SOLAR POTENTIAL OF FACADES INTEGRATING URBAN DENSITIES.
Critical review in the Chilean Urbanism normative

Compiegne, France, Julio 2015
Prof. Dra. Luz Alicia Cárdenas Jirón
University of Chile
Faculty of Architecture and Urbanism
• Introduction
The Chilean urban normative (OGUC) has spatial regulations for shaping architectural form according to three wide regions of the national territory although vast latitudinal range of it (17°S to 56°S aprox)

To avoid 3D uggly shapes in high densities building a new interesting compulsory measure was arisen about shadows on flat surfaces.

Net Billing established recently in Chile (2014) open great opportunities to install solar energy collectors on buildings so the urban form and the solar envelope emerges as a relevant issue on the urban planning

Note: OGUC means general ordenance of urbanism and construction. Ordenanza General de Urbanismo y Construcciones
SOLAR POTENTIAL OF FACADES INTEGRATING URBAN DENSITIES.
Critical review in the Chilean Urbanism normative

- Chile; cluster of normative regions for shadows and location of selected cities

- “Lustrines” building (feet box)
**Objective**: to explore the rationale of the Chilean urban normative relate to spatial arrangement and energy. To study solar potential of facades in neighbourd tall building on renewal areas.

**Method**: Heliodon 2 © was applied to simulate solar radiation on facades of an architectural project. Three cities were selected located on each cluster of regions: north, center and south established by urban normative (OGUC)
- Antofagasta (Lat. -23°38´ y Long- 70°24´)
- Santiago (Lat. -33°26´y Long. -70° 40´)
- Puerto Montt (Lat. -41°28´ y long. -72°56´)
Results and discussion:
- Solar energy reduction on facades and urban spaces because of increasing of shadows on them.
- Urban normative might be improved considering energy impacts capture whether passive or active systems.
- Urban form has to be considered to control and to get the most of sólar ressources as ERNC.
## The Chilean urban normative components link to architectural form and energy

### HORIZONTAL DISTANCE BETWEEN BUILDINGS

<table>
<thead>
<tr>
<th>Building High</th>
<th>Horizontal Distance according to windows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Windows on facade</td>
</tr>
<tr>
<td>Less than 3.5 m</td>
<td>3.0 m</td>
</tr>
<tr>
<td>between 3.5 m and 7.0 m</td>
<td>3.0 m</td>
</tr>
<tr>
<td>More than 7.0 m</td>
<td>4.0 m</td>
</tr>
</tbody>
</table>

Tabla 1: Minimum horizontal distance to boundary wall located between ground neighbour according to building heigh and windows on facade


### OBSTRUCTION ANGLE

<table>
<thead>
<tr>
<th>Administrative Region</th>
<th>“Rasantes” (Obstruction angle allowed)</th>
<th>Cluster of regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>I to III and XV Regions</td>
<td>80°</td>
<td>North</td>
</tr>
<tr>
<td>IV to X Región and RM</td>
<td>70°</td>
<td>Center</td>
</tr>
<tr>
<td>X to XII and XIV Regions</td>
<td>60°</td>
<td>South</td>
</tr>
</tbody>
</table>

Tabla 2: Obstruction angle allowed by urban normative for each cluster of regions in Chile.

• Maximum angles prescribed by normative to calculate shadows above surfaces parallel to the average tilted ground.

There are two methods:
(i) To apply angle from the bottom of the ground where boundary wall is built
(ii) To divide building height by value mentioned on table

<table>
<thead>
<tr>
<th>SOMBRA PROYECTADA</th>
<th>I A III Y XV Regiones</th>
<th>IV A X Región y RM</th>
<th>X a XII y XV Regiones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hacia el Sur</td>
<td>63°</td>
<td>57°</td>
<td>51°</td>
</tr>
<tr>
<td></td>
<td>Dividir la altura por 1.96</td>
<td>Dividir la altura por 1.54</td>
<td>Dividir la altura por 1.23</td>
</tr>
<tr>
<td>Hacia el Oriente</td>
<td>28°</td>
<td>26°</td>
<td>24°</td>
</tr>
<tr>
<td></td>
<td>Dividir la altura por 0.53</td>
<td>Dividir la altura por 0.49</td>
<td>Dividir la altura por 0.45</td>
</tr>
<tr>
<td>Hacia el Poniente</td>
<td>28°</td>
<td>26°</td>
<td>24°</td>
</tr>
<tr>
<td></td>
<td>Dividir la altura por 0.53</td>
<td>Dividir la altura por 0.49</td>
<td>Dividir la altura por 0.45</td>
</tr>
</tbody>
</table>

SOME QUESTIONS

• ¿To what seasons correspond shadows according to OGUC and Art. 2.6.13?
• ¿How does solar potential modify if same buildings project change its location in each regions? (OGUC applied)
• ¿What is the effect of shadows on solar potential on facades? (kWh/m2)
Shadows applied by urban normative correspond to equinox.

“Rasante” applied and shadows surfaces on ground according to urban normative OGUC: north, center and south.

The norther region the more floors (indoor spaces) are affected by shadows cone on facades and then solar energy supply. The norther region the less ground surfaces (outdoor spaces) are affected by shadows. Because of warm climate the latter conditions might be beneficial in urban spaces but not necessarily in indoor spaces if an active system is needed for climatisation using solar energy.
Heliodon 2 © is applied for solar energy simulation. Irradiation is calculated whether in private and public domain for three cities: Antofagasta, Santiago y Puerto Montt.
CONCLUSIONS

Shadows projected above urban spaces and building facades in three cluster of regions. Solar potential on cities.

<table>
<thead>
<tr>
<th>ENERGY TOTAL SYSTEM (kWh/m²)</th>
<th>FACADE WEST (kWh/m²)</th>
<th>INTERSTICEAL SPACE (kWh/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIFERENCIA Antof.-P.Montt</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>% PERDID POTENTIAL</td>
<td>20%</td>
<td>(-)50%</td>
</tr>
</tbody>
</table>

Shadows surfaces on urban spaces are greater (m2) on southern regions than northern meanwhile shadows on neighboring facades are lesser in southern regions than northern ones if apply OGUC.

Lost of irradiation (kWh/m2) is bigger in urban space than in building facades if compares northern city (Antofagasta) with southern city (Puerto Montt).
REFERENCES