WATER DEMAND FOR THE ELECTRICITY SECTOR - KEY CONCERNS AND PRIORITIES FOR ACTION:

Obvious and less obvious interdependencies between water and energy both today and the future

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Role of Water in Thermal Power Plant

> Necessary
  - Steam cycle make up production (water treatment plant)
  - Essential services (eg fire systems, health & safety, washing, domestic)

> Configurable principal techniques which may be water-using from which to construct site-specific BAT
  - Steam cycle cooling
  - Auxiliary cooling
  - deSOx
  - deNOx
  - Ash handling, transport & disposal
  - Coal stock management
  - [managing rainfall & site drainage]

> Implications of Carbon Capture

Individual plant for individual plant circumstances
Surface Water _River
Surface Water _Sea/Estuary
Ground Water
Used Water
Towns mains
Rain fall

Evaporation

Installation Process – combination of techniques representing site-specific BAT

Used water
Internal process re-cycling & re-use

Used Water (discharged from installation)

Bound in product
Leaks & losses

Ground Water
Unusual in power sector for permitted discharge to GW

Other Installation(s)

Surface Water _River/Stream
Surface Water _Sea/Estuary

Each plant has an individual site-specific configuration consistent with BAT and optimised to suit local water body circumstances
Why a preference for wet cooling systems?

> Hierarchy of cooling techniques based on superior thermal efficiency (MWe/MWth)
  > Once through (eg CCGT 58.8%)
  > wet/hybrid cooling towers (eg 57.8/57.5%)
  > Air cooling (eg 57.0%)

> Not easily compared - 1%pt difference between options for CCGT at design point

> Differences may appear small but they are crucial in determining plant through-life competitiveness

> Improved thermal efficiency leads to better fuel resource efficiency and reduced emissions to air /MWh produced

> Once through cooling is only possible at commercial plant scale for open coast, larger estuary & lower end of large tidal river locations in UK

> Wet/hybrid towers are possible on many UK major lowland rivers - normally mechanical tower with wet & dry sections optimised to limit plume visibility

> Multiple cooling systems are possible but lead to high capital and with implications for major component optimisation (turbines, condensers)

> Air cooling avoids surface water reliability risk but locks in certainty of inferior average thermal efficiency & increases exposure to high air temperature risk (reduced efficiency, lost MWhe and possibly forced outage)
Installation-specific optimisation of water use

> Fundamental choices determining appropriate plant water use are made during design process and limited scope for subsequent change eg

  – Once through cooling pump, culvert sizing, intake and outfall, condenser sizing linked to flow rate

  – Choice of materials and cooling water circuit chemical control regime, culvert sizing, intake & outfall linked to design choice of gross and net cooling water use

> Reducing water use may have adverse consequences for other media or the aquatic environment (eg increased chemical emissions, increased discharge temperature)

> Beware benchmarking driven by literature studies of ‘paper plant’ or plant elsewhere in the world

  – Terminology

  – Data limitations

  – Choices driven by

    • other regulatory regimes

    • specific plant circumstances (eg sensitive receptor location)

    • Operator preferences

    • Supplier-driven regimes

    – (eg high chemical usage, off the shelf v bespoke plant)
Investment Decision & Siting Factors

- Land availability & plant footprint
- Grid/market position
- Fuel & By-product routes
- Cooling Options
- Site-specific circumstances influencing BAT options
- Site-specific water arrangements influencing site-specific optimisation

Future plant mix will develop as a result of many individual investment & closure decisions made by different companies with very different circumstances and risk drivers.

- Capex competition success criteria
- Forward market and return position vs criteria
- Project Net Present Value vs criteria
- Permitting & development
  - estimated duration, cost & risk
- Through life residual project risks especially to break even point
  - inc cooling water reliability
- Leading to decision:
  - invest / wait and see/ invest but not here / don’t invest

Future plant mix will develop as a result of many individual investment & closure decisions made by different companies with very different circumstances and risk drivers.
Future Sector Water Use (Un) Predictability

> Current topic of interest around the world (water-energy-food nexus)

> Reviews of actual water use by real plant (eg Edwards 2013, Ecofys 2014)

> + Future plant & load profile pathways (eg DECC 2050)

> Leads to outcome assessments eg

  – Byers, Hall & Amezaga (national, 2014)

  – Environment Agency (by RBD, Case for Change)

  – Gasparino (stochastic by RBD 2012)
Uncertainty in future water consumption – eg DECC Nuclear Pathway

Gasparino (2012)
Uncertainty in future water consumption eg
DECC Nuclear Pathway: Humber RBD

All graphs Mm$^3$/a

Gasparino (2012)
Reduction of Freshwater Use by Preferring Estuarine and Coastal Sites?

> Water resource is not a concern for estuarine and coastal locations

> Many larger estuaries and open coasts have the potential to be suitable for once through cooling and wet tower cooling

> Some locations may be advantageous for carbon transport routes and disposal sites (CCS)

> BUT

> Limited number of candidate sites

> Acceptability of residual impacts on aquatic environment requires in depth site-specific consideration through permitting process

> Visual amenity & landscape issues for use of tower cooling (both structures ad plume visibility)

> Uncertain future implications of combination of marine spatial planning, marine strategy framework directive, water framework directive, revisit of habitats directive etc.

> Potential for operational constraints linked to water temperature
Key messages

> Use of water for cooling will remain a key driver in the coming decades
  - thermal efficiency, BAT, resource use efficiency balance
  - Coastal sites & air-cooling avoid water resource issues but have their own risks

> Future sector expected water use is highly uncertain. It will result from many individual company decisions on plant investment opportunities & closure when facing an uncertain regulatory & market future
  - Company circumstances, commercial drivers & risk appetites differ greatly

> Future actual sector national, RBD & individual plant water use in a given year will remain highly variable driven by many factors eg:
  - Electricity market, electricity demand, plant mix, fuel costs, constraints, maintenance schedules, weather, …

> Plant goal is water use optimisation not minimisation (multi-media BAT)
  - Beware benchmarking – each plant has its own water story

> Sufficiently reliable access to sufficient water is a pre-requisite for investment in water-dependent plant