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

3RD INTERNATIONAL CONFERENCE ON

**SMART ENERGY SYSTEMS AND 4TH GENERATION DISTRICT HEATING**

COPENHAGEN, 12–13 SEPTEMBER 2017

# POSITIONING

- Regional Potentials and Demands
- Regional Developements

- Local Potentials and Demands
- Local Developements


**Fuzziness of Neighborhood**

- Detailed Planning / Economics
- Projects

- Energetic Neighborhoods
- Suitabillity Areas

# THE GOAL

- **Almost climate-neutral buildings** in Germany in 2050

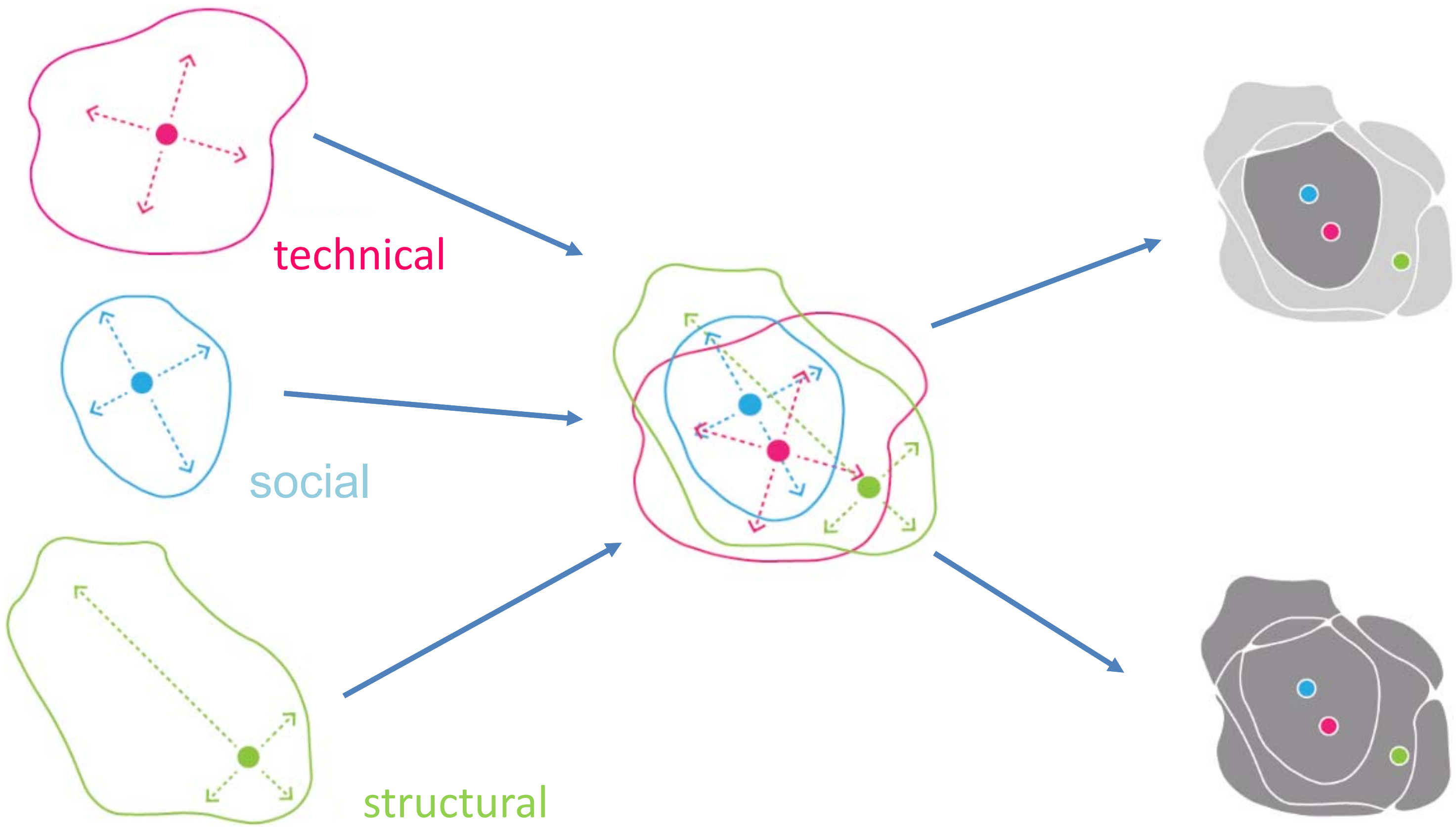
- Reduction of the **fossil** primary energy consumption by 80 % (95%)

  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

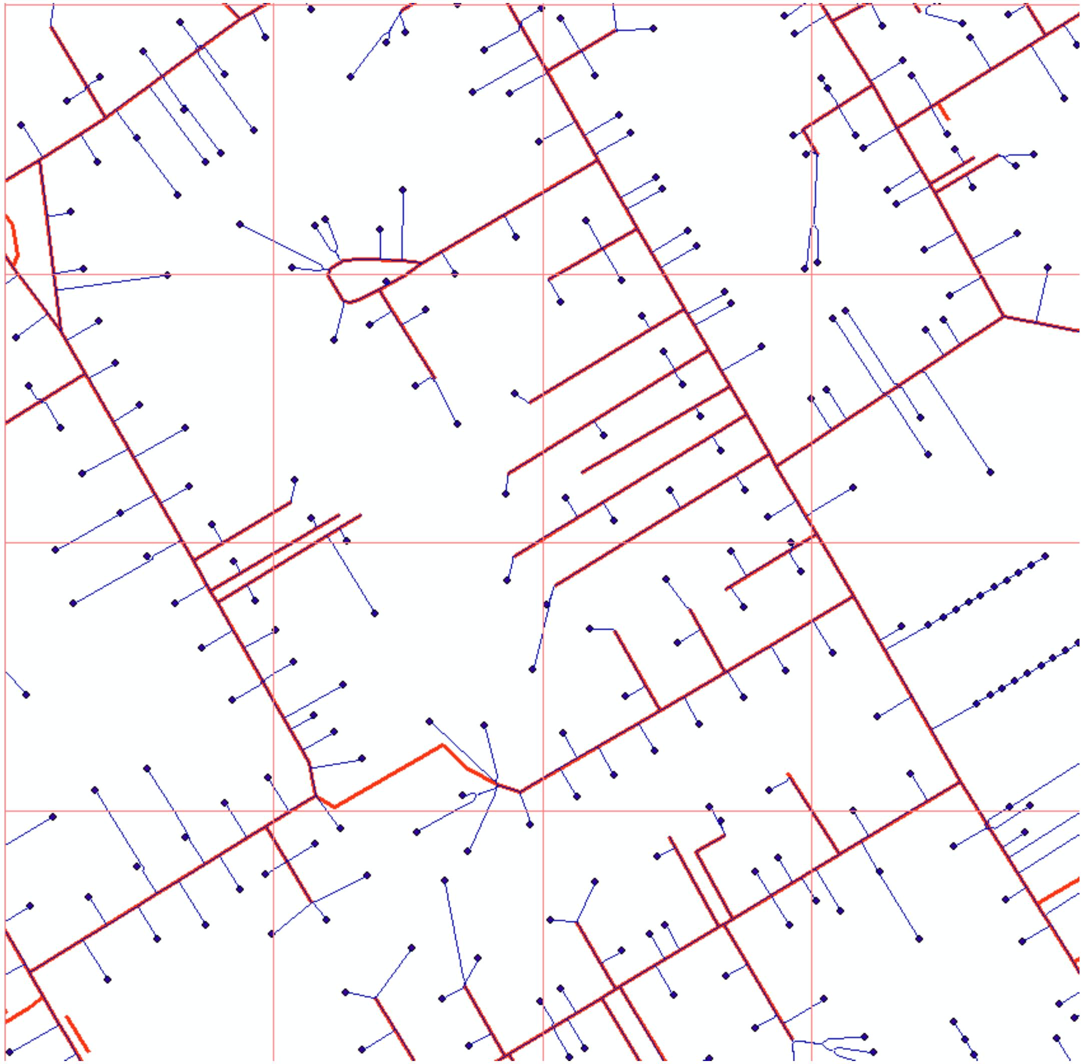
- But, not **EVERY** District Heating System is suitable!
- AND: Not at EVERY place a District Heating System is suitable!

# WHERE?
# BUILDING - DISTRICT - TOWN

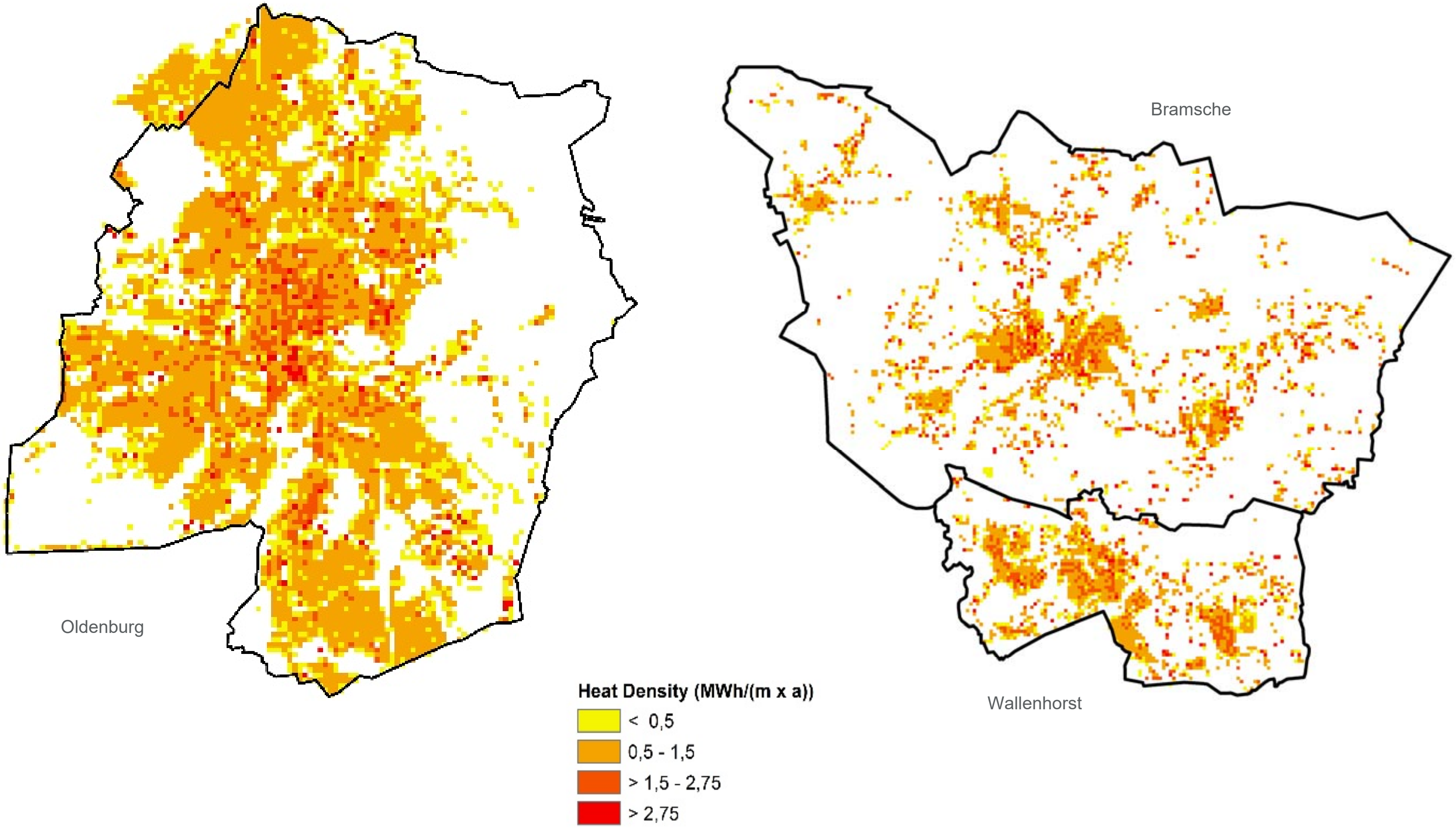



Bläser, D. (2015): Landkarte der Energiewende - Kommunale Aktivitäten und Ausstattung im Ruhrgebiet, Vortrag Energiewende Ruhr, 17.06.2015, Oberhausen

# HEAT – LINE - DENSITY

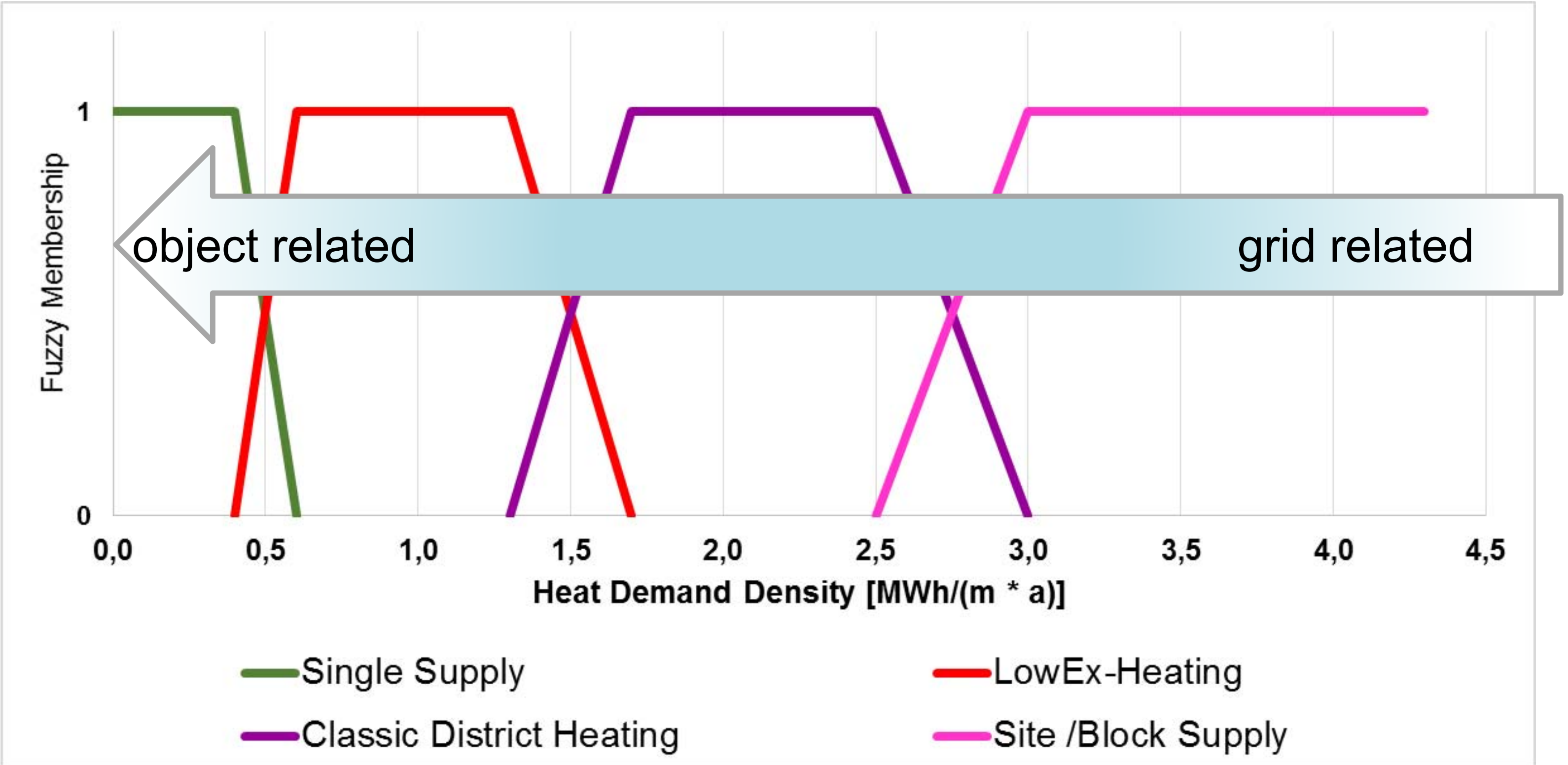


# HEAT LINE DENSITY STATUS QUO

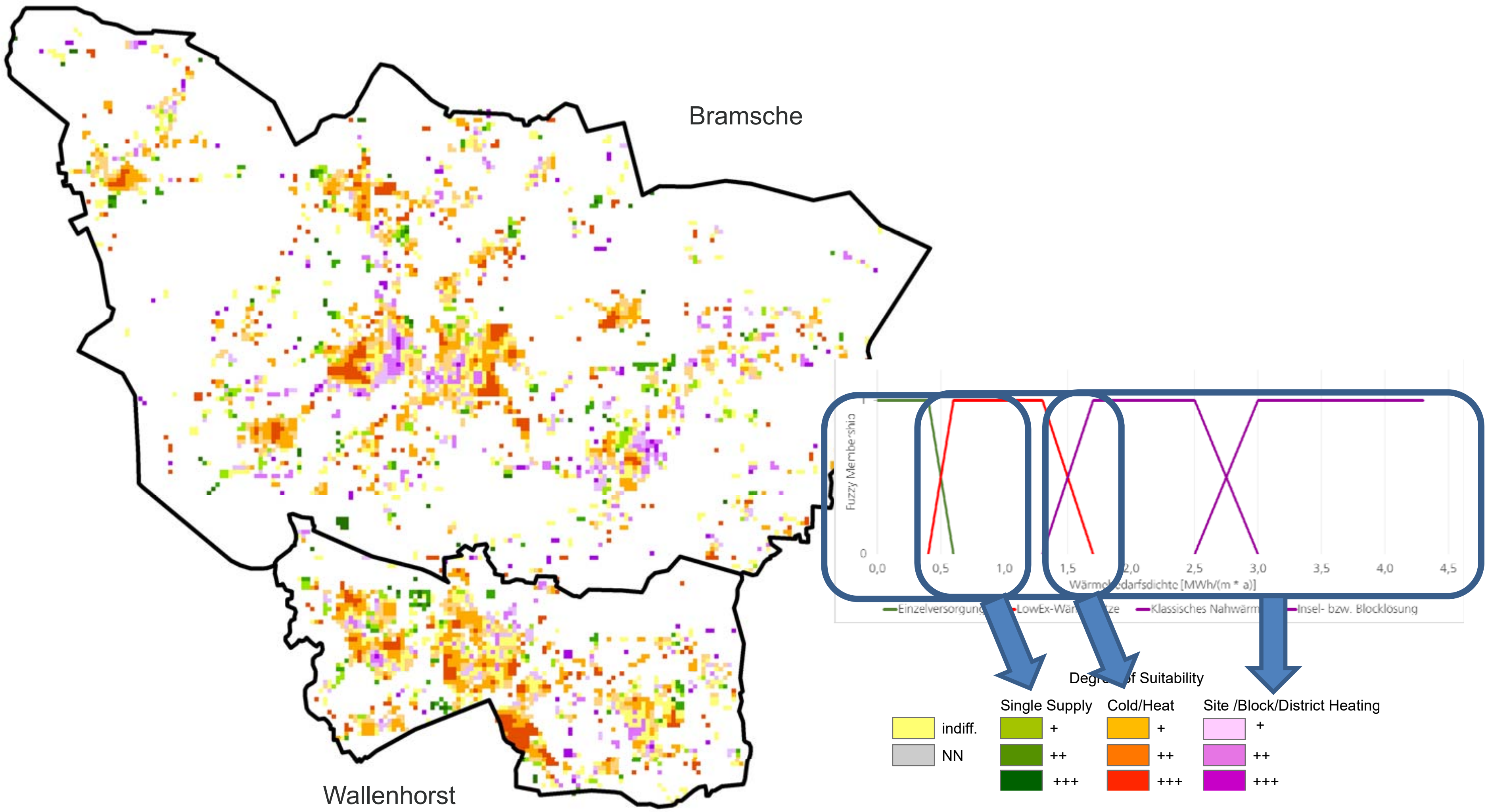


# HEAT SUPPLY OPTIONS

"Fuzzy" boundaries between economically feasible heat supply options



# SUITABILITY AREAS



# REDUCTION SCENARIOS

## Target Scenario Efficiency (PJ) – 60%

| | 2008 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| **Heating** | 2.755 | 2.346 | 1.786 | 1.002 |
| **Hot Water** | 375 | 371 | 354 | 311 |
| **Sum** | **3.130** | **2.717** | **2.140** | **1.313** |
| **In relation to 2008** | | 86,81% | 68,37% | 41,95% |

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

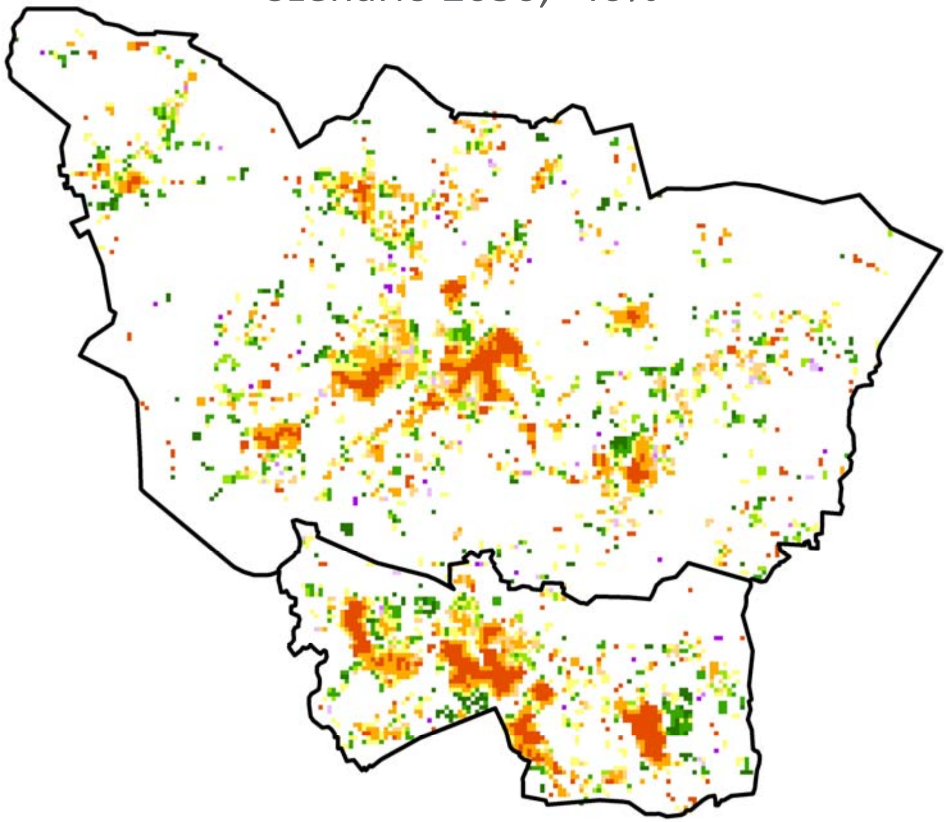
| | 2008 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| **Heating** | 2755 | 2426 | 2.060 | 1.560 |
| **Hot Water** | 375 | 371 | 358 | 328 |
| **Sum** | **3.130** | **2.797** | **2.418** | **1.888** |
| **In relation to 2008** | | 89,36% | 77,25% | 60,32% |

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

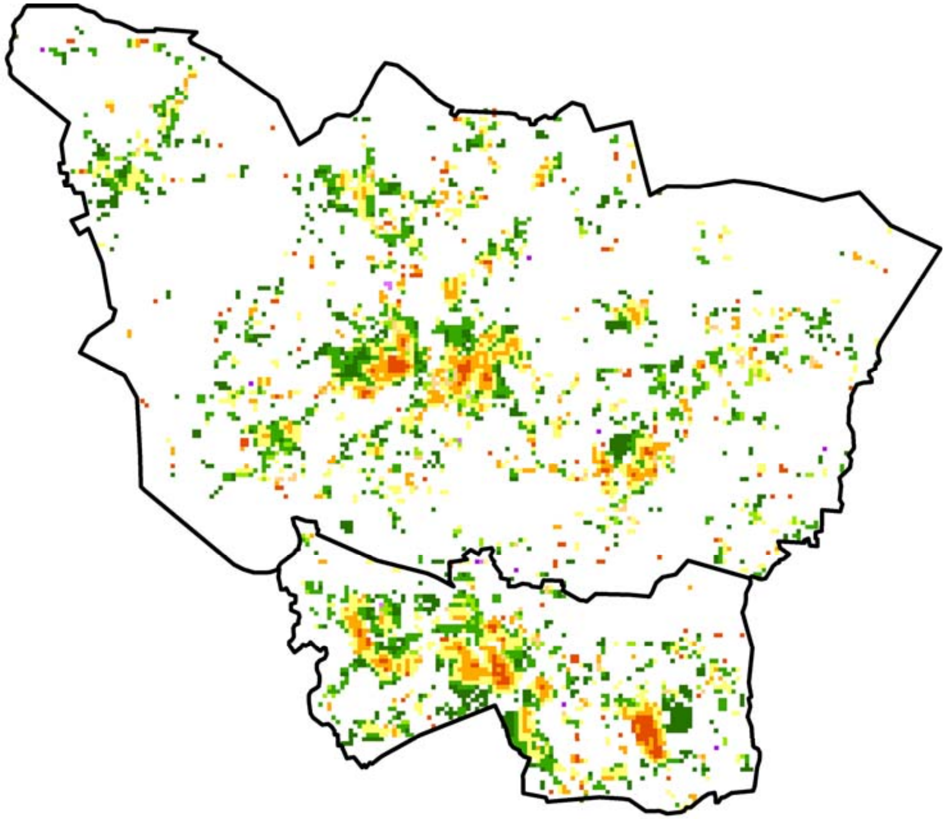
# FUTURE SUITABILITY AREAS

JADE HOCHSCHULE
Wilhelmshaven Oldenburg Elsfleth

Szenario 2050, -40%



Szenario 2050, -60%



Degree of Suitability

| | | Single Supply | | Cold/Heat | | Site /Block/District Heating | |
|---|---|---|---|---|---|---|---|
| | indiff. | | + | | + | | + |
| | NN | | ++ | | ++ | | ++ |
| | | | +++ | | +++ | | +++ |

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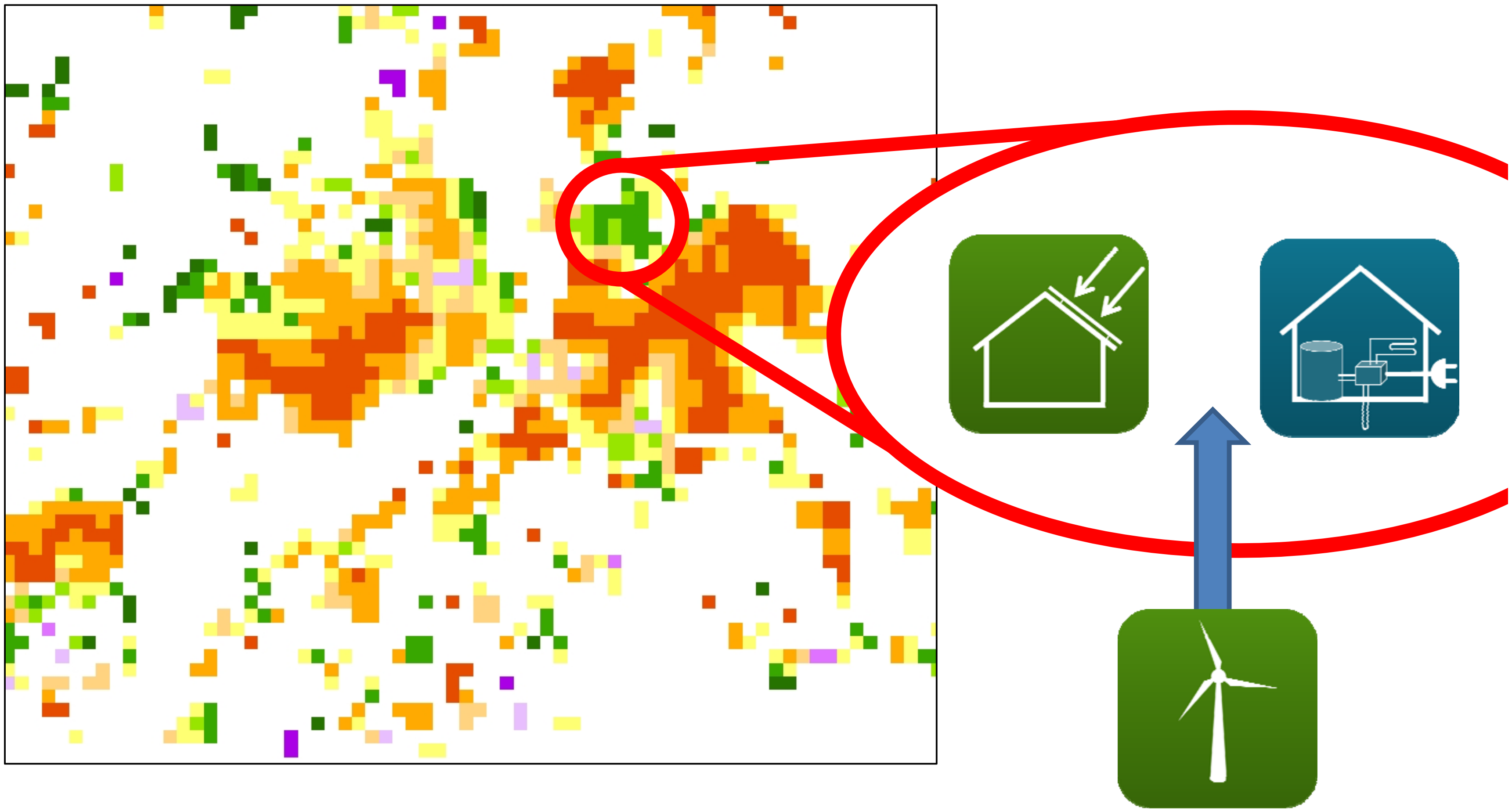
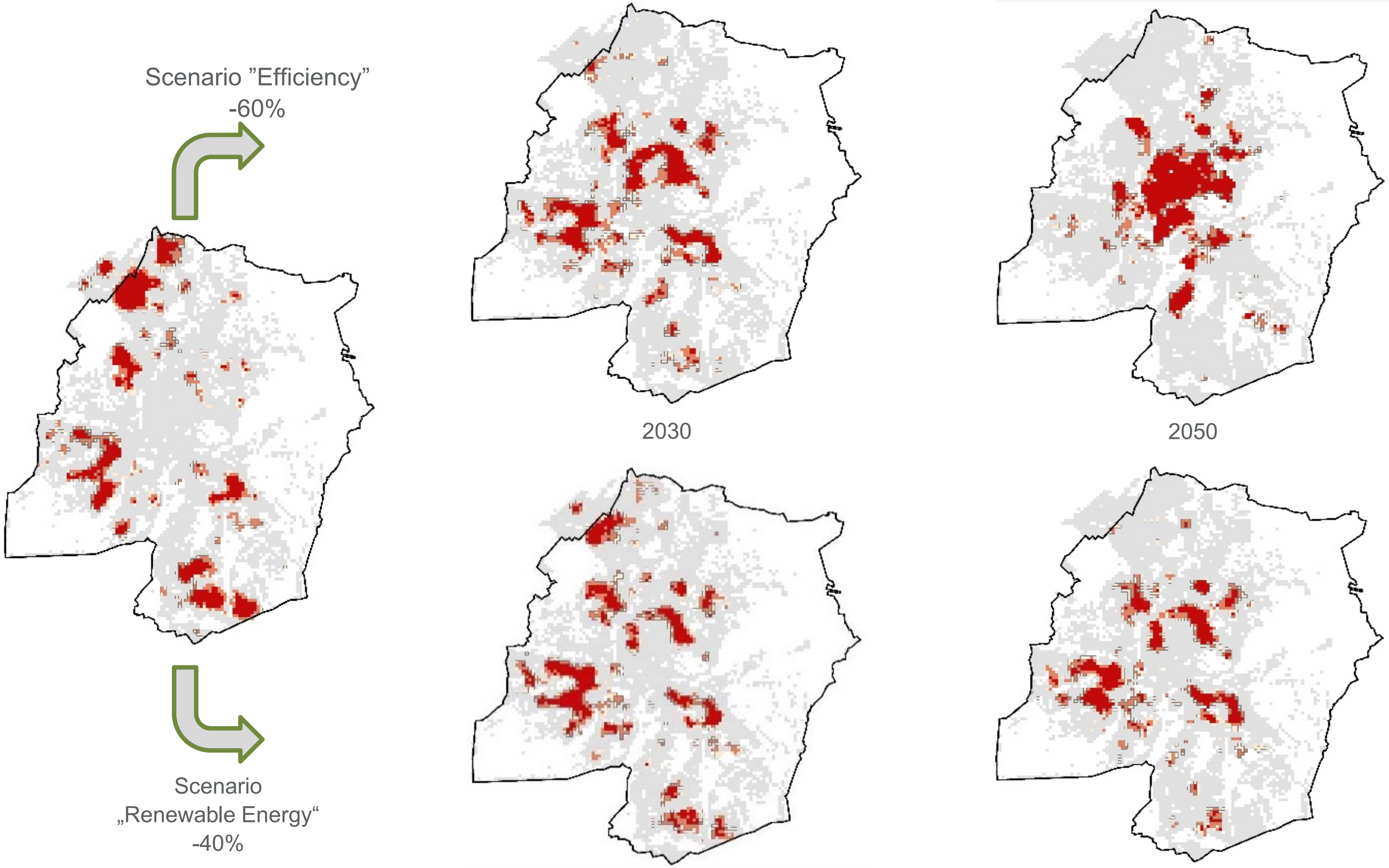
| | | +++ | | +++ | | +++ | |



# HOT SPOT ANALYSIS: LOWEX

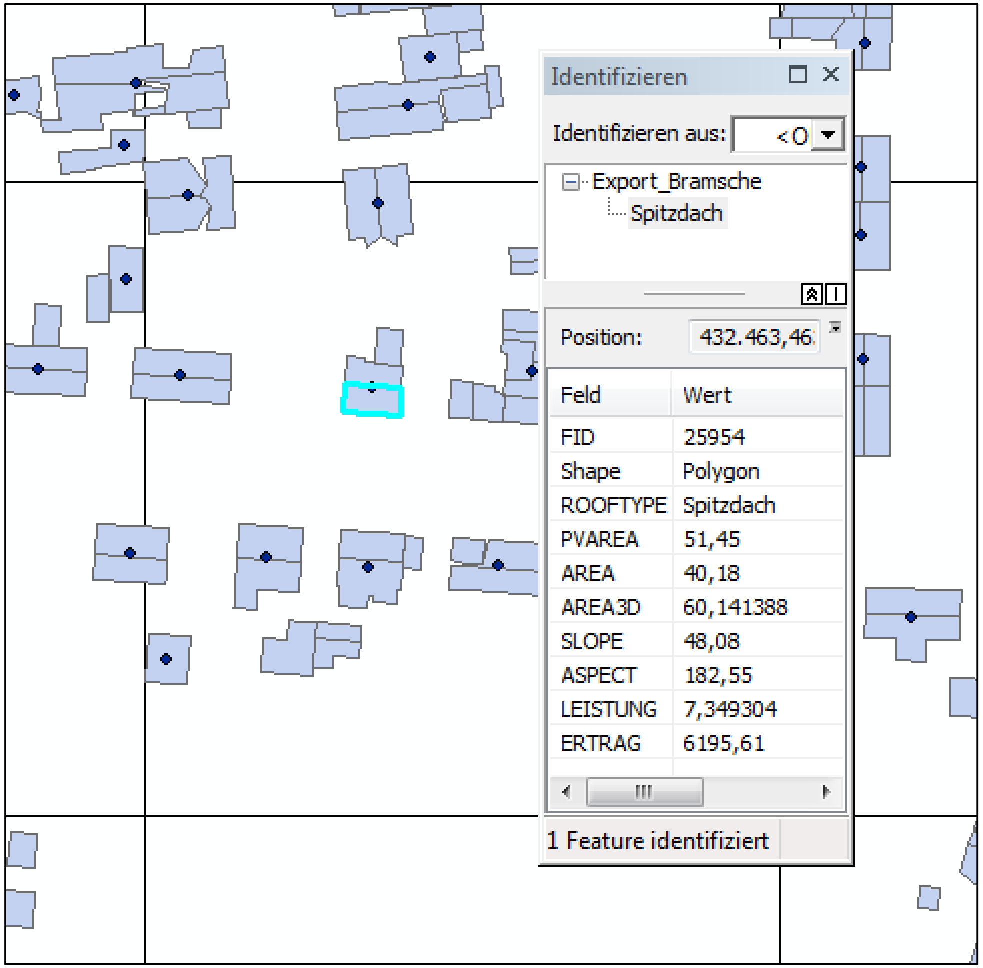


# WHAT COMES NEXT?

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




Data provided by solar cadastre of the County of Osnabrück / Geoplex GmbH

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) http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php

Raster-based aggregation

Overlay with Heat demand and Suitability Areas

# INTEGRATION OF SOLAR POWER (SUMMER)

| | Option | Pot. Solar Power (kWh) | DHW Demand (kWh) | Share pot. Solar Power to DHW | Share current Solar Power to DHW |
|---|---|---|---|---|---|
| **Status Quo** | | | | | |
| | DH | 20.512.889 | 4.954.034 | **373%** | 33% |
| | C/H | 58.229.070 | 12.317.525 | **425%** | 48% |
| | Single | 6.244.106 | 1.295.095 | **434%** | 67% |
| **2050A** | | | | | |
| | DH | 1.194.999 | 235.734 | **456%** | 29% |
| | C/H | 31.743.296 | 7.319.651 | **390%** | 31% |
| | Single | 41.804.136 | 9.204.918 | **409%** | 44% |
| **2050B** | | | | | |
| | DH | 3.675.736 | 748.038 | **442%** | 32% |
| | C/H | 70.456.589 | 15.852.872 | **400%** | 33% |
| | Single | 15.298.741 | 3.284.310 | **419%** | 48% |

# INTEGRATION OF SOLAR POWER (WINTER)

JADEHOCHSCHULE
Wilhelmshaven Oldenburg Elsfleth

| Option | Pot. Solar Power (kWh) | Heat Demand (kWh) | Share pot. Solar Power to Heat Demand | Share current Solar Power to Heat Demand | Solar Energy/HP (COP 5; 3,8) |
|---|---|---|---|---|---|
| **Status Quo** | | | | | |
| DH | 12.5 | | | | |
| C/H | 35.2 | | | | 34% |
| Single | 3.7 | | | | 26% |
| **2050A** | | | | | |
| DH | 7 | | | | |
| C/H | 19.2 | | | | 66% |
| Single | 25.3 | | | | 62% |
| **2050B** | | | | | |
| DH | 2.242.452 | 26.854.872 | 8% | 0,6% | |
| C/H | 42.684.717 | 436.732.345 | 10% | 0,8% | 49% |
| Single | 9.316.718 | 83.995.061 | 11% | 1,3% | 42% |

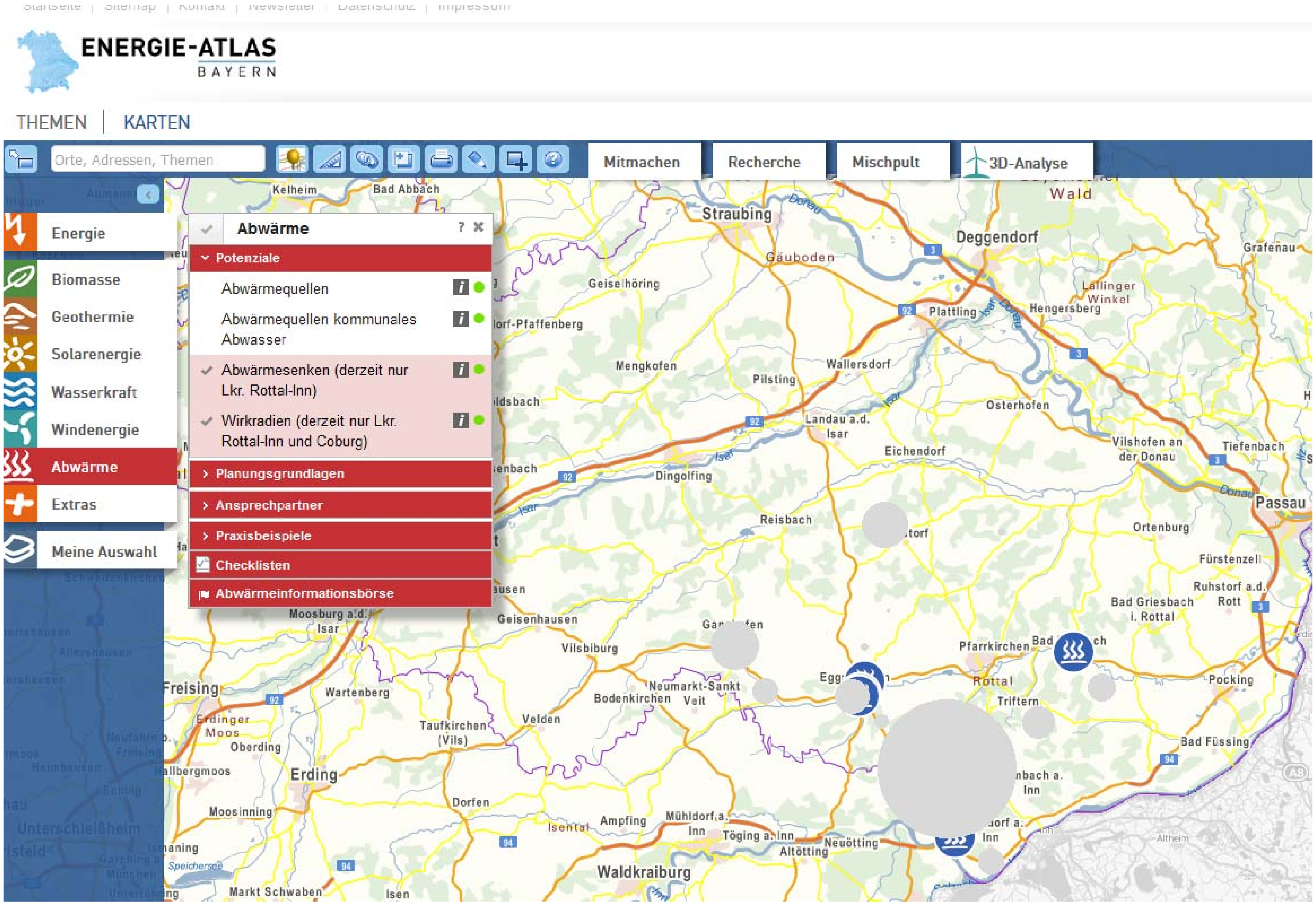
Wind Power Equivalence
(Power Generation Heating Periode)

Status Quo → 26,5 Wind Plants

2050 A → 4,2 Wind Plants

2050 B → 12,8 Wind Plants

# WASTE HEAT INTEGRATION: SEARCH RADIUS




http://geoportal.bayern.de/energieatlas-karten

# SIMPLIFIED SEARCH RADIUS

$$\text{Search Radius (m)} = \frac{\text{Usable Waste Heat } \left[\frac{\text{MWh}}{\text{a}}\right]}{0{,}00002\ \frac{MW}{m} \times 8760\ \left[\frac{\text{h}}{\text{a}}\right] + \text{Y}\ \left[\frac{\text{MWh}}{\text{m} \times \text{a}}\right]}$$

Y: Treshold of Heat Supply Options, the calculation is based on 0,5 MWh/(m x a) for LowEx and und 1,5 MWh/(m x a) classic District Heating Systems

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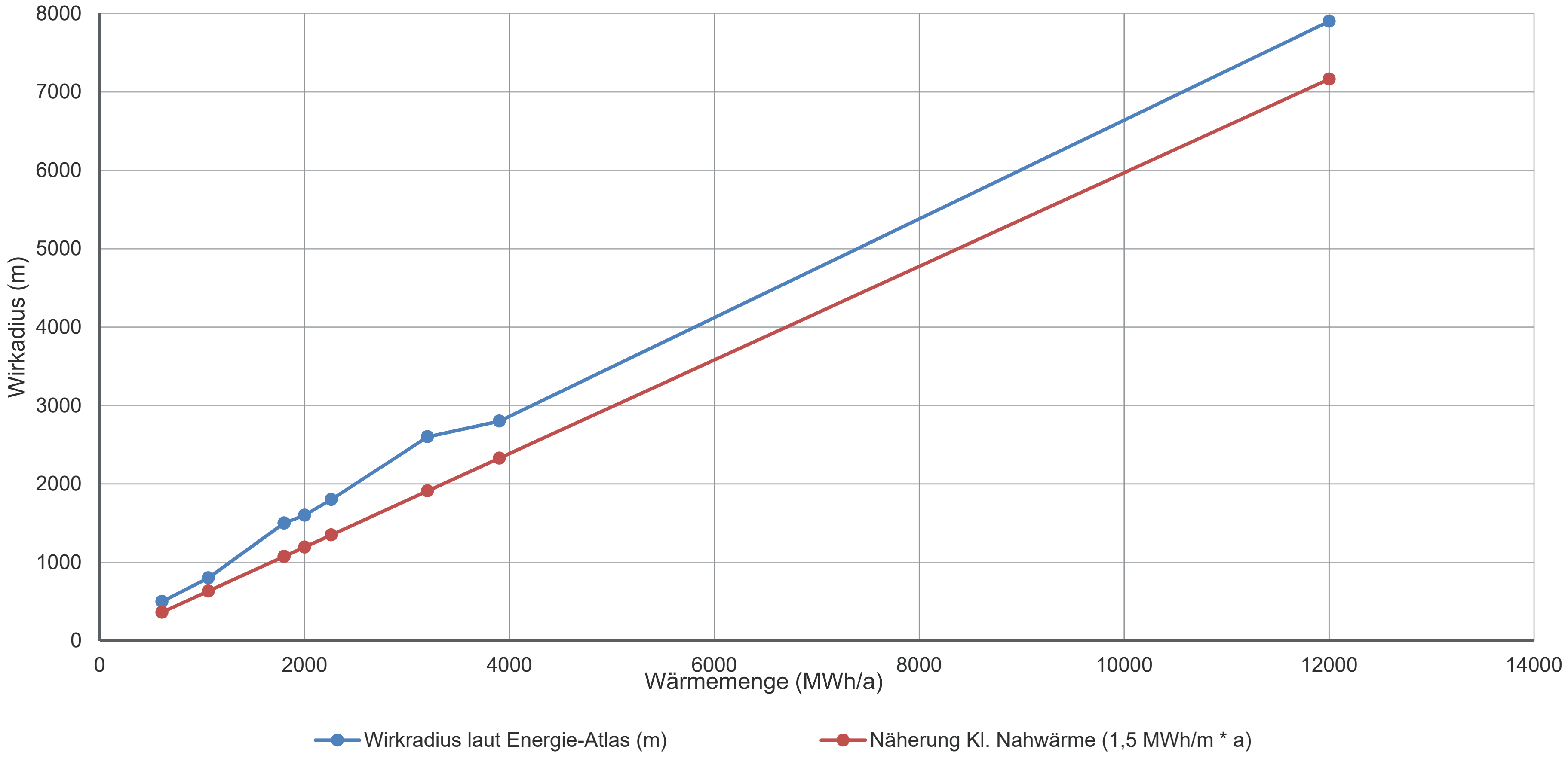
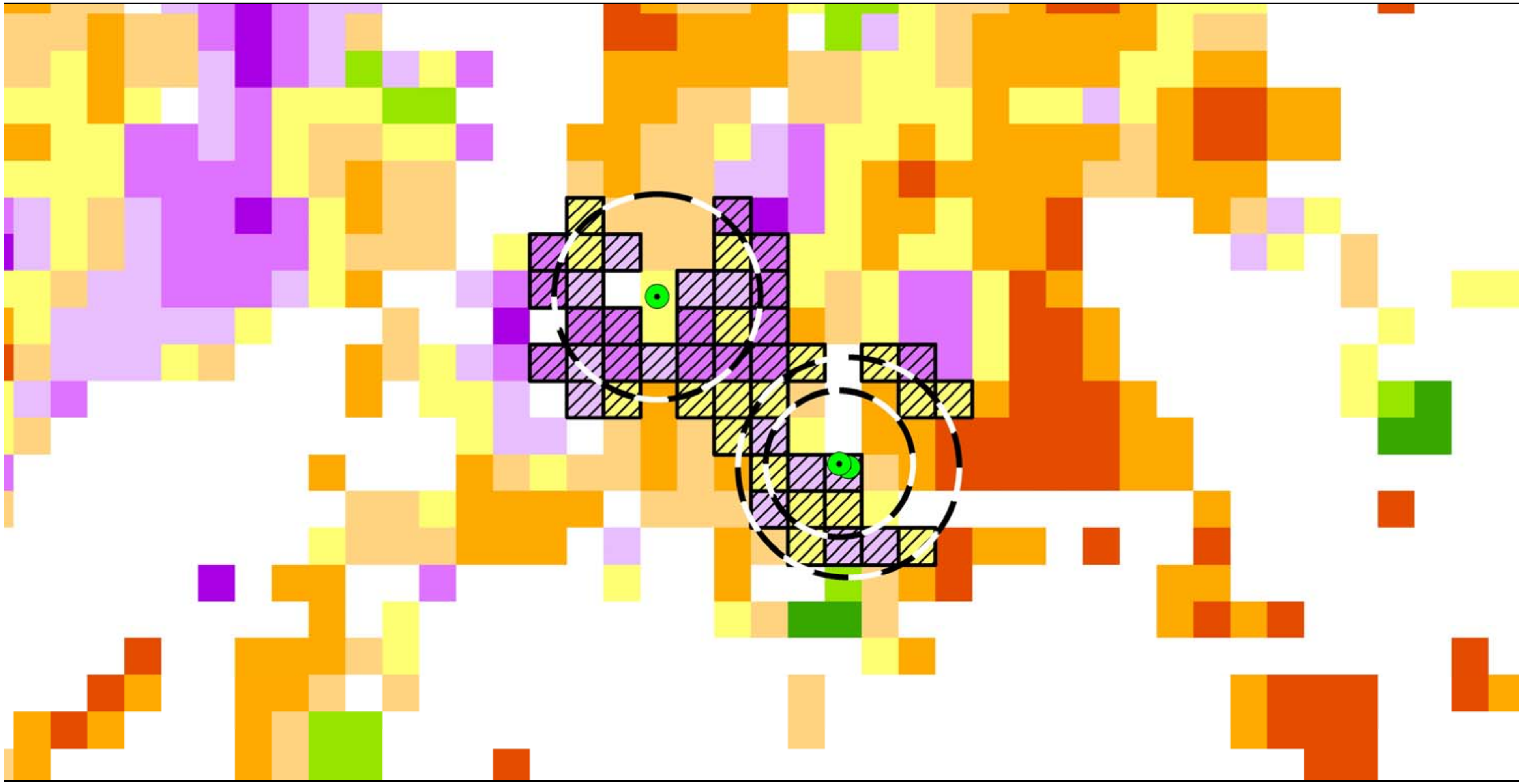
# COMPARISON



8000
7000
6000
5000
4000
3000
2000
1000
0
Wirkadius (m)
0
2000
4000
6000
8000
10000
12000
14000
Wärmemenge (MWh/a)
Wirkradius laut Energie-Atlas (m)
Näherung Kl. Nahwärme (1,5 MWh/m * a)

# MATCHING BY MAPS



Waste Heat Integration: Target System Classic District Heating

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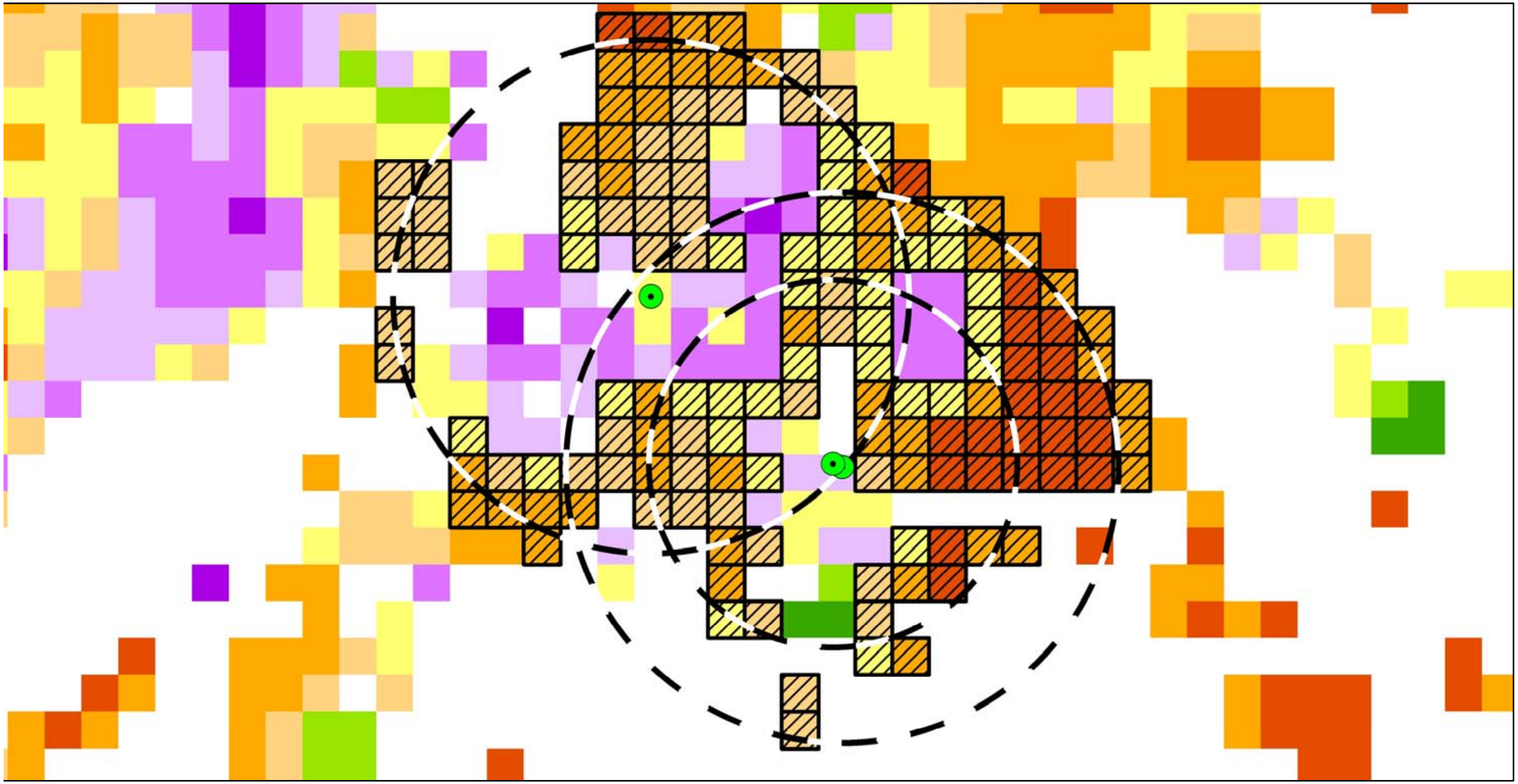

Waste Heat Integration: Target System LowEx-System

## ESSENCE

- The district and the builiding are the **operational level** of the Heat Transition. But for **substantial** discussions about a **system decision** a broader persepective 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
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