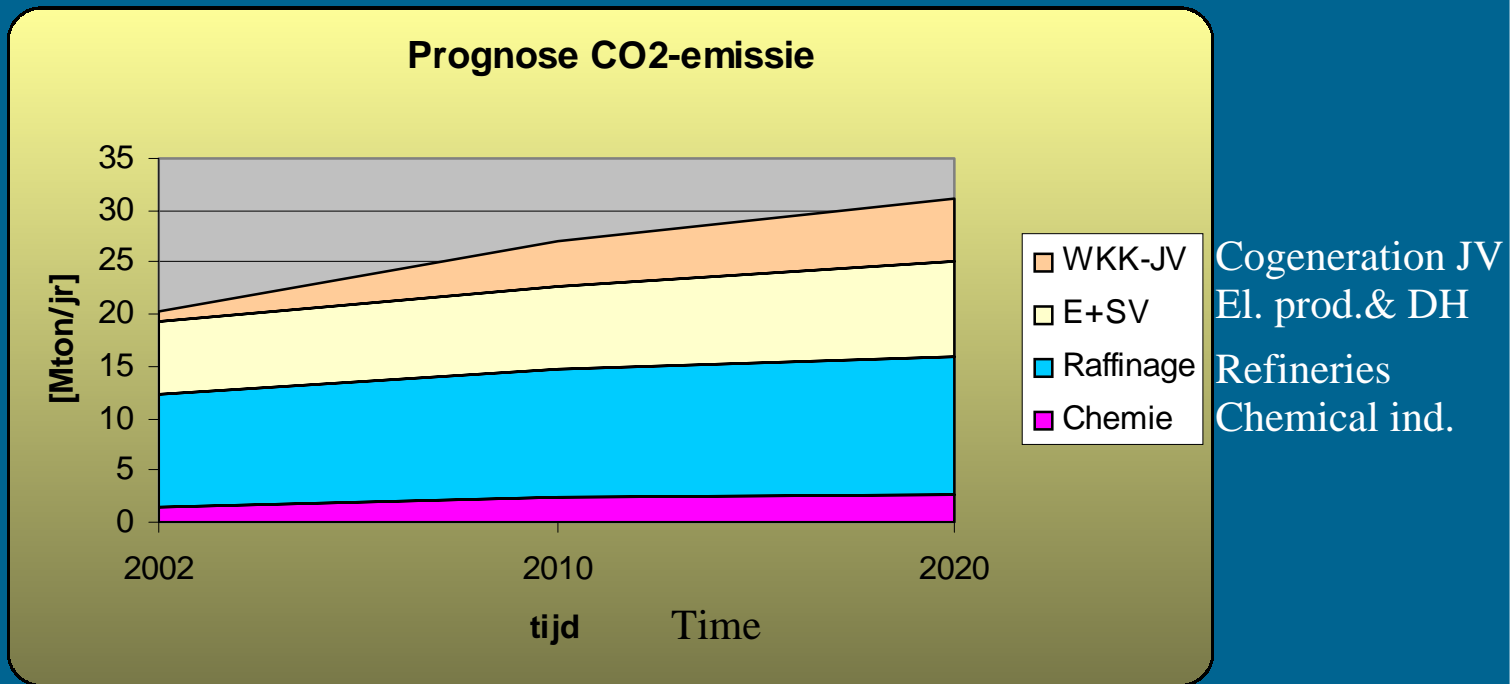
- Globalization of economy and liberalization
- Sustainability/Carbon-lean energy systems
- Energy (technology) developments
  - conversion: gasification, fuel cells etc.
  - sources: bio energy, hydrogen etc.
- Impact of IT on market conditions (foot-loose)
- Energy trends (chemical, refineries, power/heat generation) and other
- *Not if, but when: pace and form of transition?*

## Transition evolvment



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## 54% growth in CO<sub>2</sub> emission for PIC



Energy use PIC 2002: 477 PJ; projected 2020: > 758 PJ (2% renewable)

## Two strategic options for PIC

1. Aim for new, low-carbon or carbon-free energy carriers and sources and secure new actors, or
2. Retain and strengthen position as leading energy and carbon port with existing actors

## PIC ambition for 2020

*Become the preferred European location for transfer and processing of carbon-based fuels and raw materials*

Conditions:

- Authoritative in cost-effective reduction of CO<sub>2</sub> emissions due to PI activities
- Champion in energy efficiency improvements
- Experimental zone for advancements in
  - clean fossil
  - clean energy (hydrogen, syngas, heat, electricity, bio energy)

## Objectives R3 transition programme

*To realize sustainable ways of production and transportation in the Rotterdam PI-area*

- Maximized use of residual heat for space conditioning in buildings and greenhouses and other applications
- Maximized use of waste and residues as raw material
- Energy production and use with minimum CO<sub>2</sub> emission through energy efficient production methods using clean fossil and renewable fuels
- Location of companies with optimized energy and raw material synergism

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## Stakeholders

- Ministry of economic affairs (sustainable energy supply)
- Port authority
- Ministry of the environment (CO<sub>2</sub> reduction and waste policy)
- Provincial government
- Companies and utilities
- Environmental organizations

## Four transition routes

1. Sustainable fuels and raw materials
2. Sustainable infrastructure and energy carriers
3. Sustainable processing of residues and waste
4. Sustainable production processes and chains

## 1. Sustainable fuels and raw materials

- Bio energy for electricity production: co-firing of biomass in coal-fired plants and MW-size dual fuel cogeneration  
Tie in with ongoing preparations for a new coal-fired power plant at PIC
- Extension of wind energy: port-based and off-shore
- Greening of syngas and hydrogen: biomass gasification  
Hydrogen is already produced at PIC and a distribution system exists

## 2. Sustainable infrastructure and energy carriers

- Development of residual heat use for nearby district heating and glasshouse horticulture

Residual heat production PIC at 100 °C: 2 GW<sub>th</sub>  
Total potential: 20 PJ or 1 million ton CO<sub>2</sub> (1,300 ha greenhouses and 100,000 houses)

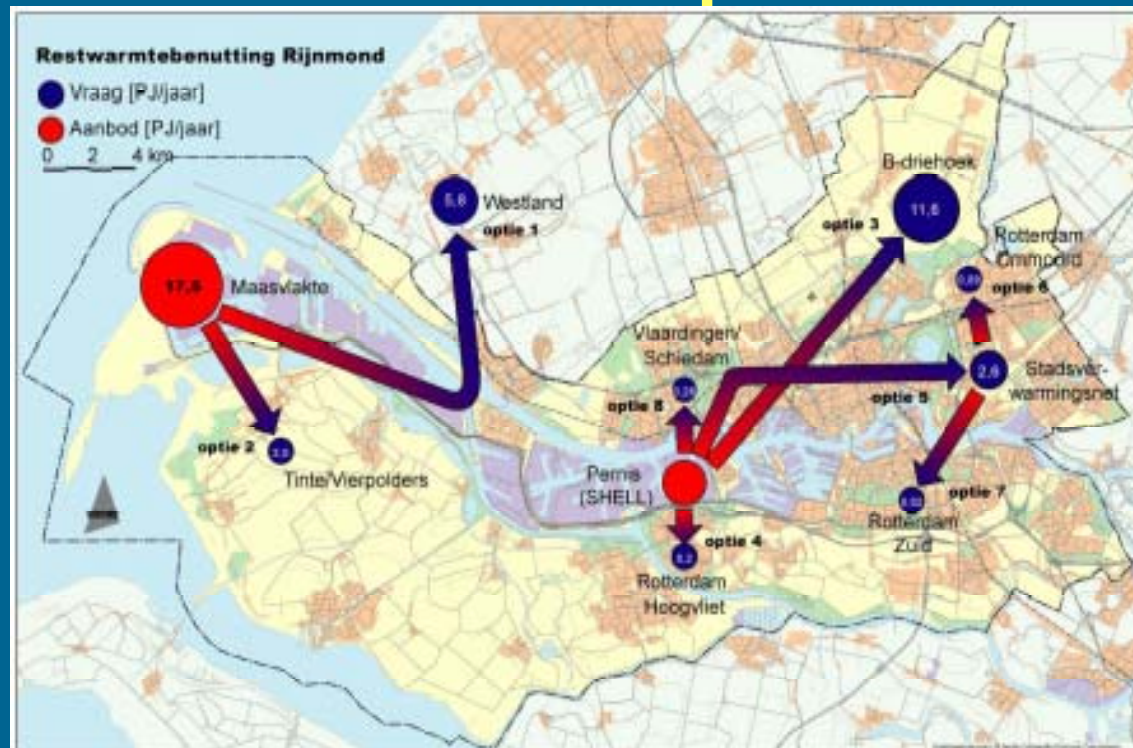
*Example Shell:*

*38 out of 262 heat sources are suitable for space heating (1.5 GJ p.a.)*

- Hydrogen infrastructure (for new applications)

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## Rotterdam PIC location - heat distribution options



### 3. Sustainable processing of residue and waste

- Establishment of a center for processing carbon-based and other waste streams for new industrial raw materials
- Clean fossil - removal/capture of CO<sub>2</sub>, supply of combined CO<sub>2</sub> and heat to glasshouse horticulture and CO<sub>2</sub> sequestration in depleted gas fields

Feasibility study 'Multi-site' for C2/C3 and other waste: processing and recovery/recycling of solid (heavy metals) and liquid waste at low cost

*Example Shell: 1 million tons CO<sub>2</sub> p.a. emitted; could be transported to nearby greenhouse customers*

### 4. Sustainable production processes and chains

- Continue and conclude bench-mark covenant and long term agreements with chem. & petrol. industry (2012)
- Continue effort for further increase of energy efficiency in processes (x.10%), production locations and integrated networks **Heat pumps, vapour recompression**
- Develop innovative production and separation processes, and
- New financing mechanisms for improved cost-effectiveness

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## Major barriers

- Residual heat:
  - Institutional impediments (undervalued in emission trading)
  - Infrastructure initial cost
  - Heat pricing and cost effectiveness (supplier) insufficient (back-up/maintenance)
  - Reduced independence (companies)
  - Guaranteed supply/purchase agreements
- Syngas: undervalued (financial)
- Waste: regulations (on-site processing etc.), inconsistent policies, lack of efficiency
- Wind energy (licensing)

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## Next steps

- Discuss strategic vision to create support
- Develop framework for transition pathways and experiments
- Determine problem ownership, leadership and responsibilities
- Implement transition pathways with market actors
- Conducting experiments

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## Potential experiments/projects

- Company being established for residual heat supply to city of Hoogvliet – additional agreements in process
- Residual heat for cooling of chemical processes, cleaning containers, drying sludge, gas expansion, ORC, chemical heat storage etc.
- Adaptation of waste licenses for processing at production point
- Demonstration project Syngas (biomass gasification)/methanol production for bus fuel
- Heat pumps for cooling DH return water for cooling purposes
- CO<sub>2</sub> supply to horticulture; storage in depleted gas fields
- CO<sub>2</sub> emission reduction credits for (residual) heat supply

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## Summary

- Strong position in transfer and processing of fossil fuel-based sources/products is key for transition to a sustainable structure
- Fragmented interest and lack of “problem” owner leaves key role for governments
- Common broadly supported vision and strategic collaboration with specific responsibilities to be organized
- Rotterdam PIC aims to be the preferred European location for carbon-based commodities in 2020, based on highly efficient, clean and sustainable solutions
- Lack of compatibility with current CO<sub>2</sub> emission reduction policy is main hurdle