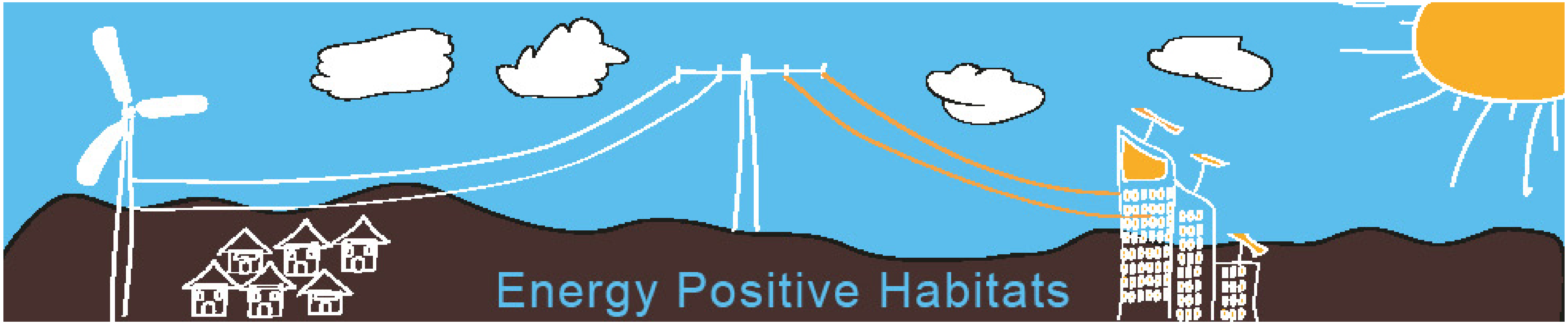
Auroville Green Practices

A Hands-on-Workshop
30 Aug to 1 Sept, 2012
Auroville (near Pondicherry)



‘Human Habitats today have become centers of energy consumption. By conserving energy with appropriate building design, reducing energy by efficient energy management and producing energy with decentralized systems that allows feeding surplus energy into the grid, we can create a shift towards energy positive habitats. Essential to this movement is the fact that humans have to change their life styles to consume less energy.‘

Building Energy Auditing & Management

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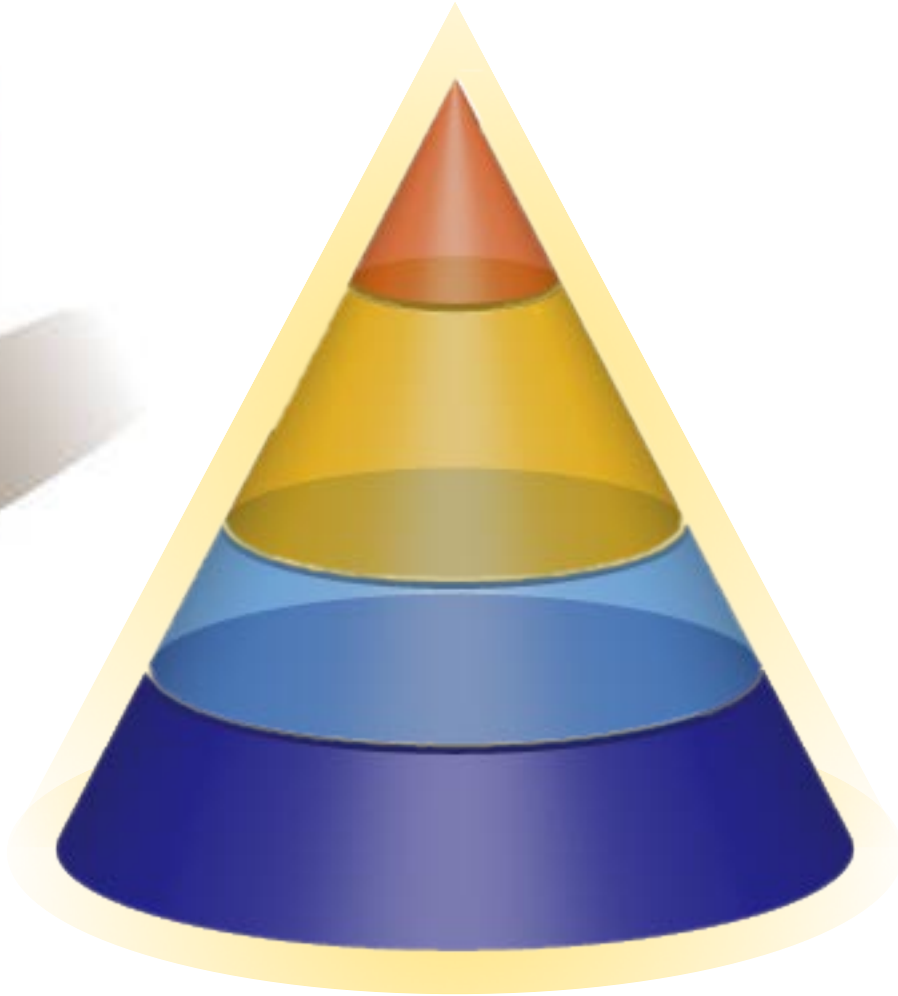
Auroville Green Practices 2012:
Energy Positive Habitats
30 August – 1 September 2012

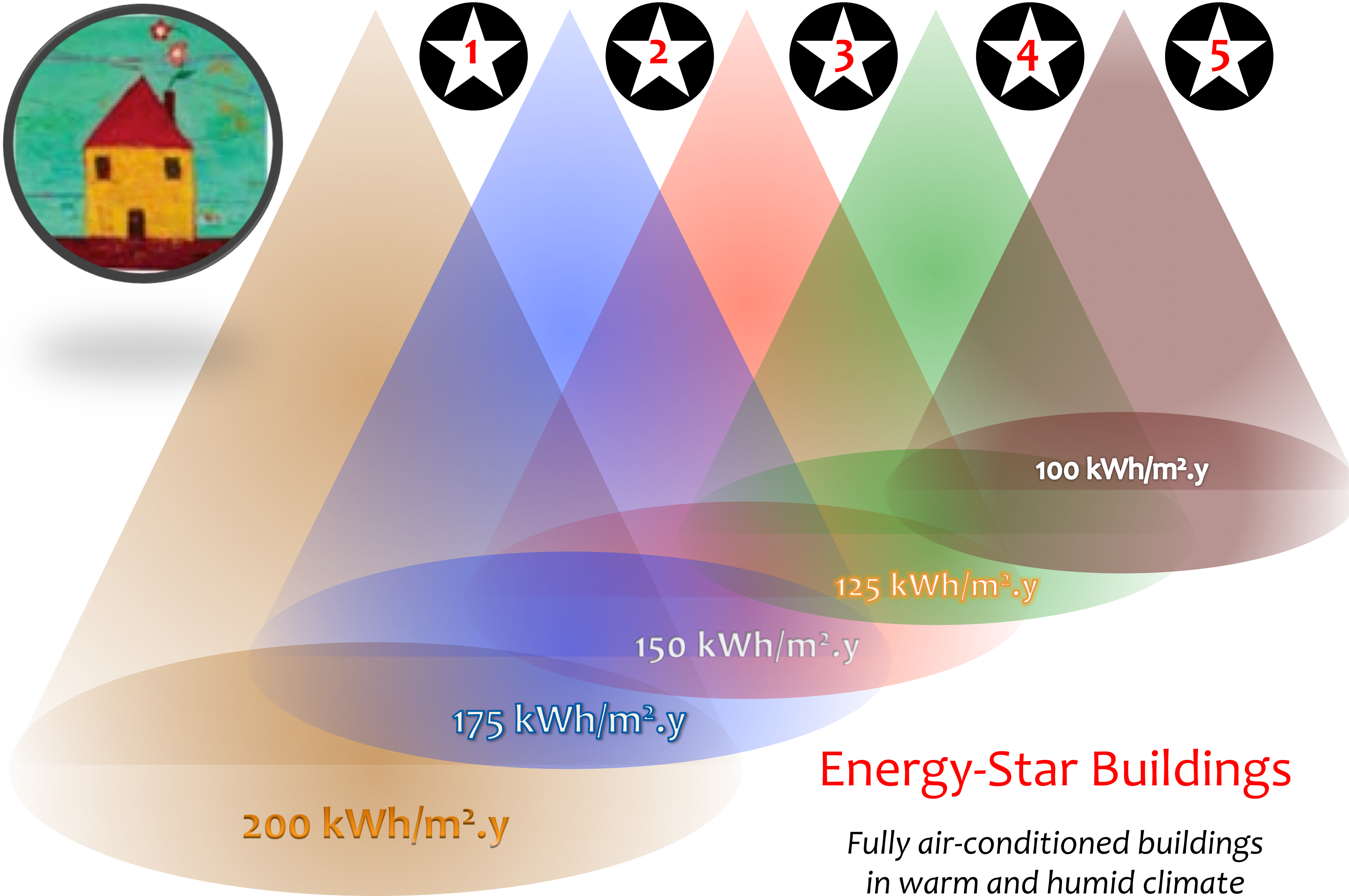
Energy in buildings

- Factors influencing the growth of energy use in buildings
  - Demographic evolution
  - Socio-cultural changes (lifestyle changes)
  - Design of building and greater use of energy consuming home and office appliances

Energy use in commercial buildings



250kWh/m^2.year



Energy-Star Buildings

Fully air-conditioned buildings in warm and humid climate

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Fully air-conditioned buildings
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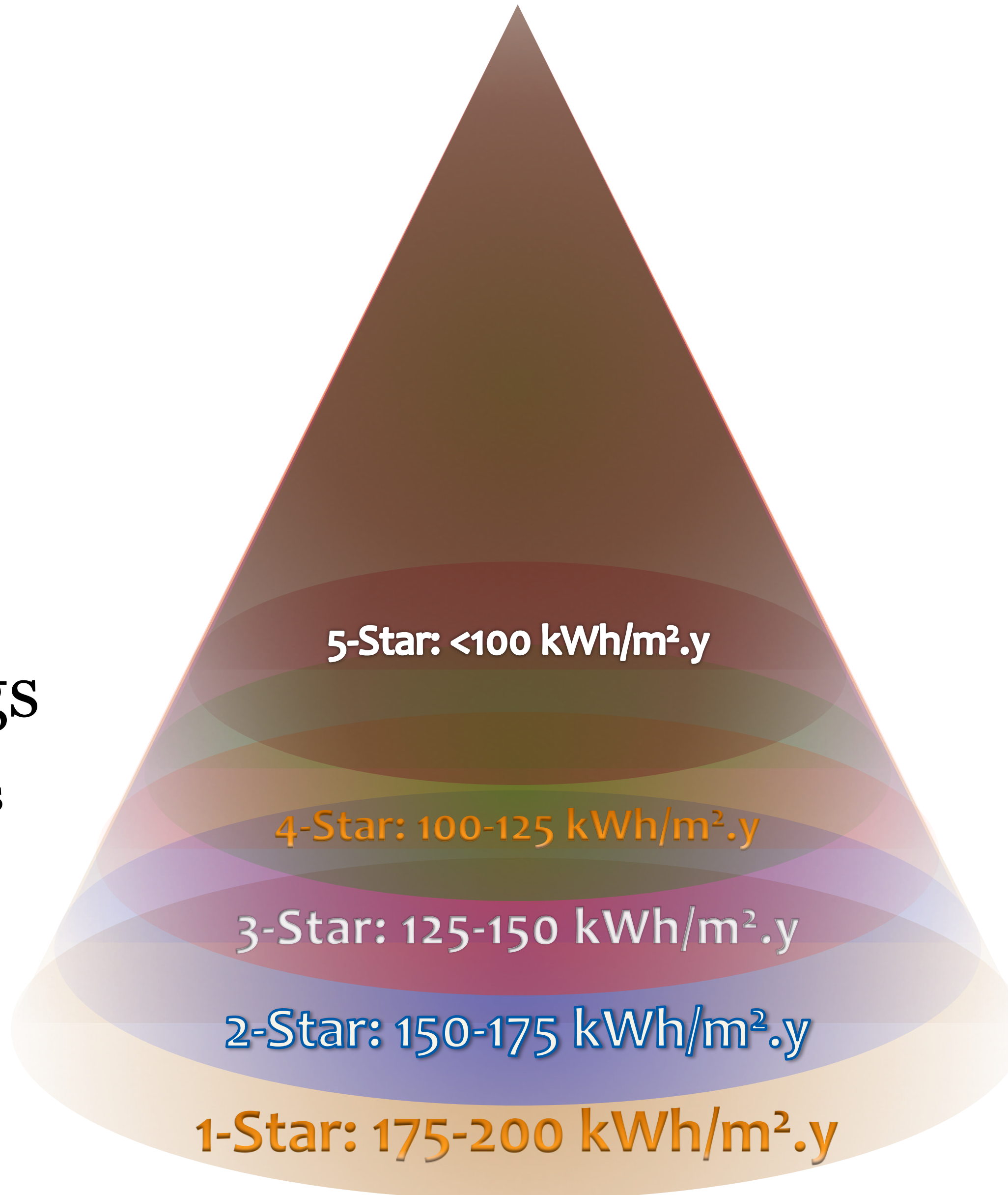
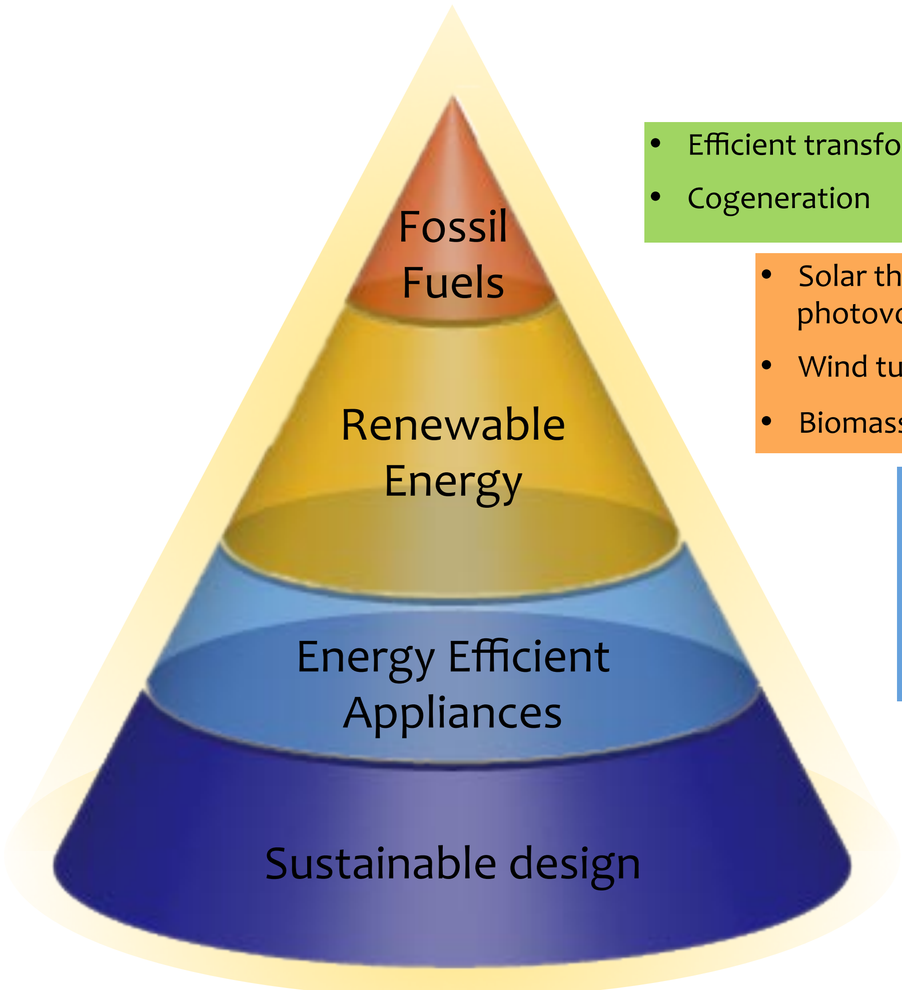


How to design low-energy buildings?



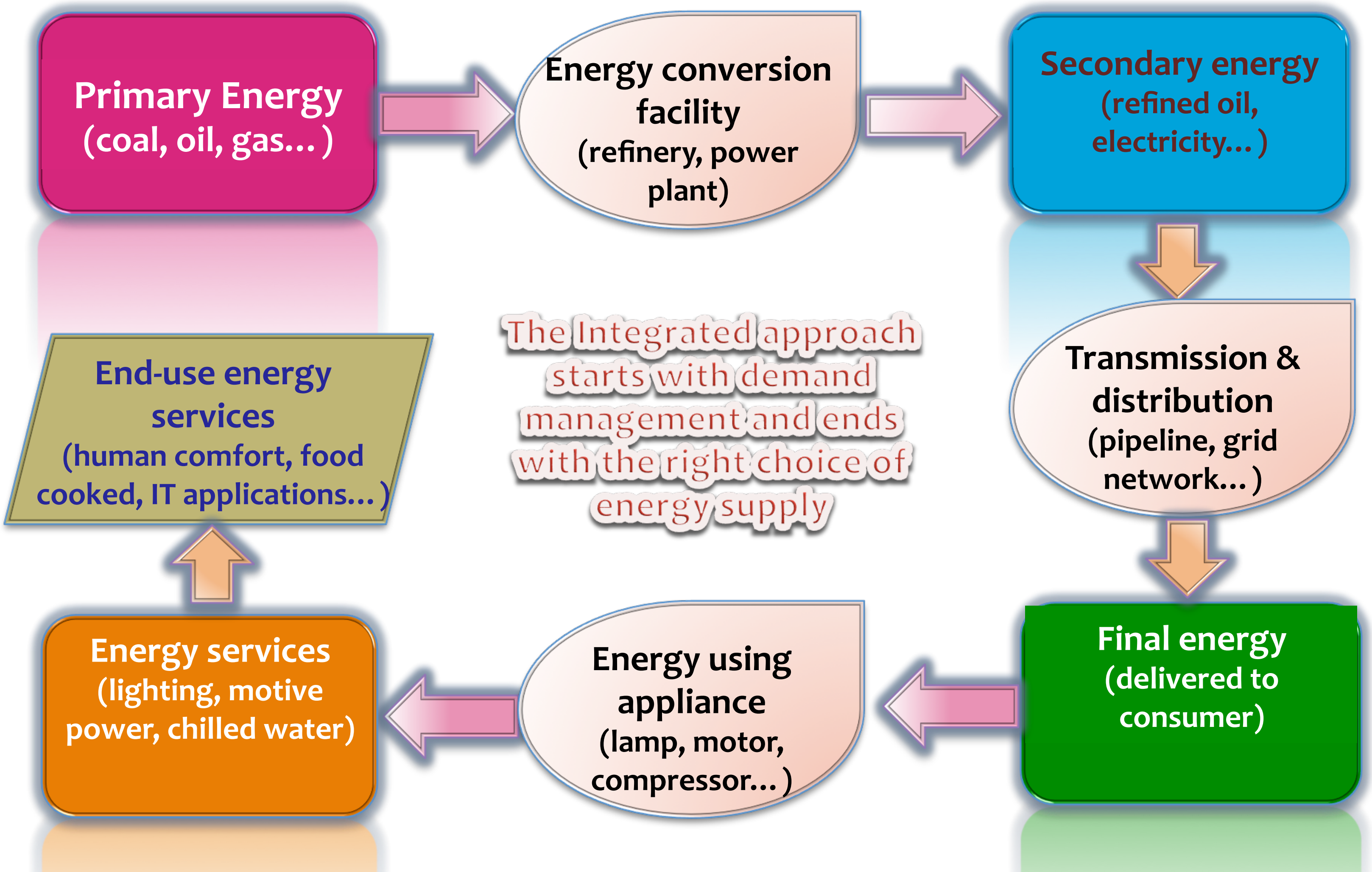
- Efficient transformer and high power factor
- Cogeneration

- Solar thermal (heating, and cooling, photovoltaic (electricity)
- Wind turbine
- Biomass and biogas

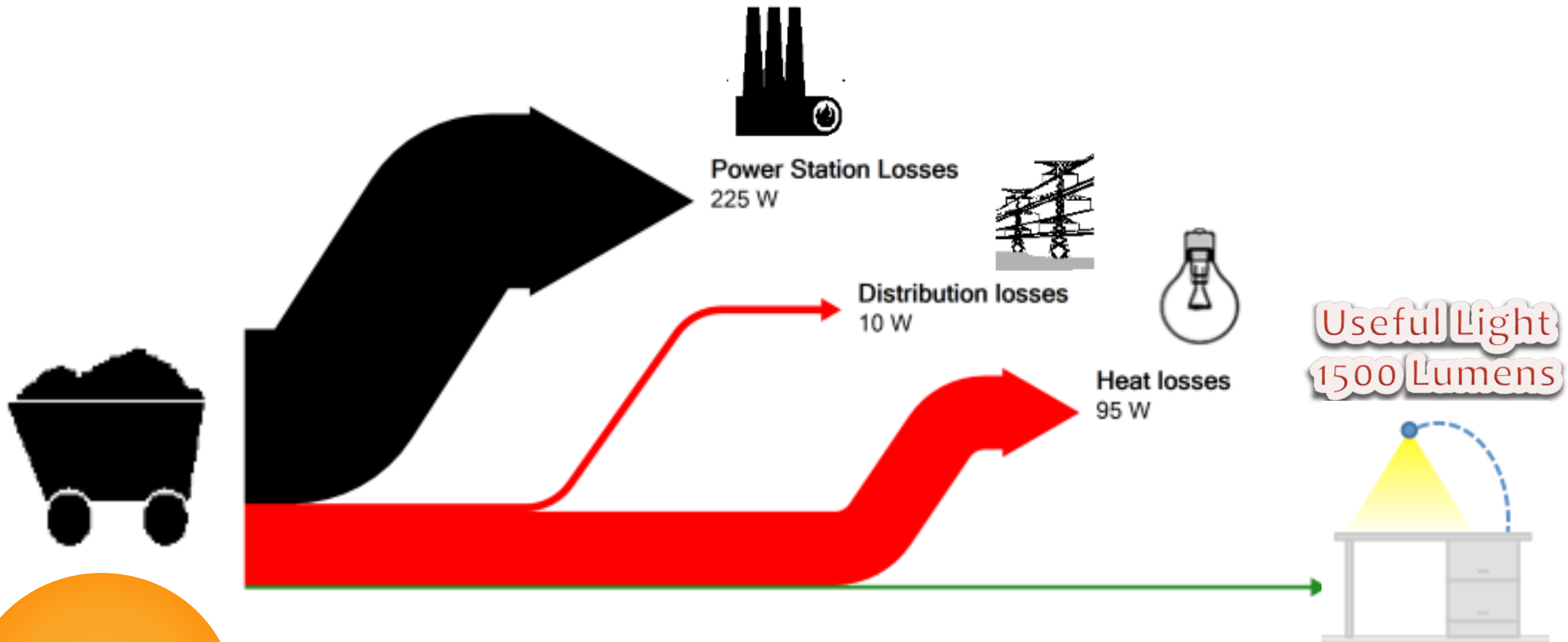
- Lighting (efficient lamps, fixtures, control…)
- Heating and cooling equipment
- Other appliances (refrigerator, washing machines, computers…)

- Passive solar design (orientation, solar protection, natural ventilation, daylighting, etc.)
- Building envelope (insulation of walls and roof, special glazing)

How efficient is the energy conversion chain?



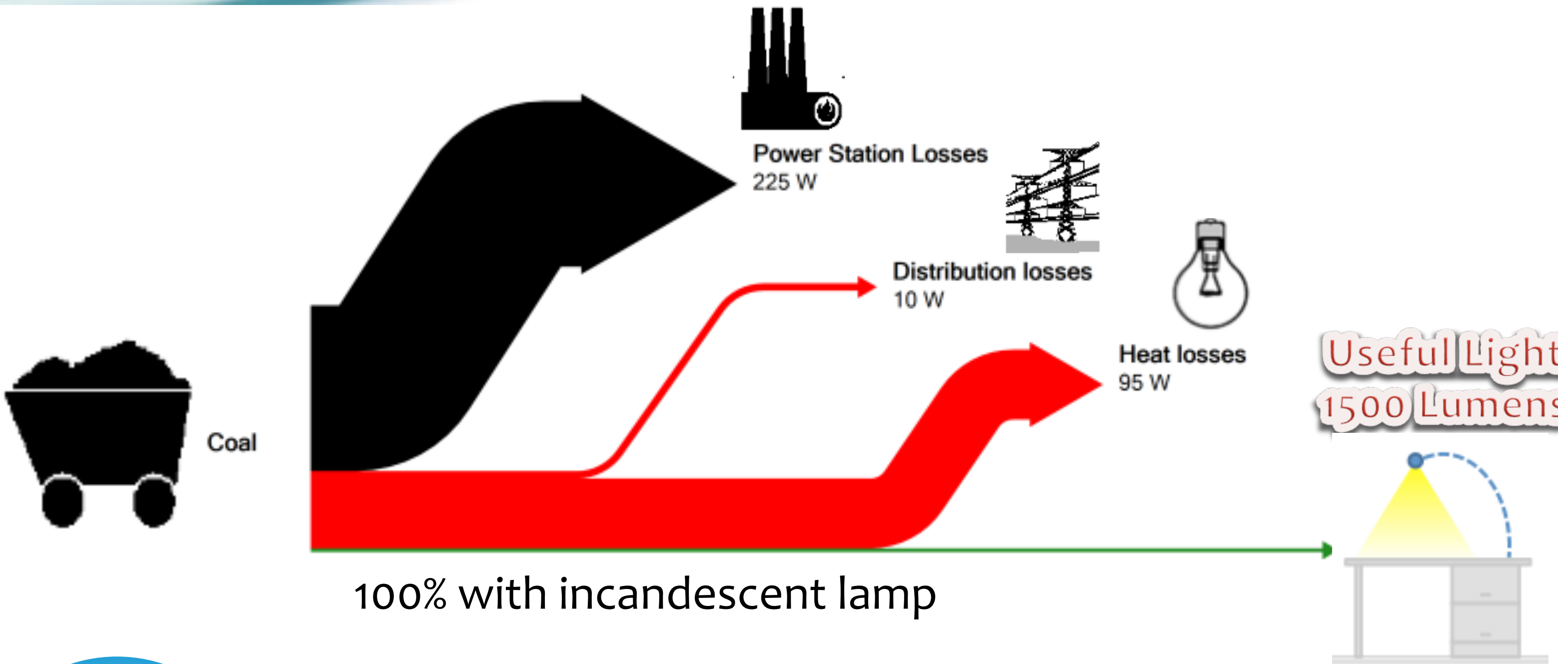
Consider the simple example of lighting



THE BASE CASE

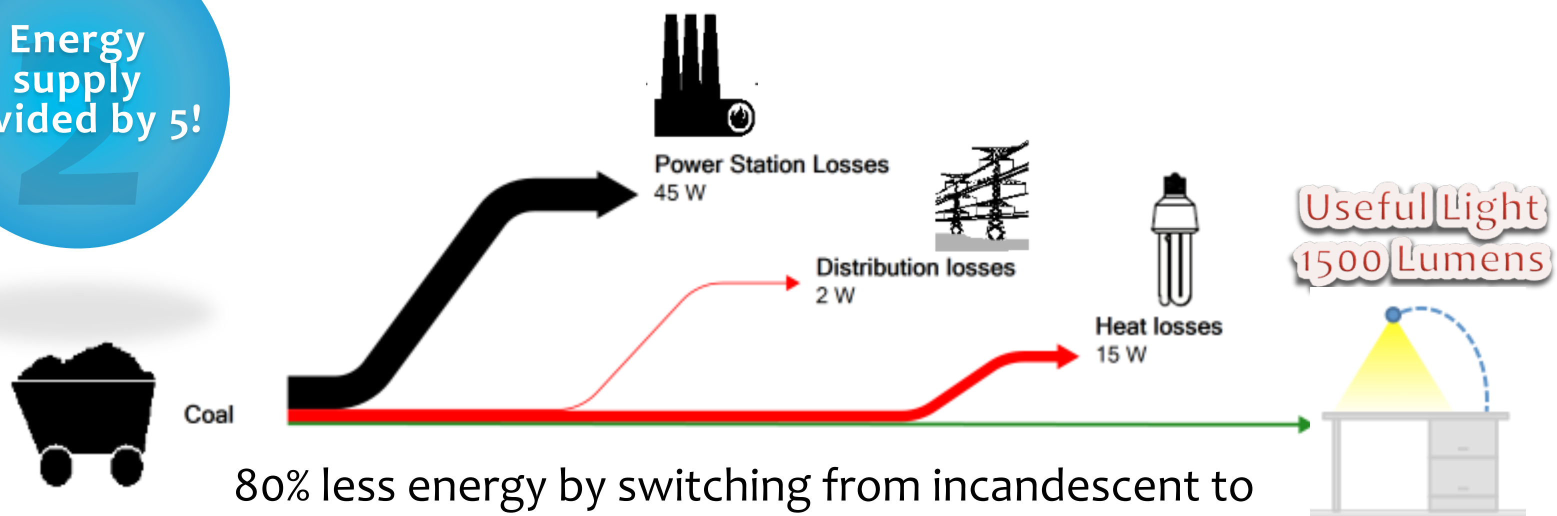
100% with incandescent lamp

Energy service delivered is a fraction of the fuel fed into a power plant

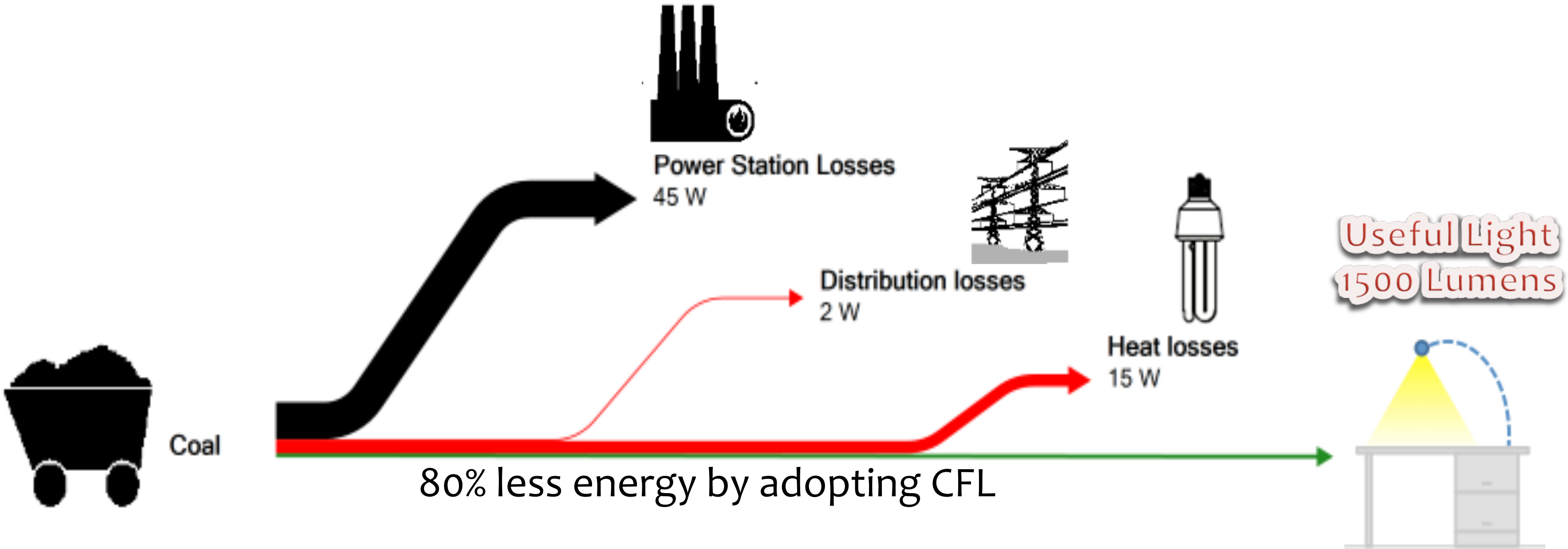


100% with incandescent lamp

Energy supply divided by 5!

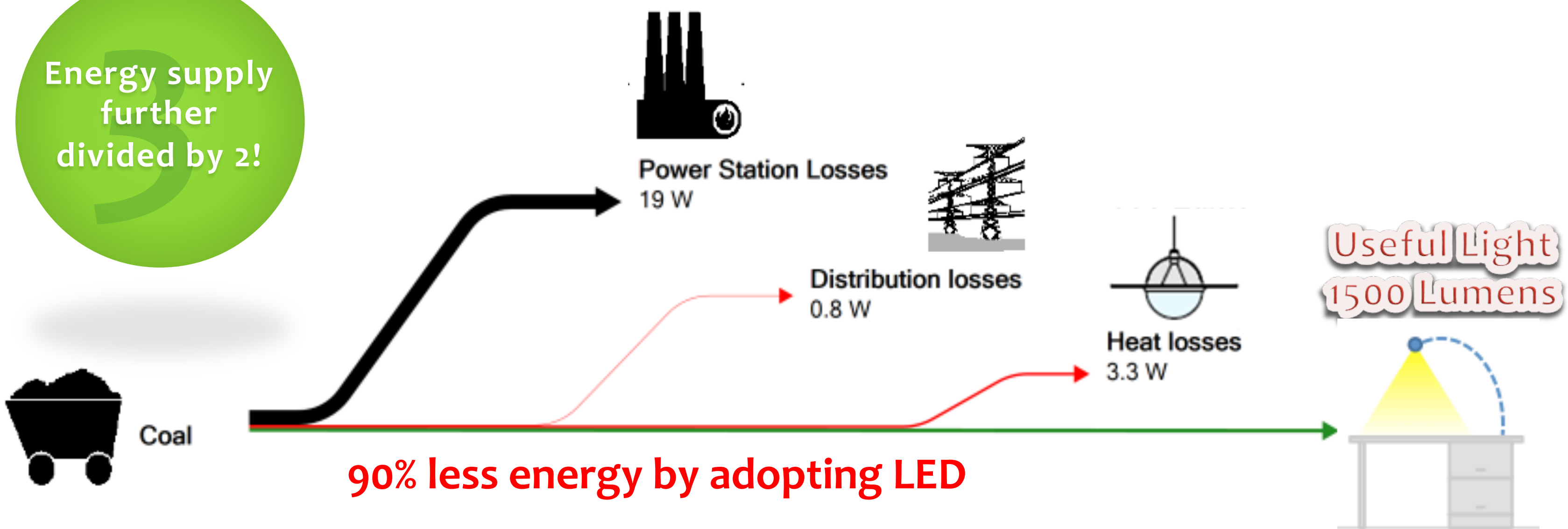


80% less energy by switching from incandescent to CFL

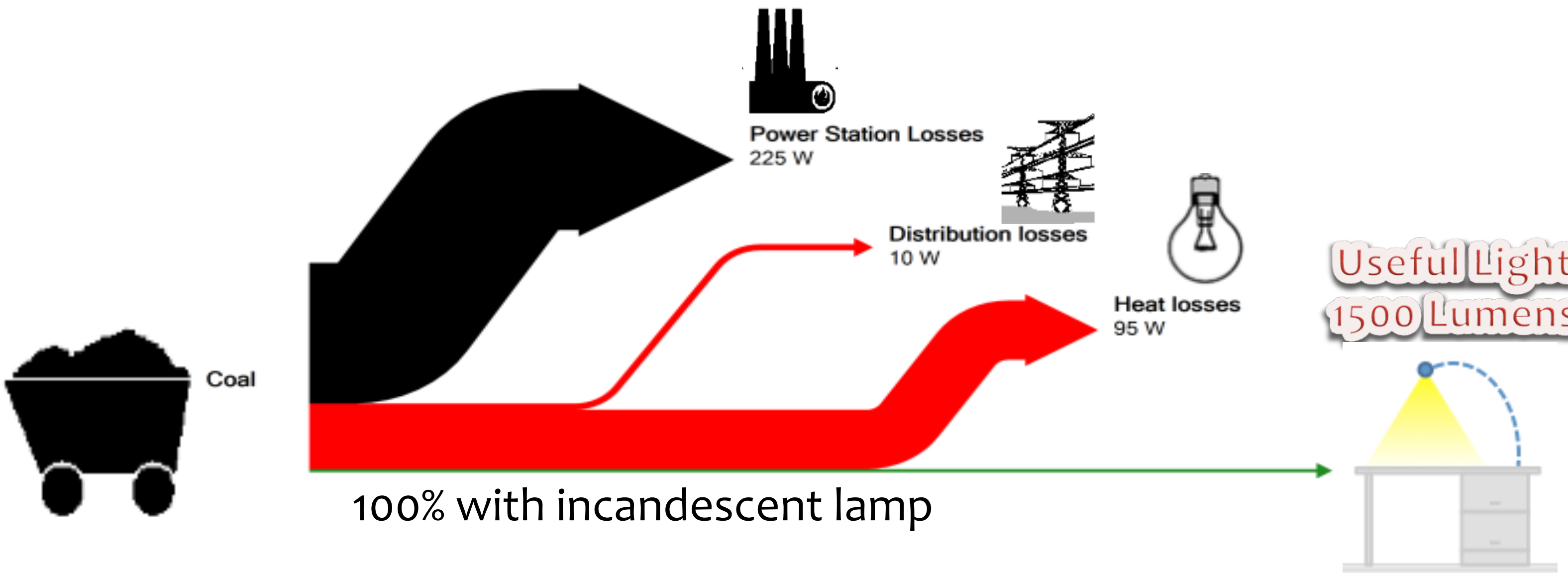


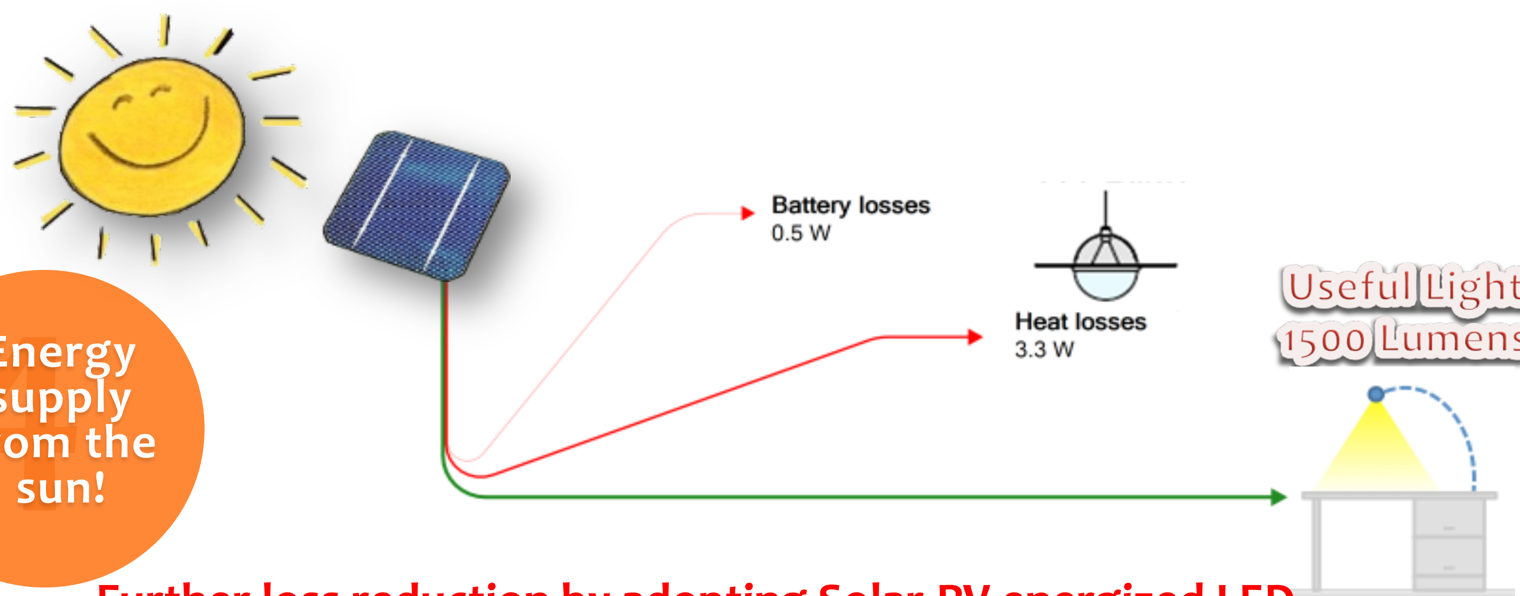
80% less energy by adopting CFL

Energy supply further divided by 2!



90% less energy by adopting LED





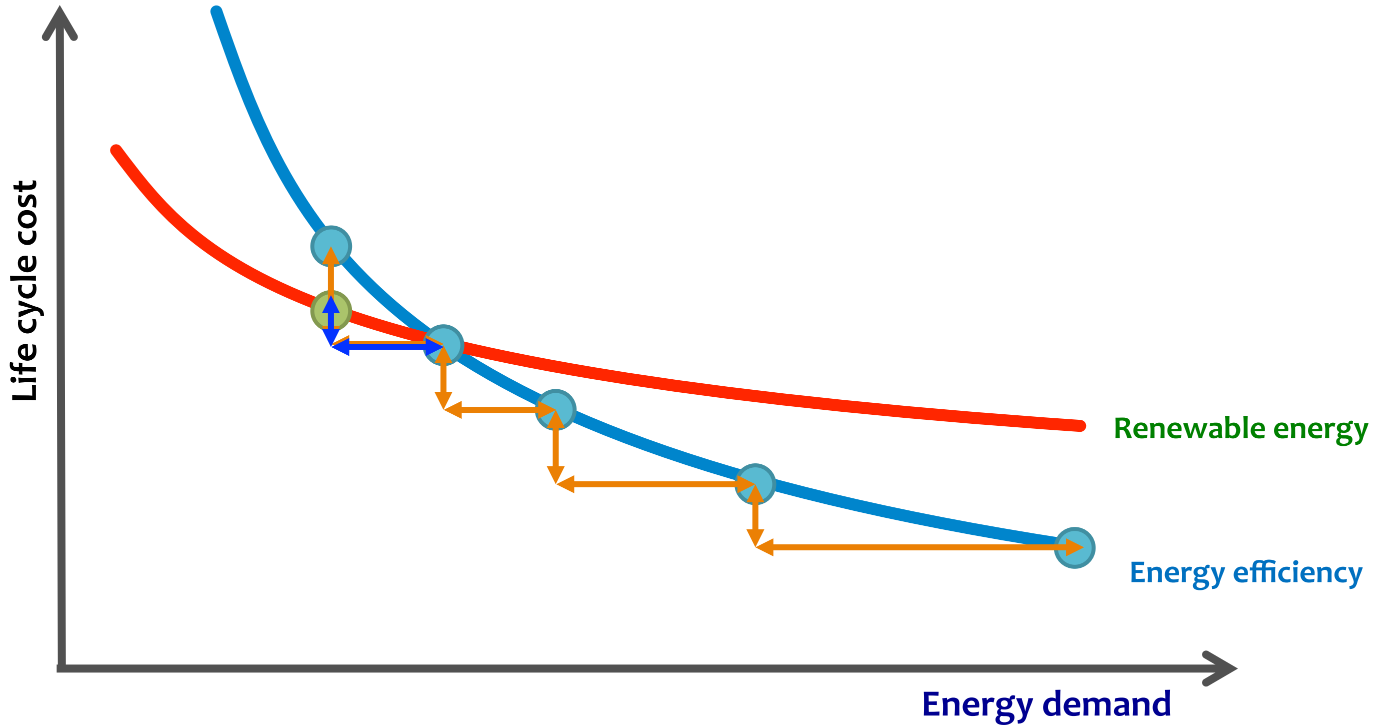
Energy supply from the sun!

Further loss reduction by adopting Solar-PV energized LED

Scope for achieving Factor-4 efficiency

- The steps that yield the greatest impacts on the whole system should be performed
- Downstream investments reduce the demand, hence lowering upstream supply-side investments and the operating costs
- Similar to lighting, there is scope for achieving Factor-4 or more efficiency by adopting the whole-system analysis approach

Energy efficiency versus Renewable energy



Initial energy efficiency measures (low-hanging fruits) are easy to attain; one can achieve high energy saving while investment stays low.

The more we try to reduce the energy demand, the higher the life cycle cost becomes!

At a certain point, Energy efficiency measures become more expensive than Renewable technologies. It is time to shift efforts to renewable energy investments.

Typical energy issues in buildings

Ever-rising energy bills

Irregular & erratic energy supply

Fed up with Power Cuts

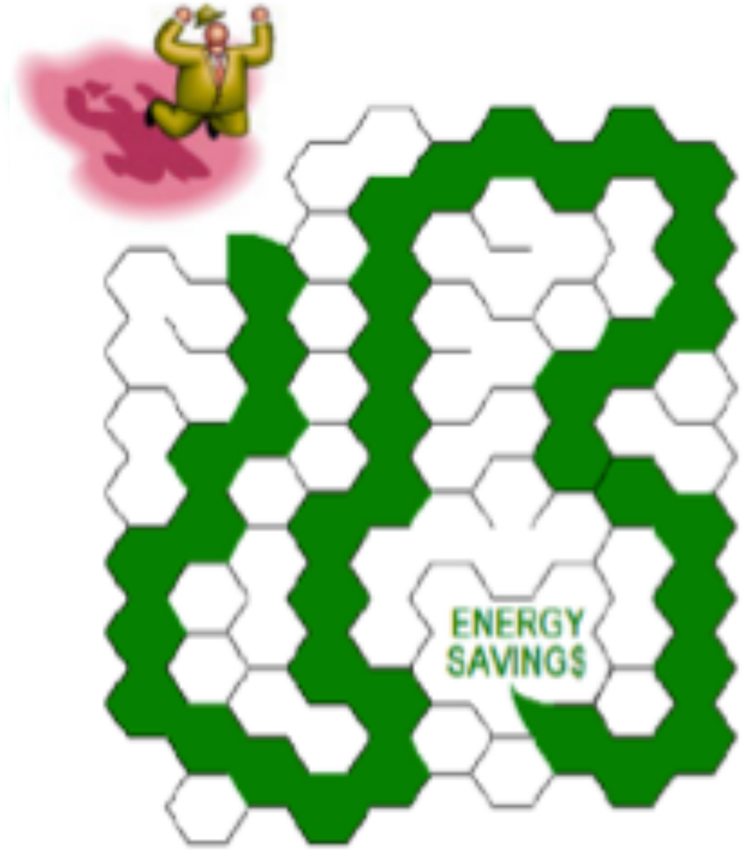
Frequent Breakdowns

The starting point is an energy audit (diagnosis)

Why energy audits?

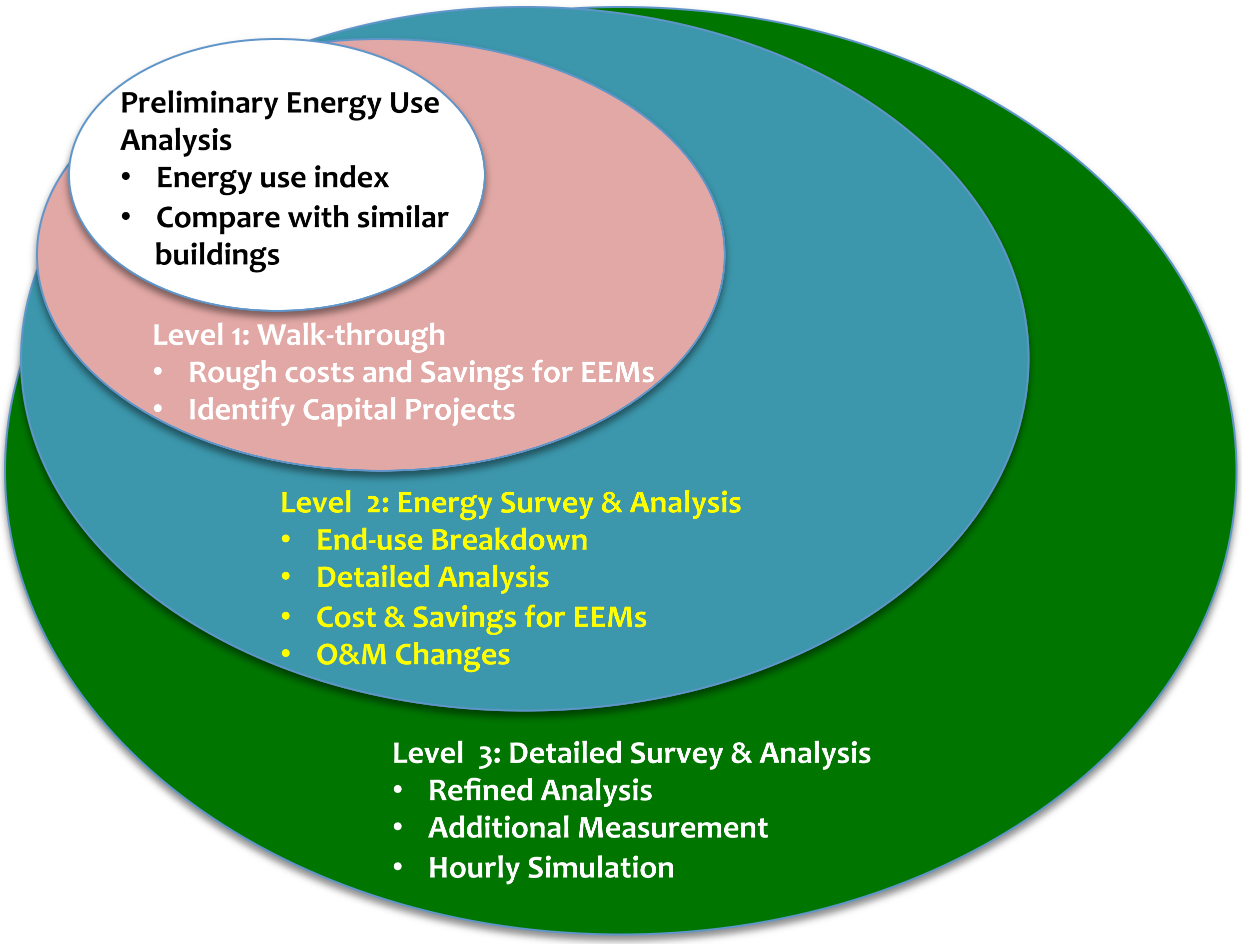
- Energy audit is the first step to reducing energy costs at your facility

- There are many ways to reduce energy costs but not all are cost-effective



- An energy audit provides focus and direction, serving as the road map to energy savings

Approach to energy auditing (ref: ASHRAE 2011)



Energy audit: Level 1

- Analysis of utility bills, brief survey or walk-through of building and facilities
  - Qualitative analysis
  - Recommendations usually do not include costs, savings and payback information
  - But recommendations address specific building areas and systems
  - Sufficient for proposing low-cost and no-cost energy saving measures

Energy audit: Level 2

- Detailed analysis of utility bills, in-depth inspection of building, breakdown of energy use by facility and identification of specific end uses
  - Quantitative analysis
  - Recommendations include implementation costs, savings and payback information
  - Sufficient for developing energy performance improvement measures
    - Replacement of inefficient equipment by energy efficient alternatives
    - Lighting, air conditioning, motive power (fans, pumps, compressors, variable frequency drives)

Steps involved in data collection

Collect data	• Data must be complete and accurate (for analysis and goal setting)
Determine appropriate level of details	• The level and scope of data collection varies from one organization to another
Account for all energy sources	• Make inventory of all energy purchased and generated on site, on cost basis
Document all energy uses	• Gather at least 3 years monthly data (energy bills, meter readings, etc.)
Collect facility and operational data	• To normalize and benchmark, collect non-energy related data

Undertake quantitative review

Develop use profiles

- Identify energy consumption peaks and valleys and determine how they relate to operations or key events

Compare performance

- Compare the use and performance data of similar facilities in buildings

Assess the financial impacts

- Identify areas of high-cost energy use

Identify data gap

- Determine areas where more information is needed

Energy audit: Level 3

- Also known as Investment-grade audit
- Thorough field inspection of facility, professional engineering analysis of energy use and potential improvements
  - Recommendations include implementation costs, savings and payback, life-cycle cost analysis
  - If needed, provision of bid specification services
  - Necessary for large-scale projects where many components and major changes are being considered
    - Major HVAC upgrades, re-design and re-engineering of HVAC systems, energy management systems
    - Major alteration to the building structure

Apply whole system design approach

1. Ask the right question
2. Benchmark against the optimal system
3. Design and optimize the whole system
4. Account for all measurable impacts
5. Design and optimize subsystems at the right time and in right sequence
6. Design and optimize subsystems in a downstream to upstream sequence
7. Review the system for potential improvements
8. Model the system
9. Track technology innovation
10. Design to create future options

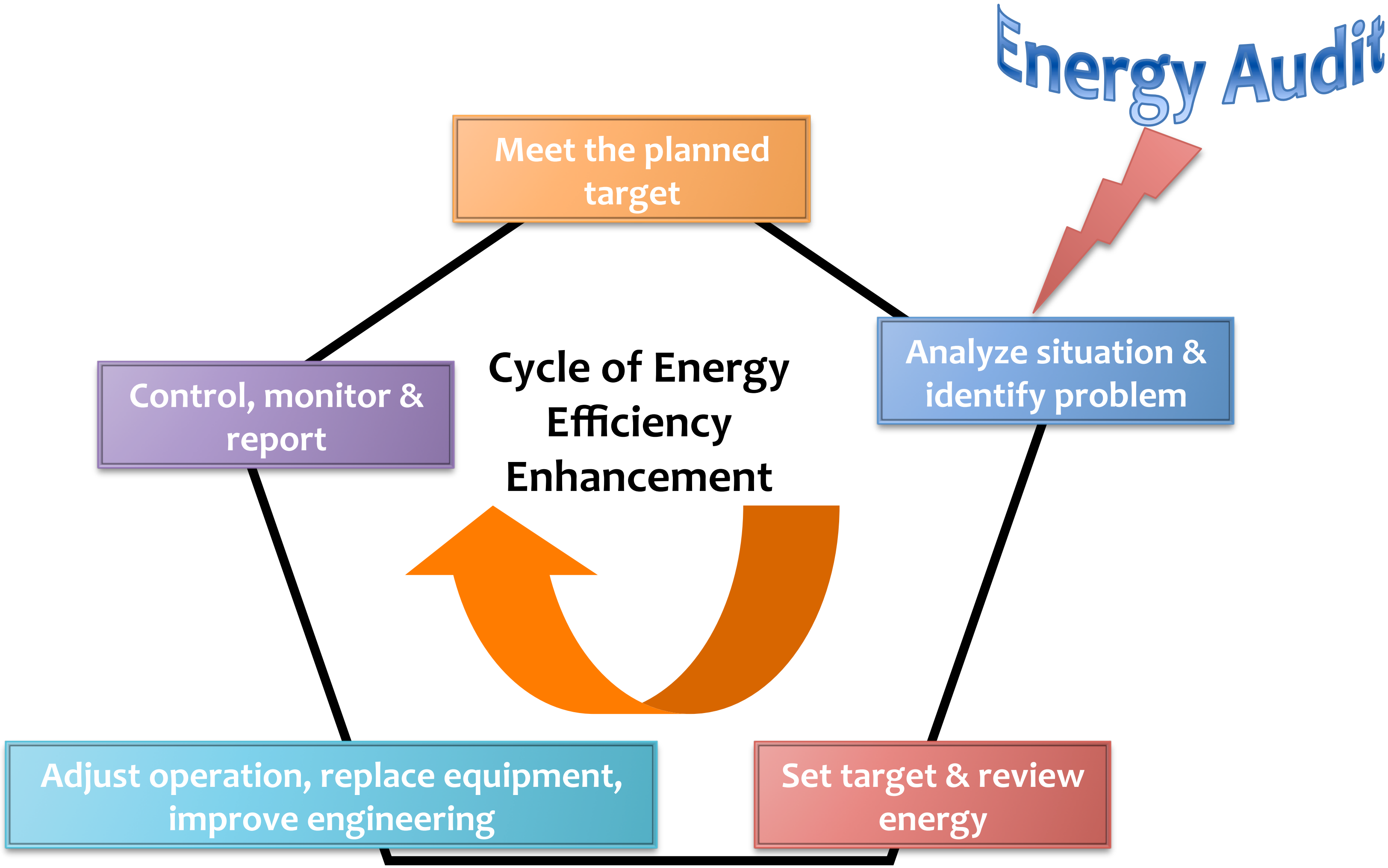
Life cycle cost analysis

Consider the “seen” and “unseen” costs and benefits of investments in energy systems

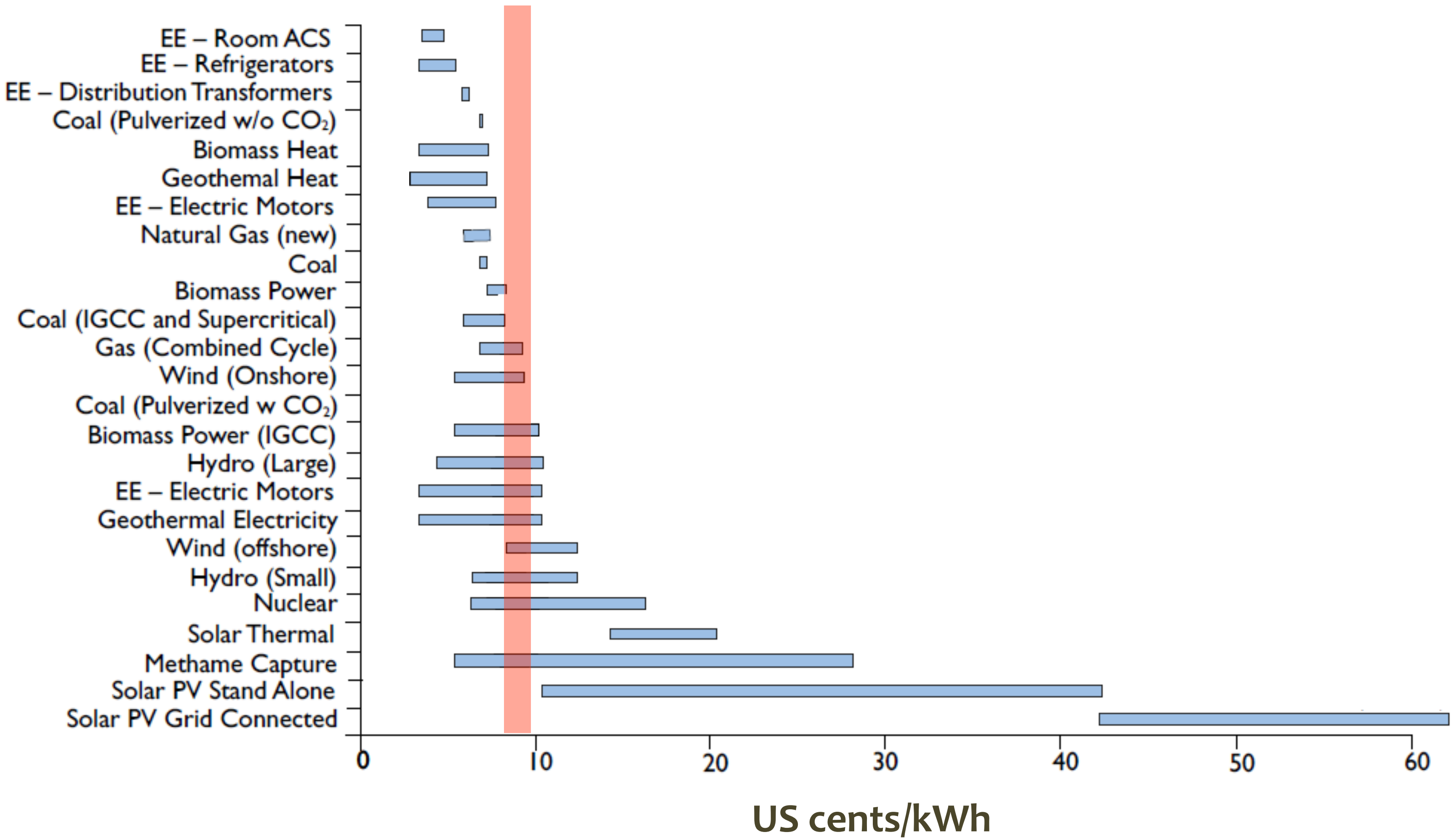
Life cycle cost analysis: simple example

Lamp	Unit	Standard	Efficient
Capacity	W	100	20
Investment	NRs	15	180
Economic life	Hours	1000	5000
Operation	hours/year	2,000	2,000
Electricity cost	Rs/kWh	**4**	**4**
Yearly electricity cost	Rs/year	800	160
Lifecycle cost (5000 hours)	Rs	**2,075**	**580**
Lamp depreciation cost	Rs/hour	0.015	0.036
Hourly electricity cost	Rs/hour	0.415	0.116
Hourly cost savings	Rs/hour		0.299
Cost of saving electricity	Rs/kWh		**0.45**

Cycling process of energy management



Life cycle cost analysis: a dynamic process



To sum up…

- Energy auditing & management are effective in reducing energy costs
  - Without affecting building's functional requirements
  - Without compromising comfort and well-being
- Gain compounded savings through whole system analysis
- Conduct life cycle cost analysis to reap long-term benefits