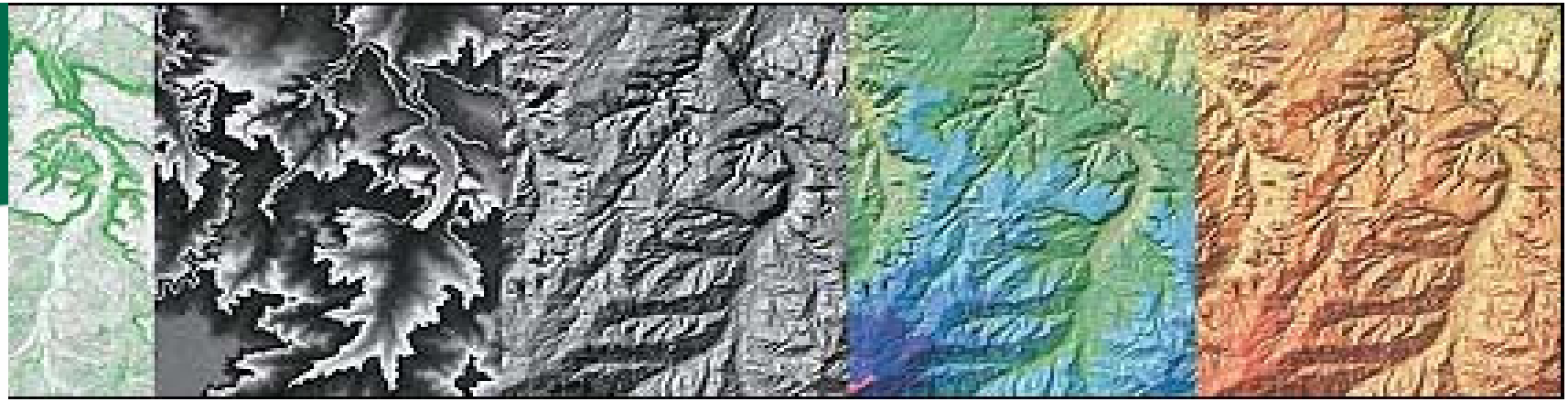


A Digital Earth framework for regional autonomy in energy supply

Josef Strobl
Centre for Geoinformatics
Salzburg University, Austria

ZGIS

ZENTRUM FÜR GEOINFORMATIK SALZBURG

CENTRE FOR GEOINFORMATICS SALZBURG

Themes

1. **Digital Earth Initiative**
2. **Renewable Energy in Regions**

Global Perspective – Local Action

Digital Earth

Digital Earth is a visionary concept for the virtual representation of the Earth that is spatially referenced and interconnected with digital knowledge archives from around the planet with vast amounts of scientific, natural, and cultural information to describe and understand the Earth and human activities. This vision states that any citizen of the planet, linked through the Internet, should be able to access this virtual world for free.

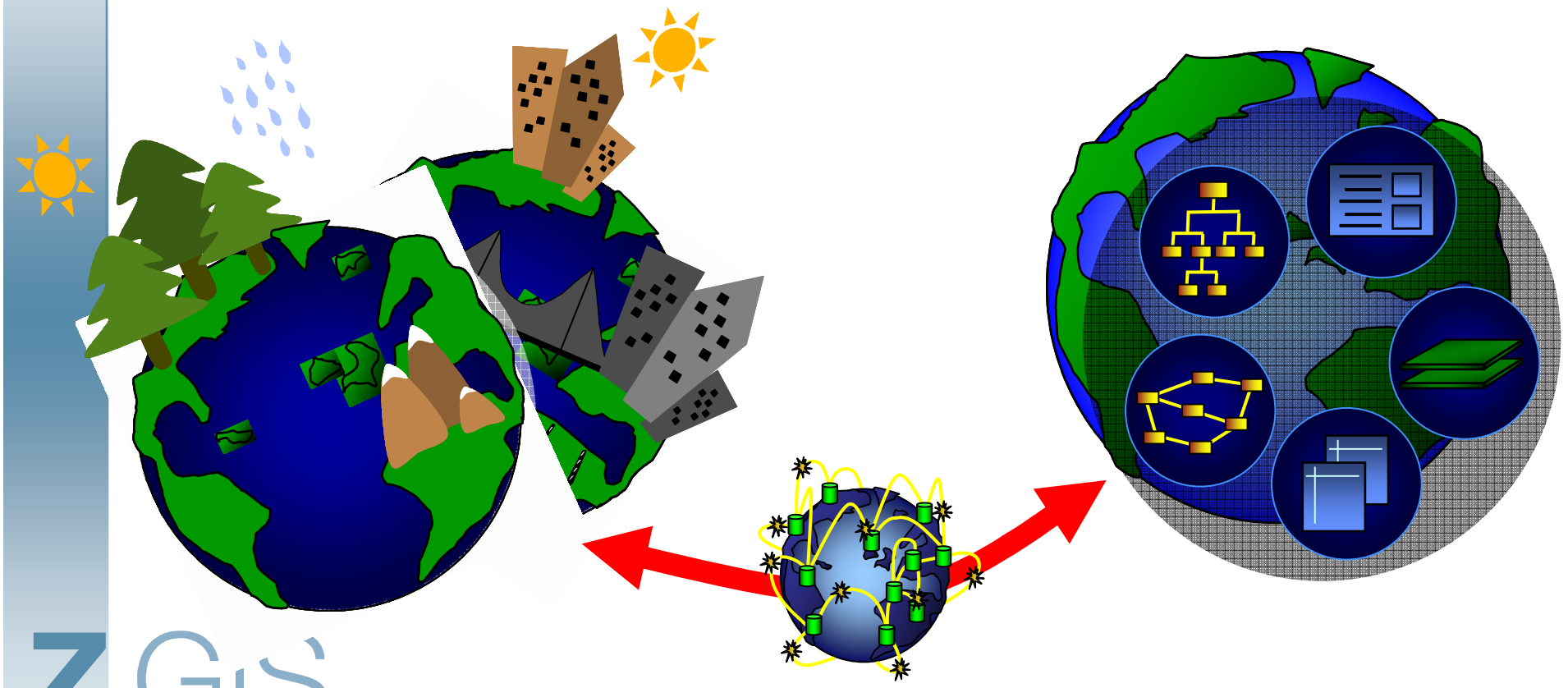
www.isde5.org

Digital Earth

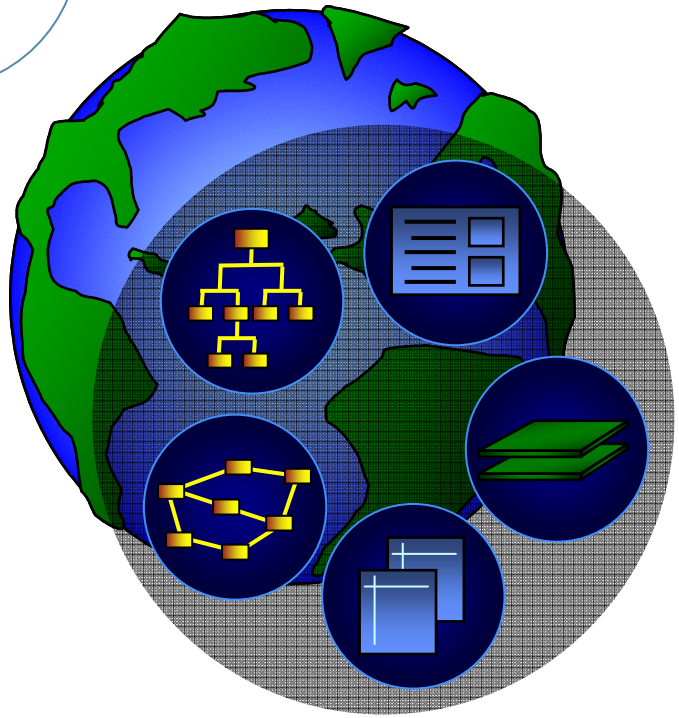
- **Largely based on Remote Sensing**
- **A Global Monitoring Framework**
  - plus modeling and simulation
- **‚Big Picture'; Systems view**
- **Providing Context for Sustainable Development**

Real < > Virtual Worlds

> Connecting through Location <



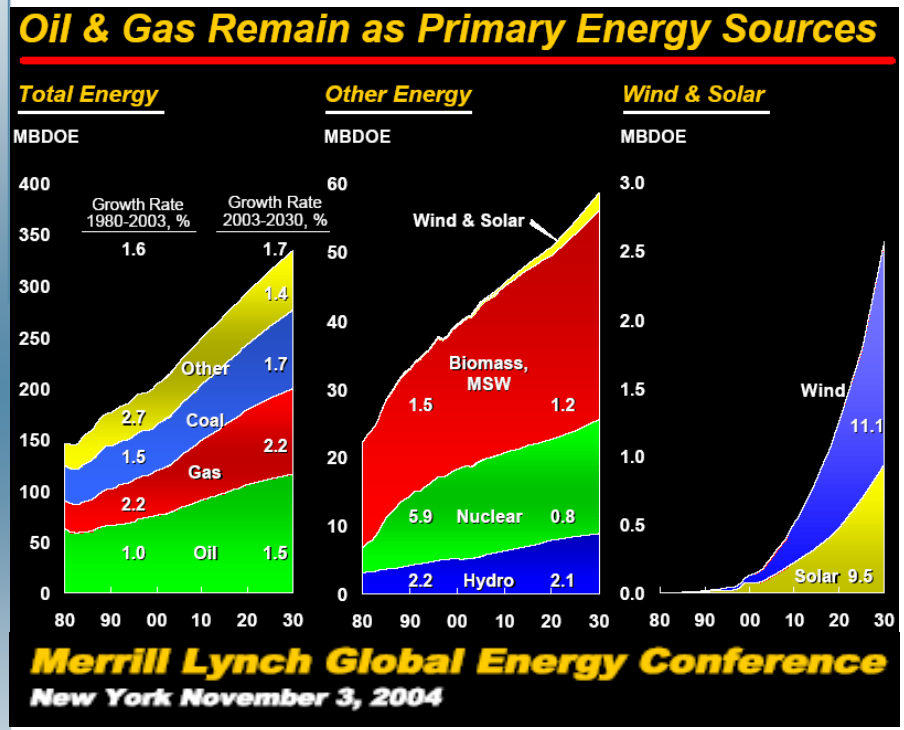
“System Earth”



- Representation
- Understanding
- Management
- Communication

. . . Geographic Information Science

"Supplying energy to a growing world population while reducing greenhouse gas emissions is one of the grand challenges that we humans must face in this century" **Global Climate & Energy Project, Stanford University**



"The world consumes two barrels of oil for every barrel discovered. So is this something you should be worried about ?"

Chevron Corporation

Main triggers

- **Cost for fossile fuels is going up (shrinking reserves are *one* factor in this)**
- **Growing awareness of political dependence; better look for *local* sustainability**

Hypotheses

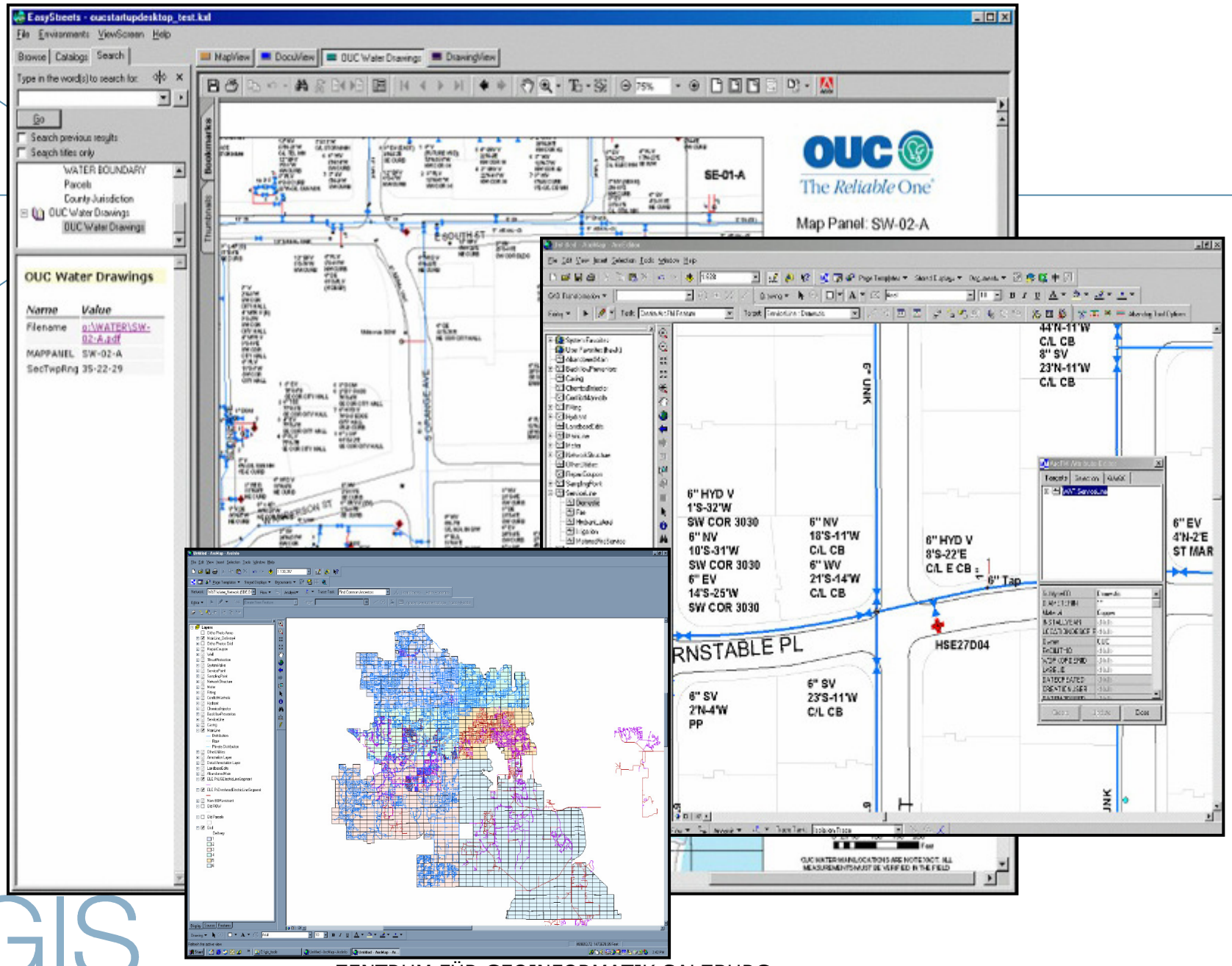
- Sustainable supply of energy is a local responsibility = distributed generation
- Temporal balancing is more challenging than totals
- Grid: from long-range transmission to intra- und inter-regional balancing

Focus on ...

- **Electricity**
- ***not*: heat, mobility**
- **(while acknowleding that there are substantial synergies, substitions and complementarities)**

Energy Industry

- **GIS used to be (and still is)**
  - a tool for asset documentation
  - a tool for distribution network planning
- **GIS is going to be**
  - a strategic enterprise level tool for
  1. planning generation from renewable sources, and
  2. managing liberalized / unbundled enterprises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File Environments ViewScreen Help
Browse Catalogs Search
MapView DocuView OUC Water Drawings DrawingView
Type in the word(s) to search for:
Go
Search previous results
Search titles only
WATER BOUNDARY
Parcels
County Jurisdiction
OUC Water Drawings
OUC Water Drawings
Name Value
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MAPPANEL SW-02-A
SecTwpRng 35-22-29
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The Reliable One
Map Panel: SW-02-A
SE-01-A
6" HYD V
1'S-32'W
SW COR 3030
6" NV
10'S-31'W
SW COR 3030
6" EV
14'S-25'W
SW COR 3030
6" NV
18'S-11'W
C/L CB
6" WV
21'S-14'W
C/L CB
6" HYD V
8'S-22'E
C/L E CB
6" Tap
HSE27D04
6" SV
2'N-4'W
PP
6" SV
23'S-11'W
C/L CB
44'N-11'W
C/L CB
8" SV
23'N-11'W
C/L CB
6" EV
4'N-2'E
ST MAR
6" UNK
JNK

Energy and Geography?

- Trend from fossile to renewable fuels
- Renewables are directly or indirectly generated from solar radiation
- Therefore substantial amounts of land are needed!
- Sensitivity to transport and storage
- Market liberalisation: Geography turns from ‚constant' to ‚variable'

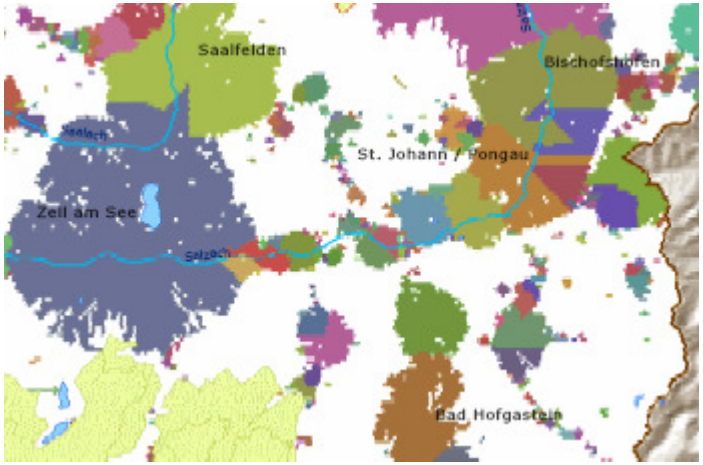
Production of renewable Energy is ‚geographic'

because of

- **Direct or indirect ‚Solar' production requiring large areas**
- **Sensitivity to transport and storage**
- **Market liberalisation: Geography turns from ‚constant' to ‚variable'**

Energy Production

… is increasingly becoming a spatial planning / zoning issue!

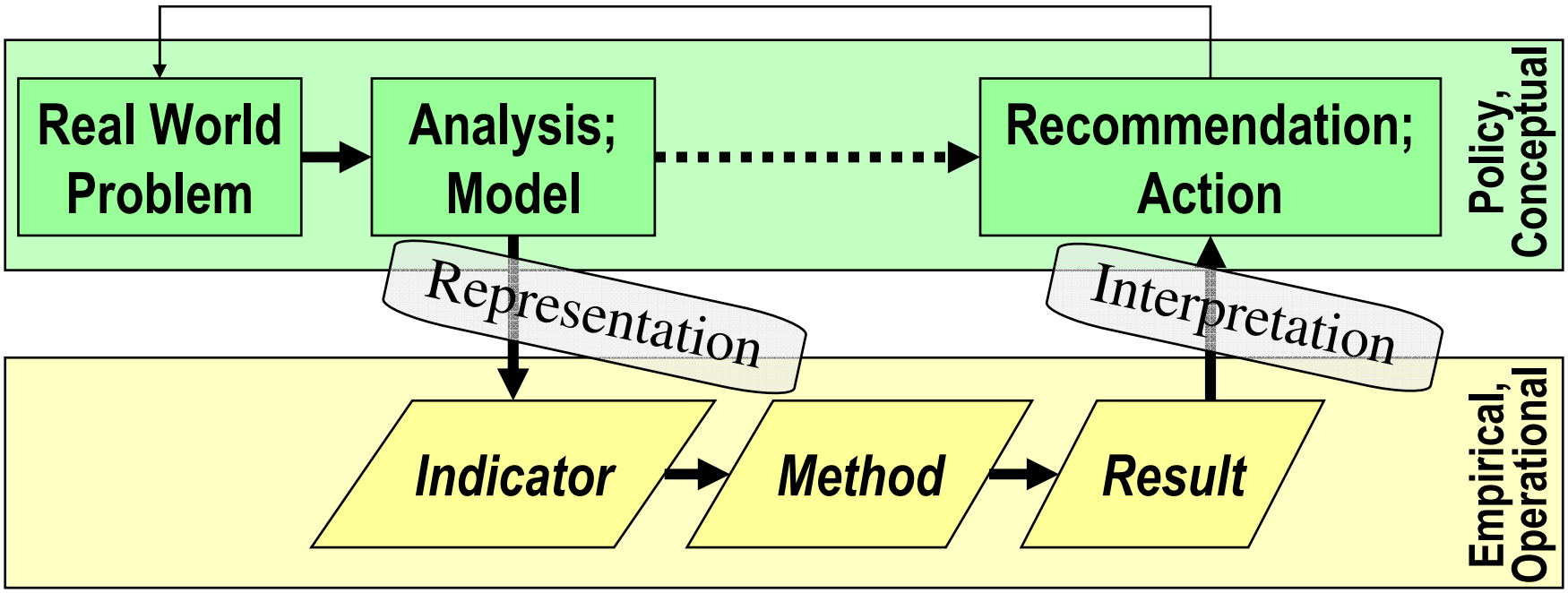


Renewables

- Photovoltaic and Solar thermal
- Wind energy
- Tidal power
- Hydropower
- Biomass (excl. biofuels)
- Geothermal

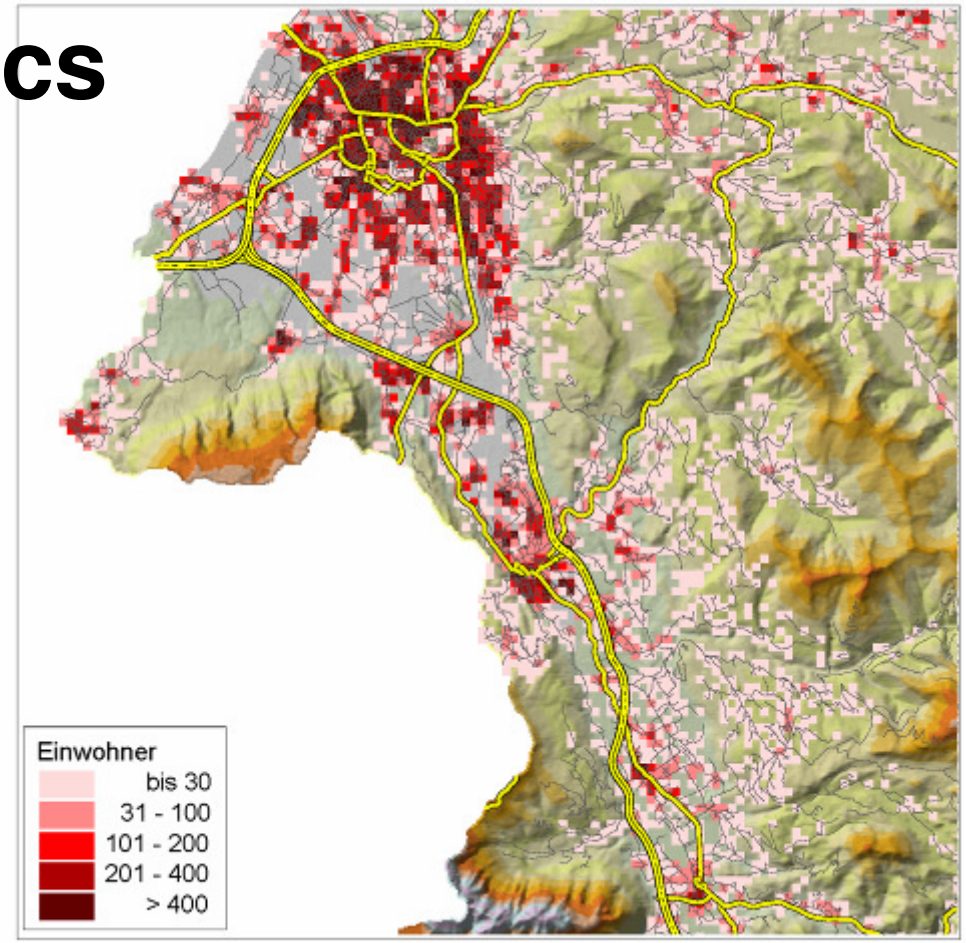
Spatial Indicators

Operational Metrics for the Real World:

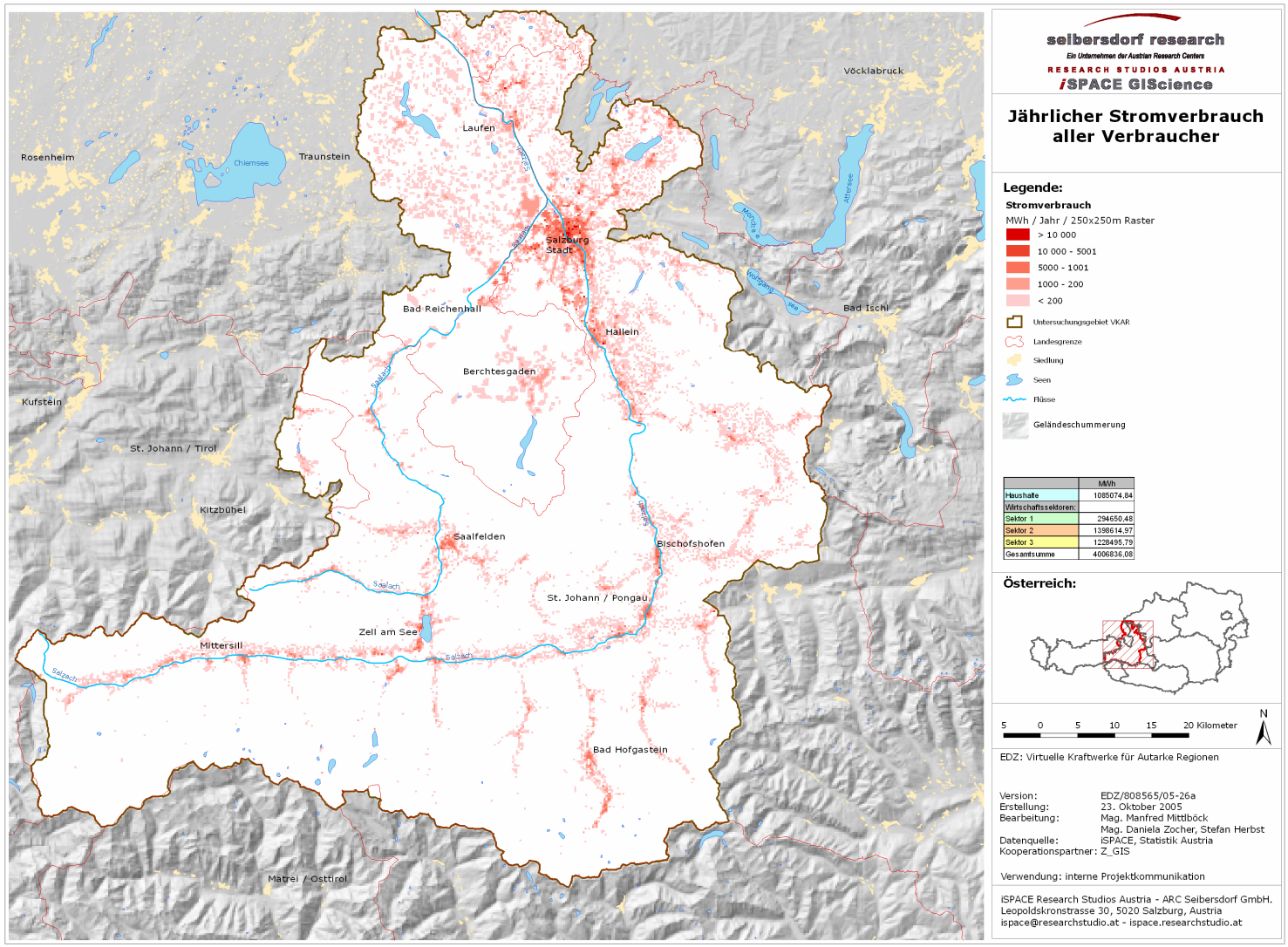


Demand indicators

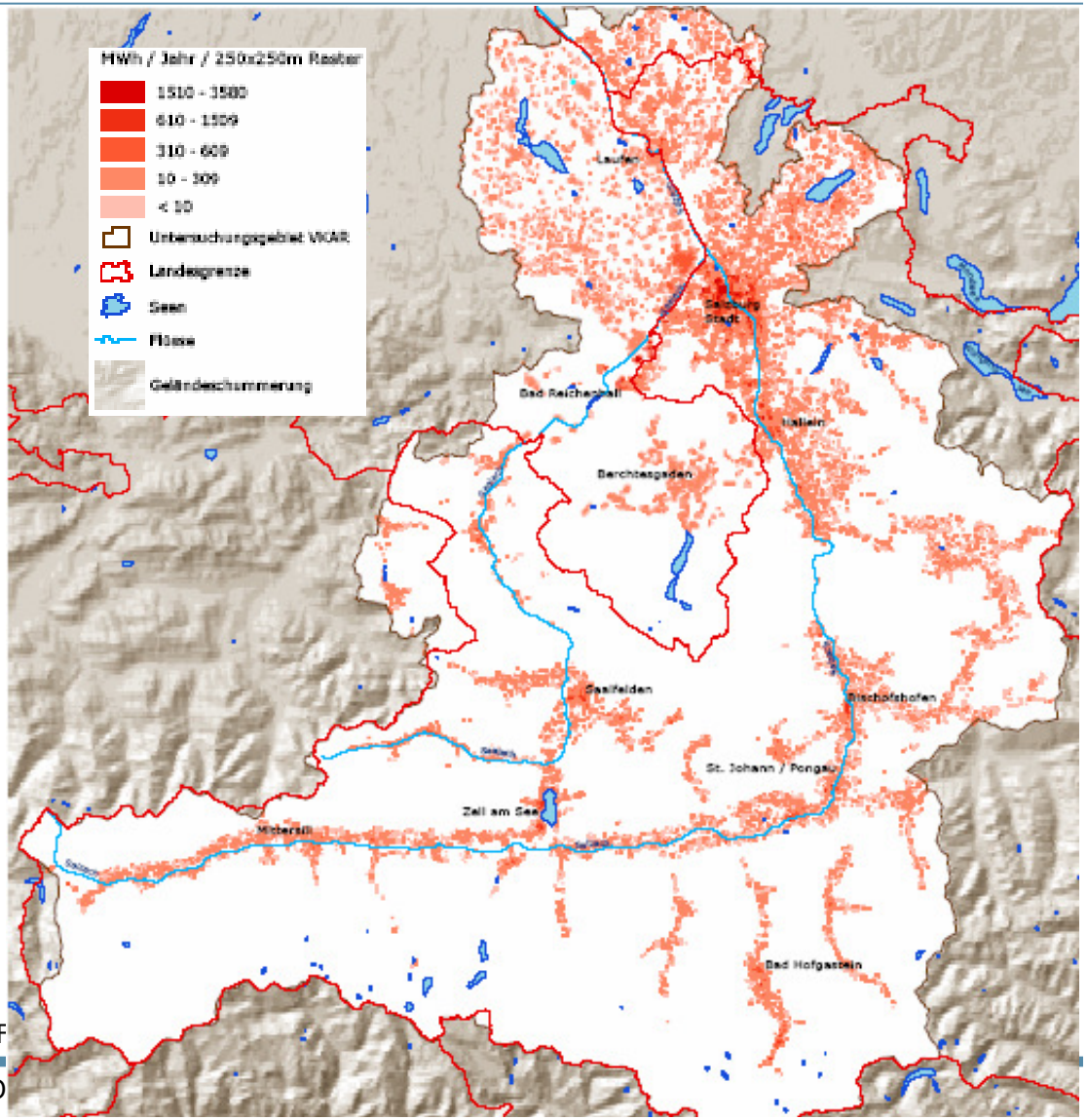
- Demographics
- Business data
- ...

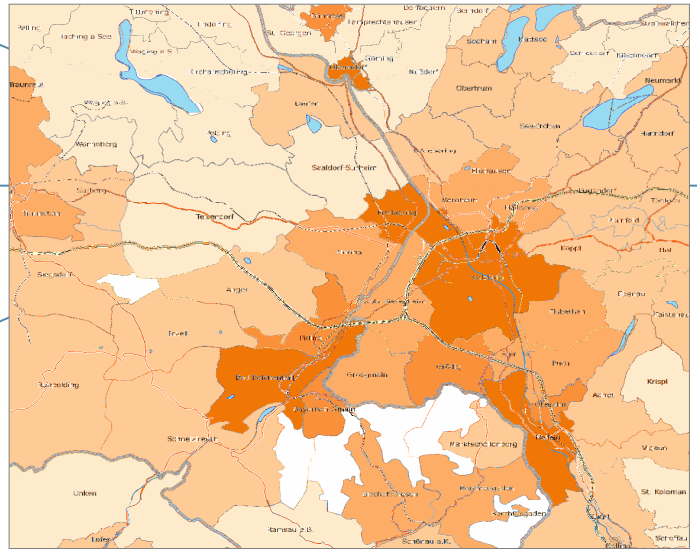


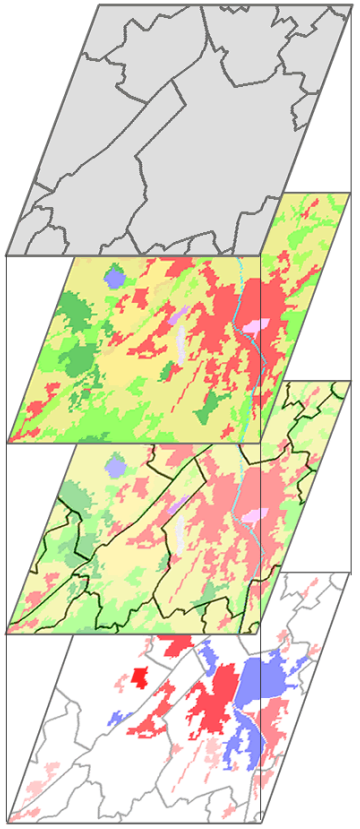
Demand / Load Modeling

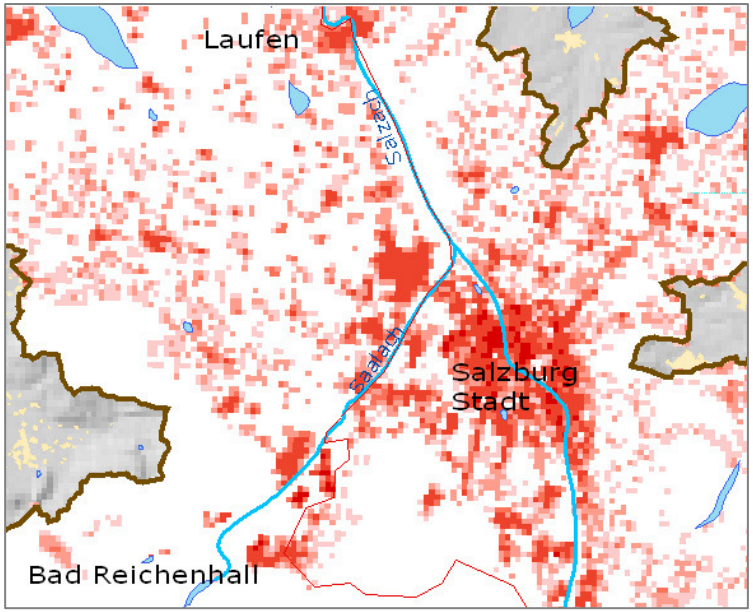


Demand from Households (~1 TWh/yr)



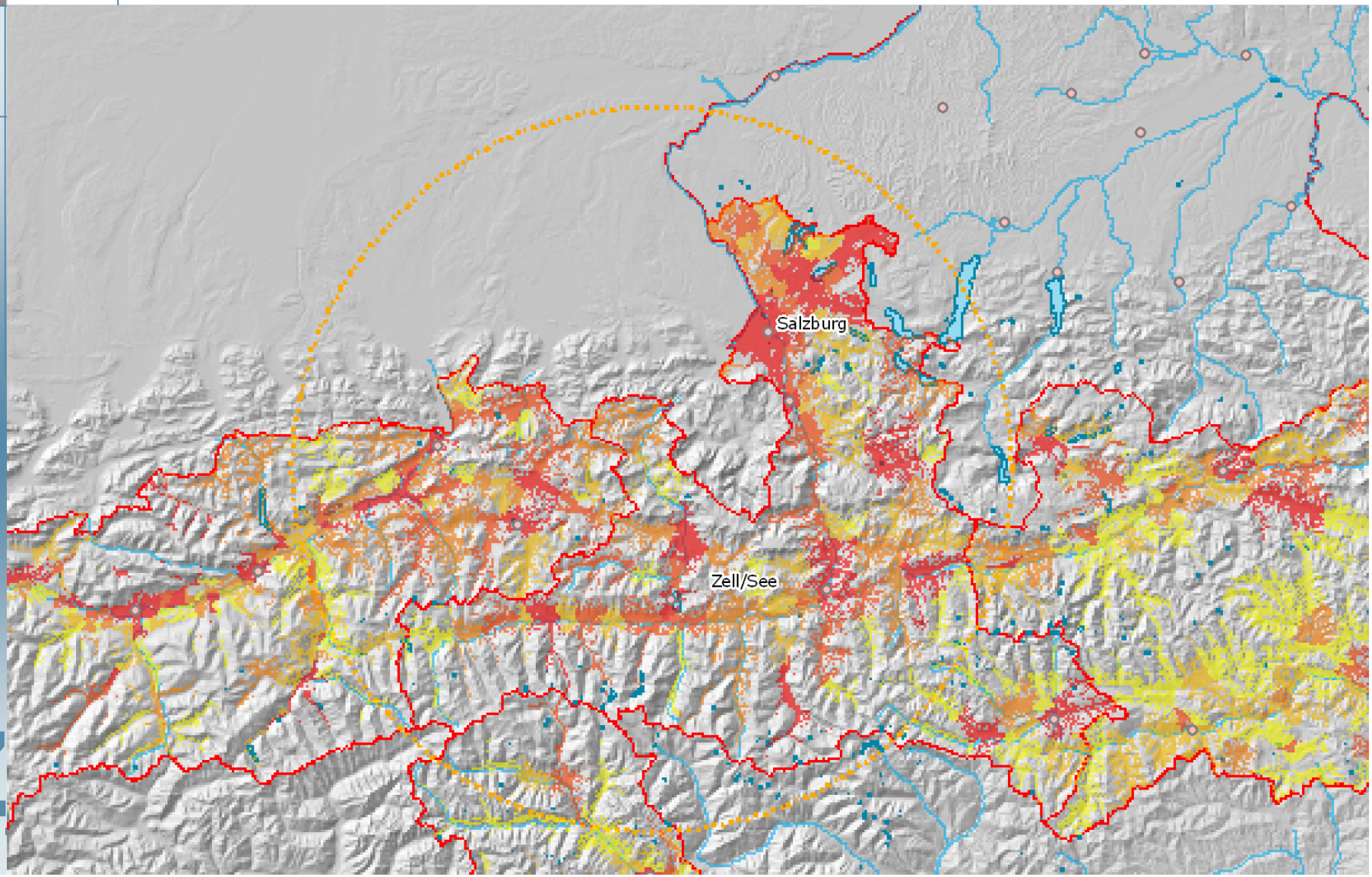


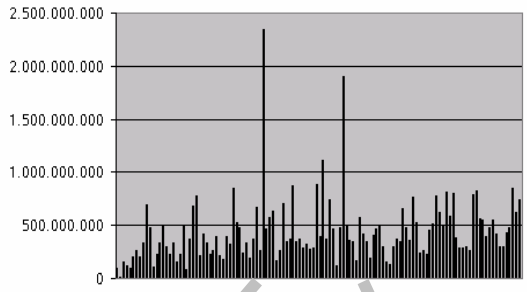

Admin. Grenzen
Landnutzung
Verfeinerung
Disaggregation
kategorisierter
Siedlungsraum

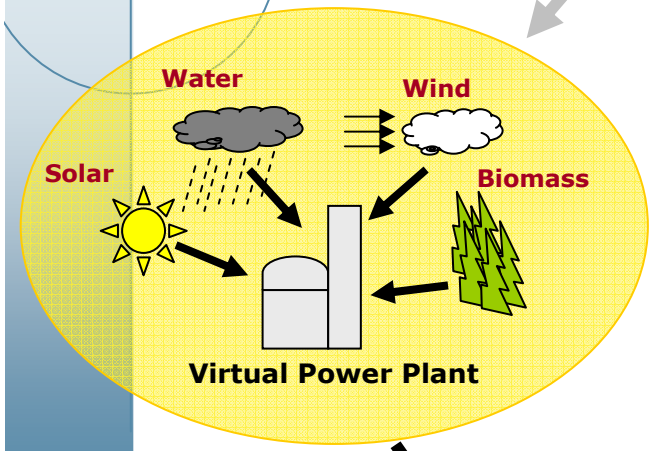

Laufen
Salzach
Salzburg
Stadt
Bad Reichenhall

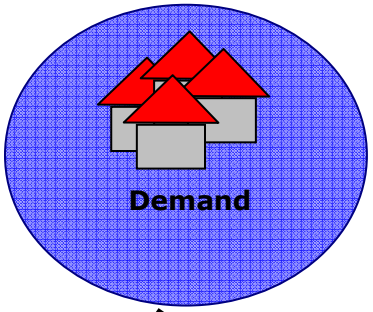
Universität Salzburg

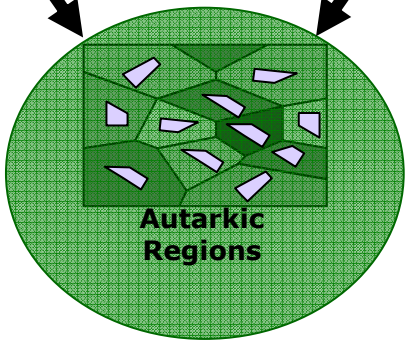
Demand forecast

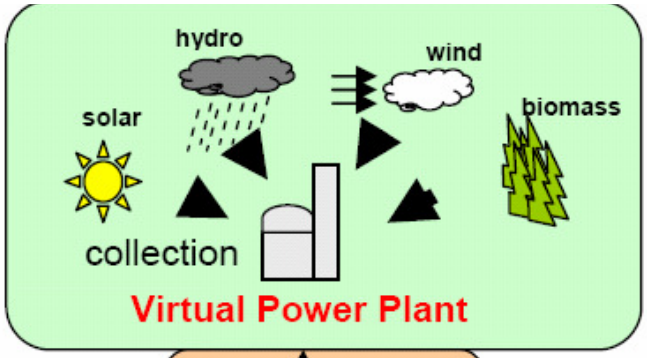


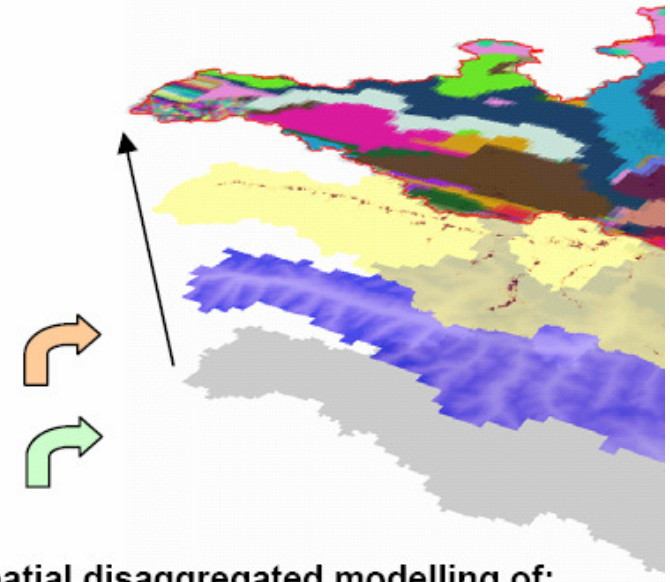








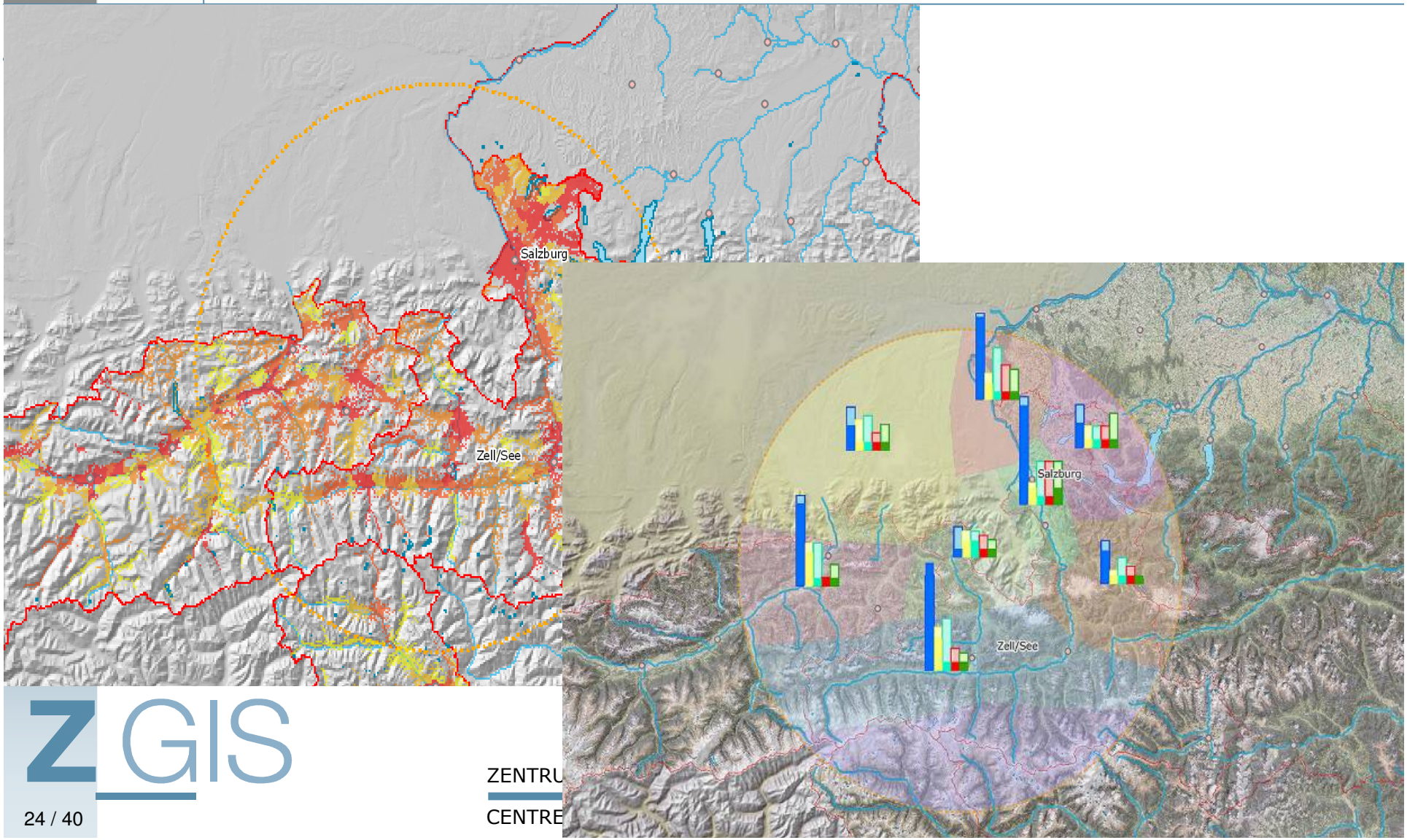




Spatial disaggregated modelling of:

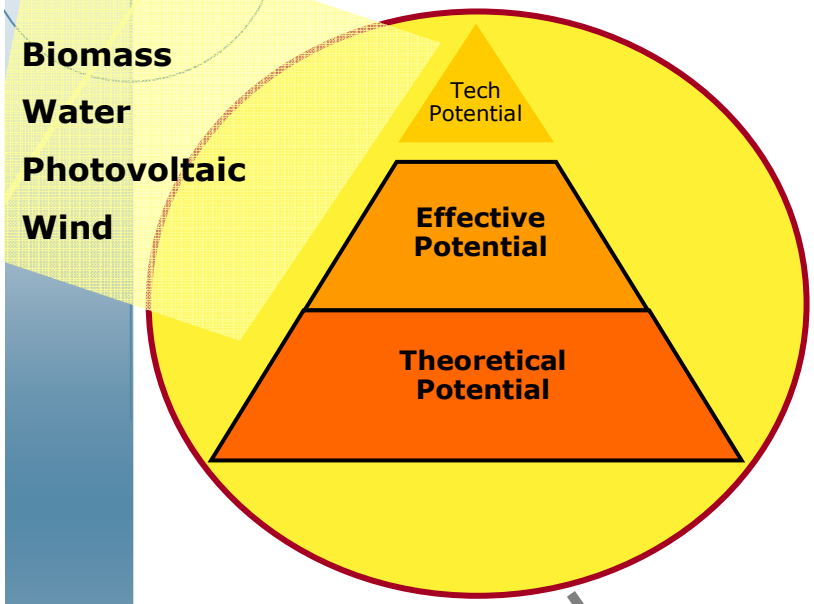
- Solar power potential
- Wind power potential
- Hydro power potential

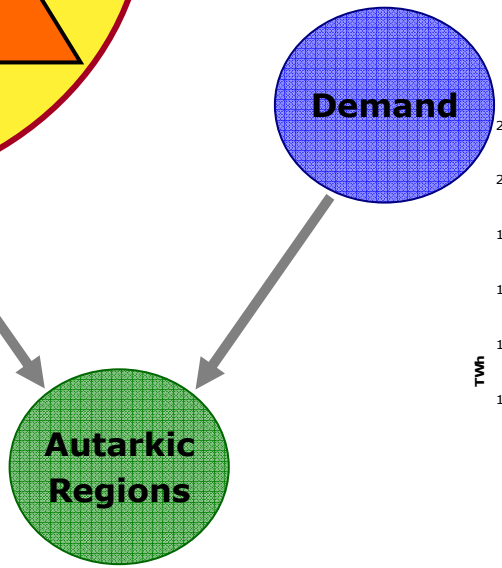
Virtual Power Plant

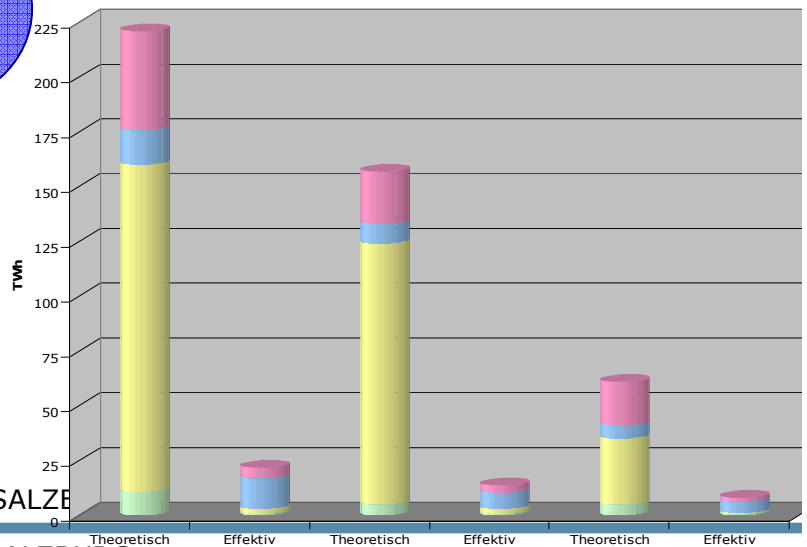


Generation Potentials

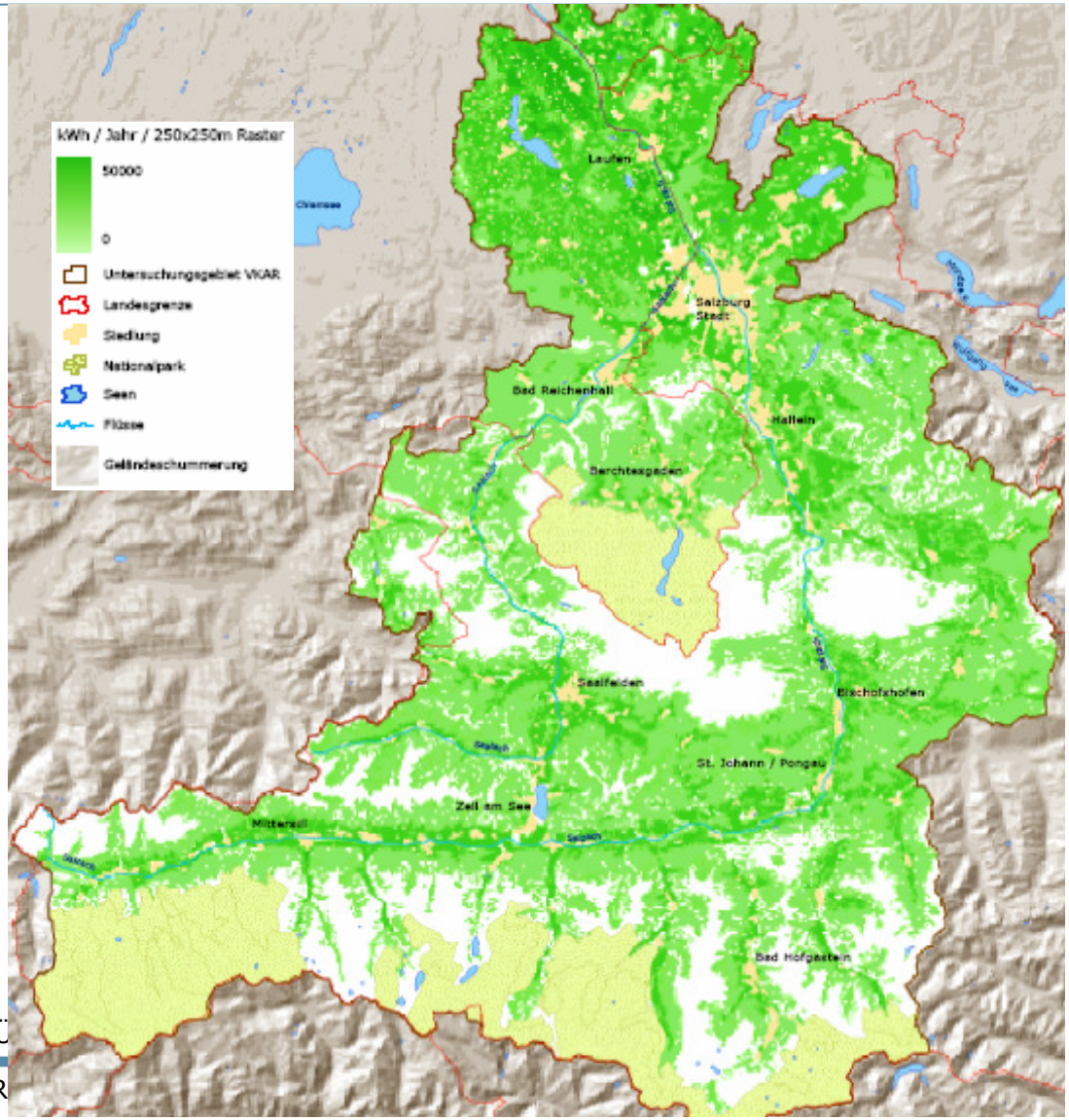
- Theoretical
- Effective
- Technical Potentials







Effective Biomass Potential (~1 TWh/yr)



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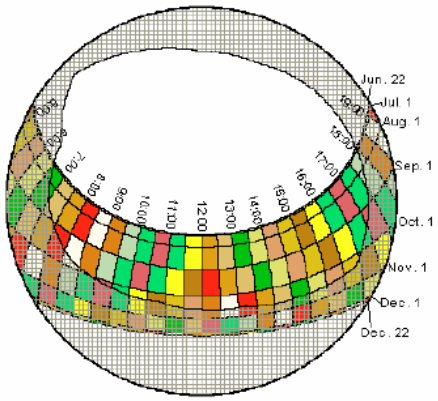
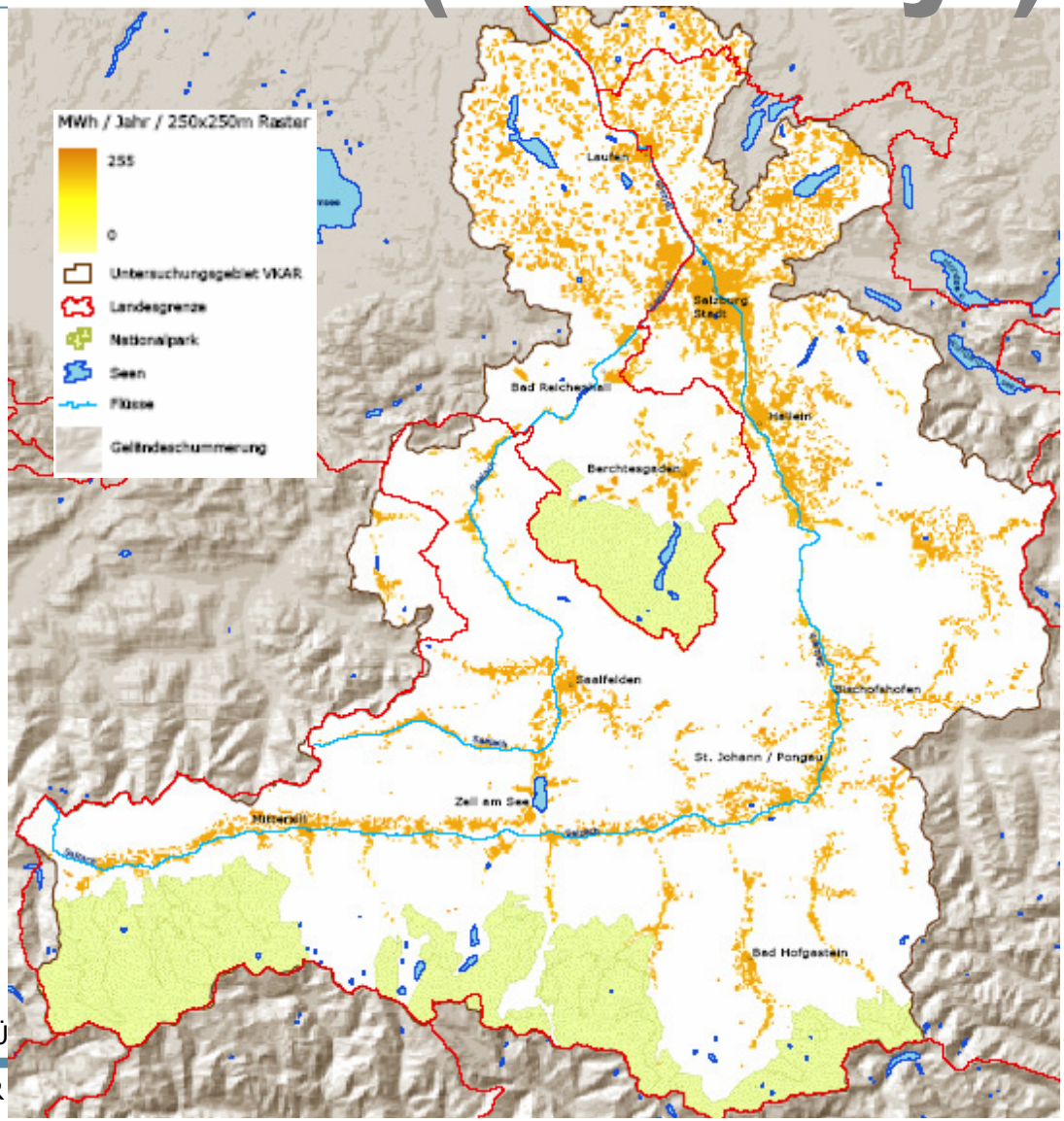
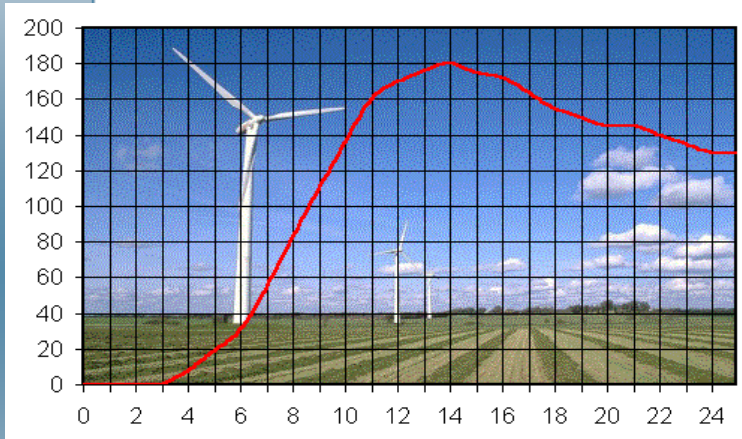
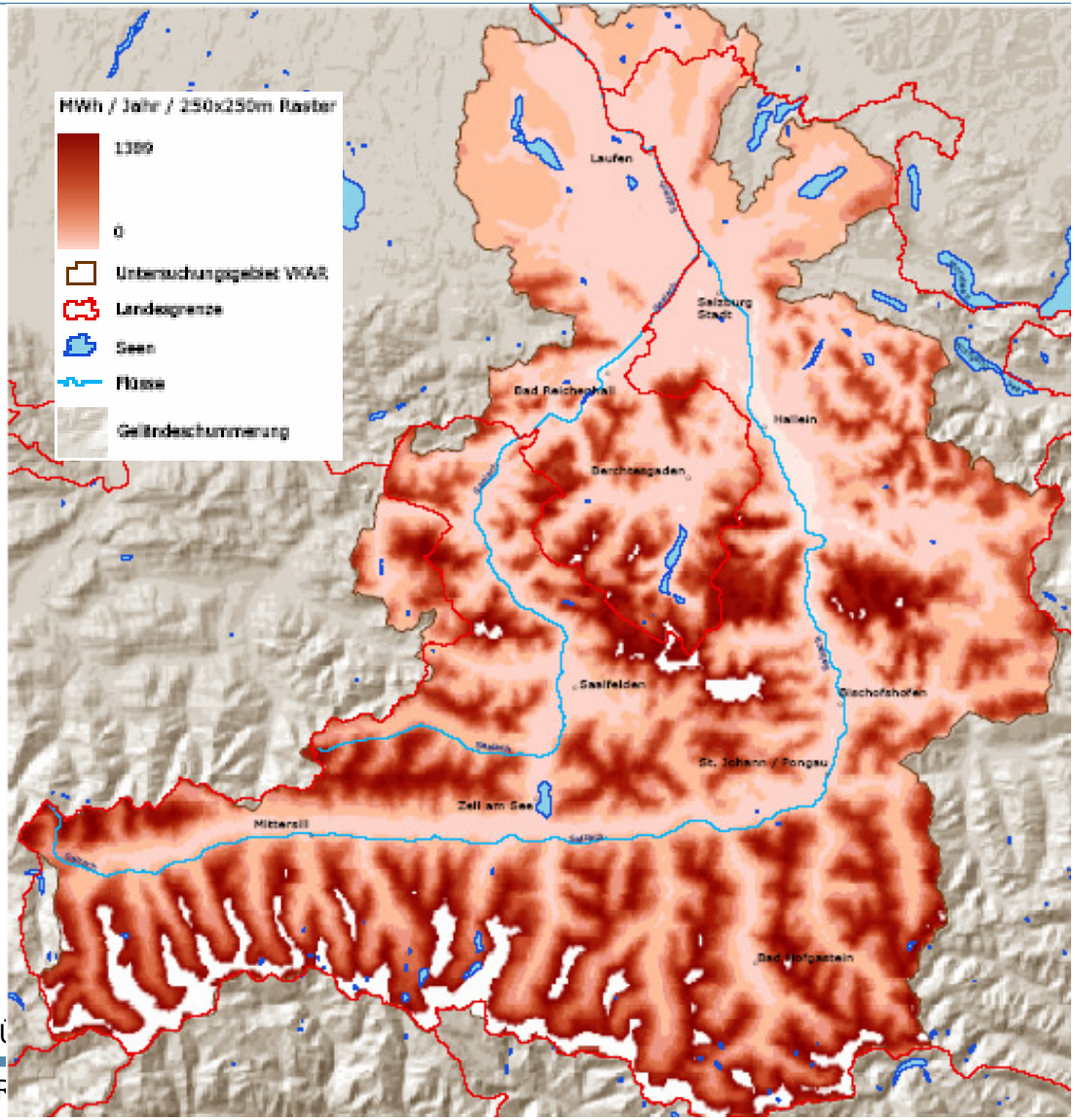
Effective Photovolt Potential (~2 TWh/yr)





Effective Wind E. Potential (~45 TWh/yr)





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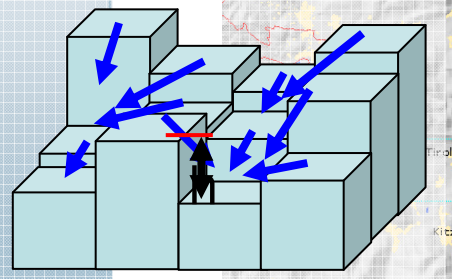
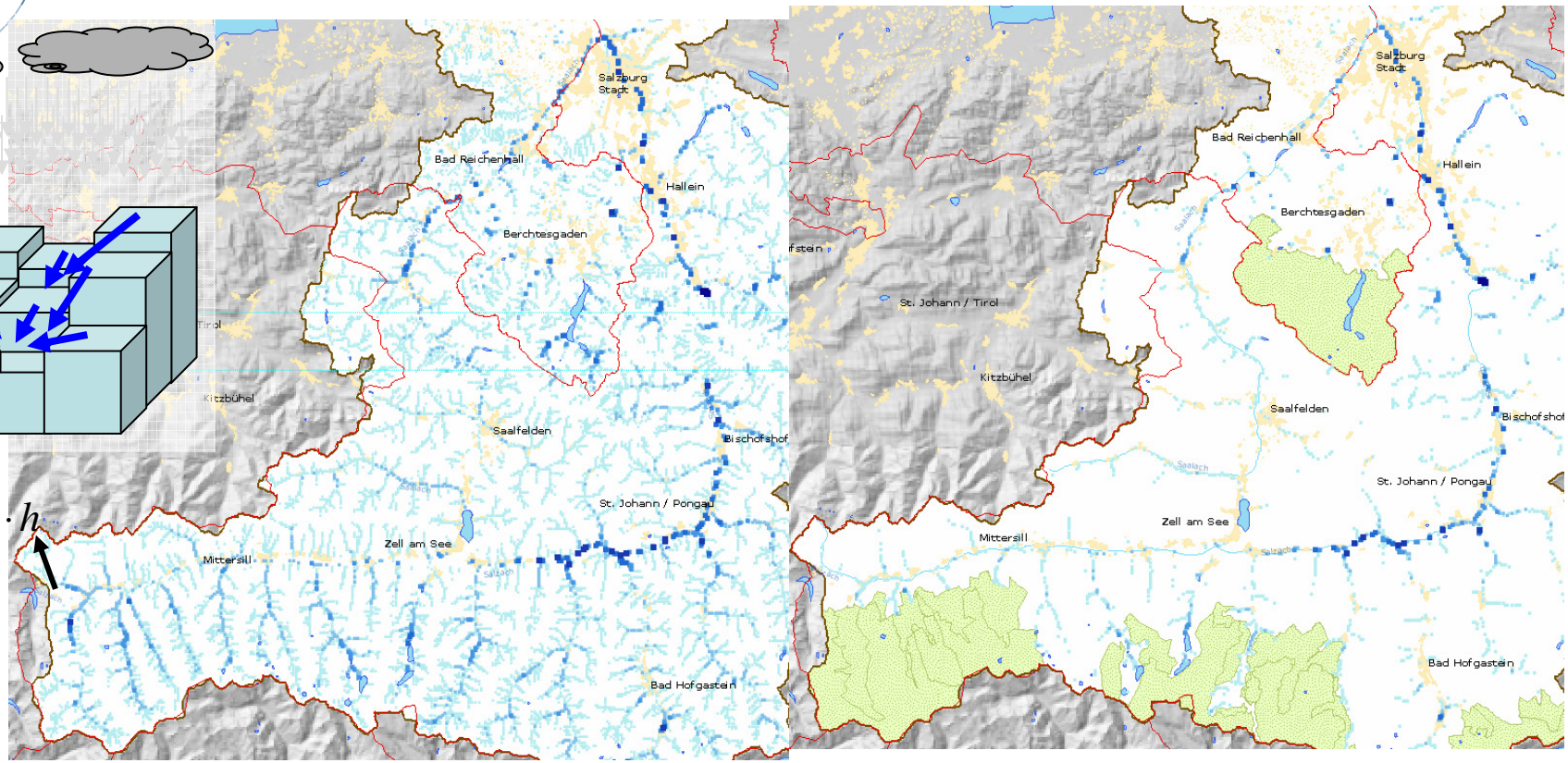
Hydropower Potentials

Theoretisches Potential (16,6 TWh)

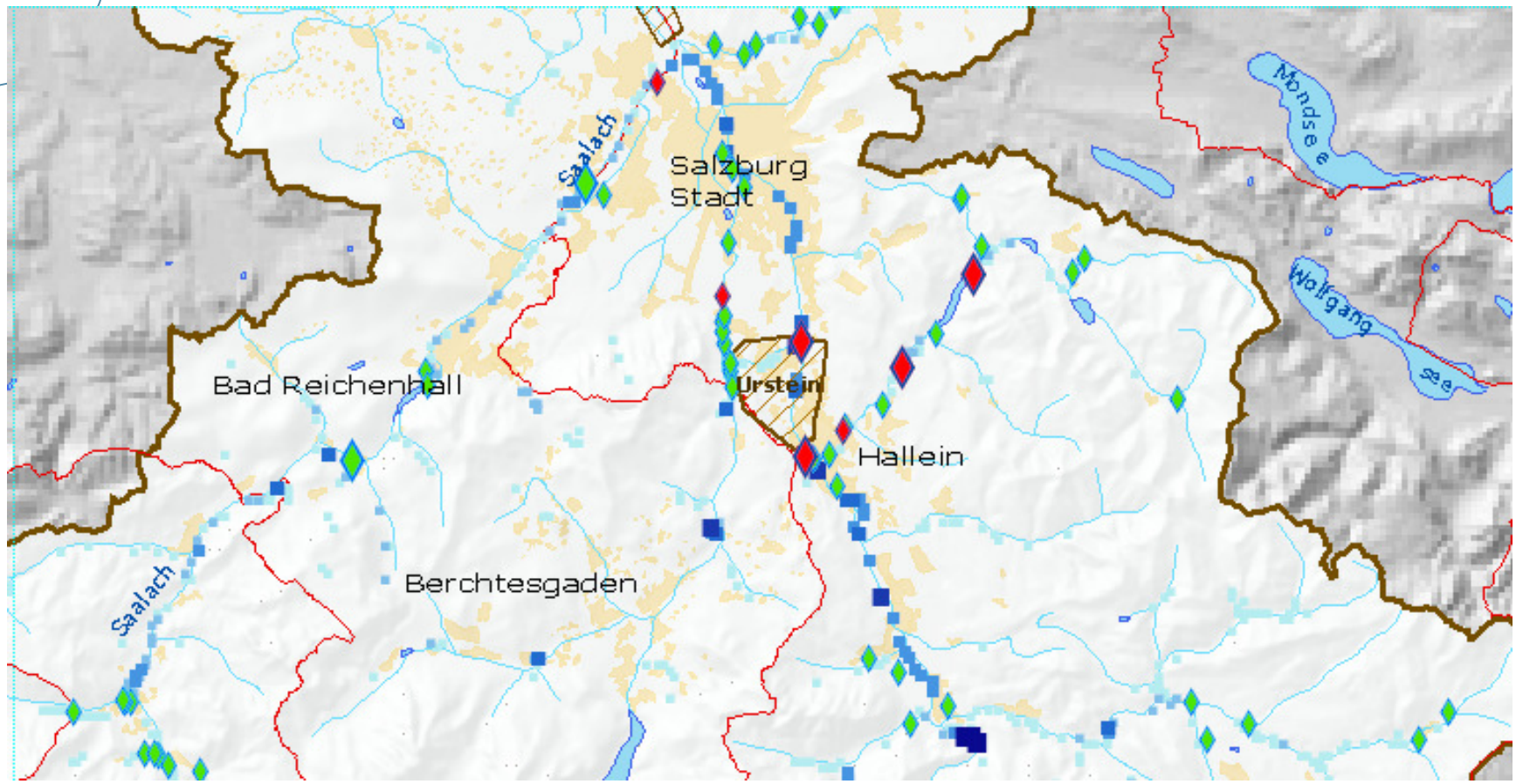


$$E = V \cdot \rho \cdot g \cdot h$$

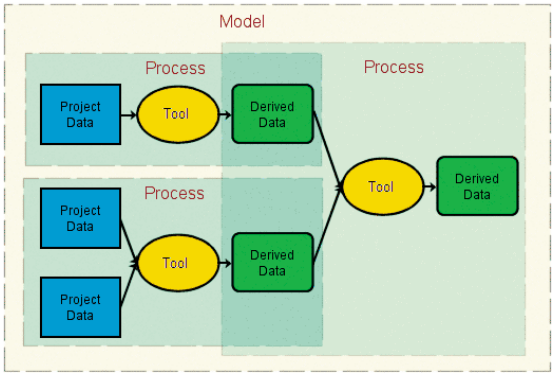
Effektives Potential (10.1 TWh)

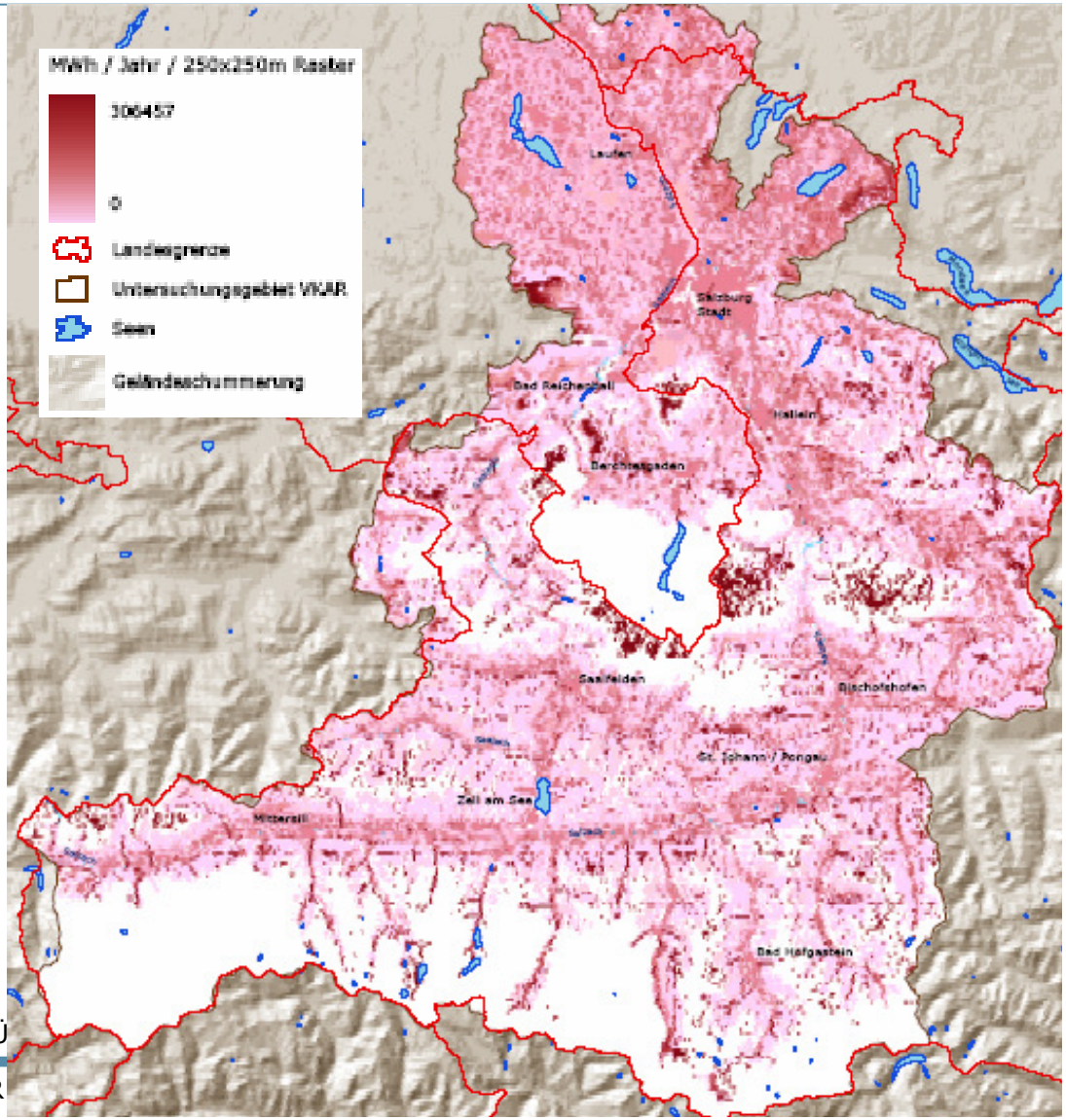


Hydropower: Site Selection

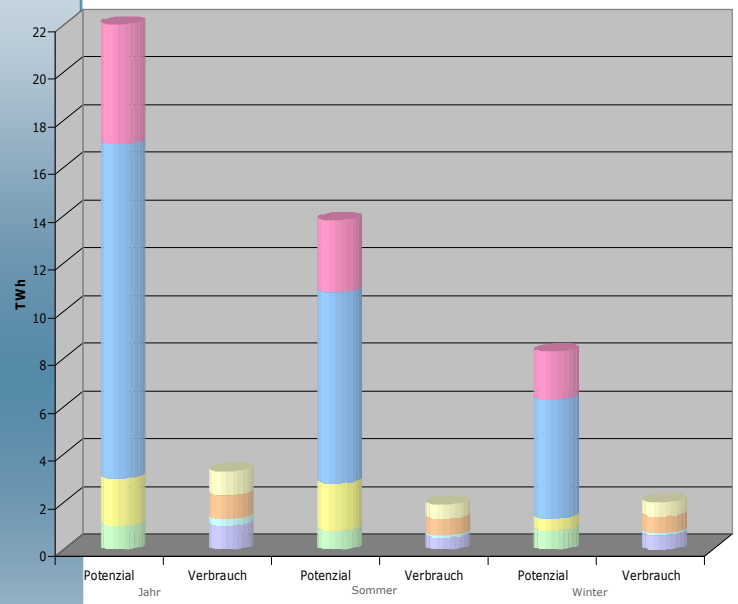


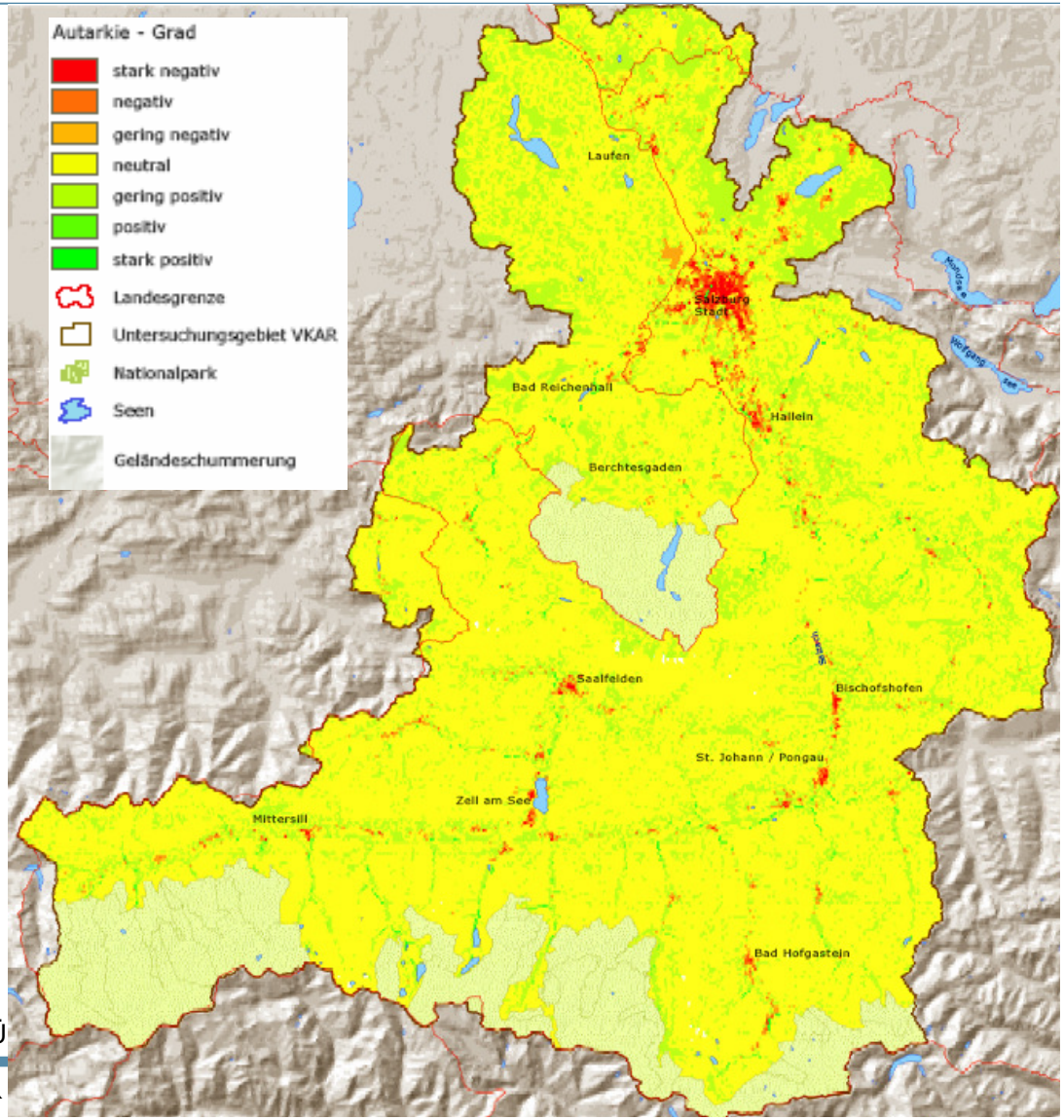
Total Effective Generation P. (~22 TWh/yr)



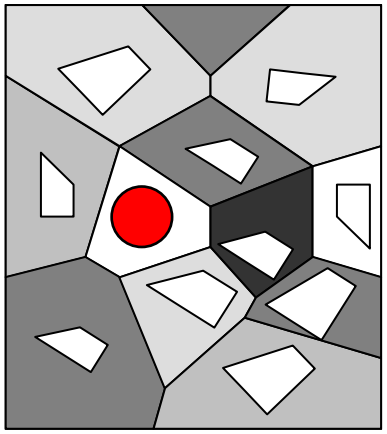


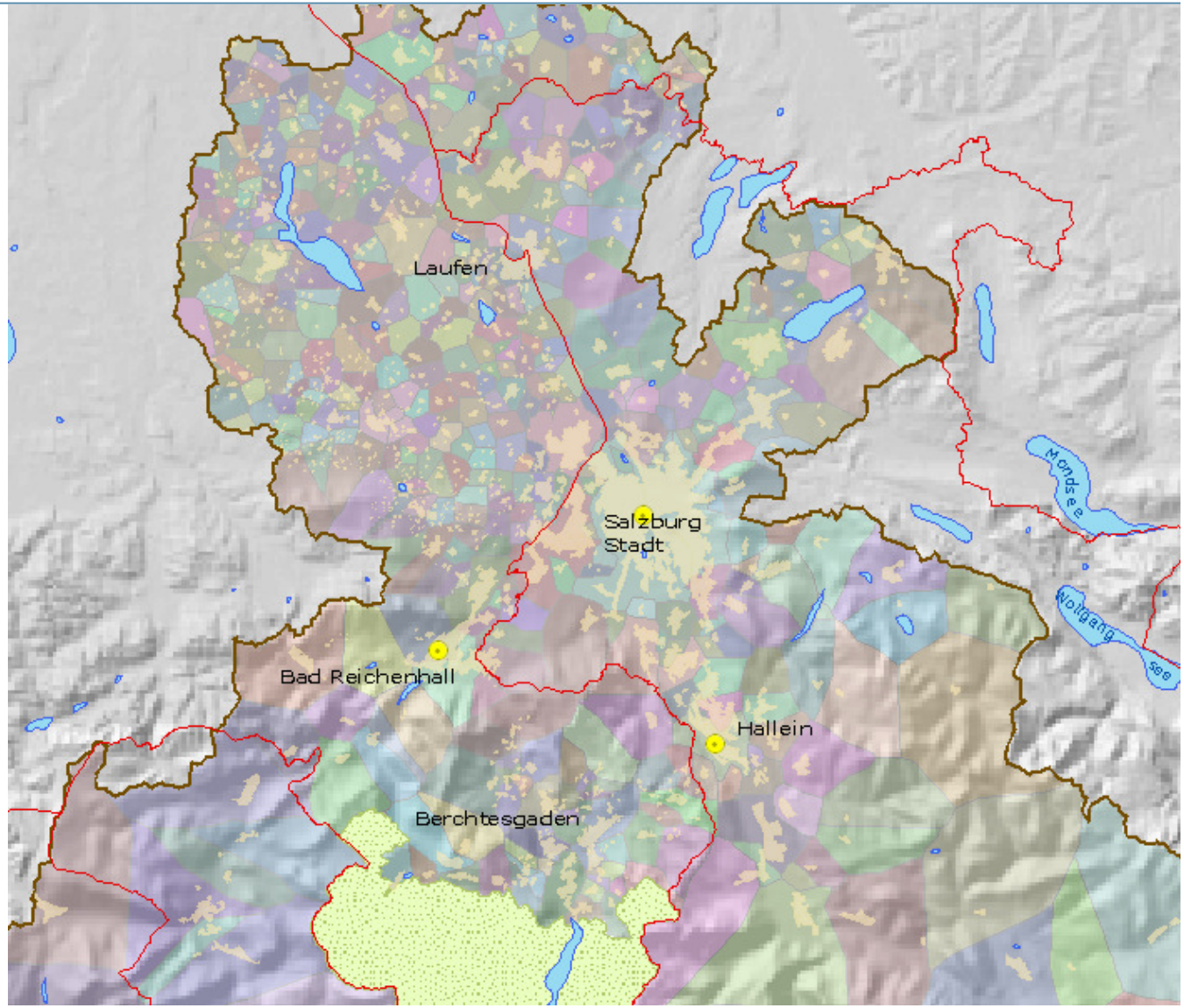
Regionalized Energy Balance



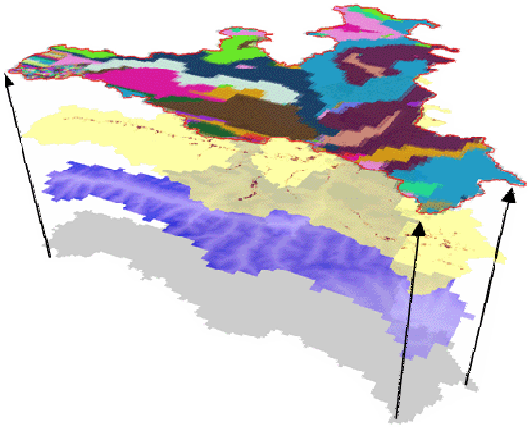


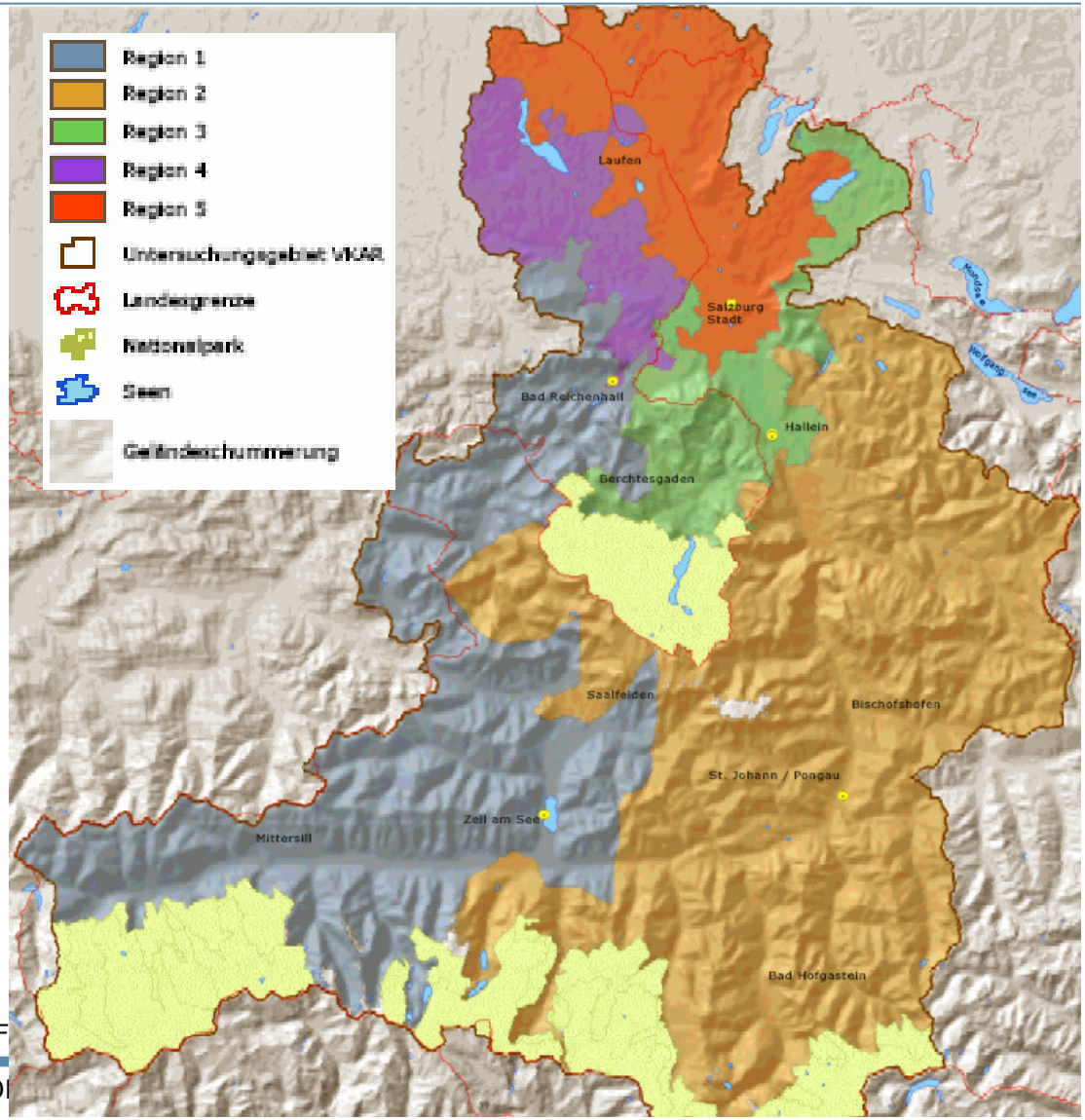
Region Growing Strategy





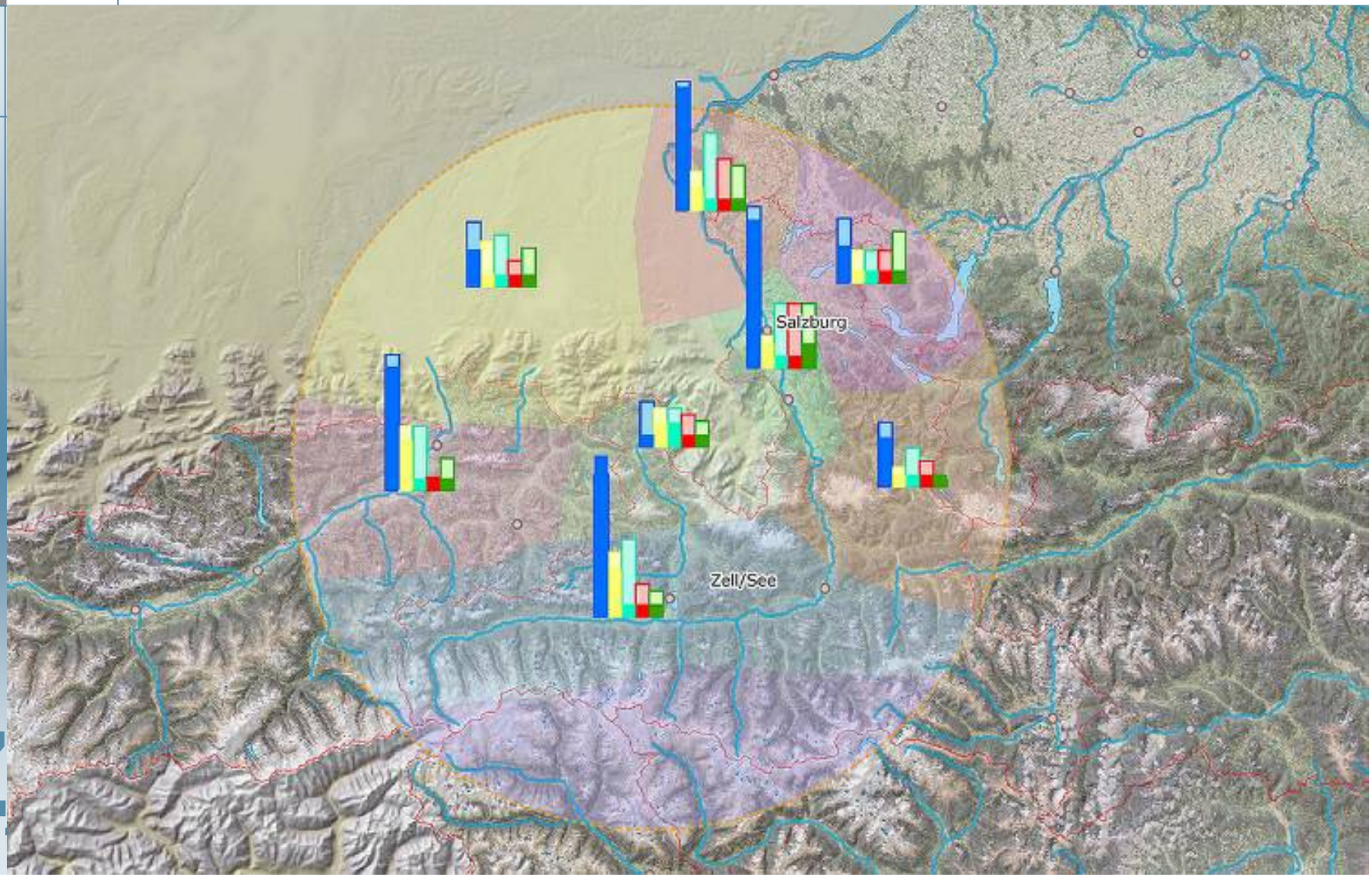
Autarkic Regions

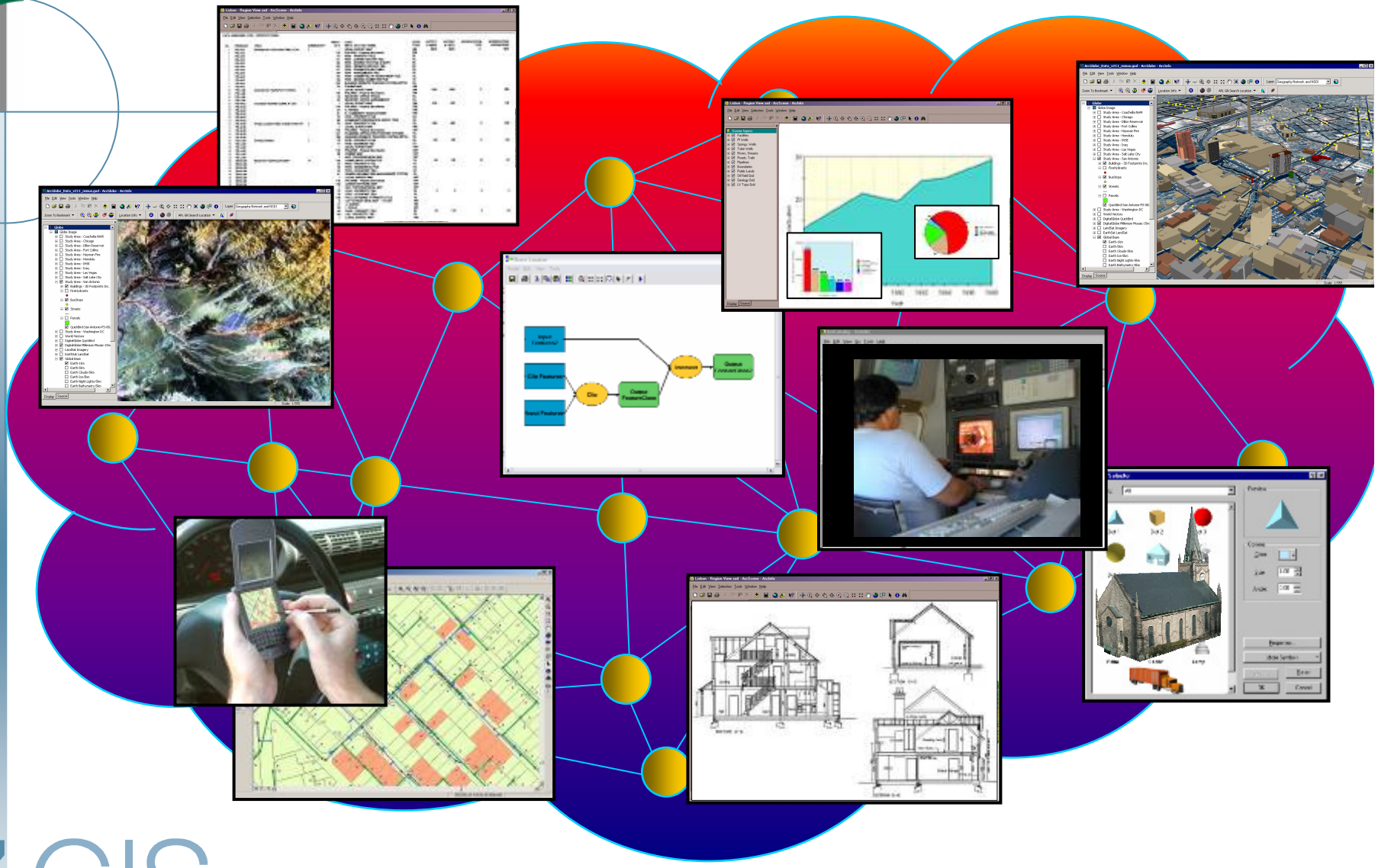




Universität Salzburg

Renewable Energy Sources



Conclusions / Directions

- **Sustainable supply of energy is a local responsibility = distributed generation**
- **Temporal balancing is more challenging than totals**
- **Grid: from long-range transmission to intra- und inter-regional balancing**