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Carbon Accounting & Groundwater Asset Management

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Is carbon accounting important?

How do we do it?

How will it develop?

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Is carbon accounting important?

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“The water industry is on the **front line** of climate change”

→ Sir John Harman, Chairman, Environment Agency

Background →

- Water sector regulators:
  - Defra, Ofwat, CCW, Environment Agency
- Defra “Future Water” national water strategy 2008
  - Focus on climate change adaptation and mitigation
  - CO2 reduction commitment
- Regulators united on importance of new Water Strategy
  - But no consensus on practical implementation
  - No clear strategy for balancing emissions, quality and price – except for inclusion of Defra Shadow Price of Carbon (SPC)

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Carbon accounting: how we do it

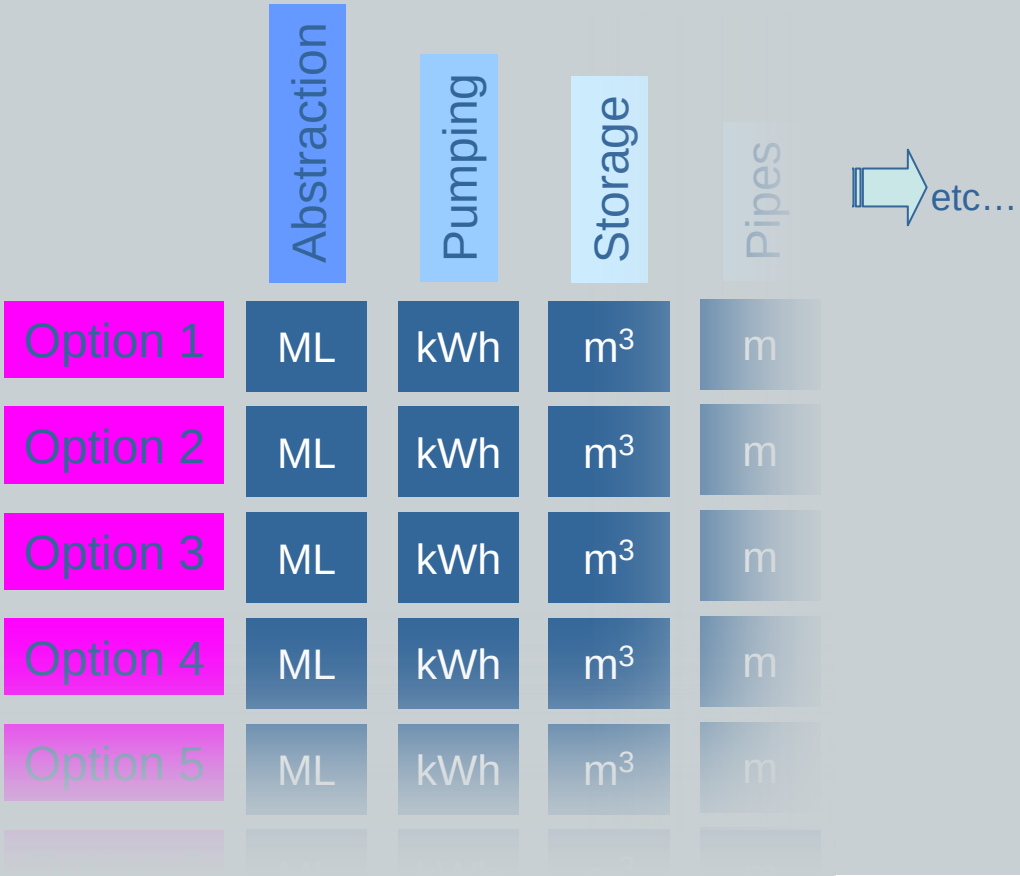
Objectives →

- To estimate the carbon effects of different choices at the early selection stage; i.e. before the design has been finalised
- To compare the CO_2 profile of processes, to help process selection
- To quantify the CO_2 impacts of designed schemes

Carbon Footprint Components →

- Construction (Embodied CO_2)
  - Materials
    - Civil
    - M&E
  - Construction energy (inc vehicle movements)
- Operational
  - Electricity consumption (pumping + plant)
  - Other energy consumption
  - Consumables (chemicals etc)
  - Direct emissions (chemical and biological processes)
  - Transportation

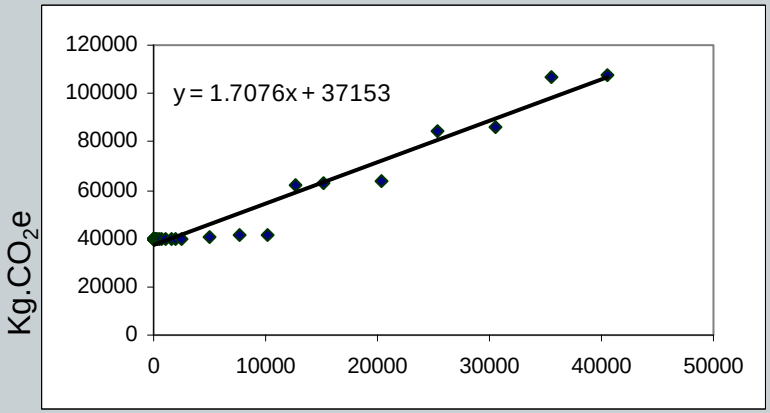
Identify capital components →



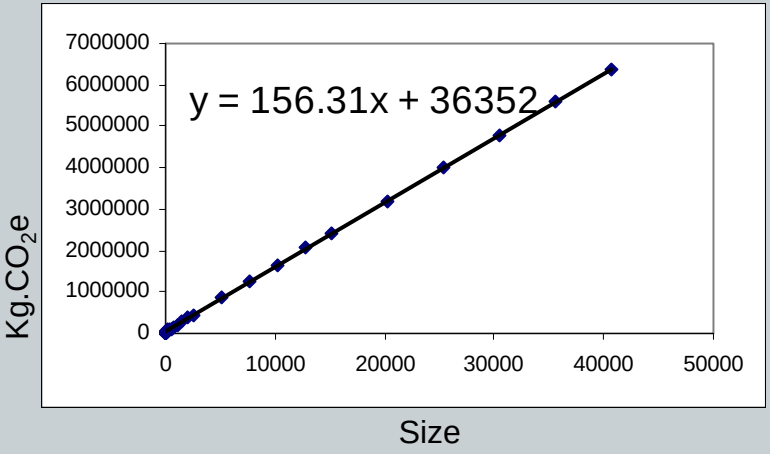
database of asset types (or activity types) and sizes in the investment plan…

Results – individual process →

Capital (embodied) carbon



Operational carbon per annum



Every process has detailed models to derive the size:CO_2e relationship.

Models can include construction, capital maintenance, and process operational CO_2e as required.

In this example the relationships are linear but in others they may be curves.

Individual process relationships are used to model whole works…

Model Detail →

Example of construction model, based on part of a borehole abstraction and pumping station

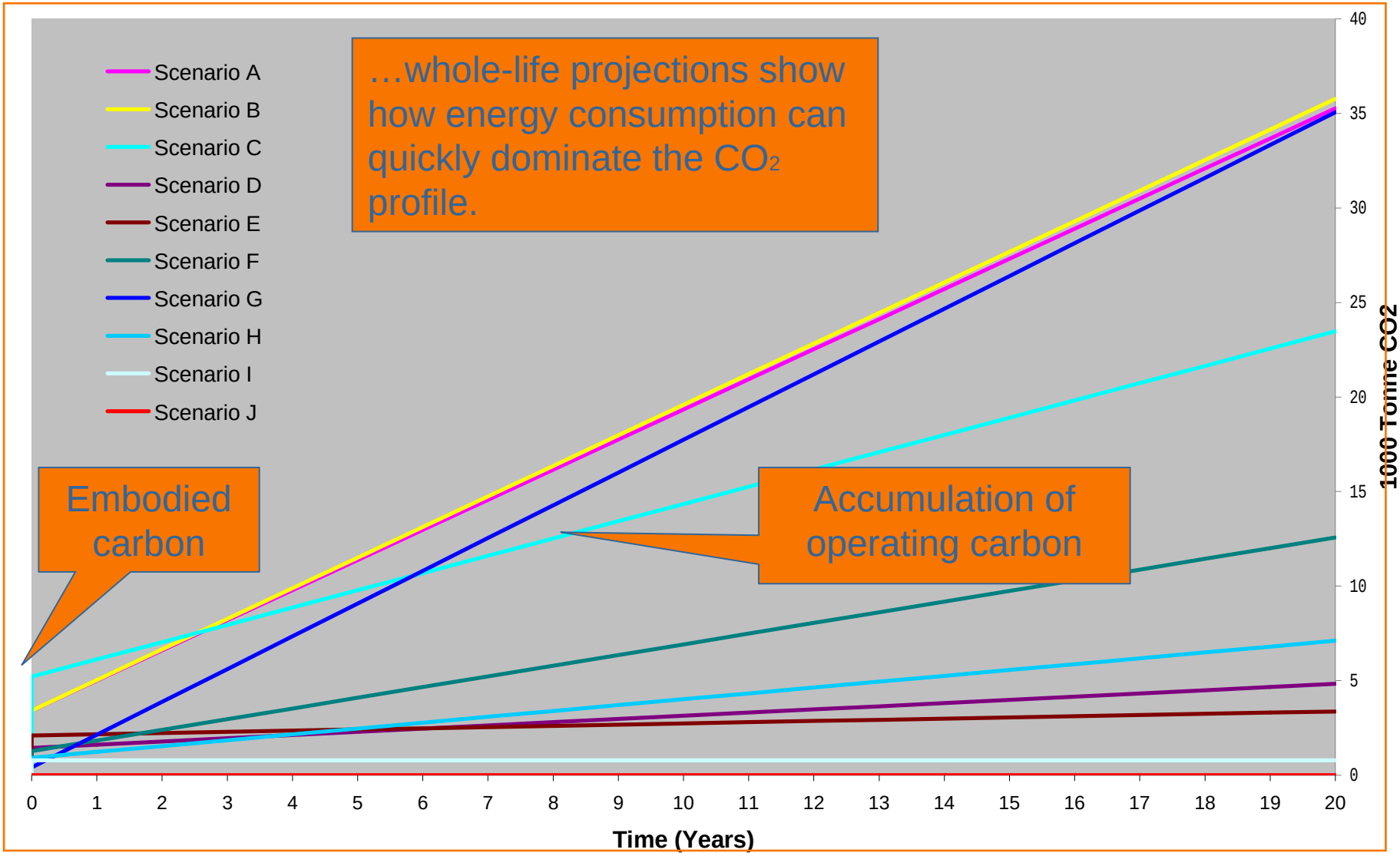
- **Abstraction** e.g. 5MLd
  - Process civil structure
    - Borehole casing
      - Stainless steel
    - Headworks
      - Precast concrete
      - In-situ concrete
      - Steel reinforcement bars
      - etc…
    - etc…
  - etc…

	Dimensions	Volume of material	Mass of material	GWP of material*	GWP $kgCO_2e$
Process civil structure					
Borehole casing					
Stainless steel	Diameter, length, mass per m		500kg	2.134**	1067
Headworks					
Precast concrete	Segment volume		500kg	0.215**	107.5
In-situ concrete	Volume m3		500kg	0.134**	67
Steel reinforcement bars	Diameter, length, mass per m		500kg	1.720**	860
etc…					
				Total	2100
					etc…

* In $kgCO_2e.kg^{-1}$

** University of Bath inventory of carbon and energy

Results (2) →


Scenario A
Scenario B
Scenario C
Scenario D
Scenario E
Scenario F
Scenario G
Scenario H
Scenario I
Scenario J
…whole-life projections show how energy consumption can quickly dominate the CO_2 profile.
Embodied carbon
Accumulation of operating carbon
1000 Tonne CO2
Time (Years)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0 5 10 15 20 25 30 35 40

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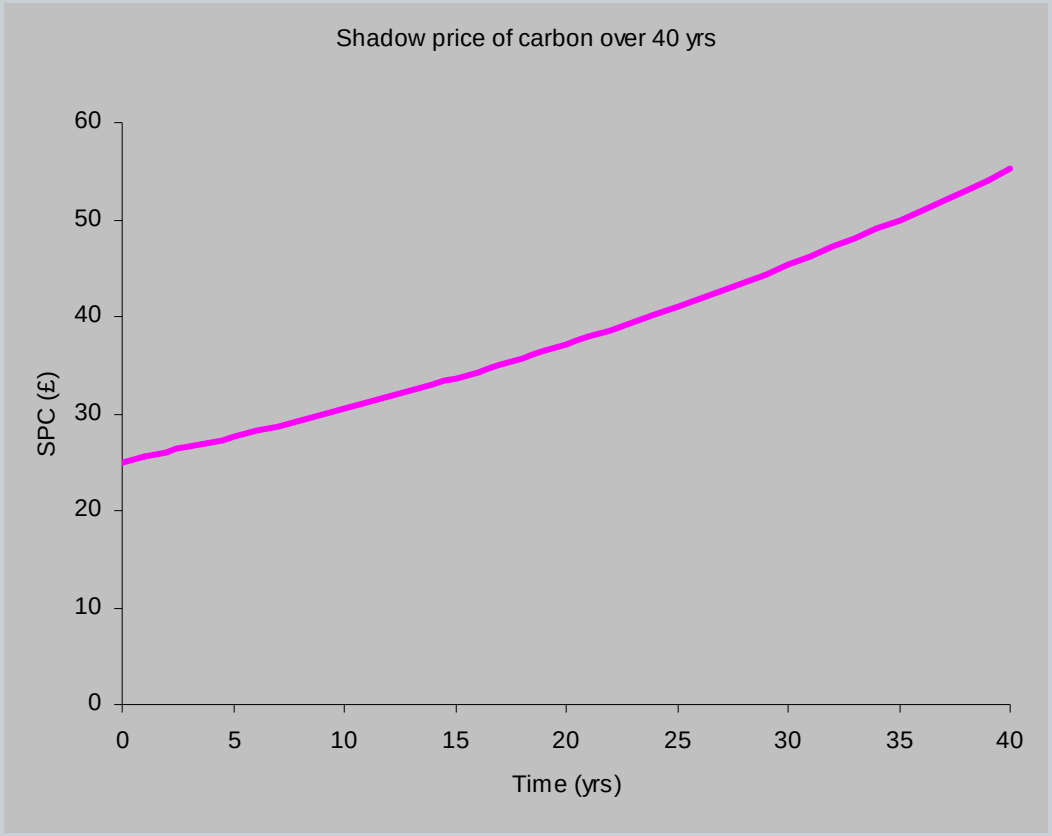
Where are we and how will CFP develop

Defra Shadow Price of Carbon →

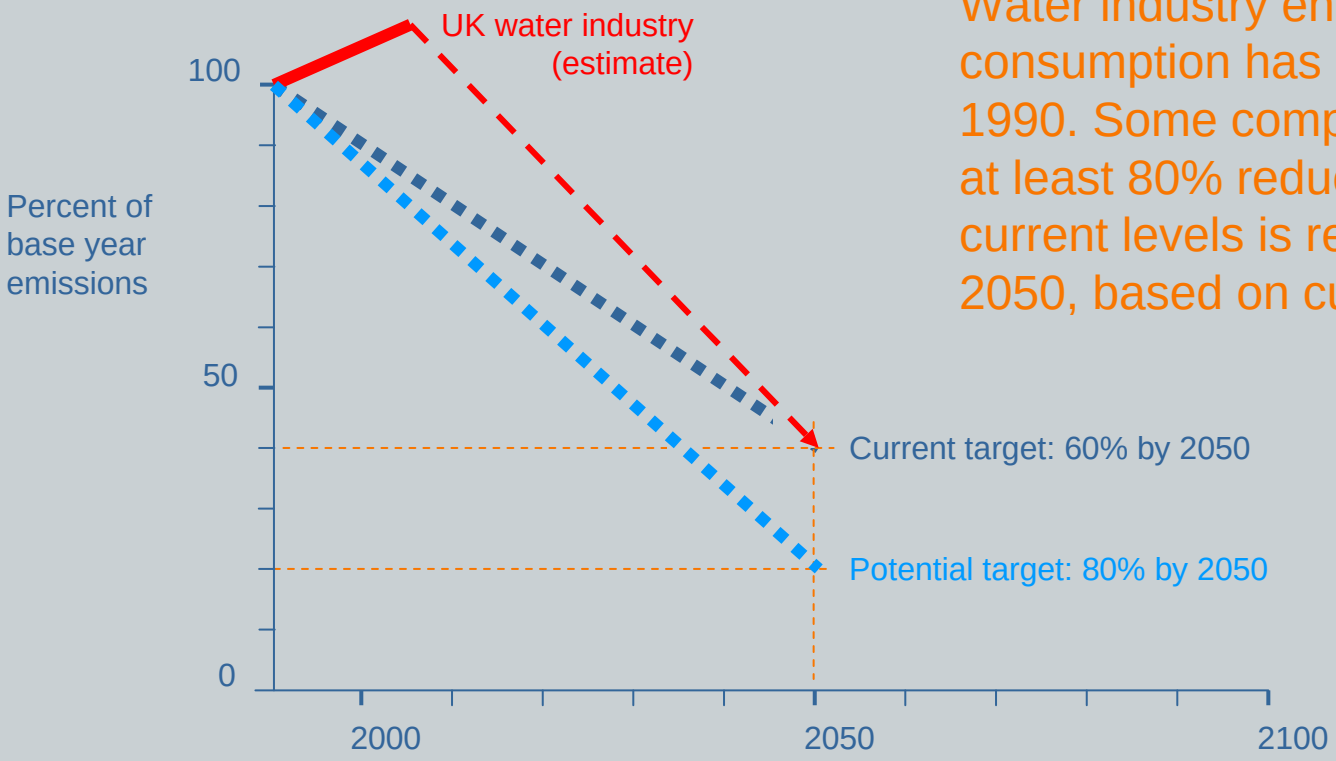


Starting value £25.tCO_2e^{-1} in 2007

Appreciates by 2%pa (current) to reflect increasing harm of continuing emissions, and desire to reduce them over time

The appreciating value of the SPC has a significant effect on the costs of carbon over extended periods

Carbon reduction commitment →



Water industry energy consumption has risen since 1990. Some companies estimate at least 80% reduction on current levels is required by 2050, based on current targets

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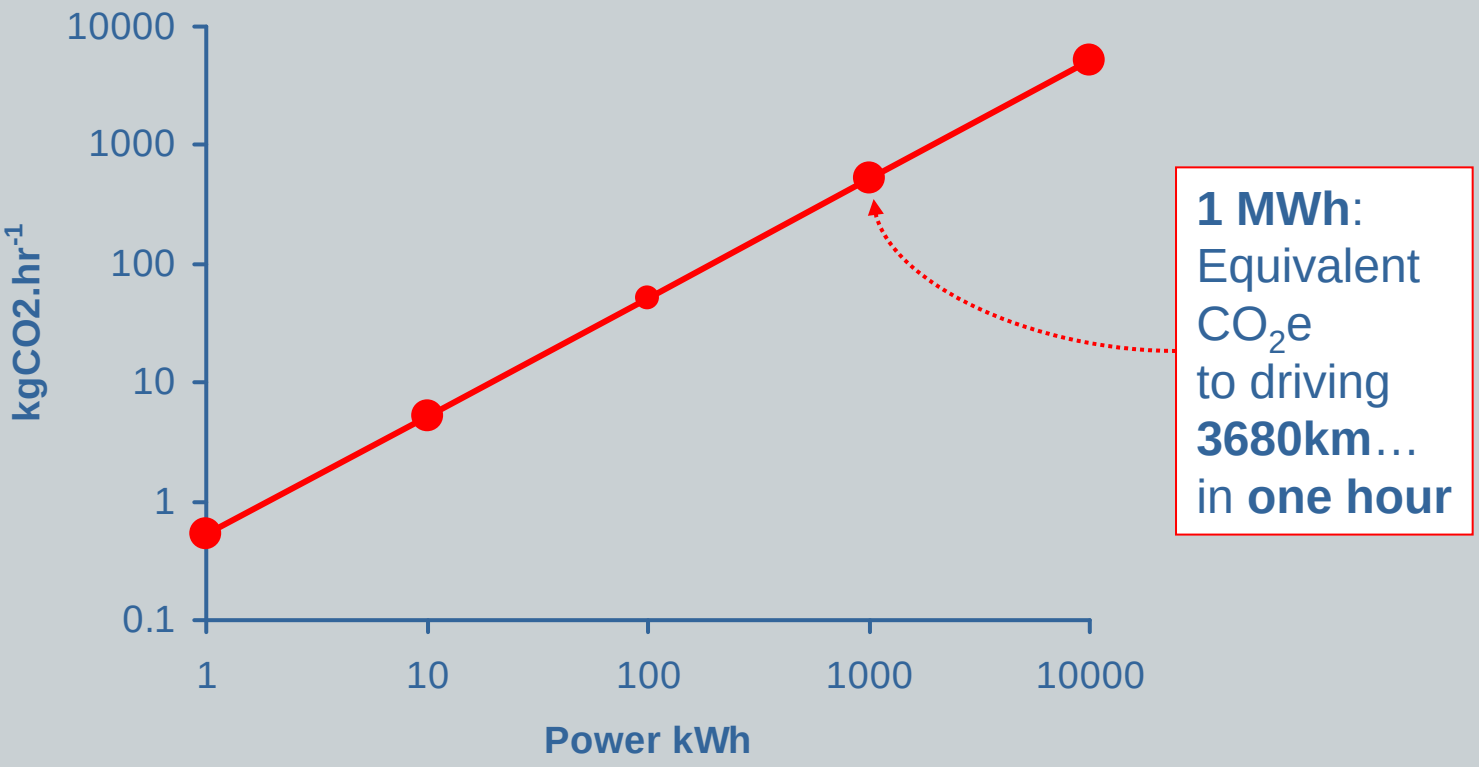
Energy focus →



Can you eliminate energy consumption from your processes?

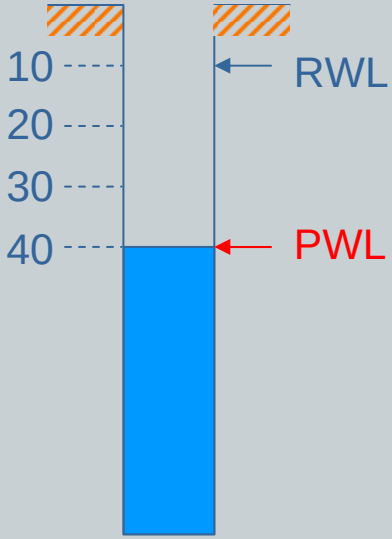
@0.523kgCO_2e.kWh^{-1} and 0.142kgCO_2e.km^{-1}

Application to Groundwater Asset Management

Borehole Scenarios →

Scenario 1

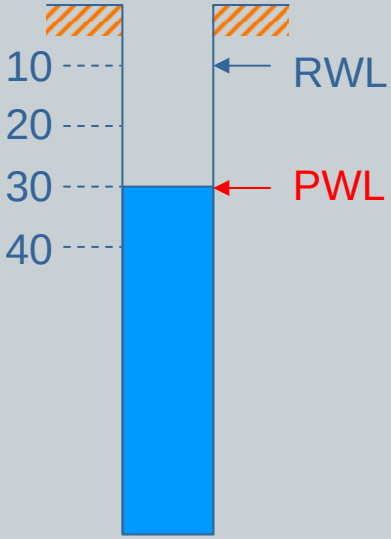
5 Ml/d



Baseline

Scenario 2

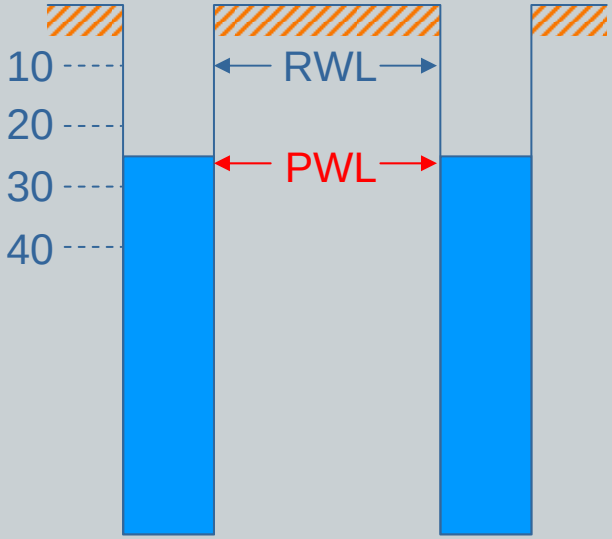
5 Ml/d



Additional investment to reduce drawdown

Scenario 3

2.5 Ml/d *2.5 Ml/d*

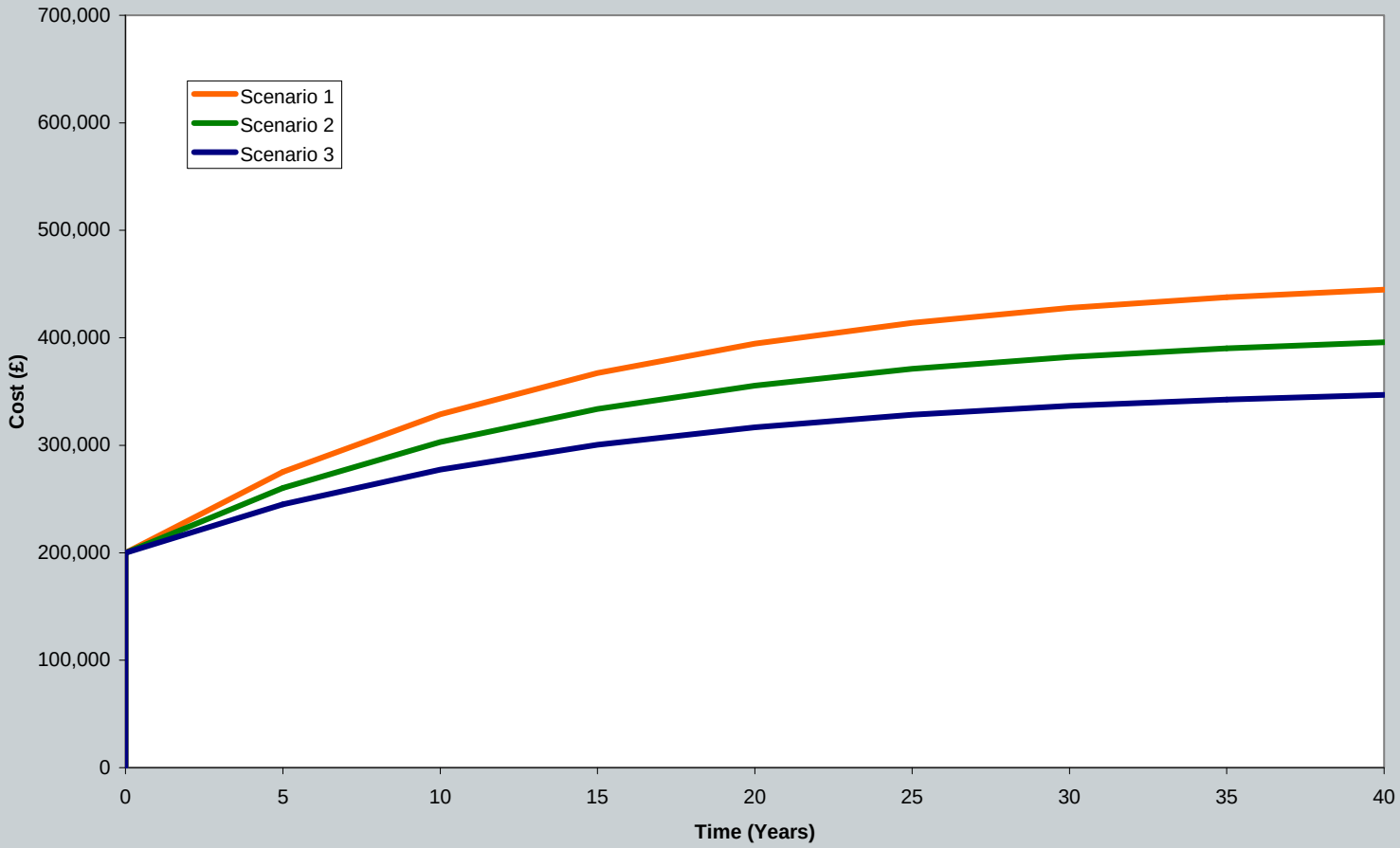


Two abstraction boreholes

WLC Assumptions →

• Baseline Capital Expenditure (CAPEX)	£200,000
• Investment Horizon	40 years
• Discount Rate	7%
• Cost of Electricity	8.0 p/kWh

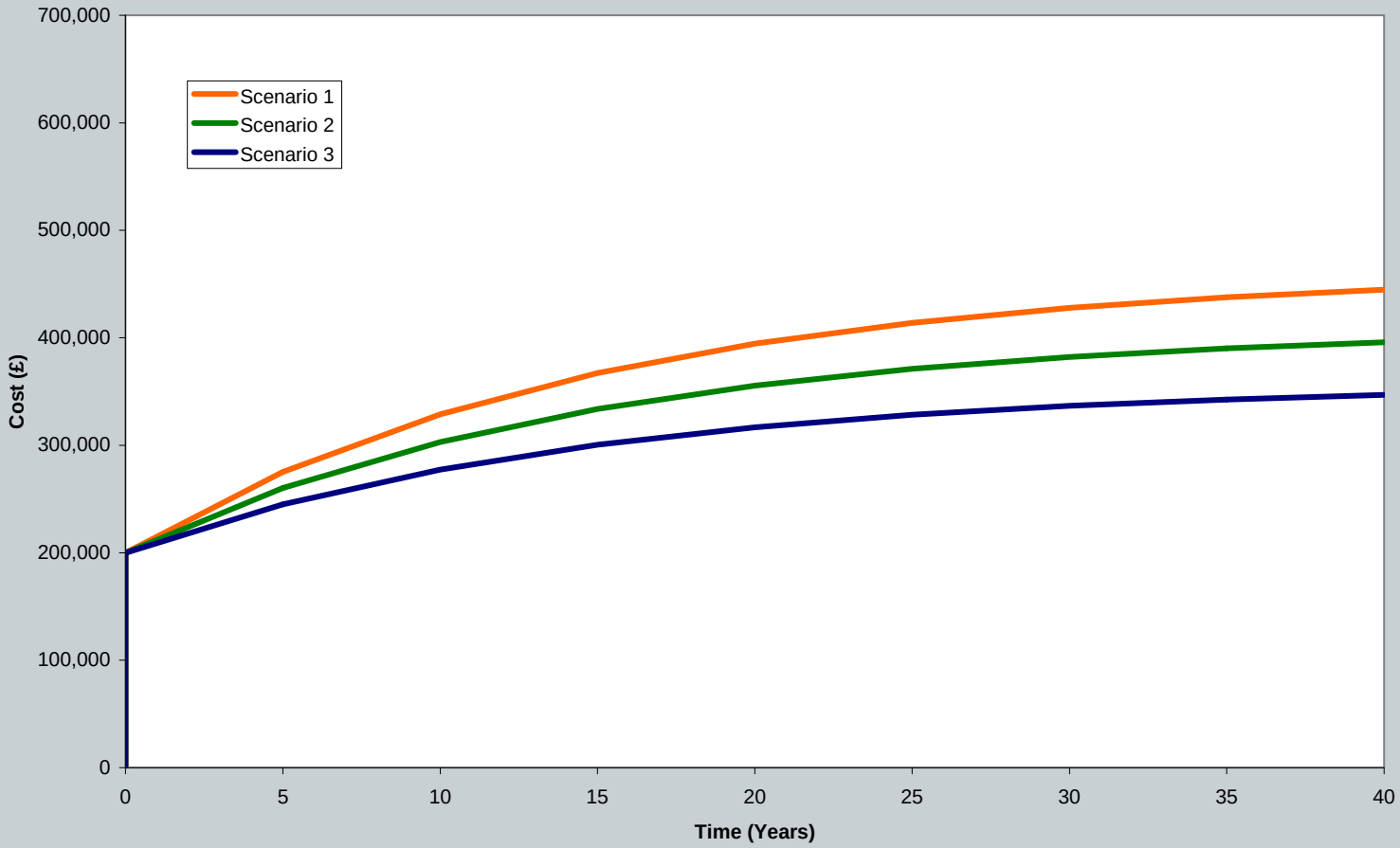
Discounted Cash Flow →



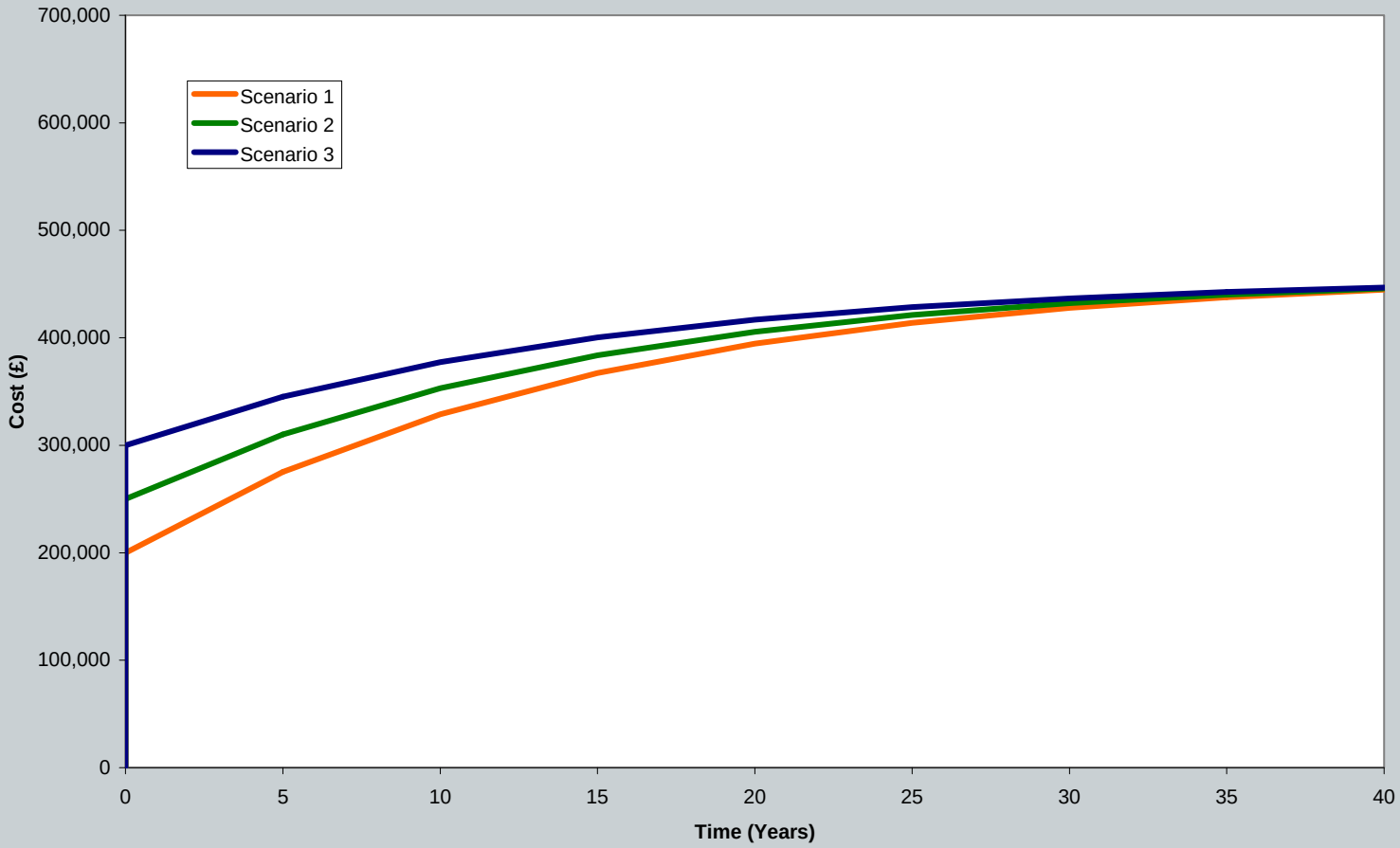
Investment Decision →

- How much additional capital can be spent on improving borehole performance to get the same WLC over 40 years as baseline investment?
- How does inclusion of CO_2e at the shadow price of carbon affect this level of additional investment?

Discounted Cash Flow →

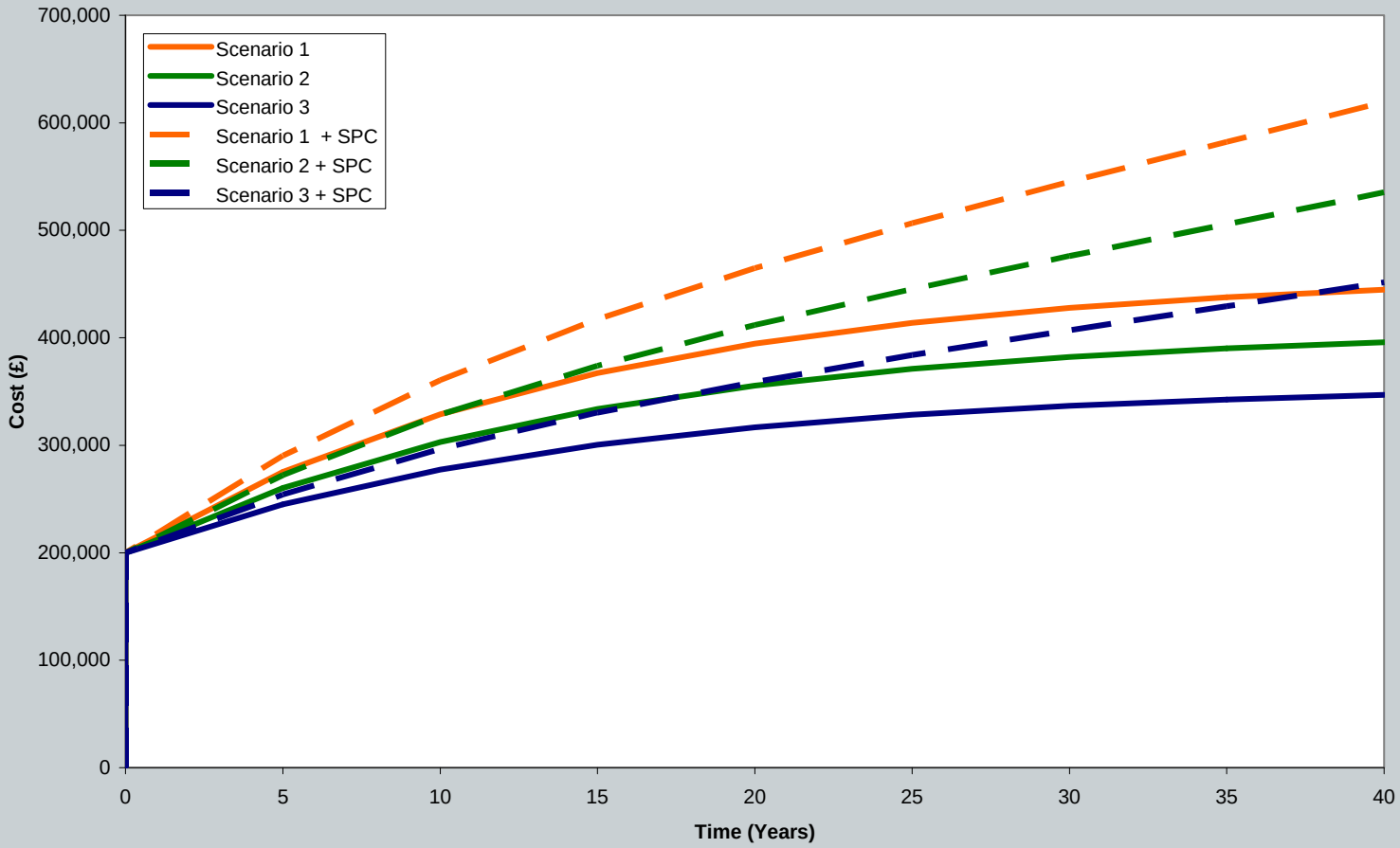


Discounted Cash Flow →

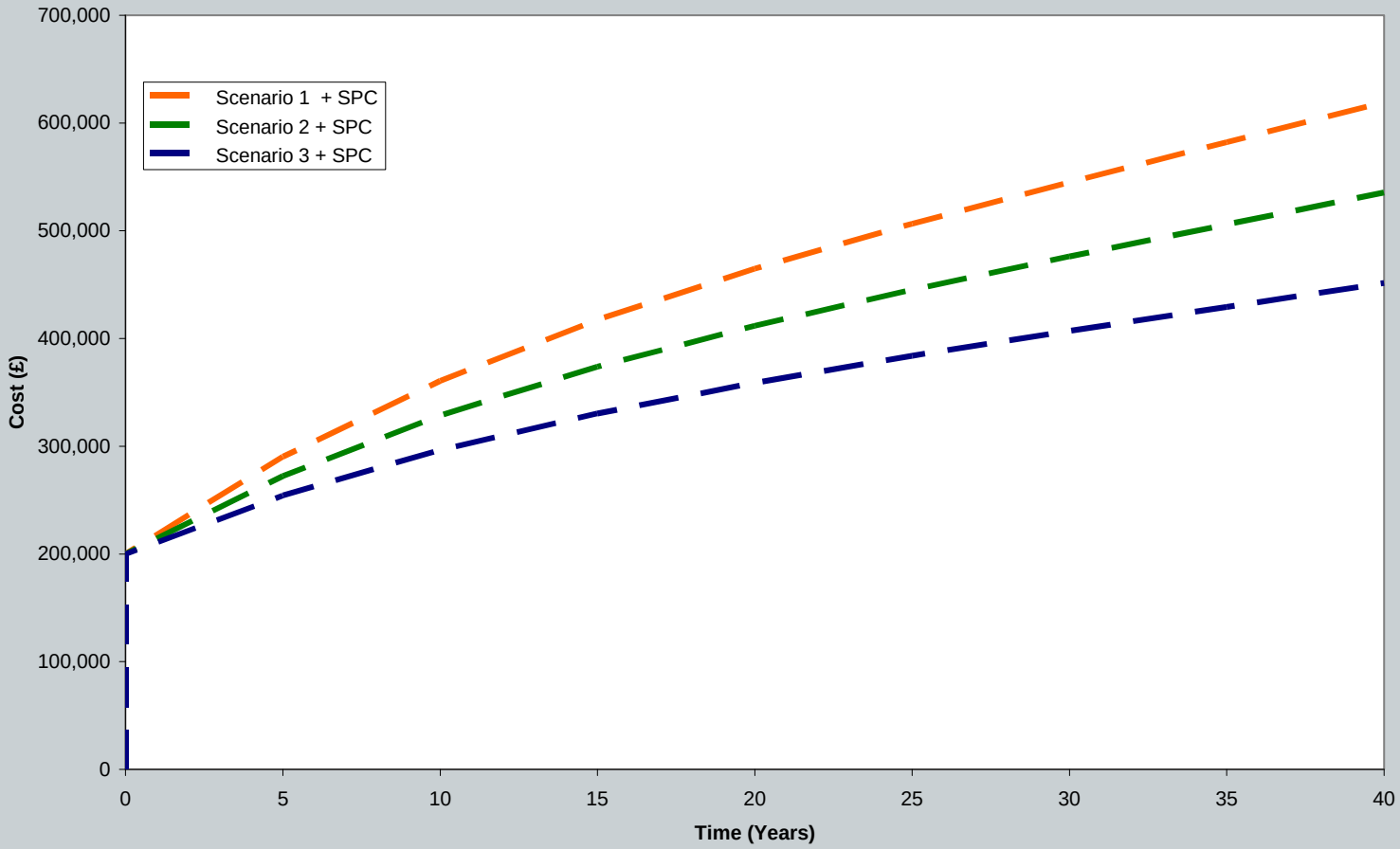


- With S2 we have invested additional £50k
- With S3 we have invested additional £100k

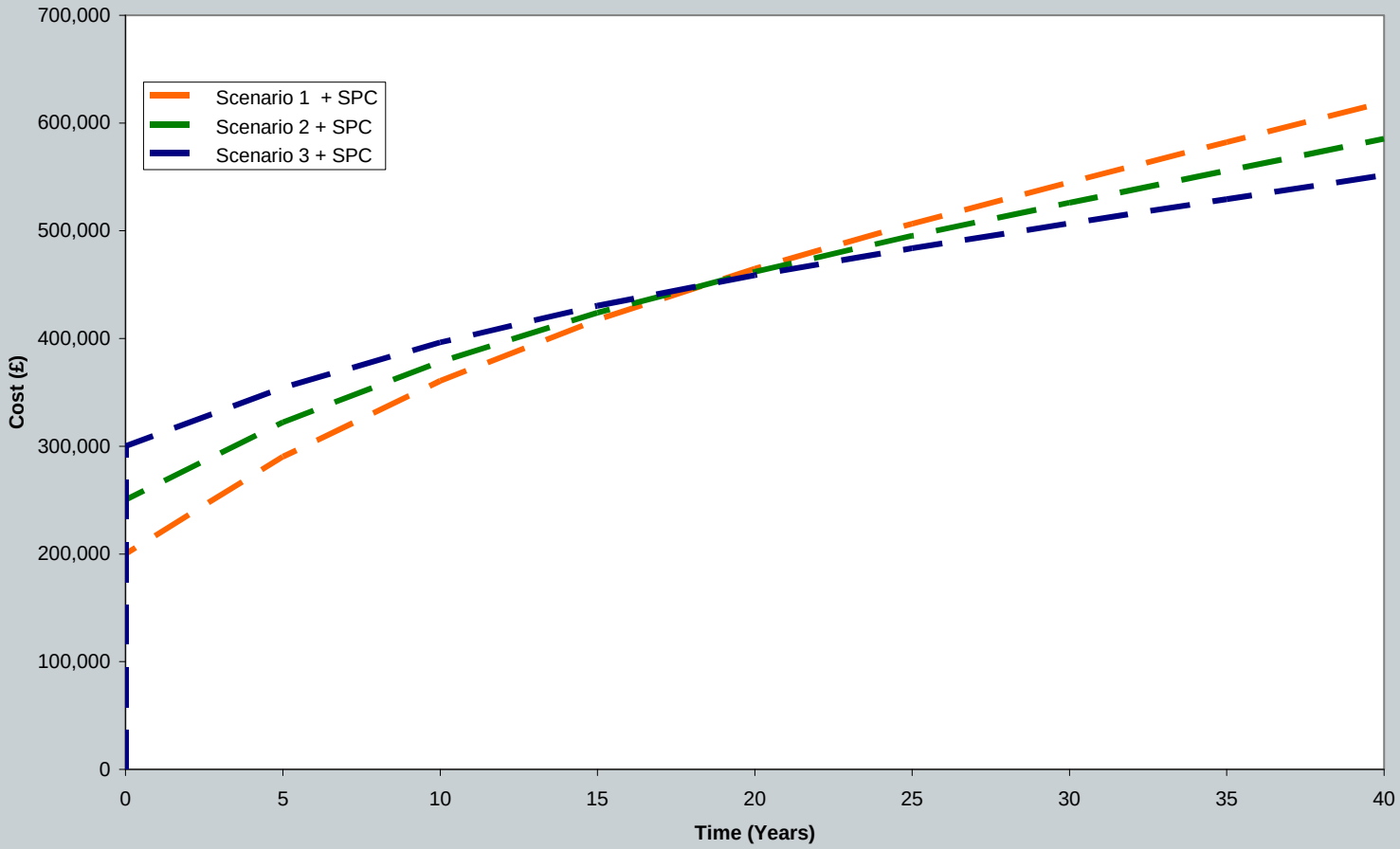
Discounted Cash Flow with / without → SPC



Discounted Cash Flow with SPC →

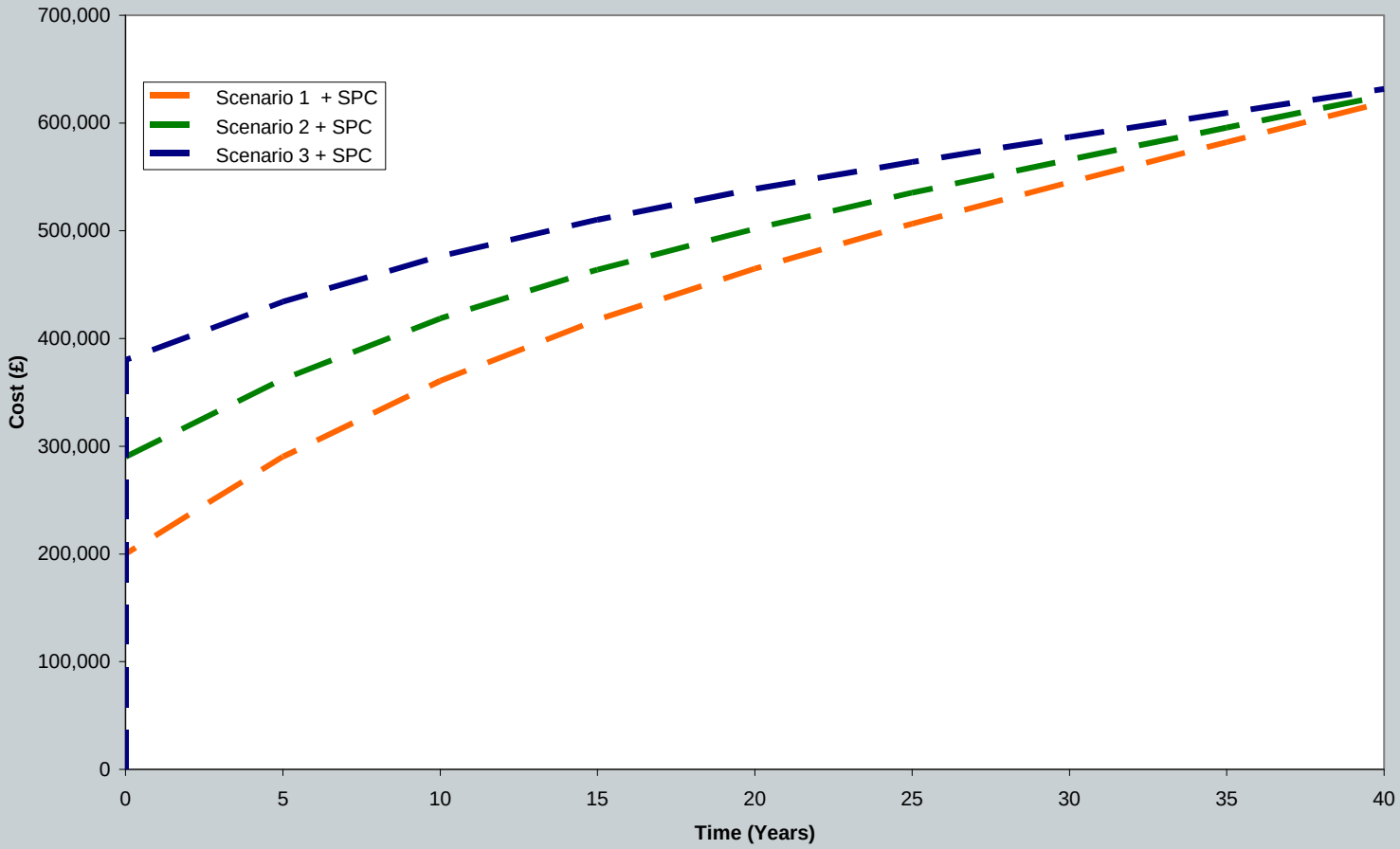


Discounted Cash Flow with SPC →



- With S2 we have invested additional £50k
- With S3 we have invested additional £100k

Discounted Cash Flow with SPC →



- With S2 we have invested additional £90k
- With S3 we have invested additional £180k

The Implications →

- Historically didn't tend to build to reduce energy costs
  - Energy costs relatively low
  - Technology not readily available
  - No carbon agenda
- Pump configuration options
- Fixed Rate vs. Variable Speed Pumps
- Centralisation of assets vs. local supplies
- Rehabilitation more favourable?
- Other!

Conclusions →

- Climate change is high on the policy agenda
- Current models suggest the focus will be on reducing operating energy requirements
- The Carbon Agenda will affect decision making process for groundwater asset management
- There is a need for water companies to be able to calculate the carbon footprints of investment options
- With consideration of SPC there is a changing balance of future operational costs (energy) against capital costs.
- The inclusion of the SPC enables water companies to make different decisions about how to invest in and operate groundwater assets.

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“Climate change means water,”

→ Martin Hurst, Director of Water, Defra

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