

# The ENERGY PROBLEM

- Climate change due to fossil CO<sub>2</sub> (and other greenhouse gas) emissions
  - Depletion of fossil fuel resources
- Fortunately, there is an interconnection between the two issues



# Annual carbon emissions CE

$$CE = P \times ES/P \times PE/ES \times CE/PE \text{ (GtC/a)}$$

**Goal:** Reduction of CE to 30 - 40 % of current value  
necessary to stabilize atmospheric CO<sub>2</sub> concentration

- P = population → 1 - 2 % increase p.a.
- ES/P = per capita energy service (heat, electricity, fuels)  
→ increase to be expected
- PE/ES = primary energy input per ES (energy efficiency)  
→ small and limited decrease possible
- CE/PE = carbon emission per PE  
→ large decrease possible



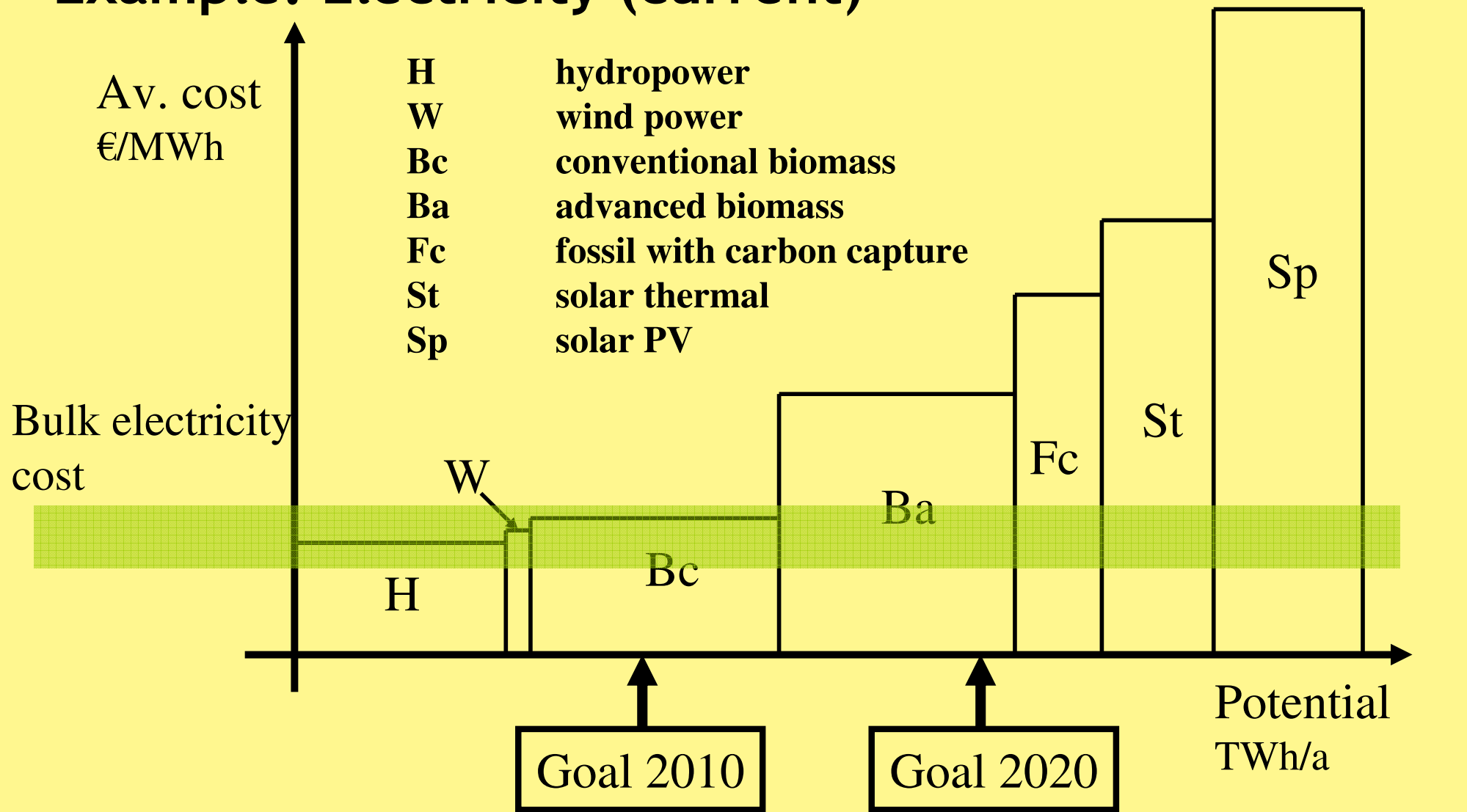
# Priorities and barriers

- Priority on reducing **CE/PE**
  - Substitute renewable or nuclear PE sources for fossil sources
- Barriers to substitution
  - Renewable (and nuclear) sources currently not cost competitive with fossil sources
  - Situation will remain as is without policy action
- Policy actions
  - R&D to reduce cost (not sufficient)
  - “Tax” on fossil fuels to increase their cost



# Contribution of renewable sources of energy

## Example: Electricity (current)



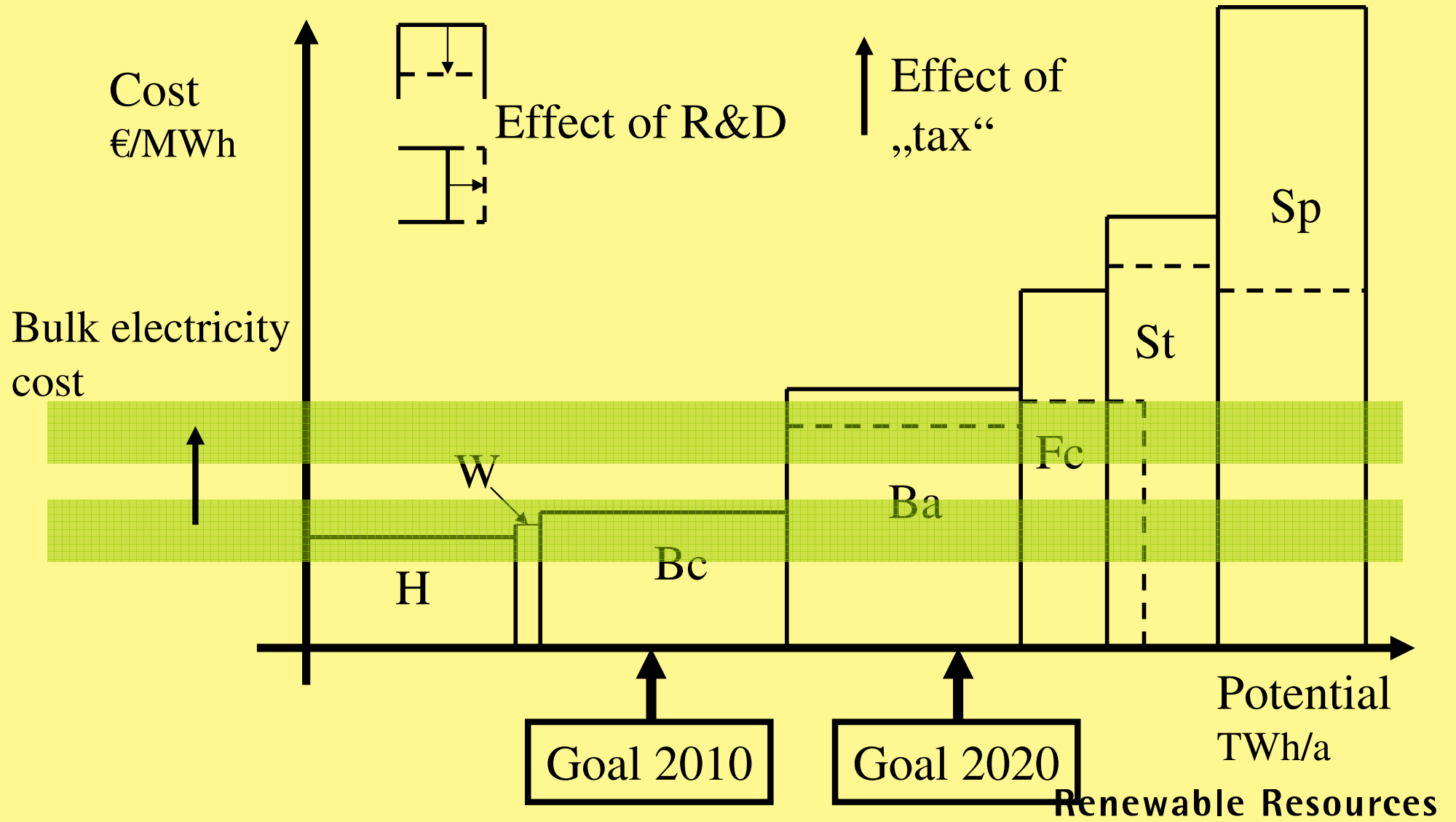
Renewable Resources



Sustainable Future

# Contribution of renewable sources of energy

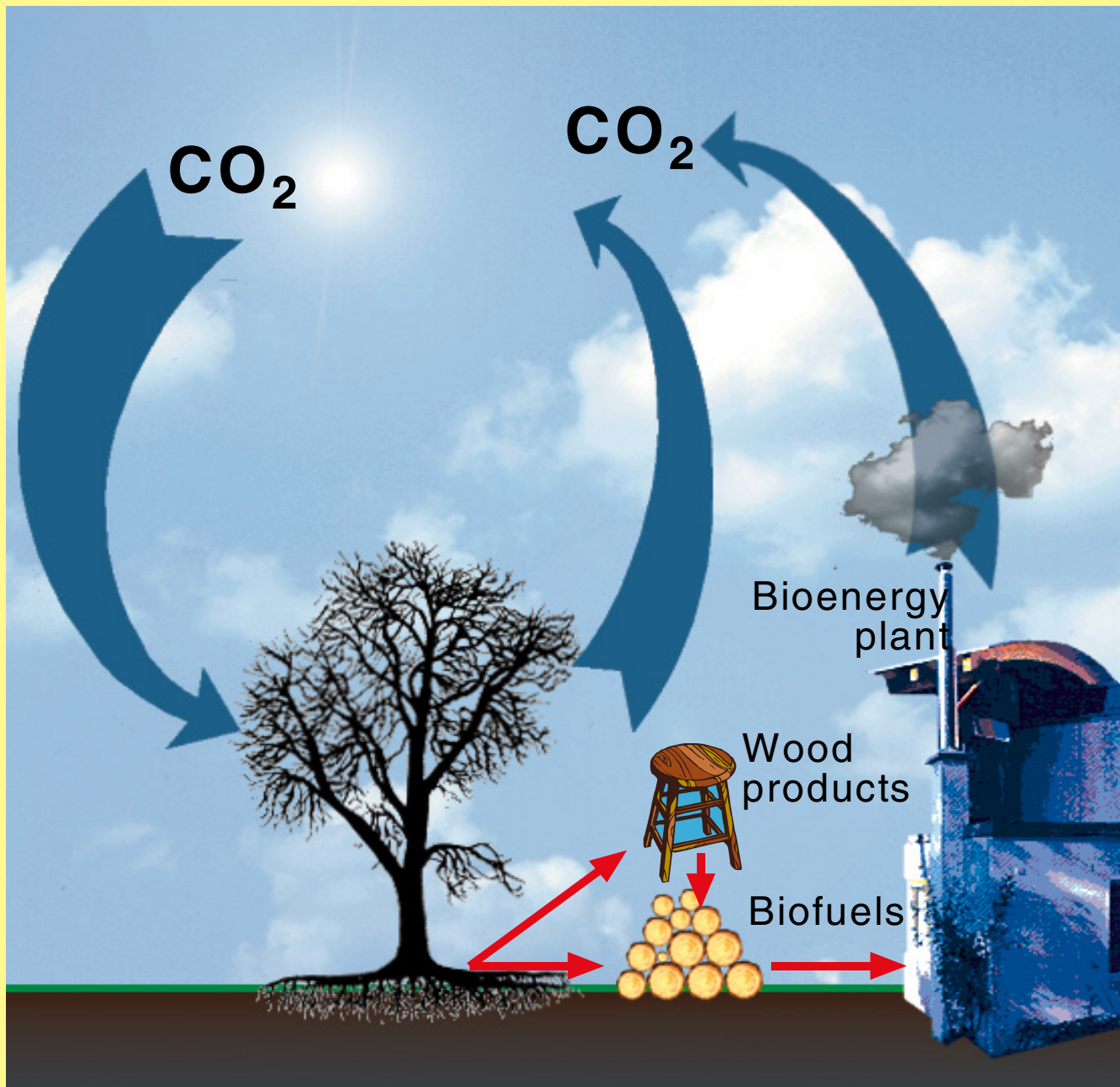
## Example: Electricity (future)



# Conclusion

- A future sustainable energy system based on renewable sources will result in substantially higher cost for the consumer
- The most important task for policy is to prepare the consumers to cope with this situation and to start gradually introducing “tax” actions to close the cost gap





# Bioenergy and the carbon cycle

Renewable Resources



Sustainable Future

# Panel: Resource trends

## Biomass for Energy

- Resource potential
  - Theoretical: several times the current fossil fuel consumption
  - Practical: distributed, in competition with other uses
- Competition
  - With food/feed and materials
  - With fossil and other renewable energy sources
- Conversion technologies (heat, electricity, fuels) basically available, but more expensive
- Climate protection policy action needed



# Panel: Resource arguments

## Biomass for Energy

- Biomass (biofuels) will become a commodity like crude oil or oil products competing on the international market
- Traditional European producers (agriculture & forestry) will not be in a favorable position (example: bioethanol from Brazil)
- Transition to energy farming will not automatically reduce cost
- Sustainable production (“certification”) will (perhaps) improve competitiveness; carbon stocks must be maintained



# Panel: Resource policies

## Biomass for Energy

- Higher cost have to be accepted, consumer-pays-principle should be basis for policy actions
  - R&D will not close the gap to competitors
  - “Information and dialog” and subsidies will not be sufficient
- “Tax” on fossil fuels is the only option (“Getting prices right”); justification through externalities of fossil fuels (cost of climate change)
- Basis is Kyoto obligation; EU Directives go in the right direction

