Developments and applications of the *Regenesys* Energy Storage System

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Innogy Limited

Regenesys

Developments and applications of the *Regenesys* Energy Storage System

- Synopsis
  - Formation of *Innogy* Limited
  - Overview of the *Regenesys* technology
  - Applications of storage and renewables and environmental benefits
  - Current development status - our first plant

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Innogy Limited

- Wholly owned subsidiary of National Power PLC
- A technology company with interests in energy storage (the *Regenesys* system), electrochemistry and fuel cell components
- Based in Harwell, Oxfordshire, UK, with facilities in Wales and North Carolina, USA

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Large scale energy storage

- National Power has developed in collaboration with other organisations a regenerative fuel cell technology for utility scale (100 > MWh) energy storage.
- Technology collaborators include…
  - The Electrosynthesis Co. Inc., US
  - Loughborough University , UK
  - Wolfson Institute, Brunel, UK
  - TWI, Cambridge, UK
- Development collaborators
  - DuPont (membrane development)
  - Agra Birwelco (Plant design)

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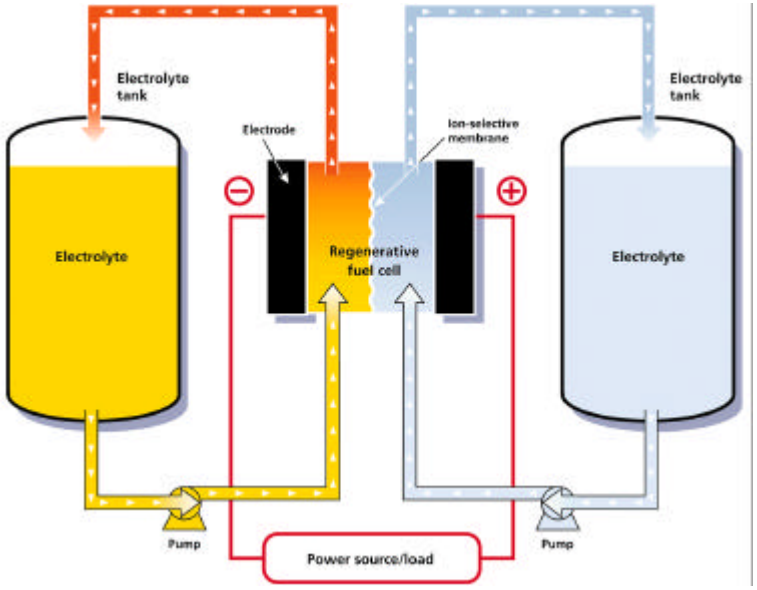
The *Regenesys* energy storage system

- Based on a regenerative fuel cell or flow battery
- Two soluble low cost electrolytes (sodium polysulphide and sodium bromide)
- Electrolytes stored outside the electrochemical cell



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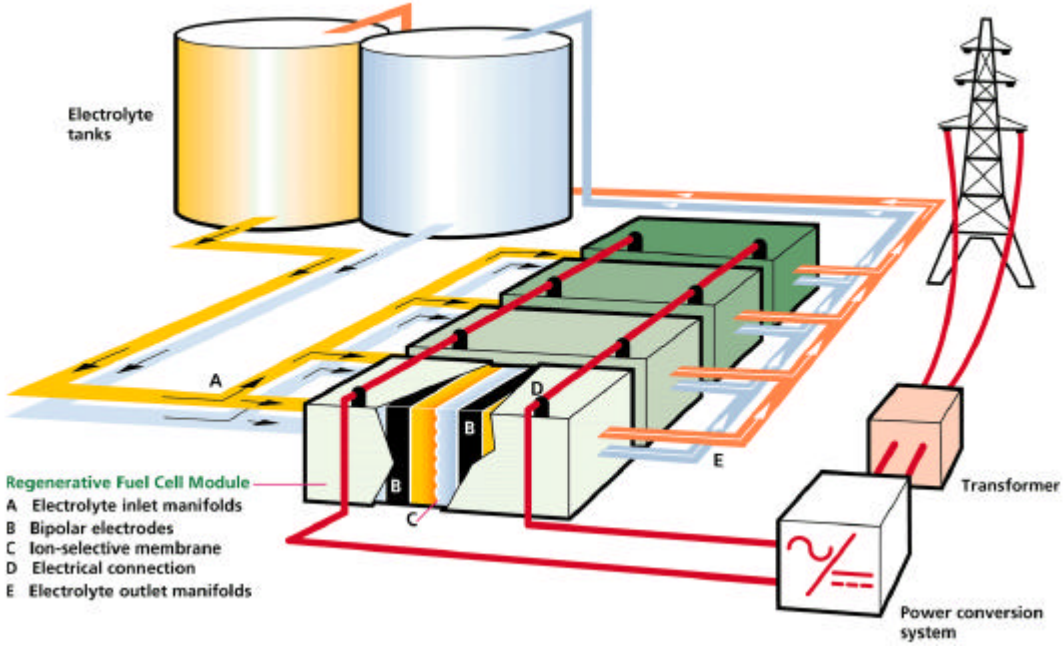

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The *Regenesys* energy storage system

- Power rating: modular 5 - 500 MW
- Discharge period: dependent on storage tank size
- Variable charge / discharge rates
- Rapid response and ramp rates (< 1 cycle)
- Real and reactive power
- High cycle lifetime
- Good efficiency
- Siting requirements: moderate footprint, no environmental hazards
- Competitive capital cost
- Low operating costs

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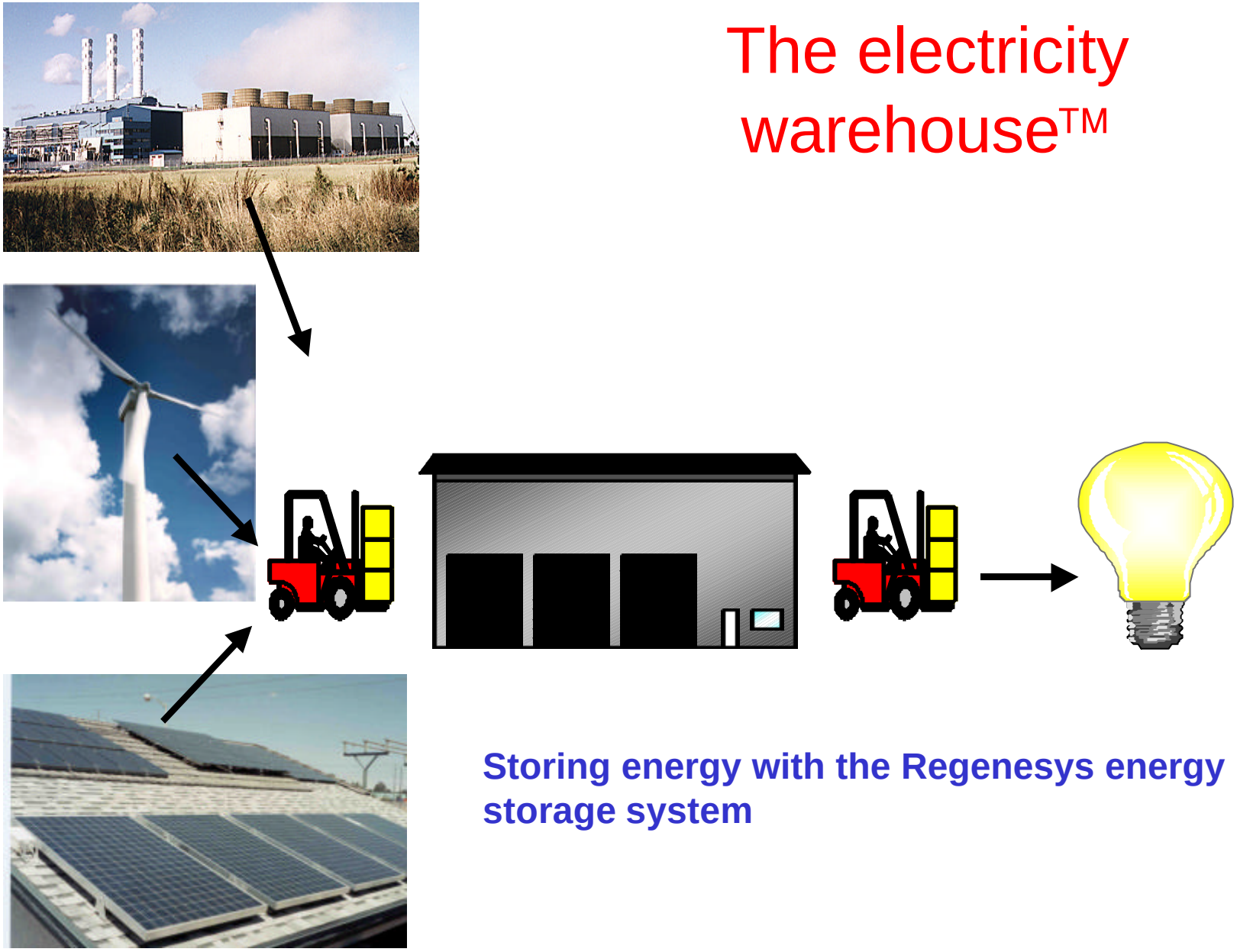
The electricity warehouse™



Storing energy with the Regenesys energy storage system

Benefits of energy storage

- Increased utilisation of most efficient generating plant
  - fuel choice / generation type choice
  - incorporation of renewables
  - economy of operation of hybrid systems
  - Environmental benefit
- Increased utilisation of transmission and distribution assets
- Cost savings in production and distribution of each MWh

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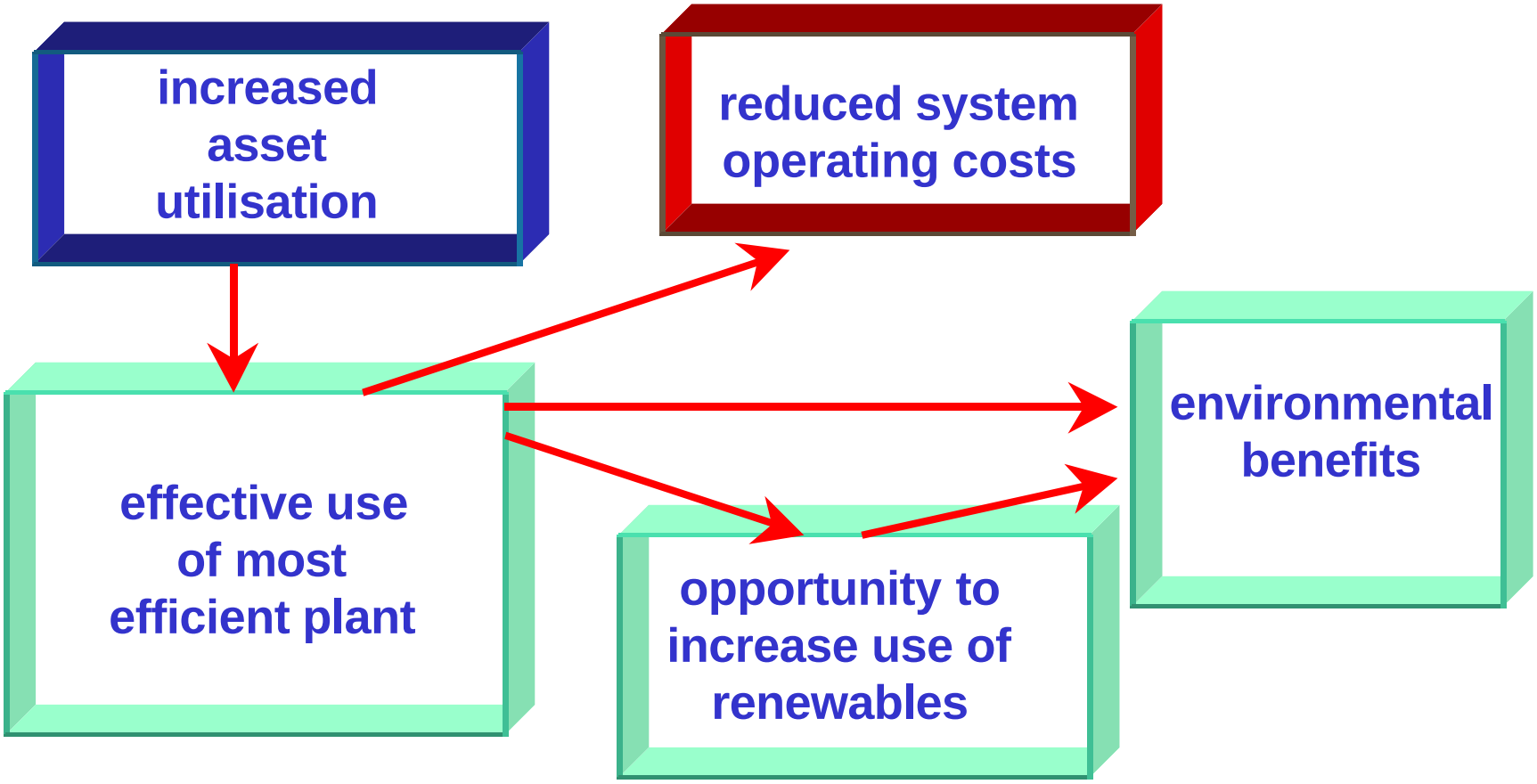
Commercial benefits of energy storage



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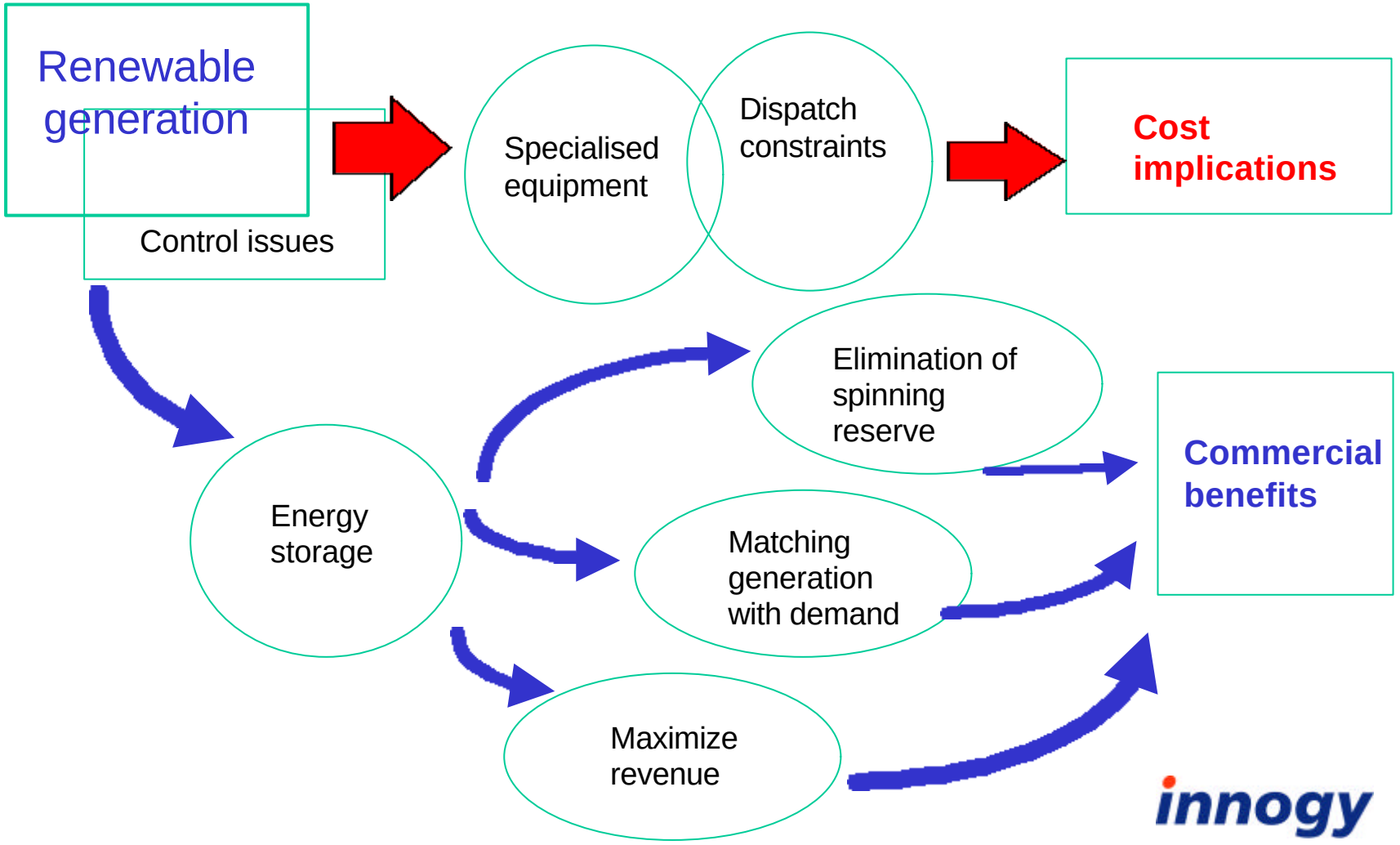
Commercial benefits of storage and renewables



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Applications of energy storage

- Generation
  - load factor improvement
  - spinning reserve
  - other ancillary services
  - integration of renewable generation
  - capacity deferral
  - fuel choice
  - emission control
- Transmission and distribution
  - t & d load factor improvement
  - ancillary services
  - tariff trading
  - distributed resources
  - power quality

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Energy storage & renewables
Generator types

- Two categories of renewables
  - dispatchable (e.g. energy from waste, bio-fuels)
  - non-dispatchable (or stochastic) (e.g. wind and solar)

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Energy storage & renewables
Reserve Capacity

- Stochastic generators have to be ‘made dispatchable’ for grid integration
- Two main options available
  - conventional reserve plant
  - storage plant

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Energy storage & renewables
Reserve plant

- Conventional reserve plant
  - expensive if ‘new-build’
  - possible using existing plant, but usually inefficient
  - significant environmental impact
  - a sub-optimal solution

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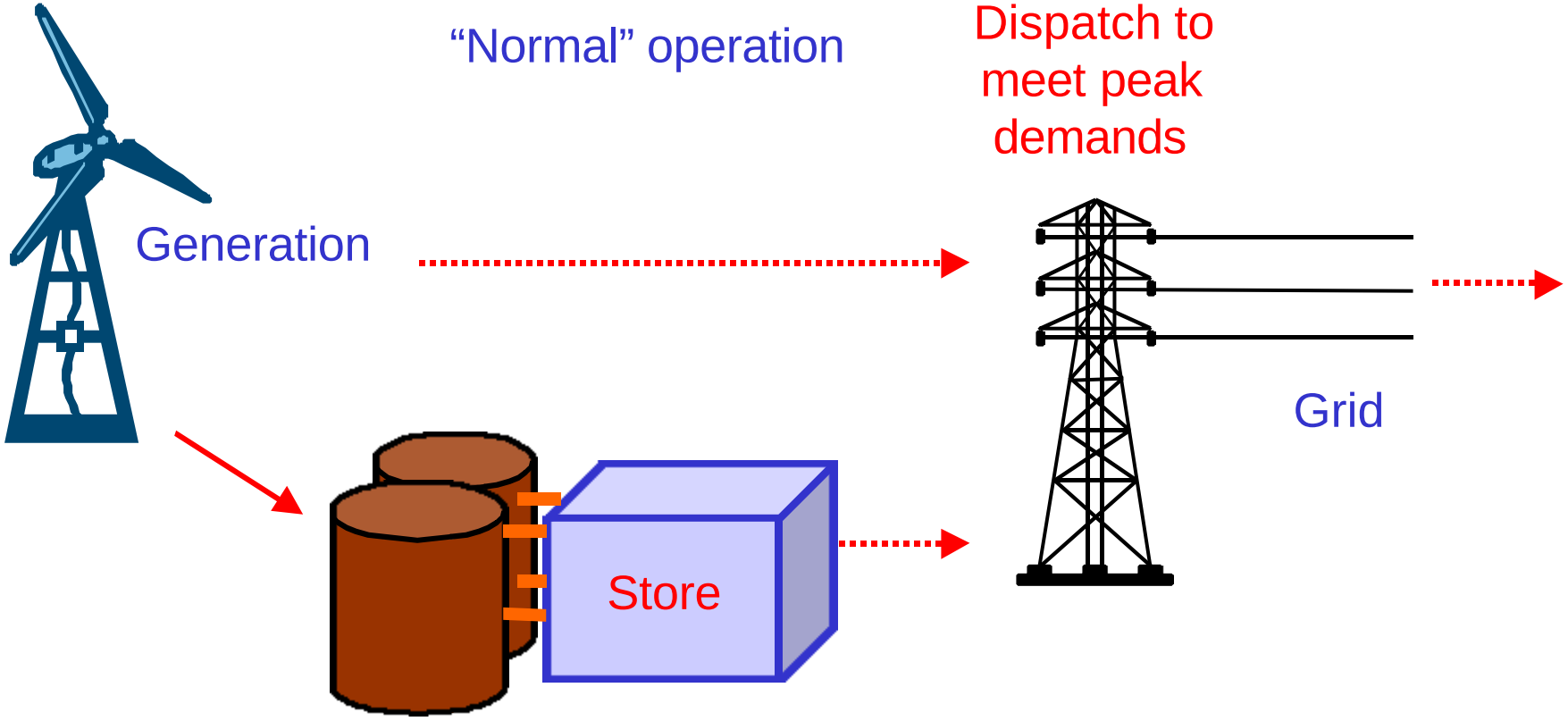
Dispatch of storage with renewable generation



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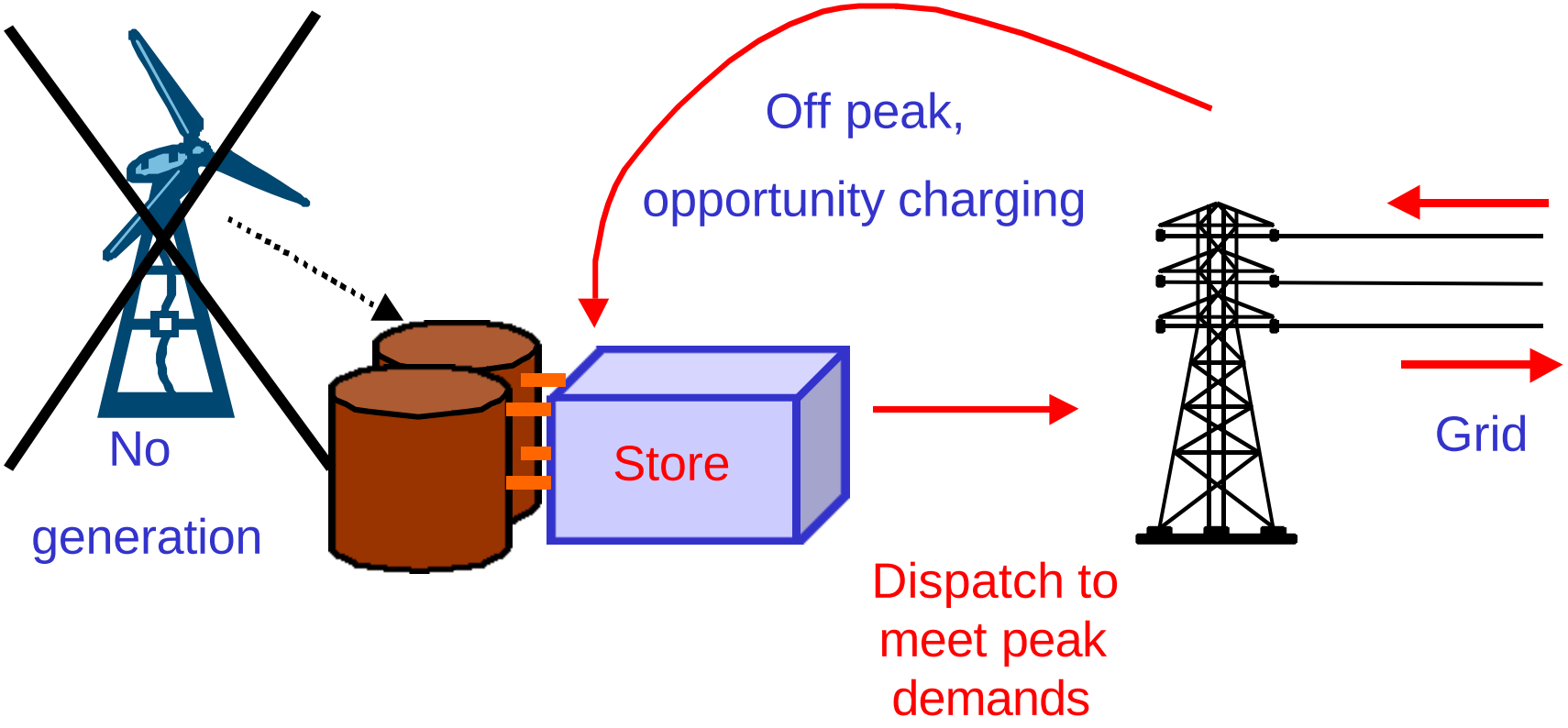
“Non renewable mode” operation



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Factors influencing size of storage plant

- Power rating:
  - match generation capability
  - peak rating?
- Size of store:
  - grid / standalone
  - arbitrage optimisation
- Project's commercial considerations:
  - lifetime
  - technology
  - operating and capital costs

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Commercial benefits of storage and renewables

Isolated systems

Grid integration

- Technical solution to control issues, hence cost advantage
- Provision of spinning reserve
- Ability to meet peak demands
- Time shifting
- Revenue maximisation

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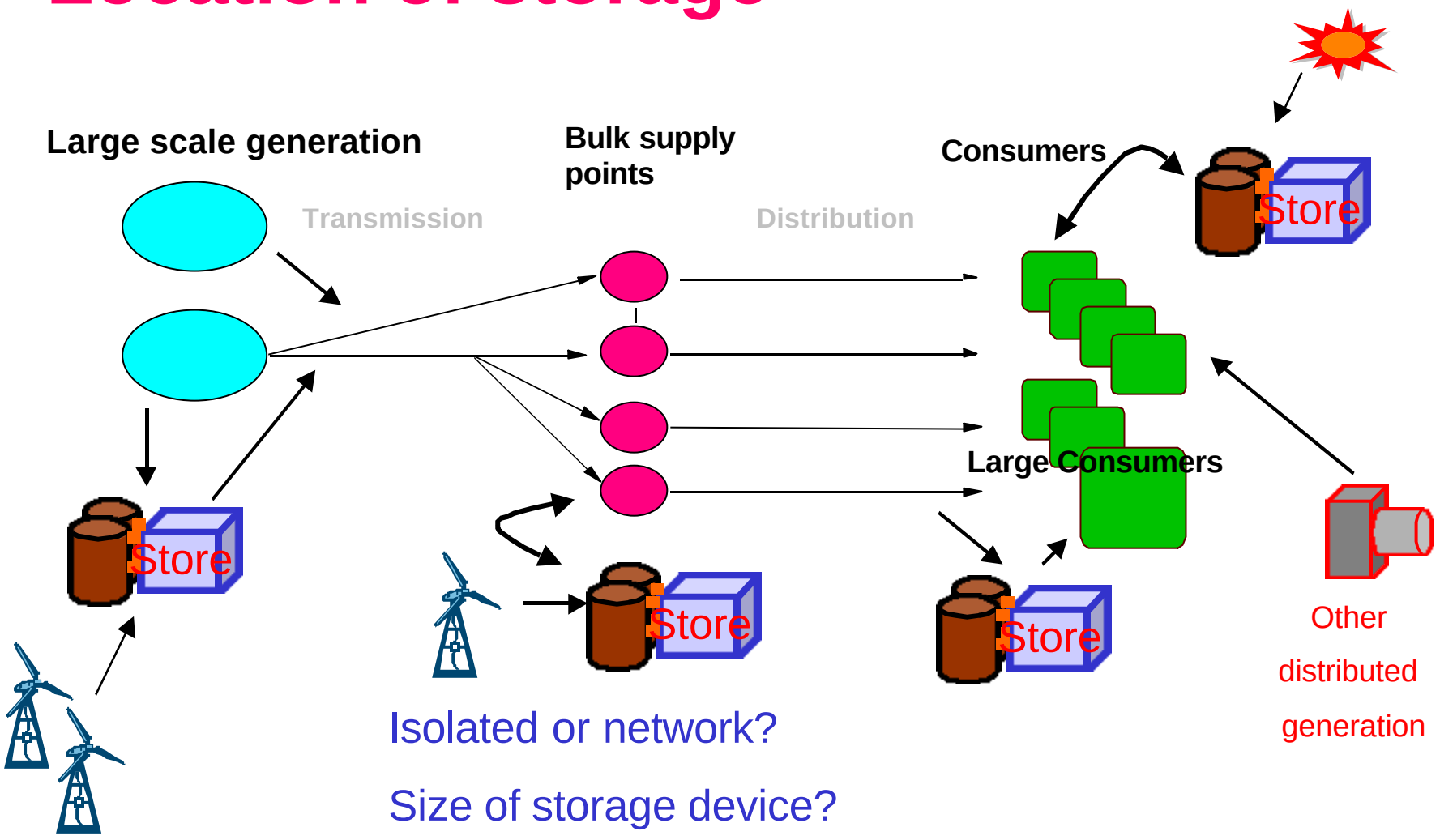
Location of storage



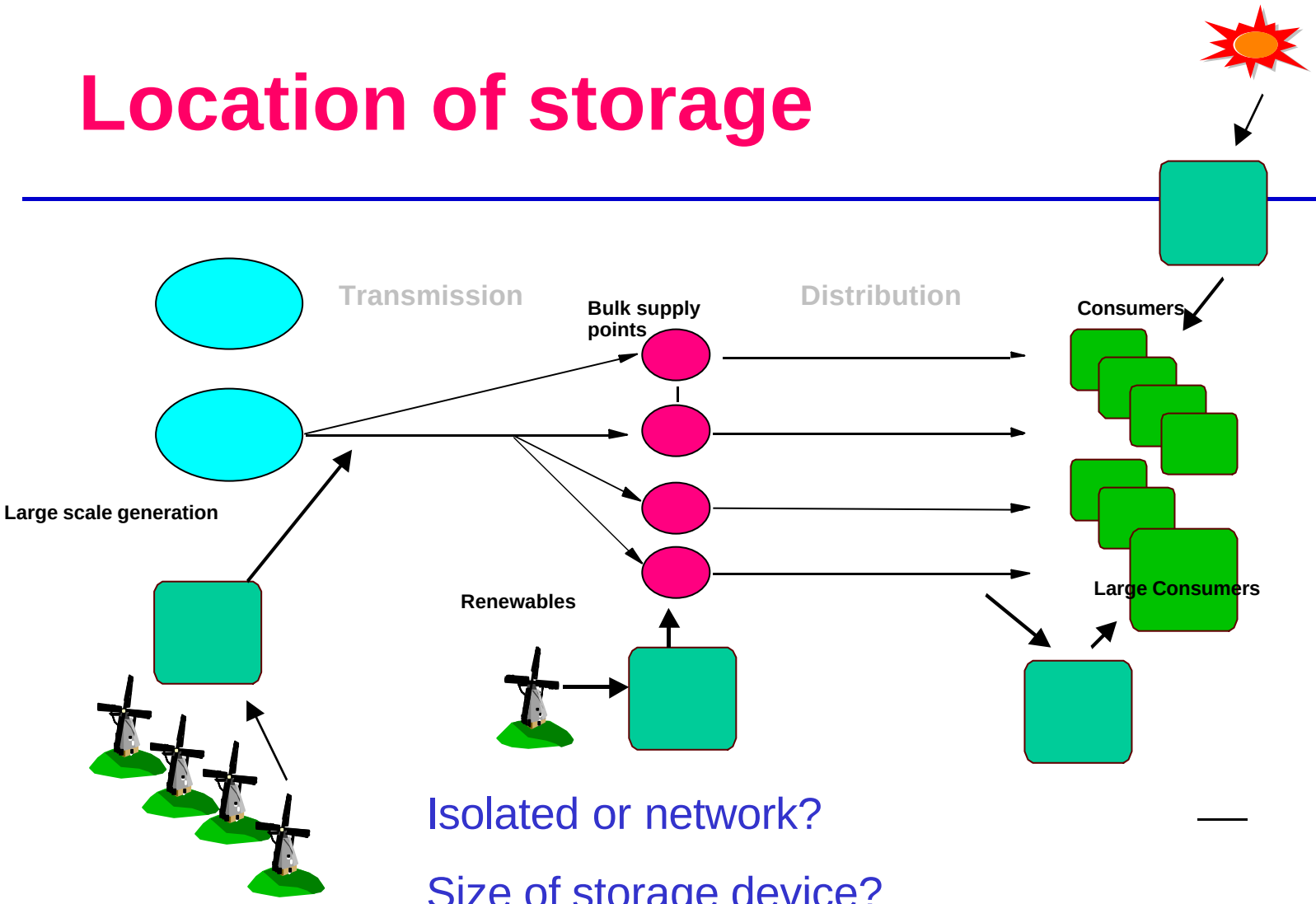
Isolated or network?

Size of storage device?

Ownership?

Size and utilisation of T & D?

Location of storage



Isolated or network?

Size of storage device?

Ownership?

Size and utilisation of T & D?

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Location of storage

Isolated systems

- ??

Grid integration

- Close to generator
- Close to customer
- Issues: Size and utilisation of t & d
- cost / value
- ownership

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Ideal characteristics of a storage device

- Power rating: to match renewable and system
- Discharge period: to meet demand
- Variable charge / discharge rates
- Rapid response and ramp rates
- Cycle lifetime
- Efficiency
- Siting requirements
- Capital cost
- Operating costs

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The Regenesys system
"First of a kind" utility scale plant

- 120 MWh Storage capacity
- Designed for 10 hours discharge time
- Maximum output 14.75MW (PCS Rating)
- Market entry total installed cost:
  - £13.9 M or $22 M
- Follow on plants at reduced cost

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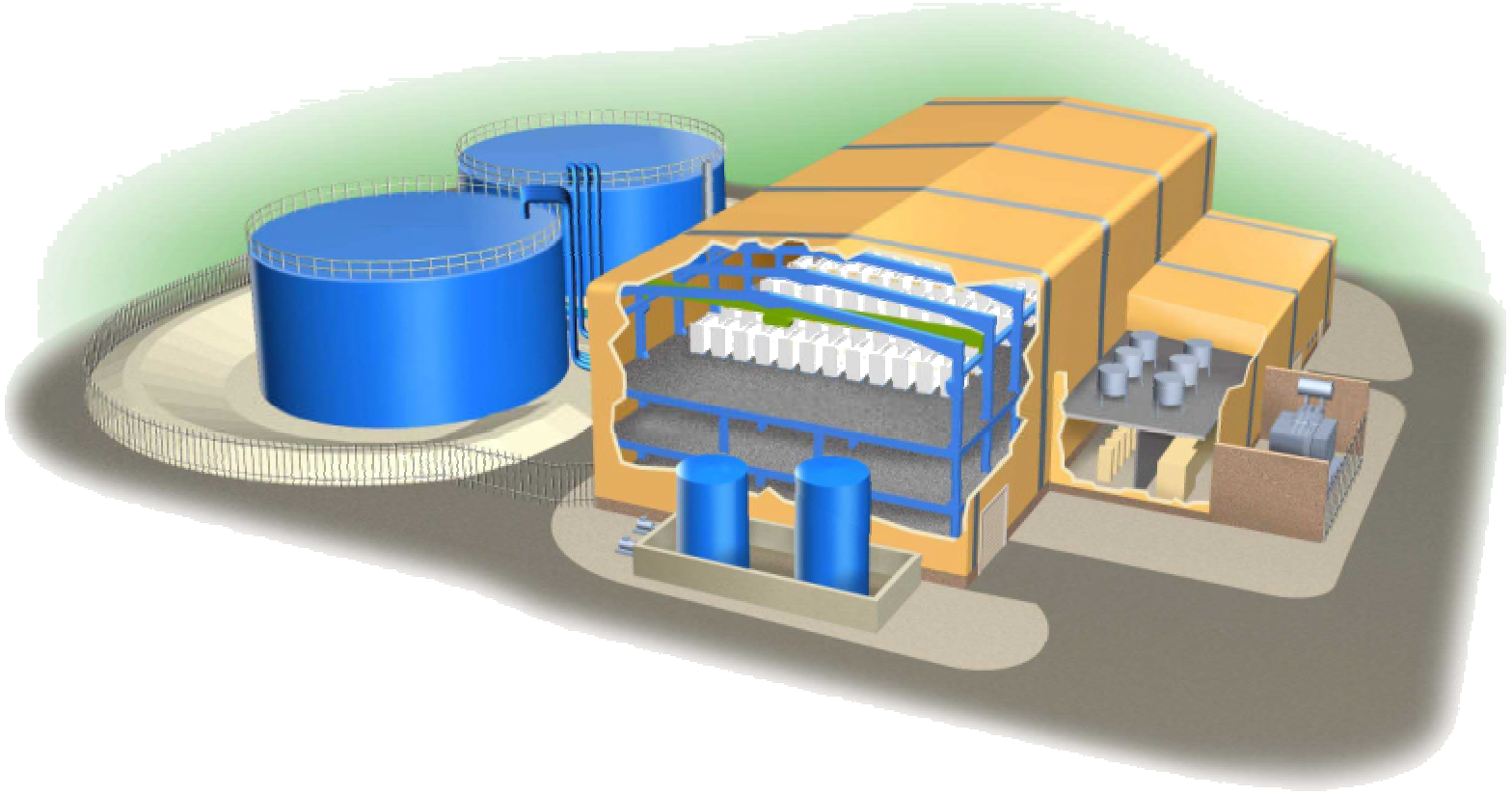
Artist’s layout of Regenesys energy storage plant



Volume of electrolytes - 1800 m^3 per tank

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Future developments

- Other sites identified in USA and Europe
- Other applications under investigation, especially in conjunction with renewables
- Different plant configurations available

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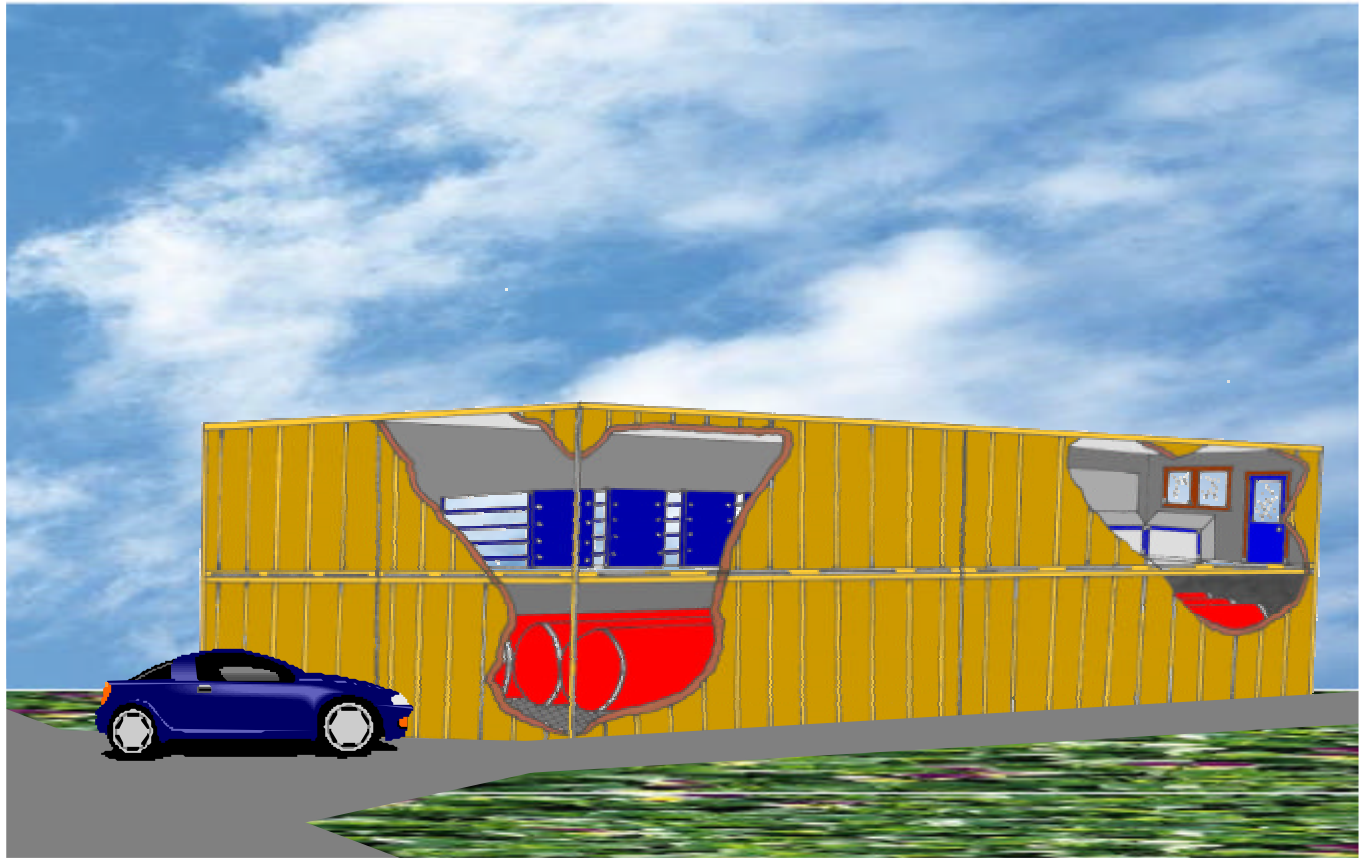
Proposal for a 2MW 20MWh containerised energy storage plant



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Conclusions (1)

- Storage and renewables: a good match
  - Small scale storage for small scale renewables
  - Large scale storage for grid connected renewables: at site of generation, or at customer site
- Storage can improve environmental performance of existing plant

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Conclusions (2)

- Large scale storage (MW and MWh) is achievable now
- Regenerative flow cells are particularly well suited to large scale applications
- The Regenesys energy storage system has many benefits on a power system and can create value for its owners / operators

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Further information

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