Modelling the Energy Transition in the Ruhr Area

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WCTRS SIG F2 Conference, Gif-sur-Yvette, 21-22/6/2018
The Great Transformation
The Great Transformation (1)

Climate researchers agree that anthropogenic greenhouse gas emissions *significantly contribute* to climate change, and that *radical measures* to reduce them and to adapt to no longer avoidable climate change are needed.

The German Advisory Council on Global Change (WBGU) in its expertise of 2011 called for a *societal contract* for a *great transformation*, a change also of *cultural* identities and established *value* perceptions and *action* patterns in *politics, economy* and private *consumption*.

In its expertise of 2016 the Council emphasised the central role of *urban and regional planning* for the achievement of this transformation.
The Great Transformation (2)

This *fundamental transformation* will affect mobility and transport in cities. Therefore urban mobility and transport constitute an *important policy field* of the transformation called for by the WBGU.

Mobility and transport cannot be analysed separately but have to be assessed *together* with urban spatial development, i.e. decisions by *households* and *firms* where to select their residences or to locate their businesses.

Urban mobility and land use planning therefore need to respond to the challenges of the *Great Transformation* together in an *integrated* way.
The Mercator Programme
The Mercator Programme

Therefore the private *Mercator Foundation* launched in 2013 *research programme* on the implementation of the *energy transition* in the municipalities of the *Ruhr Area*. Here two projects of the programme are reported:

• The aim of the project *Integrated Model Ruhr 2050* was the development of an integrated model, with which the impacts of policies to reduce energy consumption and CO₂ emissions in the Ruhr Area can be assessed.

• The focus of the project *Regional Modal Shift* was the development of transport policy scenarios and their evaluation with respect to the shift from car traffic to public transport, car-sharing, cycling and walking.
The Ruhr Area

With a population of more than five million, the Ruhr Area is one of the *major urban agglomerations* in Europe.

Through its industrial past and polycentric settlement structure it has a particular potential for the promotion of transport-saving urban development on former industrial sites.
Method
Ruhr model

In the two projects the IRPUD model originally developed at the University of Dortmund was applied.

The model is a simulation model of intraregional location and mobility decisions in an urban region. It predicts for each simulation period

- intraregional location decisions of firms, residential developers and households,
- the resulting migration and transport flows,
- the development of buildings and land use,
- the impacts of public policies in the fields of economy, housing, infrastructure and transport.
Ruhr model

In the two projects the model was extended in **space, time** and **policy fields**:  

• The study area of the model was extended to comprise the whole *Ruhr Area*.  

• The **time horizon** of the model was extended to **2050**.  

• The **policy fields** of the model were extended to include  
  - **energy consumption** and **CO₂ emissions**,  
  - **cycling** and **walking** as separate modes,  
  - **energy retrofitting** of residential buildings,  
  - market penetration of **electric vehicles**,  
  - free-floating **car-sharing**.
Ruhr model

Microsimulation
Model results

In the two projects the extended model was applied to answer the following questions:

• How will settlement structure, transport, energy and environment in the Ruhr Area develop until the year 2050 under different assumptions about urban land use and transport policies?

• What will be the impacts of land use and transport policies on energy consumption and CO$_2$ emissions?

• Which policy recommendations can be derived from the results?
Study Area
Polycentric Ruhr Area
Transport networks
Ruhr model internal zones

687 internal zones
134 external zones
Scenarios
Scenarios

In the two projects twenty scenarios from seven policy fields were examined:

**Base**: 00 **Base scenario**

**Urban form**: 11-14 **Land use**
23 **Housing**

**Energy**: 33-36 **Energy efficiency**

**Transport**: 41-44 **Car traffic (Push)**
51-53 **Public transport (Pull)**
61-62 **Cycling (Pull)**
71 **Walking (Pull)**

In addition six combinations of policies were examined as integrated strategies:

81-86 **Integrated strategies**
Scenarios

All twenty scenarios were combined with two different assumptions about the development of fuel prices:

• In the A scenarios it was assumed that fuel prices will grow by one percent annually.

• In the B scenarios it was assumed that fuel prices will grow by four percent annually.

The base scenarios are business-as-usual scenarios, i.e. it is assumed in them that all currently implemented policies will be continued in the future.

The base scenarios are the basis for the comparison between the scenarios.
Base Scenario
Accessibility work places 2050

Base scenario A00
Share of car trips 2050 (%)

Base scenario A00
Base scenarios A00/B00

- **A00 Base scenario**
- **B00 Base scenario**

**CO₂ emissions buildings and transport (t/capitaly)**

- Black line: Base scenario A00
- Red line: Low fuel prices
- Blue line: Base scenario B00
- Red line: High fuel prices

Time periods: 1990 to 2050
Policy Scenarios
Urban form scenarios

In the first two groups of scenarios policies to control the development of urban form were analysed:

1 Land use scenarios:
   A11/B11  Densification at local centres
   A12/B12  Densification at public transport stations
   A13/B13  Densification at railway stations
   A14/B14  Densification in main cities

2 Housing scenarios:
   A23/B23  Housing construction at railway stations

In the A scenarios low fuel prices and in the B scenarios high fuel prices were assumed.
Energy efficiency scenarios

In the third group of scenarios policies to save energy were analysed:

3 Energy efficiency scenarios:
   A31/B31  Energy retrofitting of buildings
   A32/B32  Promotion of electro mobility
   A33/B33  Station-less car sharing
   A34/B34  Reduction of fuel consumption

In the A scenarios low fuel prices and in the B scenarios high fuel prices were assumed.
Energy-retrofitted residential buildings 2050 (%)
Station-less car-sharing cars 2050 (%)
Car scenarios (Push)

In the fourth group of scenarios policies to reduce car traffic by making driving less attractive (push policies) were analysed:

4 Car scenarios (Push):
   A41/B41 Regional cordon fee
   A42/B42 Closing lanes of main roads
   A43/B43 Area-wide speed limits
   A44/B44 Higher parking fees

In the A scenarios low fuel prices and in the B scenarios high fuel prices were assumed.
Public transport scenarios (Pull)

In the fifth group of scenarios policies to increase the attractiveness of public transport (pull policies) were analysed:

5 Public transport scenarios (Pull):
   A51/B51 Public transport investment
   A52/B52 More trains/buses per hour
   A53/B53 Citizen ticket

In the A scenarios low fuel prices and in the B scenarios high fuel prices were assumed.
Public transport networks 2015

Base scenarios A00/B00

- Railway 2015
- S-Bahn 2015
- Metro/Streetcar 2015
- Bus 2015
Public transport investment 2020-2050

Scenarios A51/B51

Investment S-Bahn 2020-2050
Investment Metro/Streetcar 2020-2050
Public transport networks 2050

Scenarios A51/B51

- Railway 2050
- S-Bahn 2050
- Metro/Streetcar 2050
- Bus 2050
Cycling and walking scenarios (Pull)

In the sixth and seventh groups of scenarios policies to increase the attractiveness of cycling and walking (Pull-policies) were analysed:

6 Cycling scenarios (Pull):
   A61/B61 Faster cycling
   A62/B62 Express cycling routes

7 Walking scenarios (Pull):
   A71/B71 Shorter walking distances

In the A scenarios low fuel prices and in the B scenarios high fuel prices were assumed.
Integrated Strategies
Integrated strategies

In the last group of scenarios different *combinations* of policies were analysed:

8 *Integrated strategies:*
   
   A81/B81  Urban form
   A82/B82  Energy efficiency
   A83/B83  Car traffic (Push)
   A84/B84  PT/cycle/walk (Pull)
   A85/B85  All policies
   A86/B86  Selected policies

In the *A scenarios* low fuel prices and in the *B scenarios* high fuel prices were assumed.

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Integrated strategies: transport

- A00 Base scenario
- B81 Urban form
- B84 PT/cycle/walk (Pull)
- B82 Energy efficiency
- B83 Car traffic (Push)
- B85 All policies
- B86 Selected policies
- B High fuel prices

CO₂ emissions transport (t/capita/year)

- 1990
- 2000
- 2010
- 2020
- 2030
- 2040
- 2050

-78%
Comparison of scenarios: transport
Summary of Results
Summary of results

The results of the two model projects can be summarised as follows:

- **Urban form**: Urban form and transport are in mutual interaction. The *polycentric* structure of the Ruhr Area offers a *rich potential* for the promotion of development in small and medium-sized towns in the vicinity of the core cities, a precondition for shorter commuting and retail trips. But policies to develop urban form need a *long time* to be become effective.
Summary of results

• **Transport:** Policies for the implementation of the energy transition in transport can be *pull* or *push policies*:
  - **Push policies** make car driving less attractive, i.e. slower or more expensive.
  - **Pull policies** make public transport and cycling and walking more attractive.

*In general, push policies* are more effective than *pull policies*.

• **Integrated strategies:** The most successful strategies are *integrated* strategies, in which *urban form* policies and *transport* policies are combined.
Policy Recommendations
Policy recommendations

From the results of the two research projects clear policy recommendations for the municipalities and the state and Federal governments can be derived:

- **Urban form:** A comprehensive *land use plan* for the whole Ruhr Area with binding effect for counties and municipalities needs to be developed, which limits the occupation of land and promotes the concentration of development at public transport stations. Retrofitting of buildings for *energy efficiency* should be supported.
Policy recommendations

• **Transport:** To achieve the energy transition in transport, fast and consequent action by the municipalities, the public transport agencies, the regional government and the state government are required.

• **Integrated strategies:** For the implementation of the energy transition in the Ruhr Area integrated strategies are required, which address urban form, transport infrastructure and fiscal policies together.
Policy recommendations

Many of the necessary policies, in particular the push-policies, are likely to be perceived by many people as restrictions of their mobility and quality of life.

It is therefore necessary, to communicate "inconvenient truths" with rational arguments and make it clear that the recommended policies can bring significant advantages, such as improved environmental quality and a revival of neighbourhood relationships.

More information

http://www.energiewende-ruhr.de/
http://www.spiekermann-wegener.de/pro/ruhr2050_e.htm