Window Options for Florida Residences

Keeping cool and comfortable,... and saving energy too

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Florida Solar Energy Center

Florida Solar Energy Center
Half-day short course on window energy and illumination performance and background for purchase decisions

- **Many factors affect the design and choice of windows for the Florida home.**
- **After some background information, we'll take a tour through the options.**

Are windows just "holes in the insulation?"

Some are,... but "it ain't necessarily so!"

- Good windows can out-perform opaque insulated walls, energy-wise.
- Windows provide much more than energy savings!
- A building is there to provide comfort and protection from the elements, not just to save energy.
- If energy can be saved too, that's even better.

- We'll start with some basics
- Then we'll cover energy and economics
- And finish with a summary of window option recommendations

Outline of the presentation

Background Information
- Fundamentals of Window Physics
- Sun Position and Shading

High Performance Window Glazings
- Spectral Selectivity
- Hot climate versus cold climate coating technology
- Light-to-Solar Gain Ratio

Energy and Economics
- Calculating Window Energy and Economic Performance
- Simulation programs - EnergyGauge USA and EnergyGaugeFlaRes®
- Florida Building Code - Mix and match – to the extreme

There's more to windows than just energy or energy code compliance
- The cheapest window is not always best
- Human factors and long term energy and environmental aspects
- What's really wrong here?

The Bigger Picture
- History, the Peak of Oil Production
- We really need higher energy prices

The Florida Residential Windows Market
- The circle of failures – A chicken-and-egg problem
- Breaking the circle

Conclusions and Recommendations
- Final window shading and window option selection guidelines

Additional Questions and Answers, Course Evaluation

What are windows for?

- Views to the outdoors - visual connections to the natural world
- Illumination of the interior with natural daylight
- Acoustic connections to the outdoors
- Routes for emergency escape
- Protection from the discomforts of cold, heat, wind, and rain
- Do you see energy anywhere in this list?

Finding the Right Window

- It is more than just choosing a pretty window.
- We must also deal with direct sunlight:
  - **The Good**: Big windows provide a bright and open room with great views and good daylight illumination
  - **The Bad**: Overheating, fading of furnishings, blocked views
  - **The Ugly**: Killer glare from the sun, big energy bills, thermal discomfort
- Three strategies for dealing with the sun
  - Know the sun's position
  - Shape and orient the building properly
  - Shade the windows and walls properly
- Other issues
  - Choice of window frame and glazing
  - To insulate or not?
  - Impact resistance?
  - Acoustic isolation?
  - Utility concerns

Factors Affecting the Choice of Window Options

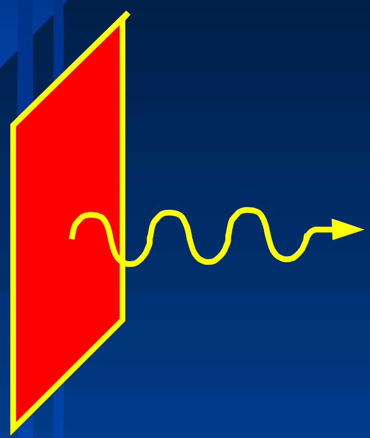
- Which way the window faces
- How much it is (or will be) shaded from the sun
- The importance ($) of thermal comfort
- The importance ($) of sound isolation
- The importance ($) of impact resistance
- New construction vs retrofit (replacement)
- Occupant preferences for style and color
- Electric utility company incentives
- Florida Building Code Compliance

Window Fundamentals to be Considered

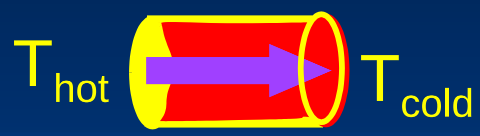
- Heat transfers (Radiation, Conduction, Convection)
- The path of the sun through the sky
- Orientation and shading
- Electromagnetic spectrum
- The solar spectrum
- Solar radiant heat gain, direct and diffuse
- Illumination — Daylighting, glare, electric lighting
- The “U-factor” — Conductive heat transfer
- Solar Heat Gain Coefficient (SHGC)
- Visible transmittance (VT)

Heat Transfer

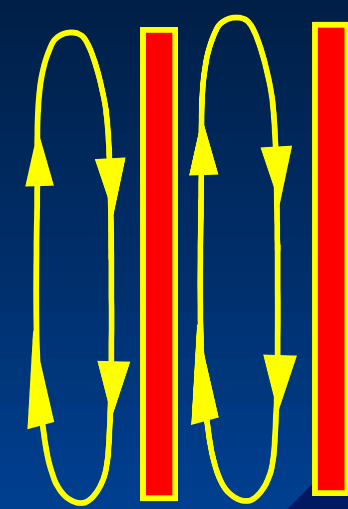
The three modes of heat transfer



Radiation

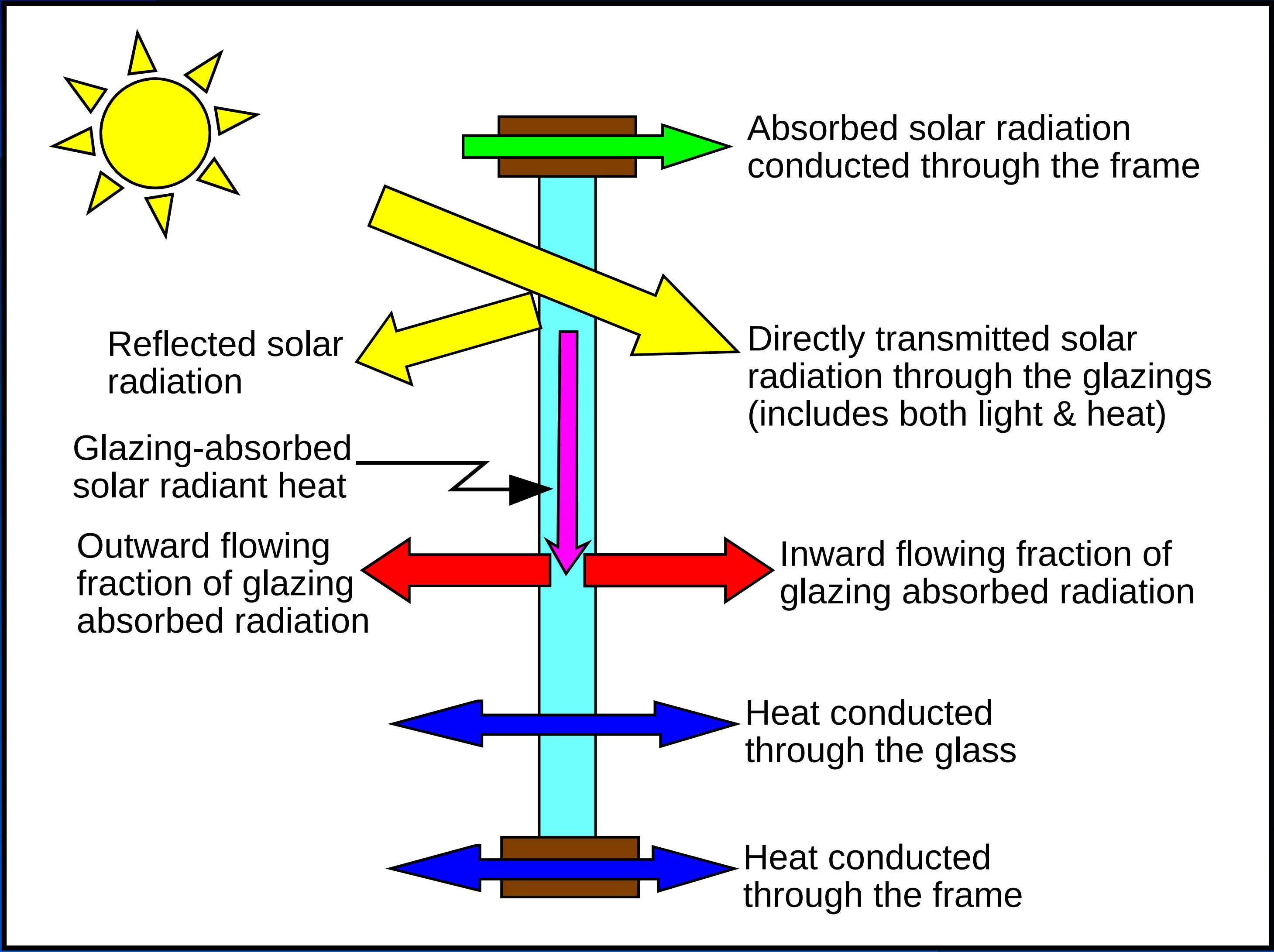


Conduction

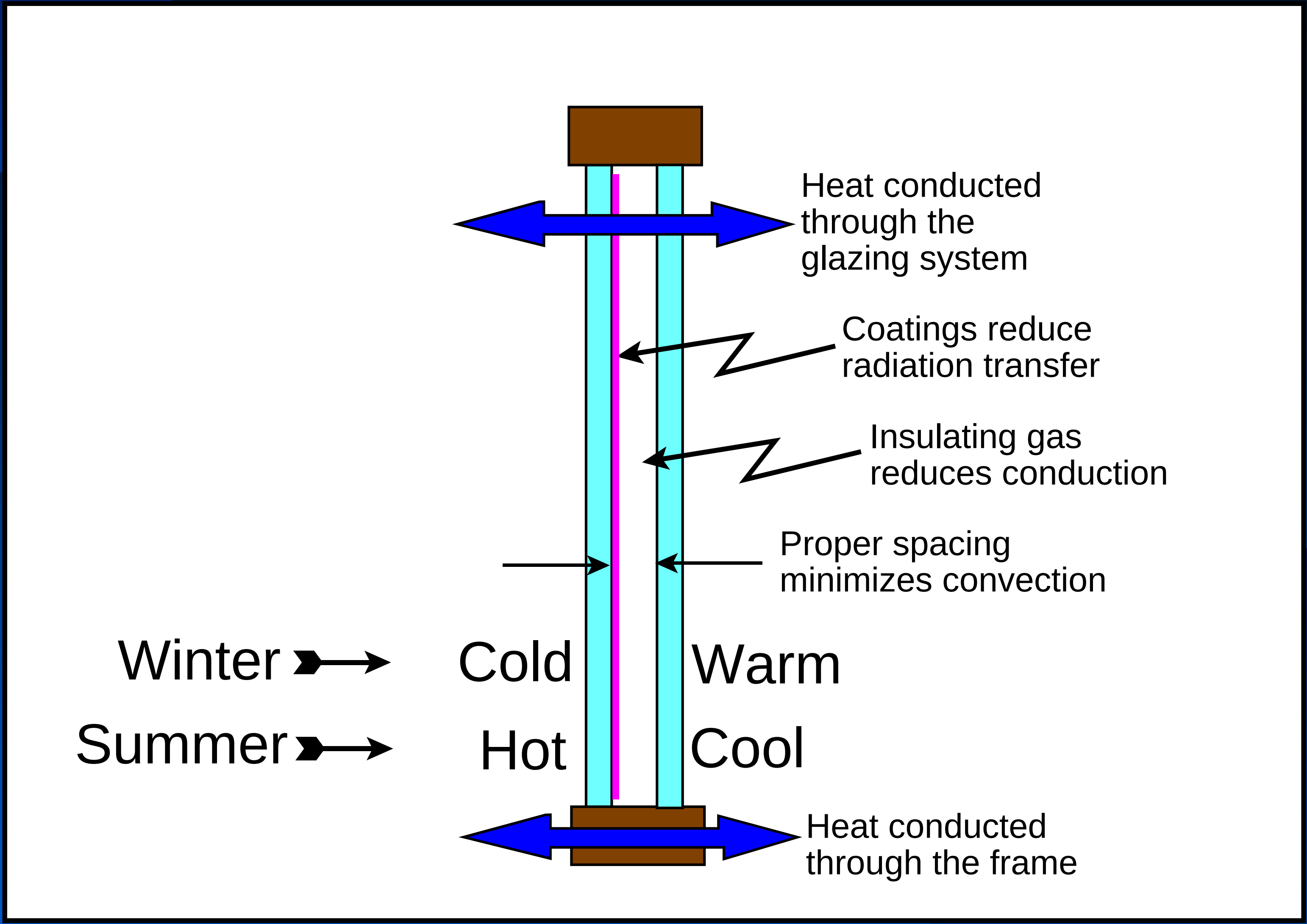


Convection

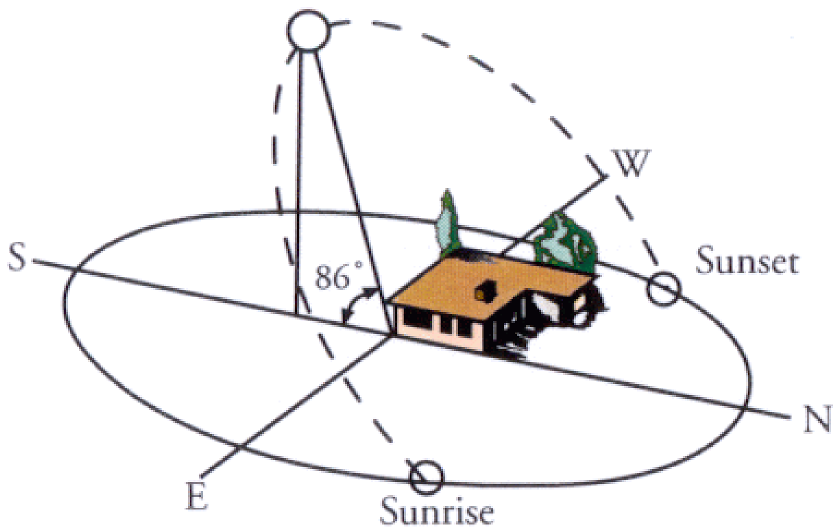
Heat Flows Through Windows



Insulated windows reduce conduction, convection, and radiation



SUMMER

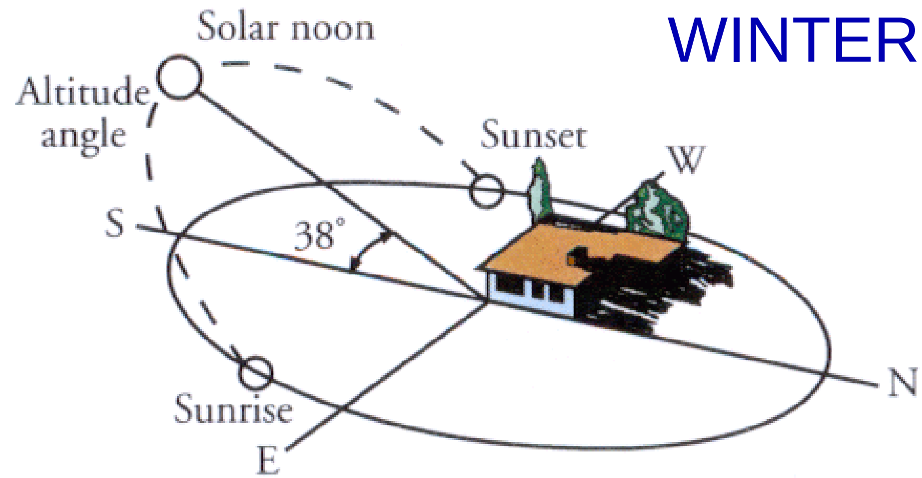


Sunpath on summer solstice at southern latitude

Sun rises north of due east, sets north of due west, and is high in the sky at noon

Shade:
overhang for noon
east to northeast morning
west to northwest afternoon

WINTER

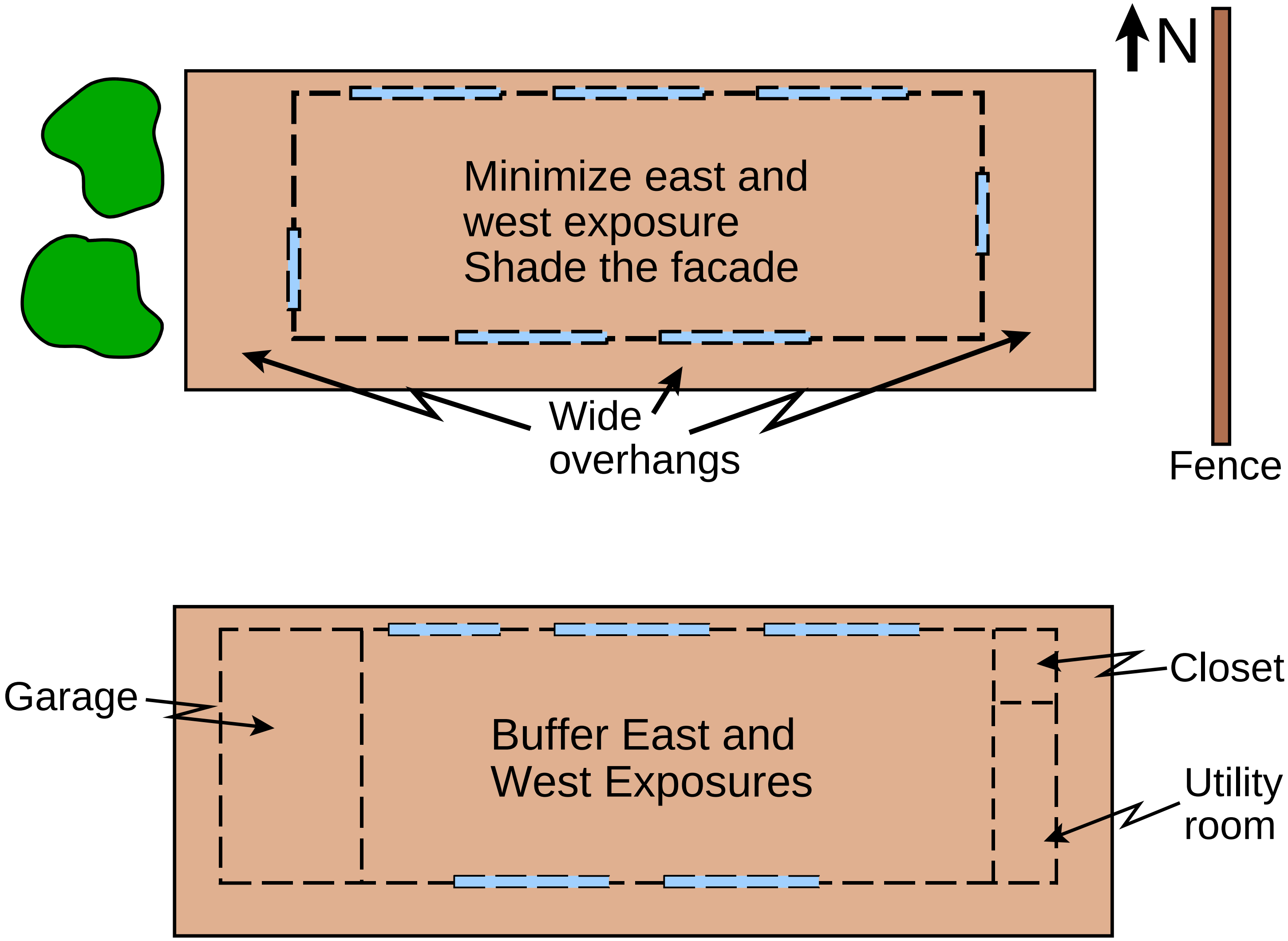


Sunpath on winter solstice at a southern latitude

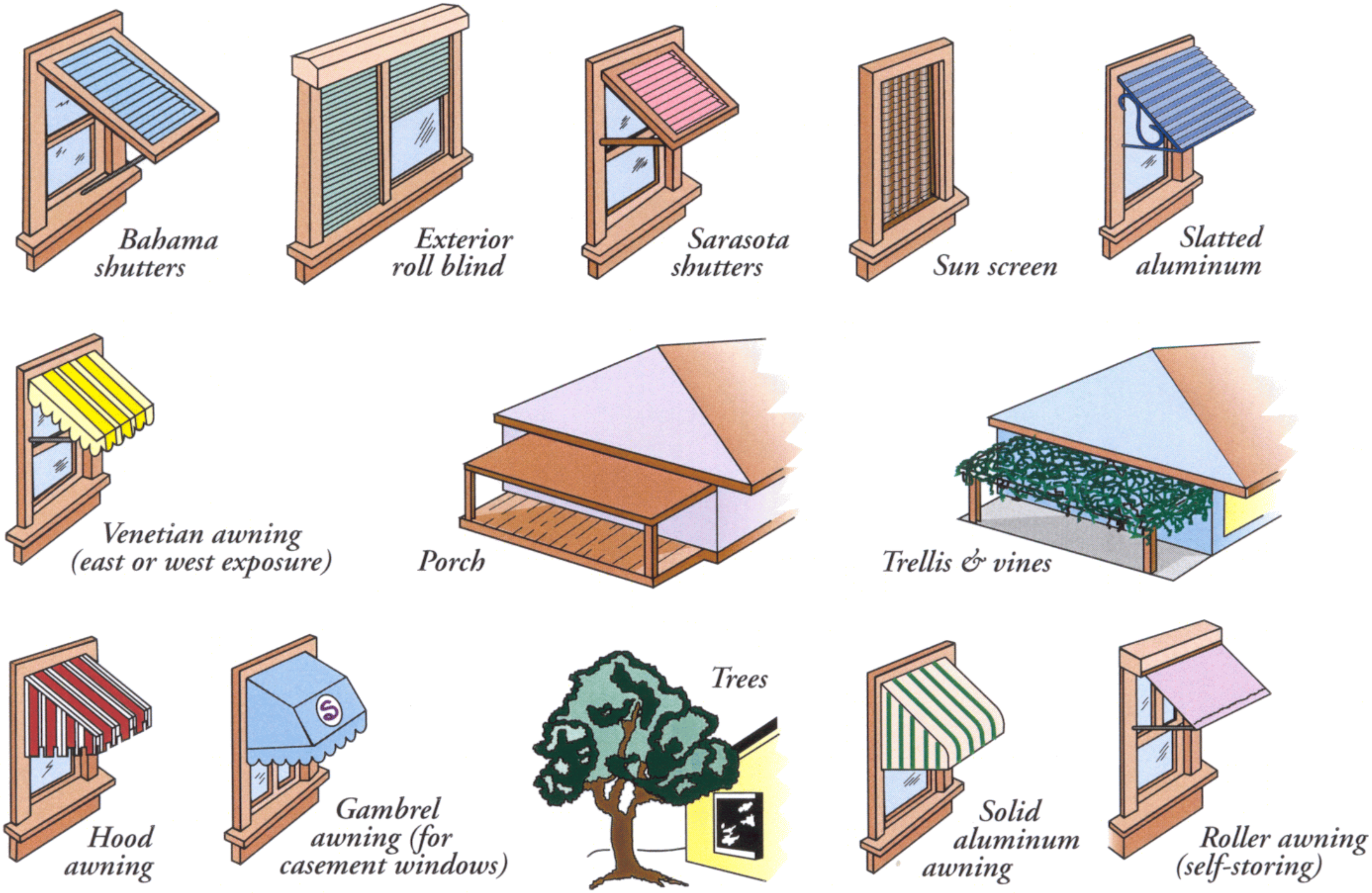
Sun rises south of due east, sets south of due west, and is low in the sky at noon

Shade: southwest to west to protect west window on warm winter days

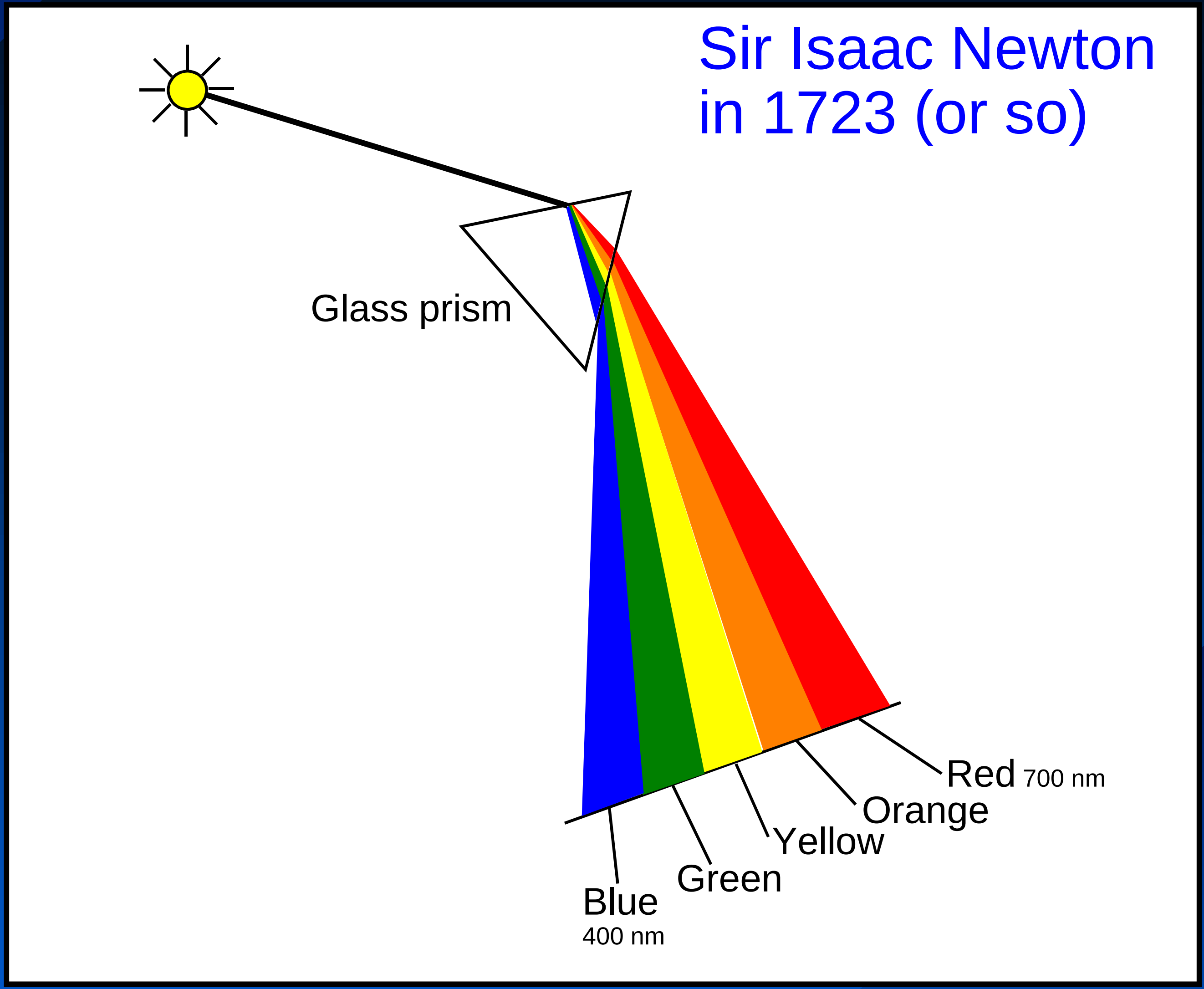
Orientation and shading



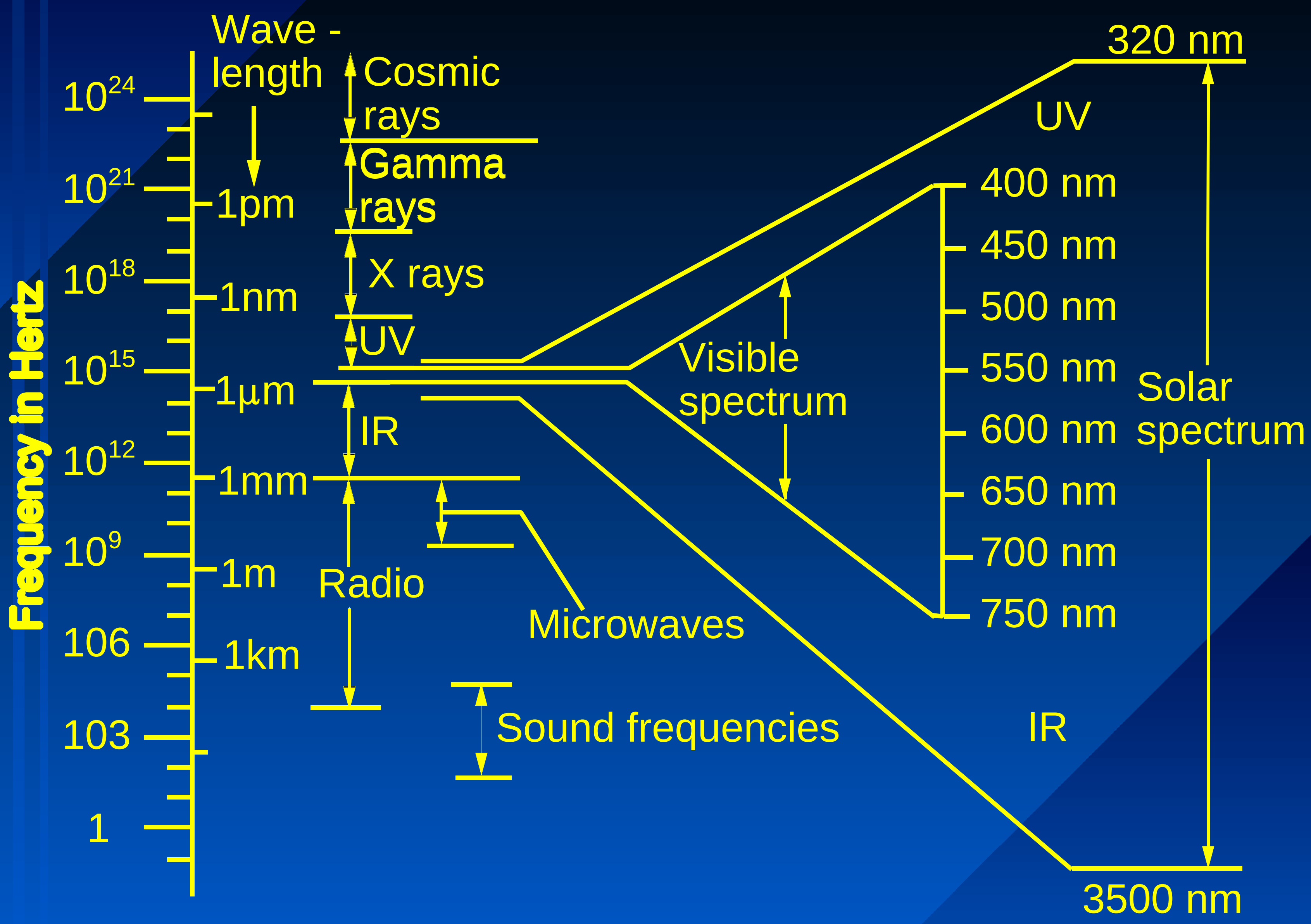
Exterior window shading strategies



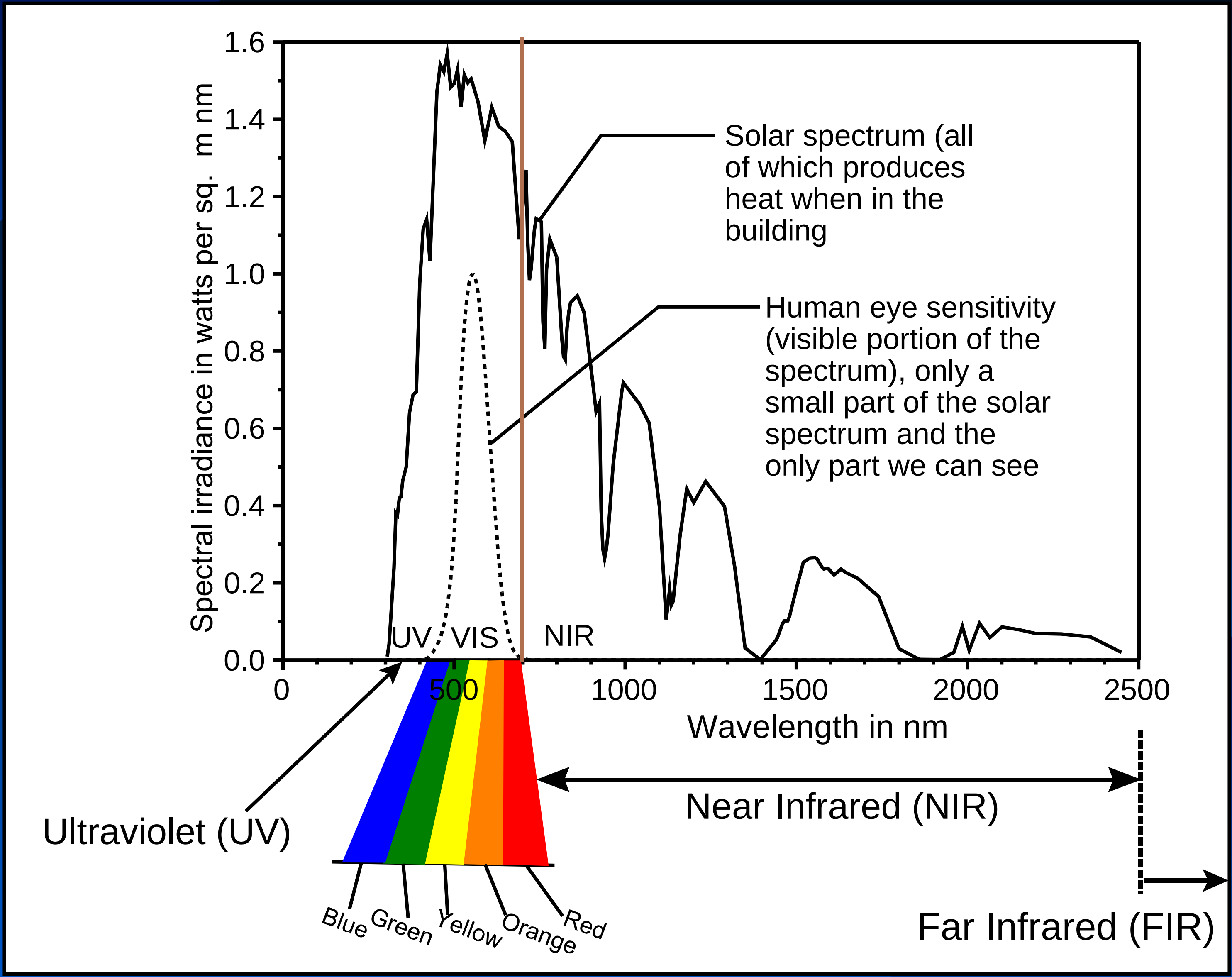
Breaking sunlight into its various colors



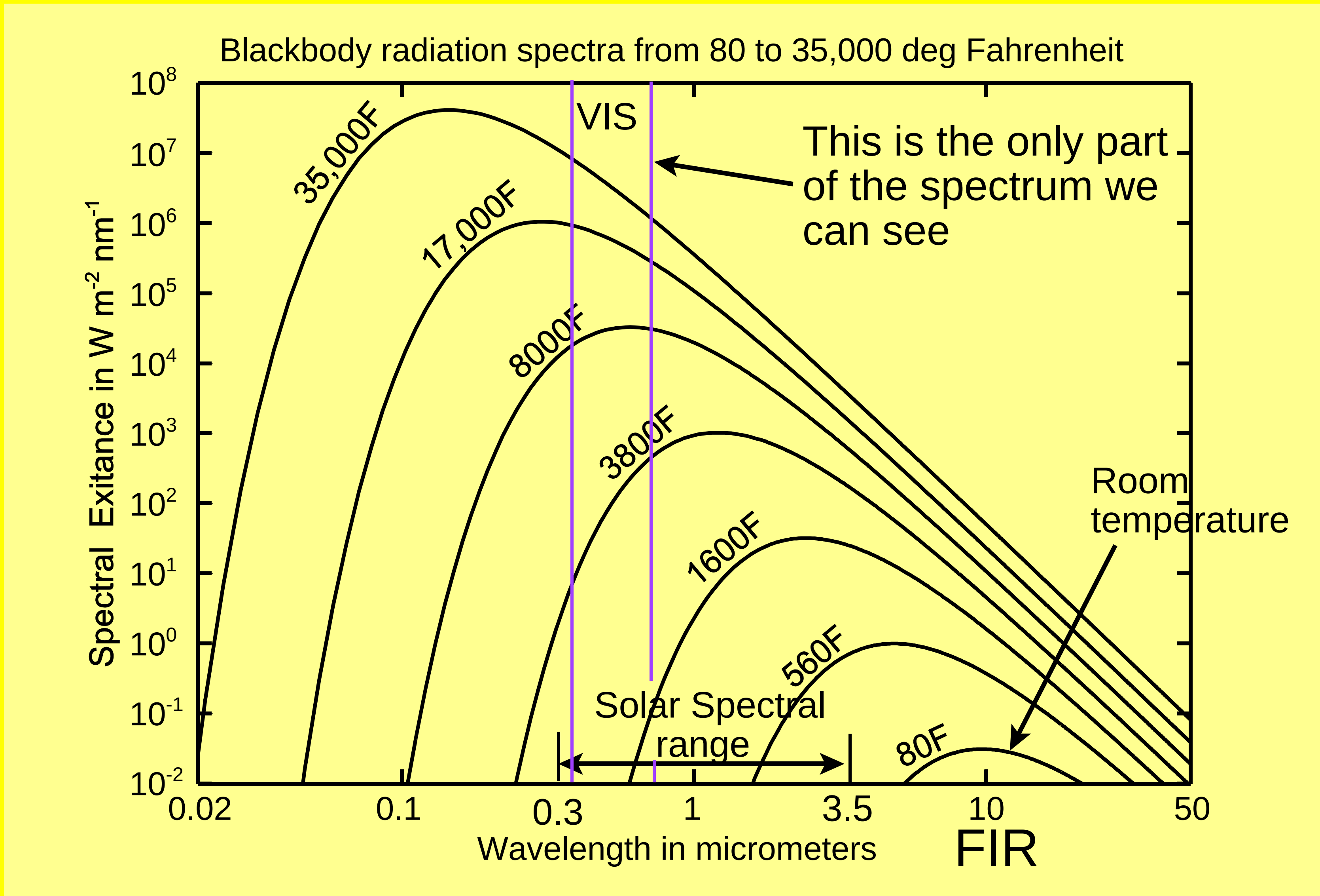
Electromagnetic Spectrum



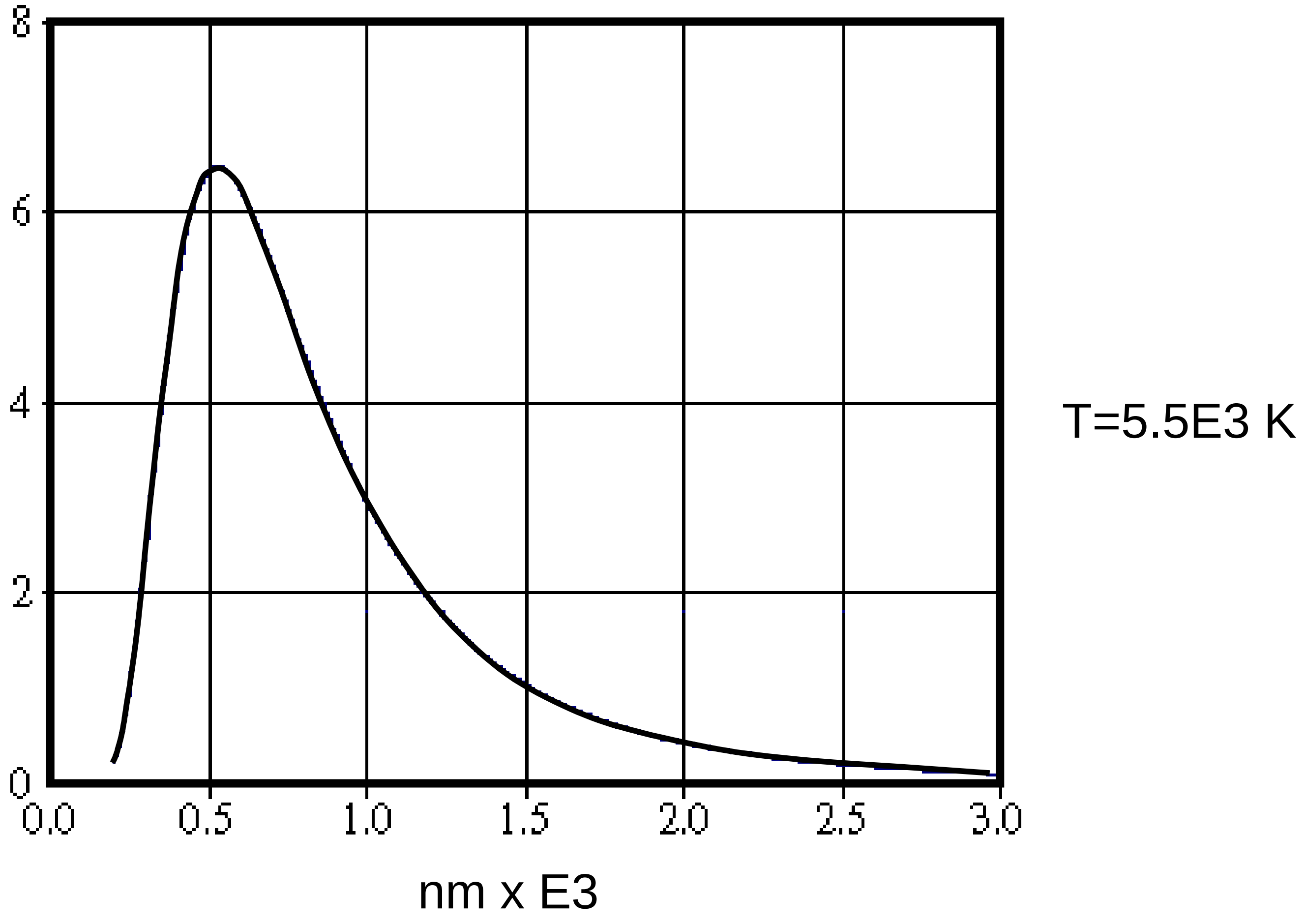
Parts of the solar spectrum



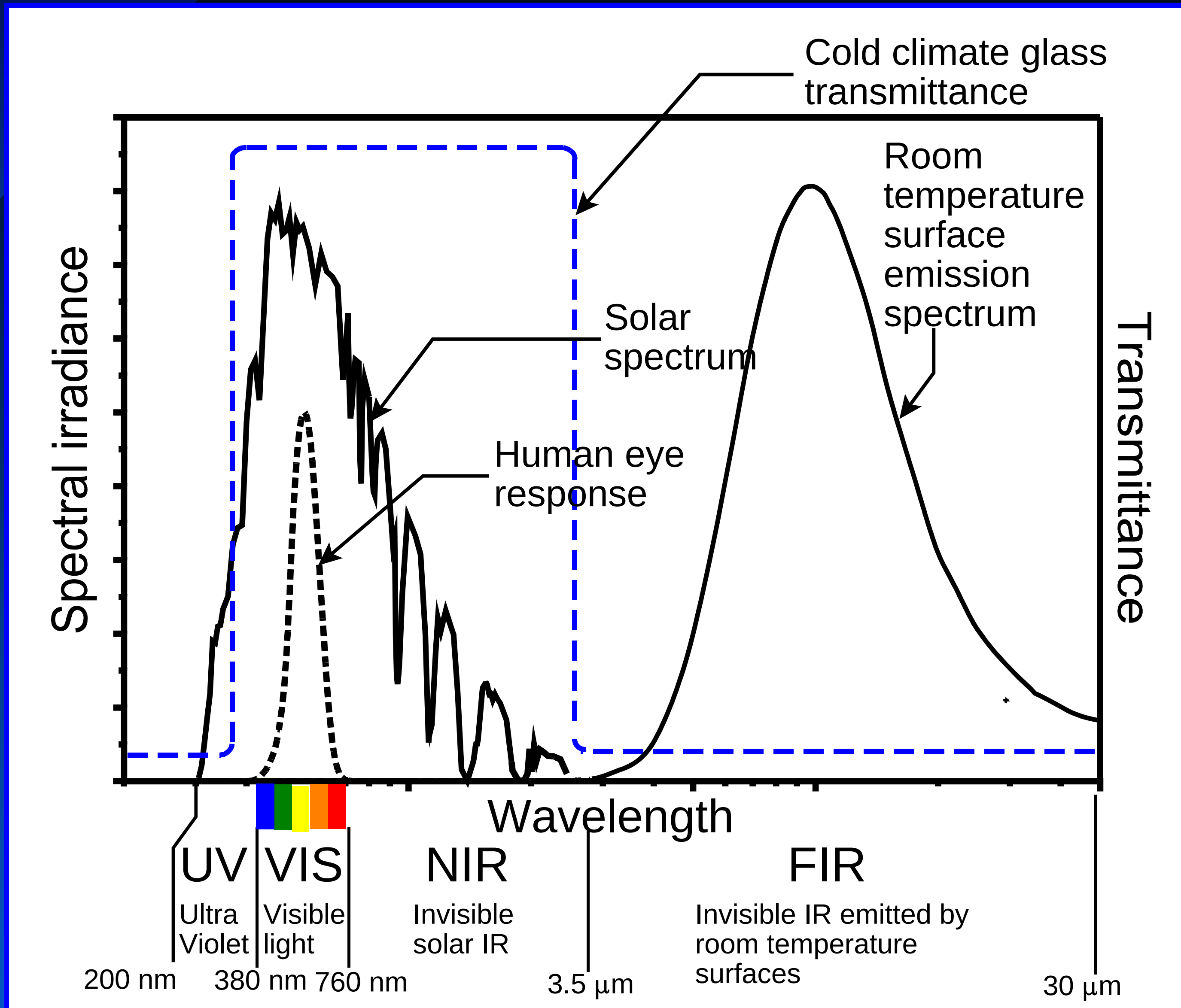
Warm Objects Emit Radiation



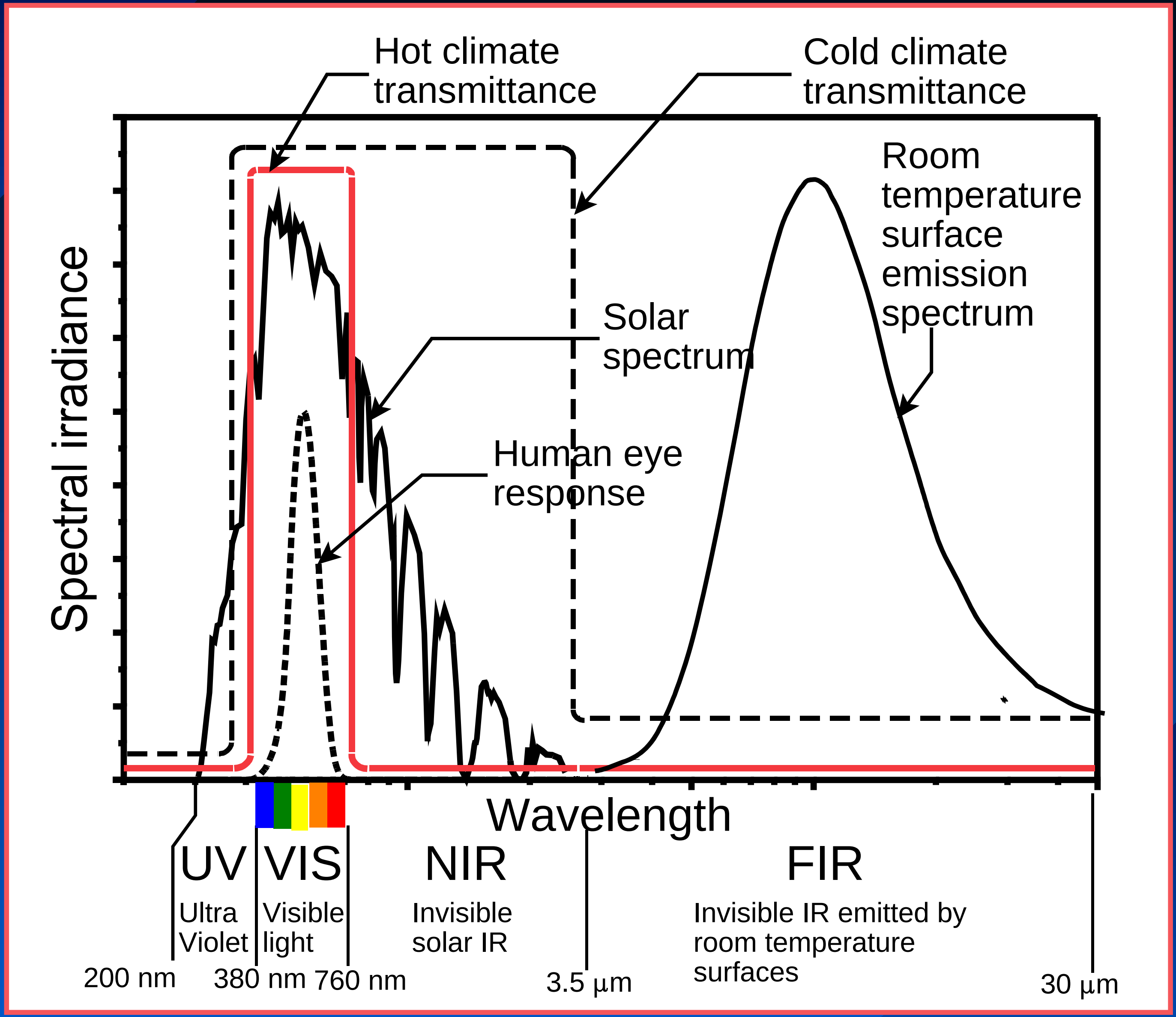
Blackbody Spectral Shape on Linear Scale



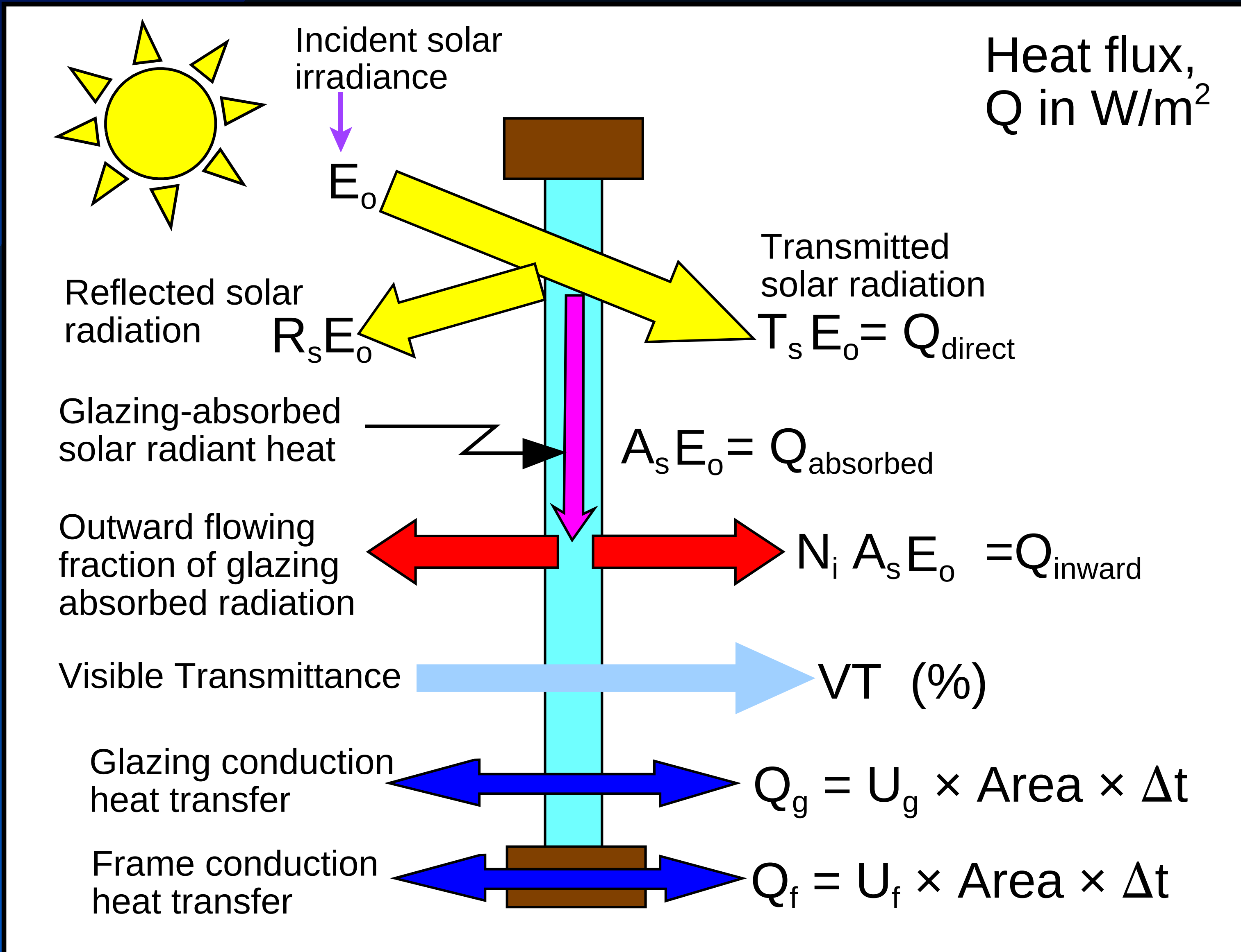
Spectral Selectivity - 1



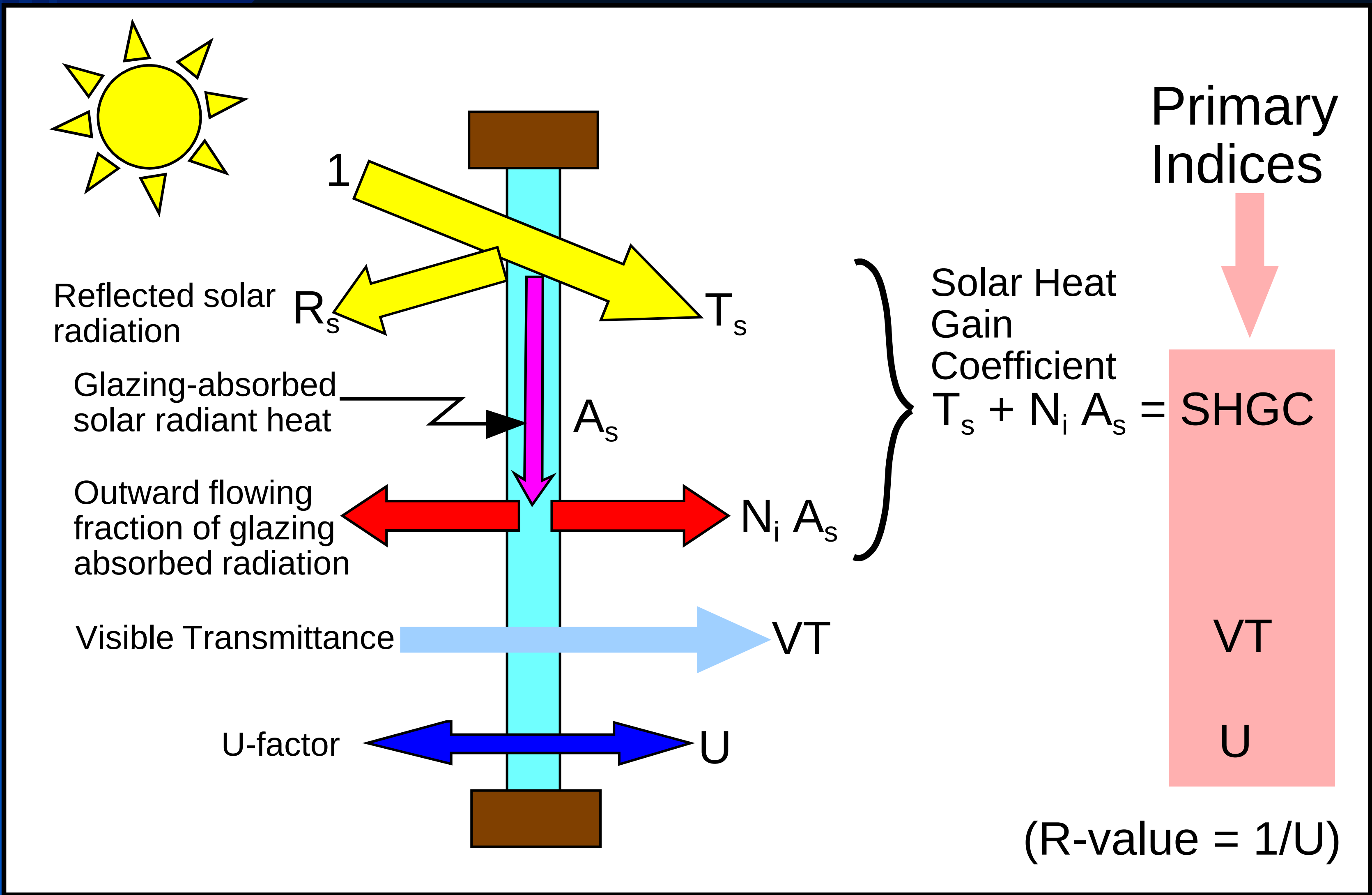
Spectral Selectivity - 2



Quantifying Heat Flows



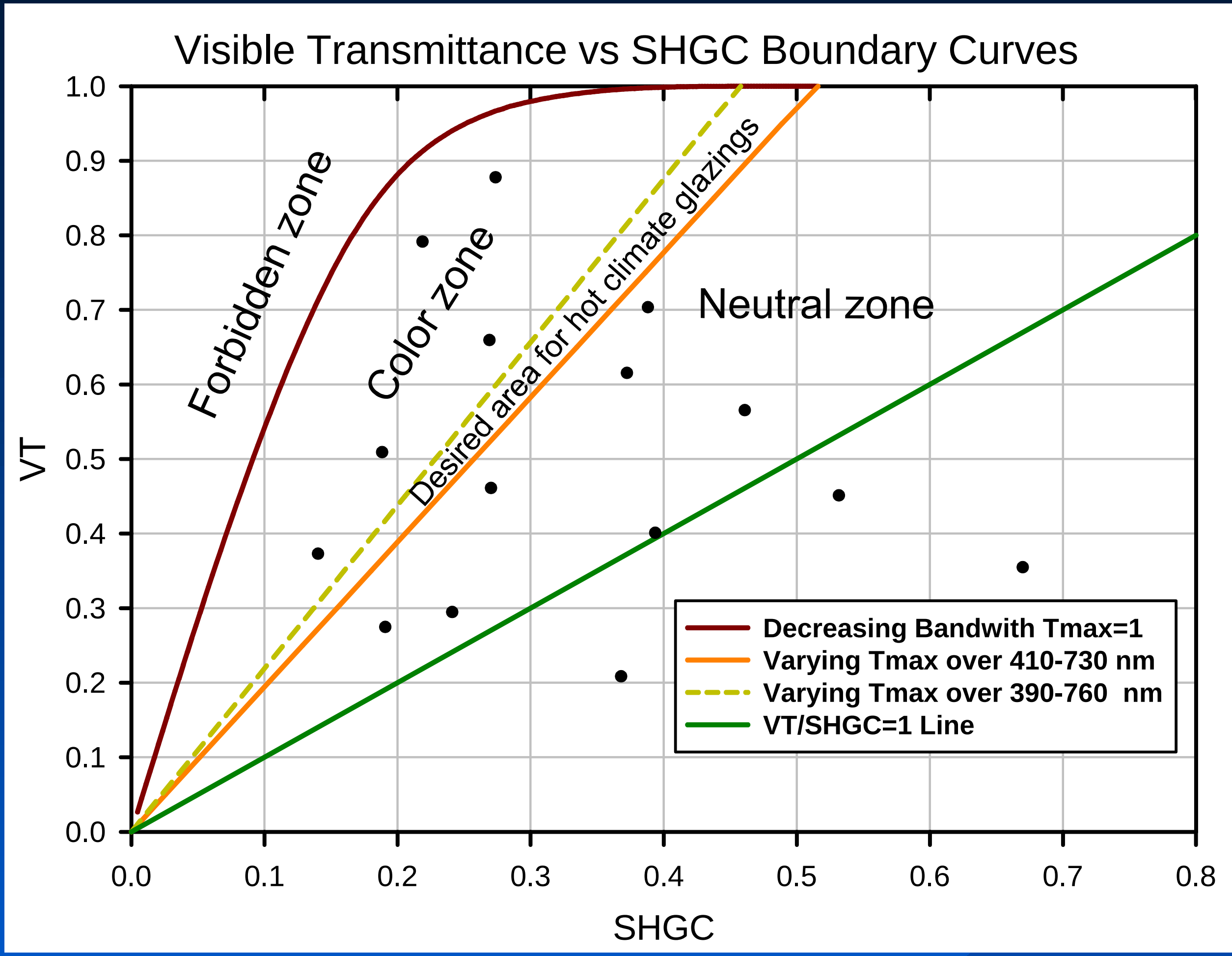
Performance Indices



Spectrally Selective Glazing Systems

Introduction to the Light-to-Solar-Gain (LSG) Ratio

The optical properties of different glazing systems can be plotted on this chart, to see how they compare with other glazings



Light to Solar Gain ratio
- A measure of spectral selectivity

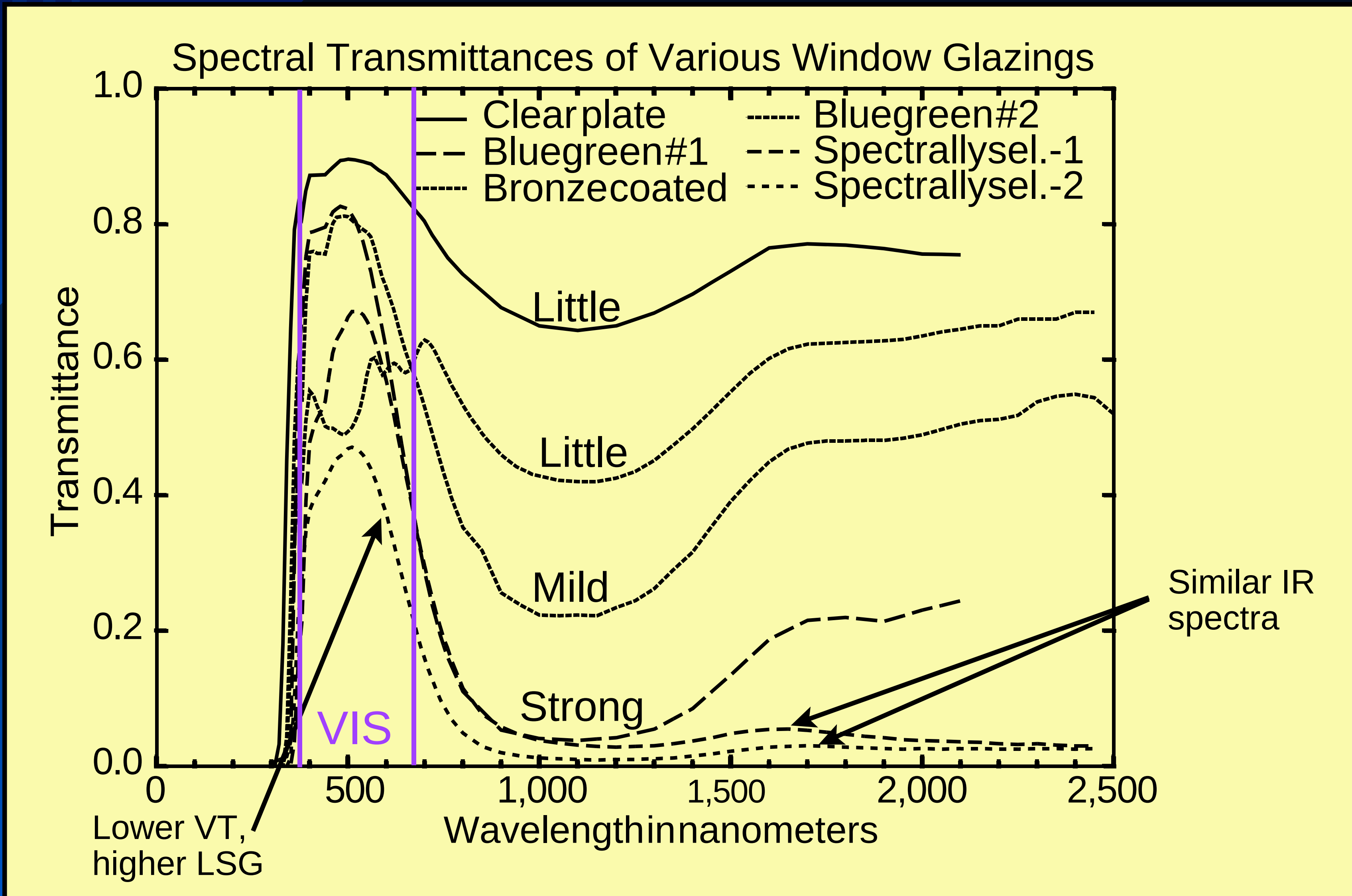
VT Visible transmittance:
Fraction of incident light transmitted

SHGC Solar heat gain coefficient:
Fraction of incident solar radiation admitted as heat gain

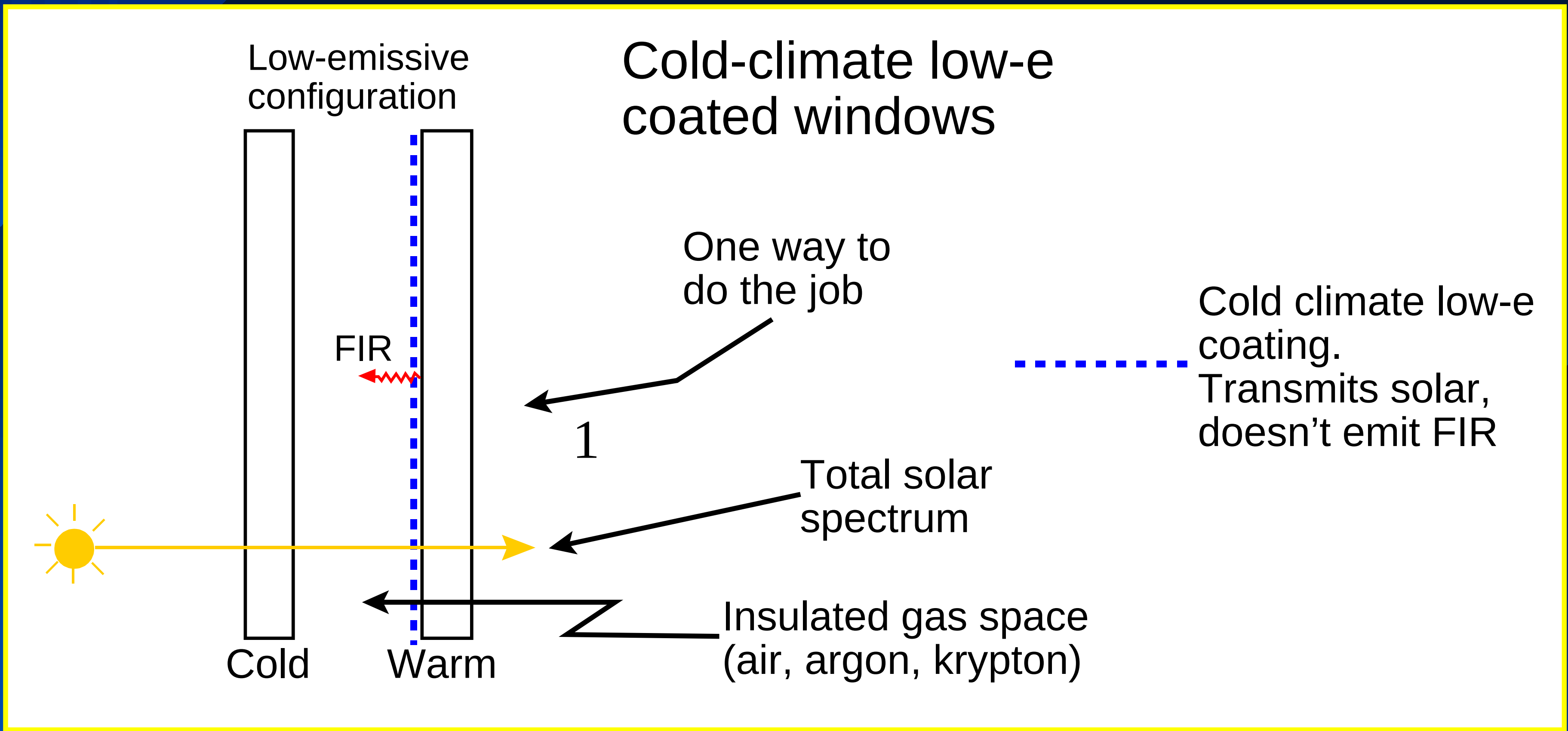
LSG Light-to-Solar Gain ratio:
Ratio of visible transmittance to solar heat gain coefficient

$$\mathbf{LSG} = \frac{\mathbf{VT}}{\mathbf{SHGC}}$$

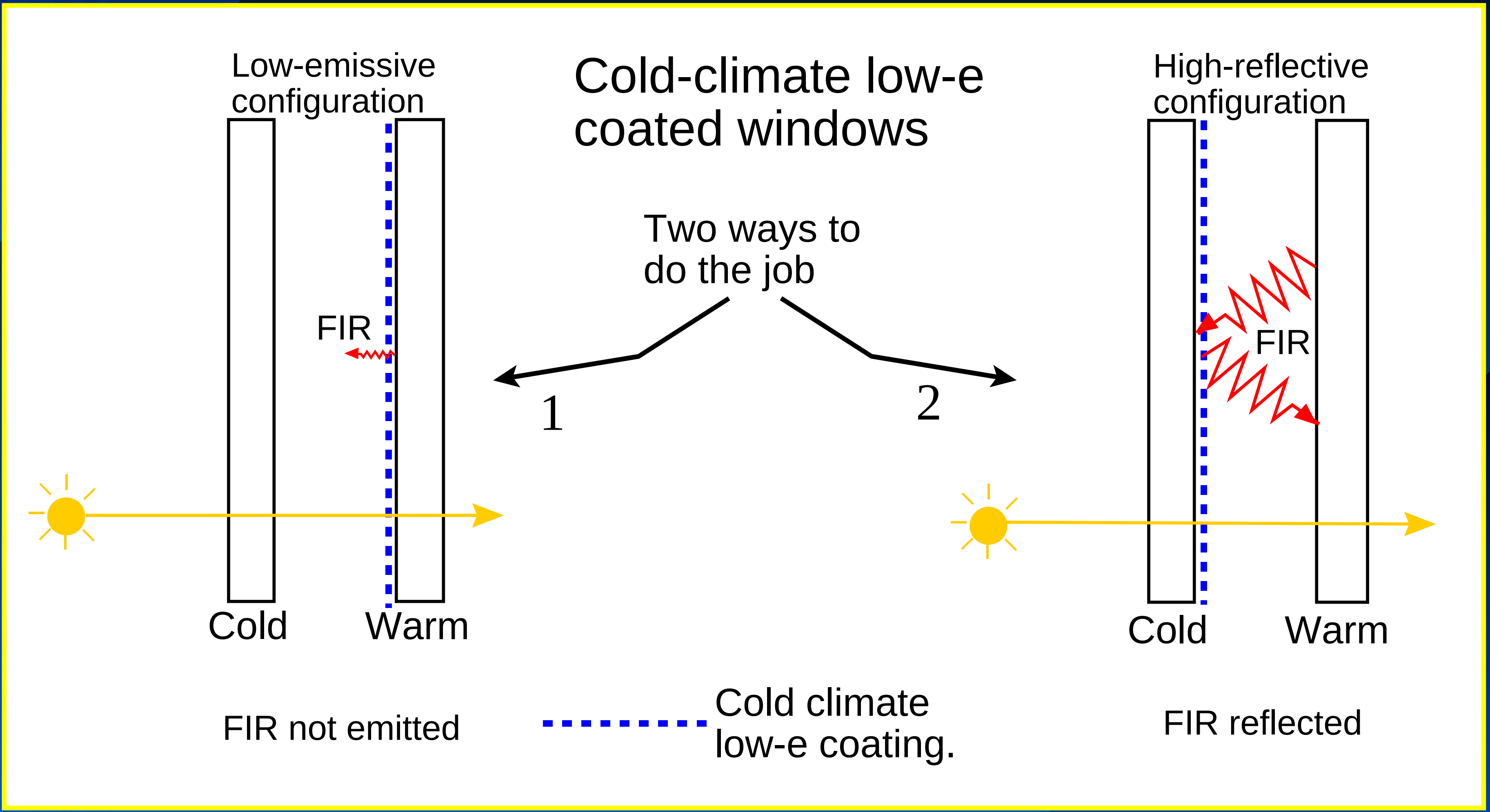
Real Spectrally Selective Glazings



Cold climate glazings
Admit and trap solar heat



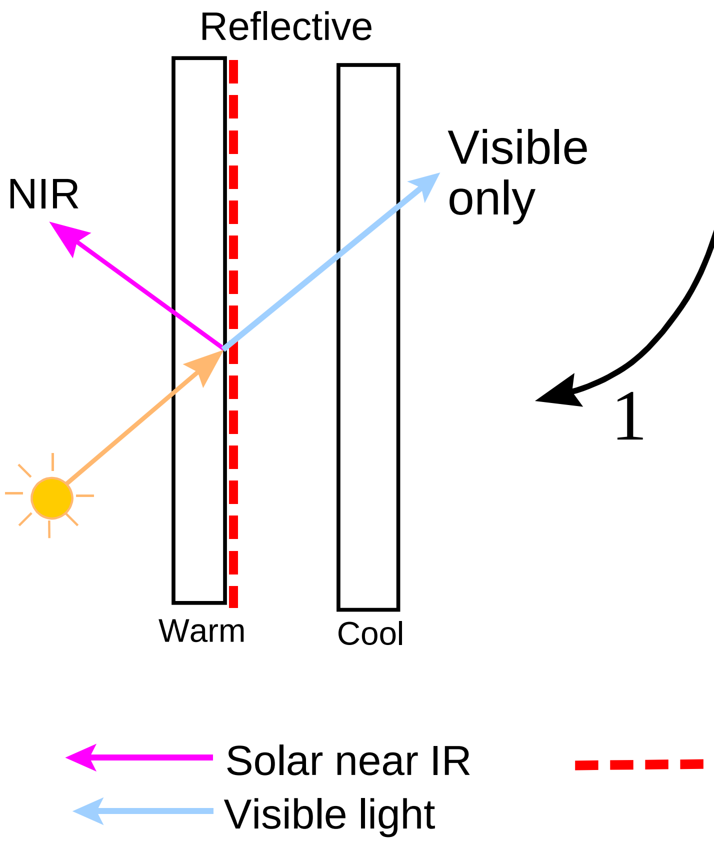
Cold climate glazings
Admit and trap solar heat



Hot Climate Glazings

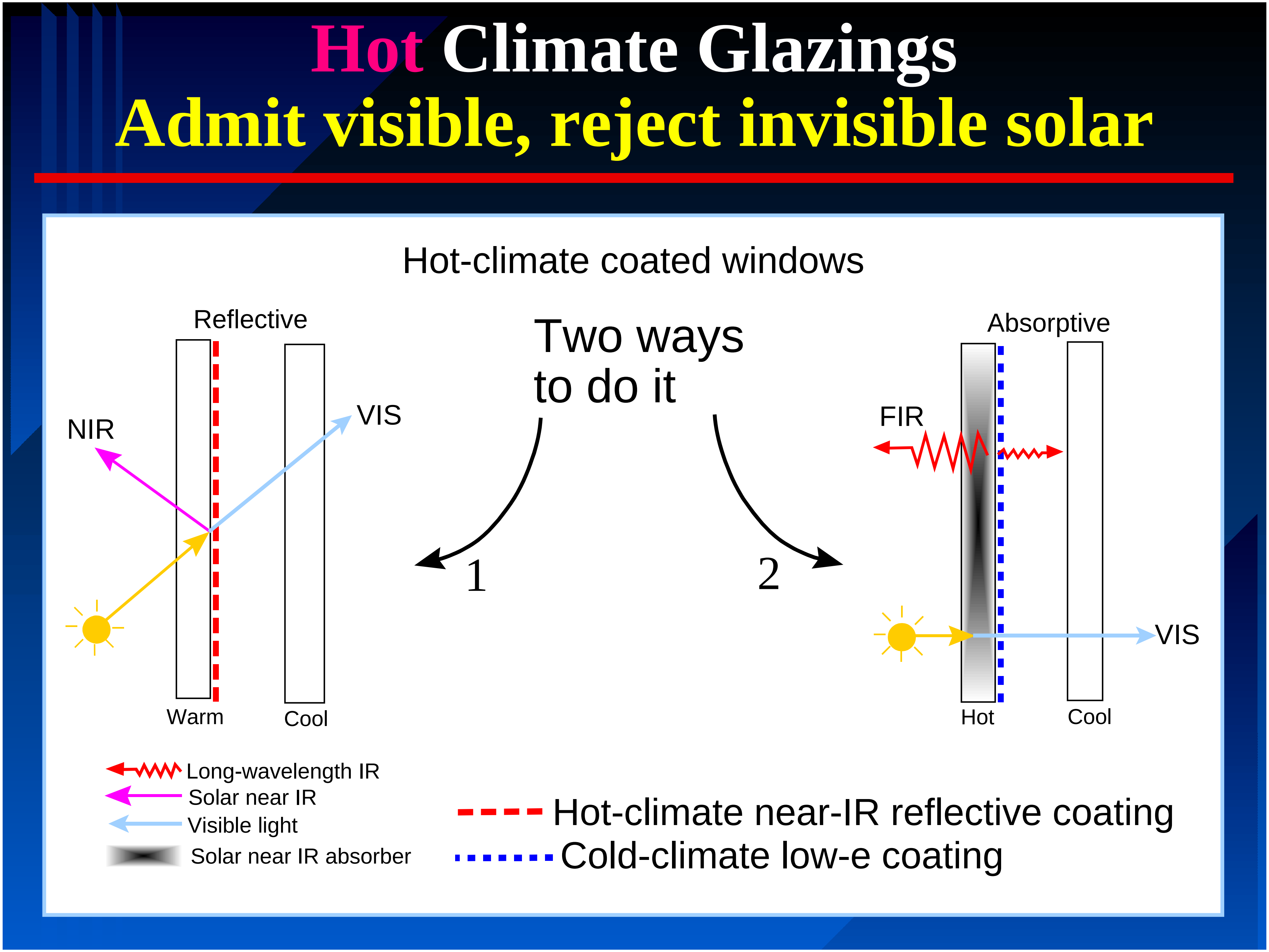
Admit visible, reject invisible solar

Hot-climate coated windows

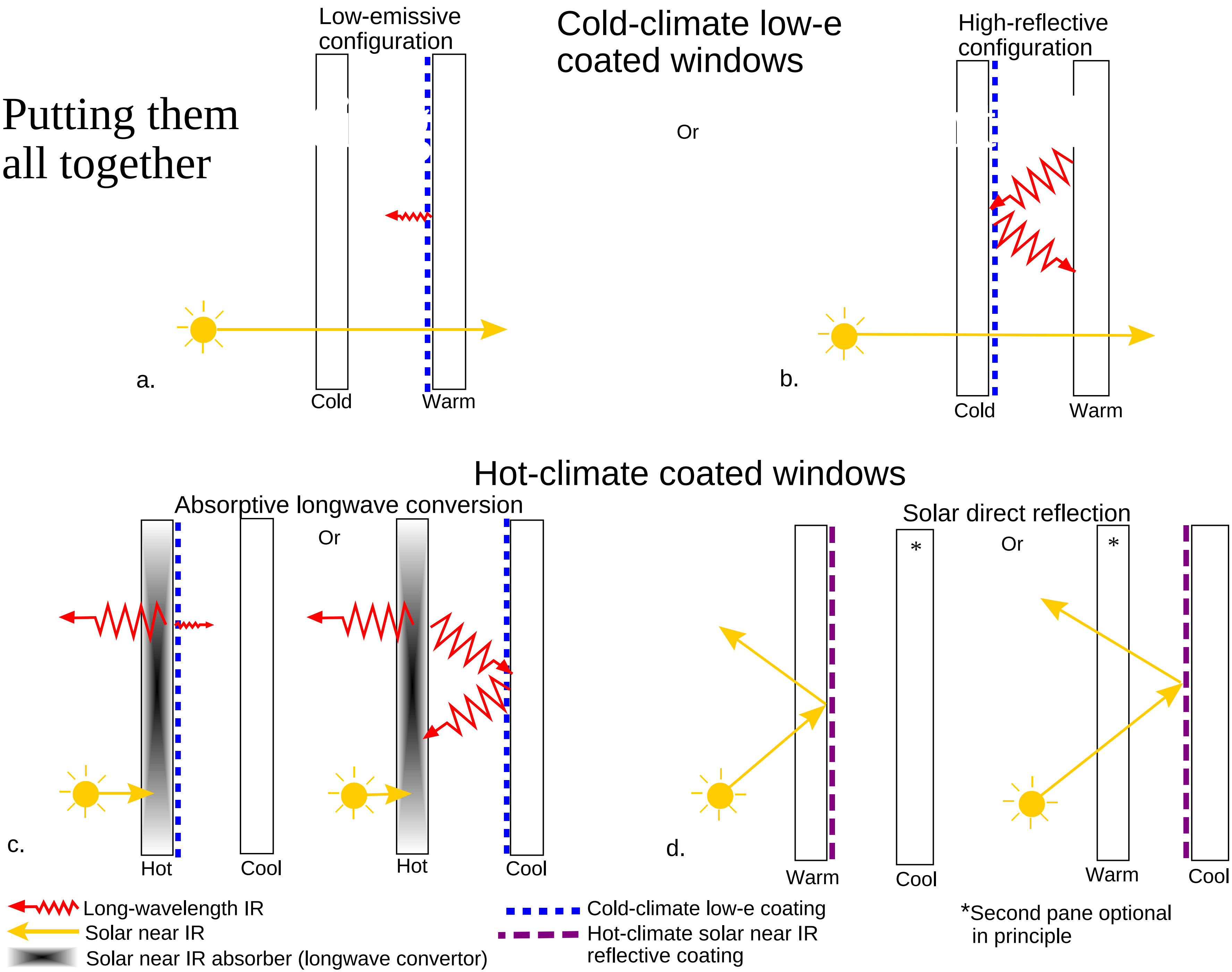


By rejecting nearly half the incident solar radiation by reflection, the SHGC is nearly half as great

Hot-climate near-IR reflective coating
(Also called “hot-climate low-e coating)


Hot Climate Glazings
Admit visible, reject invisible solar
Hot-climate coated windows
Reflective
Warm
Cool
NIR
VIS
Two ways
to do it
1
2
Absorptive
FIR
VIS
Hot
Cool
Long-wavelength IR
Solar near IR
Visible light
Solar near IR absorber
Hot-climate near-IR reflective coating
Cold-climate low-e coating

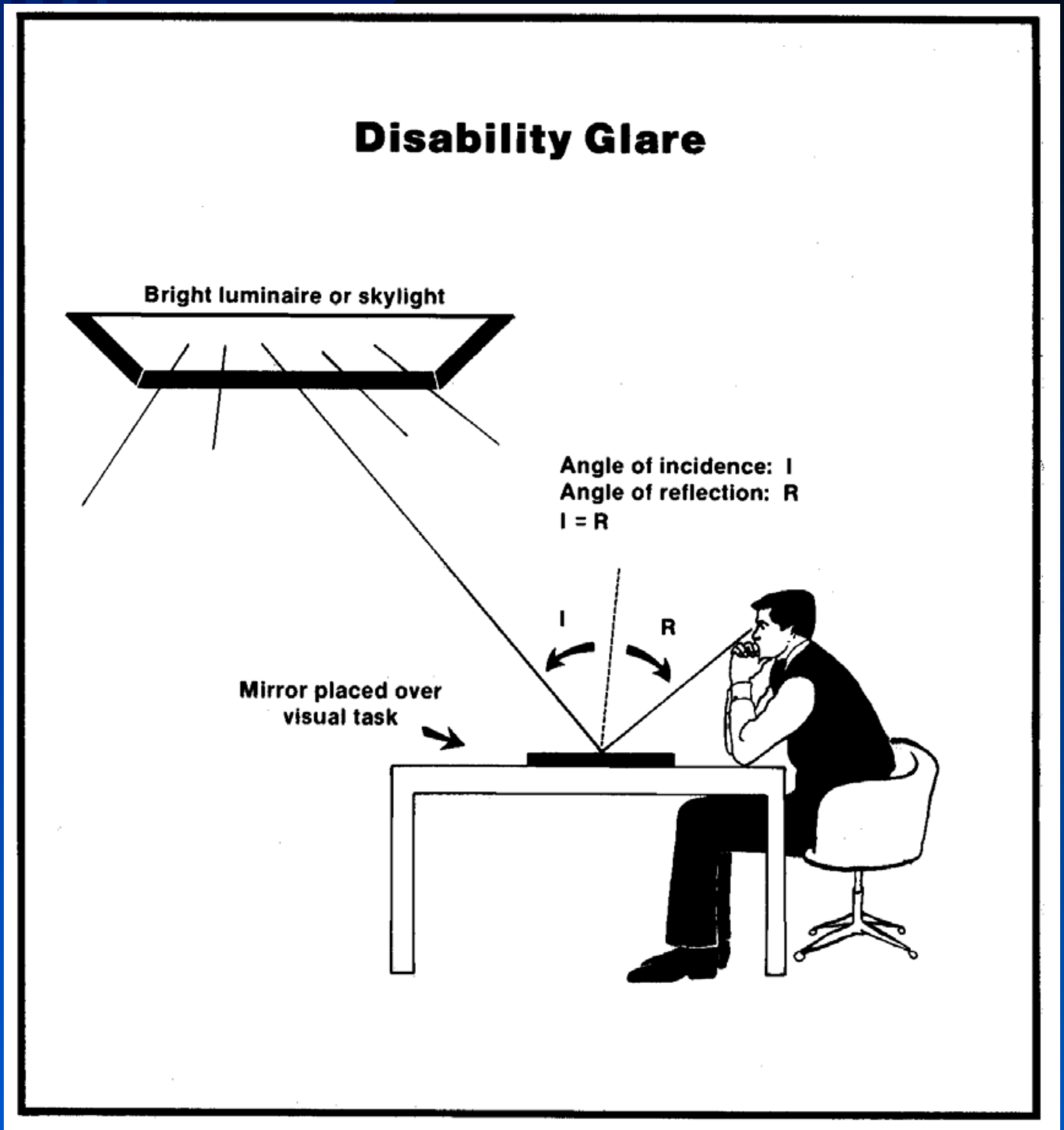
Putting them all together



Daylight Illumination

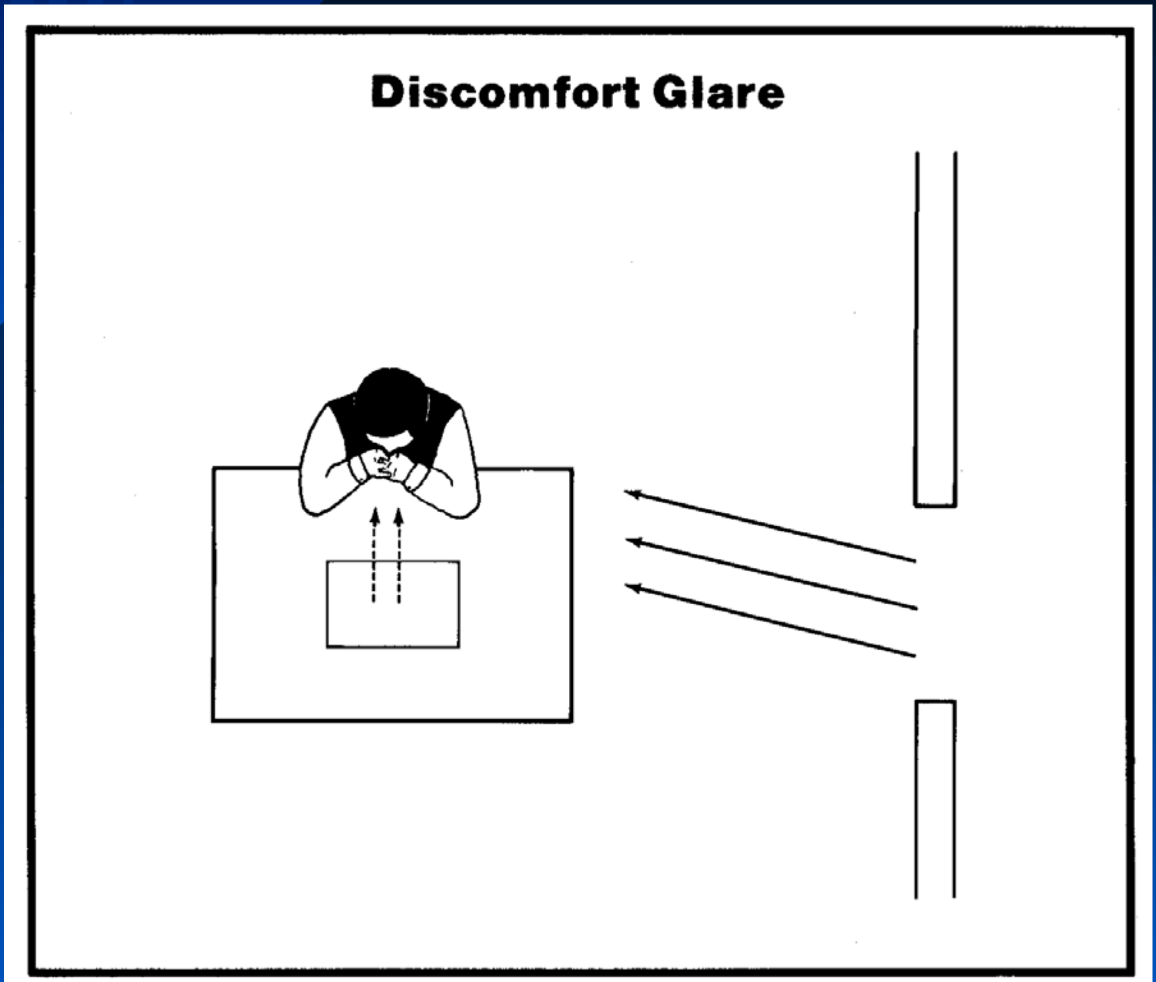
- Cool, natural daylight has good color rendering
- Daylight is healthy
- Daylighting can displace electric lighting
- Electric utility interactions
- The occupancy schedule is critical
  - Florida residential occupancies — are they different?
- Direct beam and diffuse daylight
- Glare
  - Disability glare – Disables the ability to see a visual task clearly
  - Discomfort glare – Produces extraneous light and discomfort and headaches

Disability Glare



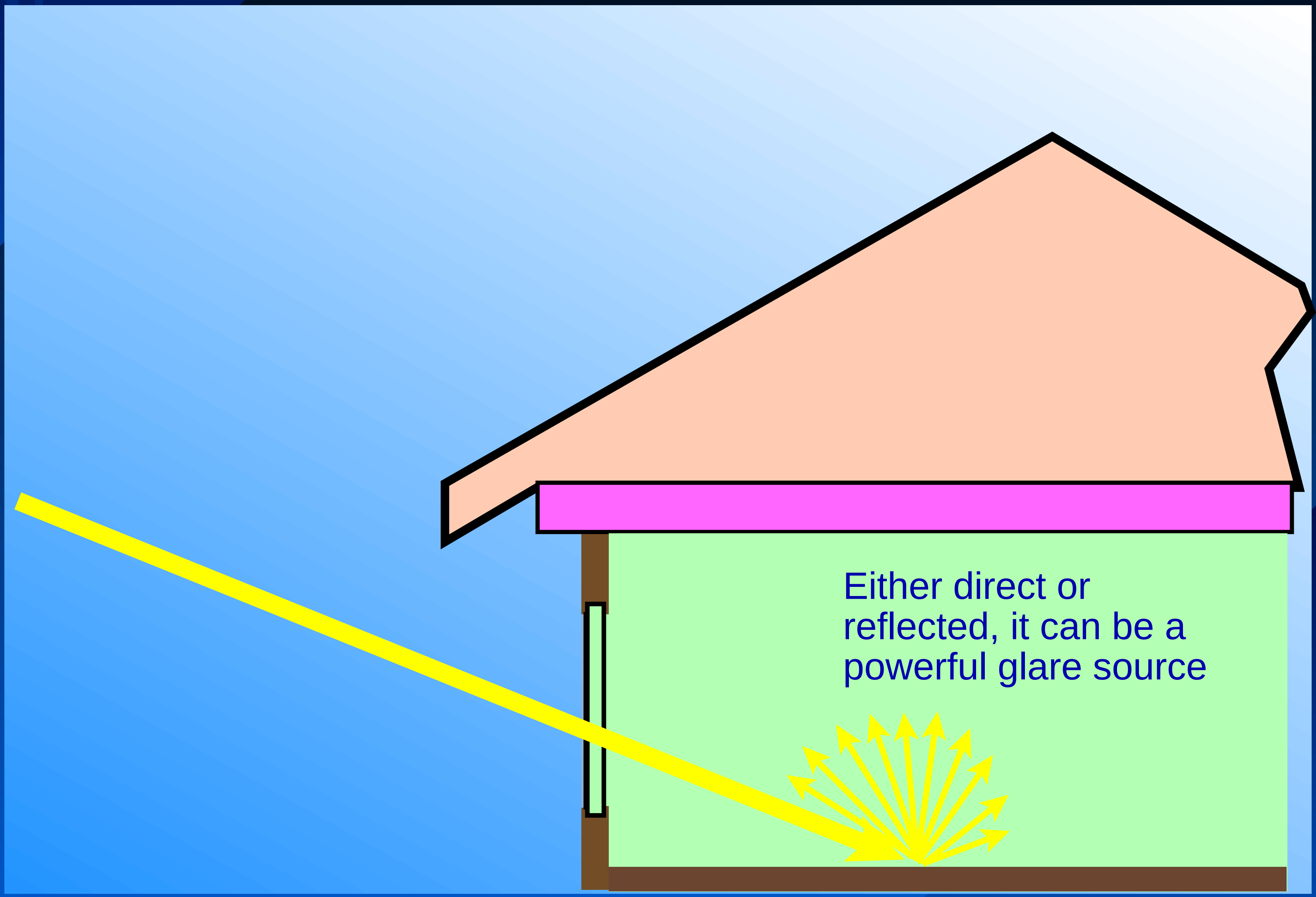
Light from overhead or behind you reflects from a shiny task. The reflected light is so bright as to greatly reduce the contrast of the task, making black letters, for example, almost as bright as the white page surrounding them. The result is a "veiling" of the task, a washing out or masking of the target, thereby disabling your ability to see the task. This is why it is called disability glare.

Discomfort Glare

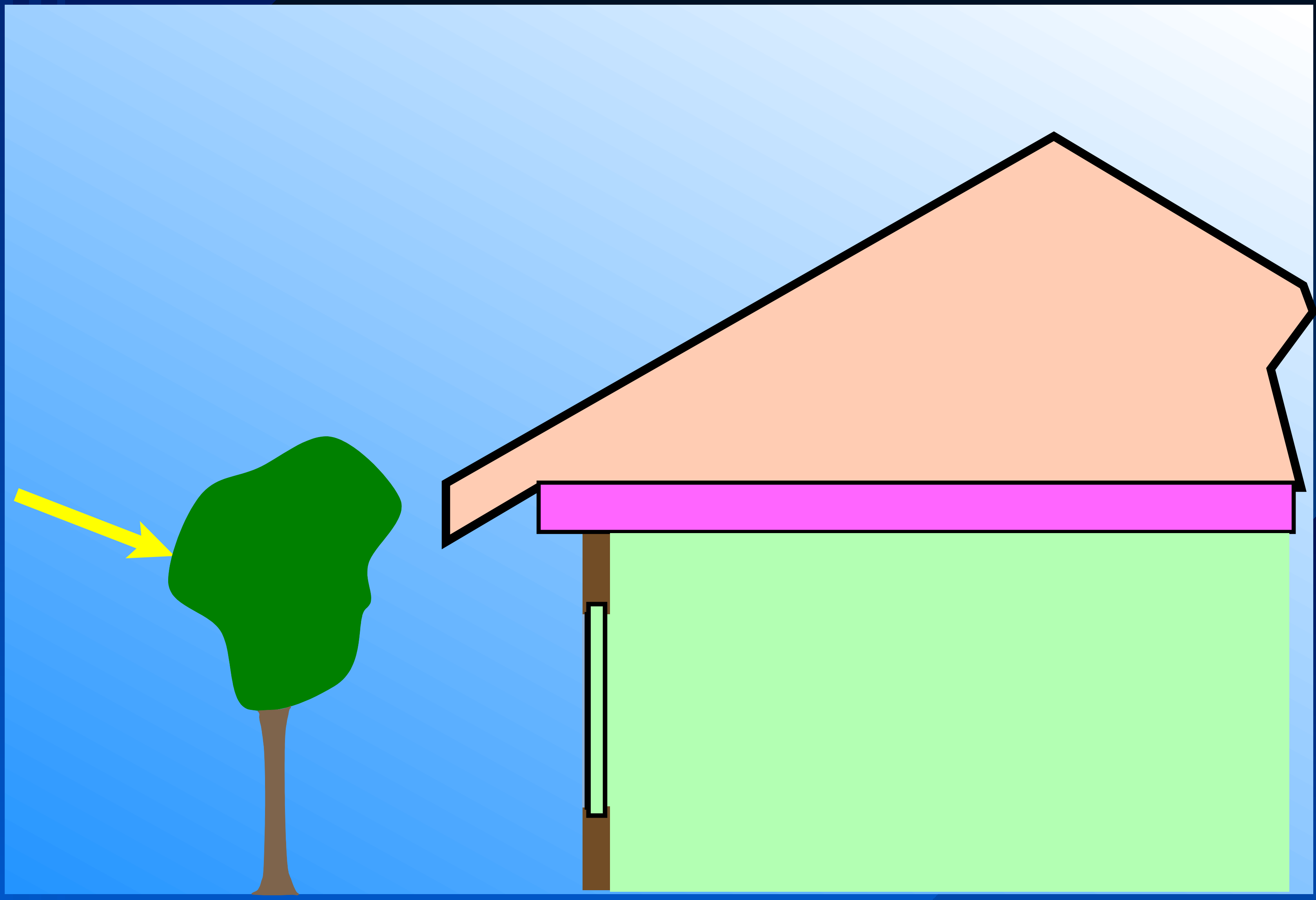


Bright light from the side enters the eye and bounces around in there. The neural system is confused by the presence of this light brighter than the task you are trying to see. The contrast of the task is not directly reduced but the brain has to work hard to see and recognize the task. This kind of glare is like "light pollution" since it is unwanted and mainly annoying. It can produce headaches when in prolonged exposure to it. The problem is mitigated by reducing the comparative brightness of the glaring source or moving it behind you where the light cannot enter your eye.

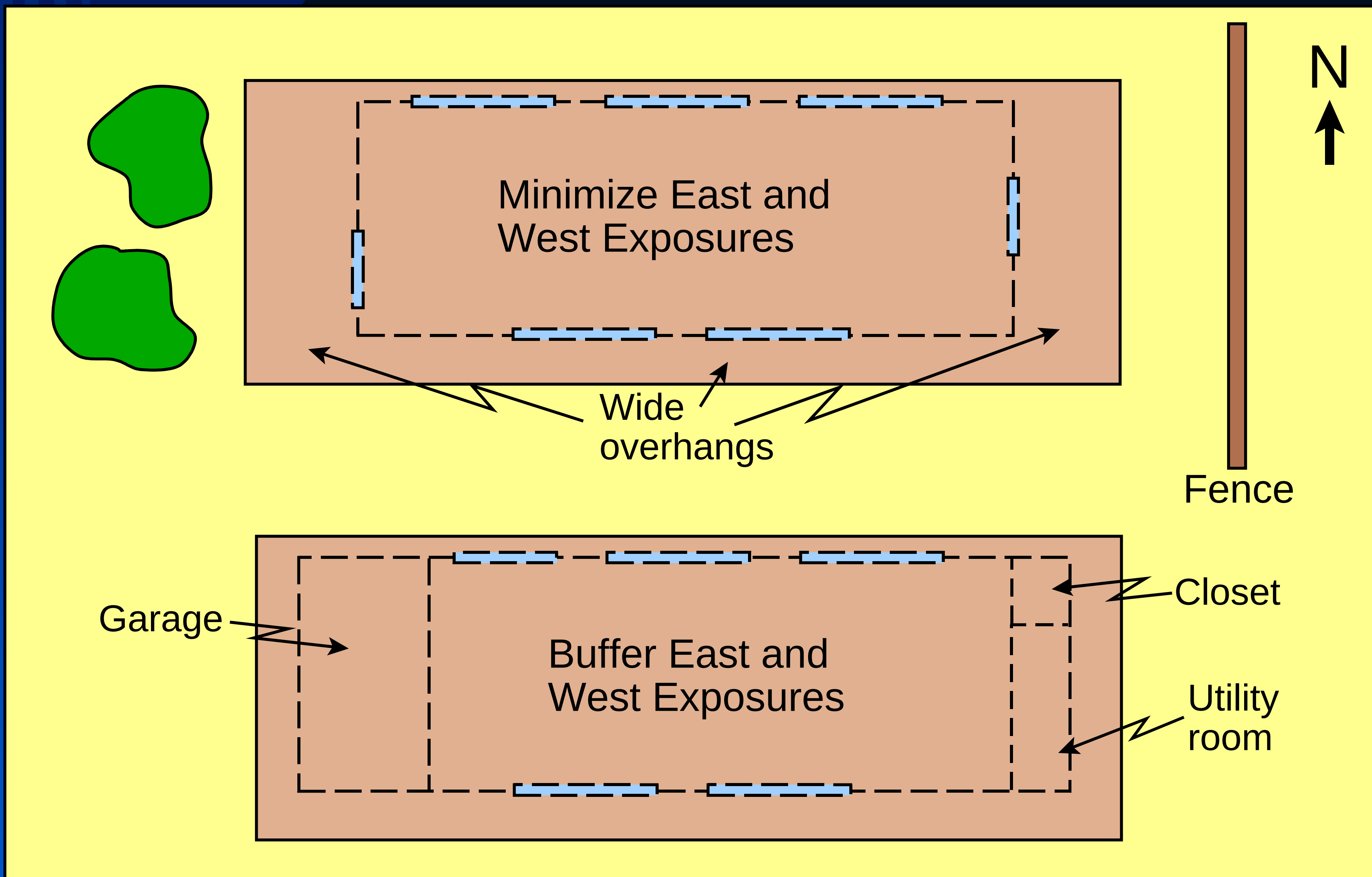
Direct Beam Solar Radiation



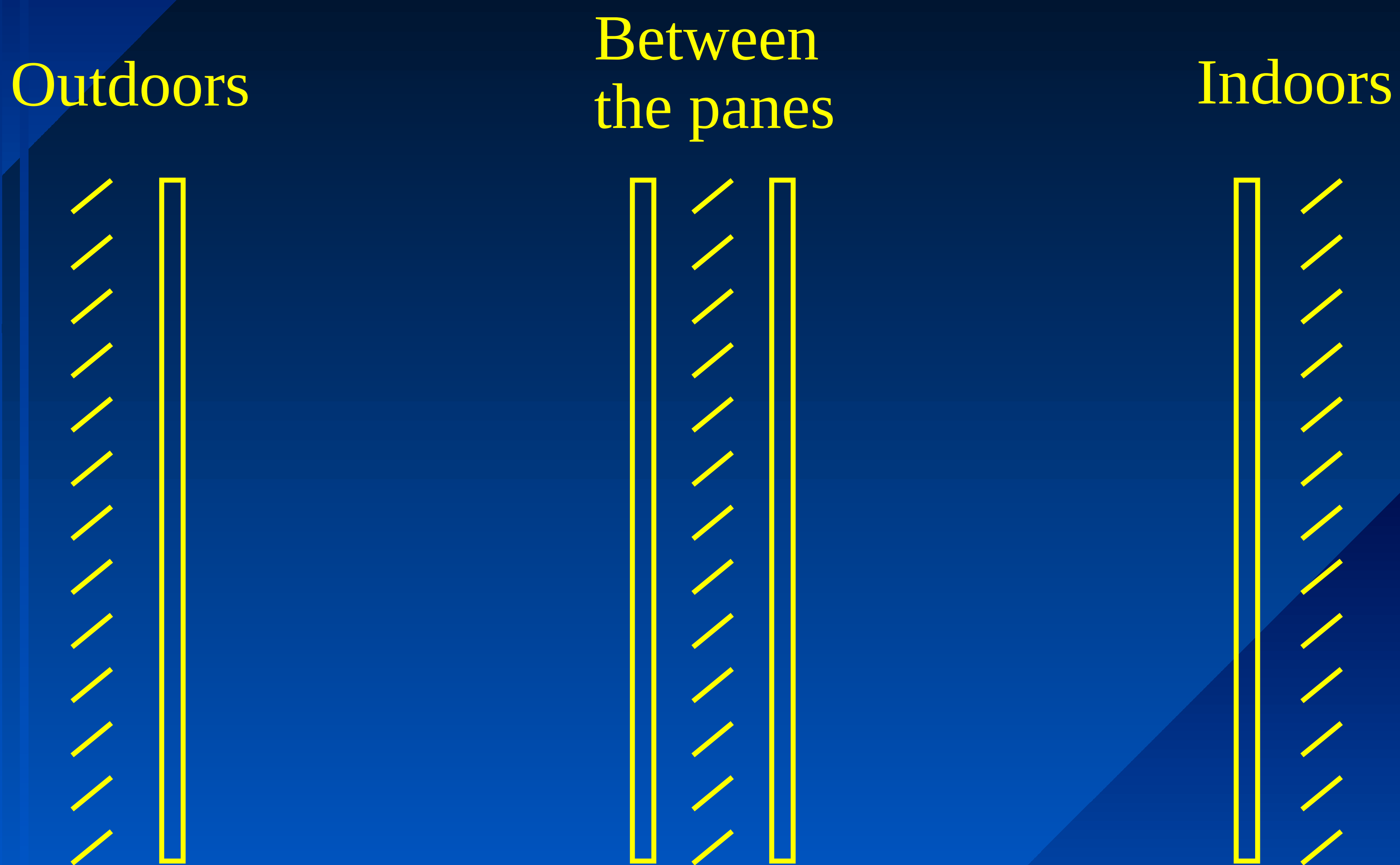
Avoiding Direct Beam



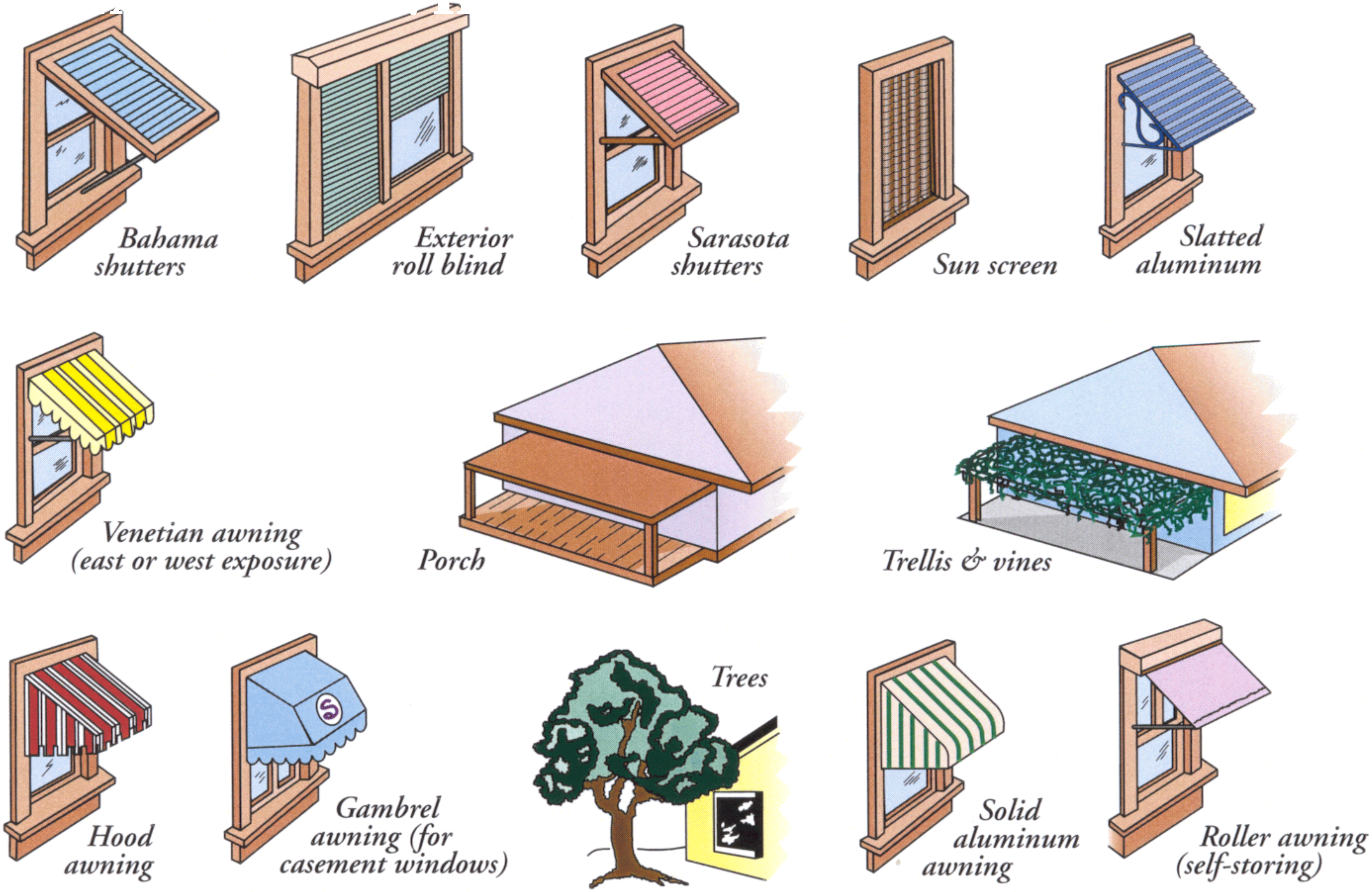
Orientation & Shading Strategies



Window Shading Strategies



Exterior window shading strategies



High Performance Glazing Systems

When shading is not permitted, desired, or possible

- To minimize solar heat gain, use **hot-climate low-e coated** glazings with **high LSG** ratio

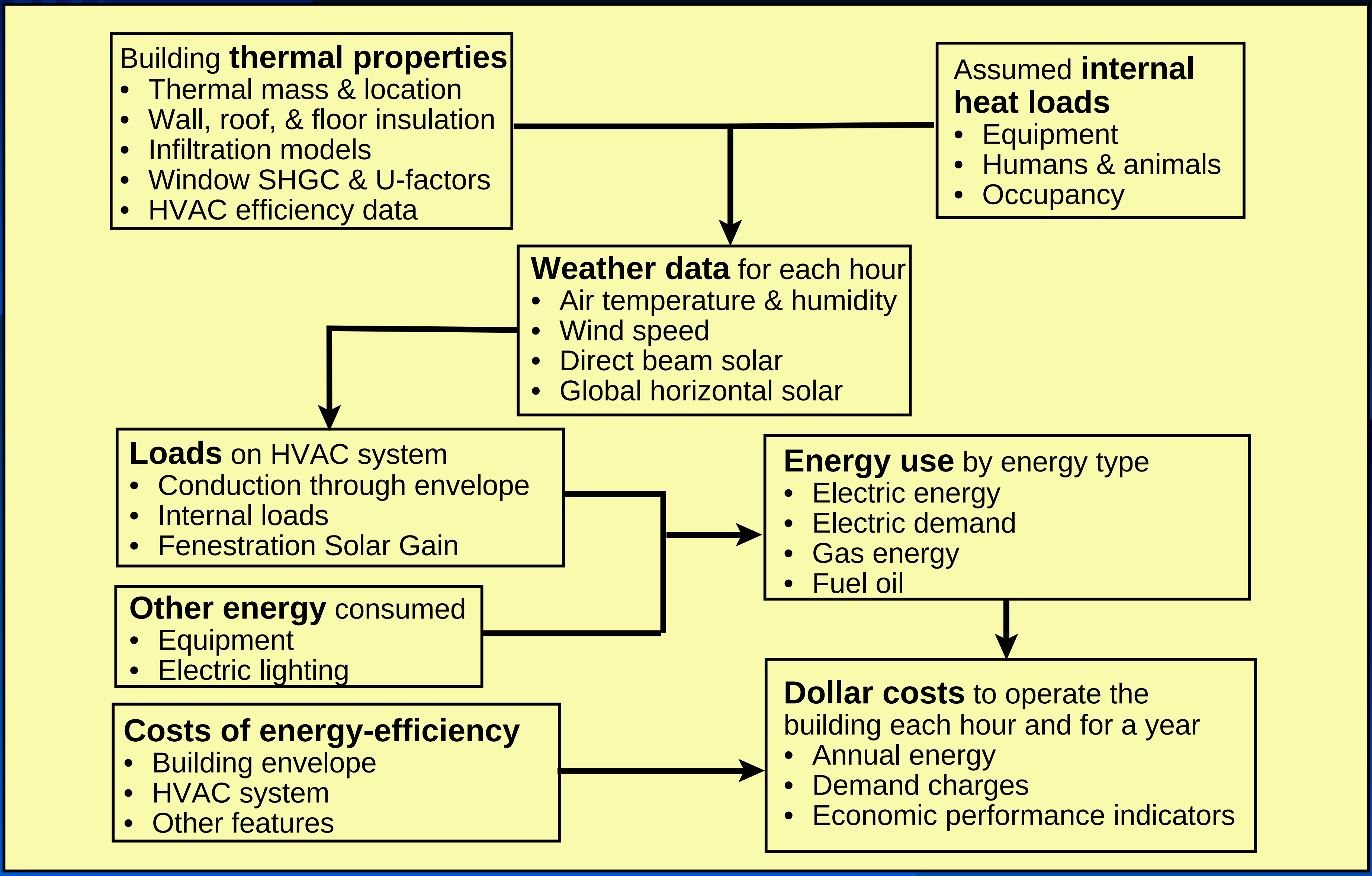
- Choose VT to fit the situation
  - **VT high** for north-facing and exposures already shaded fairly well
  - **VT low** for east- and west-facing exposures inadequately shaded

- To reduce peak load, enhancing comfort and allowing smaller air conditioners, use **double pane** windows
  - **Impact resistant** for coastal zone
  - **Insulated frames** to reduce condensation and improve comfort further

Energy Performances of Window Options

- Different window options have different energy consequences
- **Instantaneous** versus **long term hourly** performance
- For instantaneous perf., get the NFRC label information:
  U-factor   SHGC   VT
- But how do you know good values of these parameters for your application?
- You need a tool that tells you about the long-term energy and peak load consequences of a given choice
- And you would like a way to convert energy efficiency information into economic information, such as payback time
- Before describing the options, we need some background on how energy programs work and on economic indicators

Hourly Building Energy Simulations

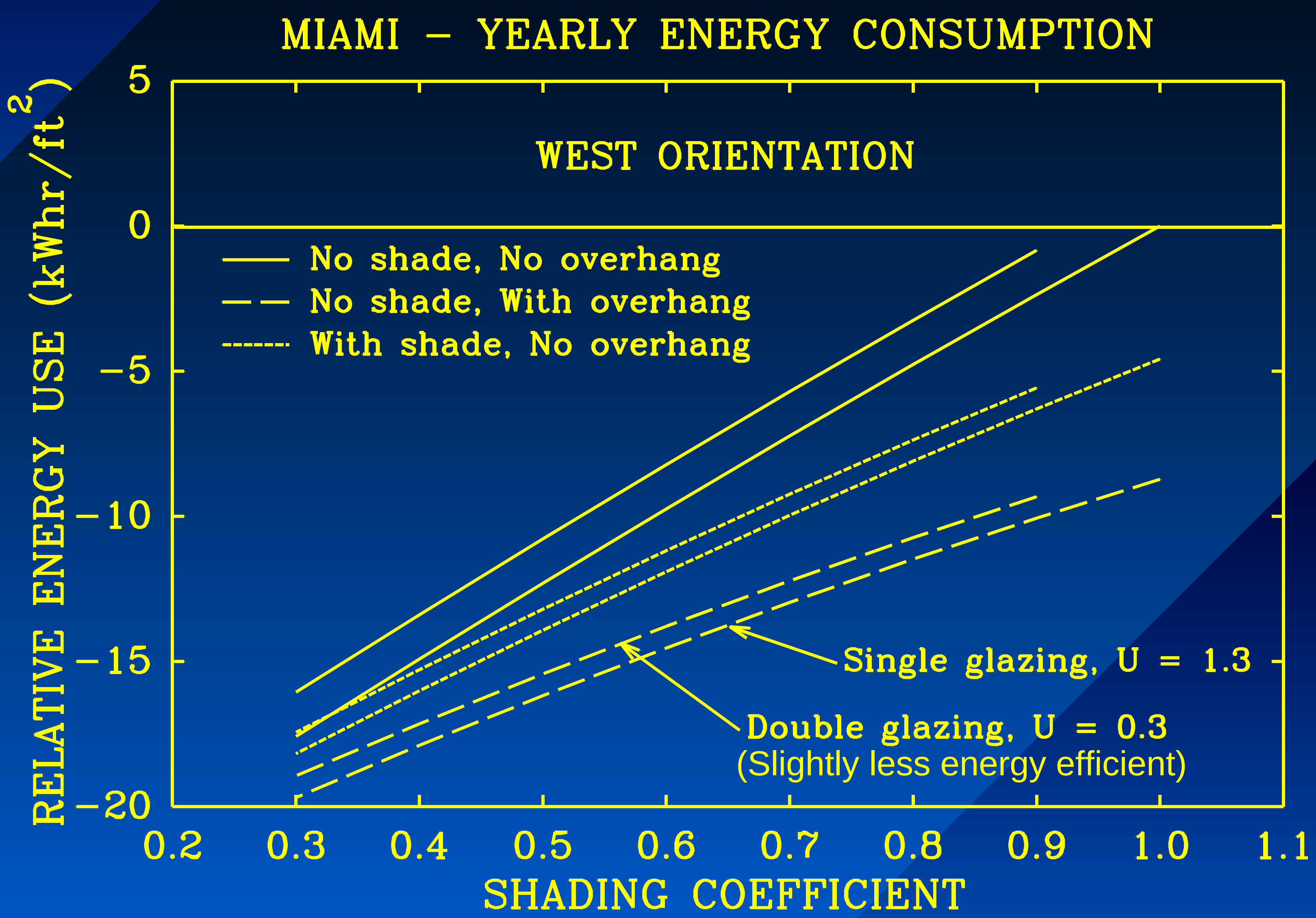


Window Energy Software

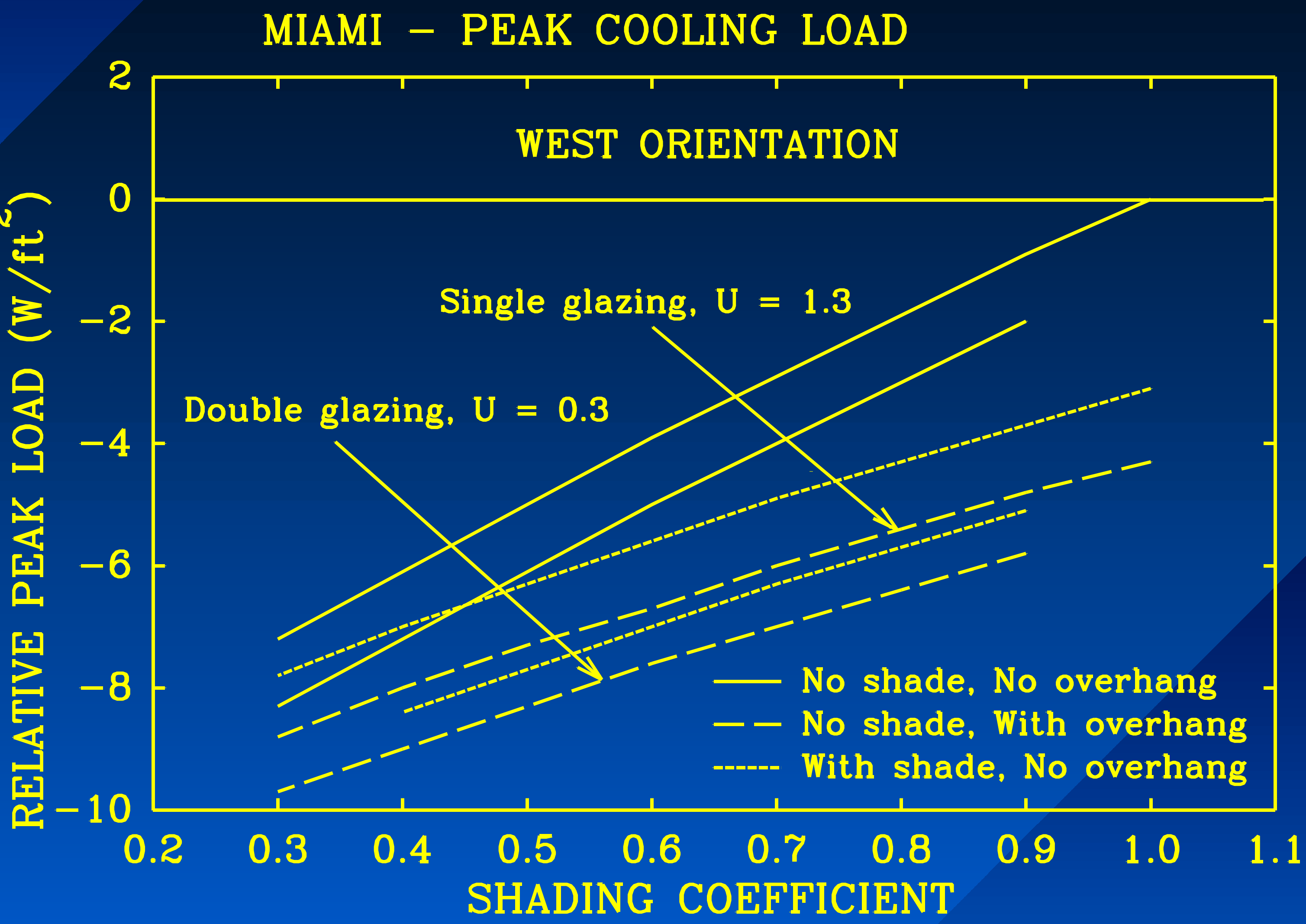
- DOE-2 — Large & complex, needs an engineer to run it
- RESFEN — Easier to run, and based on DOE-2, but you must be somewhat computer savy to run it
- EnergyGauge USA — Requires licensing and training
- EnergyGauge FlaRes — Used mainly for code compliance
- Energy performance for a typical house can be determined from www.efficientwindows.org but this treats shading only minimally
- Sample results from DOE-2 on next slide
  (Note: Shading coefficient = 0.87 SHGC)

DOE-2 Results for Miami - 1

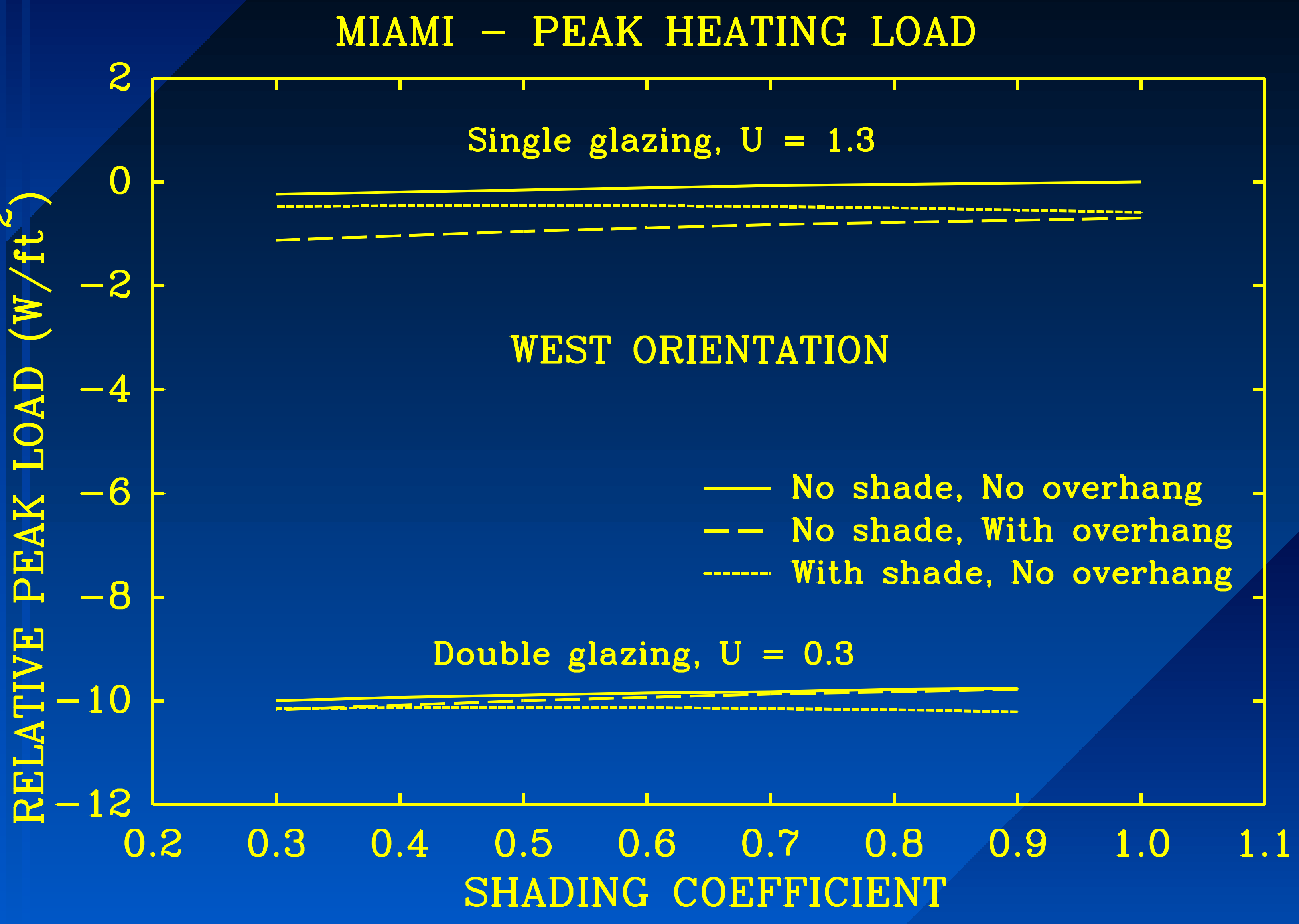
Lower
is
better



DOE-2 Results for Miami - 2



DOE-2 Results for Miami - 3



Conclusions from Miami Study

- U-factor is not that important for *annual* energy in South Florida
- Preventing solar gain is more important
- Thus low solar gain single pane, uninsulated windows would ***appear*** a good choice for Southern Florida
- At least one glass company offers "hard-coat" high LSG glass
- But there is more to the study than this.
- Further north, insulated windows become more attractive
- And there are other benefits of double pane windows:
  - Lowered Peak loads
  - Smaller, less expensive HVAC equipment
  - Acoustic isolation
  - Greater comfort and happiness
  - Motherhood and apple pie

What Can the Homeowner Do to Get Energy Performance/Information?

- Use Florida Building Code energy provisions — Minimal
- Insist on NFRC ratings — Instantaneous values only, but still important to know that the numbers are correct
- Obtain Florida Green Home Certification — Great environmentally, but modest for window energy
- Use only Energy Star windows — Good but not best
- Guidance for the average homeowner: www.efficientwindows.org/selection3.html
- Information customized for your home, use RESFEN: http://windows.lbl.gov/software/resfen/resfen.html

Where to find these resources

Florida Building Commission

http://www.floridabuilding.org/BCISOld/bc/default.asp

FSEC commentary on the new Florida Building Code
http://energygauge.com/FlaRes/new_code.htm

Florida Building Code Online

View The Florida Building Code Online at SBCCI's website:
http://www2.iccsafe.org/states/2004_florida_codes/

National Fenestration Rating Council

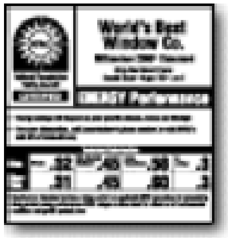
NFRC.org

www.efficientwindows.org

How to Select an Energy Efficient Window

1 **Look for the Energy Star**

Look for a product that qualifies for the Energy Star in the Northern, Central, or Southern Climate Zone. To distinguish between Energy Star products, go to Step 2.



2 **Look for Energy Efficient Window Properties on the NFRC Label**

The key window properties are U-factor, Solar Heat Gain Coefficient (SHGC), and Visible Transmittance (VT). The NFRC label provides the only reliable way to determine the window properties and to compare products. For typical cost savings from efficient windows in specific locations, go to Step 3.

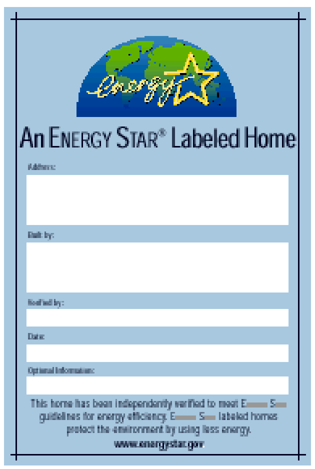
3 **Compare Annual Energy Costs for a Typical House**

Compare the annual energy use for different window options for a typical 2000-square-foot house in your state or region.

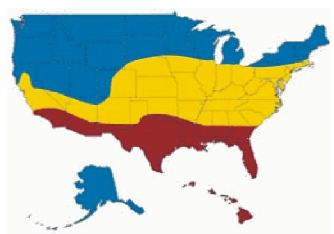
Energy Star

http://www.energystar.gov/index.cfm?c=windows_doors.pr_windows

Energy Star Homes must meet a performance standard: Have a HERS energy rating of 86 or above



Climatic Zones



Energy Star Windows must meet a prescriptive standard:
In the hot climate zone:

	Windows & Doors	Skylights
U-Factor	0.75 or below	0.75 or below
Maximum Solar Heat Gain Coefficient	0.40 or below	0.40 or below

None of the previous web sites offers much guidance on selecting window shading. The next one at least gives credit for tree shading, and a variety of other environmental sound practices.

Florida Green Home Certification

Florida Green Building Coalition, Inc., **www.floridagreenbuilding.org**

- Green Home Standard Certification based on a points rating
- “Green Home Designation Standard Checklist” publication
- Checklist includes points for Energy, Water, Site, Health, Materials, Disaster Mitigation, and a General category
- For new homes each category has a minimum number of points. The sum of the minimums (default case) is 160.
- Total points requirement is 200.
- More points required if the minimum cannot be met in a category
- Window points given for daylighting, east and west tree shading, and exceeding the Florida Energy Code HERS rating of 80

To Double-pane or not?

- For energy savings only, double pane is generally not needed in Florida (except possibly for north Florida)
- It is more important to put your money into preventing solar gain —
  On the other hand:
- The highest LSG glass is only available in double pane
- Double pane is more comfortable
- Double pane allows smaller A/C, saving dollars
- Double pane gives better acoustic isolation
- The electric utility might *pay you* to use double pane (if you ask them nicely)

Guidance for the Average Homeowner

- Purchase the best window you can afford for your situation, considering:
  - Direction the window faces
  - Degree of existing shading of that window
- Shade east- and west-facing windows from direct sunlight
  - Trees
  - Trellis vines
  - Shrubs and plants
  - Awnings and shade screens
  - Shutters
- Use double-pane glas and insulated frames to
  - Maintain thermal comfort
  - Reduce peak A/C size required
  - Save energy and electricity costs
  - Protect against possible future peak demand charges

I could stop here,

leaving you with the previous slide of recommendations,

but this is only part of the story.

What about the dollar consequences?

Are my choices cost-effective?

Here's how we tell: economic performance measures

- Payback time
- Return on Investment
- Cash flow analysis
- Life cycle costs
- Net energy analysis
- External costs

Equipment Costs — Energy Savings

- First are the dollar costs of "extra" features in the home, compared with the alternative.
  - Extra cost of double pane
  - Extra cost of hot-climate low-e coatings for reducing solar heat gain
  - Extra cost of insulating gas fill
  - Extra cost of insulated frames
  - Extra cost of external shading devices or vegetation
- Let C be the total of all the extra costs you incur, in dollars
- Then you have to know the dollar value of the energy savings in a typical year generated by these extra costs.
- This comes from an energy computer program for both the "base-case" home and the one with the extra features.
- Let S be the savings, the reduced energy cost attributable to the extra features over the year, in dollars per year.

Payback Time

- The Simple Payback Time SPT is

$$SPT = C/S$$

- Since C is in $ and S is in $/yr, the units of SPT are years.
- SPT is the time it takes for the dollar savings to equal the extra costs of the energy-saving measures, assuming no change in energy prices over the years.
- With a little effort and some complicated mathematics, you can figure out the *effective payback time* or *discounted payback time* in years, accounting for changes in the price of energy (and hence your yearly dollar savings) in the future.
- As energy prices increase, your dollar savings do as well, **and the payback time shortens**.

Return on Investment

- Return on Investment (ROI) is the annual percentage rate of dollars earned, or in this case, saved, in response to an initial expenditure (the investment) in an energy-saving technology
- If C is the cost of the investment and S is the savings, both defined on the previous slide, then the return on the investment is the ratio of the savings S each year to the initial invesement C, expressed as a percent.

$$ROI = 100\% (S/C)$$

- ROI is 1/PBT times 100%
- **The shorter the payback time, the greater the economic return on the investment**
- The escalated return on investment takes account of changing future values, but a good straight ROI, as defined above, is still a good indicator of the return on the investment.

Cash Flow Analysis

- With cash flow analysis, we assume that no money is directly invested in an energy-saving technology.
- Instead the money, the principle P, is borrowed at an interest rate I, and the dollar value of the energy savings is used to pay off the loan.
- If the technology saves more than the loan payment, then the *cash flow is positive* each month (or each year).
- If the technology saves less than the loan payment, then the *cash flow is negative*.
- Alert business managers are easy to convince, if offered a technology they don't pay for (the loan pays for it) that pays them a little extra each year.
- When interest rates are low, it is easier to have positive cash flow with such a scheme

Life-cycle Costs

- Life-cycle cost analysis seeks to consider all the costs and benefits of an energy-saving technology over the lifetime of the equipment involved.
- An investment is made.
- There are annual maintenance and service costs to add in.
- There are annual savings which may be subtracted from the costs.
- The costs and savings are projected over the system’s lifetime.
- The net, end-of-life, cost is totaled up and compared with the life-cycle costs of alternative investment.
- The *least* life-cycle cost technology is generally the one to use.
- This approach is well-tailored to adding in a variety of societal and other costs associated with the investment, if dollar values can be placed on them.

Net Energy Analysis

- Seeks to determine the total energy costs of production of an energy-saving technology.
- Then it estimates the amount of energy to be saved over the lifetime of that technology.
- If the net energy savings exceed the energy costs to manufacture, then the investment is considered to be a good one.
- The concept is most often used to compare the fossil fuel costs to manufacture and operate a system to the saved fossil fuel costs to operate over the system’s lifetime.
- The investment is a good one if less nonrenewable energy is spent than the technology saves in its lifetime.

External Costs

- External costs are the environmental and human health costs of a business operation that are not included in the business's profit and loss statement.
- External costs are "off the books" and not considered a normal cost of doing business.
- People and the environment pay these external costs—in tax dollars to clean up messes and in health care dollars and diminished health.
- External costs are not usually included in the price of a product. This sends misleading price signals to purchasers and perverts a free-market economy.
- Internalizing costs is the process of pulling external costs back into the corporations generating them, forcing them to include them in their prices offered to customers.

Aren't these economic measures overkill just for a couple of windows?

- The window market in Florida is large
- Often a selection decision applies to many windows in a home, apartment building, or high-rise condominium, not just two
- In spite of this, yes they are overkill, however: see next slide

There's More to a Window Than Just Energy or Code Compliance

Economic indicators don't express the total value of an energy-saving technology

- Cheapest is not always best
- Peak load savings are often not included
- Reduced equipment sizing is often left out
- Human factors of comfort and aesthetics are often ignored
- Acoustic isolation is another often ignored benefit
- Other Factors
  - Human health, environmental viability, economic security
- **How do you put a price on these?**

Intermission

While you take a break, please think about all the many environmental, health, comfort, and societal benefits of very energy efficient, well-insulated, well-built windows. Then ask yourself where you can purchase such good windows.

Window Market Problems in Florida

The perils of being smarter than the salesperson

- The sales person doesn’t know what you are talking about
- The window you want they don’t stock
- The window you want requires special order & costs more
- Double-pane warranties may not be long enough
- The building code doesn’t stimulate the market enough for high-performance windows
- The architect doesn’t know enough
- The builder doesn’t know enough
- Even *I* don’t know enough
- It’s a chicken-and-egg problem in a dog-eat-dog world

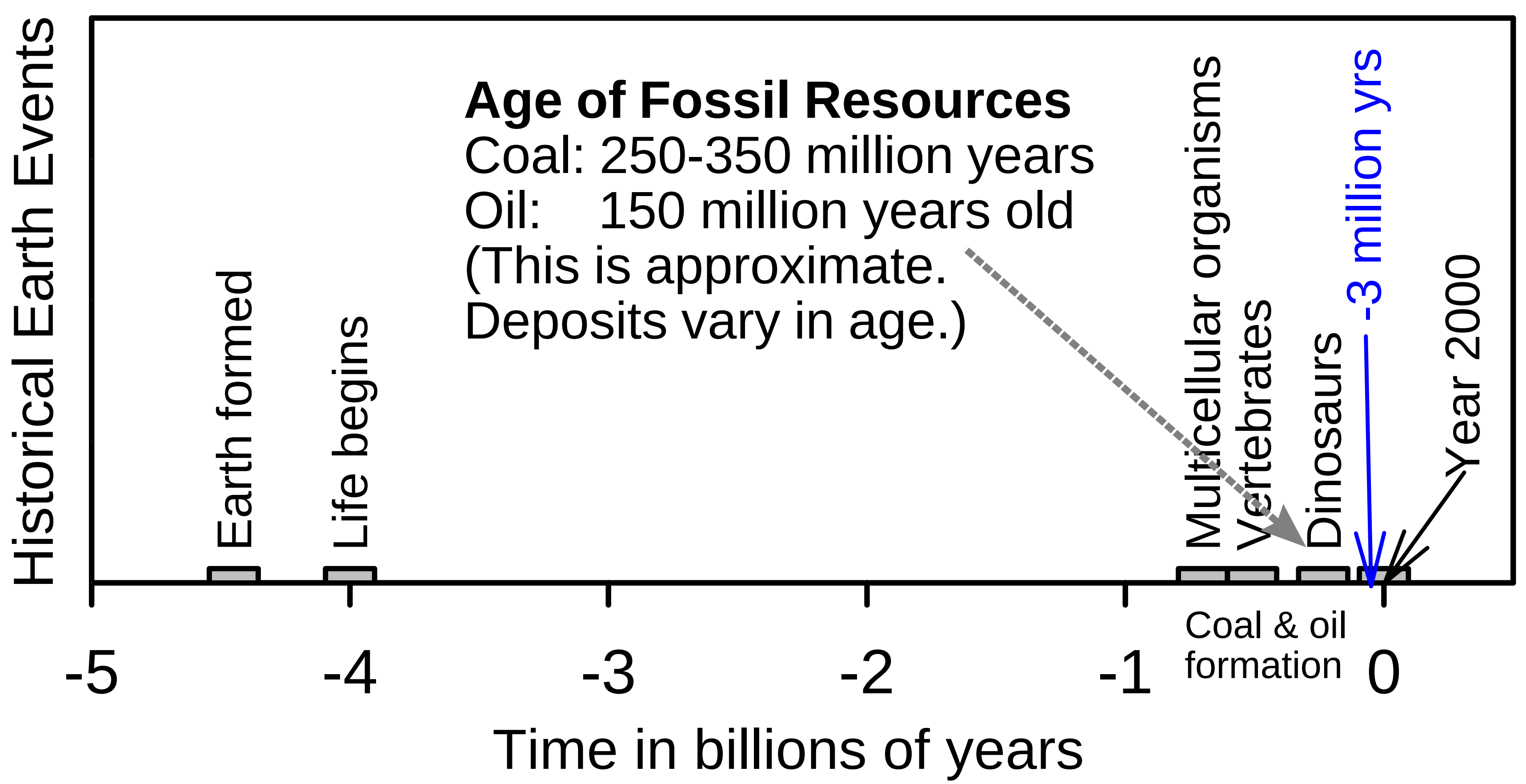
Least-cost is a powerful driver

Think of the Bigger Picture

- Choosing the least cost window and other energy-consuming building system is still too prevalent: And can be environmentally disastrous.
- One reason is relatively low energy prices.
- Energy codes work, but only minimally.
- Markets often fail to see the bigger picture, until rather late in the game, especially if they are biased in the wrong direction by government policy (such as subsidizing fossil energy).
- Let’s take a larger view ....

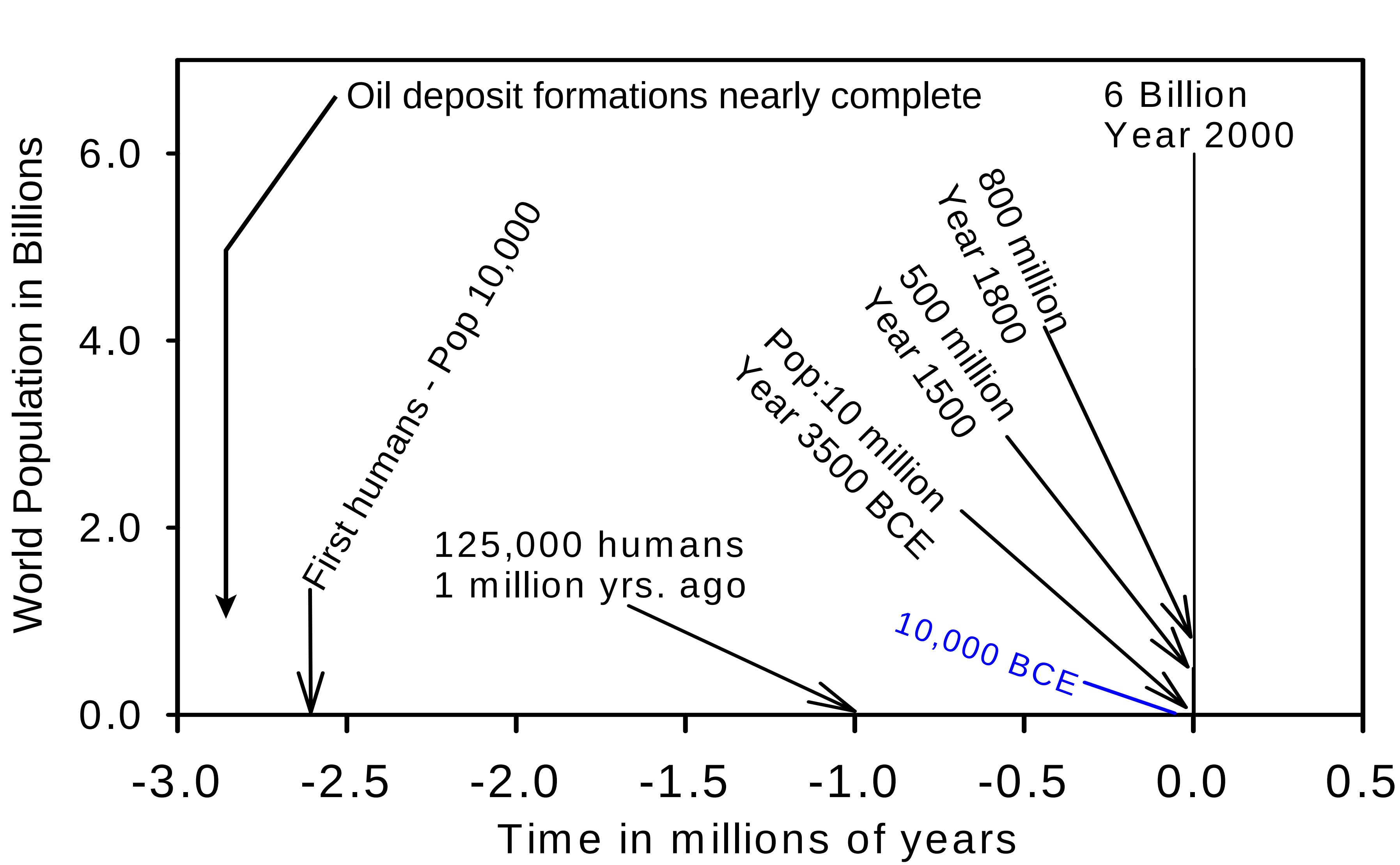
Seeing the Big Picture

Earth History

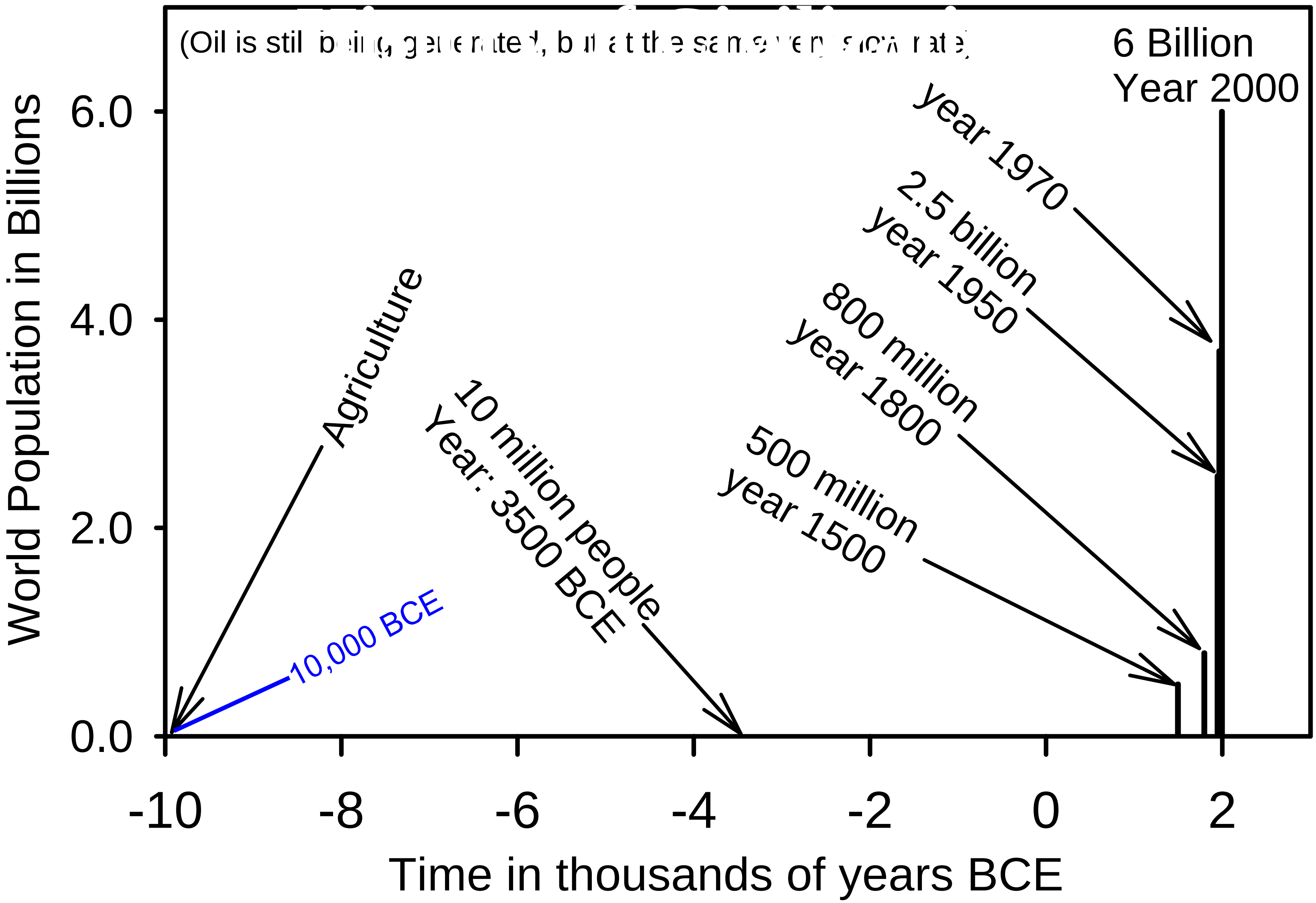


Seeing the Big Picture

Human History

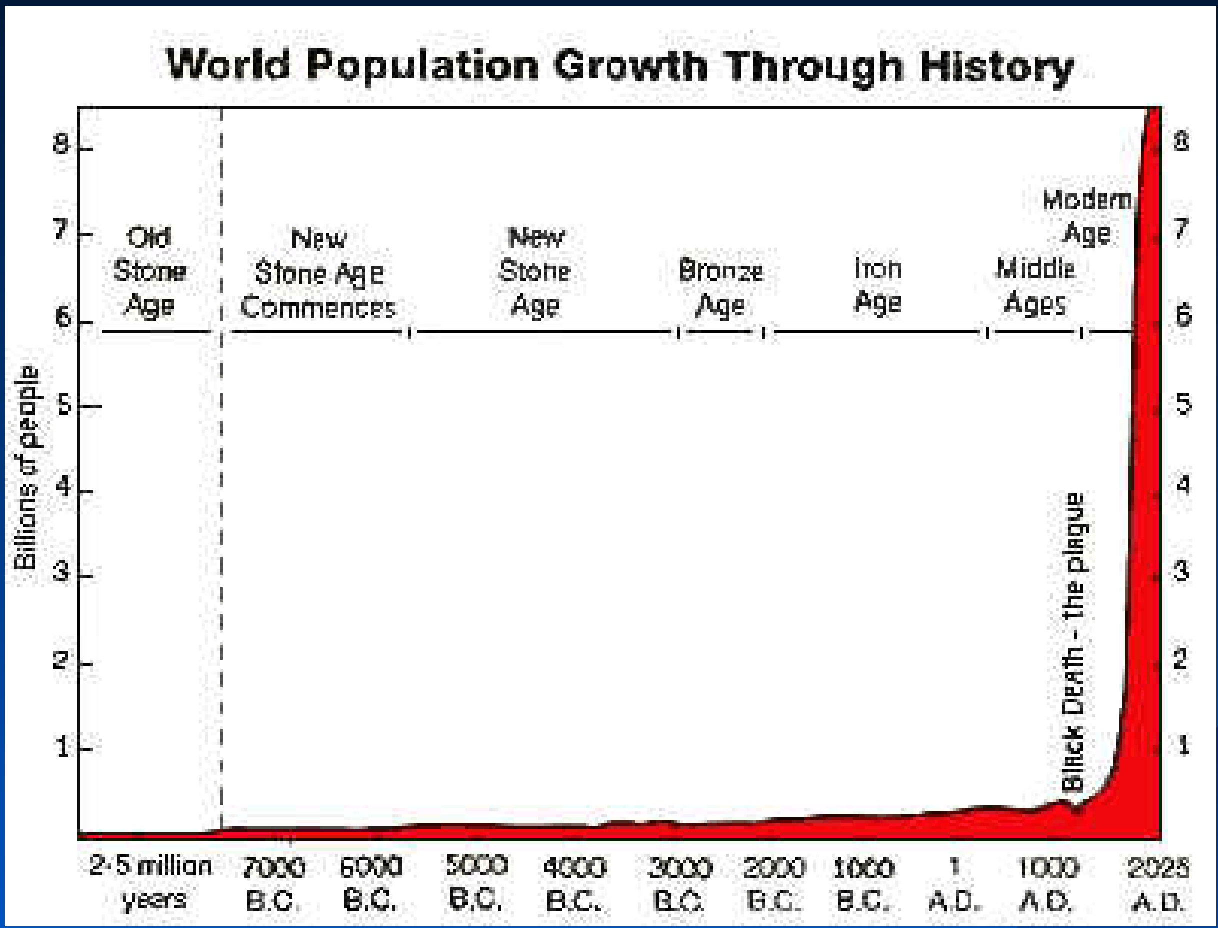


History of Civilization

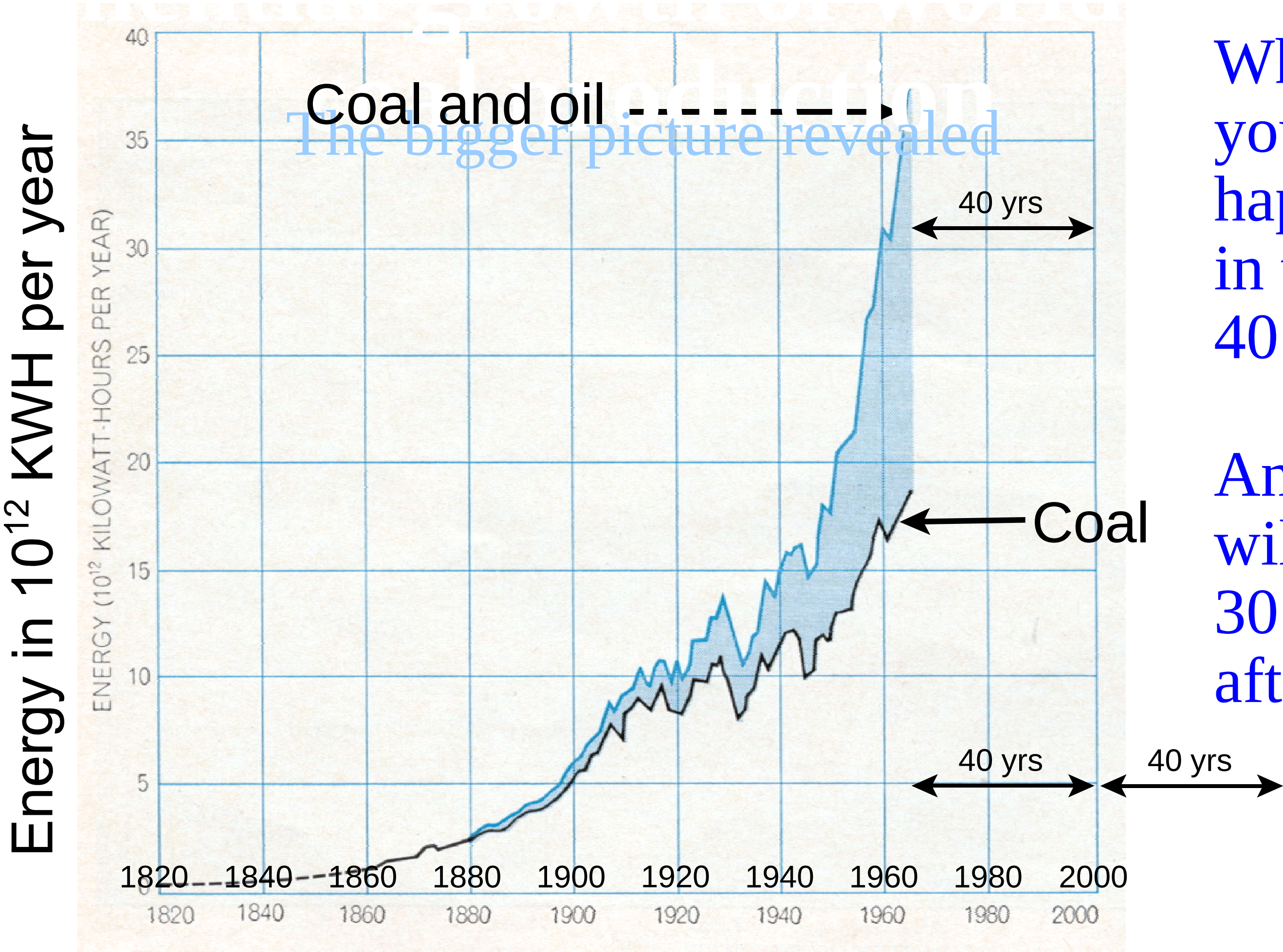


Exponential Growth

The Bigger Picture Revealed



Exponential Growth of World Coal and Oil Production



ENERGY CONTRIBUTION of coal (*black*) and coal plus oil (*color*) is portrayed in terms of their heat of combustion. Before 1900 the energy contribution from oil was barely significant. Since then the contribution from oil (*shaded area*) has risen much more rapidly than that from coal. By 1968 oil represented about 60 percent of the total. If the energy from natural gas were included, petroleum would account for about 70 percent of the total.

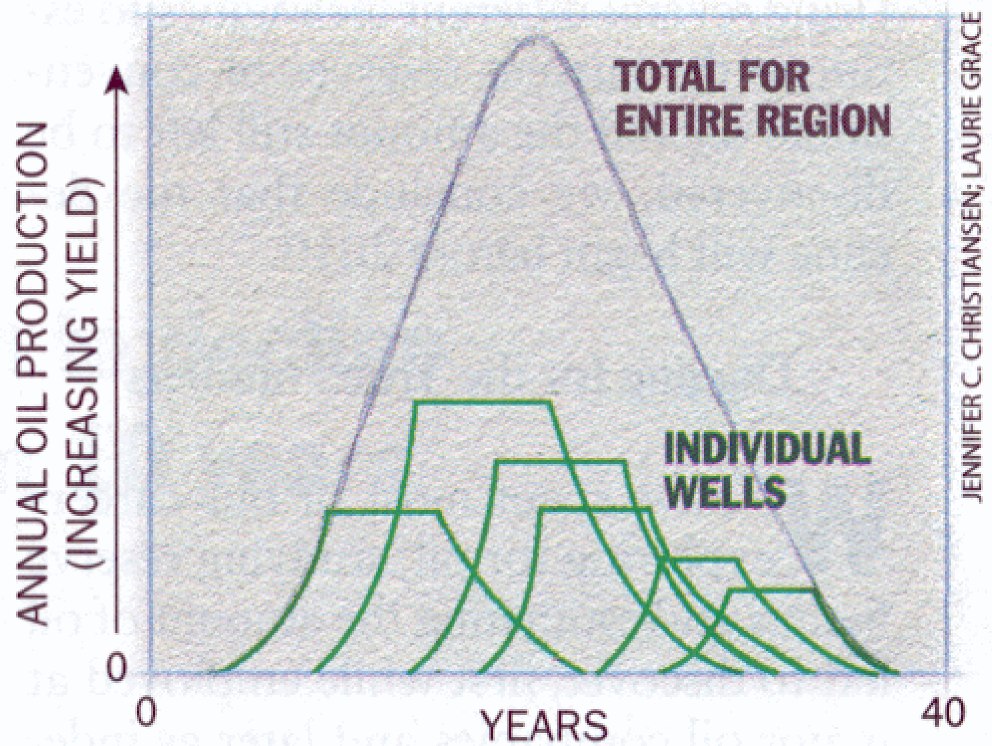
What do you think happened in the next 40 years?

And what will happen 30 years after that?

M. King Hubbert, "The Energy Resources of the Earth," *Scientific American*, September 1971, pp. 60-70.

The Future of Oil Production

FLOW OF OIL starts to fall from any large region when about half the crude is gone. Adding the output of fields of various sizes and ages (*green curves at right*) usually yields a bell-shaped production curve for the region as a whole. M. King Hubbert (*left*), a geologist with Shell Oil, exploited this fact in 1956 to predict correctly that oil from the lower 48 American states would peak around 1969.

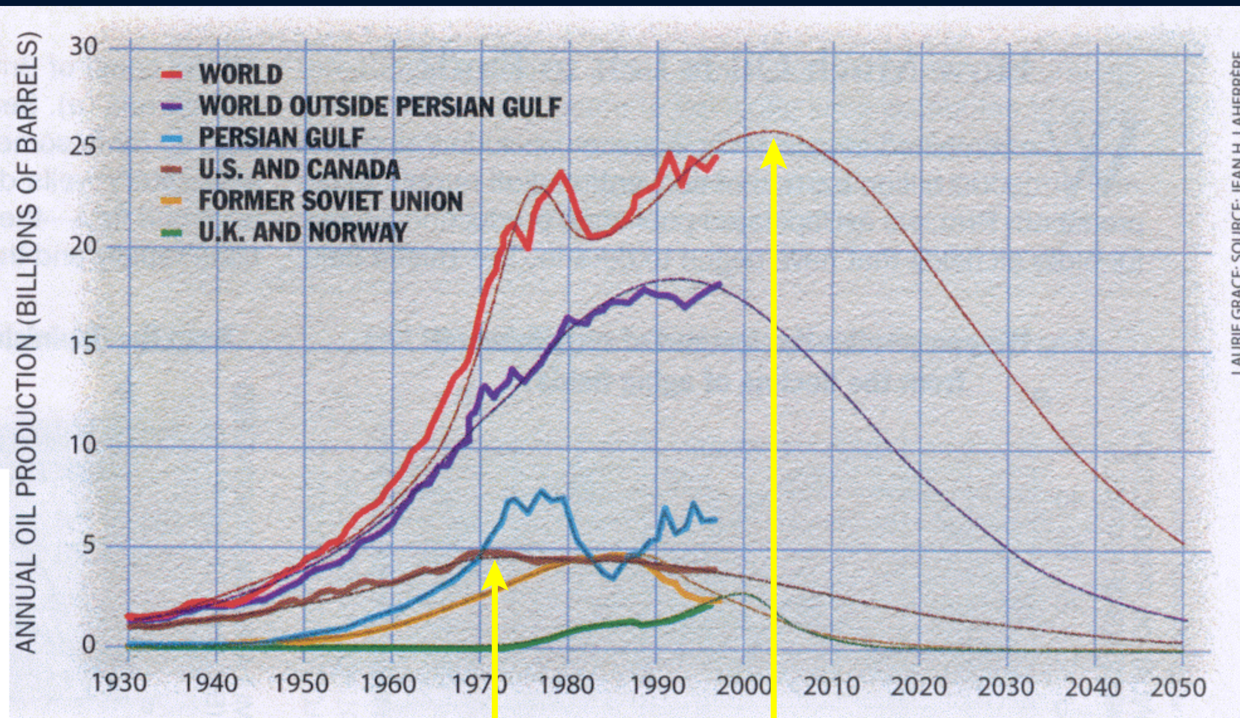


C. J. Campbell and J. H. Laherrere, “The End of Cheap Oil,” *Scientific American*, March 1998, pp. 78-83.

The Peaking and Decline of World Oil

GLOBAL PRODUCTION OF OIL, both conventional and unconventional (*red*), recovered after falling in 1973 and 1979. But a more permanent decline is less than 10 years away, according to the authors' model, based in part on multiple Hubbert curves (*lighter lines*). U.S. and Canadian oil (*brown*) topped out in 1972; production in the former Soviet Union (*yellow*) has fallen 45 percent since 1987. A crest in the oil produced outside the Persian Gulf region (*purple*) now appears imminent.

U. S. production peaked in 1972, only 3 years after 1969, the year Hubbert predicted (in 1956) it would happen.

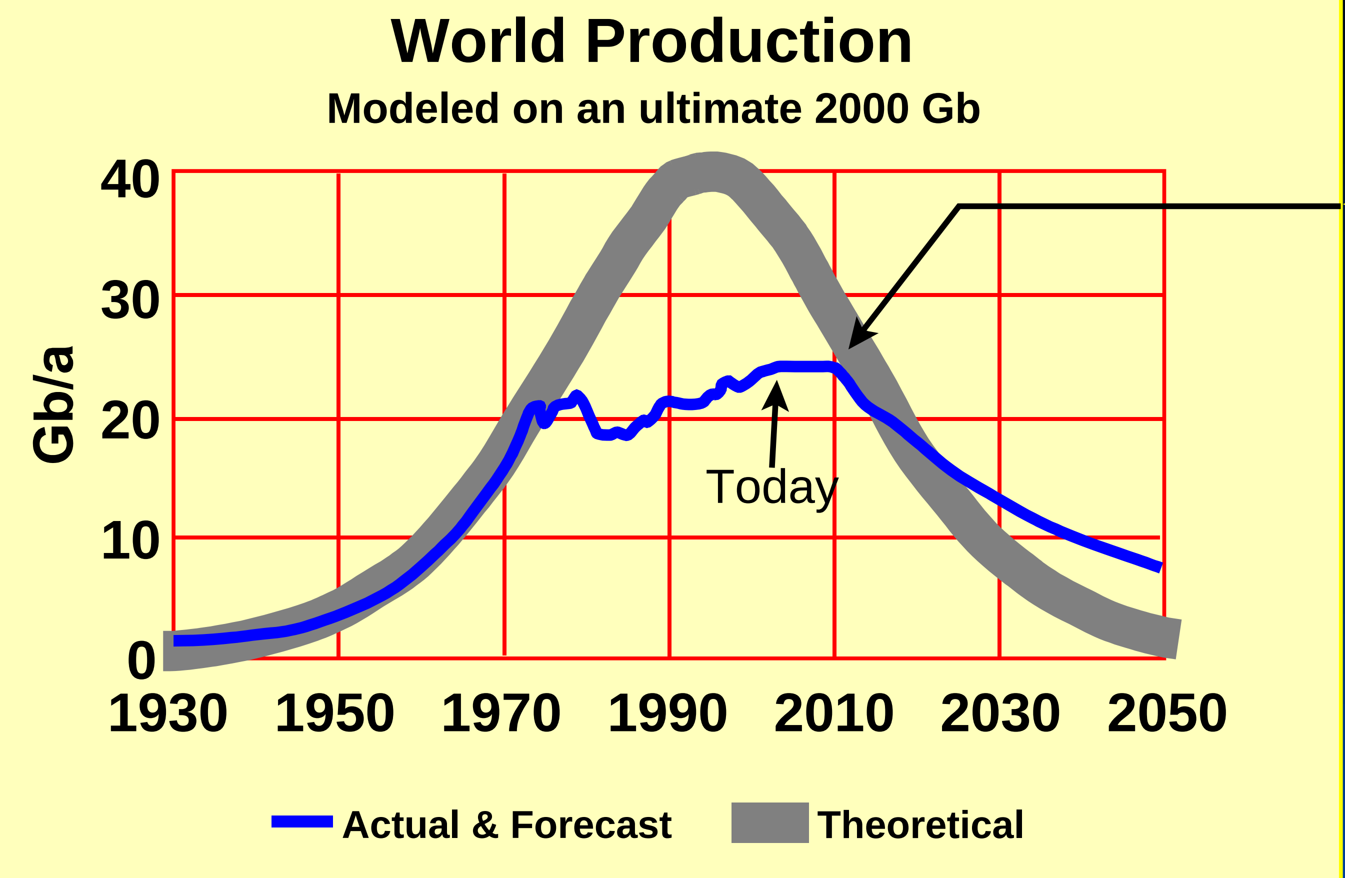


C. J. Campbell and J. H. Laherrere, "The End of Cheap Oil," *Scientific American*, March 1998, pp. 78-83.

U. S. peak
1972

World
peak

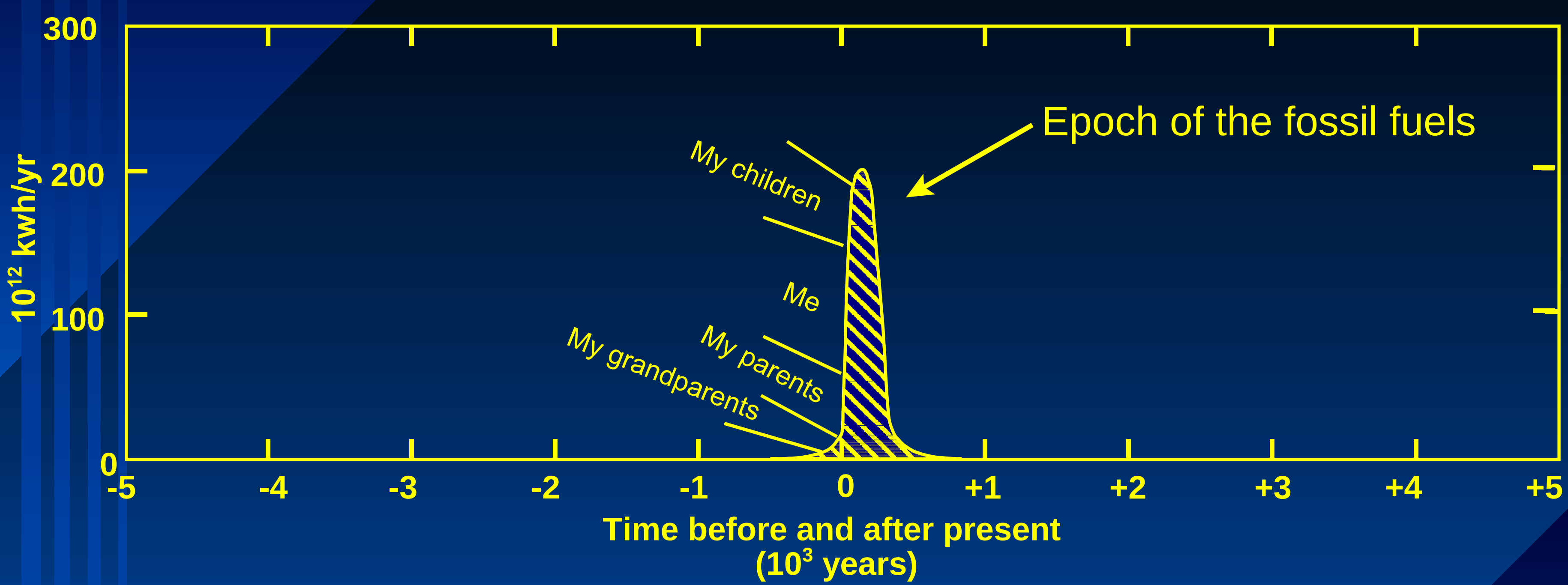
World Oil Depletion Estimate



Source: C. J. Campbell, "The Oil Peak, a Turning Point," Solar Today, July/August 2001, p. 41.

Current estimates of the date of peak world oil production:
"**2010**," made by Campbell and Laherrere in 1998, op.cit., p. 82.
"**Before 2004**.", made by Deffeyes in 2001, *Hubbert's Peak*, p. 12.
"**We may have already passed it.**" made by Campbell in 2002, private communication.

Like the flame of a candle in the long dark night



“The brevity of this in human history can best be appreciated if we plot [the above graph].” “The epoch of the fossil fuels ... is responsible for the development of our modern industrial civilization....”

M. King Hubbert, “The World’s Evolving Energy System,”Am. J. Phys., Vol. 49, No. 11, Nov. 1981, p. 1026.

The following are my views

To some extent they reflect the interests of the U.S. Department of Energy in reducing fossil energy use.

For example, DOE's zero energy home program. And the President's pronouncement that global warming is real and of human origin.

They are the views of neither the Florida Solar Energy Center nor the University of Central Florida

Some Possible Future Consequences of Declining World Oil Production

- Transportation fuel prices will increase
- Prices for transported commodities will increase
- Electricity and fuel oil prices will increase, along with the prices of the foods most heavily dependent upon fossil fuel
- A rush to conserve petroleum for more durable uses
- A push to relocate places of work closer to homes and vice versa
- Pressure on the “have-not” nations to develop on a much lower energy model than the current industrialized world one
- Pressure on the industrialized nations to use less, leaving more for developing nations to consume as they develop
- How long until this starts happening? — Middle of this decade
  How long does a good window last? — Several decades
- So what kind of window did you say you wanted for your home?

The World Economy's Response

Many people have proposed various scenarios

- Amory Lovins suggests that radical resource efficiency will dominate the market for energy-consuming systems.
  - It will happen faster than the decline in world oil production.
  - There will be no crisis as we run out of oil.
  - Energy efficiency and substitute fuels will rule the day.
- Suggested substitutes include
  - liquid fuel from renewable biomass such as corn
  - hydrogen derived from solar-powered electrolysis of water
  - other renewable sources.
- World population growth will continue. The per capita use of energy is also growing, especially in China, India, and other parts of the world. But radically increased energy efficiency will save the day. Plus increased renewable energy sources.
- Both of these will occur on a massive scale. Some say it will be enough to keep ahead of growing demand.

But there may be some limitations

- Some renewable energy systems may not pan out, due to
  - Technological problems
  - Cost problems
  - Limited resource availability
  - Adverse environmental consequences
- Public policy currently fails to offer strong incentives for energy efficiency or renewable sources. This may not change fast enough.
- As China, India, Africa, and South America grow and demand more energy-consuming technologies, new energy demand can outstrip improved energy efficiency and more use of renewables.
- What about the base of existing, already installed energy-consuming systems? They can't become efficient overnight.

"Who will fuel China?"

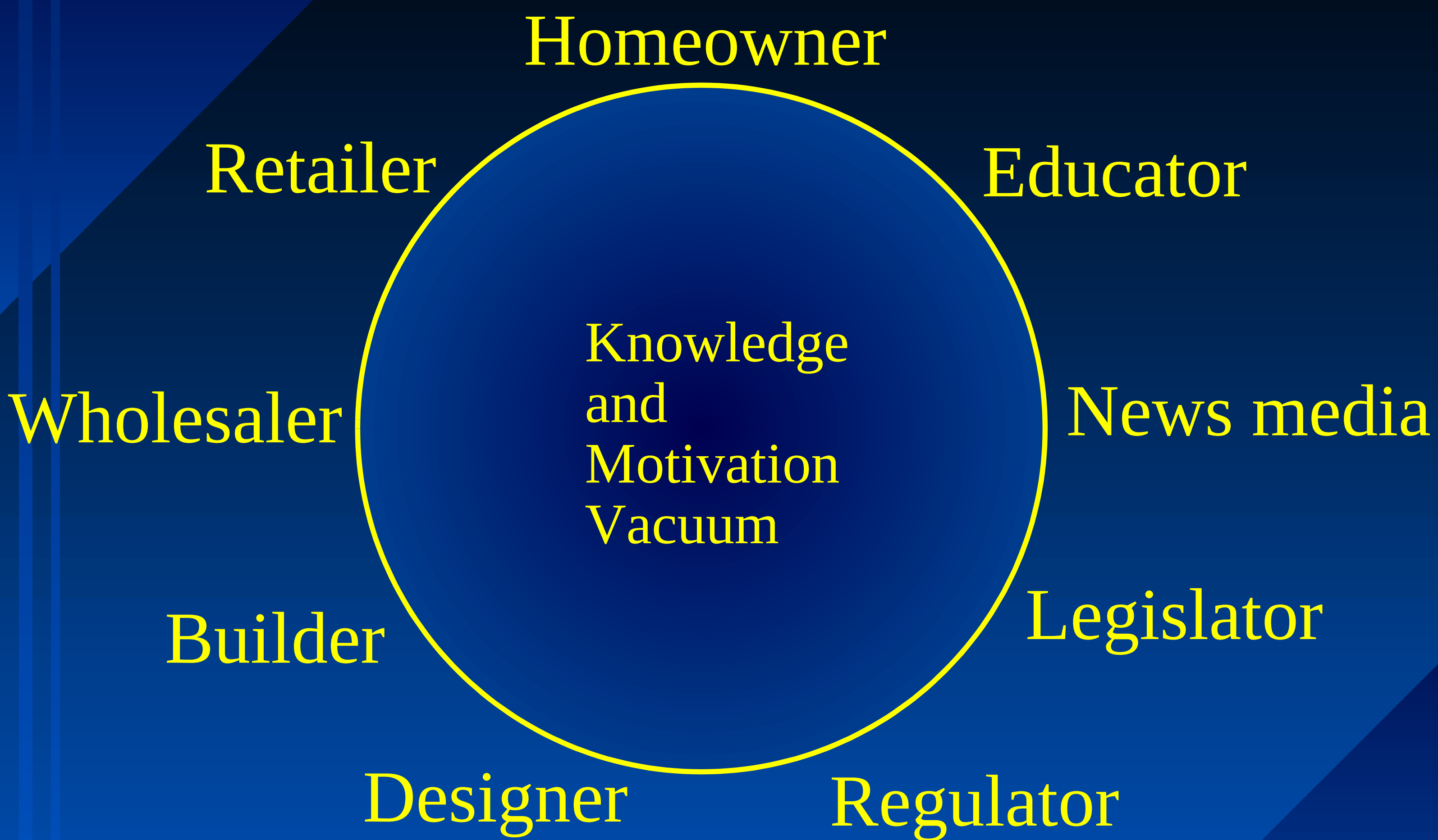
Thomas E. Drennen, John D. Erickson, *Science*, Vol. 279, 6 March 1998

- Throughout [the 1990s] China's real gross domestic product (GDP) has grown an average of over 11% each year.
- To help fuel her unprecedented growth, in 1993 China became a net importer of oil for the first time in history.
- The impact of China's total fossil fuel consumption also dominates the politics of global environmental change.
- Chinese oil imports could reach 7 to 8 million barrels per day by 2015 and 13 to 15 by 2025.
- Together with projected global declines in oil production in 20 years, these demands on the global oil market pose a serious threat to future global energy security.

In light of this

- Shouldn't we buy the *most* energy-efficient windows available?
- However, in the face of coming oil shortages, we continue to purchase what is cost-effective only in a narrow monetary sense. When energy prices are low, *more* energy consumption results, not less.
- So vendors have trouble stocking and selling better products.
- There is an inherent conflict between what the "free market" wants and what DOE and the concerned public want. And there is the natural human reluctance to change, a failure to anticipate future pressures and respond ahead of time.
- Market consequences →

The Circular Chain of Failure



“A chicken and egg problem in a dog eat dog world.”

Perhaps we need to restructure the market toward more efficient products

Market Restructuring

- How to encourage energy efficiency in new buildings?:
  - **A market-based approach** utilizes education, technical information, design assistance, financial incentives — to accelerate *voluntary* adoption of energy efficient building practices.
  - **The regulatory approach**. Energy codes are arguably the most cost-effective and permanent mechanism.
- Energy codes — the purest form of market transformation:
  - **They affect all buildings**
  - **They give clear signals to manufacturers and distributors**
  - **They are persistent**
- Only ***you*** can influence energy code revisions
- It is a political act

FSEC information resources

- Information and educational tools
  - Publications
  - Web site
  - Short courses
  - Technical assistance
- Contribute to market transformations through:
  - Education
  - Technical information
  - Design assistance
- Purpose: accelerate voluntary adoption of energy efficient building practices
- We do not set public policy.
- That’s the public’s job and its political leaders.

Public Policy

Failures of understanding, of education, of leadership, of investigative journalism, and of individual responsibility can keep us from moving to radical resource efficiency

- **What you seldom hear in the media or from politicians:**
- **Energy should cost more**, better reflecting its true cost
- Government should stop subsidizing fossil fuels, keeping energy prices arbitrarily low and sending wrong price signals
- If prices were **higher**,
  - First cost would be less important
  - Life-cycle costing would be more widely used
  - Transportation energy use would decrease
  - Petroleum would be saved and conserved as the precious commodity that it is
  - Extreme energy efficiency would be universal
  - Renewable energy would be pushed to the environmental limits
- And both the demand for and the supply of high performance windows would be much greater!

Real Security - 2

"We're looking for security in all the wrong places."

"Did we put our young people in 0.6 mile per gallon army tanks because we did not put them in 32 mile per gallon cars?"

"Real security begins at home and is built on communities that are self-sufficient and sustainable."
— Amory and Hunter Lovins

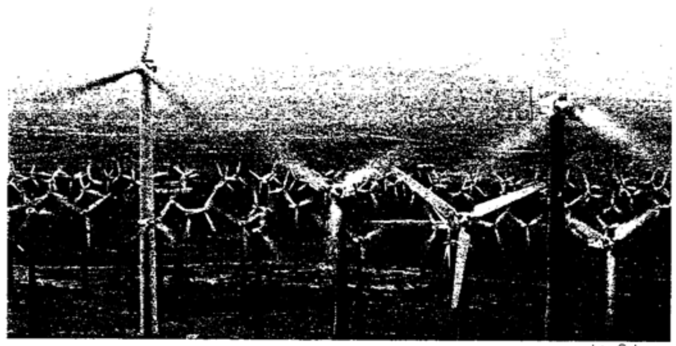
Security,

Post 9/11

what is real security?

Amory B. Lovins and L. Hunter Lovins

Y:S! Journal Spring 2002



Lee Celano

America's security faces many serious threats. Strategic planners, however, have tended to focus almost exclusively on the *military* threat. They have

gaining the capability to black out whole cities, and cause physical damage to equipment.

Reliance on fossil fuels and their extended pipelines contributes to our insecurity. Even where fuel is extracted from politically stable regions, it must be safely transported via accident-prone ships, trucks, rail, or pipeline. On October 4, 2001, a drunk shot a bullet through the Trans-Alaska Pipeline, shutting it down for 60 hours and spilling 285,000 gallons of oil. Previously, the pipeline has been shot at on over 50 occasions. A disgruntled engineer's plot to blow up critical points then profit from oil futures trading was thwarted by luck two years ago.

How, then, can America become less vulnerable to attack and more resilient to mishaps that do occur? How can we prepare for a future that may hold increasing uncertainty, unrest, and even violence? The answer may be found by basing engineering on nature. Natural systems are efficient, diverse, dispersed, and renewable, hence, inherently resilient.

The most resilience per dollar invested comes from using energy very efficiently. Minimizing energy waste

"Strategic planners...have tended to focus almost exclusively on the *military* threat. They have largely ignored equally grave vulnerabilities in vital life-support systems such as our energy, water, food, data processing, and telecommunications networks." To be more resilient to mishaps, Americans must decentralize. "The most reslience per dollar invested comes from using energy very efficiently."

Conclusions - 1

Substantial increases in efficiency of fossil energy use are essential

- Designing buildings ***down*** to a minimal energy code
  - represents failed opportunities for slowing the growth of energy demand
  - ignores comfort, produces more pollution, contributes to global warming
  - in some cases is not cost-effective even in the traditional economic sense
- Designing ***up*** to greater energy efficiency is a patriotic act—a commitment to the future of humanity and of the Earth.
  - It leads to higher quality homes, that are more comfortable and have lower energy bills.
  - It reduces pollution, lessens global warming, reduces dependence on foreign oil.
  - It directly contributes to a sustainable future.
- Better homes attract more customers, permit higher prices, and lead to greater profits for sellers.
- Designing ***up*** not only helps us enjoy our new homes but makes us feel good about ourselves and our future.

Conclusions - 2

- The last thing we want is to design down to the least common denominator, just barely meeting the Florida Energy Code
- Achieving only the minimum necessary energy performance represents failures in
  - **Understanding**
  - **Responsibility**
  - **Policy**
  - **Leadership**
- Our goals should be
  - **Disconnect from the electric utility grid to the greatest extent possible.**
  - **Install high performance windows, and very well insulated walls, ceilings, and floors**
  - **A home in Florida can drastically reduce its energy requirements and be more comfortable and enoyable as well.**
  - **If you are not yet ready to disconnect, at least strive for maximum fossil energy use efficiency.**

Final Recommendations on Windows

- **All windows:** Insist on high-LSG glazings and double-pane, insulated windows throughout the house---for energy savings, comfort, reduced peak load, and smaller A/C capacity (and cost).
- **North-facing**: Use a side-wall, or a deep window reveal to block low rising and setting sun on hot summer days
- **South-facing**:
  Use a modest overhang if you like winter sun
  Use a wide overhang to avoid sun year round
  High-LSG glazings are especially important if shading's inadequate
- **East- and West-facing**, a menu of choices:
  Dense tree shading where possible
  Awning shade
  Exterior shade screen
  Exterior roller shutters
  Highest-LSG glazing system, VT between 0.2 and 0.4
  Interior reflective operable shade
- Laminated glass for impact resistance if exterior shade is not enough for this

Getting the Products

- Pressure window sellers, wholesalers, manufacturers, and builders to specify, manufacture, sell, and install high-performance windows
- Since we may already have passed the peak in world oil production . . . .
- And if you value security, freedom, motherhood, and apple pie . . . .
- Work to lessen U.S. dependence on foreign oil through more energy efficient window systems (and energy efficient building designs).
- Work to exceed Energy Star requirements and stringent energy codes by wide margins.

Any Questions?

Additional Information & Resources

- For more information visit our windows web sites:

http://www.fsec.ucf.edu/en/consumer/buildings/window_basics/index.htm
http://www.fsec.ucf.edu/en/research/buildings/fenestration/index.htm

- A short, relatively easy to read tutorial on windows is at

http://www.fsec.ucf.edu/en/consumer/buildings/window_basics/index.htm

- This presentation is at

http://www.fsec.ucf.edu/en/consumer/buildings/window_basics/slideshows/index.htm

- Energy Crisis: www.dieoff.org
- Please fill out your evaluation questionnaires