# Electrical Energy Storage

Alan Collinson (EA Technology, UK)

Presented by

John Boyes (Sandia National Laboratories, USA)



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# Introduction

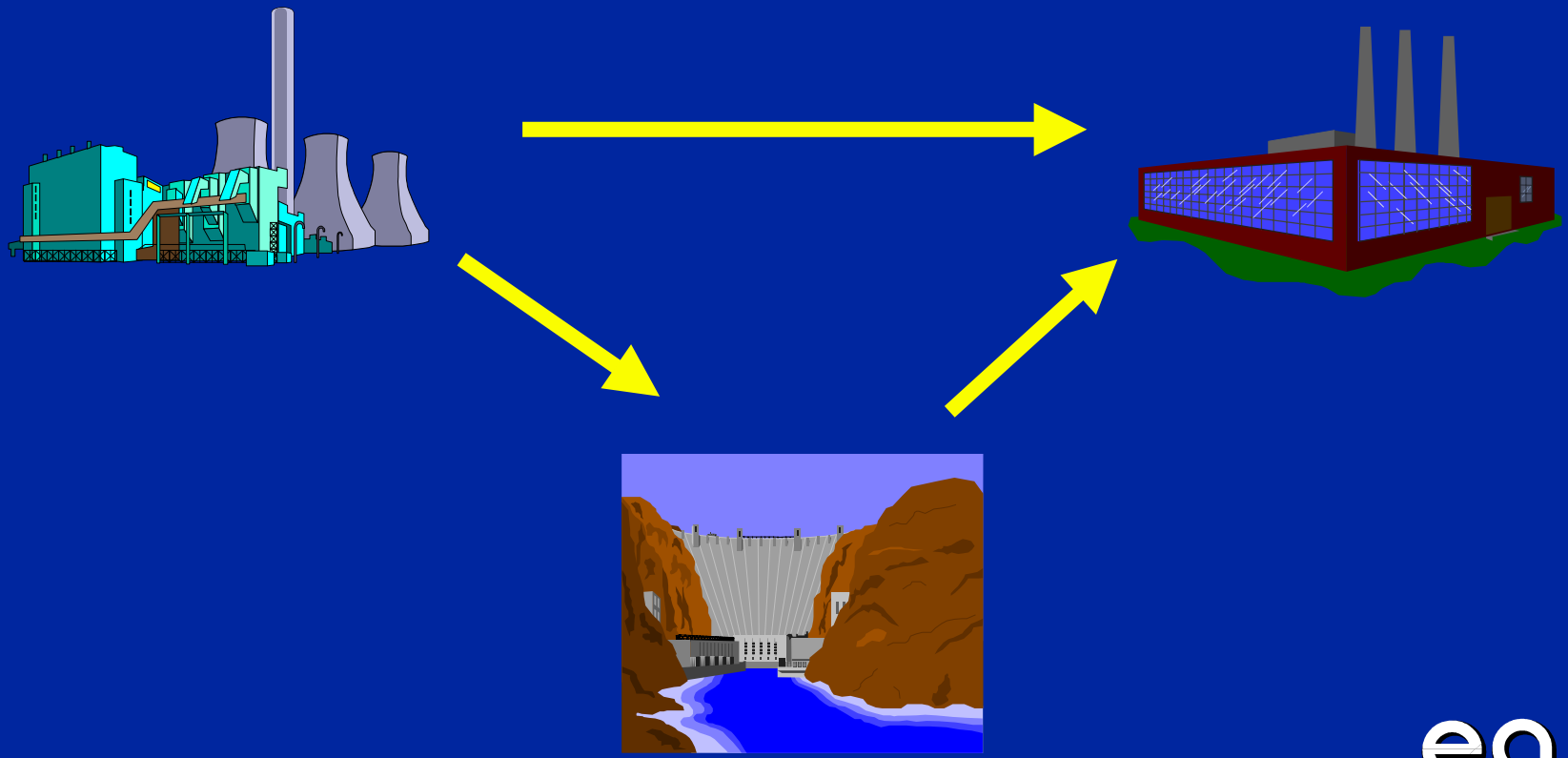
- Background
- Applications for Energy Storage
- Energy Storage Technologies
- Costs of Energy Storage Systems
- Cost/Benefits - the Cost-Benefit Model
- Integration of New & Renewable Energy Sources

# Background

- Changes in worldwide utility regulatory environment
- Increasing reliance on electricity
- More stringent environmental requirements
- Growth in new/renewable energy sources
- Move towards embedded generation
- New technological developments
- Globalisation

# Energy Storage

Decouples energy supply from energy demand



# Applications of Energy Storage

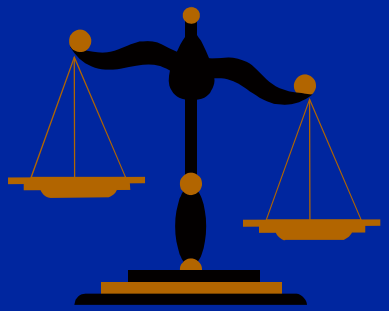
- spinning reserve
- load levelling
- integration with renewables
- frequency and voltage regulation
- network stability
- deferment of new capital equipment
- enhanced quality of supply/power quality
- enhanced overall energy efficiency
- emissions and environmental benefits
- asset management
- demand-side management

# Key Applications

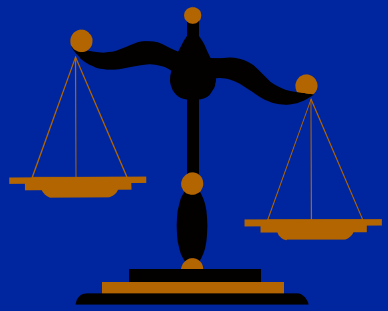
- Quality of Supply/Power Quality
- Capacity Deferral/Asset Management
- Integration of New & Renewable Energy Sources

# Storage Technologies

- Pumped Hydro
- Batteries (conventional & advanced)
- Superconducting Magnetic Energy Storage (SMES)
- Flywheels
- Fuel Cell/Electrolyser Systems
- Conventional Capacitors
- Supercapacitors/Ultracapacitors



# Energy Storage
# “The Big Issue”





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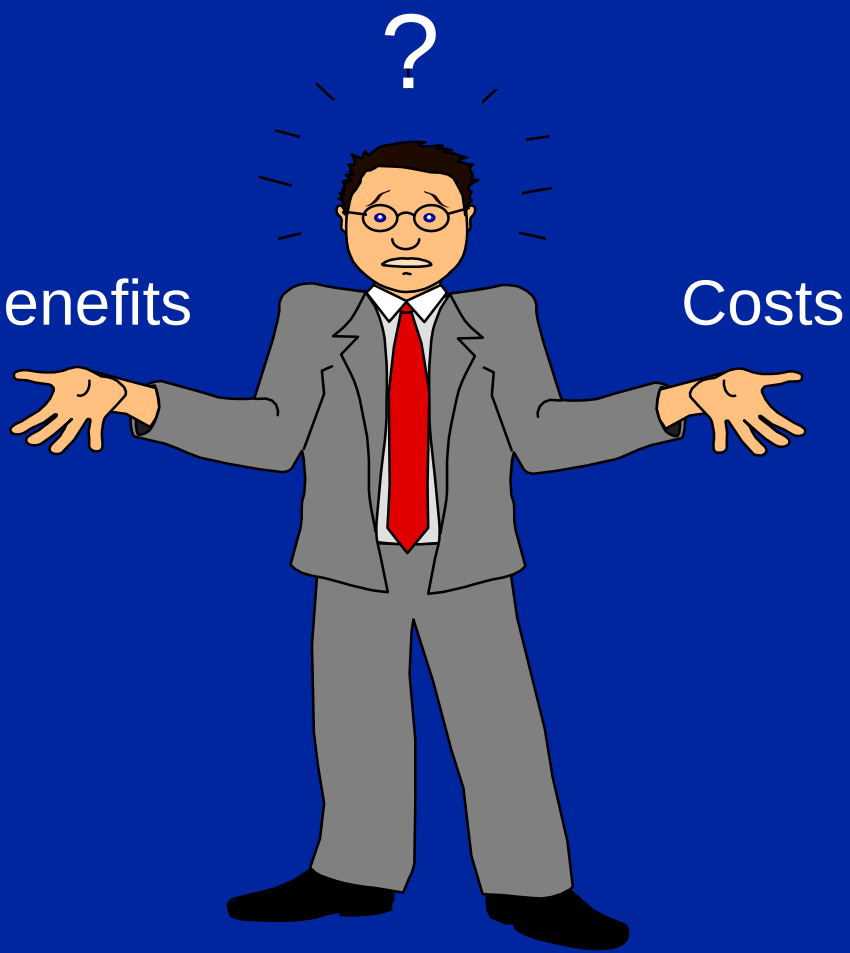




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# Energy Storage
# The Key

Match storage technology with application requirements

APPLICATION

TECHNOLOGY



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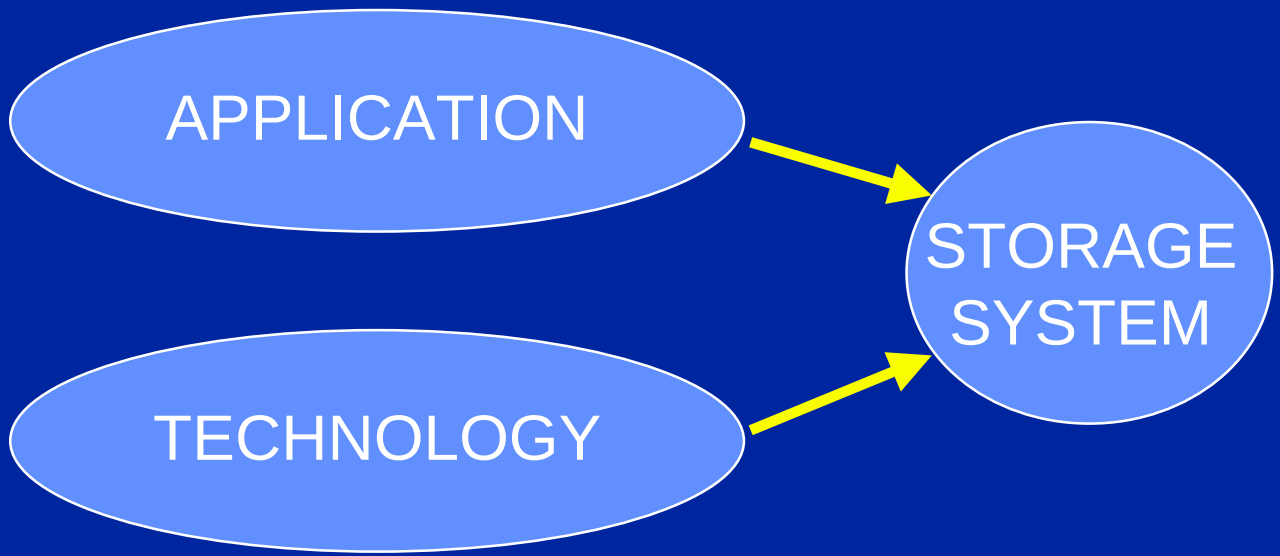
# Energy Storage
# The Key

Match storage technology with application requirements



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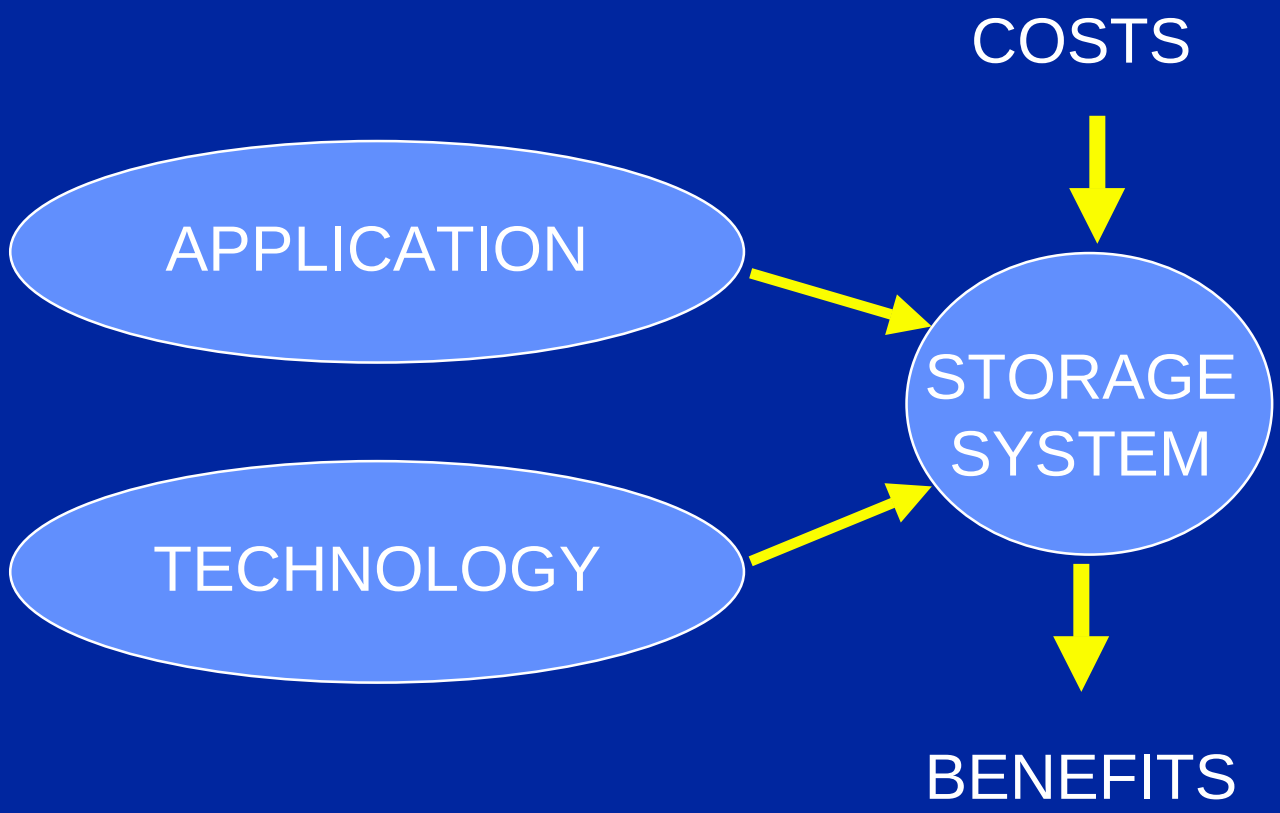
# Energy Storage
# The Key

Match storage technology with application requirements



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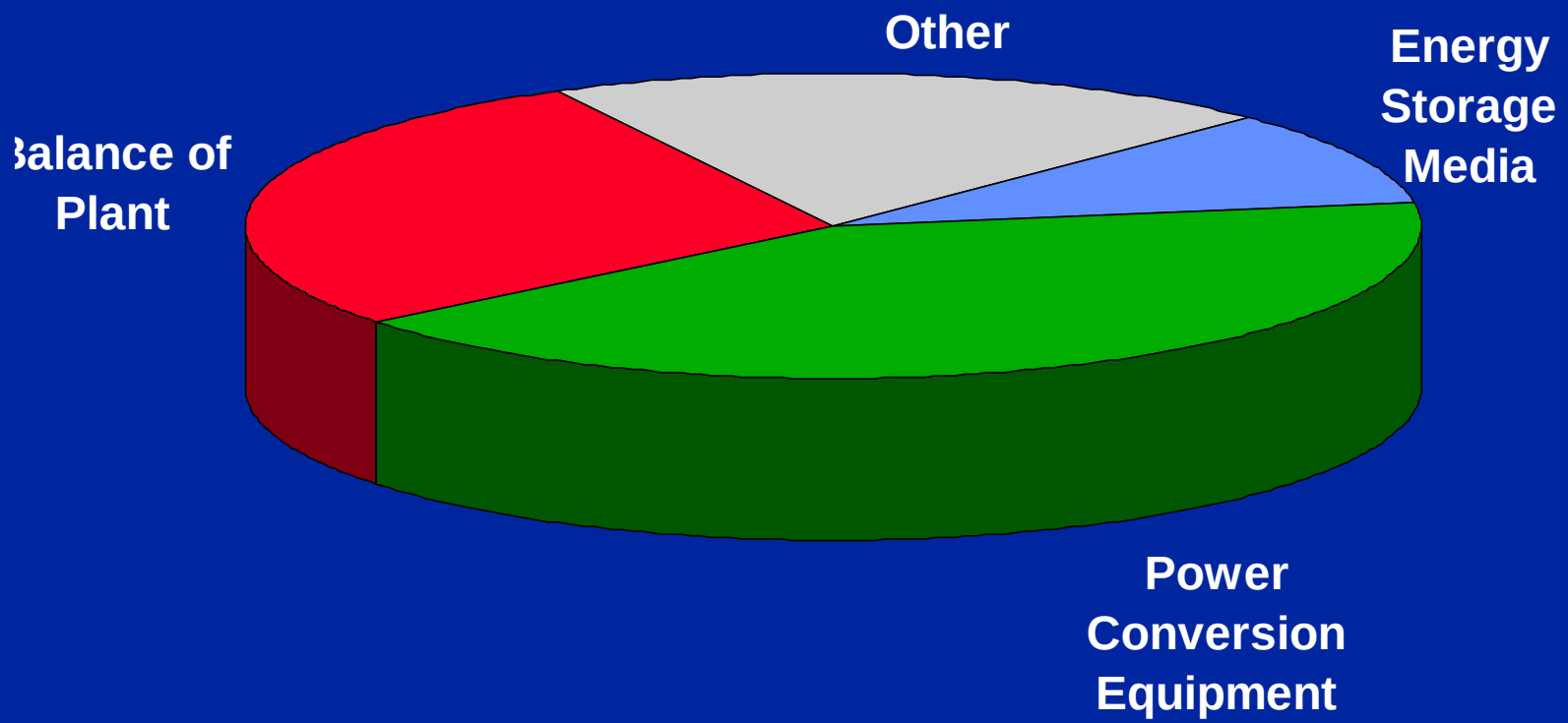
# System Costs

- Storage Media
- Power Conversion Equipment
- Balance of Plant
- Other

System Cost = F(energy) + F(power) + Fixed Cost

# System Cost
# Power Quality Application



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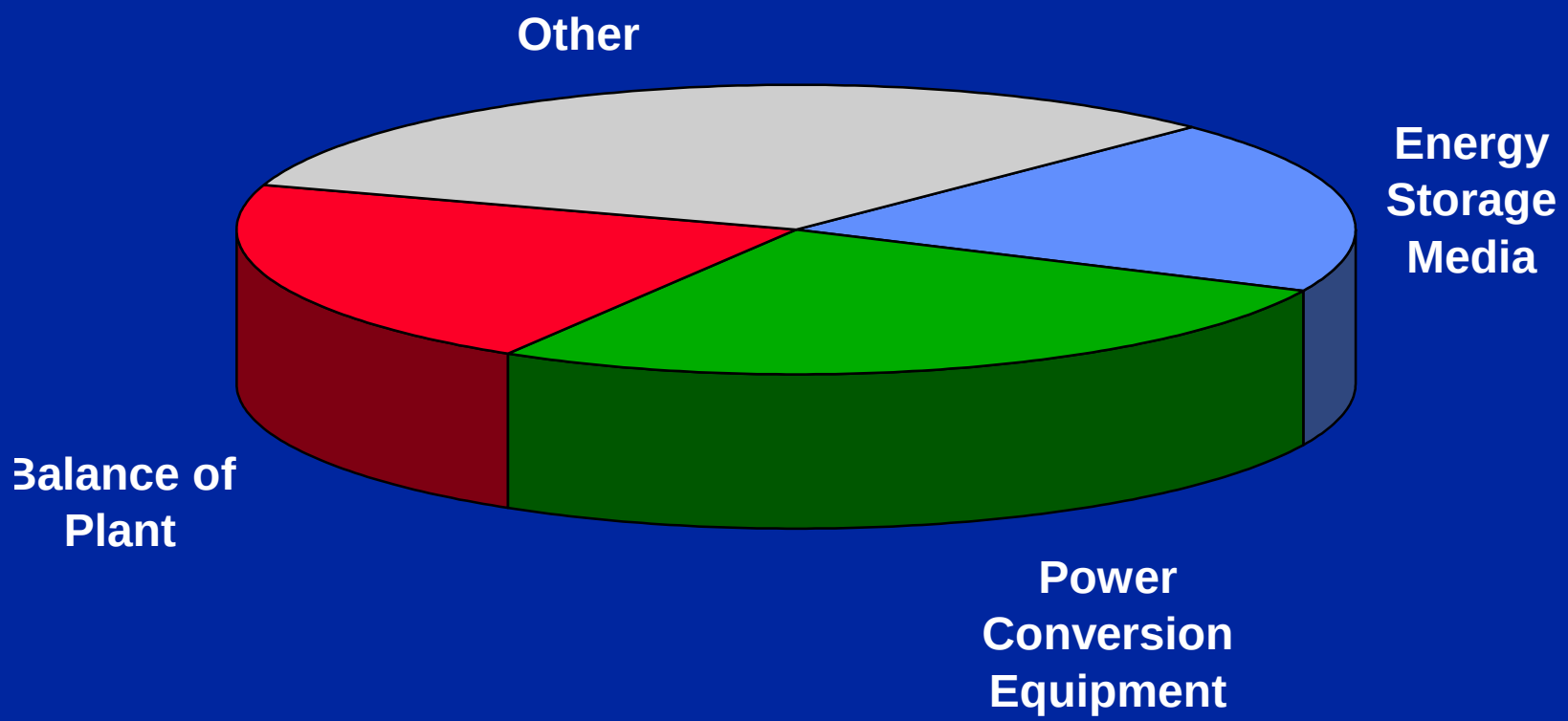
# System Cost
# Utility-Scale Energy Storage



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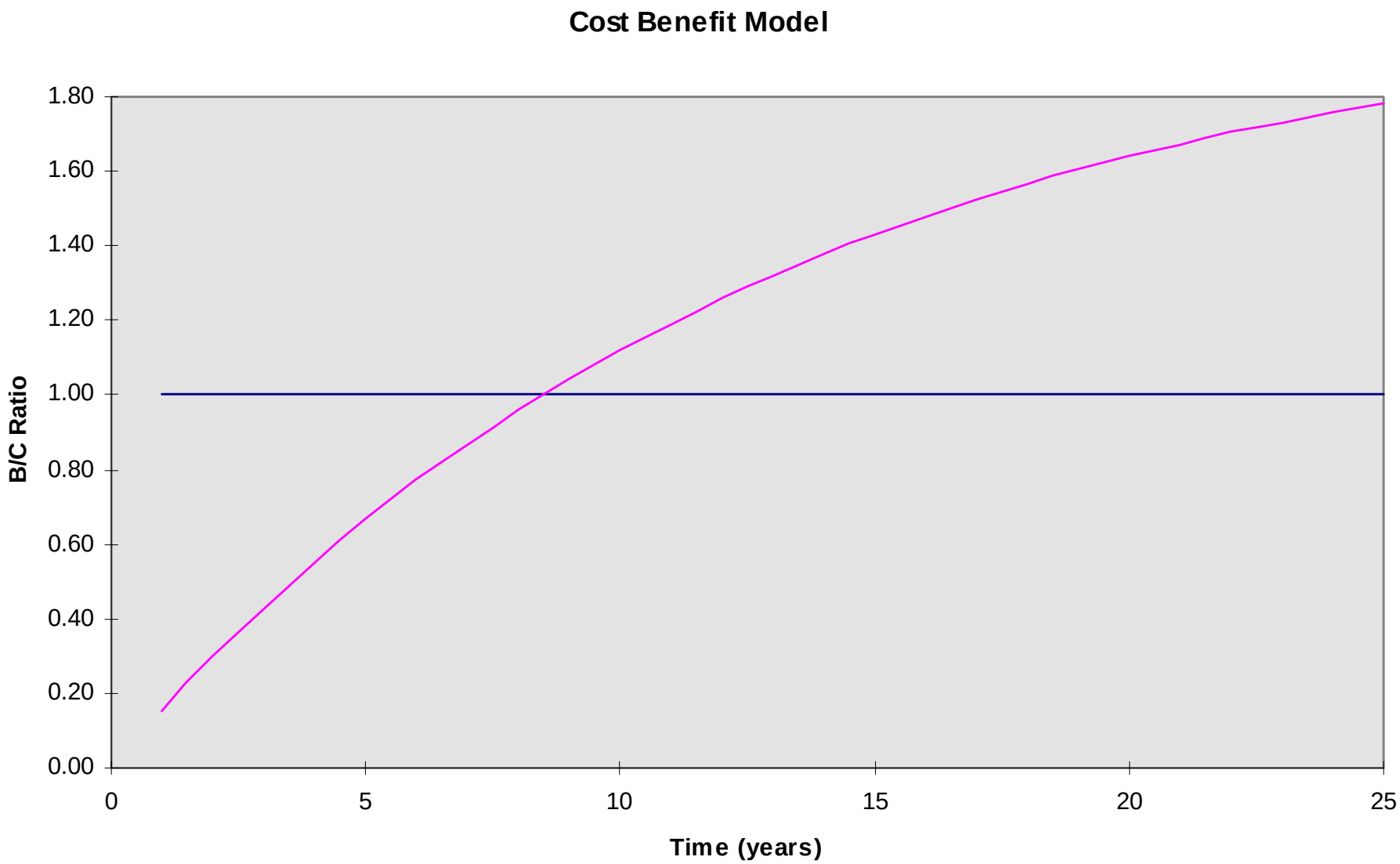
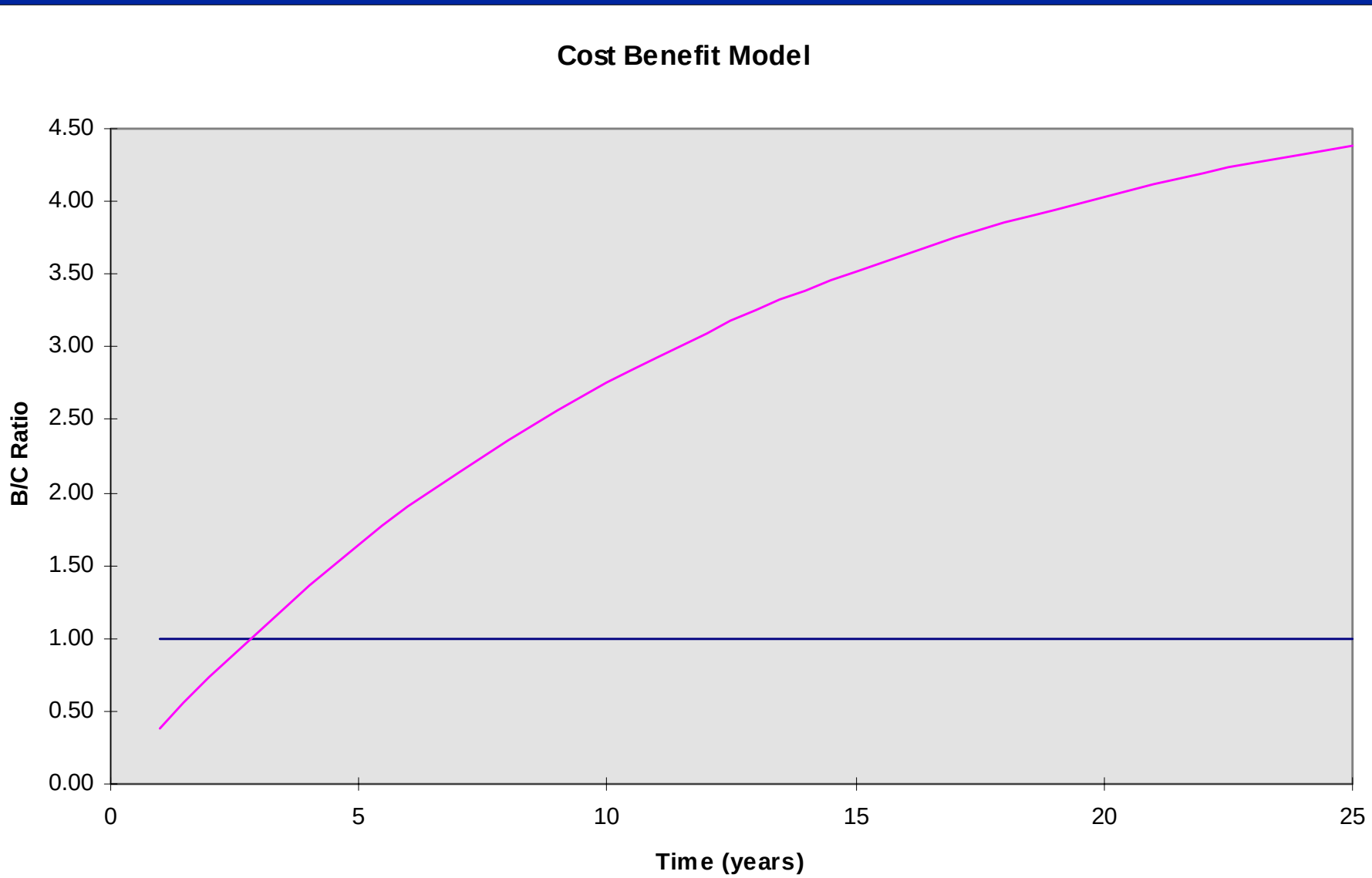
# Benefits of Energy Storage Systems

- Benefits are more difficult to quantify
- Dependant on particular circumstances
- Accurate analysis can be detailed and complex
- There can be more than one “beneficiary”
- However, a “first-pass” initial analysis is possible

# Modelling the Cost/Benefits

- Select primary application
- Consider options for multiple, secondary benefits
- Identify all possible beneficiaries
- Vary storage system parameters for optimum benefit





# Energy Storage & Renewables

- Strategic Issues
  - generator constraints
  - matching generation (supply) with load (demand)
  - firm capacity
  - scheduling
  - spinning reserve
- External Influences
  - emissions reductions (Kyoto targets)
  - cleaner energy systems
  - more efficient energy use

# Electrical Energy Storage & Renewables "IEA Annex 15"

- Part of the Implementing Agreement entitled:

  *"Energy Conservation through Energy Storage"*
- Builds on the work carried out in previous Annex 9
- Will examine strategic issues
- Modelling of storage/renewables/network interaction
- Scope Definition Workshop (October 2000)
- Annex commencement November 2000



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# Conclusions

- Utility-scale energy storage systems exist now
- Technologies are improving and knowledge of their application is increasing
- Demonstrations can help to overcome barriers in market acceptance
- Energy storage is needed to meet the future challenge of integration of new and renewable energy sources

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abc@eatl.co.uk



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