Euro Sun 2010 –to ranking and developing of residential areas according to criterion of sustainability

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ABSTRACT

In Styria residential areas get developed and ranked in order to their availability and infrastructure.
A judgement of climatic quality doesn't take place.

In future residential areas have also to be judged by

- quantity of sun hours
- exploitation of solar energy

In consideration of different forecast periods and the expected change of quantity of sun hours and possible exploitation of solar energy, residential areas must be ranked. Costs of increasing the quantity of sun hours and the exploitation of solar energy must be included into the judgement.

This applies sustainable criterion to the development and support of residential areas

KEYWORDS: develop, rank, judgement of climatic quality, quantity of sun hours, exploitation of solar energy, different forecast periods, sustainable criterion to the development and support of residential areas, self sufficiency energy supply

1. INDRODUCTION

Even medicinal and urban classical Greek literature suggested location and development of settlements on climatic boundary conditions, especially on terms of quality and dynamic of fresh air.

2. ACTUAL SITUATION

Actual regional development planning as well as building laws neglects climatic, especially solar quantity facts.
They solve as natural conditions of residential areas

- static quality
- security against avalanches, danger of flooding…
- infrastructural equipment
- protection of pollutions.

Climatic deliberations only are included in the distance rules of building laws. Some countries demand the incidence of a 45 degree light in first floor windows. These regulations come into effect fist in development or object plans, but not in land utilizations plans or local zoning plans.

Styrian planning laws rule election and development of residential areas in order to

- Natural courses
- Availability
- Possibility of infrastructural equipment,
- but neglecting the expected costs.

As a result of these judging criteria climatic and topographic non suitable residential areas are developed and supported by public purse, according to the political aim to keep the number of population in non profitable locations constant or increasing.

3. AIM

Aim of regional and urban development planning must be to reduce sustainable the costs of building land, especially residential areas. Therefore there must be examined not only the costs by public purse but private costs too. (Buildings-, operating- and maintenance costs)

A sustainable development of residential areas must prove self sufficiency energy supply, mostly in form of solar energy:

- Wind power stations cannot be erected in neighbourhood to residential areas.(Noise, shadow..)
- Geothermal power stations might influence negatively the natural ground of building areas.

A sustainable regional and urban development planning must calculate buildings-, operating- and maintenance costs per m^2 /net building area before determination and ranking of residential areas.

In Styria according to the Styrian building law “heating” of a residential area can be determined positive or negative : as passive or zero Energy houses. This offers the possibility to rank building areas, especially residential areas in order of their capacity to self sufficiency energy supply, according to duration and intensity of insolation.

Countries must determine yearly, monthly and daily guidelines and develop relations to the specific location. As consequence of a national income accounts, climatic non sufficient locations must be given up and the number of supporting costs by public purse can be reduced.

A similar situation was at the end of the 15^{th} and the beginning of the 16^{th} century, as the value of gold sank, therefore the cultivation of high mountains living locations got uneconomic und were given up.

4. SUGGESTION

Insolation (in kWh/m²/a) of a location deviates of many years average only in fact of air pollution and global radiation. It follows a trend, which can be ignored in medium – term analysis or be influenced by short or medium shadow building elements under dynamic boundary conditions.

4.1 statistical boundary conditions

The expected, topographic limited insolation on an area can be measured. Dependent on the throw of shadow of different elements lines get created, to determine

- percentage of possible sunshine
- highness of the sun over the effective horizon
- intensity of insolation

and get out the energetically support of an area.

These theoretical quantities must be related to the average cloud cover of the examined area. The ranking of the building areas occurs on the potential generation of solar energy, assuming static boundary conditions.

4.2 dynamical boundary conditions

Dynamical boundary conditions are more complex

4.2.1 Shadowing by forest

An existing, shadowing forest relates a span of solar restrictions.

4.2.2 Shadowing by neighbouring building

4.2.2.1
A shadow of an existing building is static, when developing and building plans don't increase the already existing building density.

4.2.2.2
Styrian Town and Country Planning acts, zoning laws don't rule the shadowing of areas.
In Styria allow only development plans to rule the shadowing of building areas by defining the maximal highness of buildings. Therefore it ought to be possible also to implement the definition of maximal highness in land use plans.

The shadowing of an area is to examine under the aspect of the maximal allowed highness and the so determined necessary distance of buildings. Therefore the dynamic boundary conditions get statically boundary conditions.

The global expected area of sun insolation can be vaguely calculated on terms of building density:

$$BSf = f_h + f_v$$

- open location of building (BD)

  - under assumption of nearly quadratic building areas : $F = a^2$

$$f_h = \frac{F * BD}{NF} = \frac{a^2 * BD}{NF}$$

$$f_v = 2 * NF * HF * \sqrt{F * BD} = 2 * NF * HF * \sqrt{\frac{a^2 * BD}{NF}}$$

$$BSf = \frac{a^2 * BD}{NF} + 2 * NF * HF * \sqrt{\frac{a^2 * BD}{NF}}$$

- on the assumption of square building areas: F = a * b

$$BSf = f_h + f_v = a^2 * c$$

$$f_h = \frac{F * BD}{NF} = \frac{a * b * BD}{NF}$$

$$f_v = 2 * NF * HF * \sqrt{\frac{F * BD}{NF}} = 2 * NF * HF * \sqrt{\frac{a * b * BD}{NF}}$$

$$BSf = \frac{a * b * BD}{NF} + 2 * NF * HF * \sqrt{\frac{a * b * BD}{HF}}$$

bzw.

$$= \frac{a^2 * c * BD}{NF} + 2 * NF * HF * \sqrt{\frac{a^2 * c * BD}{NF}}$$

- closed location of building (BD)

- under assumption of nearly quadratic building areas : F = a²

$$BSf = f_h + f_v$$

$$fh = \frac{a^2 * BD}{NF}$$

$$fv = NF * HF * a$$

$$BSf = \frac{a^2 * BD}{NF} + NF * HF * a$$

$$= a * \left[a * \frac{BD}{NF} + 2 * NF * HF \right]$$

- on the assumption of square building areas: F = a * b

$$BSf = f_h + f_v = a^2 * c$$

$$fh = \frac{a * b * BD}{NF}$$

$$fv = NF * HF * a \quad \text{wenn a > b}$$

bzw.

$$= NF * HF * b \quad \text{wenn b > a}$$

$$BSf = a * \left[\frac{b * BD}{NF} + NF * HF \right] \quad \text{wenn a > b}$$

bzw.

$$= a * \left[\frac{a * c * BD}{NF} + NF * HF \right] \quad \text{wenn a > b}$$

oder

$$= b * \left[\frac{a * BD}{NF} + NF * HF \right] \quad \text{wenn b > a}$$

bzw.

$$= a * c * \left[\frac{a * BD}{NF} + NF * HF \right] \quad \text{wenn b > a}$$

This means:

F	*area of an estate*
a, b	*length of the estate, rule: b = a * c*
BSf	*area of a building with sunshine*
f_n	*horizontal area of a house with sunshine (flat roof)*
f_v	*vertical area of a house with sunshine*
	under presumption:
	1 length und 2 halve broads at open location of buildings and
	1 length at closed location of buildings
NF	*Number of floors*
HF	*Highness of a floor*
BD	*building density*

5. SEQUENCE

If areas shall be ranked for their consummation by their energetically quality, first have to be defined threshold values according to ecological and medicines criteria as:

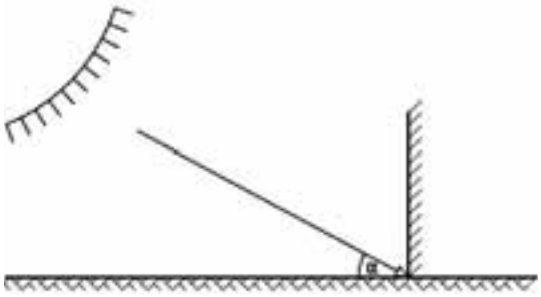
- regarding a day
  - the minimum demanded daily gain of energy (in kWh/m²/d
    - area of facade
    - area of estate
  - the minimum demanded yearly gain of energy (in kWh/m²/a)
    - area of facade
    - area of estate

  or
  - the minimum demanded yearly gain of energy during the summer month (in kWh/m²/a)
    - area of facade
    - area of estate

  - the minimum demanded yearly gain of energy during the winter month (in kWh/m²/a)
    - area of facade
    - area of estate

The gain of energy of $1m^2$ ground floor is ident the gain of energy of $1m^2$ facade, including the following weightings:

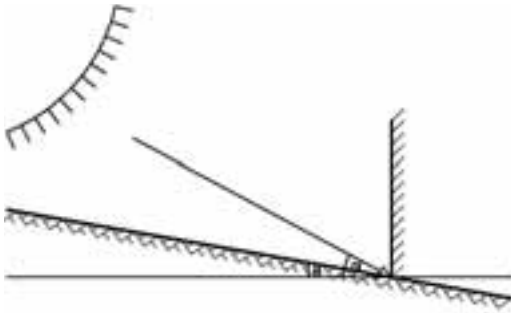
- flat ground with the factor (tgα)



α *angle of sunray*

fig. 1

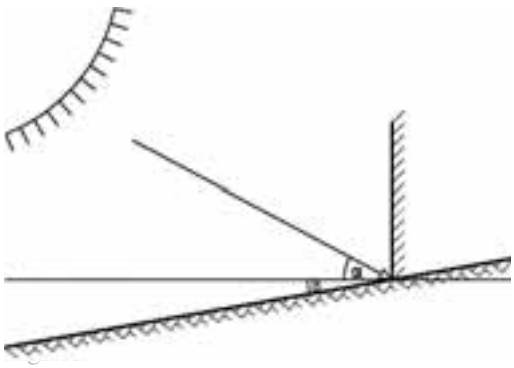
- decreasing ground with the factor (tgα - tgβ)



α *angle of sunray*
β *angle of hill*

fig. 2

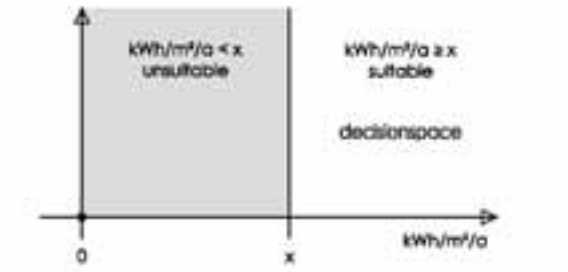
- increasing ground with the factor (tgα)



α *angle of sunray*
β *angle of hill*

fig. 3

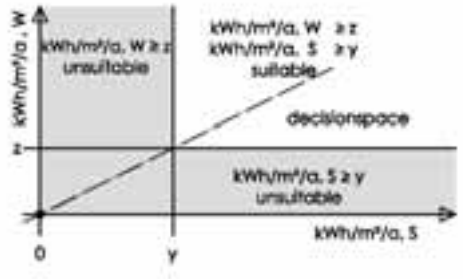
- A coarse distinction allows a ranking of potential building areas in order of their annual insulation (in kWh/m²/a)



kWh/m²/a *insolation per m² area during a year*
x *minimum demanded insolation per m2 area during a year*

fig. 4

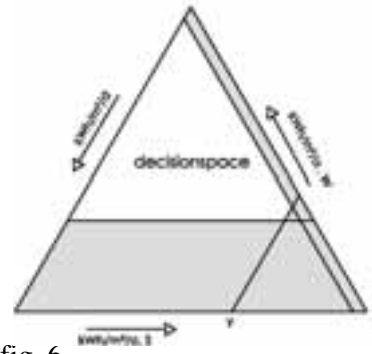
- An evaluation that takes latitude, winter and summer month into consideration is a classification according to kWh/m²/a,s during the summer months and kWh/m²/a,w during the winter months. Dividing in winter and summer months brings following results



kWh/m²/a,s *insolation per m² area during the summer months*
kWh/m²/a,w *insolation per m² area during the winter month*
y *minimum demanded insolation per m2 area during the summer month*
z *minimum demanded insolation per m2 area during the winter month*

fig. 5

- Even this division is not satisfying, as locations that have no insolation during a certain time of the year cannot be accounted with this method. The minimum accepted insolation (kWh/m²/d) must be defined by a triangle diagram.



kWh/m²/d *insolation per m² area during a day*

fig. 6

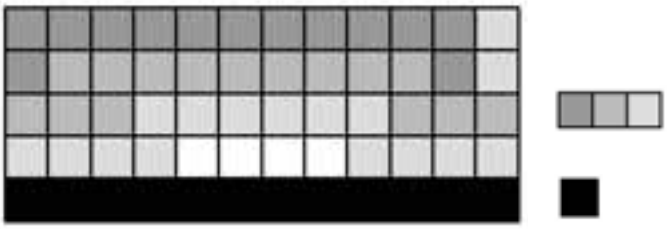
The white areas in the upper diagrams mark the liberty of determination according to the variables, which fulfil the limits of minimum demanded insolation.

A further ranking of boundary conditions for variables is possible

- without weighting the variables under the aspect of maximal fulfilling
    a. The insolation during a day
    b. The insolation during the winter months

- with weighting the variables by rescaling the criteria along the axis of the diagram.

In order to the isolines of the (kWh/m²/s/w/d) areas with similar insolation get grouped as well as groups of similar insolation.



different areas with similar insolation

shadowing building or forest

fig. 7

6. CONCLUSIONS

Building locations, especially living locations ought to be ranked, according to annual insolation (ΣkWh) with the aim

- to spread living areas with to little solar impact "a priori"
- to stop the wasting of supporting costs by public purse in shady locations immediately.
- to review building costs but also reviewing building costs + capitalized operating costs (e.g. heating costs and tax - deductible commuting expenses for employees). Tax - deductible commuting expenses for employees have to be judged as external operating costs.
- suggested building locations in neighbourhood of forests to be refused in order of its long growing time and lacking insolation as a follow of growing shadow
- to qualify development plans in order to their gain of insolation
- to examine development plans and projects impact for shadowing the neighbourhood

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