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Managing Water Responsibly in the Process Industries

Power and productivity for a better world™

Topics

- What is Responsible water use?
- Is there enough water to go round?
- Alternative water supplies for industry
- Reducing demand
- Drivers for change
- Getting started
- How much can we save?
- What can we do better?

Sustainable Vs Responsible

- Sustainability has become the buzz word – but what does it mean?
- Definitions refer to 3 components
  - Economic
  - Environmental
  - Social
- But definitions of “Sustainable Water Use” are too vague - or maybe too political
- Allows users to choose their own definition – normally Economic
- Result is slow progress, no ownership

Adams, W.M. (2006). "The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century."

- Prefer to use the term *Responsible*
  - And to challenge each person to be responsible for water use in their industry.

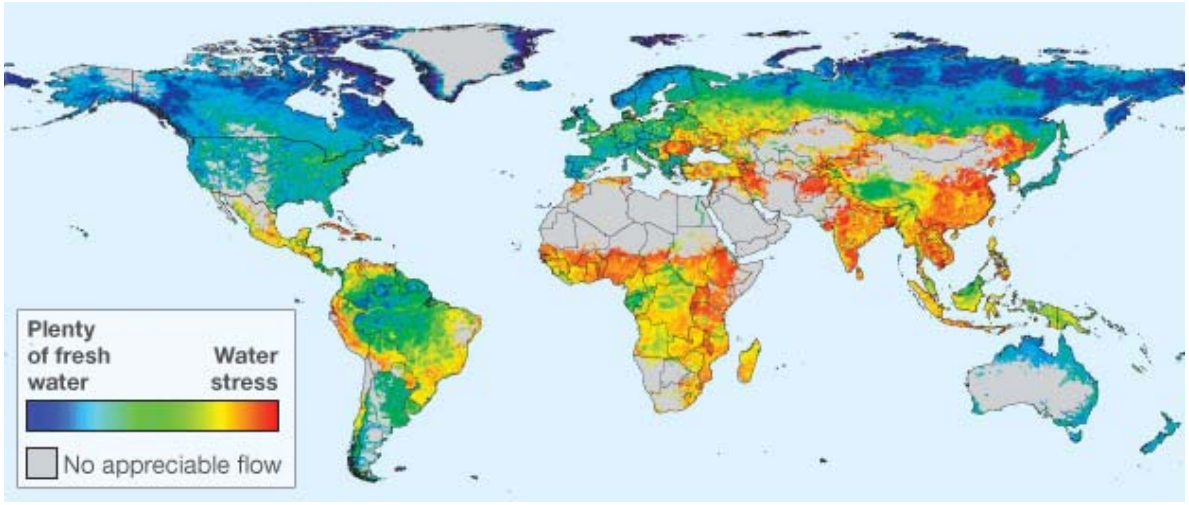
Water, water everywhere ...

- There is no shortage of water in the world
- There is more than enough to satisfy all our needs
  - Human consumption
  - Agricultural
  - Industrial
- Unfortunately the vast majority is present as sea water or in the polar ice caps and is not readily available

- There *is* a shortage of fresh, accessible, renewable water
  - Less than 0.5 % of the water in the world
- It is not evenly distributed and often arrives inconveniently
  - Large geographical areas with too little water and with too much water
- And, if the climate scientists are correct, the patterns of rainfall and fresh water availability will change ...

Future water shortage?

- The BBC recently produced a series of articles on their website showing a map of present “water scarcity” showing much of the USA, Europe to be “under high stress”



- But then commented that “when the impact of the infrastructure that distributes and conserves water is added in – the “managed” picture – most of the serious threat disappears from these regions.”
- It is those regions without the distribution infrastructure which face the biggest threat.

http://www.bbc.co.uk/news/science-environment-11435522

Who uses all the water?

- Pattern of usage:

Agricultural use	~ 70 %
Municipal / Domestic	8 - 15 %
Industrial	15 – 22 %

- Exact values depend on definitions, but
- Remarkably consistent between developed and developing countries

- With
  - Population growth
  - Economic development
  - Climate change

  something is going to have to give
- Present supply-based water industry will be constrained by water availability and cost of distribution

- Either need to reduce demand or look for alternative sources...

What are the alternatives?
Desalination

- There are well established processes to produce fresh water from sea water
  - Thermal desalination
  - Membrane desalination
- Widely practiced - where there are no alternatives
  - Middle East, Africa
- But the water produced is more expensive than abstraction from rivers, lakes and wells
- It appears that we would prefer to use non-renewable sources of water such as deep wells rather than pay more for water
- It may make economic sense, but is this Responsible?

What are the alternatives?
Reusing Municipal Waste Water

- Ready supply of partially purified water
- Tertiary treatment processes established

- Still meets public resistance due to “yuck” factor
  - But Singapore blend NEWater back into Municipal supply
  - In several area in the US, water “recharge and recovery” is used
  - And Londoners use water abstracted from The Thames...
- One of these supplies has been through a membrane
  - Which one would you rather drink?

- Industry has no such emotional constraints
  - Eraring PS in NSW uses tertiary treated sewage as their sole water source
  - Peterborough PS also use tertiary treated sewage
  - Palo Verde Nuclear Plant uses effluent and reclaimed water from Phoenix for its cooling systems
  - Brisbane supply only tertiary treated sewage to some of its industrial areas

What are the alternatives?
Using Grade 2 and Grade 3 waters

- Does industry need to use potable water?
  - Potability is not a property which (most) industry needs
- Industry needs a water supply which, above all, is reliable
- We would also like the water we use to be
  - Free from suspended solids
  - Low in organic contamination
  - Microbiologically “clean”
  - Of stable ionic composition (ideally)

- Processes used in the production of potable water can (largely) achieve this -
  - But we could also choose to operate these processes ourselves
- The key challenge is whether it is Responsible to use Grade 1 water sources for industrial supply?
  - Or should we leave these for domestic consumption?

We are where we are – or are we?

- It is easy to rely on the Water Companies to provide our water
  - Economies of scale, installed distribution system, subsidising potable water users, able to negotiate discount for “bulk” usage, etc
- And, of course, it makes sense for us to continue to use the existing infrastructure – for now
  - Rapid changes would distort the market and incur extra costs in the short term
- But it is important to recognise that our present system of supply management of water is not Responsible
  - And to make changes for the future
  - Voluntarily, in our own timeframe
- There are many alternative sources of lower grade water which could be successfully treated to a suitable quality for industrial use
  - By large users for their own use
  - By third party utilities for groups of users

Is Industry playing its part?

- Industrial examples quoted are driven by water stress
- Could we be doing more even when water supply is not stressed?

- Do we measure our water consumption?
- Do we have actions in place to reduce our water consumption?
- Do we know what “best practice” is for our industry sector?
- Where does our water supply come from?
- Have we examined the opportunity from lower grade sources?
  - Rivers, canals?
- Do we reuse water on our plants? [Not just recirculate...]

- Do we know what our water really costs us?
  - Not just the cost per m^3, but the total cost?

- Could we do more?
- Is our use of water Responsible?

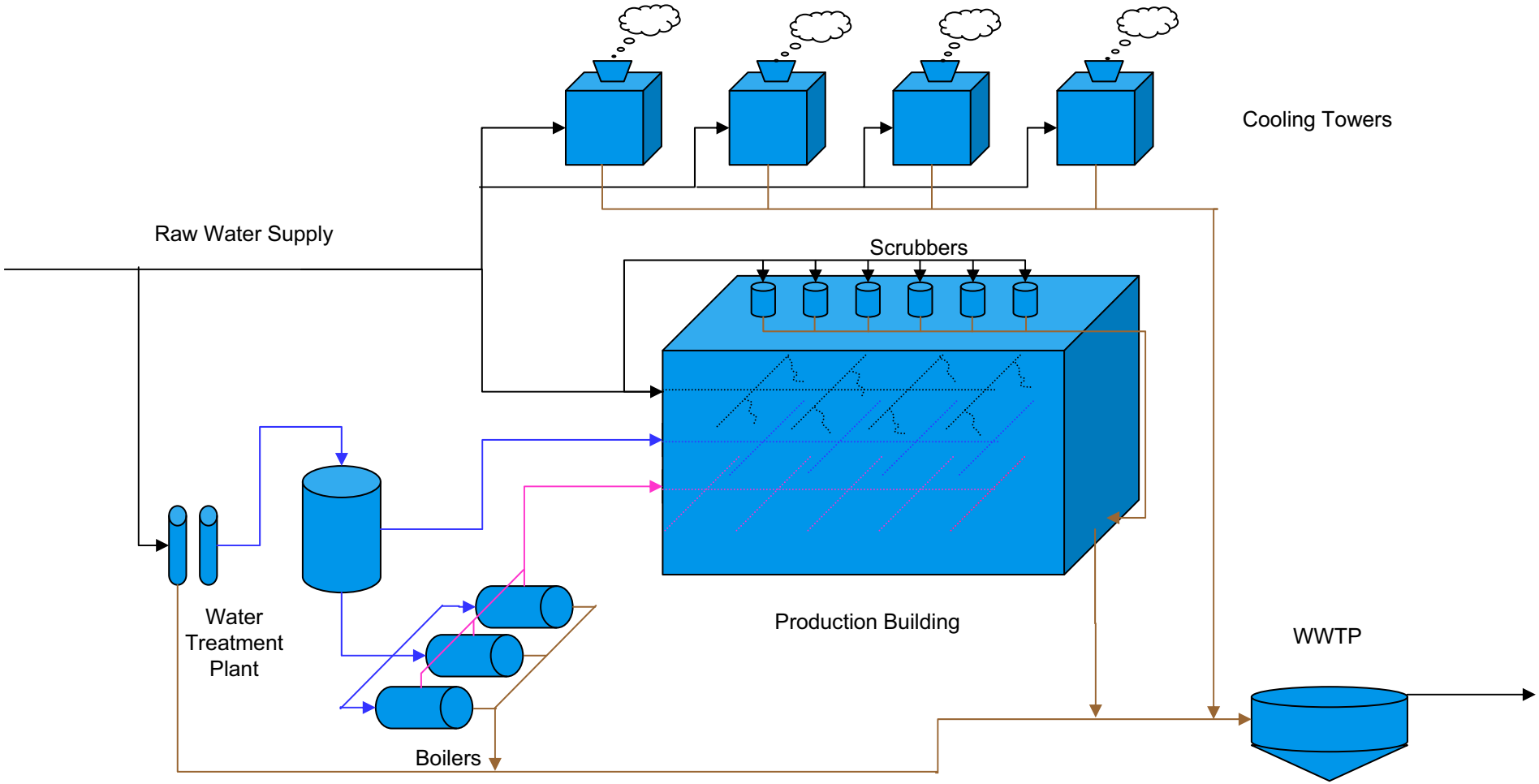
Reducing demand

- Before we spend a lot of time and money building new water treatment plants, how much water do we need?
- Unfortunately few users know.
- Water has a “value” to industry which far exceeds its cost
  - It is simply not worth taking “risks” with our processes when the water we use is so cheap
- Which is fine when there is enough water available
  - But what will you do when there isn’t?
  - Even in the UK, water supply in some regions is very limited
    - East Anglia is “drier than Jordan”
    - North West suffered supply restrictions this year
- Domestic consumers take the first restrictions on supply
  - Is this Responsible when industry could do much more?

Present operation of industrial water systems

- Operated as stand-alone independent systems
  - Safe
  - “Because it is so cheap” to purchase
  - To avoid common mode problems
  - To prevent constraints on the process
- As a result we operate systems in parallel, rather than in series, e.g.
  - Condensate put to drain rather than recovering to boilers or even to cooling system
  - Clean water used for plant washing
  - “Waste” water put to drain and not reused
  - Rainwater not recovered
  - At times our discharge is “purer” than our raw water

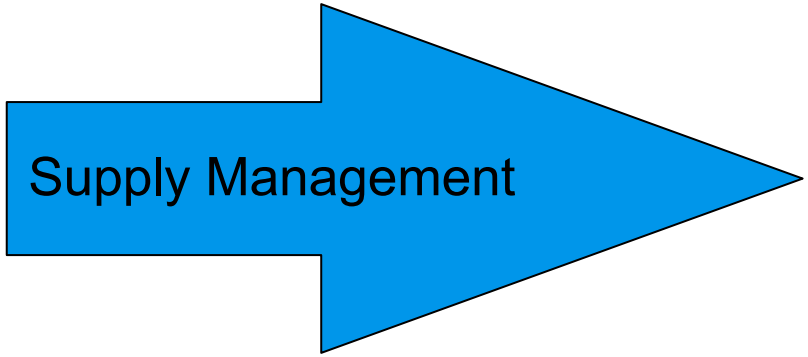
Simple water network



External drivers for change

- The drivers will not be the same for everyone. But will include:
  - Rising cost of water – to buy and to discharge
  - Falling availability of water - in the right place and in the right quantities
  - Stricter anti-pollution laws to reduce contamination
  - Extension of IPPC legislation to reduce fresh water consumption
  - Growing public concern for both health and lifestyle
  - “Green” pressure – growing concern about sustainability

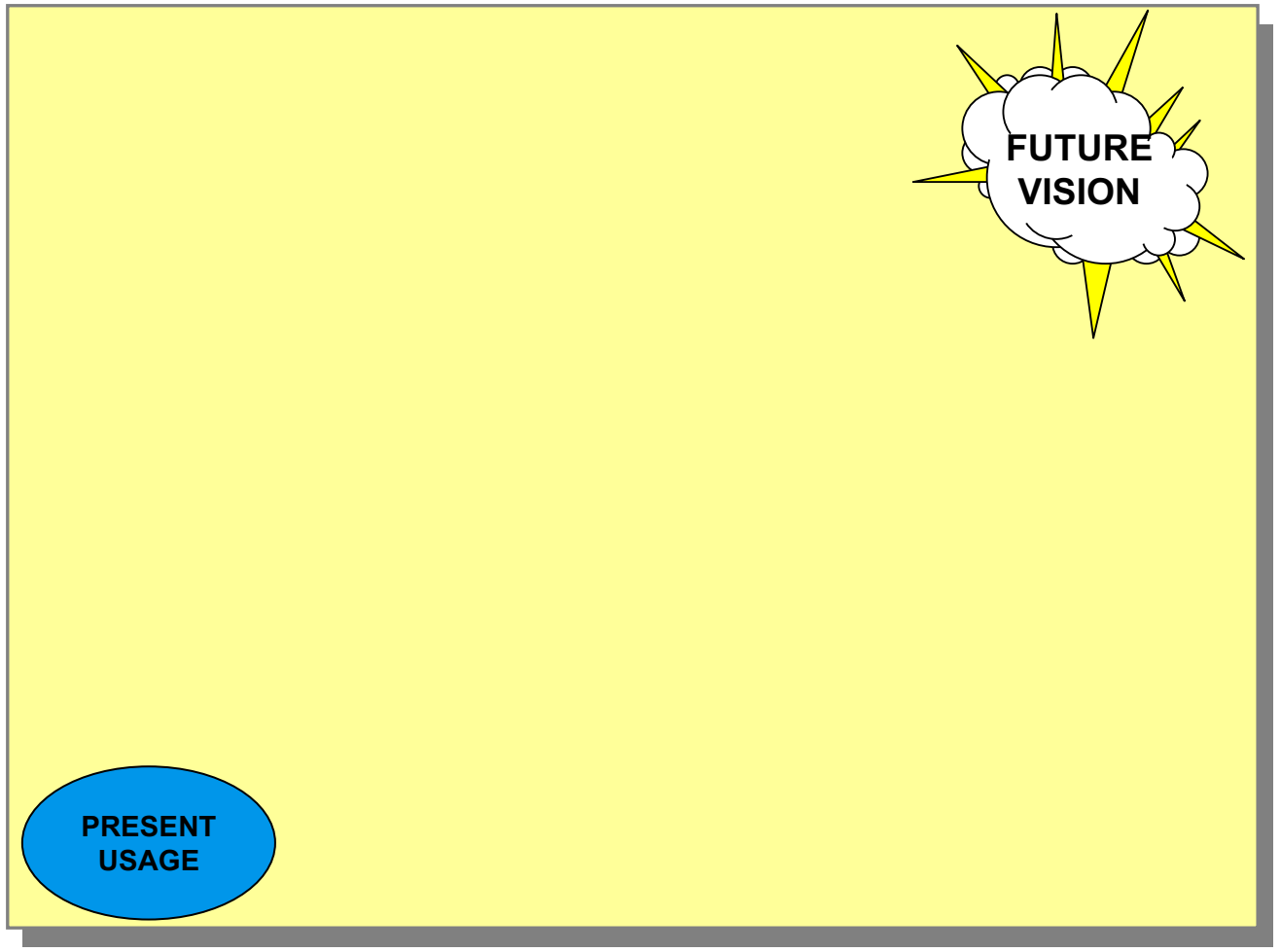
  - In response, the way in which we use water will have to change



to

Demand Management and Resource Conservation

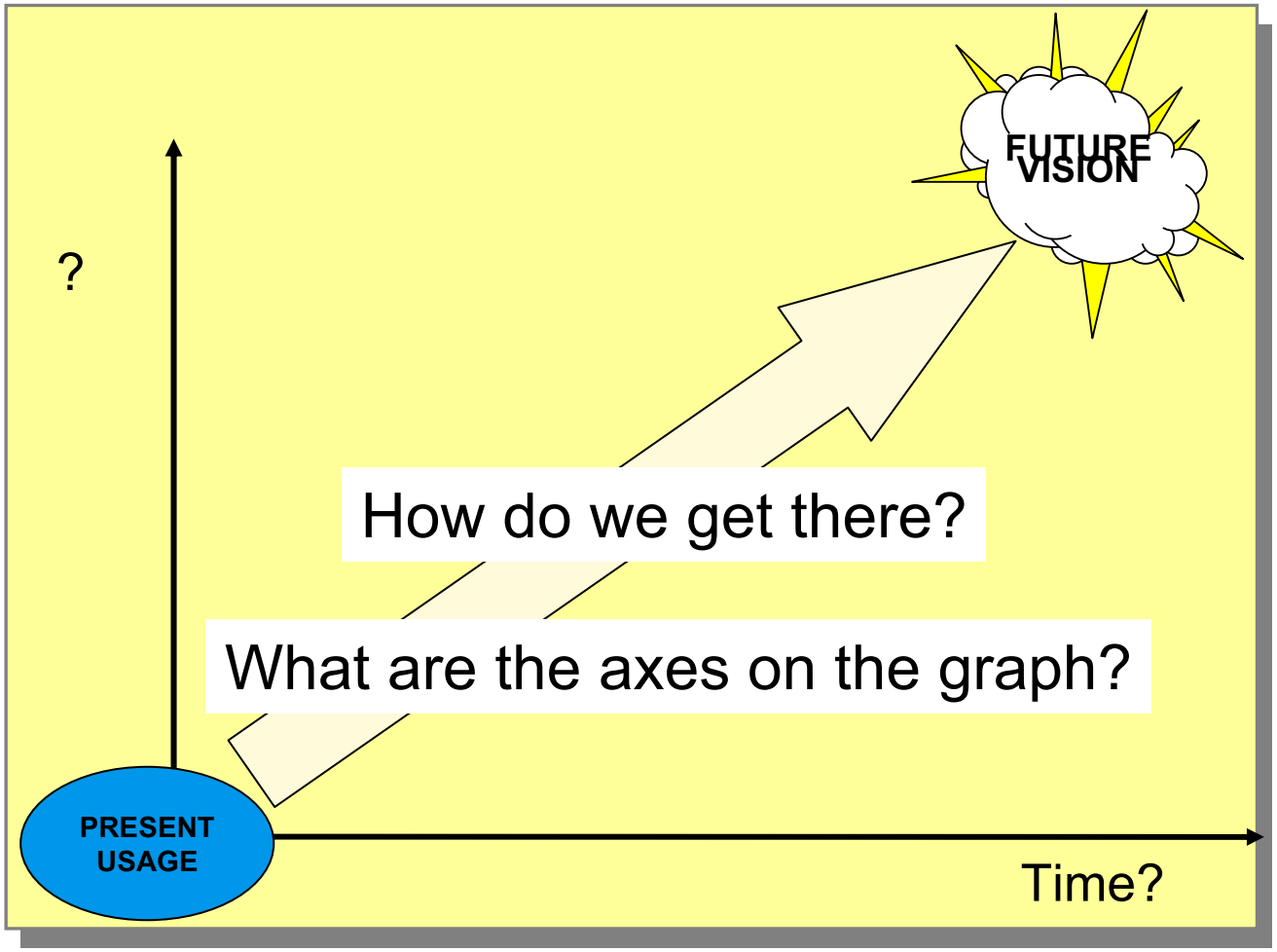
How could it be?



Vision of future water management

- Core process water use protected for quality and quantity
- Fully integrated water use, reuse and recycle
- Water streams operated in series, not parallel
- Water used more than once
- Primary focus on maximising recovery of products and raw materials
- Focus on removing contaminants at source, not in end-of-pipe treatment facility
- Recovery of waste streams into more tolerant systems, e.g. cooling systems
- Water efficiency as a design specification for new plants

So what is stopping us?



Reasons for not getting started

- Present availability of water
- Cost of water and effluent treatment manageable
- Cost of investment
- Business priorities
- Technology availability
- Impact on product quality
- Don’t know where to start
- Don’t want to be the first
- There is no shortage of water - and if there was we could develop the technology when it was needed
- Drivers and concerns will be unique to each application
  - Progress will only be made when the drivers outweigh the concerns
  - But need to be sure to consider ALL the factors

Need to consider all relevant factors
Economic case

- Savings in the water purchase bill are unlikely to justify the water use reduction scheme
- But, if we consider ALL the factors, the economic case may be more attractive, e.g.
  - Availability of water for future expansion
  - Reduced capital for WWT plant expansion
  - Greater WWT plant capacity
  - Simpler technology for WWT
  - Product and raw material recovery
  - Meeting discharge consents reliably
  - Improved company image
  - Continued licence to operate, etc..
- Decision to minimise water use is Strategic and Visionary rather than Economic

Need to consider all the relevant factors
Technology for water use reduction

- The good news is that we are not limited by the availability of treatment technologies and applications
- Many of the technologies are already in use for water purification
  - Clarification, filtration, GAC, iron removal, reverse osmosis, etc
- Some application development may be required

- But we will need to develop and install better measurement and control technology
  - Potential to go wrong is greater
  - Consequences of going wrong are greater

Need to consider all relevant factors
You're not the first!

- There are many examples of successful water use reduction schemes in operation
- Largely driven by water availability
  - Changing rainfall patterns, limited water treatment plant capacity
- Or by legislation
  - e.g. California restrict use of fresh water for cooling system make-up
- Or increasingly by major shareholders
  - Want to be sure that the business in which they are investing is sustainable
- Or by industry pressure
  - Pulp & Paper
  - Brewing

But progress remains slow

- Water use reduction seen as last resort rather than strategic investment
- Piecemeal solutions forgotten as problems are “solved” and personnel move on
- Problems - and solutions - seen as local and specific

- Above all we need a consistent methodology to help us improve our use of water to
  - Help us with better management of the whole water network
  - Allow us to understand the costs and benefits
  - Develop reuse / recycle schemes with confidence
  - Ensure that we meet our environmental commitments
  - Convince key personnel of the benefits of improved water management
  - Provide a sustainable future

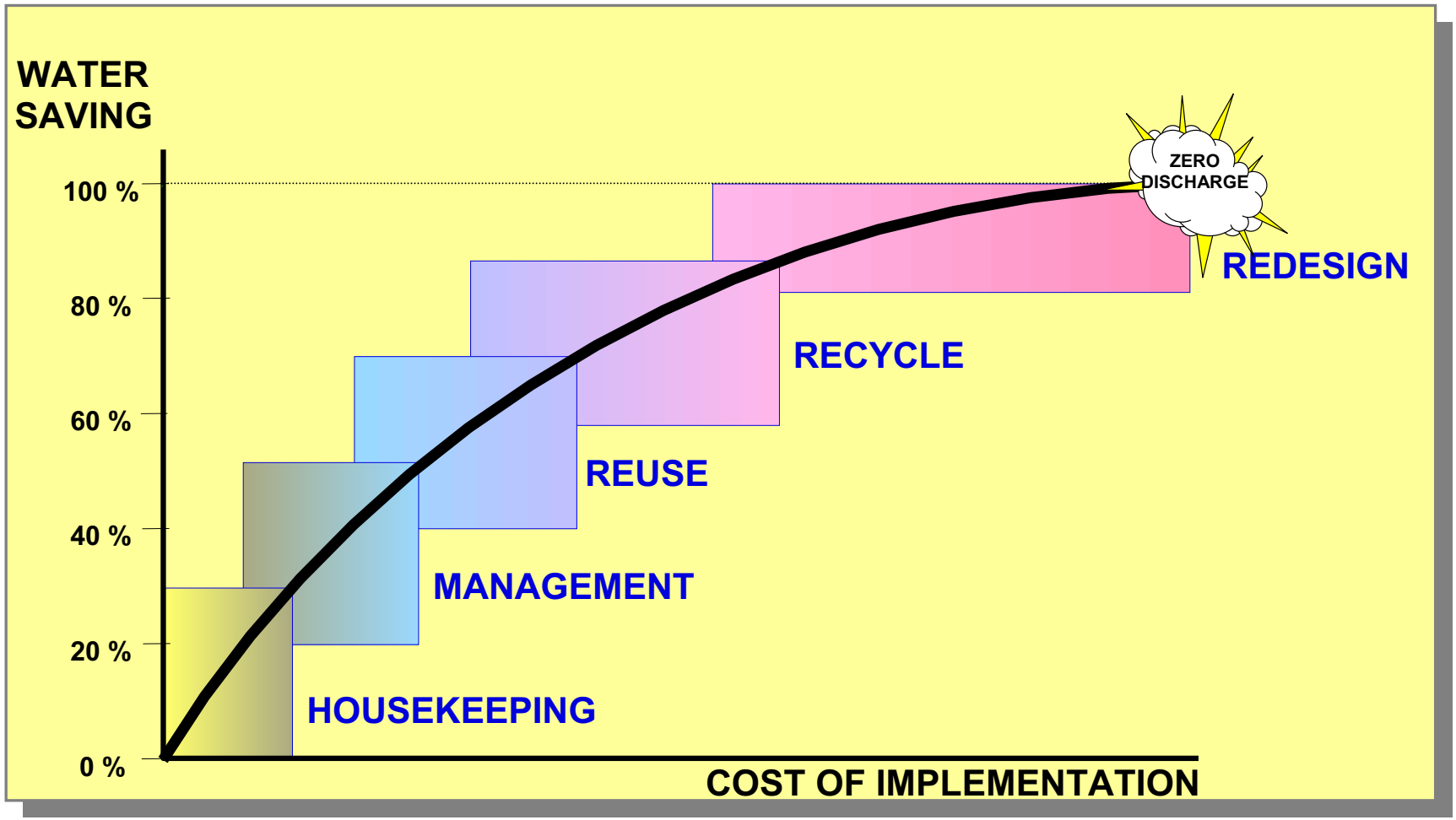
  - And maintain these improvements

Water use reduction
Where do we start?

- Cannot achieve full savings in one step
  - Need to move in smaller steps which are justifiable, economic, achievable, manageable
  - Benefits are cumulative - every little helps
- Start with the cheapest and most cost effective - the “low hanging fruit”
  - Demonstrate benefits, savings
  - Establish correct ethos
- There is little point in installing exotic water reuse/recycle schemes if
  - You don’t know how much water you are using
  - You don’t control wastage

- There is a natural hierarchy of activity...

Water use reduction
Hierarchy of activity



Water use reduction
Six steps

1. Establish water balance
2. Improve housekeeping
3. Improve management of existing water users

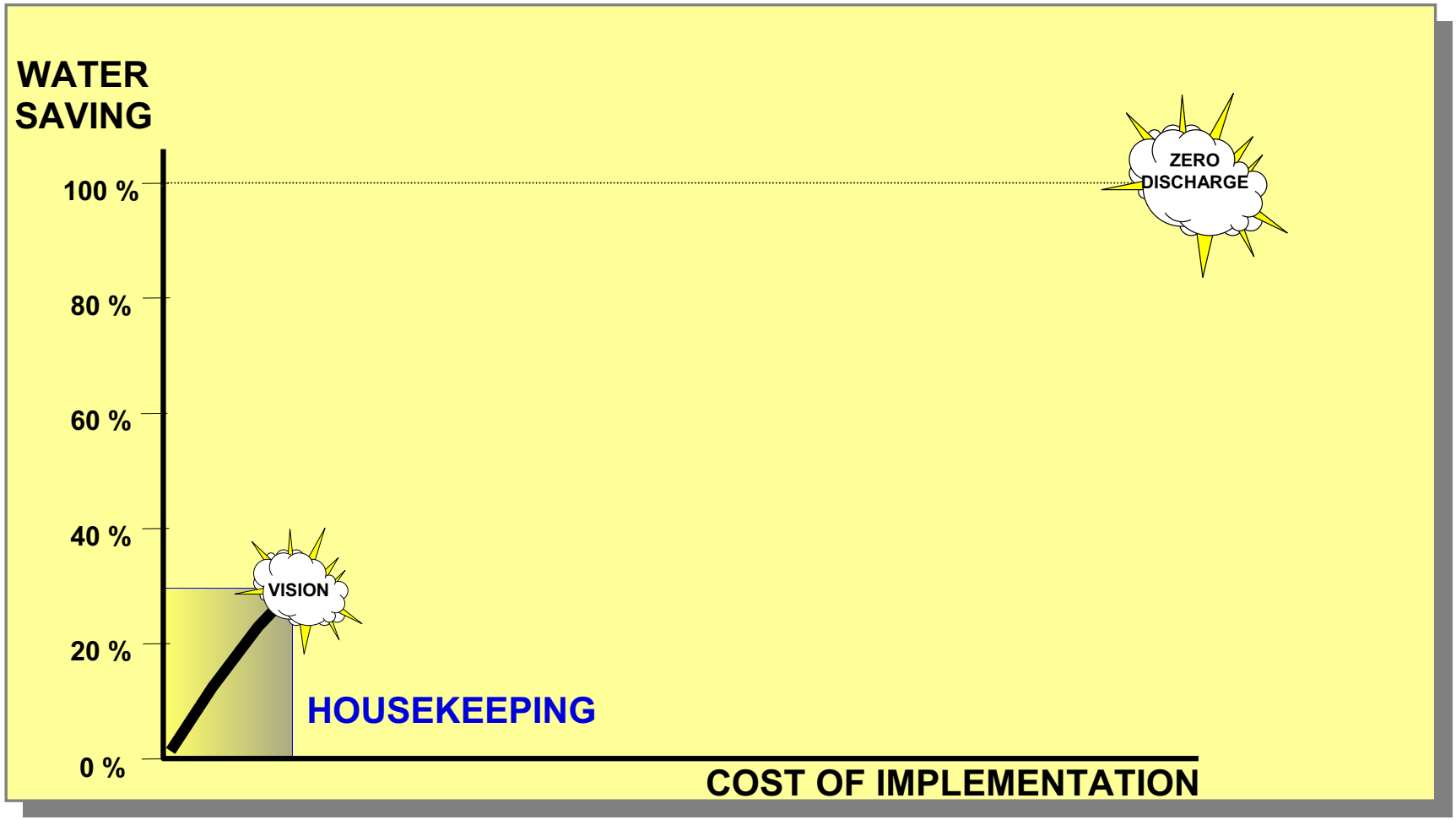
For today will focus on these steps

4. Look for opportunities to reuse water
5. Install treatment processes to recycle water
6. Redesign the system, where possible, to eliminate the use of water

Water use reduction
Step 1: Water balance

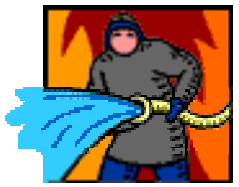
- Important to know
  - How much water you are using
  - Where you are using the water
  - Where you are losing the water
- Initial water balance may not account for more than 70 to 80% of water use
- Use of local meters essential
- Establish useful metrics
  - e.g. water used per tonne of product
- Simply establishing the water balance will often identify improvement opportunities
- If you can't measure the improvement, there will be no incentive to continue

Water use reduction
Step 2: Housekeeping



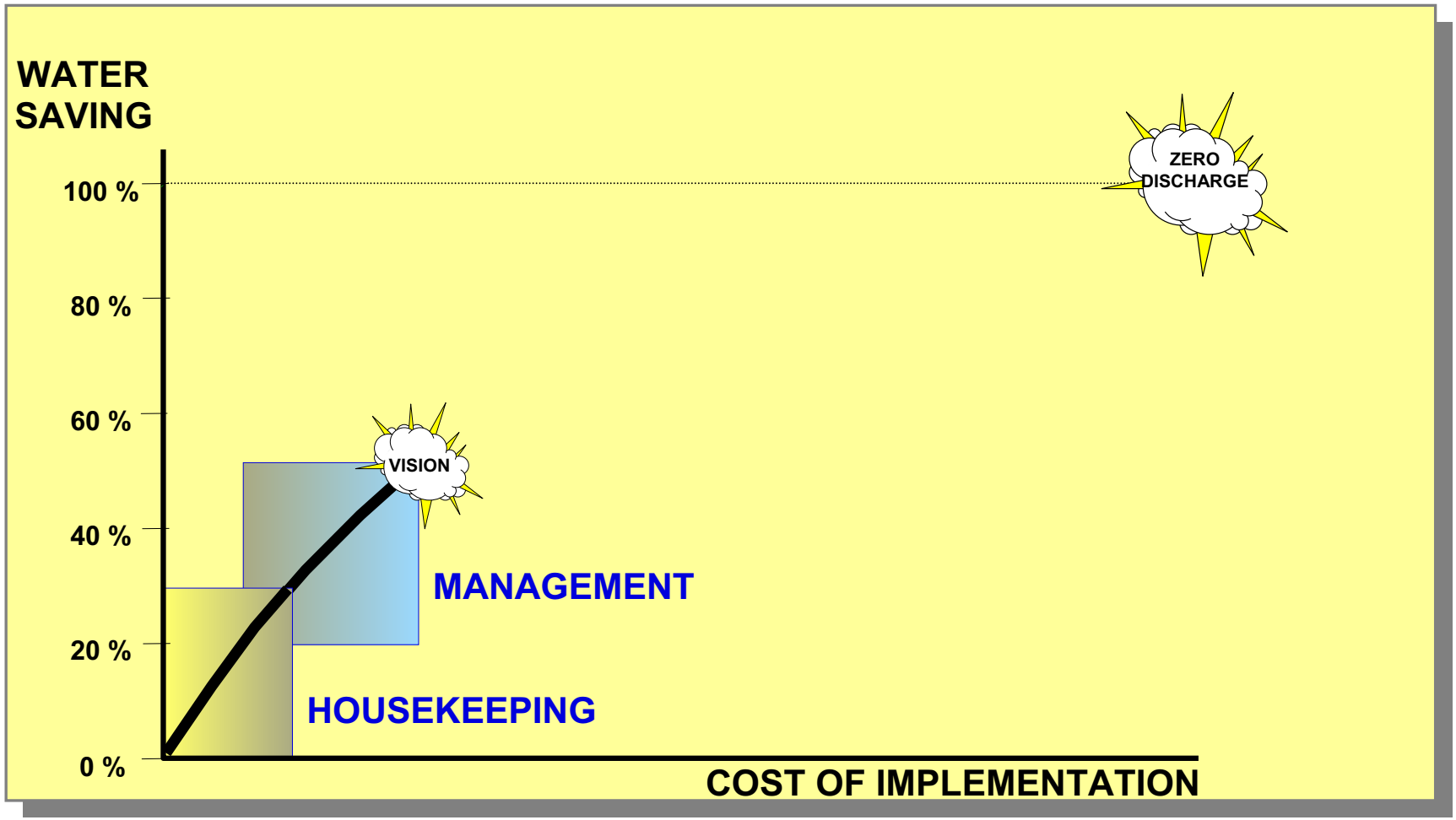
Water use reduction
Housekeeping

- Reductions in wastage
  - Leaks
  - Untended taps and hoses
- Better cleaning methods
  - Sprays in place of fill and drain
  - Hose triggers
- Awareness
  - Education and training



- Need to adopt policy of Zero Tolerance towards wastage
  - Essential if we are to build a platform for further improvements

Water use reduction
Step 3: Management of water systems



Water use reduction
Management of water systems

- Better operation of existing water uses

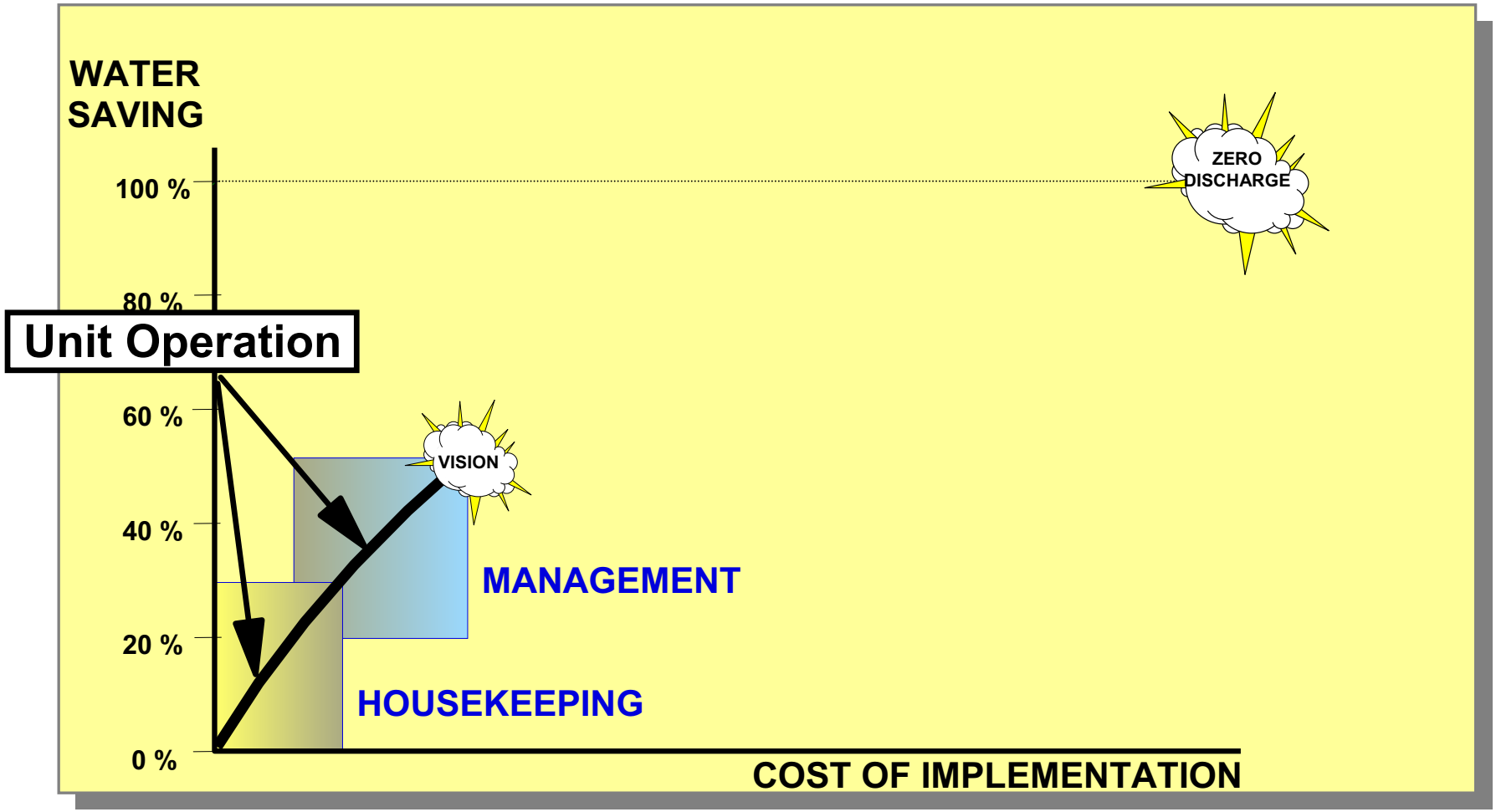
- Utilities, e.g. cooling systems, boilers, water treatment plant
  - Examine efficiency
  - Maximise cycles, reduce blowdown
  - Tighten control - operate closer to the limit

- Process, e.g. product washing, essential cleaning duties between batches, product formulation
  - Reduce excess usage
  - Define and operate to required standard
  - Better techniques, e.g. counterflow washing
  - Better control and measurement
  - Local reuse of water

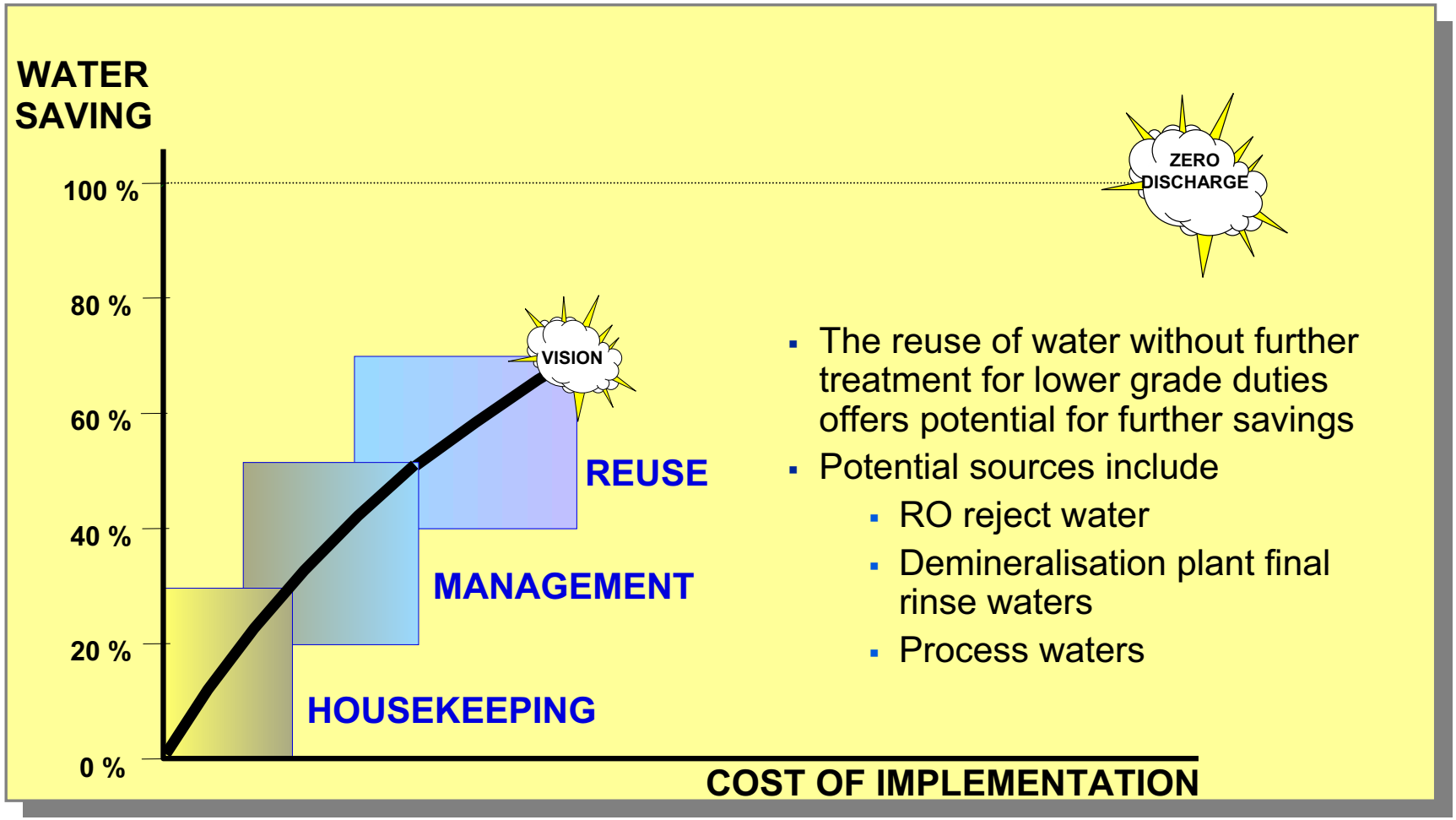
Water use reduction
Housekeeping and management - 2

- Experience has shown that there are potential savings of 50% or even more in water use through better housekeeping and management of water systems
  - Depending on where you start and which industry you are in
- It is not worth pursuing reuse and recycle opportunities until you have implemented these
  - Danger of sub-optimisation or embedding poor practice
- Limiting activities within Unit Operations reduces overall risk and allows protection of Core Process
- Once savings have been achieved, can consider what further improvements can be justified

Water use reduction
Housekeeping and management

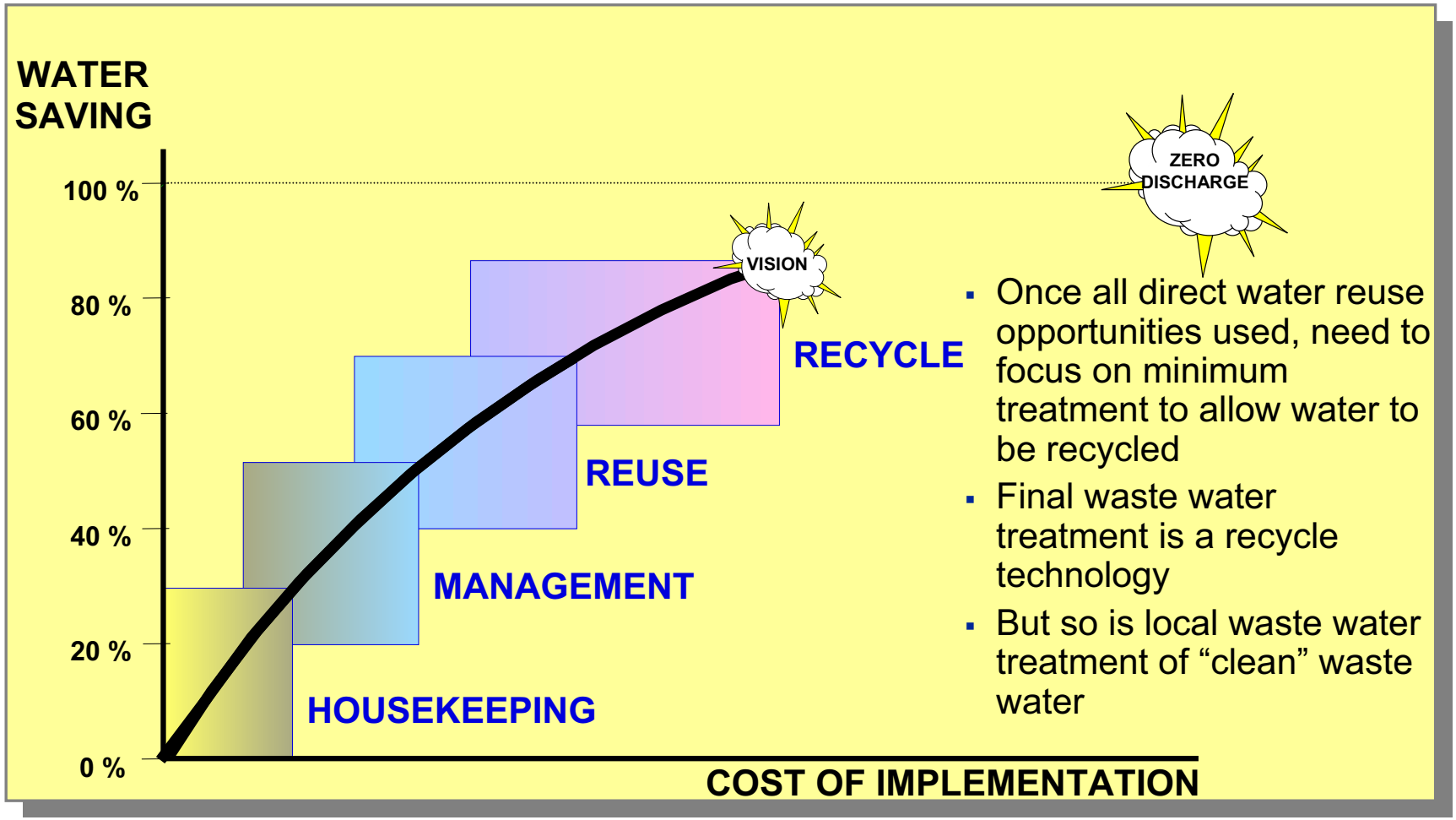


Water reuse/recycle
Step 4: Reuse of water without treatment



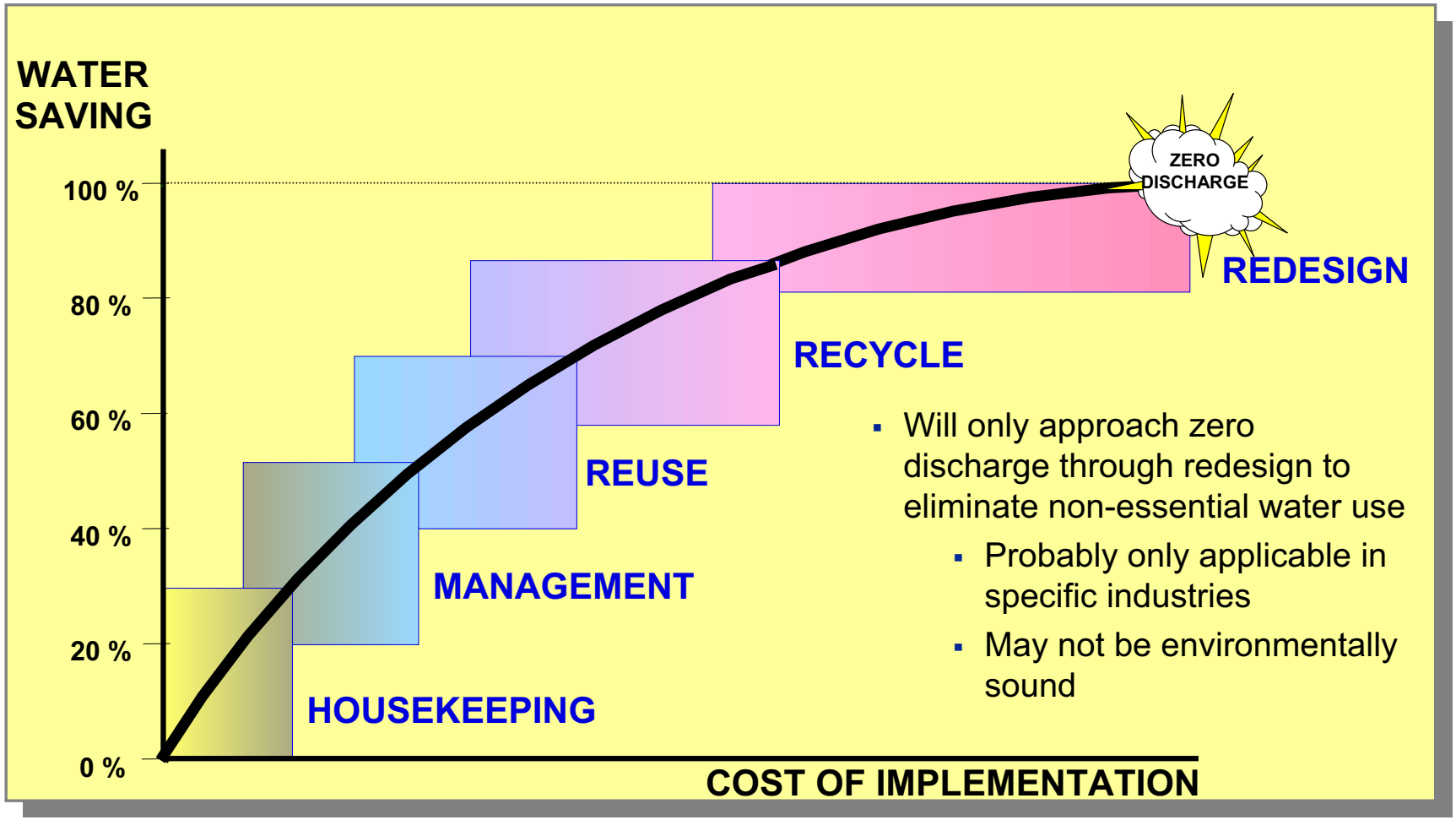
- The reuse of water without further treatment for lower grade duties offers potential for further savings
- Potential sources include
  - RO reject water
  - Demineralisation plant final rinse waters
  - Process waters

Water reuse/recycle
Step 5: Recycle of water after treatment



- Once all direct water reuse opportunities used, need to focus on minimum treatment to allow water to be recycled
- Final waste water treatment is a recycle technology
- But so is local waste water treatment of “clean” waste water

Approaching zero discharge
Step 6: Redesign systems with no water use



- Will only approach zero discharge through redesign to eliminate non-essential water use
  - Probably only applicable in specific industries
  - May not be environmentally sound

If it is so easy, why don't we do it?

- Experience has suggested that the indicative savings shown are relevant across a range of process industries, but will depend on local conditions

- But if 50% or more of water use in process industries can be saved through simple measures such as
  - better housekeeping,
  - improved management of water systems and
  - reusing "waste" water for lower grade duties

  why are we not doing this?

- 3 reasons:
  - Water is too cheap
  - We don't measure or report water use
  - We are worried about unexpected consequences on our core processes

- Is this Responsible?

Taking responsibility
Is there a will ...?

- Achieving reductions in water use is relatively easy in practice
  - But financial justification is more difficult unless you look at the bigger picture
  - Savings in the cost of water are unlikely to support more than the simplest measures
- The problem is that, for most companies, there is no one with technical responsibility for water use
  - Until this changes, progress will continue to be slow
    - It will depend on local water shortages or
    - Individual responsibility
- So how do we encourage companies to take a responsible attitude towards water use?

Raising responsibility
Possible mechanisms?

- Raising awareness/education:
  - Academic courses in universities to teach industrial water treatment as part of degree courses in chemical engineering, chemistry, environmental engineering, etc
  - Industry bodies (SCI, CIA, RSC, IChemE, etc) to promote activities to raise awareness of need to use water responsibly
- Company reporting:
  - Companies to report water usage against targets as part of environmental reporting

and if all else fails

- Legislation:
  - Legislation to “encourage” companies to be more responsible
    - Taxing use of potable water for industrial processes
    - Requiring companies to use a set percentage of recycled water
    - Stricter reinforcement of existing IPPC legislation

Summary and conclusions

- Our present use of water is not sustainable and is not responsible
- Most problems have their origin in design - due to a lack of understanding/specification during design
- Start with the easy schemes first, but don't expect that all systems will be easy!
- There are easy wins from better housekeeping and management of existing water systems
- Water reuse / recycle likely to be more important as resources decline and available water quality deteriorates
- Design methodology for reuse / recycle schemes still in its infancy
- To make real progress we need to move industrial water treatment from a “black art” to be recognised and valued activity
- And create the right environment for industrial water use

Where will water reuse / recycle fit?

- ✓ Large water users
- ✓ Large polluters
- ✓ High value products
- ✓ High toxicity wastes
- ✓ Poor water availability
- ✓ High cost water
- ✓ Inland sites
- ✓ Sites with disposal problems
- ✓ Tightening environmental legislation

- ✗ Net generators of water
- ✗ Processes with dilute feed streams
- ✗ Cheap water costs
- ✗ Water readily available
- ✗ No pressing environmental constraints
- ✗ Estuarine sites
- ✗ Small water users

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