CIWEM Water and Environment 2011

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Using the Big Society concept to deliver a new industrial future founded on the UK Water Industry

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MWH

BUILDING A BETTER WORLD

What is the Big Society?

- Coalition Governments statement of aims

- "We want to give citizens, communities and local government the power and information they need to come together and solve the problems they face and build the Britain they want."

Stated objectives:

•Giving communities more power

•Encouraging people to take an active role in their communities

•Transferring power from central to local government

•Supporting co-ops, mutuals, charities and social enterprises

•Publication of government data (implying publication and dissemination of government information)

Building the Big Society - Cabinet Office
http://www.cabinetoffice.gov.uk/news/building-big-society

What is the Big Society and WHY propose it?

- **PMs 2009 Hugo Young Lecture**

" ....a new focus on empowering and enabling individuals, families and communities to take control of their lives so we create the avenues through which responsibility and opportunity can develop."

To address "poverty, inequality, social breakdown and injustice "

The concept also presents an apparent consensus on the role of the state (if not its size) –

David Cameron quoting Peter Mandelson on the "smart, strategic state"
"[Mandelson] made the case for government to 'steer and shape the networks and institutions of a globalised economy and society,' so it could better 'manage the system so as to minimise and deal with the shocks'. And he argued for active policy to ensure 'markets function effectively'. Well I think we can all agree with that. "

- <u>2010-11 Public Administration Select Committee Report: "*Who does UK National Strategy*"</u>

"If we now have a need for national strategy, we have all but lost the capacity to think strategically . We have simply fallen out of the habit , and have lost the culture of strategy making."

What is the Big Society?

Summary

Big Society goals (PMs 2009 Hugo Young Lecture)

1. Empowerment and engagement of the members of British society in its development

2. by increasing transparency and accountability

3. Encouraging and supporting social responsibility

4. All supported by providing ‘smart strategic ‘Government that can effectively manage the challenges of the global economy and globalisation

5. Society can propose; Government can facilitate?

The latter (5) is for Government to enable.

Mapping the Big Society objectives onto the UK Water industry

BIG SOCIETY

- ➢Empowerment and engagement
- ➢transparency and accountability
- ➢Encouraging and supporting social responsibility

❑Providing ‘smart strategic ‘government
-to meet challenges of globalisation

U.K. WATER INDUSTRY

- ➢Empowerment and engagement of stakeholders and public
- ➢transparency and accountability with stakeholders and public
- ➢Encouraging and supporting social responsibility – consult public in service provision and development

❑facilitating ‘smart strategic ‘government –providing strategic risk appreciation in industry development

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U.K. WATER INDUSTRY

✓Empowerment: mostly effective regulation by OFWAT, EA; customers needs registered -

- ▪value for money on billing/ affordability-no shock increases?
- ▪no sewer flooding
- ▪ green/ sustainable development- addressing climate change

✓Accounts published and reviewed by OFWAT. More transparency will help.

✓the industry now tends to carry out public opinion surveys on service provision and development before an AMP (see empowerment above). Stakeholder consultation occurs on some projects. More consultation will help

NO. Government not there yet –nor is the water industry there yet or yet to start providing the required strategic risk appreciation (EPSRC, 2010: Global Water Security- an Engineering Perspective)

Water Industry and the Big Society Goals

Water Industry Status

- Empowerment and engagement of the members of British society in its development
  - ✓Reasonable progress in right direction but more consultation on projects is also possible

- by increasing transparency and accountability
  - ✓Reasonable progress in right direction but more voluntary publication of corporate aims and how progress towards them meets public and stakeholder requirements would help

- Encouraging and supporting social responsibility
  - ✓Some progress in right direction but more engagement of public in schemes that have an immediate public impact would help

- Facilitating ‘smart strategic ‘government that can effectively manage the challenges of the global economy and globalisation
  - x Currently failing -on an issue that also affects billing and affordability risk (EPSRC, 2010: Global Water Security-an Engineering Perspective; Cave Review, etc)

How can the last Big Society goal be better addressed by the water industry and the government?

Characteristics of Water Industry Assets: A Changing Risk profile

- The water industry has to operate and maintain **substantial capital assets**
- Historically, capital costs were focus of cost reduction and incentivisation
- However, in future customer billing is vulnerable to operating cost increases: WLC has to capture these risks

$$NPV = \sum_{k=1}^{N} IC_k + \left(\frac{1-(1+i)^{-n}}{i}\right) \sum_{k=1}^{N} OC_k$$

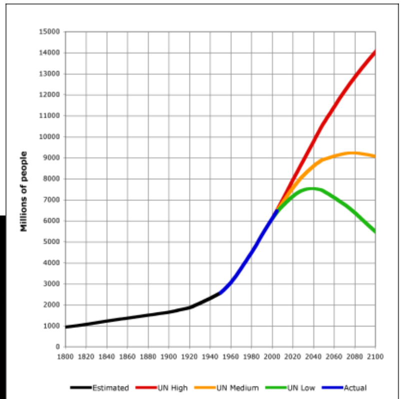
- Inflation
- Interest rate
- Discount Rate

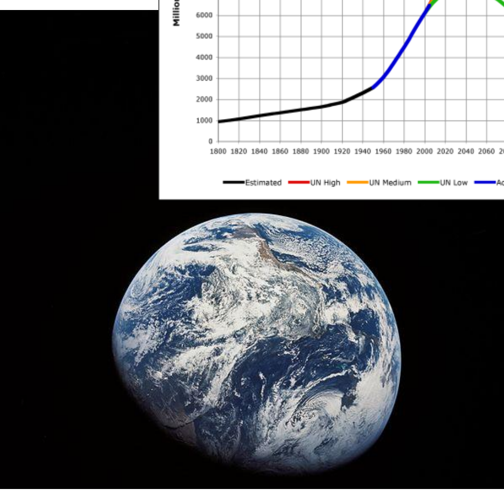
- CAPITAL COST
  - Assets are assumed to have on average a 40 year life; this is sound; but...
  - Assets **have seen regulation change during their active life**, requiring upgrades in asset capability as well as capacity (stranded asset risk put capital investment in jeopardy)
  - Risk averse WLC needs to include operating cost risk assessment scenarios

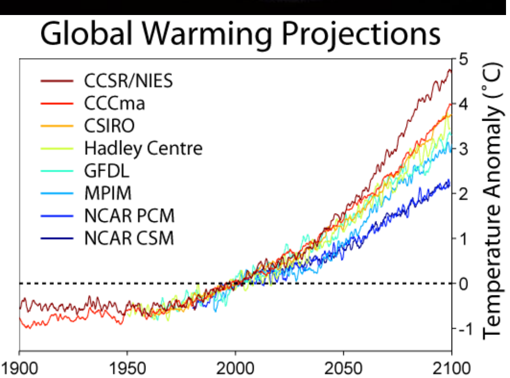
- OPERATING COSTS: Principal Risks over the average asset life – **to 2050**
  - Salaries
  - Energy (Electricity and fuel)
  - Chemicals

What are the Principal Global Macroeconomic Trends to 2050?

What long term risks are well established?







- **Population**: Will increase by 50% from now to 2050 and demand for food and energy will grow up to 2050 at least

- **Climate Change**: The ICPP 450ppm atmospheric carbon dioxide target threshold only offers 50% probability of restricting global warming to 2^{O}C; but even its target is currently not receiving the required investment, so attaining the lower 350ppm target is very unlikely

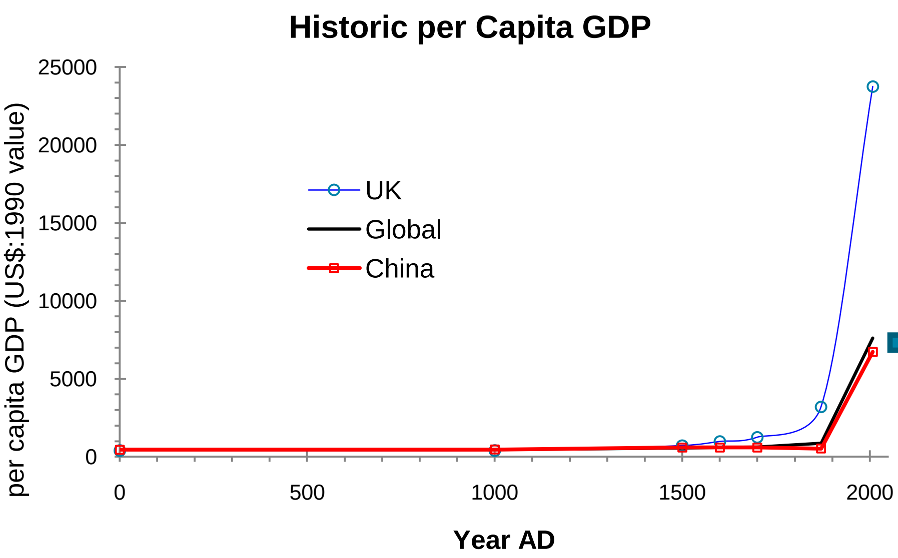
- **Common political goals across states**: Virtually all nation states are committed to competing on the basis of GDP and committed to increasing *per capita* GDP

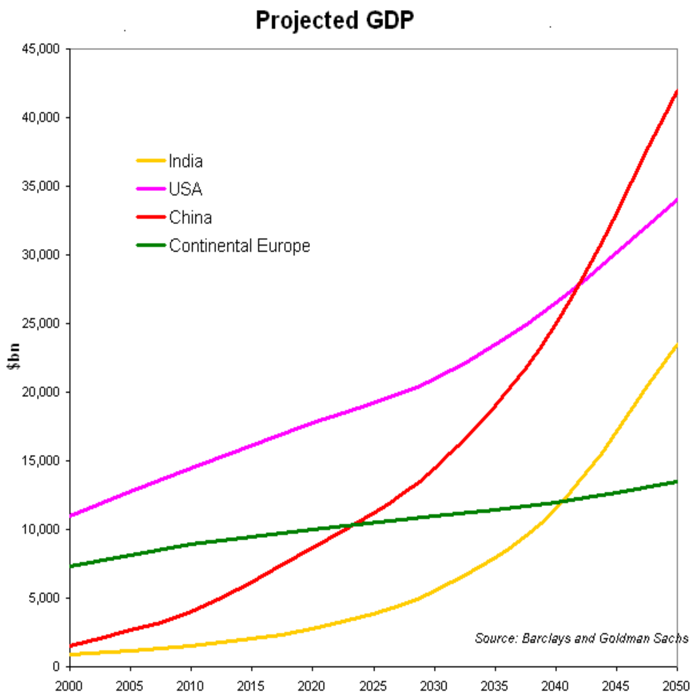
These trends are linked and feed back into each other

$$CO_2 \text{ Emissions} = \text{Population} \times (\text{GDP}/\text{Population}) \times (\text{Energy}/\text{GDP}) \times (CO_2/\text{Energy})$$

The Kaya Identity

How does competition in GDP terms link to other risks?





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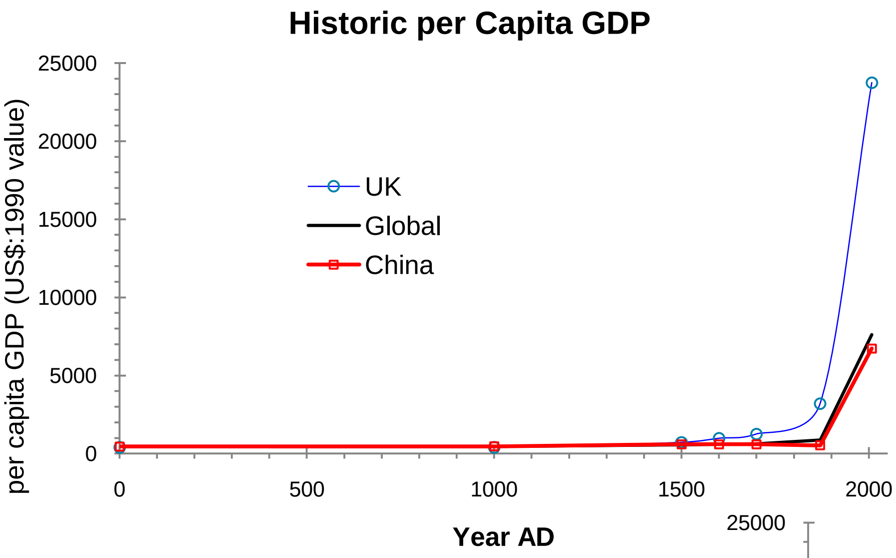
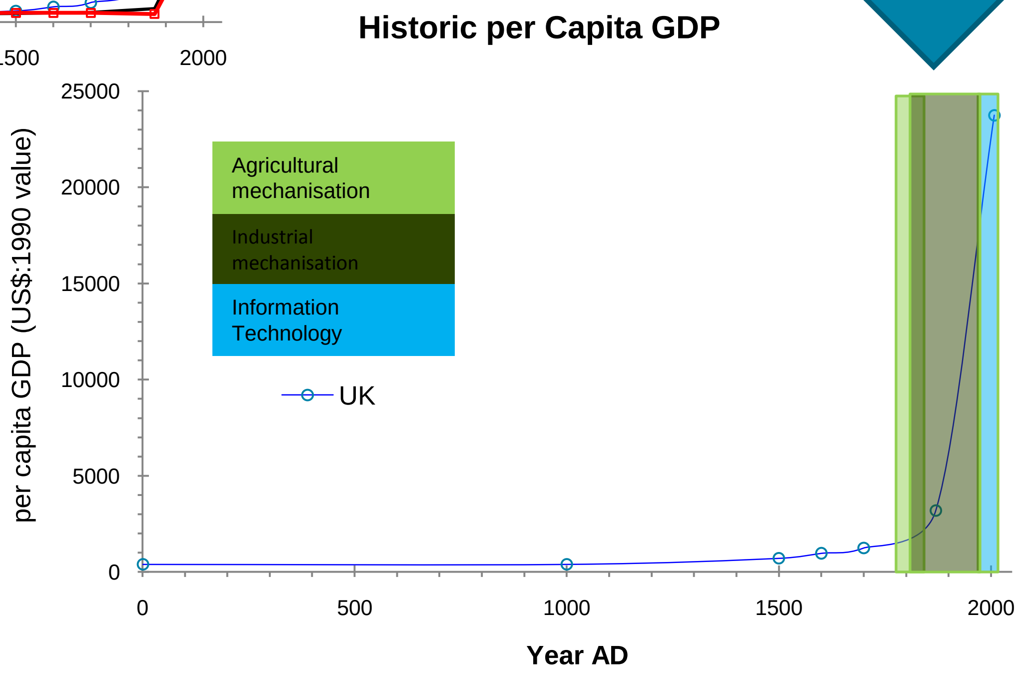
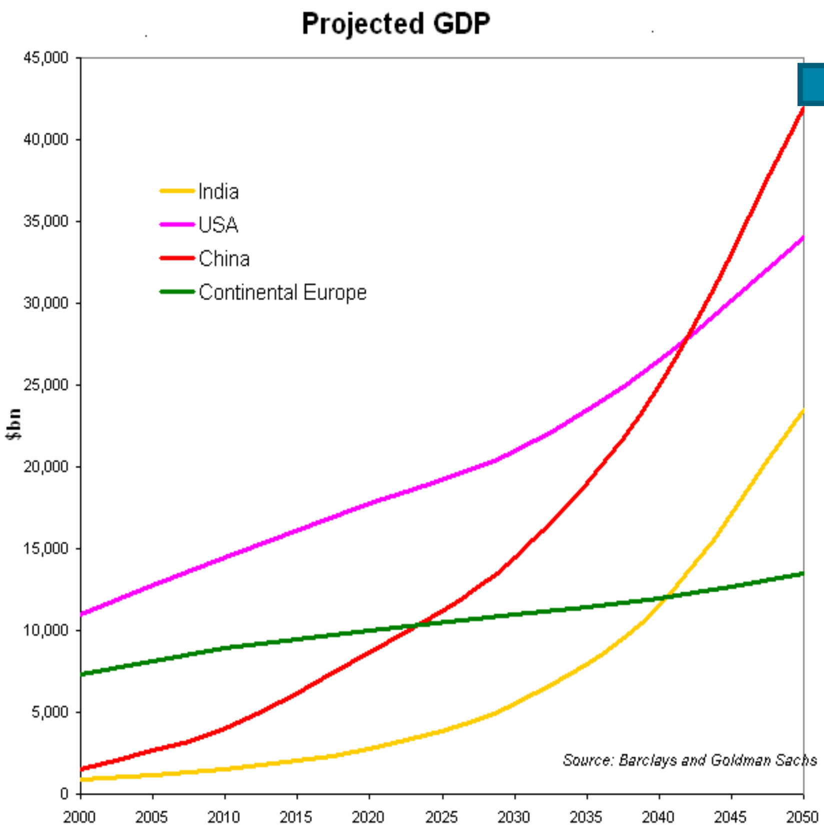
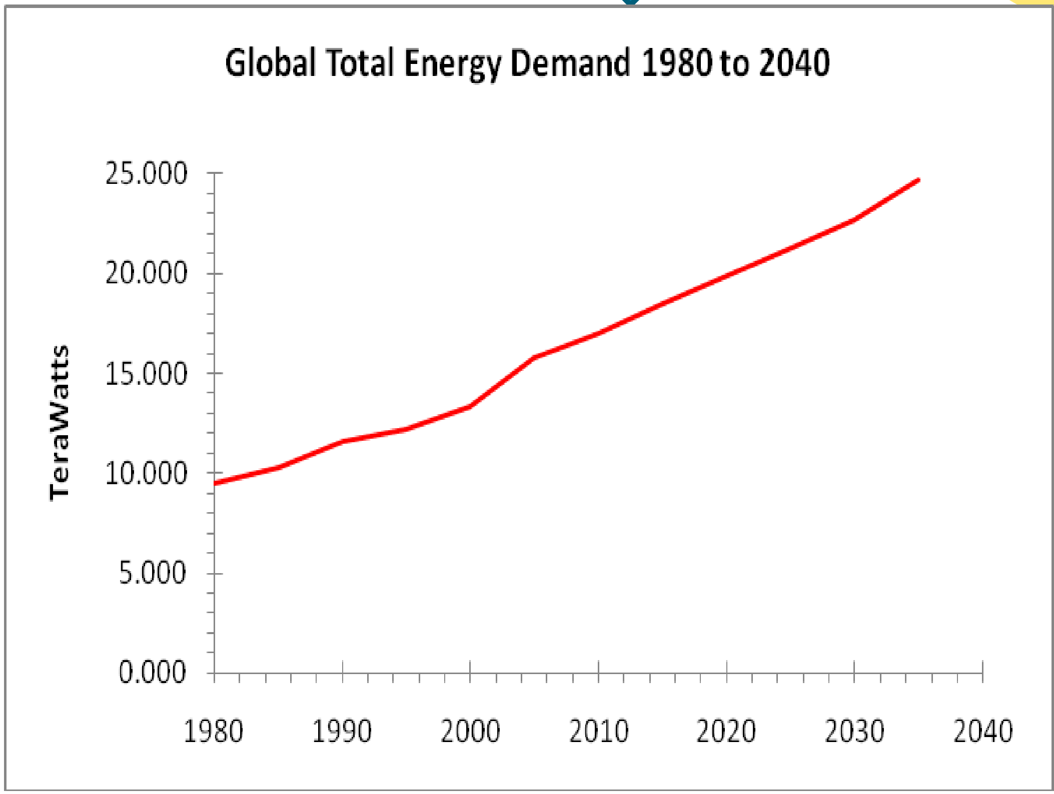




How are these issues linked?:
Emerging economies; GDP and global demand for energy





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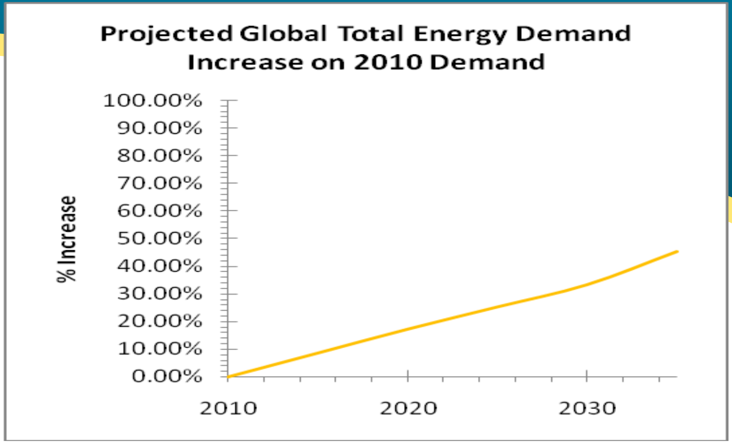
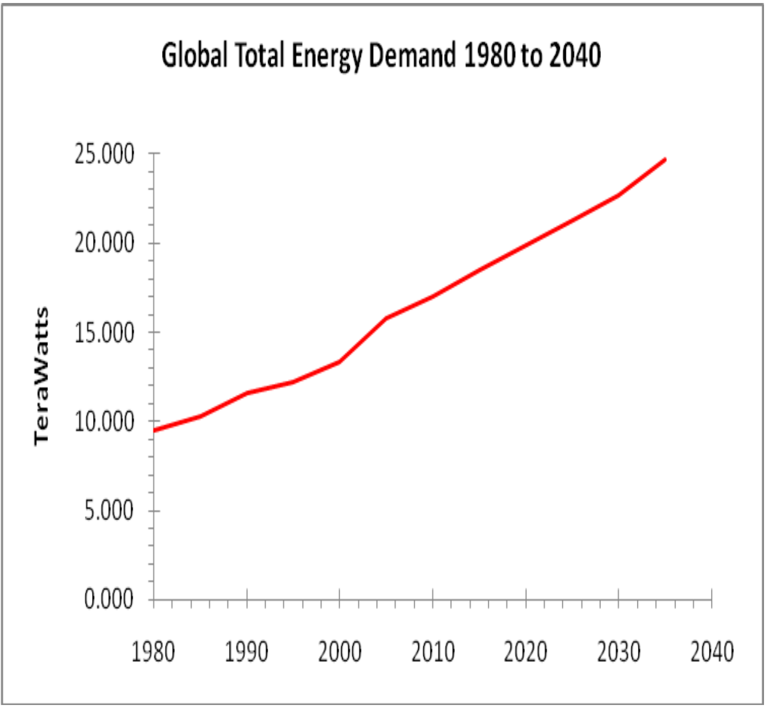
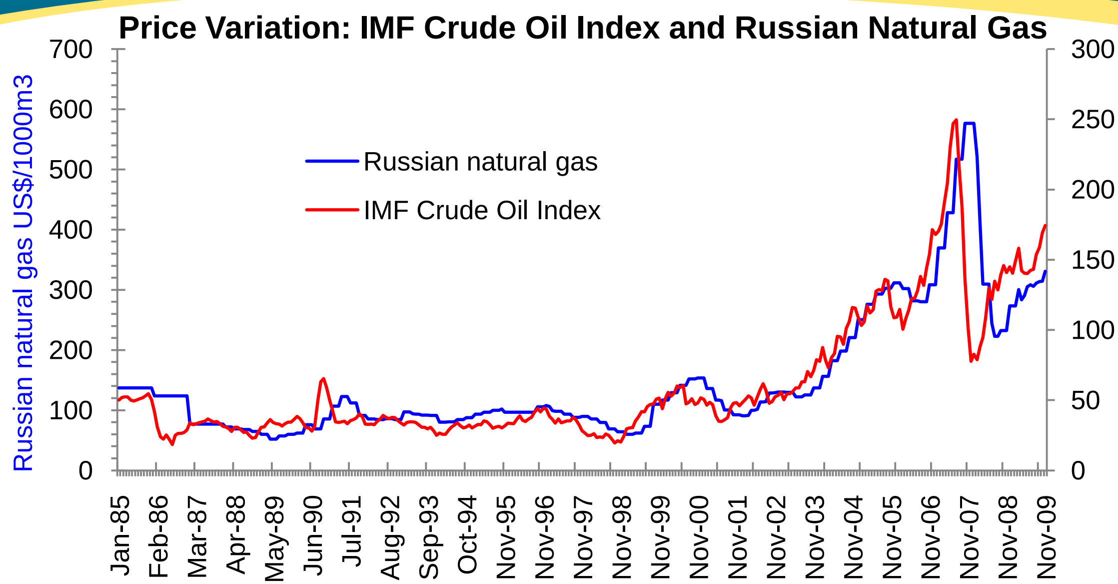
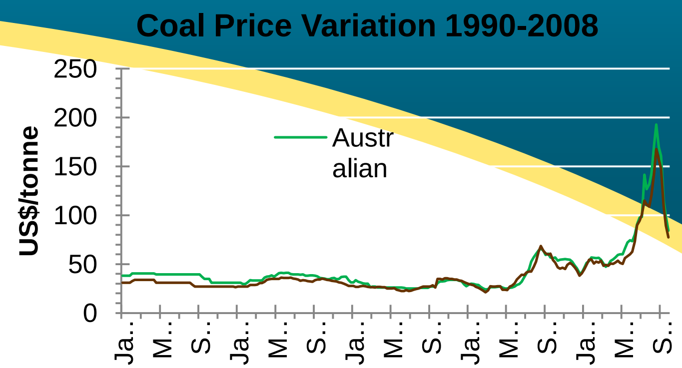


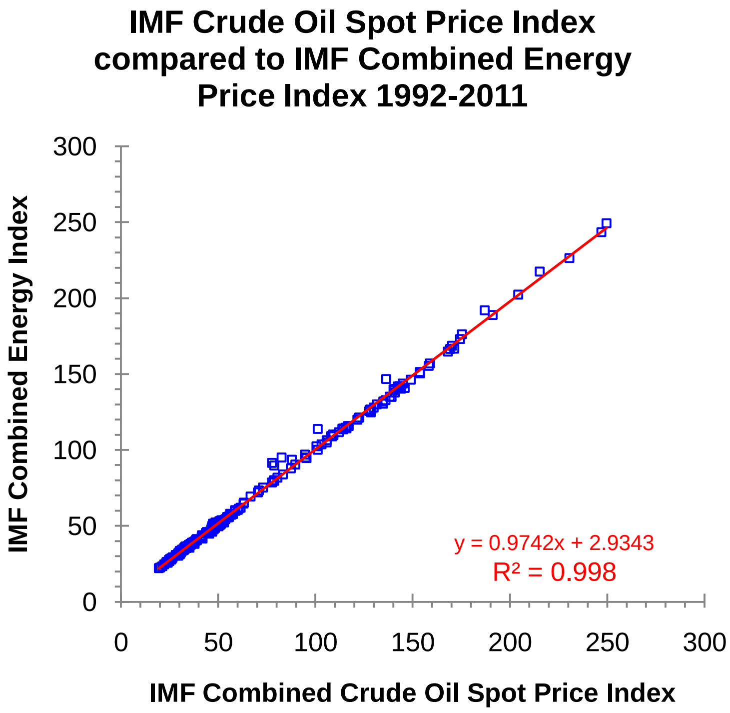


- Energy Efficiency has increased but there is increasingly more machine use; in leisure now as well as work
- Global energy is projected to exceed supply (US-EIA (2010); International Energy Agency(2010))
- International Energy Agency: US$26trillion of extra electricity generating capacity is required by 2030
- An extra US$10.5trillion will need to be spent to decarbonise the global electricity generating capacity so that it is aligned with the IPPC 450ppm threshold
- Increased electricity demand will increase emissions otherwise

How are these issues linked?:
GDP; global demand for energy and energy price inflation

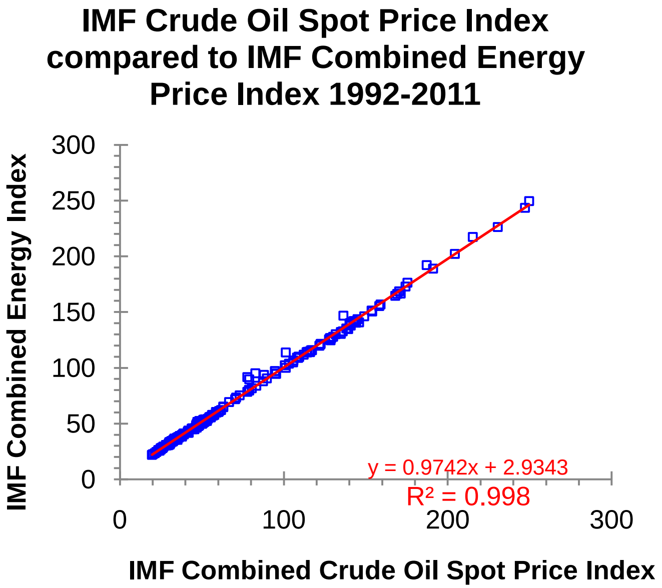


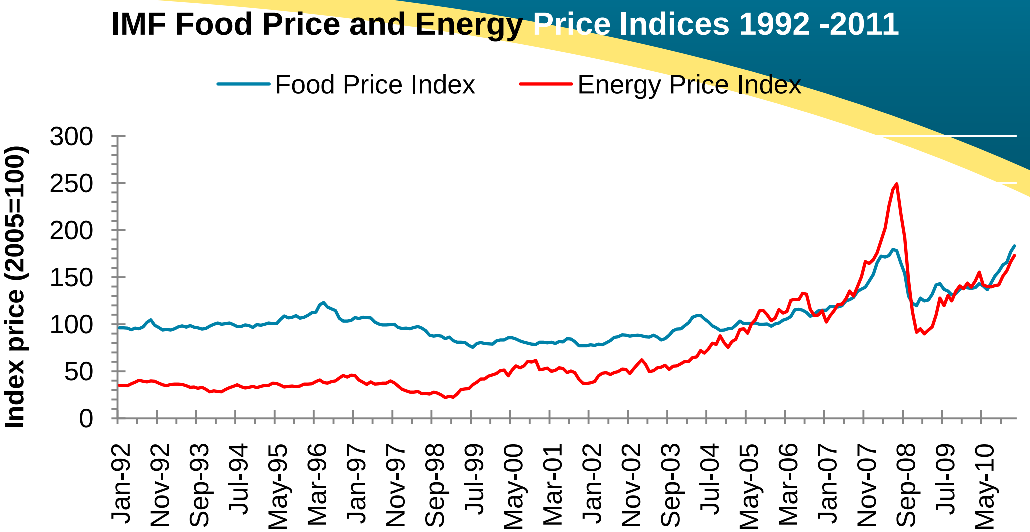


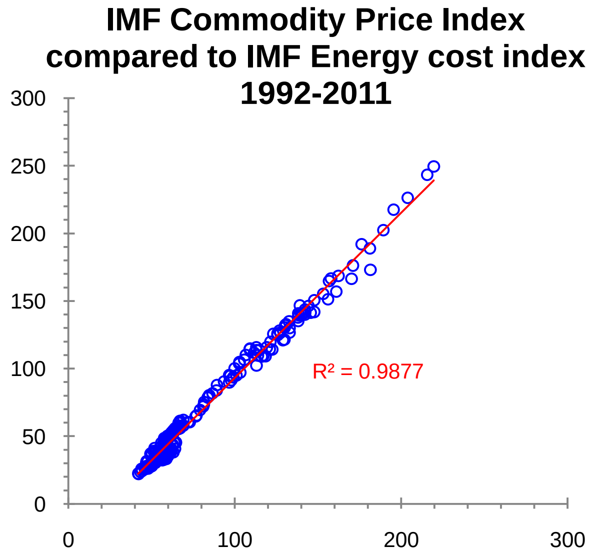


- UK electricity generation is now mainly natural gas fuelled and will become increasingly so
- Other fossil fuel price trends track oil when supply outstrips demand: some gas contracts are index linked to oil (Russia; Norway)

How are these issues linked?: Energy price inflation – downstream effects







- ○ Energy price increases affect food price
- ○ Recent energy price increases have exerted strong upward pressure on the overall cost of living
- ○ Consequence is high risk of long term wage price inflation

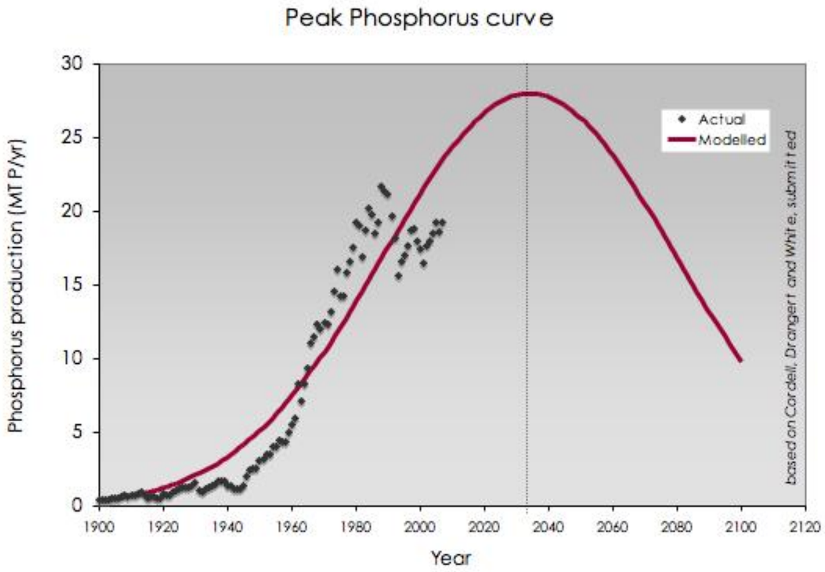
How are these trends interlinked?
Population and Food demand and Price

Global Population and Food

- ❑ Price Trends
- ❑ Risk: Demand will outstrip supply – long term food price inflation
  - UN World Food Programme estimates food production needs to increase by 70-100% by 2050 to meet demand
  - Average food profile changes – average *per capita* increases and livestock double
    - Livestock presently produces18% of global GHGs; 37% of CH_4, 65% of N_2O
  - Climate change is increasing agricultural (food production) losses
  - Energy and Food competing for land: The UN projections of land requirement do not allow for unrestricted competition for land with bio-fuel crops
    - *In 2009 26% of U.S. grain crops went to biofuels*
    - *World Bank report: Biofuel crops responsible for 75% of global food price increases in 2008*
  - Land-take: 90% of the land that will meet that need is *already under agricultural production*
  - This implies intensive farming and fertiliser demand *will increase significantly*

How are these trends interlinked?: Phosphorus and Food Production and the UK water footprint

Food; Fertiliser and Phosphorus



- Ore prices up 700% in 2007-08
- P containing fertiliser prices up 300%
- Governments already moving to regulate P: China has placed a 135% tariff on P reserves
- *Peak Phosphorus 2034*

Production of artificial fertilizers has a high demand

When energy costs increase, fertiliser costs increase

- P essential to food production
- P in sewage will become a recoverable strategic resource

Most (67%) of the UK water footprint is virtual – it is associated with UK imports and water scarcity in the producing country risks increasing import prices or restricting production

- This includes food and is another food price inflation driver

How are these trends interlinked?:
Long term Investment Risk Summary 2010 -2050

Water Industry Risks

- Salary inflation risk
- Energy and electricity cost inflation risk
- Chemical cost inflation risk
- OPERATING COSTS UNDER significant inflationary pressure
- Such strong upward cost pressure on operations will raise customer costs and billing
- CAPITAL cost risk from stranded assets: carbon footprint and resource recovery converts high energy intensity assets into an OPERATING RISK BURDEN

- **Short term Regional risk: U.K.**
- Oil and energy price shock likely in AMP5 or AMP6 (probably AMP5)
- Potential Supply shock consequences: stagnation in GDP growth combined with inflation as cost pressures mount and combine
- STAGFLATION risk depending on how central banks/Government handle economy

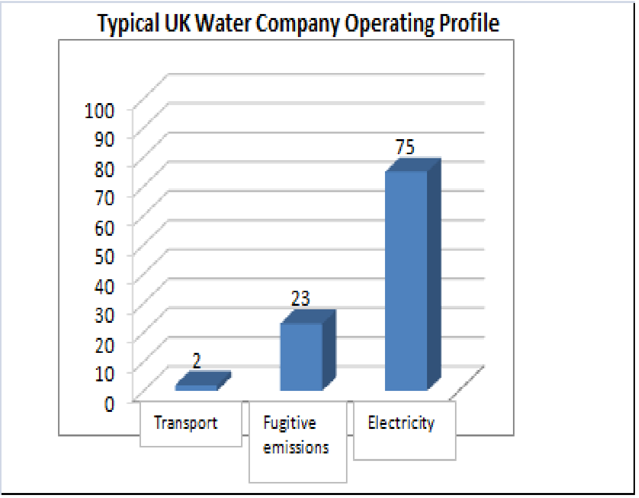
How do we continue growing GDP sustainably (commerce and climate)

How do we continue to increase GDP while reducing price risks from population growth, energy demand and climate change to the water industry?

Exploit Resource Recovery Opportunities

- Increase energy efficiency (reduce electricity and fuel demand)
- Decarbonise: maximise **renewable energy recovery** associated with our processes
- Extend assets to allow future recovery of **strategic resources** (*e.g.* Phosphorus)
- Defray operating cost risks (**Extend assets to recover energy and allow future recovery of high value products**)

The Water Industry and its Opportunities:
Energy Resource Recovery is a foundation for product Resource Recovery

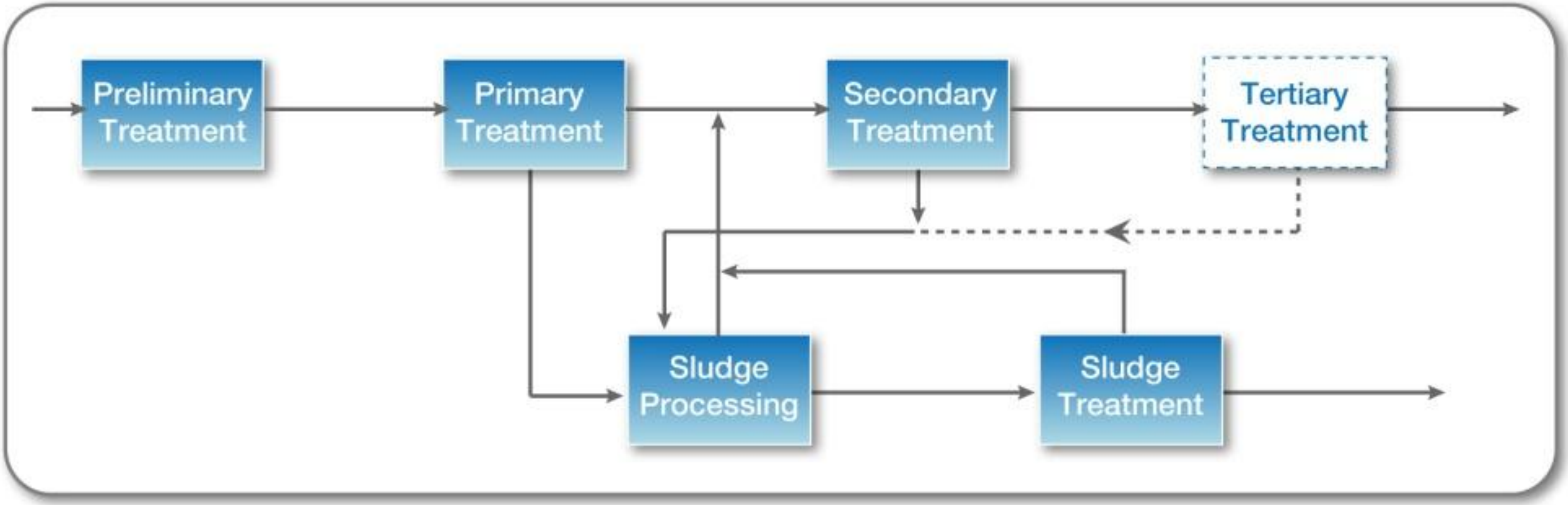


- Reducing carbon is not just reducing carbon – its reducing operating cost risk from energy prices and carbon taxes

- FOLLOW THE ENERGY
- Principal Renewable energy sources – Mass flux:
  - Calorific value of solids collected
  - Heat in sewage

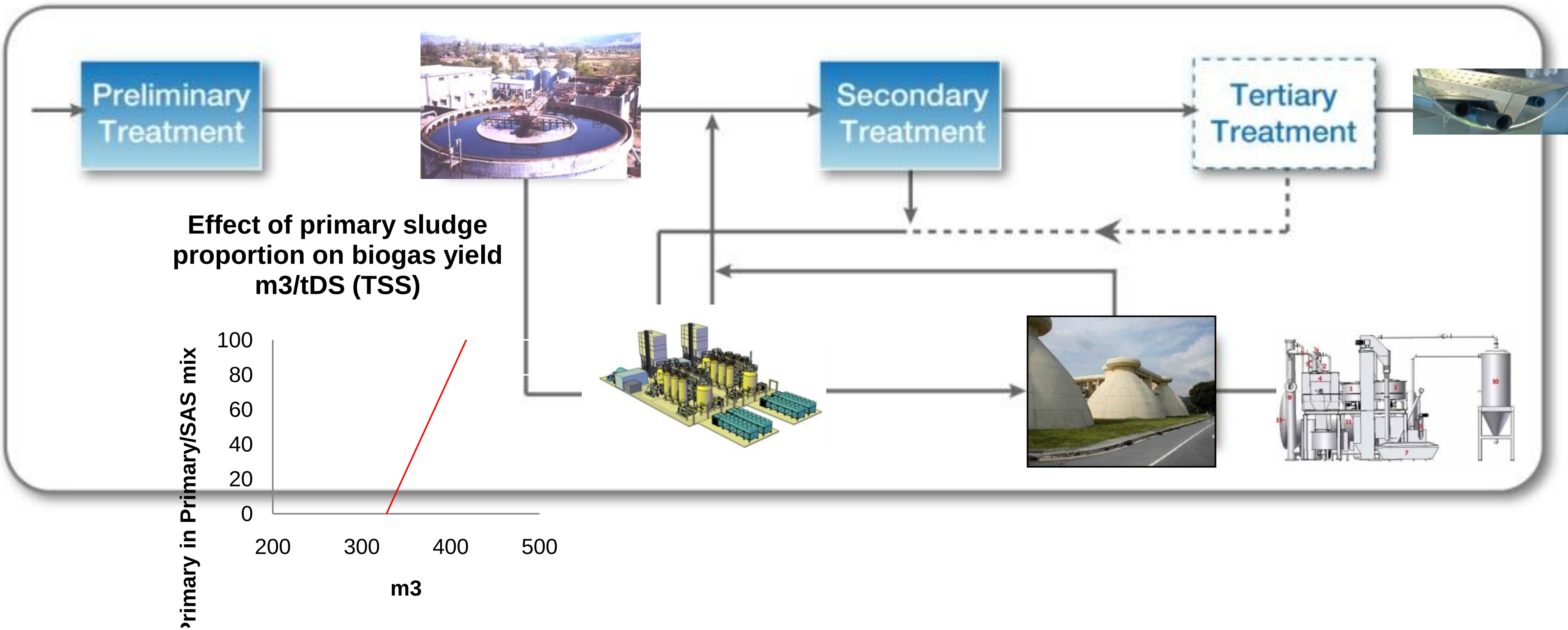
- FOLLOW THE PRODUCT POTENTIAL
  - Solids processing for energy and material resource recovery
- Sewage sludge is a Phosphorus source and a source of high value products; from hydrogen to butanol

Maximising Indigenous Resource Renewable Energy Recovery



- Maximise calorific value upstream while reducing power demand
  - Enhanced Primary treatment: 80%+ solids capture
- Maximise calorific value immediately upstream
  - Enhanced Digestion (Thermal hydrolysis/EH/ultrasonics)
- Maximise calorific value downstream and heat recovery
- Digested Sludge Gasification

Maximising Energy Recovery based on existing assets



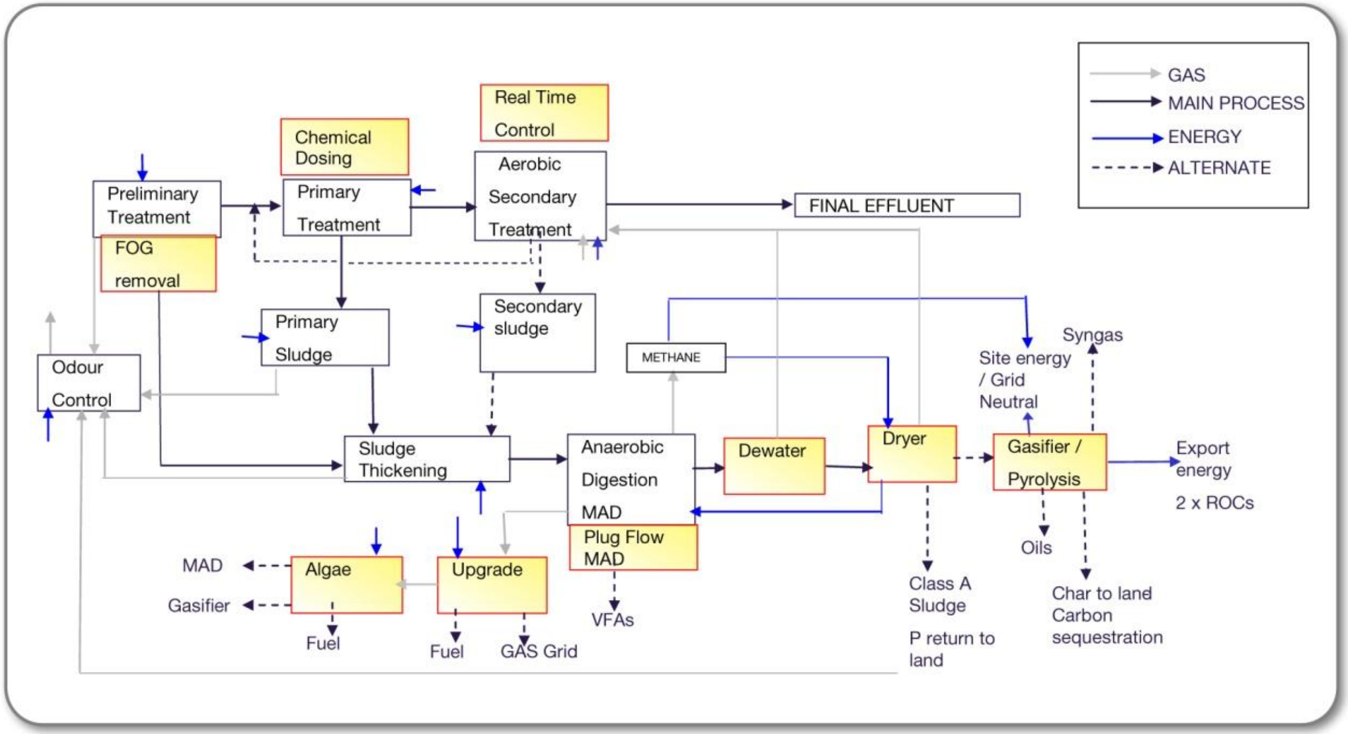
- Enhanced Primary treatment: 80%+ solids capture with FOGs (Boost biogas yield 800m3/tonne FOG)
- Enhanced Digestion (Thermal hydrolysis: up to 70% increase in biogas production rate) (Biogas ROCs; RHI)
- Digested Sludge Gasification: 275-600kWh/tDS plus recoverable heat (2ROCs; RHI)
- Final Effluent heat recovery (heat exchange)

Providing Capital Efficiency

- <u>How to Maximise Capital Efficiency</u>

Many processes can have their useful asset life extended to the full civil asset potential.

Opportunity - Build on the foundation provided by the existing assets



- An Enabling Technology approach – selection of process technologies that can be integrated with existing assets that have a viable remaining life and which extend the capacity and capability of those assets

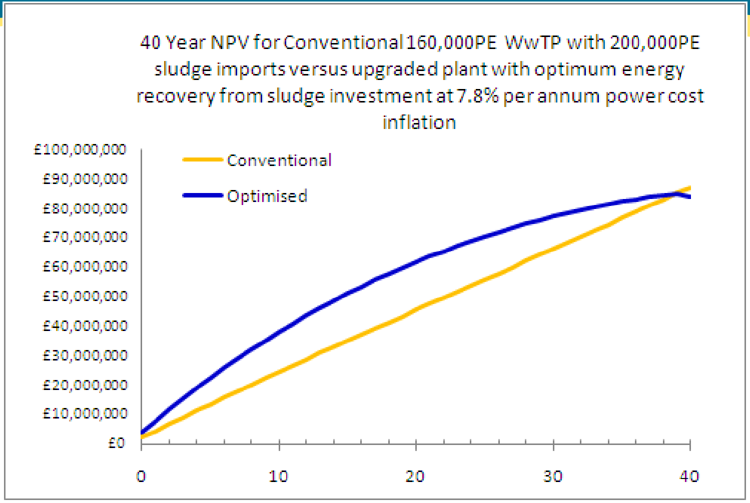
Managing Water Industry Investment Risk to 2050: taking the risk out of the cost estimates

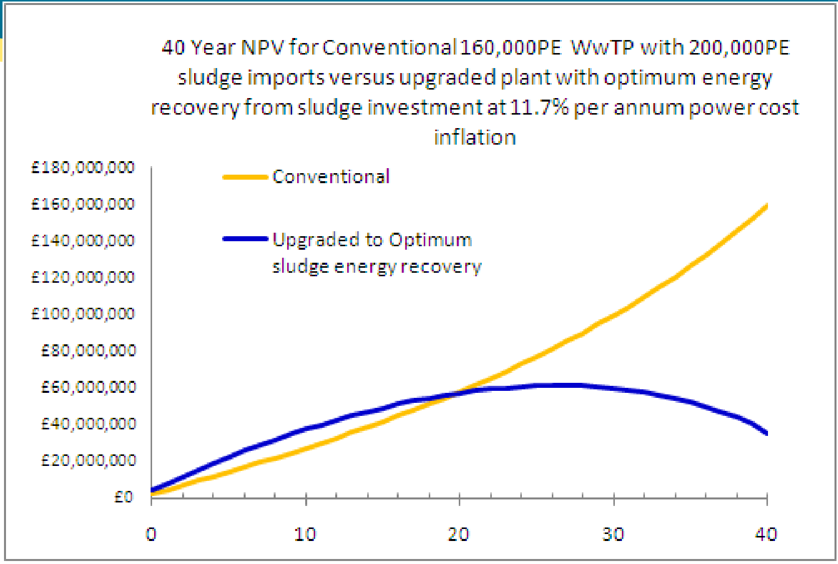
- Lowest risk capital solution and lowest operating risk will be provided by a risk capturing 40 year whole life cost

$$NPV = \sum_{k=1}^{N} IC_k + \left(\frac{1-(1+i)^{-n}}{i}\right) \sum_{k=1}^{N} OC_k$$

- Carry out risk scenarios – sensitivity analysis
- Don't make artificial assumptions for the WLC calculation (*e.g.* OFWAT current):
  - Carry out sensitivity analyses for:
    - ✓ Power cost inflation (UK: 1970-2000; power cost inflation averaged 11.7% *per annum* versus 7.8% *per annum* RPIX – *this factor is even underestimated historically*)
    - ✓ Salary and chemical cost inflation
  - If your assumptions about the operating cost risk are wrong - your discount rate assumptions are also likely to be erroneous (further under-pricing value of operating cost reducing schemes)
  - During recession periods - do not underestimate cost of capital- if in doubt- establish sensitivity

Managing Water Industry Investment Risk to 2050: providing accurate information





- **CASE STUDY**: Upgrading 160kPE WWTP with 200kPE sludge imports to maximise renewable energy from sludge
- Inflation assessments should be subject to sensitivity analysis
- The assumption that industrial electricity price inflation follows RPI is wrong
- For example, historically, (for 1970-2000 which includes the OPEC price shock); UK RPI averaged 7.8% *per annum* while industrial power cost inflation averaged 11.7% *per annum*
- Applying the RPI assumption would lead to the investment being falsely rejected -
- Because- at the real power cost inflation of 11.7% the investment is paid off in 20 years and in the remaining 20 years of the upgraded WWTP reduces NPV by £123MM through reduced electricity costs
- By following the RPIX assumption, extra operating costs worth £123MM in NPV terms are incurred – how much is passed to the customer?

Filling the current water industry Big Society responsibility gap delivers the water industry multiple benefits

- Only a 20-30% reduction in WwTP electricity demand is achieved by energy efficiency measures

- Wastewater treatment can only achieve energy neutrality through generating the remaining 70-80% of site demand through renewable energy

- OFWAT say they support renewable energy generating measures which are based on indigenous water industry opportunities

- Maximising energy return from sewage sludge and heat recovery from sewage are indigenous water industry opportunities

- Investing in WwTPs to maximise renewable energy recovery is compatible with developing WWTPs to material resource recovery, beginning with Phosphorus

- This is strategic sustainable investment that reduces operational cost risk to bills and addresses the global risk profile to 2050

Resource Recovery: Energy and Potential Products from Tertiary treatment

- **Algal BNR system** for BOD, COD and N polishing and P removal and recovery

Confine the algal activity to the sewage works and harvest it for beneficial reuse

- Activated Lagoon

- Waste algal mass to digestion for Phosphorus (P) recovery and extra biogas or biodiesel
- Algal biomass co-digestion with sewage sludge -Biogas yield similar to that for SAS
- P recovered from digestion process
- Future potential to sell algal biomass to algal biodiesel producers and digest their waste algal biomass for a service charge; again recovering P
- Beneficial re-use of carbon dioxide from digesters if biogas upgrading takes place- pumped to algal pond diffusers

Resource Recovery: Maximising the Resource Recovery Potential of Anaerobic Digestion

- **Serial Thermophilic (55^{O}C)Digestion**

. Run tanks in series (4 gives approximate plug flow) and upgrade mixing to optimal.

- Requires sludge-sludge heat exchangers in addition to sludge-water heat exchangers
- Waste heat collected in heat transfer ring main drawing waste heat from digested sludge gasification and from final effluent for sludge drying, which is supplemented by biogas fired boilers. Excess biogas remains on large plants for other end-uses

- Benefits: Increased pathogen kill / increased biogas production rate /or increased throughput on same plant volume
- Benefits: Platform for product recovery and its development
  - VFAs from acidogenic tank, for onsite activated sludge Bio-P removal
  - VFAs to a sidestream *Clostridium acetobutylicum* 37^{O}C fermenter will allow bio-butanol production. Present butanol value $1300/tonne
  - VFAs for recovery and sale – bioplastics precursor

The face of the future? – high value wastewater treatment as a ‘green’ production industry

<u>Potential Products</u>

- Algal biomass - Lipids – Algal Biodiesel (renewable fuel genuinely without competition for food production for land or Phosphorus)

- Methane (for heating/energy /methanol production/ electricity generation/ methane grid export)
- Carbon dioxide (chemical ;or for algal biomass)
- Volatile Fatty Acids (on –site BNR and/or chemical feedstock, including Biopolymer/bioplastic feedstock)

- Phosphorus (strategic resource for food production)
- Nitrogen/ammonia/nitrates (fertiliser sand explosives/ chemical feedstocks)
- Methanol (from methane – physical/chemical transformation or biotransformation) (Vehicle fuel or medium value chemical feedstock)
- Butanol (sidestream Clostridial fermentation) (Vehicle fuel or high value chemical feedstock)
- Acetone (sidestream Clostridial fermentation) (high value chemical feedstock)
- Hydrogen (Syngas and/or anaerobic digestion) (clean fuel/ chemical feedstock)

Other possible recovery: rare earths/ selected metals

UK Water industry delivering to, and benefitting from, the responsibilities of a Big Society approach

BIG SOCIETY

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- ➢transparency and accountability
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❑Providing 'smart strategic 'government
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