Bottom Up Versus Top Down Approaches Towards Low Energy Neighbourhoods in Austria

Anna M. Fulterer, F. Mautner, D.Venus, I.Leusbrock
Heimo Staller

AEE - Institute for Sustainable Technologies (AEE INTEC)
8200 Gleisdorf, Feldgasse 19, AUSTRIA
Bottom Up

Demand for
Building and Energy

Energy concept
Detailed Plans
Bottom Up

check
- Existing infrastructure
- Data
- Potentials
- Targets

Demand for
Building and Energy

Energy concept
Detailed Plans
Top Down

- Demand for Building and Energy
- Energy concept
  - Detailed Plans
- check
  - Existing infrastructure
  - Data
  - Potentials
  - Targets

Municipality:
Develop Strategies
Top Down

check
• Existing infrastructure
• Data
• Potentials
• Targets

Demand for Building and Energy

Energy concept
Detailed Plans

Municipality:
Develop Strategies

Investigate and Document
• Existing infrastructure
• Potentials
• Targets
Top Down

- Demand for Building and Energy
- Check
  - Existing infrastructure
  - Data
  - Potentials
  - Targets
- Energy concept Detailed Plans
- Municipality: Develop Strategies
- Investigate and Document
  - Existing infrastructure
  - Potentials
  - Targets
- Builder / planner / investor
Top Down

Demand for Building and Energy

check
- Existing infrastructure
- Data
- Potentials
- Targets

Municipality:
Develop Strategies

Investigate and Document
- Existing infrastructure
- Potentials
- Targets

Builder / planner / investor

Energy concept
Detailed Plans

Energy concept
Detailed Plans
Bottom Up <-> Top Down

Bottom Up:
- Starting point is the single building or building group
- Role of energy provider
- Integration into local grids
- Main motivation: building owner

Top Down:
- Starting from community / town
- Energy provider is a main stakeholder
- Buildings are seen as end-consumers
- Main motivation: community, energy provider
Focus

• Who drove the process?

• What was the demand?

• Successful integration of buildings / energy system of community?
Dieselweg: Renovation of a neighbourhood of multi family houses in Graz

Starting point:
- Suburban residential area in Graz
- 14038 m², 204 appartments
- Heated by single devices (fossil fuel or electric devices)
- low envelope quality

Driving Forces:
- Low income due to vacancies (high energy consumption, poor comfort)
- Need for good publicity and investment return

Aim: Show the way towards a solar-autarkic neighbourhood

Heating demand:
BEFORE: 142 - 225 kWh/m²a
AFTER: 9 - 12 kWh/m²a
Dieselweg: Renovation of a neighbourhood of multi family houses in Graz

Innovative technical solutions:
- HVAC via facade (heating, ventilation)
- Solar thermal and PV
- Heat pump and large hot water storage for each building
- Ventilation by small units (one per apartment)

Tools:
- Baseline Study
- Calculation of Energy consumption
- Simulation (building, HVAC)
- Monitoring of energy consumption and comfort

Funding:
- via subsidies, funding for innovations, research projects
- higher income due to slightly higher rental fees and low vacancies
Dieselweg: Renovation of a neighbourhood of multi family houses in Graz

District heating and Gas grids

- DH 2010-2015
- DH 2013-2025
- DH from 2020
- Gas now
- Gas future
- Gas far future

Successful integration into existing grids?

- HEAT: No connection to district heating—'autarkic' island solution per building
- POWER: Connected to grid. Generated power is fed into the grid (legislative and financial reasons)
Kapfenberg: Renovation of a multi family house in Austria

Starting point:
- Residential area in the north of Styria
- 2845 m² - 36 appартments
- Heated by single devices (fossil fuel or electric devices) or small central heating systems, low envelope quality

Driving Forces:
- Low income due to vacancies (small appartment, high energy consumption, poor comfort)
- Need for good publicity and investment return

Aim: Renovation to Plus Energy Residential Building

Heat + DHW consumption
BEFORE: 108 kWh/m²a
AFTER: ~30 kWh/m²a
Kapfenberg: Renovation of a multi family house in Austria

Innovative technical solutions:
- HVAC via facade (heating)
- Solar thermal and PV
- Connected to district heating (backup, load peaks)
- Central ventilation with heat recovery / heat recovery by heat pump for DHW

Tools:
- Baseline Study
- Calculation of Energy consumption
- Simulation (building, HVAC)
- Monitoring of energy consumption and comfort

Funding:
- via subsidies, funding for innovations, research projects
- higher income due to slightly higher rental fees and low vacancies
Kapfenberg: Renovation of a multi family house in Austria

The area east of the residential building was already connected to DH ( miệng).

Successful integration into existing grids?

- **HEAT:** Active energy generation (HP+ heat recovery, solar collectors). DH as backup and for load peaks.
- **POWER:** PV energy fed into grid, grid power for HP and other requirements (legislative and economical reasons).
Energy Master Planning Processes of communities

- **Main driving force:**
  
  energy strategy of communities

**Status analysis**
- Energy relevant data
- Energy consumption and GHG emissions
- Energy Potentials

**Strategy development**
- Create scenarios for the future
- Spatial modelling and simulation
- Derivation of measures

**Implementation**
- On levels of organisation, planning, project and realisation

**Quality assessment and monitoring**

**Aim:** Gather Information
- Methods: use GIS and various sources
  - Open questions:
    - best way to gather data (Energy provider, community, final consumer). Privacy

**Definition of measures:**
- Renovation of heat generation, buildings, use renewables etc.

**Give access to information**
- Open questions:
  - How to require implementation (eg local financial subsidies programmes, legally binding master plan ?)
Methods - Workflow

Spatial energy and infrastructure analysis and modeling
GIS, statistics, energy balancing, roadmapping

Data acquisition, geodatabase management

Pre-processing (check, verify, extend database)

Spatial analysis / spatial modeling
- Characterization of existing infrastructures, energy demands and local resources

Renovation and modernization roadmap
- Building renovation roadmap based on hourly HWB* calculation (acc. to EN ISO 13790)
- Scenarios for increased share of renewables in heating sector and DH extension

Dynamic building and utility network simulation
- Automated workflow coupling geodatabase with IDA ICE building simulation framework

In-depth analysis / simulations in high temporal resolution
physical models, (dynamic) simulation
Spatial analysis and modeling

### Setting-up geodatabase

- CAD (e.g. network plans)
- (open) government data
- Open data (e.g. OSM)
- Remote sensing data
- Orthofotos
- Statistics
- Other (*.xlsx, *.txt, *.shp)

---

Final geodatabase

- Geolocation of all buildings and energy supply networks
- **Full characterisation of residential sector** for basic energetic analysis
- **Only partial characterisation of industry, commercial and public sector**
- Land use / zoning

---

Pre-processing

- Address points
- Building polygons
- Digital elevation model
- Orthofotos
- Land use classes
- Land use zones
- Build-up floor area
- Building height
- Number of floors
- Energy networks
- Gross floor area (GFA)
- Building use category
- Building age classes
- Building heating system
- Space heating demand (HWB)
- Building renovation state
Salzburg Schallmoos: EMP for a quarter in Salzburg

Main driving force:
Energy and climate strategy of Salzburg

Data acquisition and analysis
Definition of high priority areas
Plan: Start with high priority: renovate neighbourhoods that are up to now coal – heated
Demonstration project + ERS
Towards Plus Energy Neighbourhoods

Starting point:
- Industrial wasteland, in Graz
- Need of new residential space in a growing town
- Investors have taken over the area

Driving Forces:
- Investor: Need for investment return
- Town and Neighbours: Upgrade of the area
- Town: Need for apartments
- Town: No further emissions due to already bad air quality

Aim: Plan and build a new urban district. Reach Plus energy and realize energy exchange between residential and commercial areas.
Demonstration project + ERS Towards Plus Energy Neighbourhoods

Innovative technical solutions:
• Solar thermal collectors
• Foundation: Ground heat collector
• Heat pumps
• Energy exchange between commercial and residential area. (Summer heat is stored for heating in winter)

Results:
Consumption (residential): 35 kWh/m²a
Plus Energy **NOT REACHED**

• PV was not realized
• no energy exchange for cooling of supermarket
• less energy demand for cooling
Demonstration project + ERS Towards Plus Energy Neighbourhoods
Demonstration project + ERS
Towards Plus Energy Neighbourhoods

Funding:
• via subsidies, funding for innovations, research projects
• Contracting for cooling energy

Tools:
• Baseline Study
• Calculation of Energy consumption
• Simulation (building, HVAC)
  TRNSYS, PHPP, simplex (heat network)
• Monitoring of energy consumption and comfort

• Optimization of the consumption of single residential buildings
• Energy concept for single residential buildings and network
• Concept for energy network with existing (commercial) buildings
• Load profiles for residential areas
• Simulation of the model with TRNSYS, Calculation of Variants and Optimization with SIMPLEX (simulation tool for heat networks)
Demonstration project + ERS Towards Plus Energy Neighbourhoods

Successful integration into existing energy system?

HEAT:
- Neighbouring buildings as first backup, district heat as second backup
- Heat/cooling exchange with neighbouring building is technically possible. Organisationally not

POWER:
- Connected to power grid

DH was planned for this area already before 2010

part 1: commercial / office + residential

part 2: residential
Process Design of Energy Master Planning in Austria

Source: CraveZero

- Priority areas
- Priority energy supply system
Process design

Possible uses, Available Infrastructure (e.g. mobility)

Land Use Plan

Energy Use Plan

Locally available resources

Demand

From experience, Depending on local resources

Alternative energy supply systems

Local energy master plan

Detailed building and system design

Calculation

Simulations (comfort, end energy requirement)
Example Salzburg-Lehen: **Low-temperature SDH grid**

Solar thermal system connected to a low-temperature heating network supplying around 68,000m² of heated floor area

2,048m²_{\text{gross}} flat plate collector field (mounted on 13 separate roofs)

200 m³ energy storage

Auxiliary heating: storage integrated HP (160 kW_{\text{th}}) + district heating

DH supply temperatures: 65/35

Monitoring: 07/2013 – 06/2014
Example Salzburg-Lehen: **Low-temperature SDH grid**

Solar thermal system connected to a low-temperature heating network supplying around 68,000m² of heated floor area.
Conclusion and Outlook

TOP DOWN:

• Communities define energy and emission strategies

• Development of a common procedure for land use and energy planning

• Energy planning to accompany land use planning

BOTTOM UP:

• Provide information on local energy supply system

• Potential for renewable energies

• Cooperation with neighbours
Conclusion and Outlook

• TOP DOWN:
  • Communities define energy and emission strategies
  • Development of a common procedure for land use and energy planning
  • Energy planning to accompany land use planning

• BOTTOM UP:
  • Provide information on local energy supply system
  • Potential for renewable energies
  • Cooperation with neighbours

Data acquisition (consumption, return temperature)
Data exchange (GIS, BIM, …)
System optimisation (buildings and energy systems)
Steering measures
Thank you for your Attention
Kirchberg am Walde: Partial Renovation of a rural school

Starting point:
- Agricultural and forestry school in Upper Styria
- >7680 m² - 36 appartments
- Dormitory, canteen, school building

Driving Forces:
- Bad comfort and need for more space
- Need for good publicity (to have enough pupils)

Aim: Rebuilding of the dormitory house, thermal renovation of all buildings, where possible

Heat + DHW consumption
BEFORE: xxx kWh/m²a
AFTER: 14.4 kWh/m²a
Kirchberg am Walde: Partial Renovation of a rural school

Innovative technical solutions:
- Rebuilding the dormitory
- Careful renovation of historic monuments

Tools:
- Baseline Study
- Calculation/Measurement of Energy consumption of single buildings
- Simulation (building, HVAC)

Funding:
- Public funding
- Income via PV feed in

- No optimization of heat network
- Single building approach