A Spatial Approach for a Future-Oriented Heat Planning in Urban Areas
POSITIONING

- Regional Potentials and Demands
- Regional Developments

Regional planning

- Local Potentials and Demands
- Local Developments

Urban Planning

Fuzziness of Neighborhood

Detailed Energy Planning

- Detailed Planning / Economics
- Projects

Strategic Energy Planning

- Energetic Neighborhoods
- Suitability Areas
THE GOAL

• Almost climate-neutral buildings in Germany in 2050

• Reduction of the fossil primary energy consumption by 80 % (95%)

  Two levers:
  – Reduction of the Heat Demand
  – Integration of Renewable Energy Sources into the Heat Supply

• District Heating Systems are particularly suitable to integrate Renewable Energy Sources

• But, not EVERY District Heating System is suitable!
• AND: Not at EVERY place a District Heating System is suitable!
"Fuzzy" boundaries between economically feasible heat supply options

- Single Supply
- LowEx-Heating
- Classic District Heating
- Site /Block Supply
SUITABILITY AREAS

Degree of Suitability

Site / Block / District Heating

Single Supply Cold / Heat

indiff.

++

+++
## REDUCTION SCENARIOS

### Target Scenario Efficiency (PJ) – 60%

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2020</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>2.755</td>
<td>2.346</td>
<td>1.786</td>
<td>1.002</td>
</tr>
<tr>
<td>Hot Water</td>
<td>375</td>
<td>371</td>
<td>354</td>
<td>311</td>
</tr>
<tr>
<td>Sum</td>
<td>3.130</td>
<td>2.717</td>
<td>2.140</td>
<td>1.313</td>
</tr>
<tr>
<td>In relation to 2008</td>
<td>86.81%</td>
<td>68.37%</td>
<td>41.95%</td>
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</table>

### Target Scenario Renewable Energy (PJ) – 40%

<table>
<thead>
<tr>
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<th>2008</th>
<th>2020</th>
<th>2030</th>
<th>2050</th>
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</thead>
<tbody>
<tr>
<td>Heating</td>
<td>2755</td>
<td>2426</td>
<td>2.060</td>
<td>1.560</td>
</tr>
<tr>
<td>Hot Water</td>
<td>375</td>
<td>371</td>
<td>358</td>
<td>328</td>
</tr>
<tr>
<td>Sum</td>
<td>3.130</td>
<td>2.797</td>
<td>2.418</td>
<td>1.888</td>
</tr>
<tr>
<td>In relation to 2008</td>
<td>89.36%</td>
<td>77.25%</td>
<td>60.32%</td>
<td></td>
</tr>
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</table>

N. Thamling, M. Pehnt, and J. Kirchner, “Hintergrundpapier zur Energieeffizienzstrategie Gebäude.” IWU, ifeu, PROGNOS, Berlin, Heidelberg, Darmstadt, 2015, p. 41
FUTURE SUITABILITY AREAS

Szenario 2050, -40%

Degree of Suitability

<table>
<thead>
<tr>
<th>Site / Block / District Heating</th>
<th>Single Supply</th>
<th>Cold / Heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>indiff.</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>NN</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>+</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>+</td>
<td>++</td>
<td>++</td>
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</tbody>
</table>

3rd international conference on SMART ENERGY SYSTEMS AND 4TH GENERATION DISTRICT HEATING
Copenhagen, 12-13 September 2017
FUTURE SUITABILITY AREAS

Szenario 2050, -40%

Degree of Suitability

- indiff.
- NN

Single Supply
- +
- ++
- +++

Cold/Heat
- +
- ++
- +++

Site /Block/District Heating
- +
- ++
- +++

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HOT SPOT ANALYSIS: LOWEX

Scenario "Efficiency" -60%

Scenario "Renewable Energy" -40%
WHAT COMES NEXT?

Integration of solar power (roof)
→ Where and to which extent is it possible to cover the energy demand for DHW by solar power?

Integration of industrial waste heat
→ Where and to which spatial extent is it possible to take industrial waste heat into account for heat supply?
INTEGRATION OF SOLAR POWER

Differentiation by aspect, rooftyp and season (heating period (Oct.-April) and non-heating period (May-Sept.)

Power harvest calculated by PV Classic GIS (10% losses) 

Raster-based aggregation

Overlay with Heat demand and Suitability Areas

Data provided by solar cadastre of the County of Osnabrück / Geoplex GmbH
## INTEGRATION OF SOLAR POWER (SUMMER)

<table>
<thead>
<tr>
<th>Option</th>
<th>Pot. Solar Power (kWh)</th>
<th>DHW Demand (kWh)</th>
<th>Share pot. Solar Power to DHW</th>
<th>Share current Solar Power to DHW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Status Quo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH</td>
<td>20.512.889</td>
<td>4.954.034</td>
<td>373%</td>
<td>33%</td>
</tr>
<tr>
<td>C/H</td>
<td>58.229.070</td>
<td>12.317.525</td>
<td>425%</td>
<td>48%</td>
</tr>
<tr>
<td>Single</td>
<td>6.244.106</td>
<td>1.295.095</td>
<td>434%</td>
<td>67%</td>
</tr>
<tr>
<td><strong>2050A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH</td>
<td>1.194.999</td>
<td>235.734</td>
<td>456%</td>
<td>29%</td>
</tr>
<tr>
<td>C/H</td>
<td>31.743.296</td>
<td>7.319.651</td>
<td>390%</td>
<td>31%</td>
</tr>
<tr>
<td>Single</td>
<td>41.804.136</td>
<td>9.204.918</td>
<td>409%</td>
<td>44%</td>
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<tr>
<td><strong>2050B</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH</td>
<td>3.675.736</td>
<td>748.038</td>
<td>442%</td>
<td>32%</td>
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<tr>
<td>C/H</td>
<td>70.456.589</td>
<td>15.852.872</td>
<td>400%</td>
<td>33%</td>
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<tr>
<td>Single</td>
<td>15.298.741</td>
<td>3.284.310</td>
<td>419%</td>
<td>48%</td>
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</table>
# INTEGRATION OF SOLAR POWER (WINTER)

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Status Quo</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DH</td>
<td>12.5</td>
<td>26.319.051</td>
<td>5%</td>
<td>0.4%</td>
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<tr>
<td>C/H</td>
<td>35.256</td>
<td>524.530.543</td>
<td>7%</td>
<td>0.8%</td>
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<tr>
<td>Single</td>
<td>3.782</td>
<td>54.286</td>
<td>7%</td>
<td>1.1%</td>
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<tr>
<td><strong>2050A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C/H</td>
<td>19.2</td>
<td>35.286</td>
<td>13%</td>
<td>1.0%</td>
<td></td>
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<tr>
<td>Single</td>
<td>25.377</td>
<td>156.653</td>
<td>16%</td>
<td>1.7%</td>
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<tr>
<td><strong>2050B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH</td>
<td>2.242.452</td>
<td>26.854.872</td>
<td>8%</td>
<td>0.6%</td>
<td></td>
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<tr>
<td>C/H</td>
<td>42.684.717</td>
<td>436.732.345</td>
<td>10%</td>
<td>0.8%</td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>9.316.718</td>
<td>83.995.061</td>
<td>11%</td>
<td>1.3%</td>
<td></td>
</tr>
</tbody>
</table>

Wind Power Equivalence (Power Generation Heating Periode)

Status Quo → 26,5 Wind Plants

2050 A → 4,2 Wind Plants

2050 B → 12,8 Wind Plants

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WASTE HEAT INTEGRATION: SEARCH RADIUS

http://geoportal.bayern.de/energieatlas-karten
Search Radius (m) = \frac{\text{Usable Waste Heat} \left[ \frac{\text{MWh}}{\text{a}} \right]}{0.00002 \frac{\text{MW}}{m} \times 8760 \left[ \frac{h}{\text{a}} \right] + Y \left[ \frac{\text{MWh}}{m \times \text{a}} \right]}

Y: Threshold of Heat Supply Options, the calculation is based on 0.5 MWh/(m x a) for LowEx and 1.5 MWh/(m x a) classic District Heating Systems

DOI: 10.14627/537633011
Matching by Maps

Waste Heat Integration: Target System Classic District Heating
MATCHING BY MAPS

Waste Heat Integration: Target System LowEx-System
The district and the building are the operational level of the Heat Transition. But for substantial discussions about a system decision a broader perspective is needed (spatially and temporally).

The space and energy driven detection of Energy Supply Options offers
- guardrails for the following detailed planning,
- an explicit spatial longterm strategy, and enables
- a dynamic update of data (heat demand, local reduction scenarios etc.), and
- the monitoring and controlling of measurements.
THANK YOU FOR YOUR ATTENTION

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Sonnenaufgang hinter dem Steinkohlekraftwerk Mehrum bei Hohenhameln in Niedersachsen
Bildquelle: dpa / tagesschau.de; 22.08.2017