



# Using Building Energy Codes to Promote Energy Efficiency



1911-2011

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# Contents

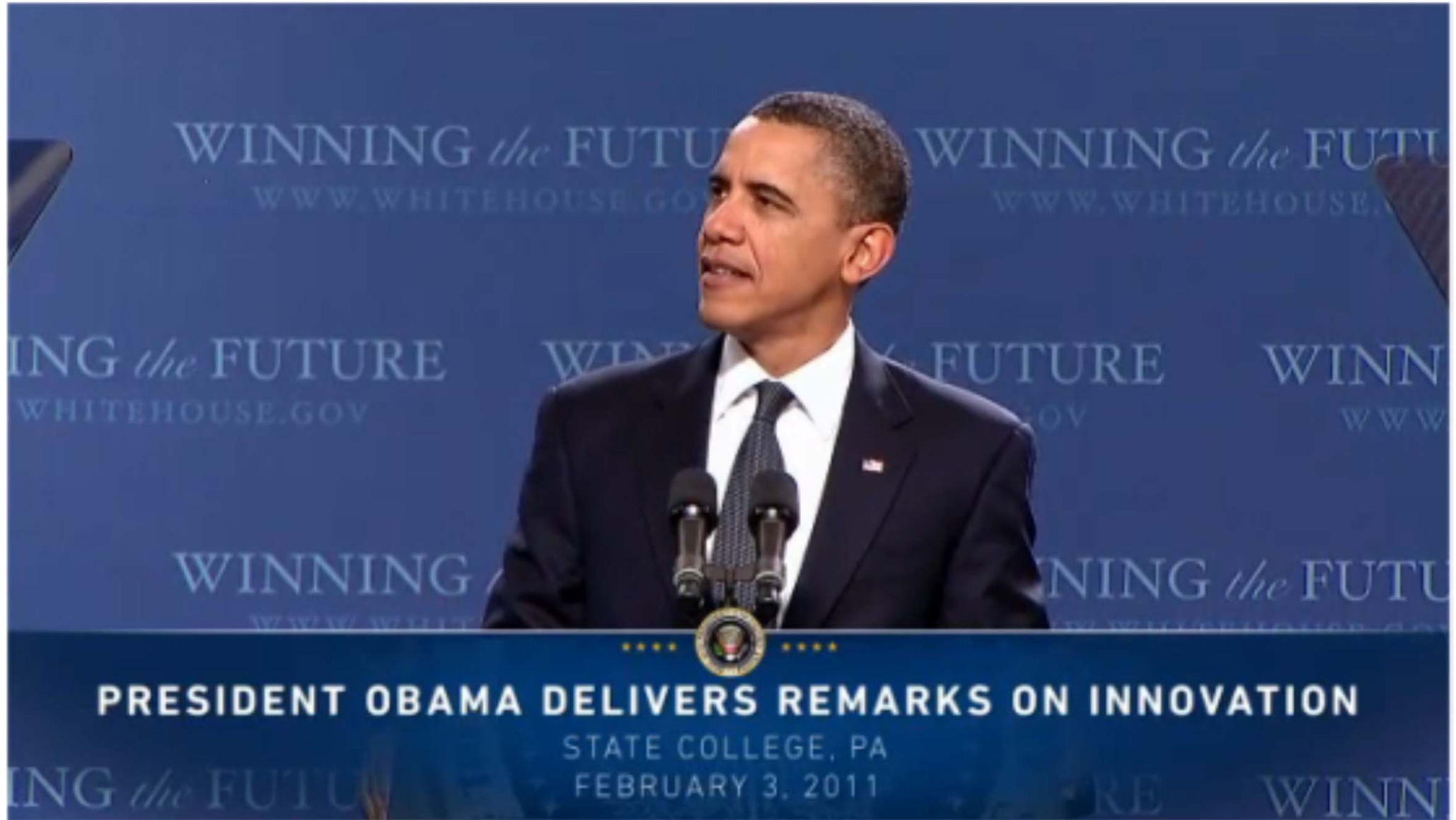


- Why energy efficiency?
- Why building energy codes?
- Characteristics of BEC
- Implementation issues
- Conclusions



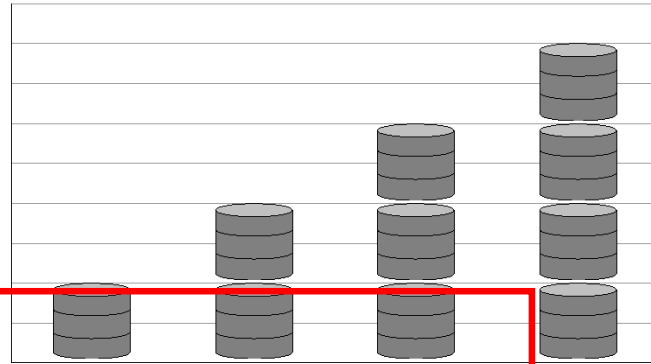
# President Obama's Plan to Win the Future by Making American Businesses More Energy Efficient through the Better Buildings Initiative

- ▶ make commercial buildings 20% more energy efficient by 2020
- ▶ get twice as much of its electricity from clean energy sources by 2035

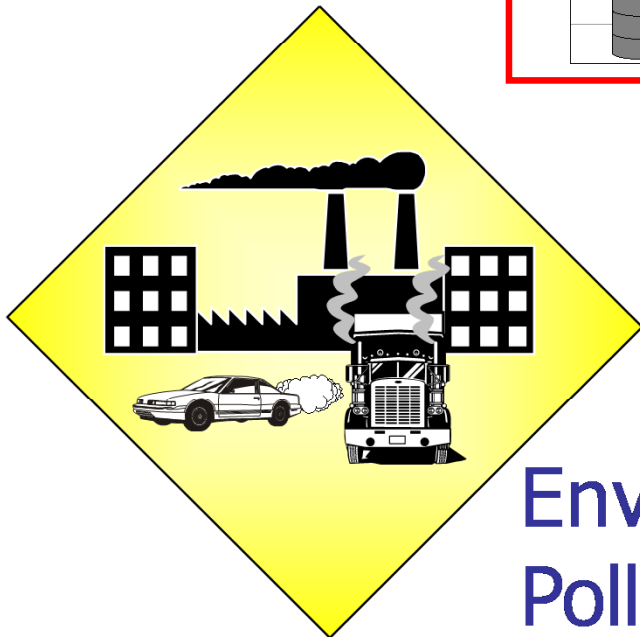


(Source: [www.whitehouse.gov/blog/2011/02/03/winning-future-through-innovation-and-better-buildings](http://www.whitehouse.gov/blog/2011/02/03/winning-future-through-innovation-and-better-buildings))

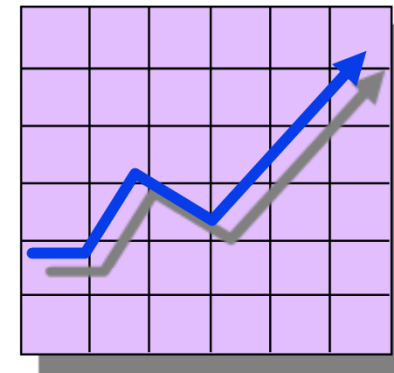
# The challenges facing us...



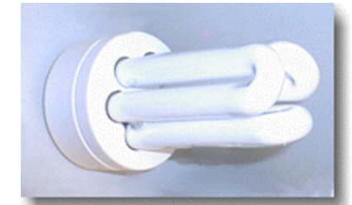
Growing  
Petroleum  
Consumption



Environmental  
Pollution



Economic  
Competitiveness



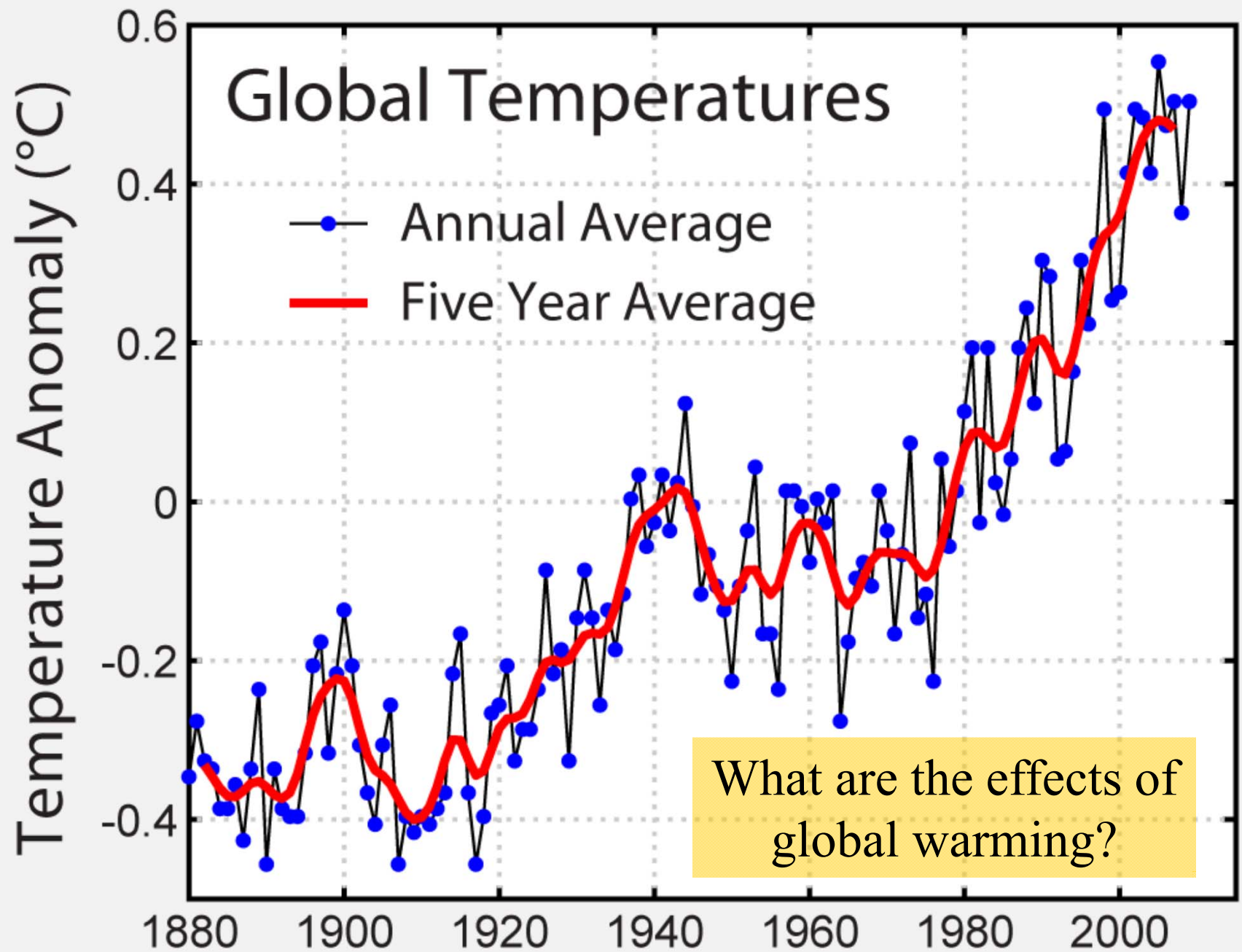
# Why energy efficiency?

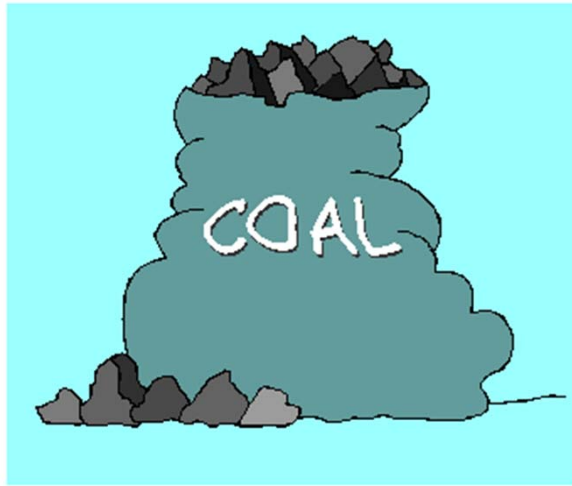
- **Energy** is important to every society
  - Economic, environmental & social impacts
  - It is also a key issue for *sustainable development*
- Use energy ...
  - Consume finite fossil fuels (oil, coal, natural gas)
  - Cause air pollution & environmental damage
  - Contribute to global warming
  - Cost money





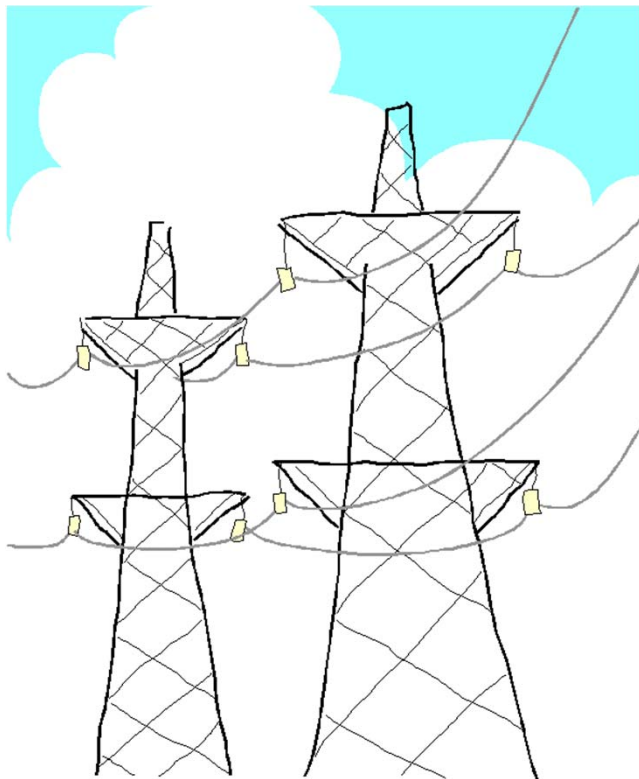
# 1880-2009 global mean surface temperature anomaly relative to 1961-1990





Different forms of  
energy

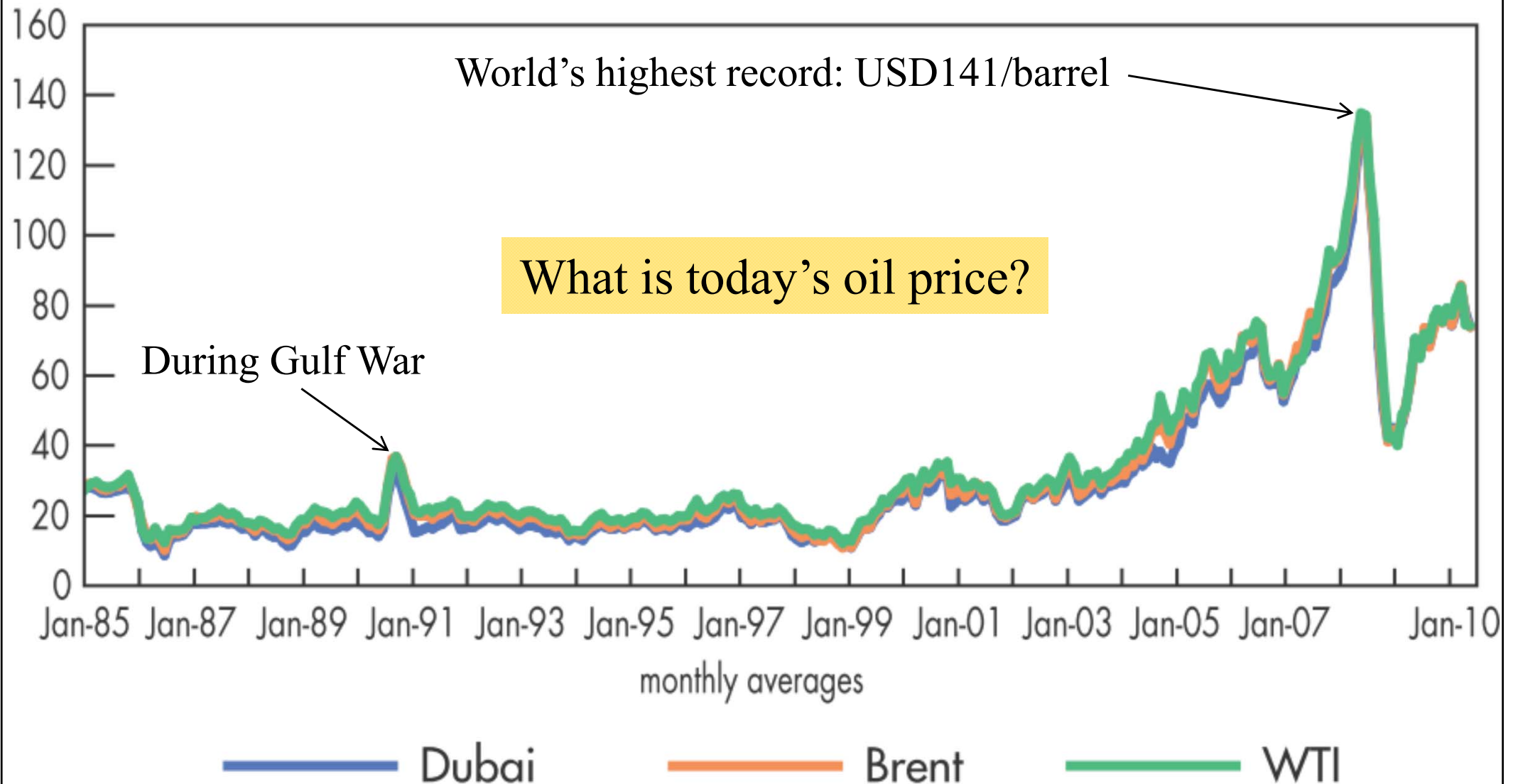
能源



Which one(s) is/are most important nowadays?



# Key crude oil spot prices in USD/barrel

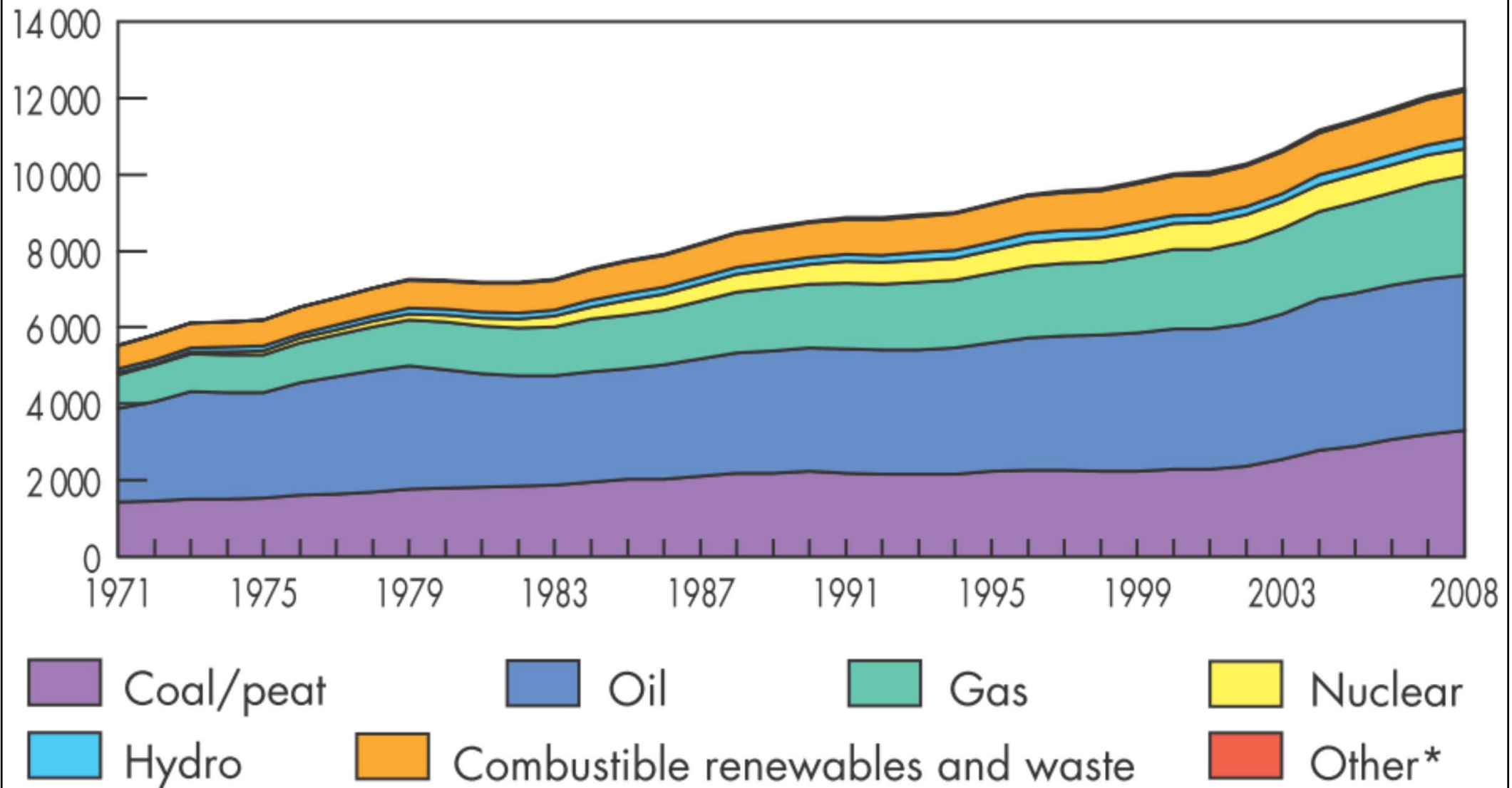


(\* Source: IEA, 2010. *Key World Energy Statistics 2010*, International Energy Agency, Paris. Available at [www.iea.org](http://www.iea.org))



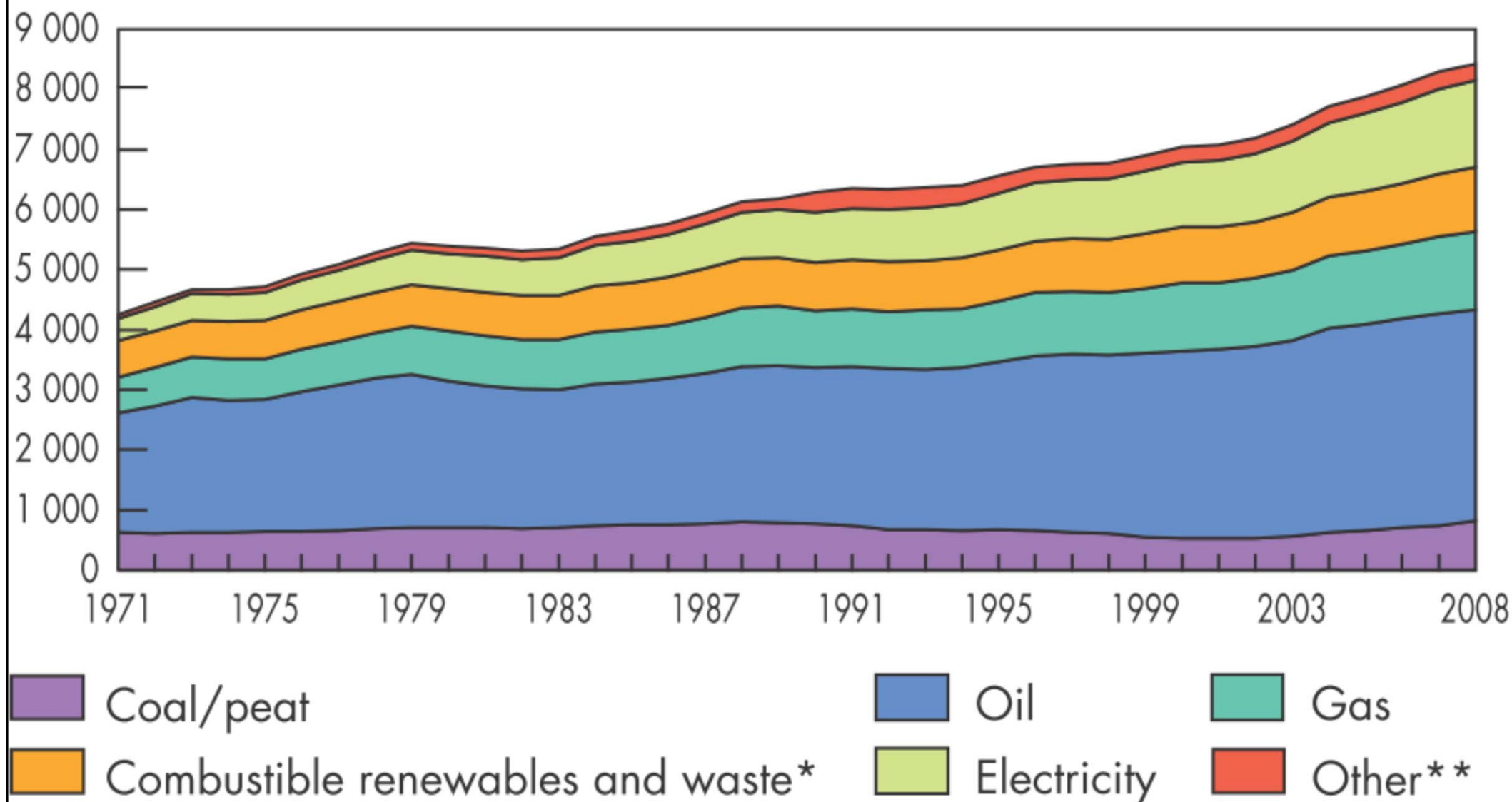
(TPES)

Evolution from 1971 to 2008 of world total primary energy supply by fuel (Mtoe)



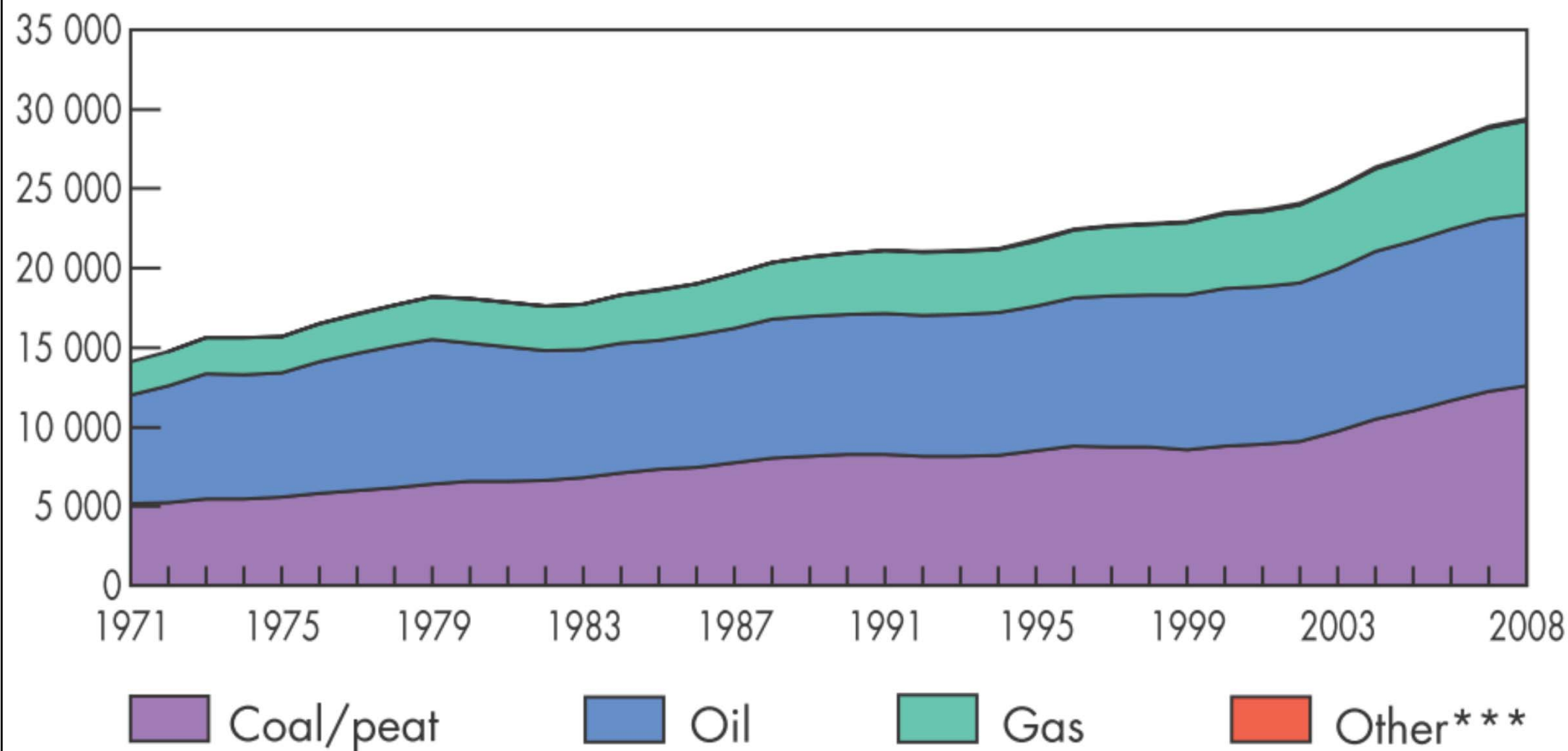
(\* Source: IEA, 2010. *Key World Energy Statistics 2010*, International Energy Agency, Paris. Available at [www.iea.org](http://www.iea.org))

# Evolution from 1971 to 2008 of world total final consumption by fuel (Mtoe)



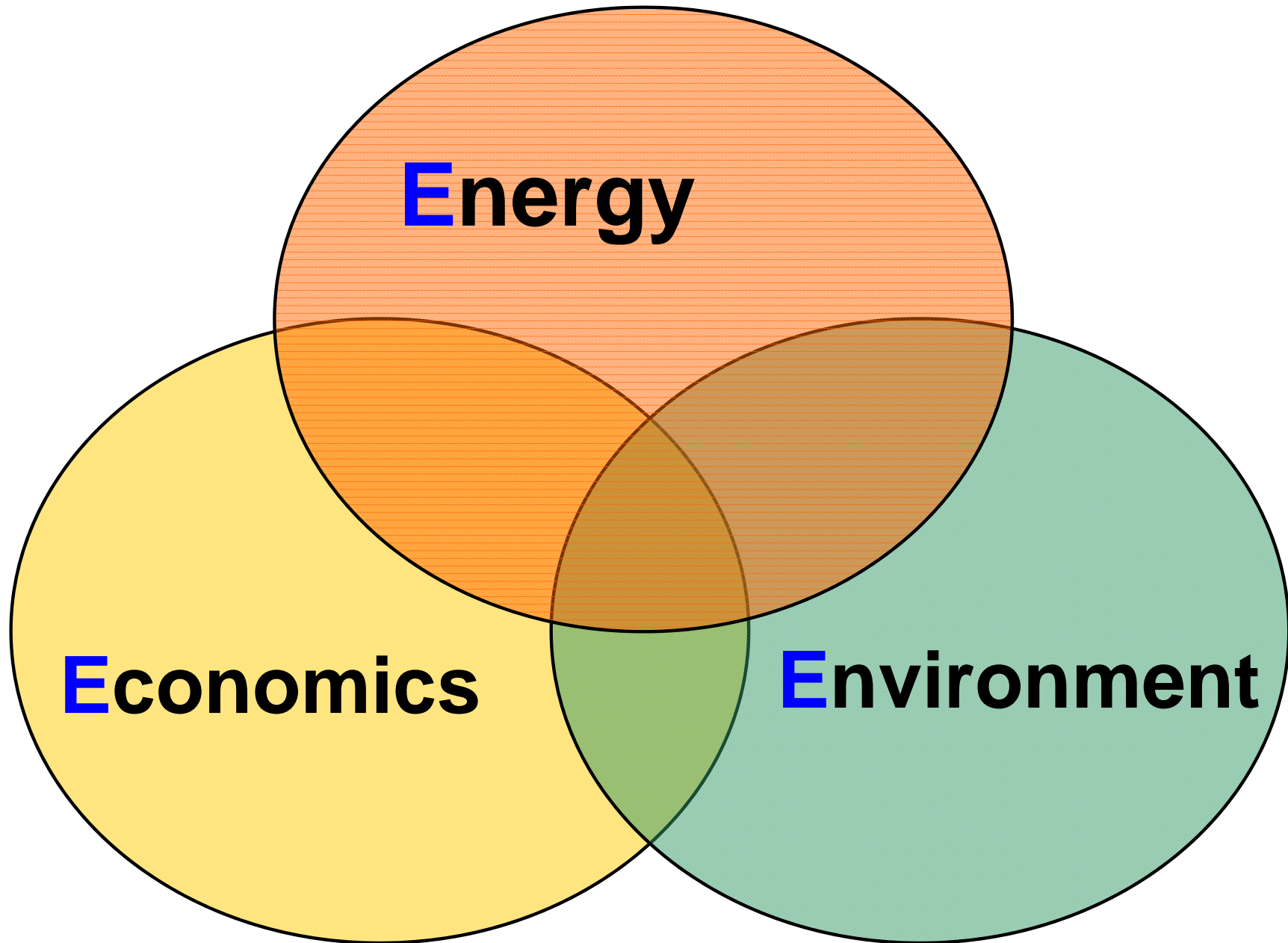
(\* Source: IEA, 2010. *Key World Energy Statistics 2010*, International Energy Agency, Paris. Available at [www.iea.org](http://www.iea.org))

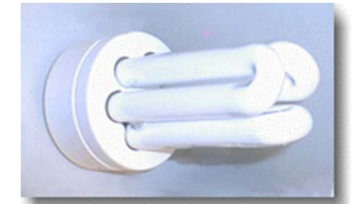
# Evolution from 1971 to 2008 of world\* CO<sub>2</sub> emissions\*\* by fuel (Mt of CO<sub>2</sub>)



(\* Source: IEA, 2010. *Key World Energy Statistics 2010*, International Energy Agency, Paris. Available at [www.iea.org](http://www.iea.org))

# 3 'E' Relationships





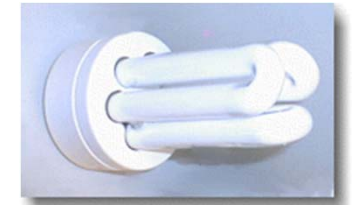
# Why energy efficiency?

- Video: Energy efficiency -- The World in 2030 (4:22)



- [www.youtube.com/watch?v=QG3HNQiEaTM](http://www.youtube.com/watch?v=QG3HNQiEaTM)
- Growth of human population
  - 6.5 billions in 2010 => 8.3 billions in 2030
- Energy demand +53%; CO<sub>2</sub> emissions +55%
- The best energy source: Energy Efficiency
- How to improve it in Industry, Mobility and Housing?





# Why energy efficiency?

- Future energy options:



- Coal, oil and natural gas

- Resource depletion, environmental impacts, energy security, fuel price



- Nuclear energy

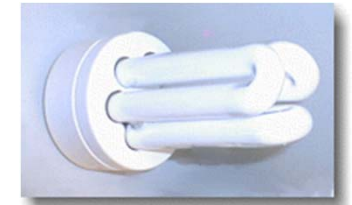
- After Fukushima nuclear accidents, safety is doubtful!



- Renewable energy

- Still limited and costly to develop

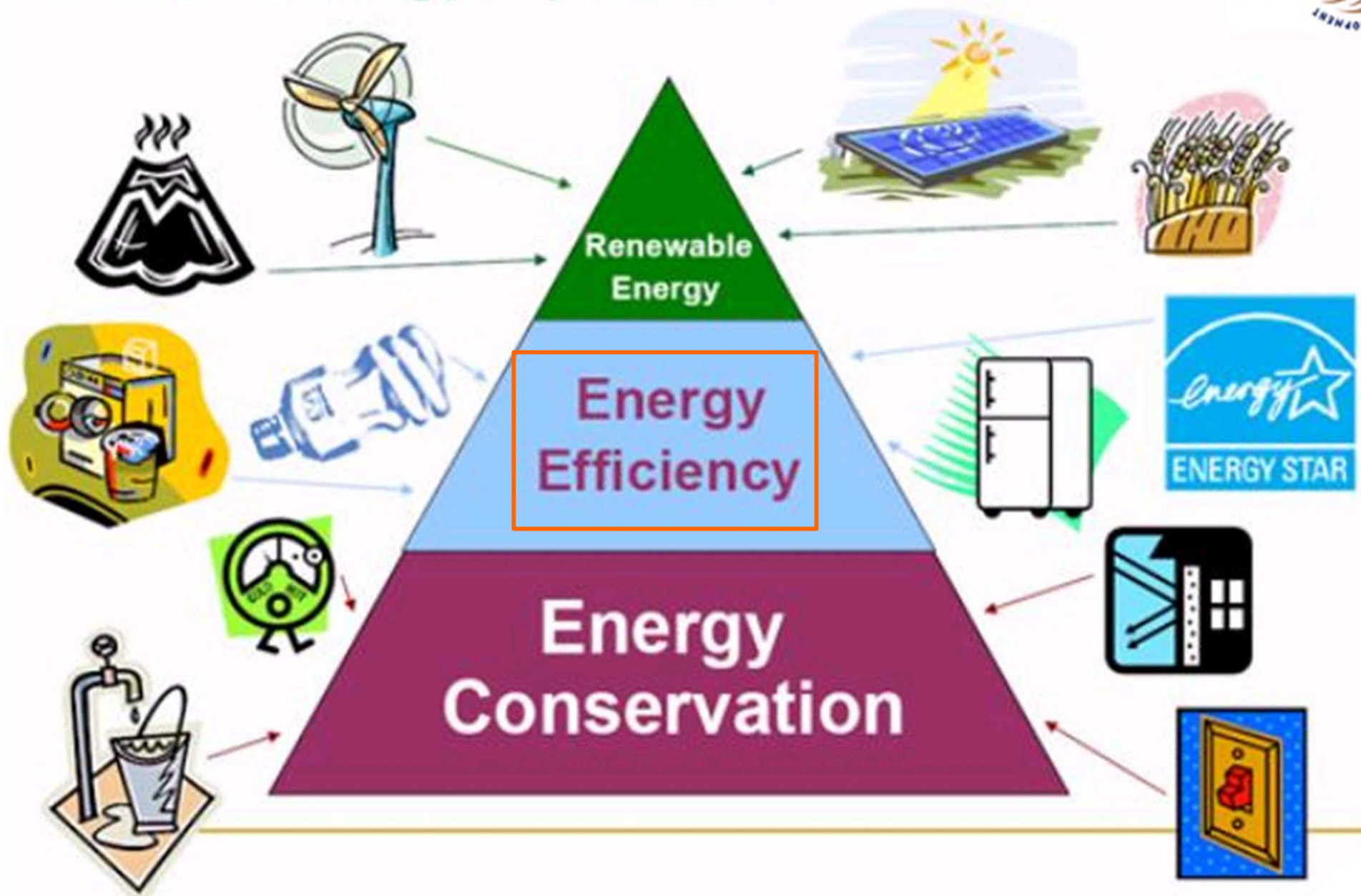
- Energy efficiency is an important, smarter and more practical option



# Why energy efficiency?

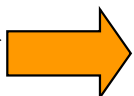
- **EE = Energy Efficiency**
  - Efficient use of energy, also called the “*fifth fuel*”
  - Use less energy to provide the same level of energy service (*Doing More with Less*)
  - Achieved by more efficient technology or process
  - According to the International Energy Agency ([www.iea.org](http://www.iea.org)), energy efficiency in the following 3 sectors could reduce the world’s energy needs in 2050 by one third:
    - Buildings, industrial processes, transportation

# The Energy Pyramid





Building  
Energy  
Codes



### ***Energy Efficiency***

- Buildings
- Industries
- Transport
- Appliance
- Utilities
- Energy management

Important energy sector

### ***Energy Supply***

- Coal
- Oil
- Natural gas
- Nuclear
- Electricity
- Renewable energy

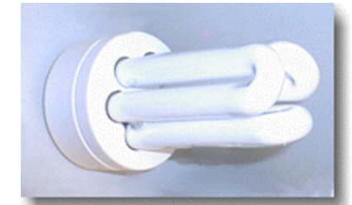
### ***Energy Resources***

- Coal
- Oil
- Natural gas
- Nuclear energy
- Renewable energy

### ***Other Issues***

- Energy security
- Energy and environment
- Energy economics

Building sector in the overall energy policy



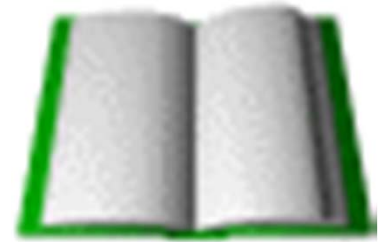
# Why energy efficiency?

- Possible benefits from energy efficiency:
  - Improved building design and operation
  - Better working environments
  - Life-cycle cost savings
  - Added market value of buildings
  - Reduced CO<sub>2</sub> emissions and consumption of finite fossil fuels
  - Reduced capital cost by better integration of building fabric and systems



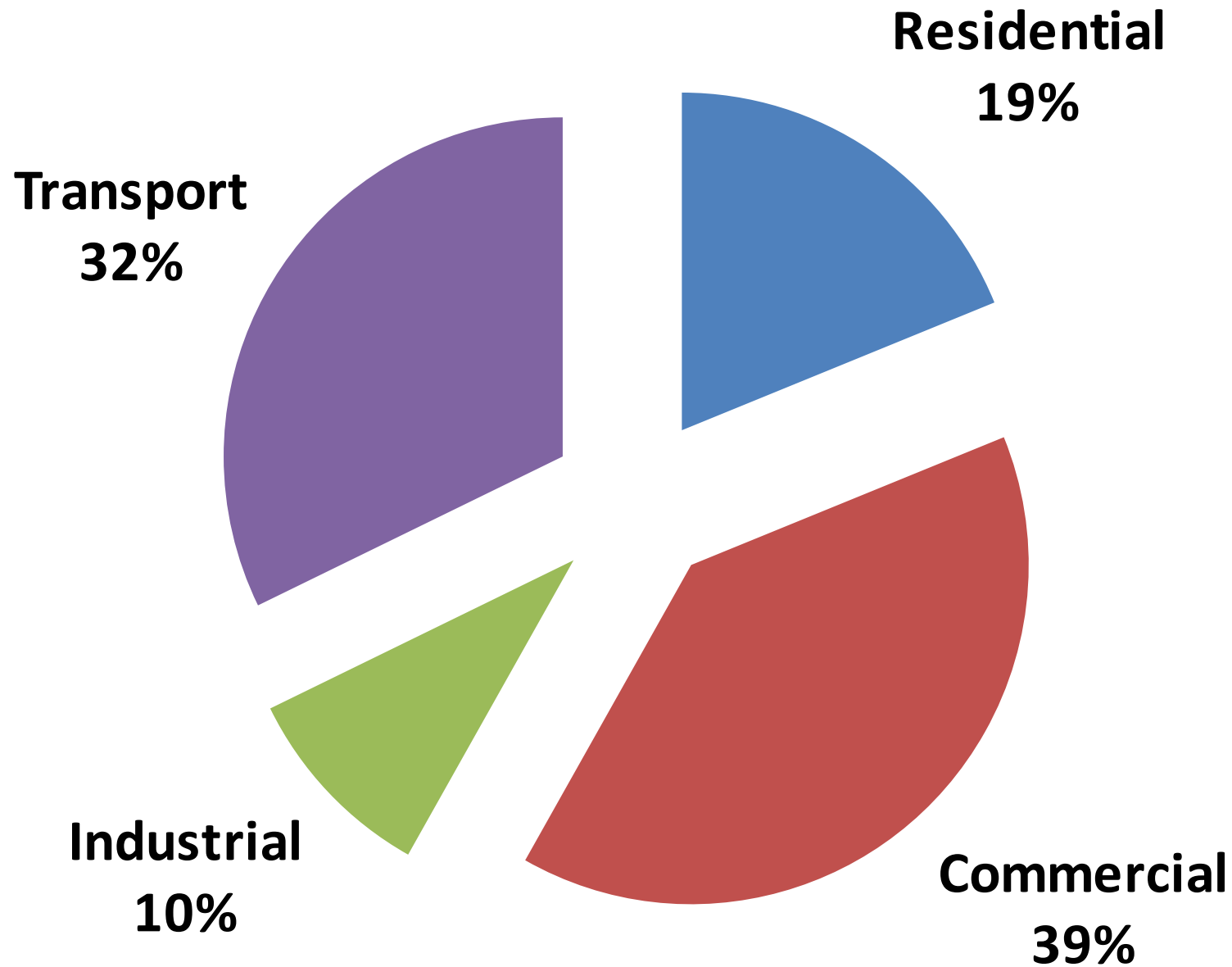


# Why building energy codes?



- In Hong Kong, buildings constitute 60-70% of total energy end-use and 58% of final energy requirements
  - Residential + commercial + industrial
- The potential for energy saving is large
- But the barriers to promoting energy efficiency in buildings are yet to overcome
- Energy efficiency is often discounted and hard to sell in a commercial free market

# Energy end-use by sector (2008)



(Data source: EMSD)

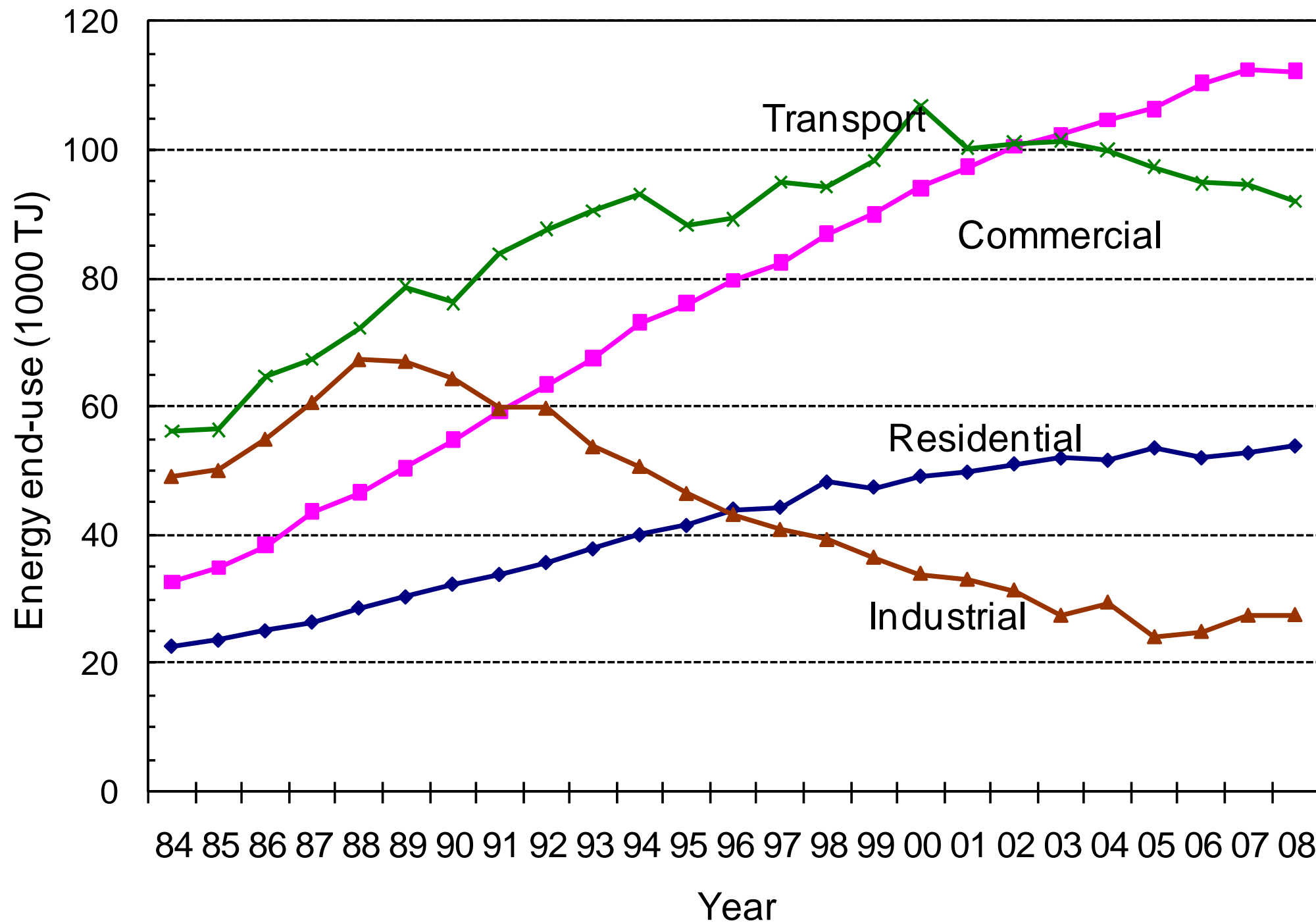
Energy end-use in Hong Kong

**Table 1 - Final energy requirements (FER)  
in Hong Kong (year 2009)**

Unit: MJ	Commercial	Residential	Industrial	Total
Electricity	98 860 (66%)	38 972 (26%)	11 143 (8%)	148 975 (100%)
Town gas	11 069 (41%)	15 303 (56%)	902 (3%)	27 274 (100%)
Elec. + town gas	109 929	54 275	12 045	176 249
% in total FER	35.8%	17.7%	3.9%	57.5%

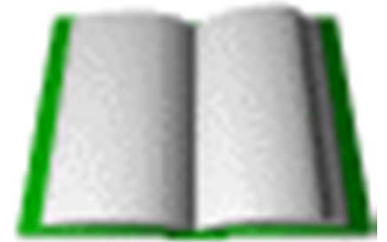
Total FER for 2009 = 306 774 TJ

(\* Data Source: *Hong Kong Energy Statistics 2009 Annual Report*)



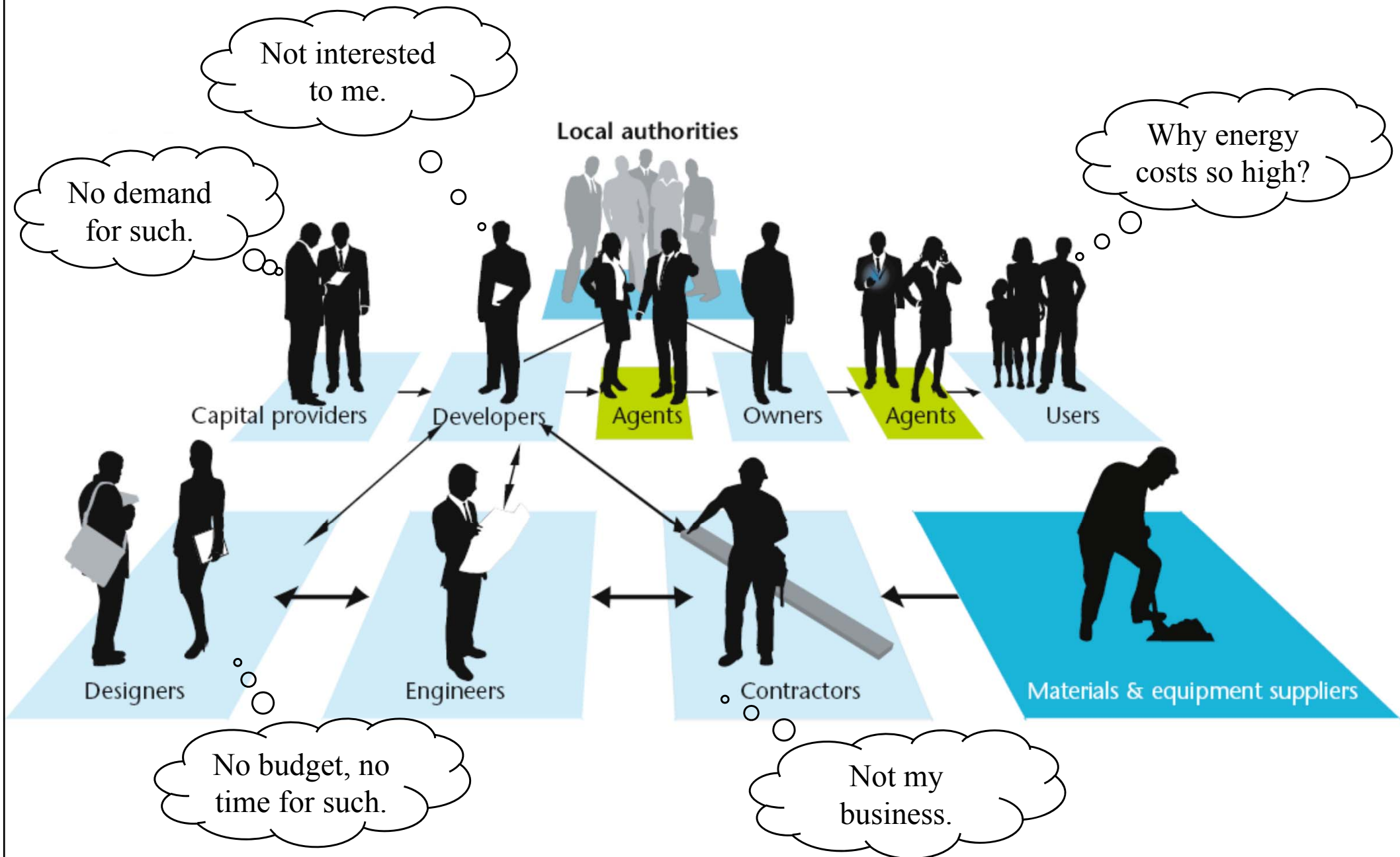
(Data source: EMSD) Energy end-use in Hong Kong by sectors, 1984-2008

# Why building energy codes?



- Barriers to energy efficiency
  - Developers and builders not interested to save energy for tenants and end-users
  - Utilities not encouraged to end-use energy efficiency (because it may reduce their profits)
  - Lack of efficiency attitudes and awareness
  - Lack of information on energy performance
  - Perceived riskiness of efficiency measures
  - Limited access to capital





## The complex value chain in the building sector

# Top ten reasons for building energy codes

<b>10.</b> They establish a common foundation for evaluating, regulating, and incentivizing building performance, technologies, design, and construction.	<b>5.</b> They provide a common basis upon which to educate the building design and construction community in energy efficiency.
<b>9.</b> They support more widespread decisions and actions that lead to efficient buildings.	<b>4.</b> They safeguard owners and tenants from long-term financial burdens that can result from short-term design and construction decisions.
<b>8.</b> They help drive the development and deployment of new building technologies and design strategies.	<b>3.</b> They continue to progress in terms of stringency, scope, and enforcement emphasis -- which will enhance the skills of the current workforce.
<b>7.</b> They provide a cost-effective step toward mitigating problems associated with growing demand for energy and power resources.	<b>2.</b> They help protect the natural environment from unnecessary emissions.
<b>6.</b> They can lock in the use of energy efficient technologies that have been proven through incentive programs, freeing up resources to focus on additional technologies.	<b>1.</b> They reduce the vast amount of energy that is needlessly consumed each year for commercial and residential buildings that lack adequate energy efficiency features.



# Characteristics of BEC

- Building Energy Codes (*BEC*)
  - Set out minimum energy consumption objectives
  - Form part of the energy policy
  - Control building design and/or operation
- Energy audit requirements (in some countries)
  - Essential for existing buildings
- Energy management programmes
  - Promote good practices in design and operation



# Characteristics of BEC

- Basic functions of BEC:
  - Raise concerns and awareness of energy efficiency
  - Promote energy efficient design & operation
  - Facilitate energy conservation products & services
  - Provide a basis for building energy performance
  - Help achieve energy policy goals
- Code requirements
  - Prescriptive approach
  - Performance approach



# Characteristics of BEC

- Prescriptive approach
  - Specifies for each building component the minimum requirements to satisfy the code
  - Advantages:
    - Simple to use & follow
    - Easy to check & enforce
  - Drawbacks:
    - Rather restrictive
    - Barrier to innovation & performance optimisation
    - Hinder cross-country product trading

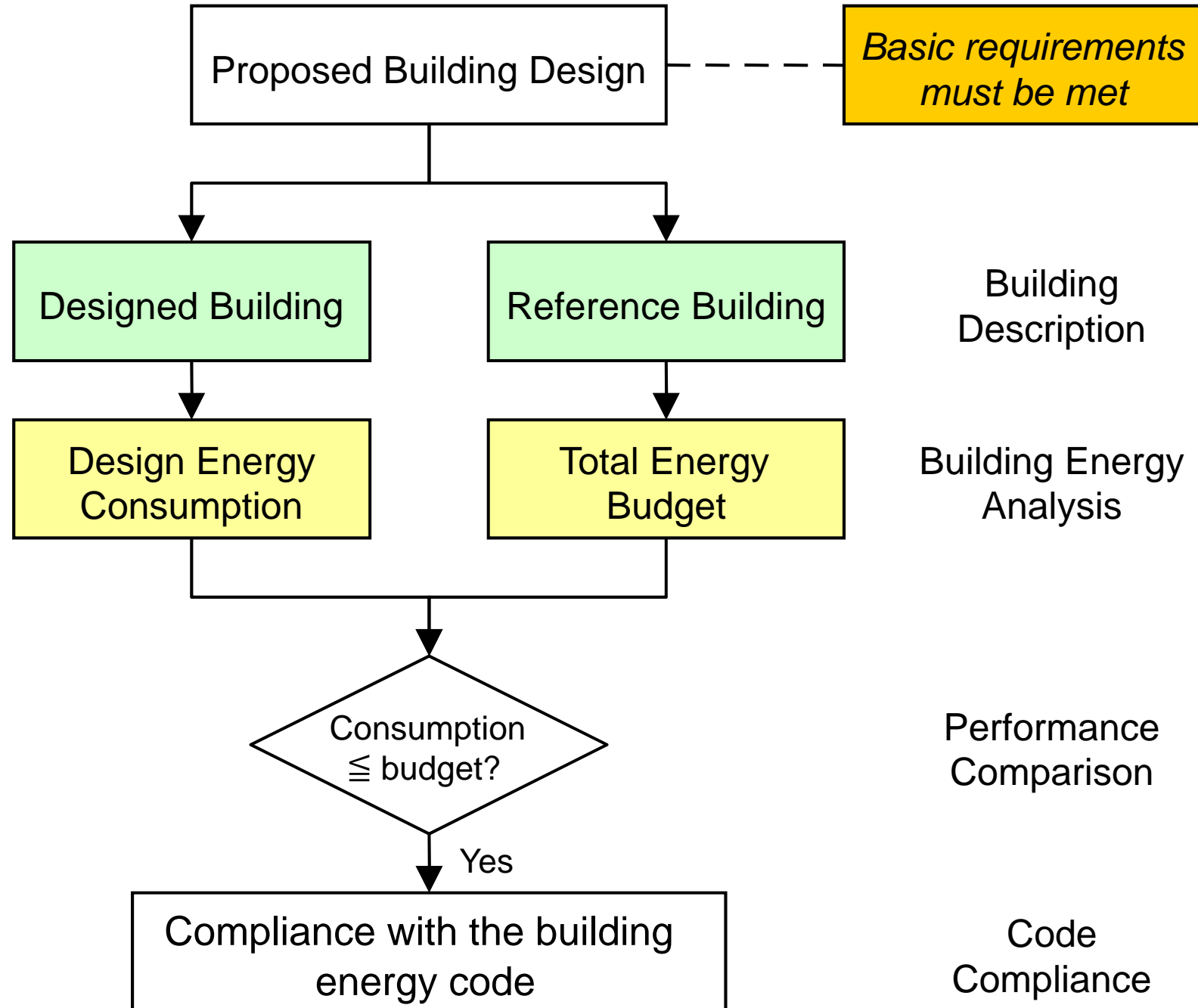




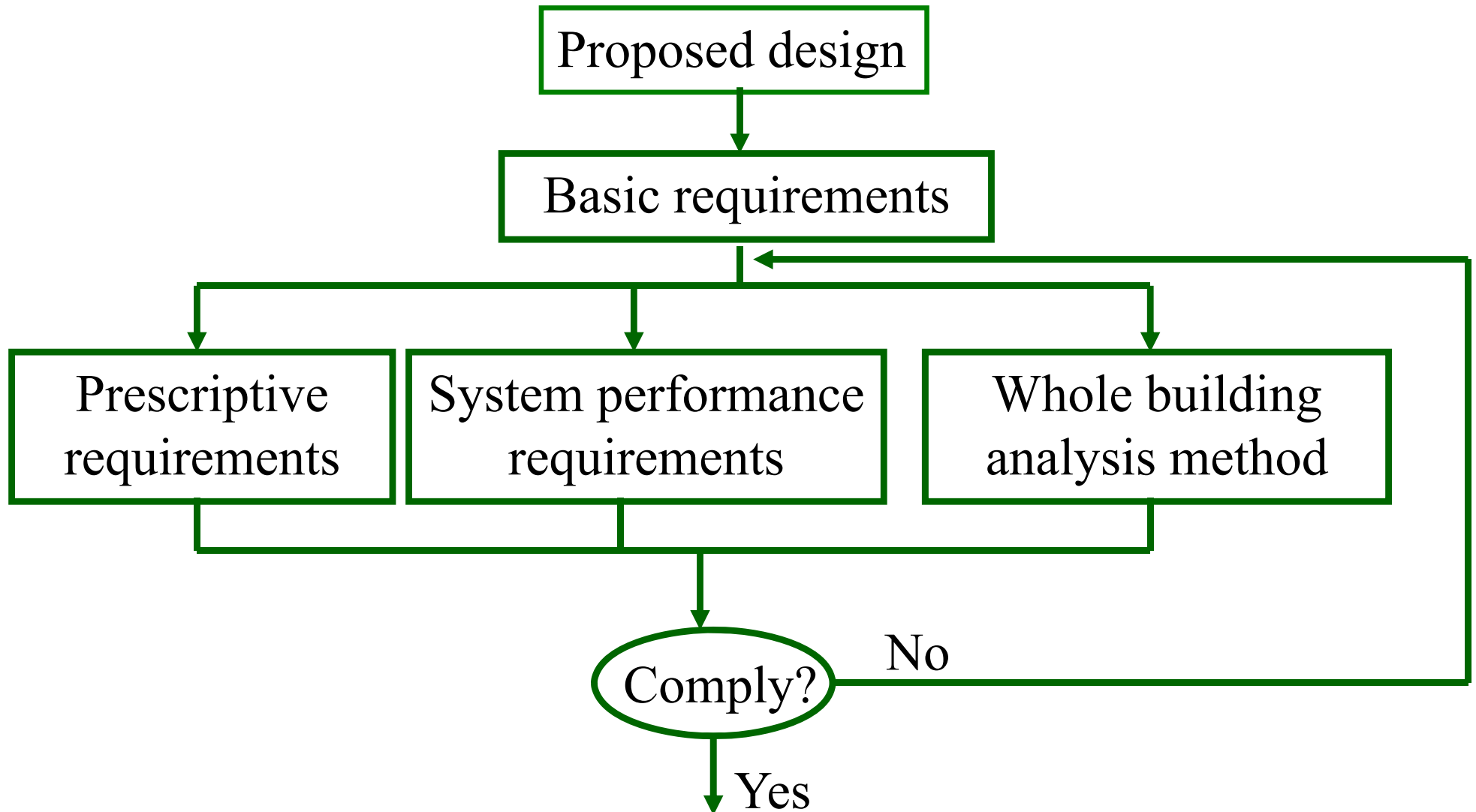
# Characteristics of BEC

- Performance approach
  - State the goal(s) and allows the use of any solution to demonstrate compliance
  - Advantages:
    - More clearly explains what the code intends
    - Permits innovation & alternative solutions
    - More flexible regulatory environment, easily updated
    - Encourage building/technology research
  - Drawbacks:
    - Often more efforts are needed for analysis/compliance
    - Can be very complex & require more expertise

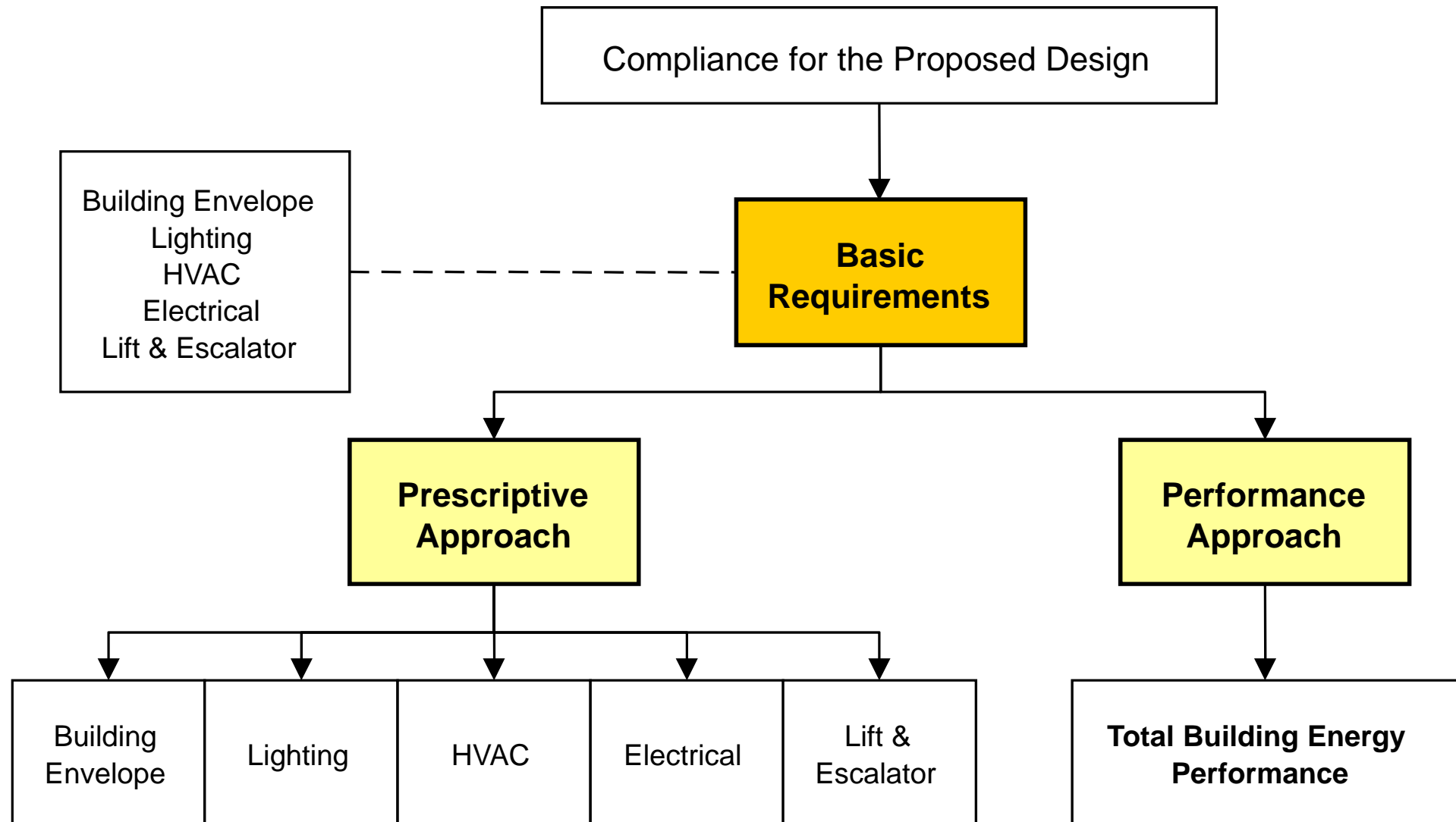
# Compliance method for performance approach

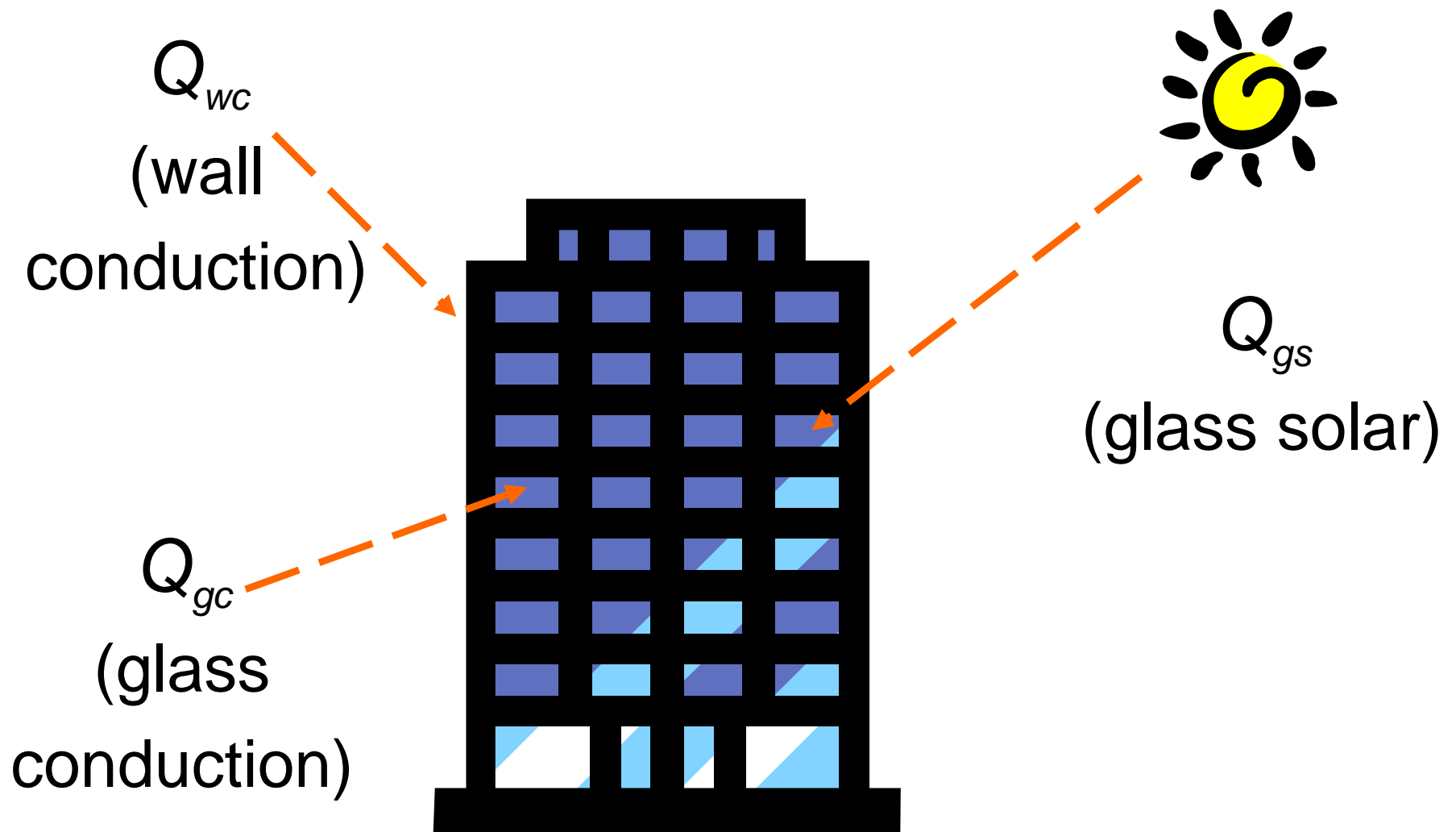


# Compliance paths in building energy codes



# Proposed framework of the comprehensive BECs in Hong Kong





$$\begin{aligned}
 OTTV_i &= \frac{Q_{wc} + Q_{gc} + Q_{gs}}{A_i} \\
 &= \frac{(A_w \cdot U_w \cdot TD_{eq}) + (A_f \cdot U_f \cdot DT) + (A_f \cdot SC \cdot SF)}{A_i}
 \end{aligned}$$



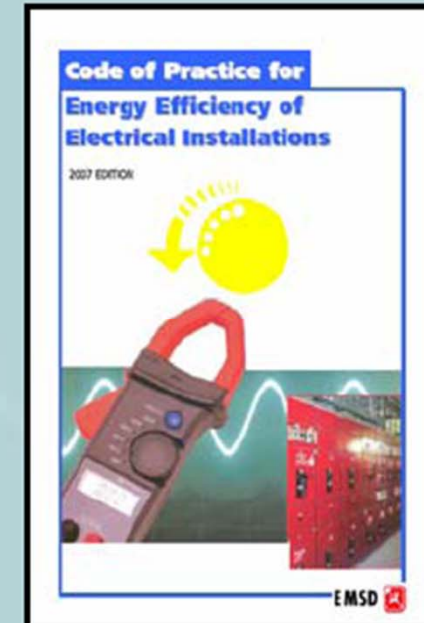
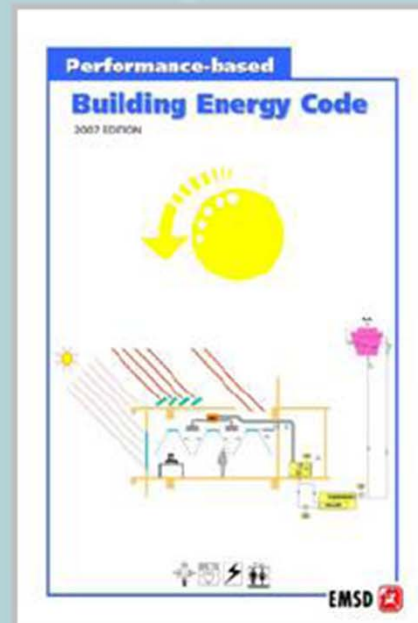
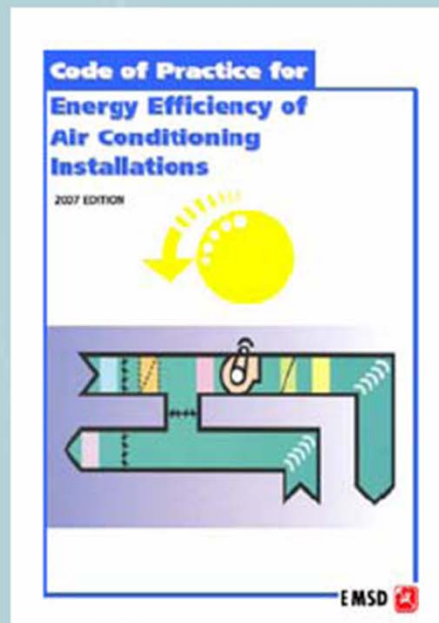
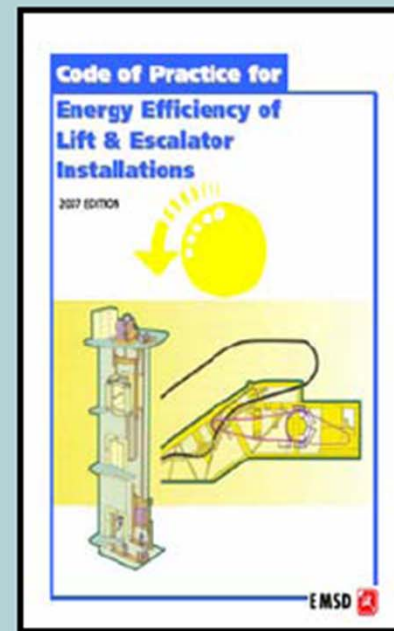
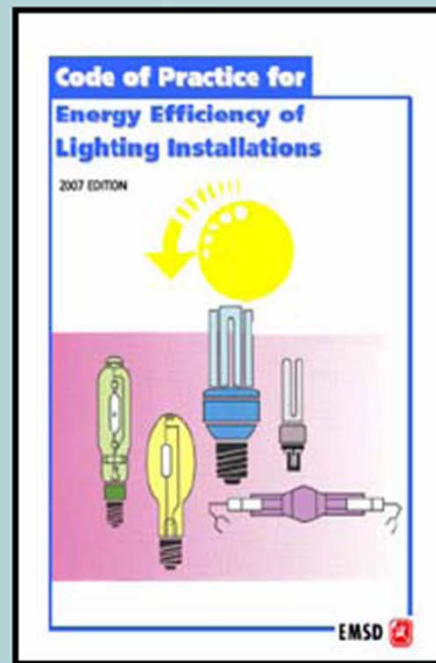
# Characteristics of BEC

- OTTV equation for Hong Kong:

$$OTTV_i = \frac{(A_w \cdot U_w \cdot \alpha \cdot TD_{eq}) + (A_f \cdot SC \cdot ESM \cdot SF)}{A_i}$$

- Two major differences from the general form:
  - Glass conduction term was omitted
  - Solar absorptivity and external shading multiplier were introduced





## Building Energy Codes in Hong Kong

(Source: [www.emsd.gov.hk](http://www.emsd.gov.hk))

## Building energy codes in Hong Kong

Energy Code	Date Implemented	Scope
OTTV	Jul 1995 (Mandatory)	Comm bldgs & hotels
Lighting	Jul 1998 (Voluntary)*	All bldgs except domestic, indust. & medical
Air conditioning	Jul 1998 (Voluntary)*	All bldgs except domestic, indust. & medical
Electrical	Feb 1999 (Voluntary)*	All buildings
Lifts & escalators	Dec 1999 (Voluntary)*	All buildings
Performance-based code	2004 (Voluntary)*	Comm bldgs & hotels

\* Combined and become mandatory in 2011 under the *Buildings Energy Efficiency Ordinance*. (See [www.emsd.gov.hk/emsd/eng/pee/mibec.shtml](http://www.emsd.gov.hk/emsd/eng/pee/mibec.shtml) for details)

# Hong Kong's Buildings Energy Efficiency Ordinance

- The Bill for mandatory implementation of the Building Energy Codes (**BEC**) was passed by the Legislative Council on 24 Nov 2010. Together with the amendments they were gazetted to be the Buildings Energy Efficiency Ordinance (**BEEO**) (Cap. 610) on 3 Dec 2010
- The Ordinance (except Parts 2 to 6) would come into operation on 21 Feb 2011. Vetting of the subsidiary regulations detailing the fees and registration of Registered Energy Assessor (**REA**) will be completed in the 1st quarter of 2011 and then the registration of REA will commence in the 2nd quarter of 2011
- There will be 18-month grace period for Parts 2 to 6
- BEEO will be fully implemented in mid-2012

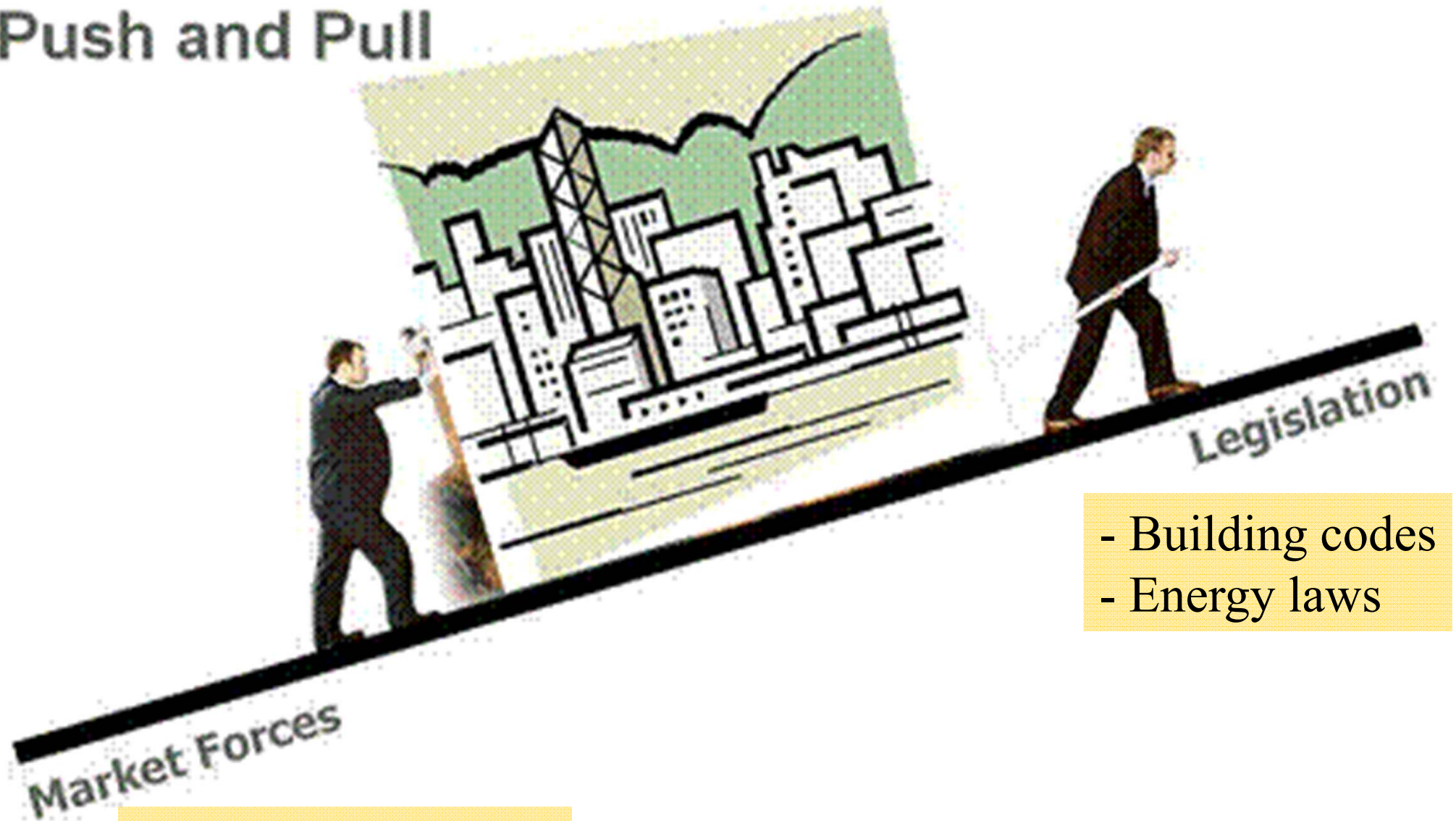


# Implementation issues

- **Strategy for promoting energy efficiency**
  - Legislation (**PULL**)
    - Building codes, energy laws
  - Market forces (**PUSH**)
    - Improve awareness & information
- Reverse the vicious circle
  - Change market behaviour & overcome barriers
  - Increase investments in energy efficiency measures among the stakeholders

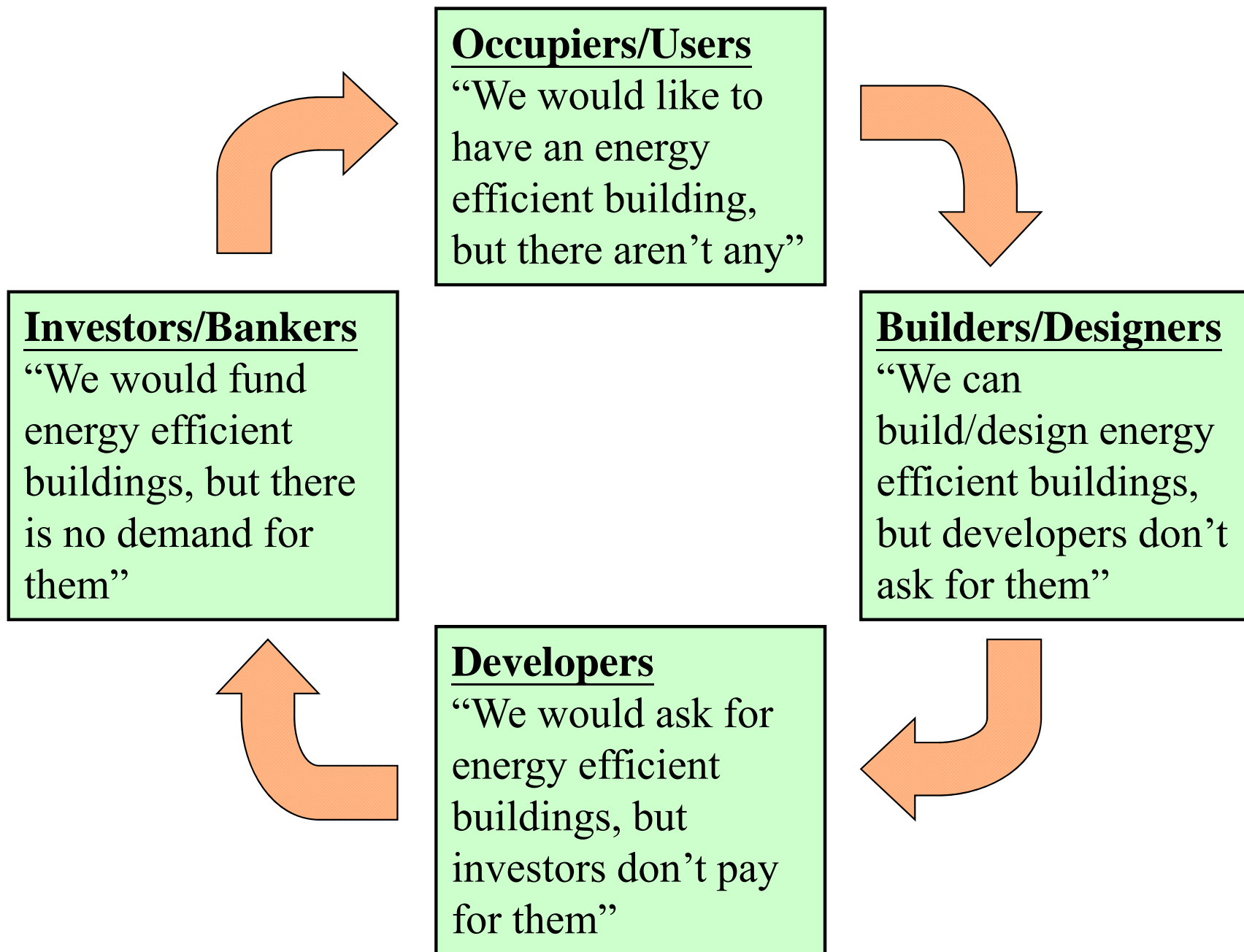
# Strategy for promoting energy efficiency in buildings

## Push and Pull



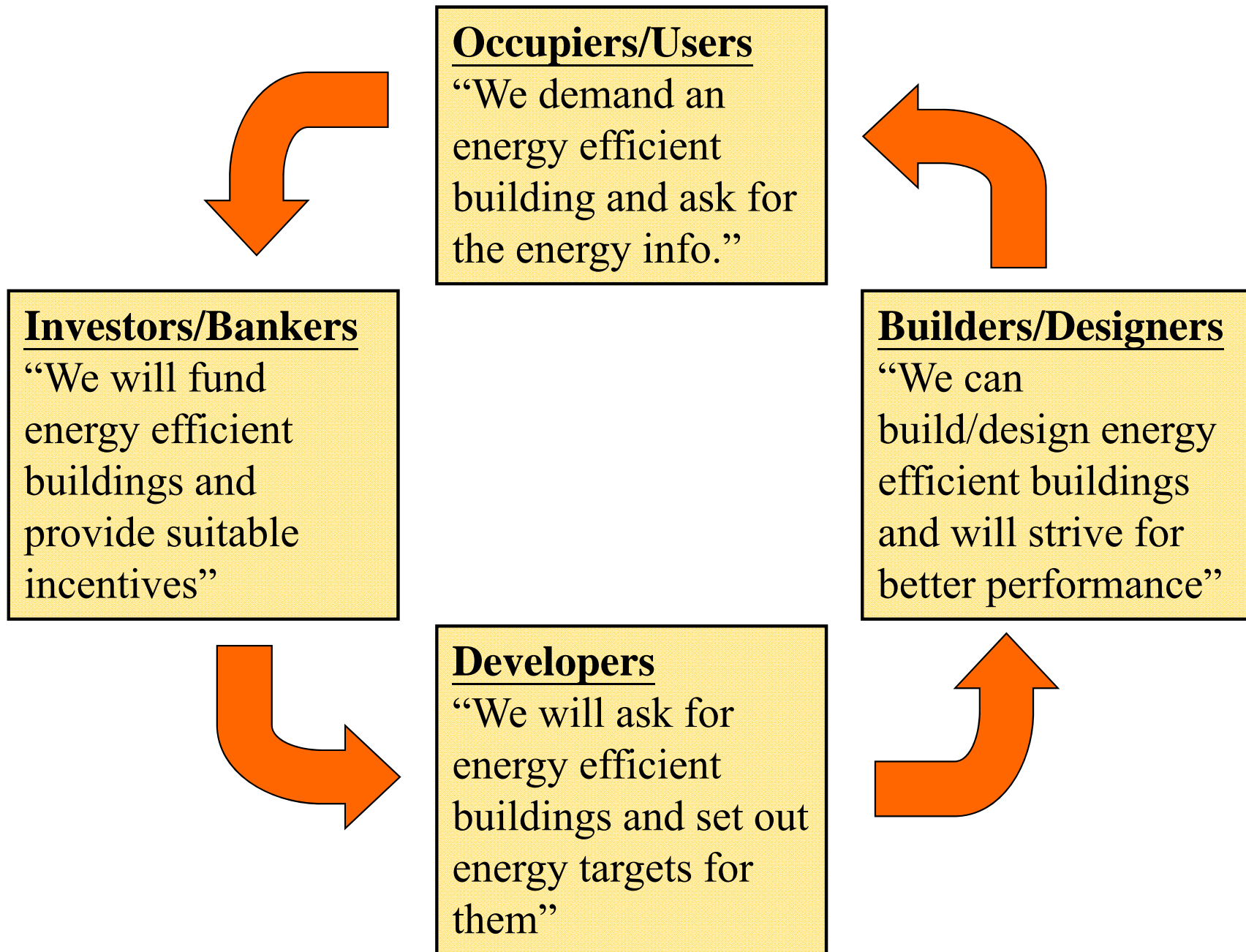
- Energy labels
- Voluntary schemes

- Building codes
- Energy laws



The **vicious circle** of energy efficient buildings  
(From EU studies)



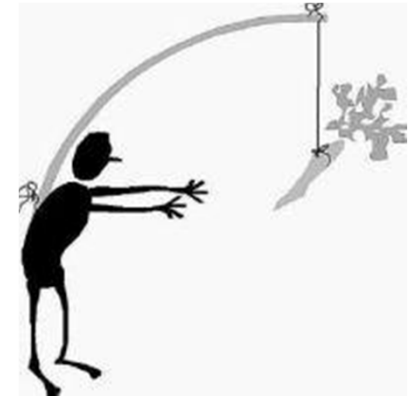


Reverse the viscous circle and overcome market barriers

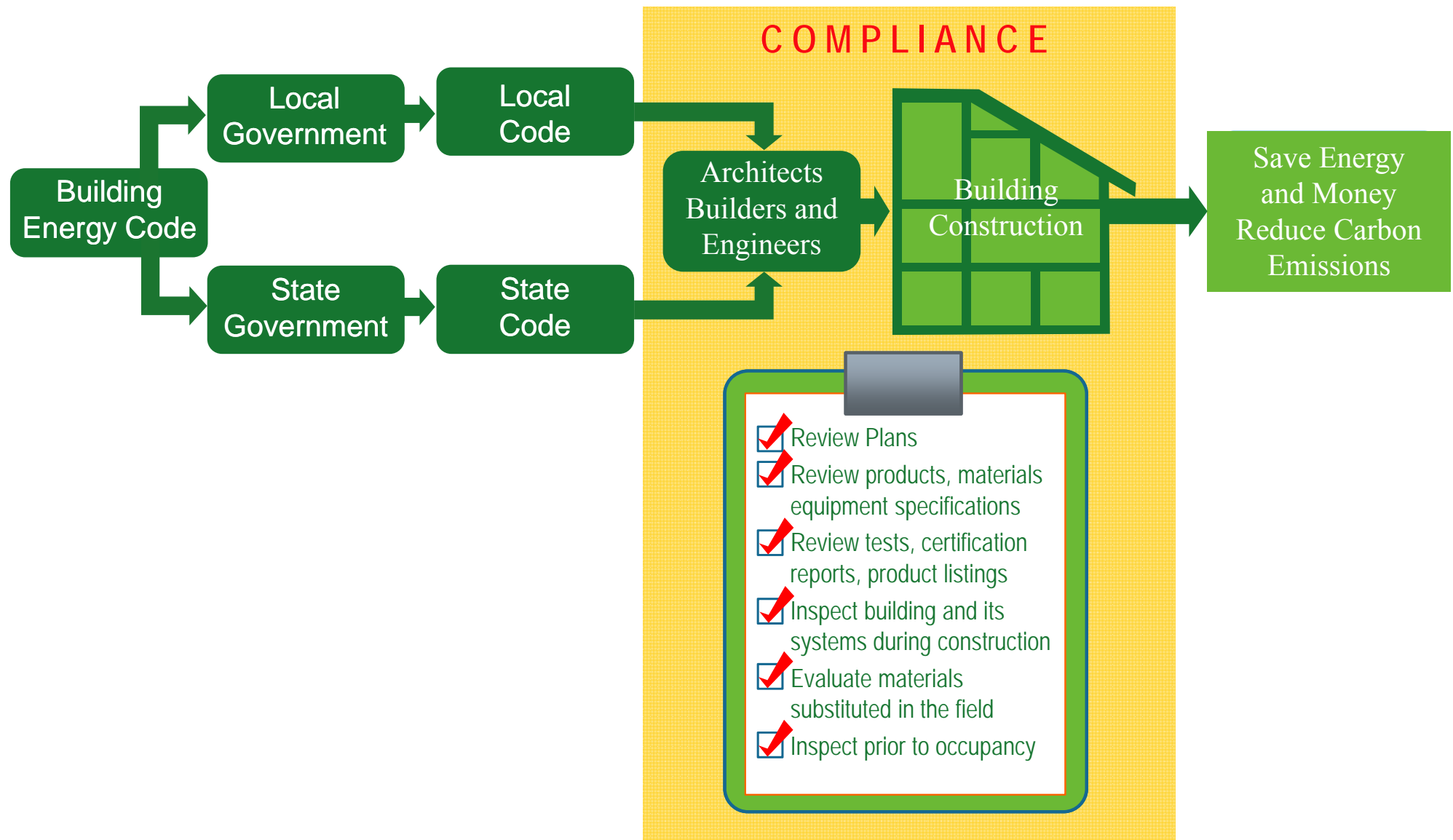
# Implementation issues



- Mandatory vs Voluntary
  - “Stick and carrot” approach
  - Voluntary method only is not effective in commercial markets like Hong Kong
- Strategy for code promotion & enforcement
  - Legislation and incentives
  - Information and education
  - Energy professionals (e.g. Registered Energy Assessor) and technology development



# Code compliance and the building process in USA



# Implementation issues



- Good and effective BEC
  - Encourages more efficient design & operation
  - Relatively easy to understand & enforce
  - Gives designers maximum discretion without compromising efficiency
  - Developed with cooperation and input from a variety of stakeholders
  - Accounts for interactions among systems
  - Reviewed and updated regularly

# Implementation issues



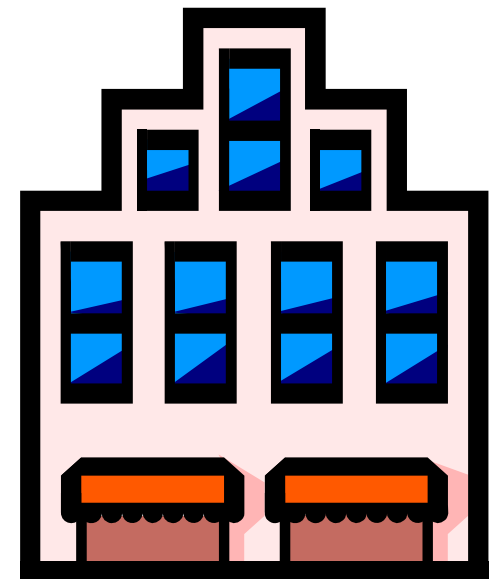
- Potential drawbacks to BEC
  - Costly bureaucratic burdens on design & construction
  - Can invite abuse (i.e. graft)
  - Are difficult to enforce
  - Typically more “stick” than “carrot”
- Difficulties in developing BEC
  - Every building is unique; not standardised products
  - Must reflect & be responsive to different climates
  - Can be difficult to achieve consensus without compromising stringency



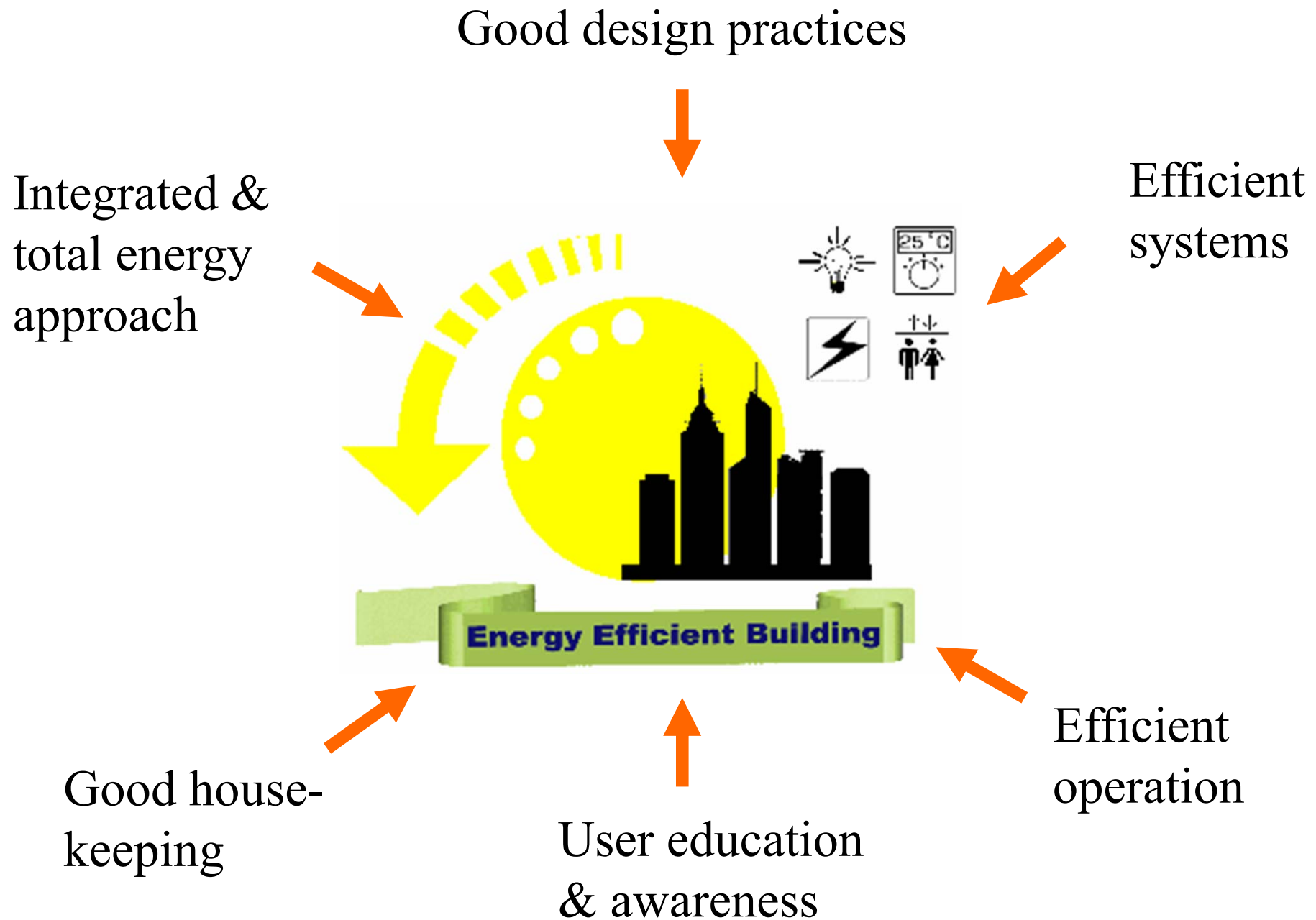
# Implementation issues



- For new buildings
  - Designing the building
    - Design strategy
    - Control strategies
    - Commissioning
- For existing buildings
  - Operating and upgrading the building
    - Building management
    - Refurbishment/renovation/retrofitting
    - Maintenance and monitoring







# Conclusions



- Energy efficiency is very important to every society in the world; it is a smarter option for sustainable energy
- Building energy codes can help promote energy conservation and set the baseline & ratings for building energy performance
- Better strategy to promote energy efficiency:
  - Legislation (**PULL**) and market forces (**PUSH**)

# Conclusions



- Video: Energy, let's save it! (3:40)
  - [www.youtube.com/watch?v=1-g73ty9v04](http://www.youtube.com/watch?v=1-g73ty9v04)
  - Education/promotion cartoons from Europe
  - Describe the effects of wasting energy
  - Highlight some measures to reduce wastage, e.g.
    - Energy saving lamps, thermostat setting, thermal insulation, switch off appliances, car pooling, energy labels



# THANK YOU



Examples of energy efficient buildings