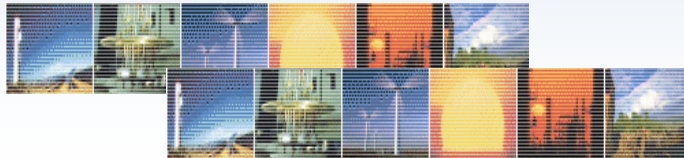


The connection of TIMES with GIS

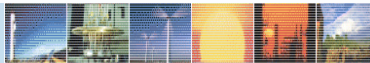
Markus BIBERACHER

ETSAP Workshop 2005, Oxford



Content

- Why is GIS important in that context?
- TIMES and the access to GIS
- Union: GIS – Energy Models
- GIS Interface
- Global link scenario
- Conclusion

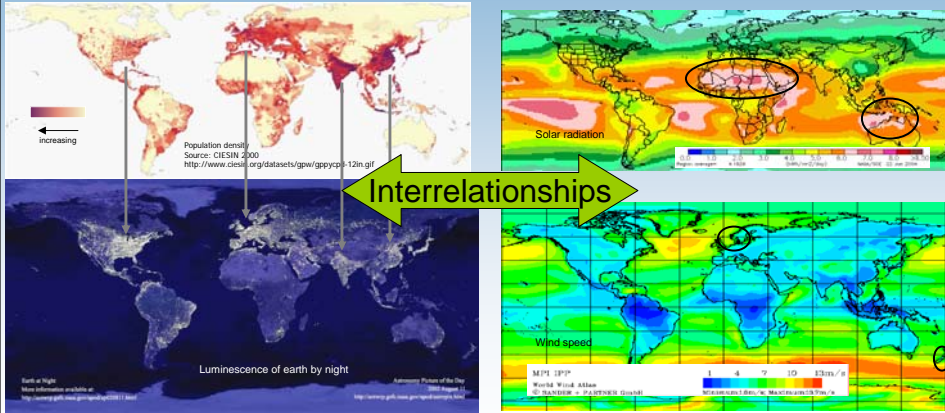


Motivation

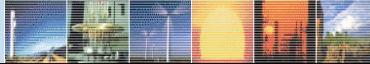
Energy demand and supply show a strong geographical dependence:

Needs

Supply



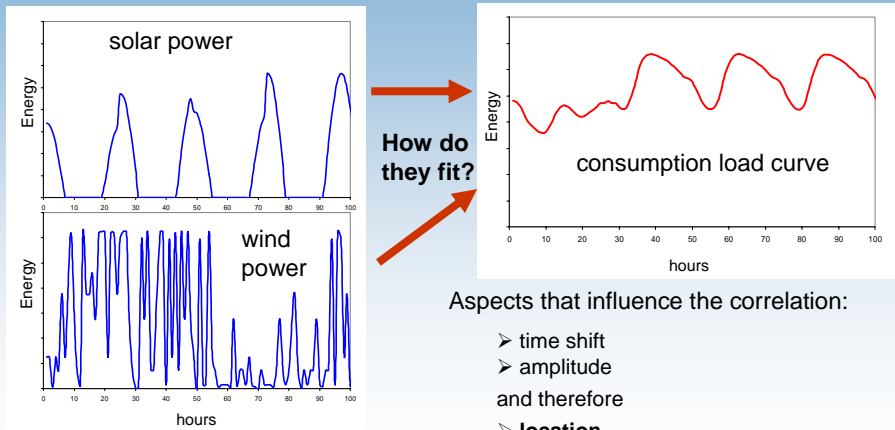
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Renewables

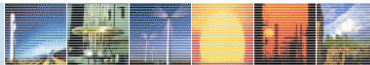
Characteristical load curves for:



Aspects that influence the correlation:

- time shift
- amplitude
- and therefore
- location

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TIMES

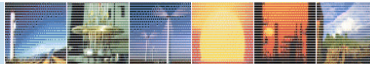
... the TIMES model aims to supply energy services at minimum global cost (more accurately at minimum loss of surplus) by simultaneously making equipment investment and operating, primary energy supply, and energy trade decisions, by region.

Common modelling aim:

Long-term forecast for dynamics in energy systems based on macro economic decisions.

Intended modelling aim:

Optimal system buildup under competition constraints due to different location depending process behaviour.



TIMES and regionalization

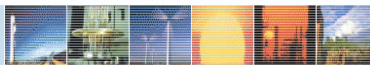
.. Optimal system buildup under competition constraints due to different location depending process behaviour.



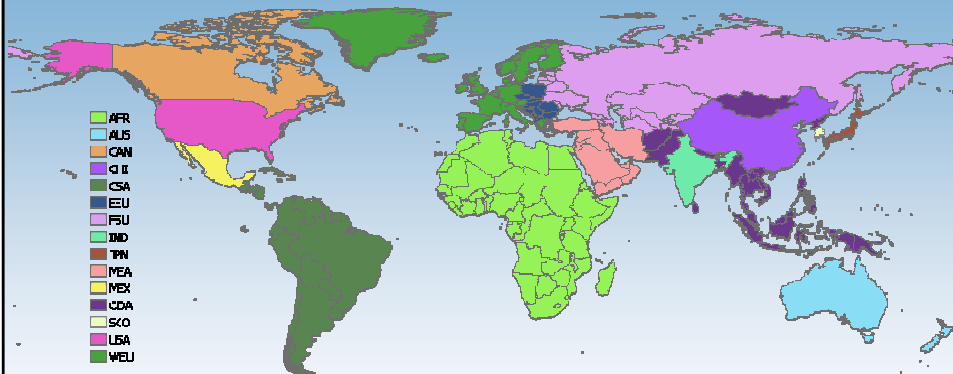
Its more or less already realized in the modelling of multi- regional energy systems



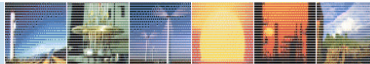
One example: EFDA 15 regions model



EFDA 15 Regions



- equal processes in different regions are described by region dependent parameters
- exchange between different regions is modelled by bilateral or multilateral trade



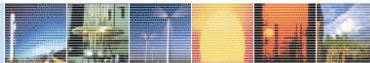
Union: GIS – Energy models

GIS (Geo Information System):

- spatial data concepts
- spatial modelling concepts
- ...

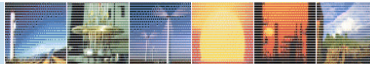
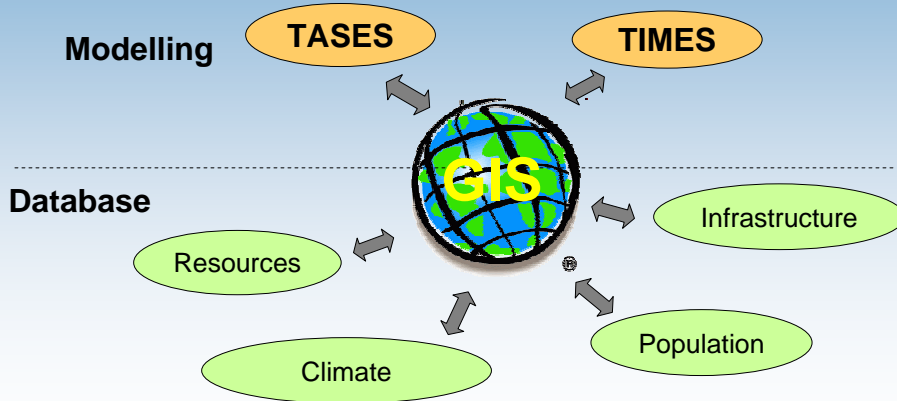
Energy system models:

- economical sketch
- market background
- technological input
- ...

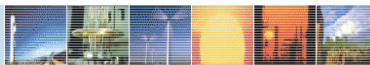
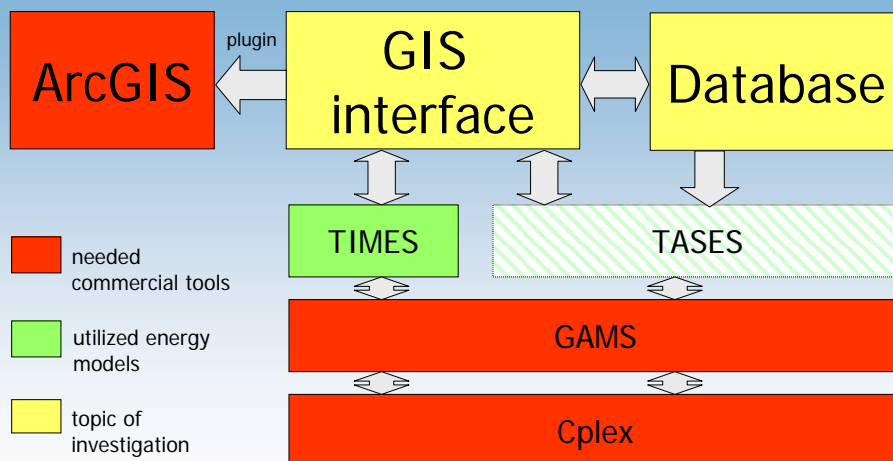


Intention

Joining GIS databases with energy system modelling issues in one common – GIS based – interface:

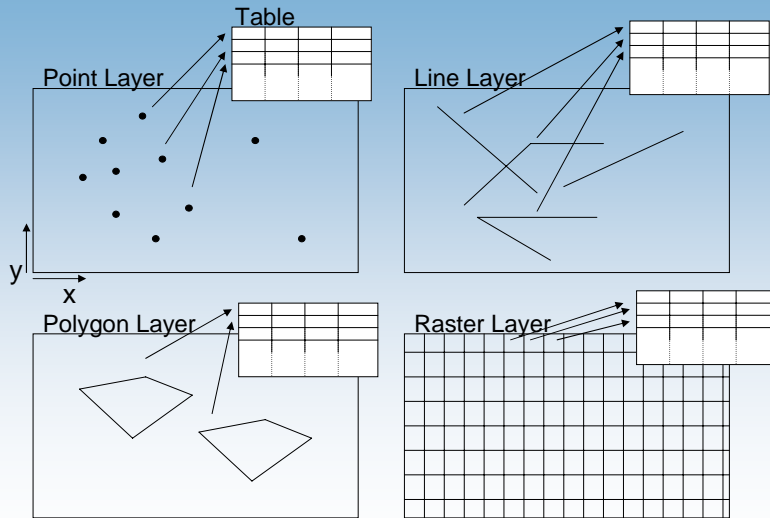


Implementation

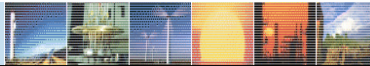


ArcGIS...

..is a software tool to administrate the following graphical data:



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GIS Interface

RES administration via ArcView

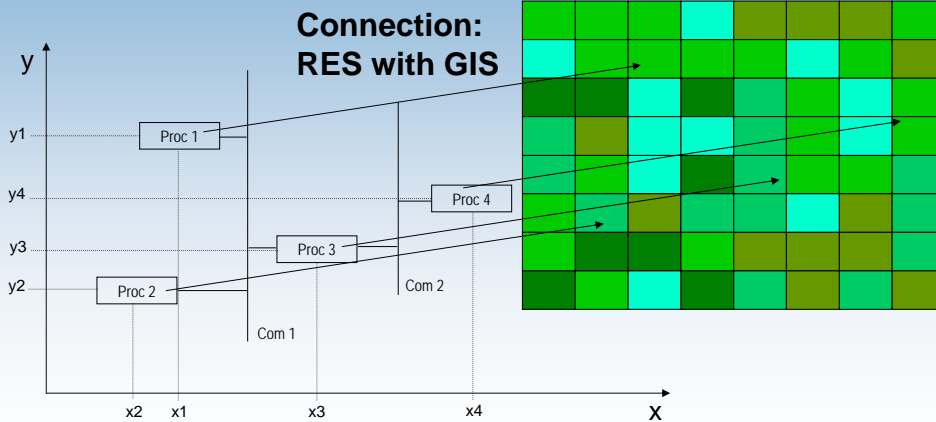
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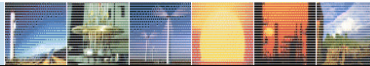
TIMES and spatial relations

What does this mean more in detail?

GIS dataset in background

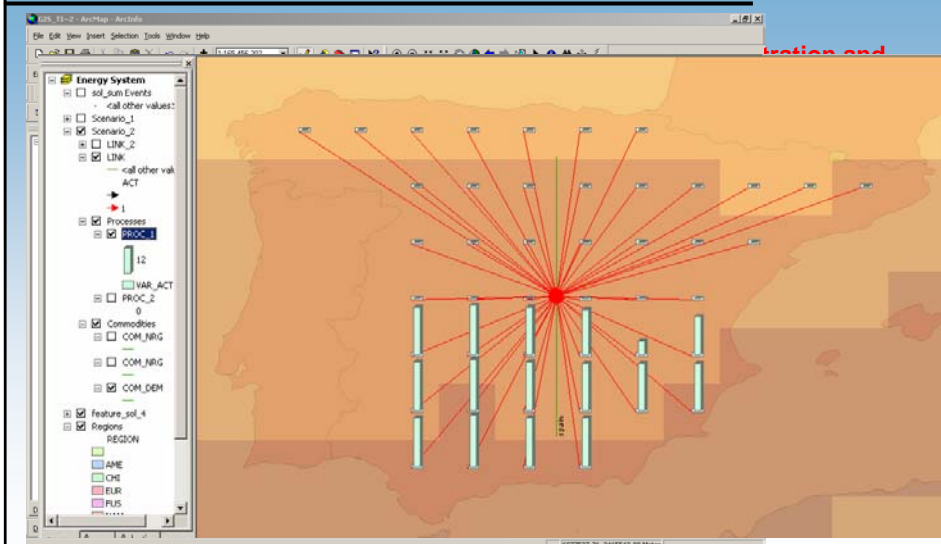


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GIS Interface



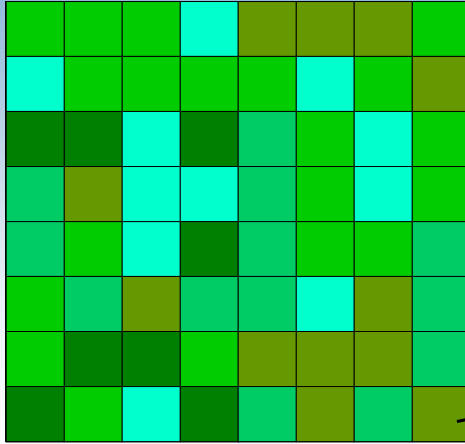
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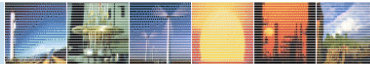
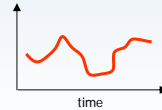
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Preparation of GIS datasets

Therefore the preparation of datasets will be processed as follows:

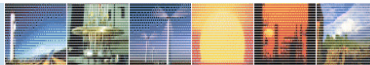
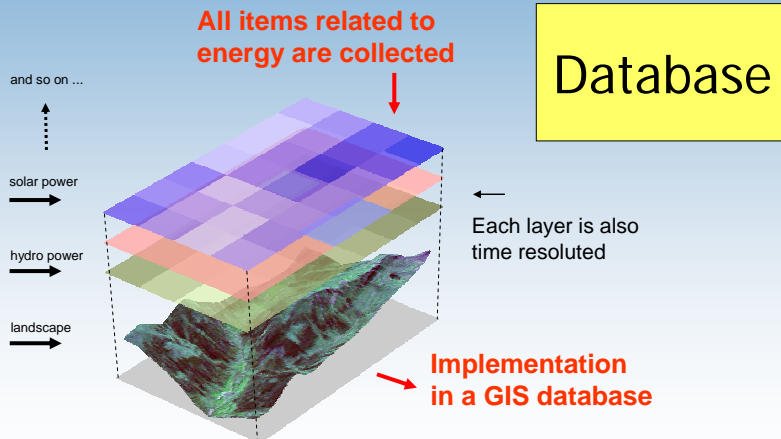


1. Depending on the modeling task the region of interest has to be chosen.
2. An useful grid resolution for data administration has to be chosen.
3. For this grid resolution the data has to be processed – based on existing data and reasonable model assumptions ..
4. .. including the necessary time resolution.

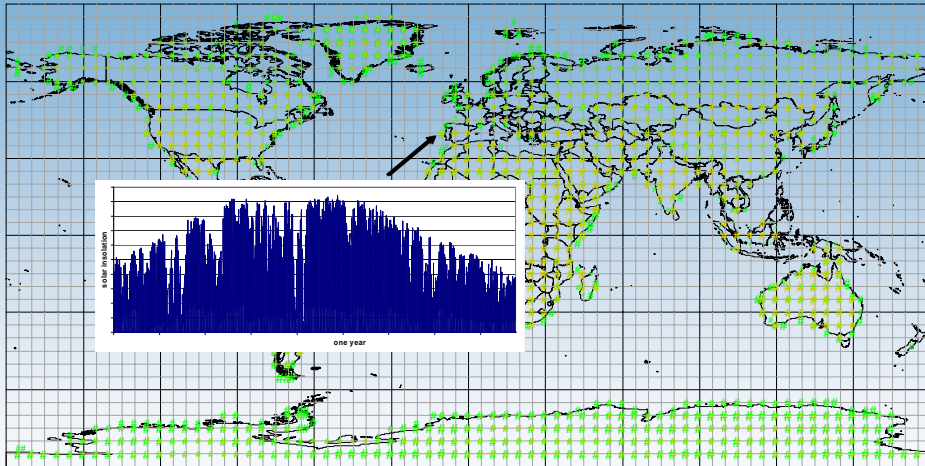


Implementation of database

All potentials, consumptions and other relevant parameters are collected in single raster datasets with a predefined equal cell size.

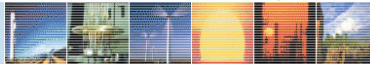


Global datasets



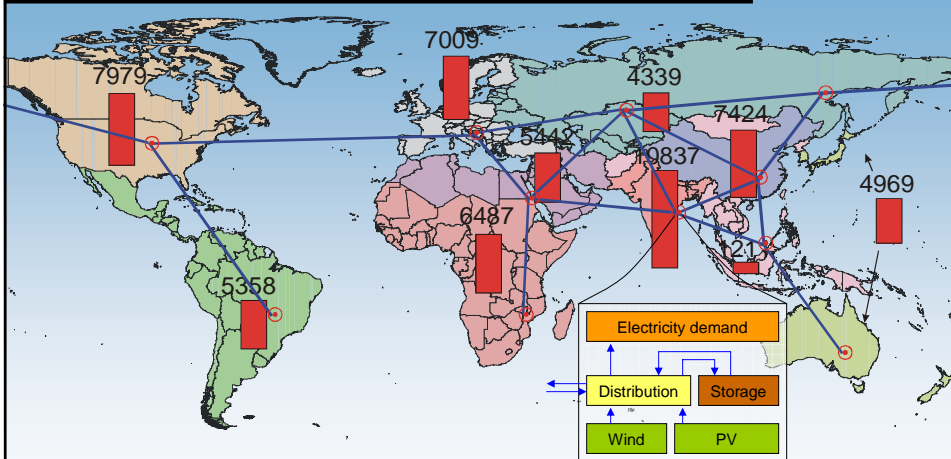
- Resolution: 5° x 5° grid pattern
- 6 hour values for wind velocities (gained from World Wind Atlas)
- 1 hour values for solar radiation (processed from NASA daily average values)

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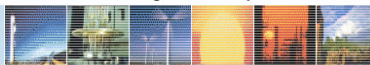
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Global link



- world is divided in several regions
- each region is represented by an annual electricity consumption in TWh
- each region is connected to its nearest neighbours by transmission lines

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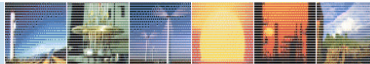


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Global link

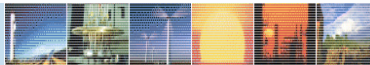
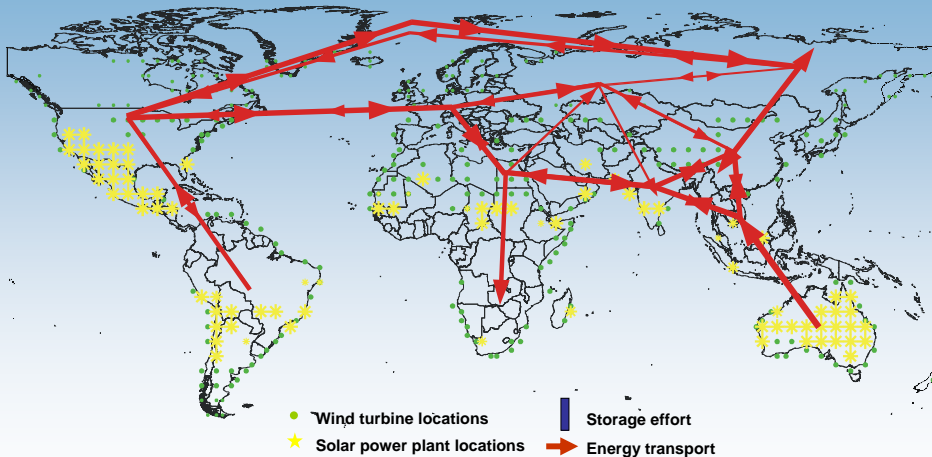
How would a system solution look like, if only solar and wind power are available to cover the global electricity consumption?

Objective function: **Minimal System Costs**



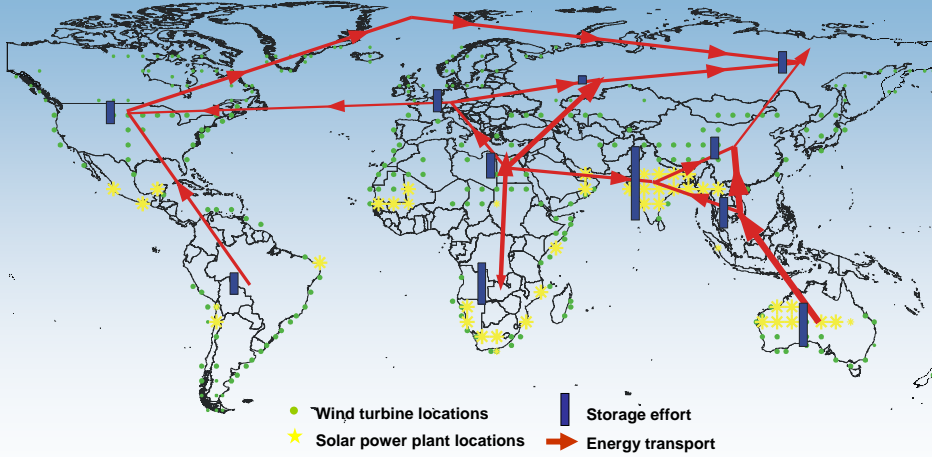
Global link

... no storage facilities available



Global link

... storage available and expensive



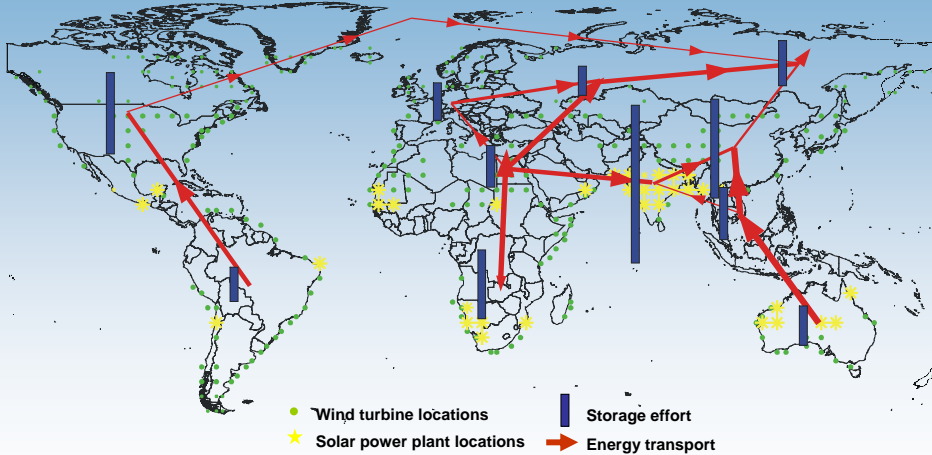
Ciemat



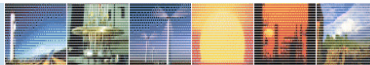
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Global link

... storage available and cheap



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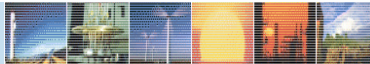
Global link

Aspects that have to be considered:

- favoured plant locations are strongly dependent on **ALL other** scenario settings
- high potentials of renewable energy sources are in general not near to high potentials of consumption
- time shift on a day/night and seasonal scale are of great impact

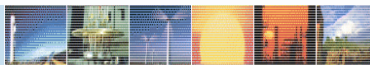


Geographical impacts are of major importance !!!



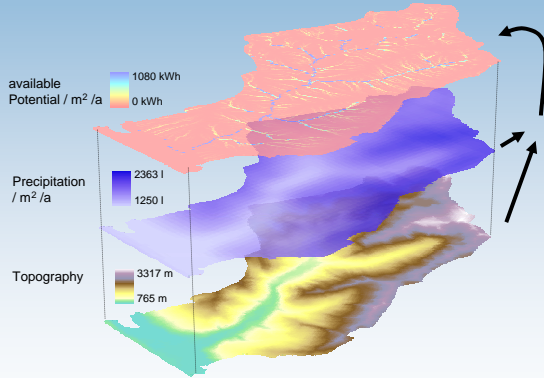
Conclusion

- Geography is the main driver in the task of modelling future energy systems;
- Intention to couple **energy system models like TIMES** with **GIS** and corresponding databases;
- .. and therefore enlarge the modelling range by geographic relations;
- one global linked scenario as example;

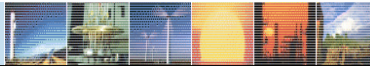


Hydro power dataset

Example: Valley in the alps

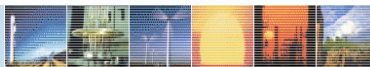
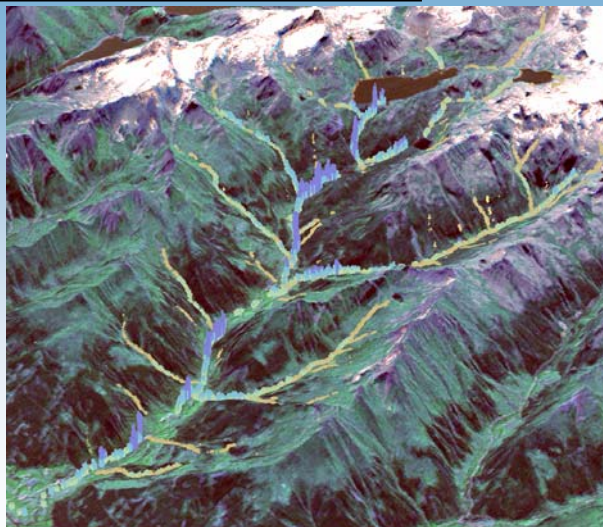
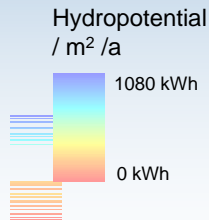


Based on the knowledge of topography and spatial resolved precipitation the spatial resolved hydro power potential can be estimated.



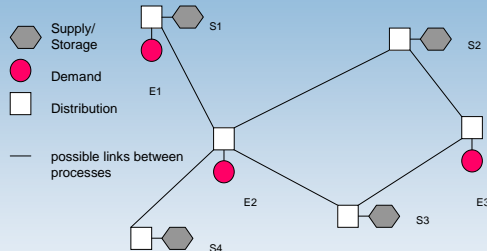
Hydro power dataset

3d - visualization



TASES Model

Time And Space resolved Energy Simulation



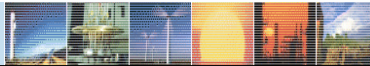
Based on this structure TASES provides the following features:

1. **Simulation of time resolved flows between each two linked processes – based on an assumed heuristic.**
2. **Linear optimization of the complete system cost.**

The TASES model administrates processes and possible links between two processes and all that with an arbitrary time resolution.

Constraints:
Demand assumptions, potential restrictions

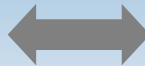
Constants:
specific process costs



TIMES and TASES

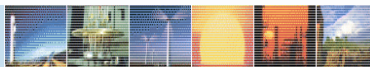
TIMES

- economical background
- energy markets
- market sensibilities
- forecast



TASES

- geographical background
- load dependencies
- best fit

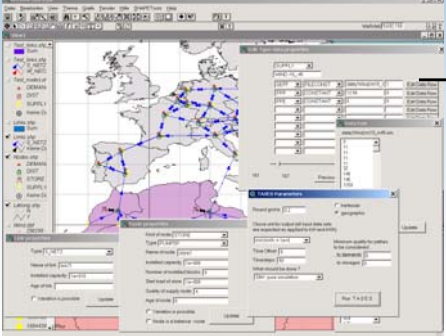


GIS Interface

GIS interface

Data input via ArcView
(Input is supported by dialogs)

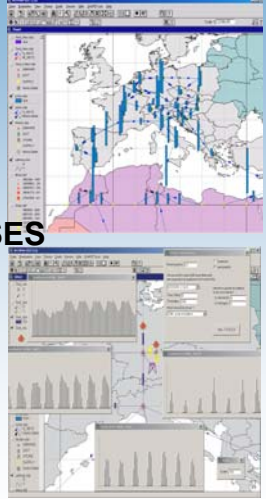
Data output via ArcView


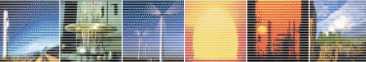


(geographic resolved output)

TIMES, TASES

(output of timeseries)

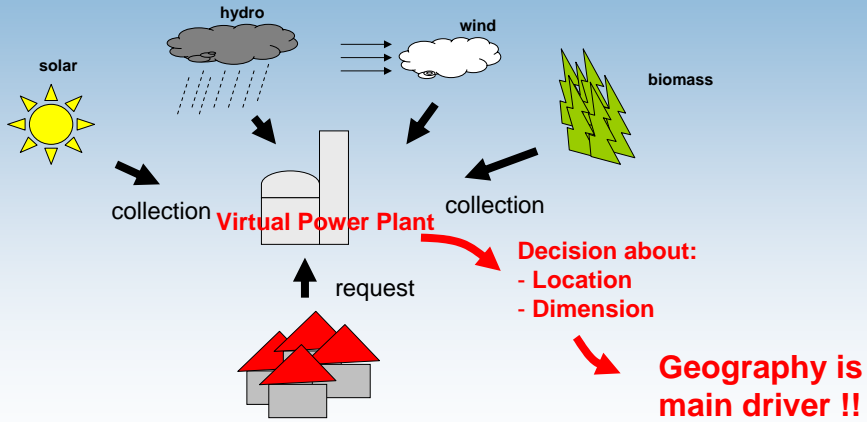



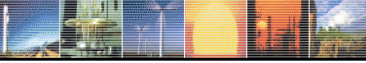



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Virtual Power Plant

Related to this database a 'Virtual Power Plant' is understood as follows:



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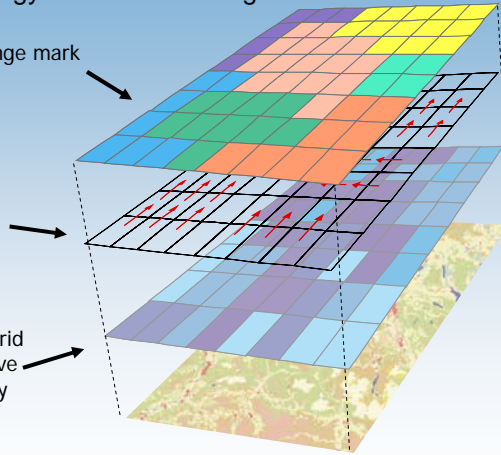
Project: VPAR

Virtual Power Plants across Energy-Autonomous Regions

Neighboring cells without energy exchange mark possible cluster bounds.

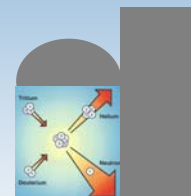
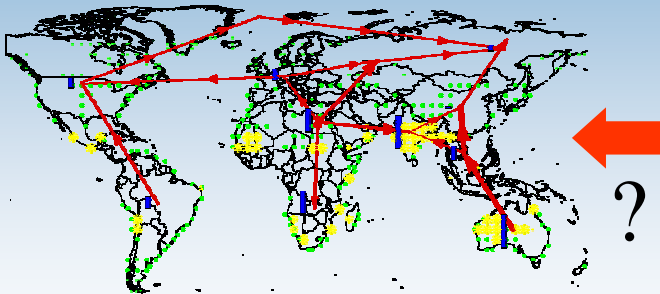
A balance function, that describes a flow between positive and negative cell values, that compensate for all „request“ cell values, is accepted as feasible system solution.

Based on the geographical database a grid layer is calculated with cumulated positive (energy potentials) and negative (energy needs) cell values.



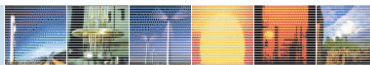
Project: FUSGLOB

How would fusion change the most competitive energy system solution without fusion?



Fusion power

Based on a multi regional model approach with special regard to geographical dependencies this question will be treated.



But ...

Is it really useful to focus on global solutions?

What possible role can fusion play in such a solution?

Or does it make sense to focus on more regional decoupled solutions?



Two projects are under investigation to treat this questions

