Solar Planning Consideration for BISTS

How Solar Thermal Works

Solar thermal systems collect solar radiation for use in heating air and/ or water for domestic, commercial or industrial purposes. Sometimes, they are used to produce steam, which then drives turbines to generate electricity.

The principle of solar thermal energy can be used from the household level to the industrial level. What every solar thermal system has in common, is a solar collector.

Solar water heating – known as solar thermal systems – capture the free heat from the sun and use it to heat up water for use in the home. It is a simple process:

1. panels on the roof absorb heat from the sun – they are known as the collector
2. the water in the panels heats up
3. this hot water is pumped through a coil in the cylinder
4. which transfers the heat to the water in the cylinder

Siting

The ideal situation for solar panels is facing due south, although they are effective facing anywhere between south east and south west. As a rule of thumb one needs between 1-2m2 of collector (solar panels) per person living in the house. Shade on the panels at any time of day will reduce the performance.

Most panels are mounted on a roof, but they can also be integrated on building facades. It is important that they get direct sunlight. To get the best results they should be at an angle between 20 and 50 degrees from horizontal.

Solar thermal panels should provide most of the hot water from April to September and make a worthwhile contribution in the months on either side of that period. Outside of that estimates vary depending on location.

The Energy Saving Trust field trials found that solar thermal panels will provide about 60 per cent of a household's hot water needs, if well-installed and properly used.

Benefits

How much one benefits from a solar thermal systems will depend on a variety of factors:

1. How much hot water the household or business uses. The higher the usage, the more benefit one gets from a solar thermal system.
2. How much interest one takes in how the system works and adapt to make the most of the free hot water (i.e. having showers in the evening rather than the morning). The sun isn’t as reliable as a timer clock.
3. The size of the cylinder (many cylinders only hold enough water for a day’s supply of hot water).

1. How one programs the back up heating. If the control panel does not allow programming the hot water and central heating separately, one may not get the maximum benefit from the solar panels when the heating is turned on. By only boosting the hot water once the sun has gone down, one maximizes the opportunity for solar heating.
2. Adequate insulation of both cylinder and pipes carrying hot water.
3. Allowing hot water temperature to vary. If one does not need high temperatures all the time, one will have less need for back-up heating and will also reduce heat loss.

Types of solar thermal panels

Flat plate panels consist of an absorber plate in an insulated metal box. The top of the box is glass or plastic, to let the sun's energy through, while the insulation minimizes heat loss. Lots of thin tubes carry water through the absorber plate heating it up as it passes through.

Instead of a plate, evacuated tube collectors have glass tubes containing metal absorber tubes, through which water is pumped. Each tube is a vacuum (the air is 'evacuated' hence the name), which minimizes heat loss.

The Energy Saving Trust field trial found little difference in performance between the two. For many people the decision is a matter of aesthetics.

Costs

The cost of installing a solar thermal system will depend on the type and quality of the panels, whether one needs scaffolding, and how easy it is to integrate into the existing plumbing system.

As a guide, in the U.K. average systems are likely to cost between £3,900 for a two person household to £5,000 for a six person household according to the Solar Trade Association.

A cost- effective time to install would be when a new hot water cylinder is needed or when repairs are done on the roof (or at the same time as a solar PV installation).

The European Solar Thermal Industry Federation (ESTIF) . . .

. . . is the voice of the solar thermal industry, actively promoting the use of solar thermal technology for renewable heating and cooling in Europe. With around 80 members from 17 European countries, ESTIF represents the entire value chain.

ESTIF'S MISSION IS TO ACHIEVE HIGH PRIORITY AND ACCEPTANCE FOR SOLAR THERMAL AS A KEY ELEMENT FOR SUSTAINABLE HEATING AND COOLING IN EUROPE AND, WITH IMMEDIATE EFFECT, TO WORK FOR THE IMPLEMENTATION OF ALL NECESSARY STEPS TO REALISE THE HIGH POTENTIAL OF SOLAR THERMAL.

Regulations

Solar ordinances are regulations requiring that solar energy provides a minimum share of the heating demand. Usually, they apply to new buildings, those undergoing major refurbishment and sometimes when the heating system is being replaced.

A decade ago, the idea of making the use of solar or renewable energy compulsory sounded radical and politically unrealistic in most parts of the world. However, solar obligations have now been adopted or are being discussed in a number of countries, regions and local authorities in Europe and beyond.

Obligations

In June, 2007, while discussing the contents of the future EU Directive on Renewable Energies, the ITRE Committee of the European Parliament called on the Commission to “ . . . speed up the widespread adoption in all Member States of best practice regulations making it compulsory, at least where existing buildings are substantially renovated and new buildings are built, for a minimum proportion of the heating requirement to be met from renewable sources, as it already is in a growing number of regions and municipalities.”

Solar obligations are probably the single most powerful tool for promoting the use of renewables in new buildings. Practical experience shows their numerous benefits.

However, solar obligations fundamentally change the way in which the solar thermal market grows and customers will often search for the cheapest possible solution. Therefore, solar obligations must include appropriate quality assurance measures.

Spain (national level)

The Spanish government adopted a new Technical Building Code (CTE, Codigo Tecnico de la Edificacion) in March 2006 which includes an obligation (since September 2006) to cover part of the domestic hot water (DHW) demand with solar thermal energy. This obligation applies to all new buildings and to those undergoing major refurbishments.

The required solar contribution varies between 30 and 70 % depending on three main factors:

1. domestic hot water demand of the building (liters/day)
2. climate zone
3. conventional fuel to be replaced (only for refurbishments)

Barcelona: the pioneer of solar regulation in Europe

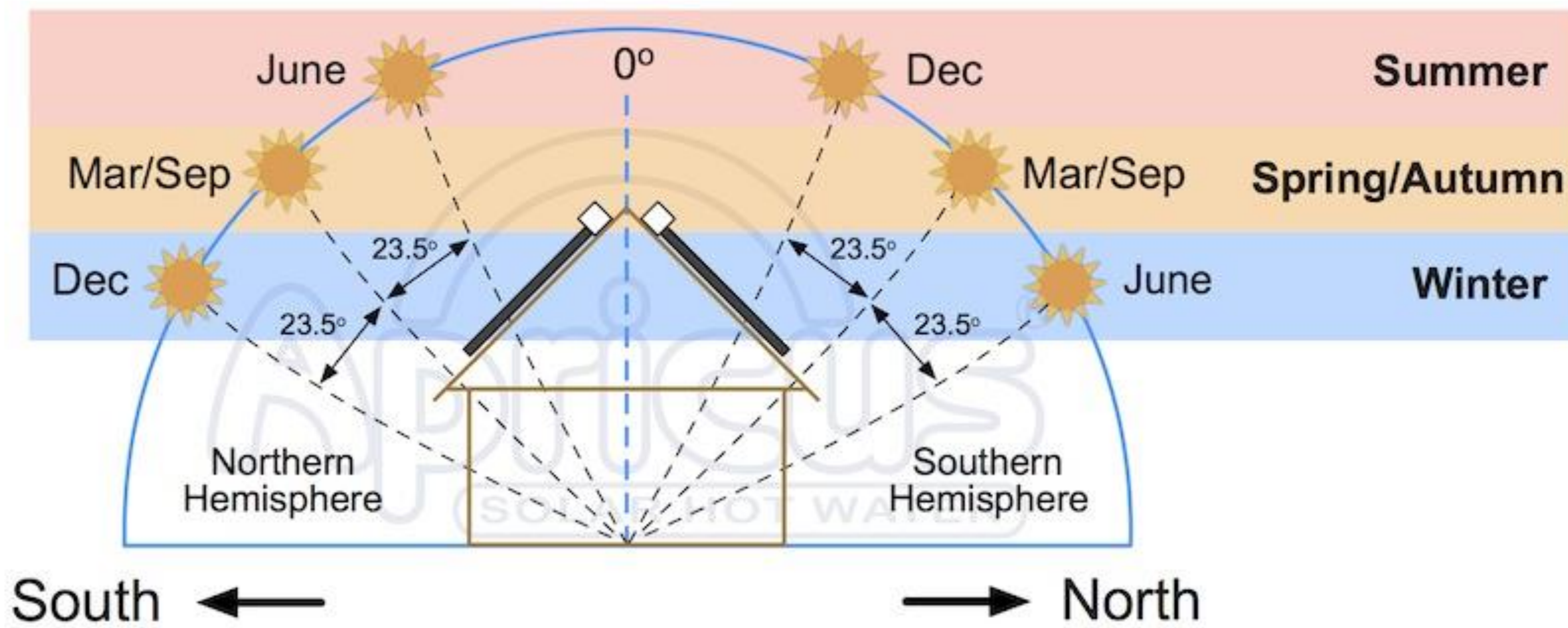
The City of Barcelona has been the pioneer for Solar Regulations in Europe. The first Solar Ordinance came into force in 2000 and required that a certain share of the domestic hot water demand be supplied by solar thermal, in new buildings and those undergoing major refurbishment.

The implementation led to a significant increase in the use of solar thermal, thereby even stimulating the market for buildings not covered by the ordinance. The regulation was popular with decision makers and received widespread public support. Therefore, the number of buildings targeted increased and procedures, architectural integration, as well as quality requirements improved thanks to the revision approved in 2006.

Installation Angle

Solar thermal collectors need to face the sun to obtain maximum sunlight exposure. The installation angle should be equal to or up to 15^{o} higher than the latitude of the location. This angle ensures optimal heat output throughout the year. Depending on the application, higher or lower installation angles may be more suitable as determined by the solar professional designing and installing the system.

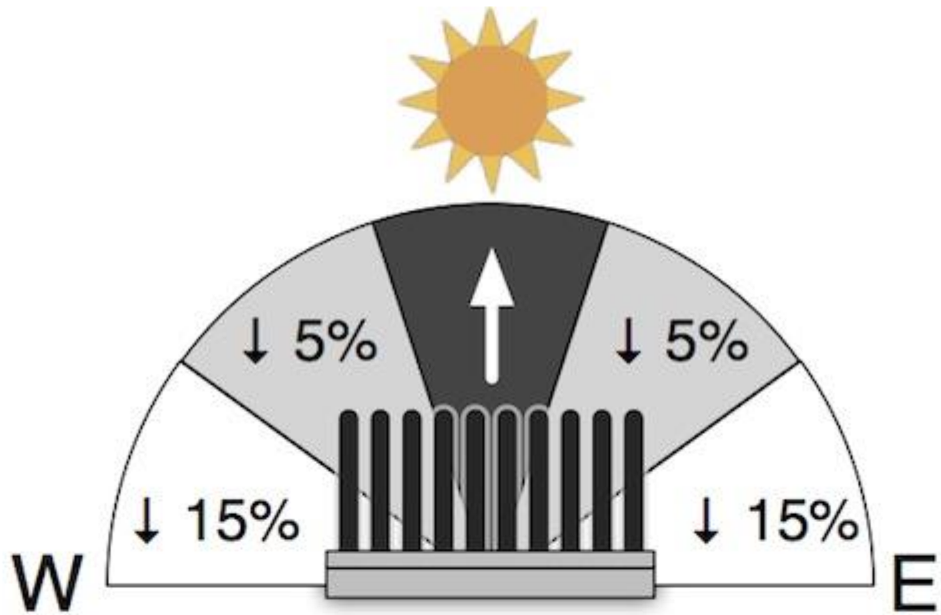
The diagram below shows the path of the sun throughout the sky, cycling from low in the sky in the winter, to high in the sky during the summer.


June
0º
Dec
Summer
Mar/Sep
Mar/Sep
Spring/Autumn
23.5º
23.5º
Dec
June
Winter
23.5º
23.5º
Northern Hemisphere
Southern Hemisphere
South
North

Direction

Solar collectors should face as close as possible to the equator, which is the direction of the midday sun. Based on needing to face the equator, this means that in the northern hemisphere the collector should face south, in the southern hemisphere the collector should face north.

It may not always be possible to mount the collector due north/south and so 45^{o} east or west is acceptable and will not reduce collector output too much. Facing the collector more easterly will increase morning sunlight exposure, westerly will increase afternoon sunlight exposure. Pointing further away from the equator direction will reduce daily output and so a larger solar system may be required.


↓ 5%
↓ 5%
↓ 15%
↓ 15%
W
E

European Solar Insolation Levels

Country	City	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year Avg
ES	Madrid	40° 24' N	3° 41' W	3.03	3.87	5.1	5.41	5.87	6.76	6.98	6.57	5.54	3.97	3.01	2.61	4.9
ES	Malaga	36° 40' N	4° 29' W	3.11	3.87	5.13	5.84	6.29	7.2	7.54	7.07	5.81	4.23	3.2	2.69	5.17
ES	Barcelona	41° 17' N	2° 04' E	3.76	4.67	5.38	5.53	5.51	5.81	6.05	5.72	5.22	4.28	3.51	3.34	4.9
ES	Alicante	38° 17' N	0° 33' W	3.33	3.96	4.9	5.62	5.91	6.46	6.62	6.17	5.11	4.2	3.29	2.91	4.88
ES	Oviedo	43° 21' N	5° 50' W	2.3	2.88	3.97	4.44	4.78	5.03	5.16	4.86	4.34	3.04	2.25	1.99	3.76

Notes:
1. Values in kWh/m2/day
2. Insolation level for equator pointing collector installed at latitude angle.
3. Source: NASA surface meteorology and solar energy.

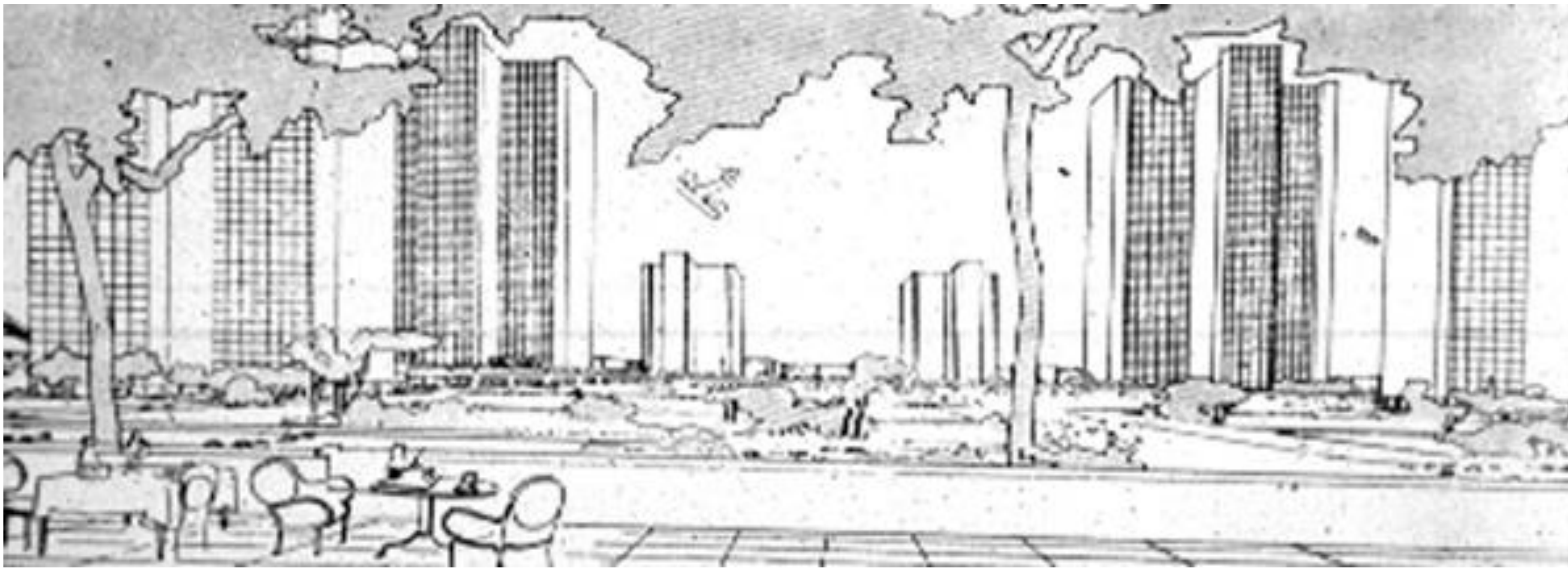

Carrer de Laureà Miró
Can Clota
N-340
B-20
Escola Oficial Idiomes Esplugues
Carrer del Molí
Parc de Can Vidalet
Plaça del Taxi
Carrer de la Lleialtat
Carrer Primer de Maig
Carrer Cedres
Av. Ciutat de l'Hospitalet
Plaça de Blas Infante
LA FONT DEL MIG
Can Oliveres

Considerations for Urban Density

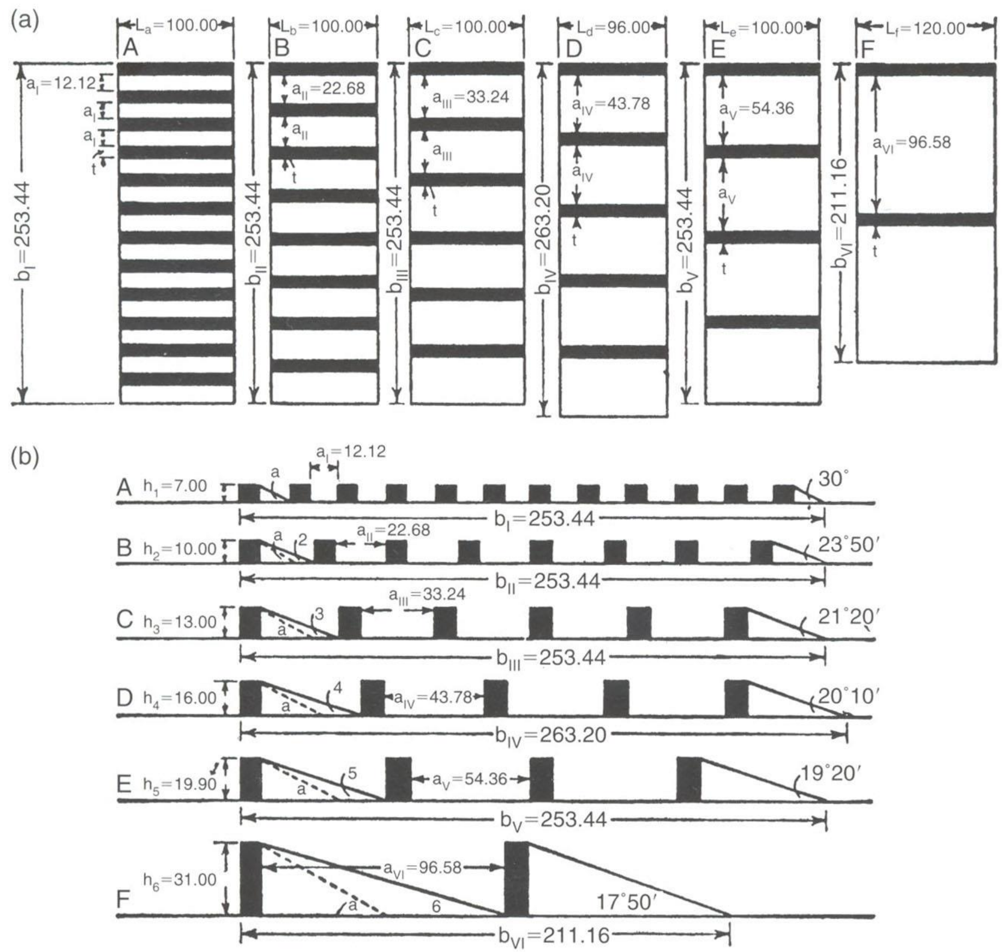
Barcelona - Area	
• City	101.4 km^2 (39.2 sq mi)
Barcelona - Population (2015)	
• City	1,604,555
• Density	16,000/km^2 (41,000/sq mi)
• Urban	4,693,000
• Metro	5,375,774

Considerations for Solar Planning

The Radiant City (by LeCorbusier)

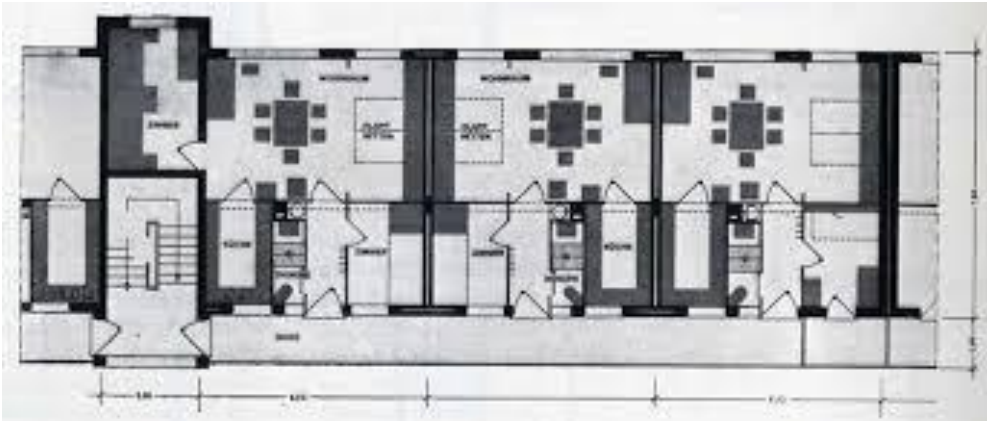


The Slab Block (by Gropius)

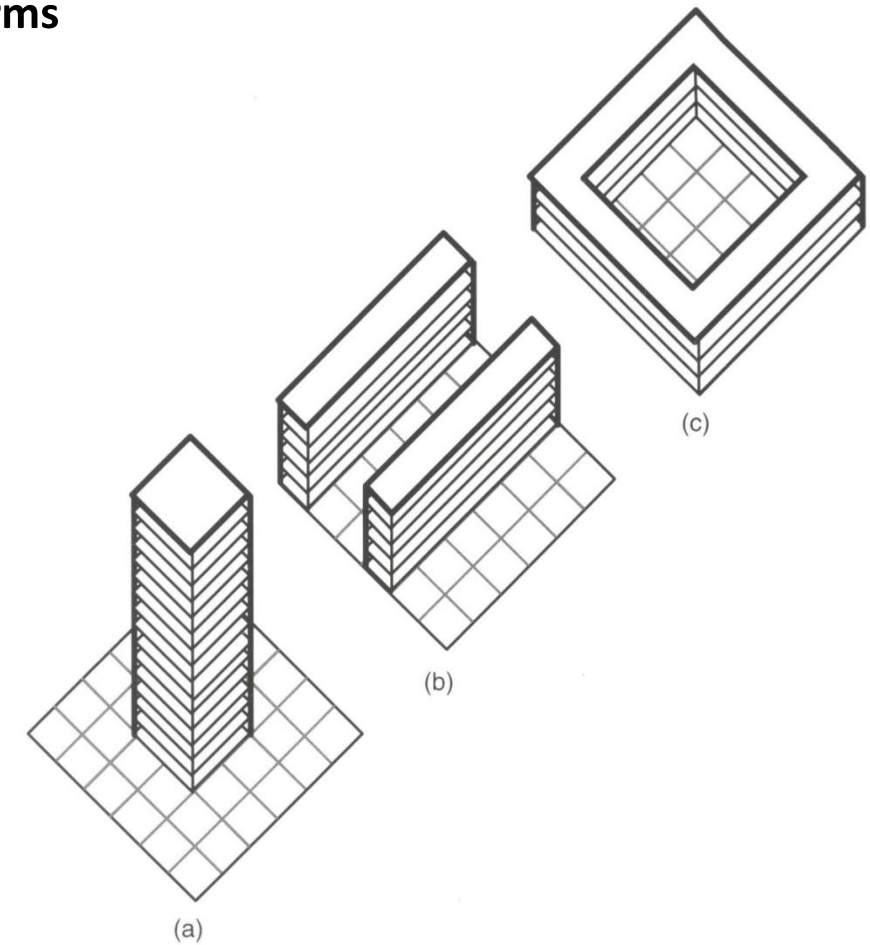


Walter Gropius' analysis of slab block layout to maximise sunlight and daylight

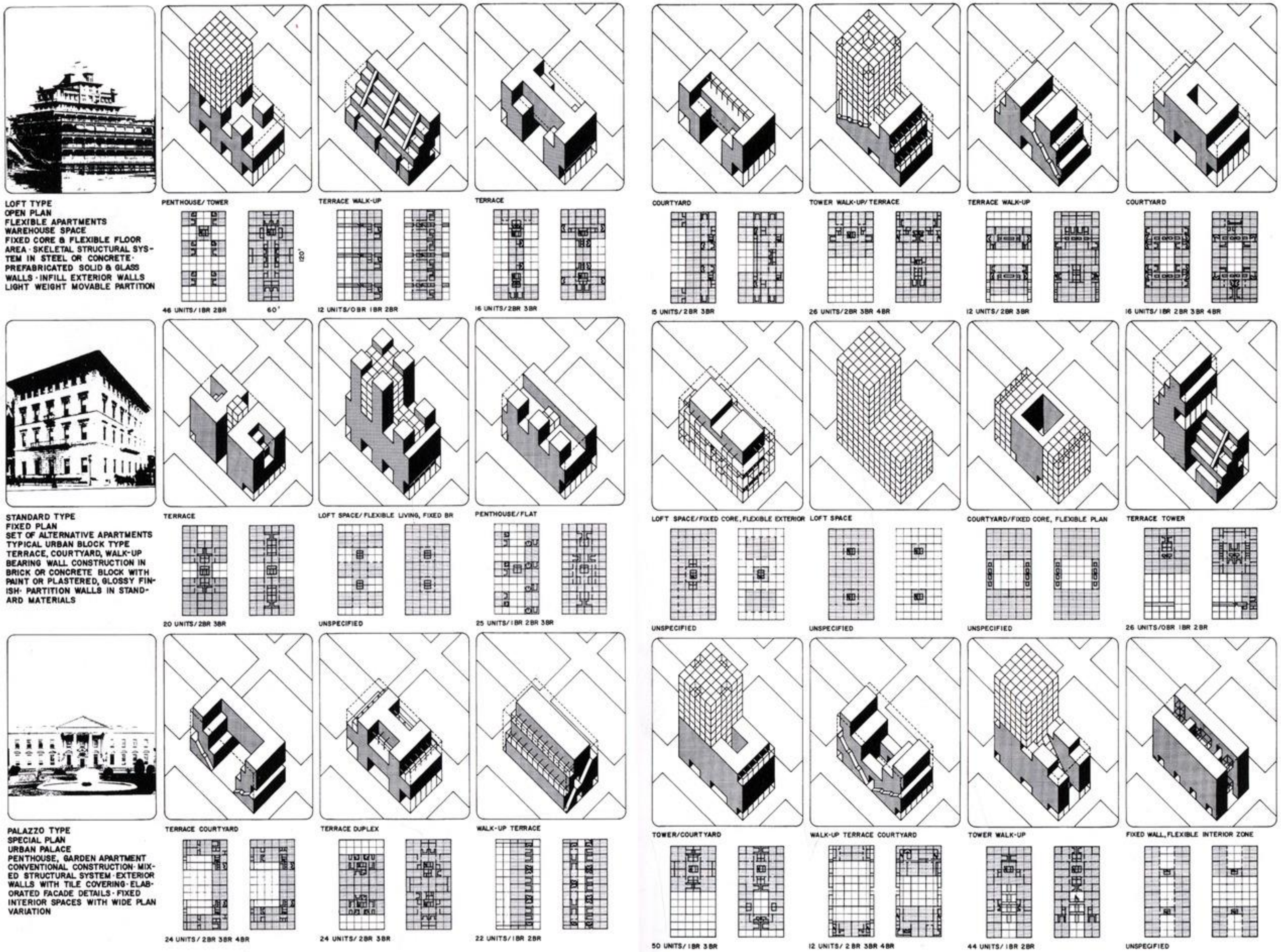
Slab Block - Plans



Basic Block Forms



Basic forms of urban development. The same amount of floor-space built as ‘pavilion’, ‘street’ and ‘patio’ forms


LOFT TYPE
OPEN PLAN
FLEXIBLE APARTMENTS
WAREHOUSE SPACE
FIXED CORE & FLEXIBLE FLOOR AREA · SKELETAL STRUCTURAL SYSTEM IN STEEL OR CONCRETE · PREFABRICATED SOLID & GLASS WALLS · INFILL EXTERIOR WALLS LIGHT WEIGHT MOVABLE PARTITION
PENTHOUSE/ TOWER
46 UNITS/ 1BR 2BR
60'
120'
TERRACE WALK-UP
12 UNITS/0BR 1BR 2BR
TERRACE
16 UNITS/2BR 3BR
COURTYARD
15 UNITS/ 2BR 3BR
TOWER WALK-UP/ TERRACE
26 UNITS/2BR 3BR 4BR
TERRACE WALK-UP
12 UNITS/ 2BR 3BR
COURTYARD
16 UNITS/ 1BR 2BR 3BR 4BR
STANDARD TYPE
FIXED PLAN
SET OF ALTERNATIVE APARTMENTS
TYPICAL URBAN BLOCK TYPE
TERRACE, COURTYARD, WALK-UP
BEARING WALL CONSTRUCTION IN BRICK OR CONCRETE BLOCK WITH PAINT OR PLASTERED, GLOSSY FINISH · PARTITION WALLS IN STANDARD MATERIALS
TERRACE
20 UNITS/ 2BR 3BR
LOFT SPACE/ FLEXIBLE LIVING, FIXED BR
UNSPECIFIED
PENTHOUSE/ FLAT
25 UNITS/ 1BR 2BR 3BR
LOFT SPACE/FIXED CORE, FLEXIBLE EXTERIOR
UNSPECIFIED
LOFT SPACE
UNSPECIFIED
COURTYARD/FIXED CORE, FLEXIBLE PLAN
UNSPECIFIED
TERRACE TOWER
26 UNITS/0BR 1BR 2BR
PALAZZO TYPE
SPECIAL PLAN
URBAN PALACE
PENTHOUSE, GARDEN APARTMENT
CONVENTIONAL CONSTRUCTION · MIXED STRUCTURAL SYSTEM · EXTERIOR WALLS WITH TILE COVERING · ELABORATED FACADE DETAILS · FIXED INTERIOR SPACES WITH WIDE PLAN VARIATION
TERRACE COURTYARD
24 UNITS/ 2BR 3BR 4BR
TERRACE DUPLEX
24 UNITS/ 2BR 3BR
WALK-UP TERRACE
22 UNITS/ 1BR 2BR
TOWER/COURTYARD
50 UNITS/ 1BR 3BR
WALK-UP TERRACE COURTYARD
12 UNITS/ 2BR 3BR 4BR
TOWER WALK-UP
44 UNITS/ 1BR 2BR
FIXED WALL, FLEXIBLE INTERIOR ZONE
UNSPECIFIED

Basic elements of a good passive solar system include:

1. Site orientation- The first consideration to **harness light, sun and wind** is the placement of the home and elements around it. Elements like yard plants can also have an impact. The sun is higher in summer and lower in winter, so one can **plant trees that shield from the summer rays**, but don’t block the heat in the winter.
2. Windows- Windows can be tilted to take in the majority of the sun’s rays to store for heat. They are also tilted to control overheating. One can also open and close regular windows to **help control temperature**.

1. Heat-absorbing materials- Materials like concrete, stone, brick and tile store heat energy well. Darker colors also **trap the energy more efficiently**, and a well-insulated and tightly-sealed home will help **hold the steady temperatures**. Sometimes, water, which is twice as absorbent of the heat, can be used to store the energy.
2. Distribution- There are different ways to move the stored heat where one wants it to go, which can be as simple as allowing it to pass through a touching object. Air flow can also be controlled to **move temperatures throughout the entire home**.

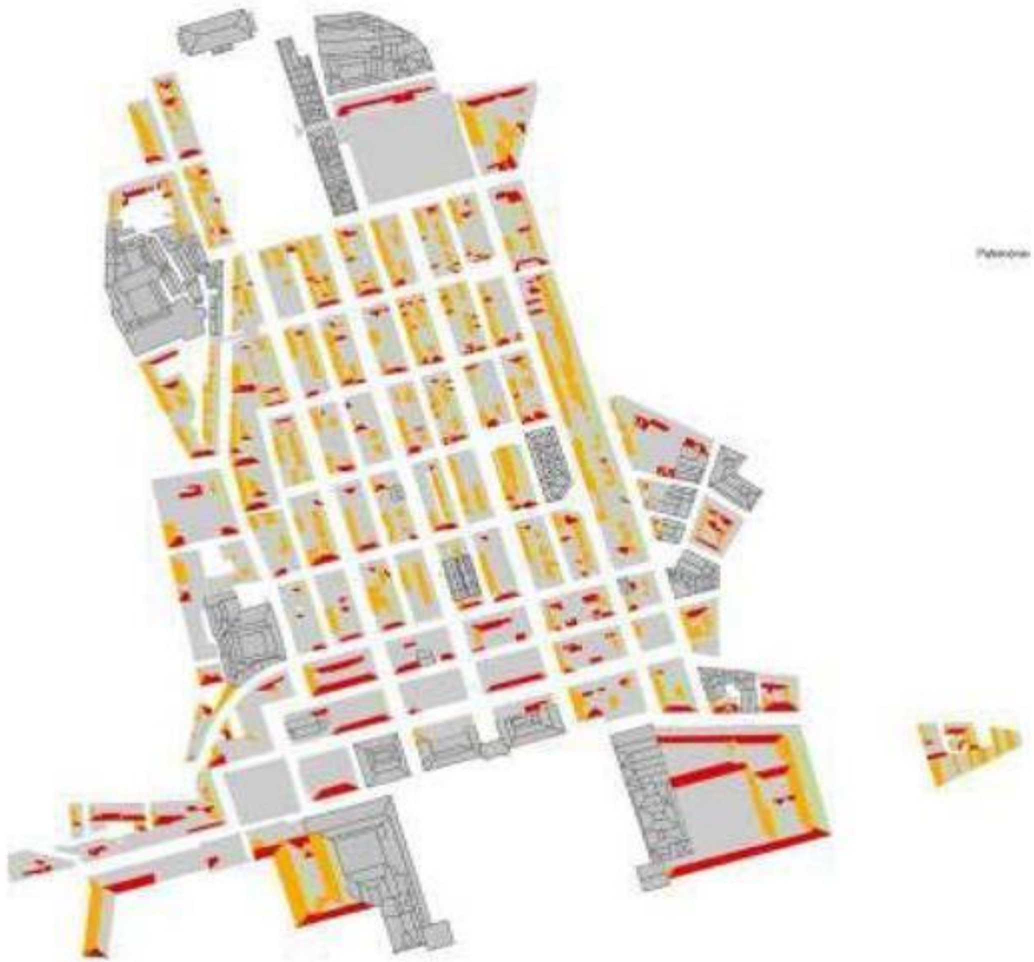
1. Control- To be sure that the home's passive solar system doesn't work too well and overheat on a hot day, one can **add control measures**, which include overhangs to shield from the sun, temperature-controlled fans or specialized blinds and shutters. Prevailing winds can also be a simple but huge help in **summer cooling**.

The south side of a building gets the most sun, so that's where many of the **sun collection features** are located. When one filters the heat in through **southern-facing windows**, the area inside where the heat is collected is called the **sunspace**. One can then use fans to move the heat from the sunspace to the rest of the home.

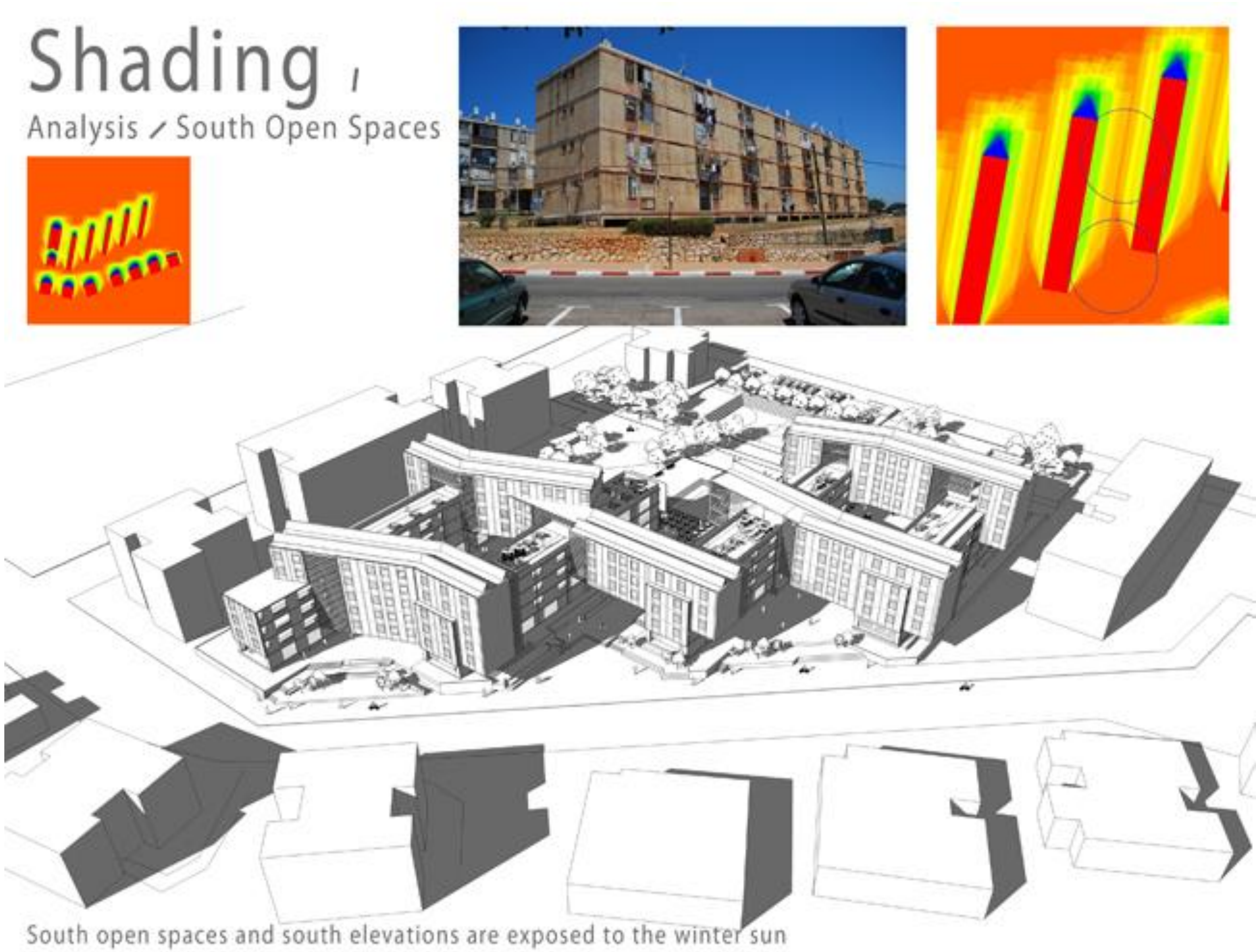
Case Studies – Relevant Precedents

The Vauban Neighborhood in Freiburg

General Siting Examples

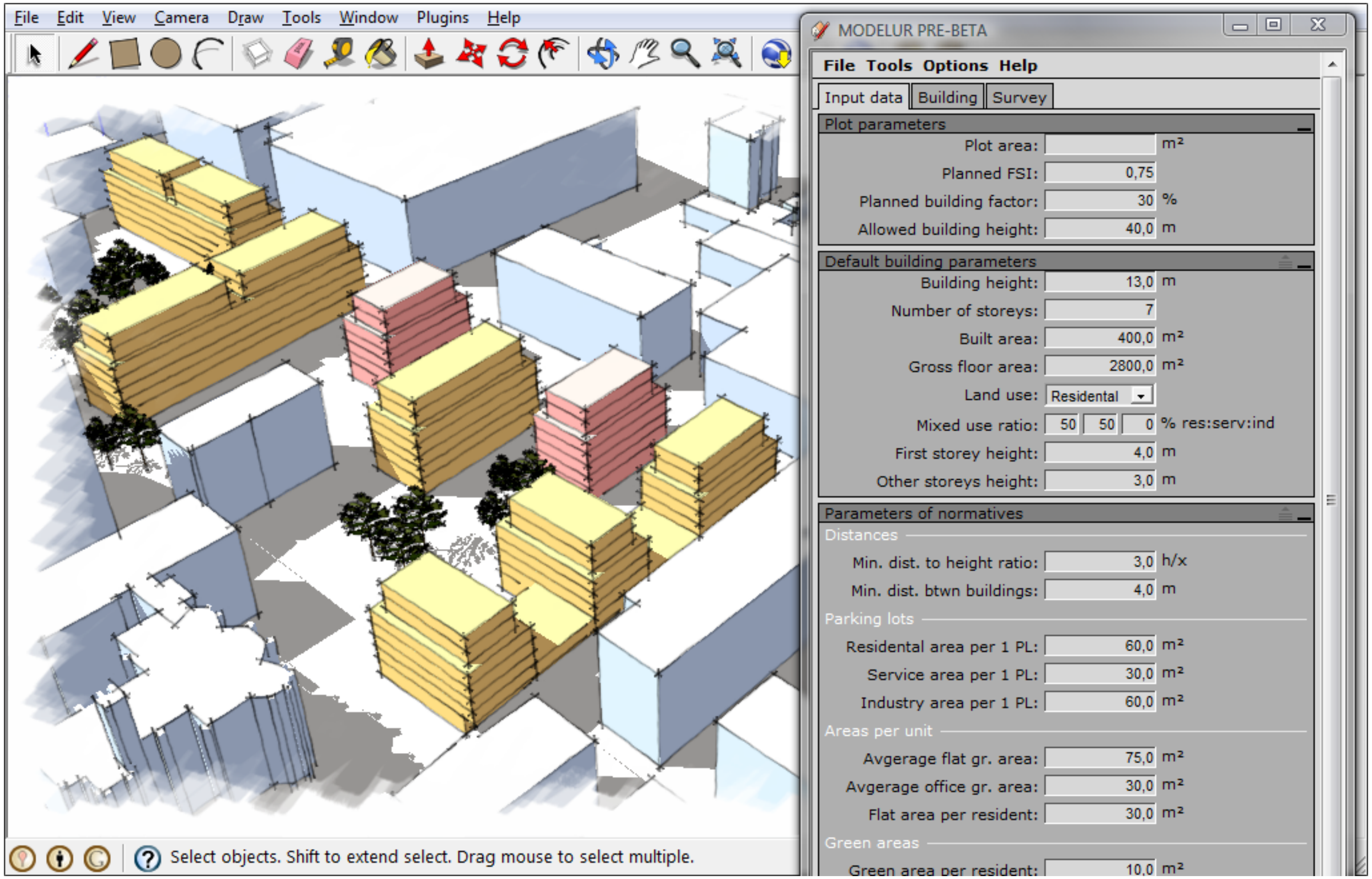



N
0 50 100 200 300 400 Meters
Legend (Wh/m2)
High : 1.25842e+006
Low : 1476.82


Shading
Analysis / South Open Spaces
South open spaces and south elevations are exposed to the winter sun

Building Integration Examples

Sketch-Up a concept . . .



. . . and let the games begin!