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Making business decisions under uncertainty

Andrew Haslett FREng, Chief Engineer

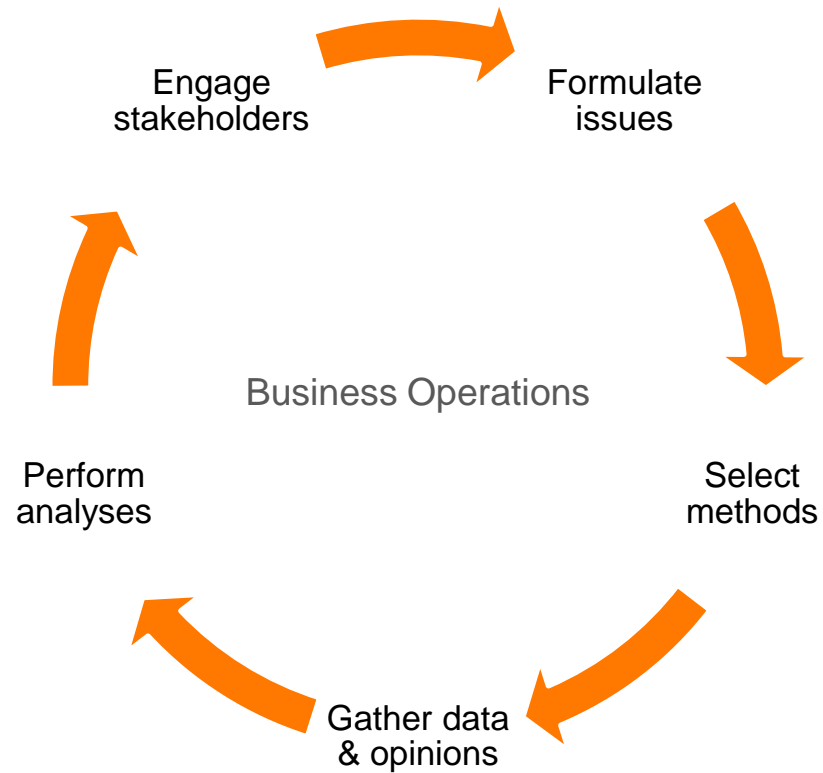
15th June 2018

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The circle of business life





ETI - history



Vision

Secure, sustainable and affordable energy for present and future generations

Mission

To accelerate the development, demonstration and eventual commercial deployment of a focused portfolio of energy technologies which will increase energy efficiency, reduce greenhouse gas emissions and help achieve energy and climate change goals

Members



+ Programme Associate



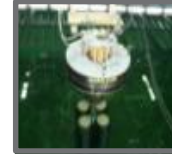


Managing a portfolio of options

Knowledge Building <£5m, 6-24 months



Bioenergy
Multi-site field trial to study impact of bioenergy crops on soil carbonisation and greenhouse gas emissions



Marine
Optimising wave and tidal array yields



Carbon Capture & Storage
First comprehensive UK CO2 storage database

Developing Technology £5-15m, 2-4 years



Energy Storage & Distribution
New approach to storing electricity at scale



Marine
3 phase 11kv wet-mate connector with integrated communications

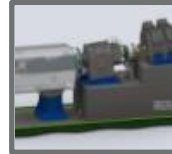


Transport
Increasing efficiencies of HDV land and marine vehicles by up to 30%

Demonstrating technology and system solutions



Offshore Wind
New designs for Floating turbine platforms reducing generating costs



Offshore Wind
World leading facility to increase reliability of new turbines



Marine
1MW tidal generator providing environmental impact and performance

**£15-30m+,
3-5 years**



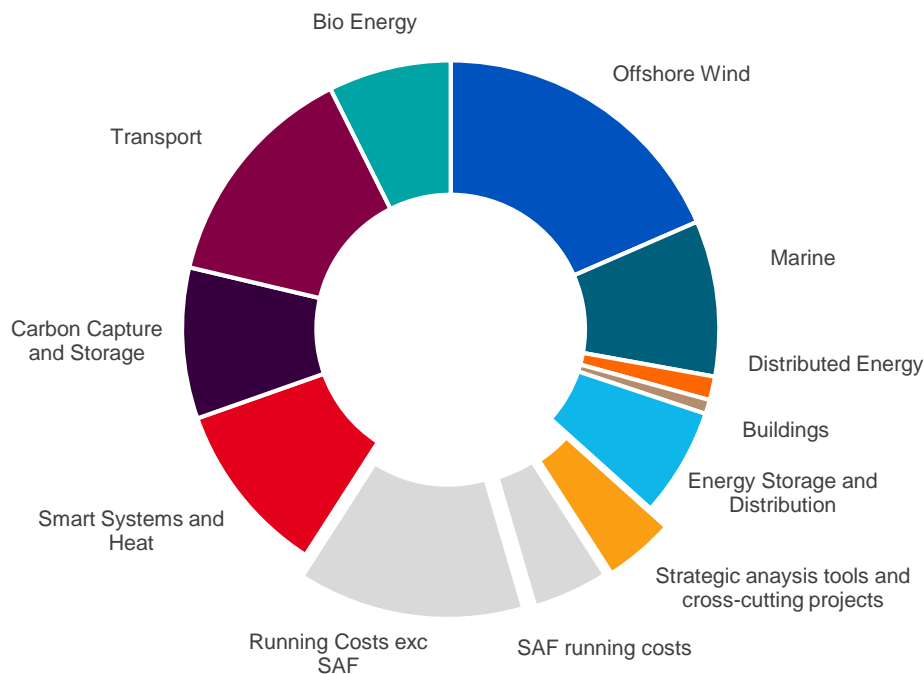
A national energy system design tool
Integrating heat, power, transport and infrastructure
Searching for the lowest cost solution



ETI lifetime view (2008-2019)

A likely look back from 2019

ETI £360M – 10+ year portfolio

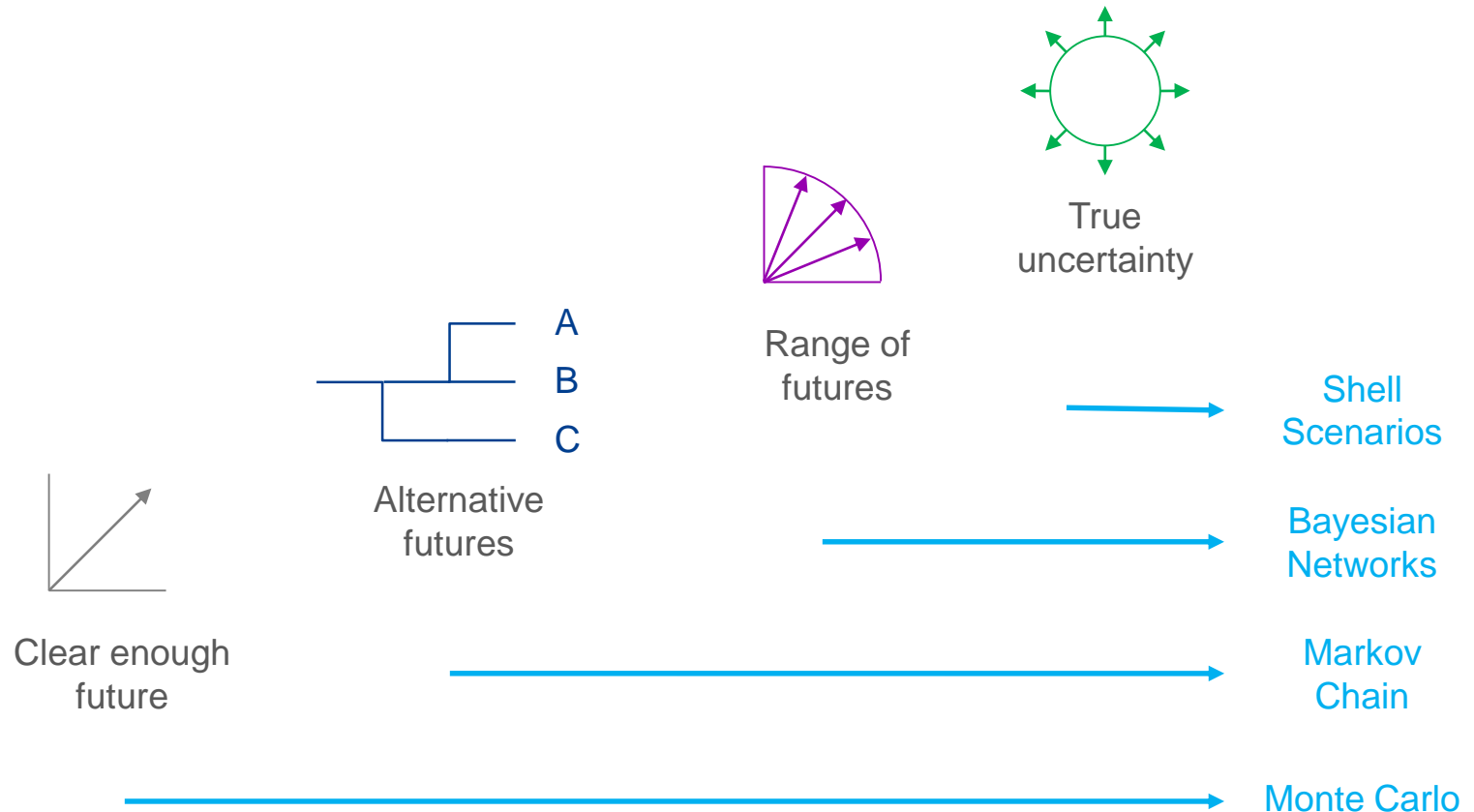


SAF = Strategic Analysis Function
in-house ETI capability providing national energy system strategic analysis and design,
energy technology and systems advice and knowledge

- >150 projects
- >200 delivery partners (industrials, start-ups, academia, NGOs, consultancies, finance)
- Project finance, equity and debt support
- Development of >2,000 people – most still in the sector
- >100 new patents (ETI)
- ~500 academic papers published
- Created ETI energy systems Strategic Analysis Function – UK focused initially but now being contracted by groups from around the world
- New information and evidence base which has supported many £100s millions investment and policy decisions in industry and government – much now placed in public domain
- >15 new commercial products and services which have resulted wholly from ETI project work (many more which incorporate elements of ETI work)
- Value realisation and ongoing revenues through -
 - ⇒ Royalties on 3rd party product / service sales
 - ⇒ Equity and secured debt
 - ⇒ IP licensing
 - ⇒ ETI Strategic analysis services
 - ⇒ Knowledge dissemination



Strategy under (residual) uncertainty

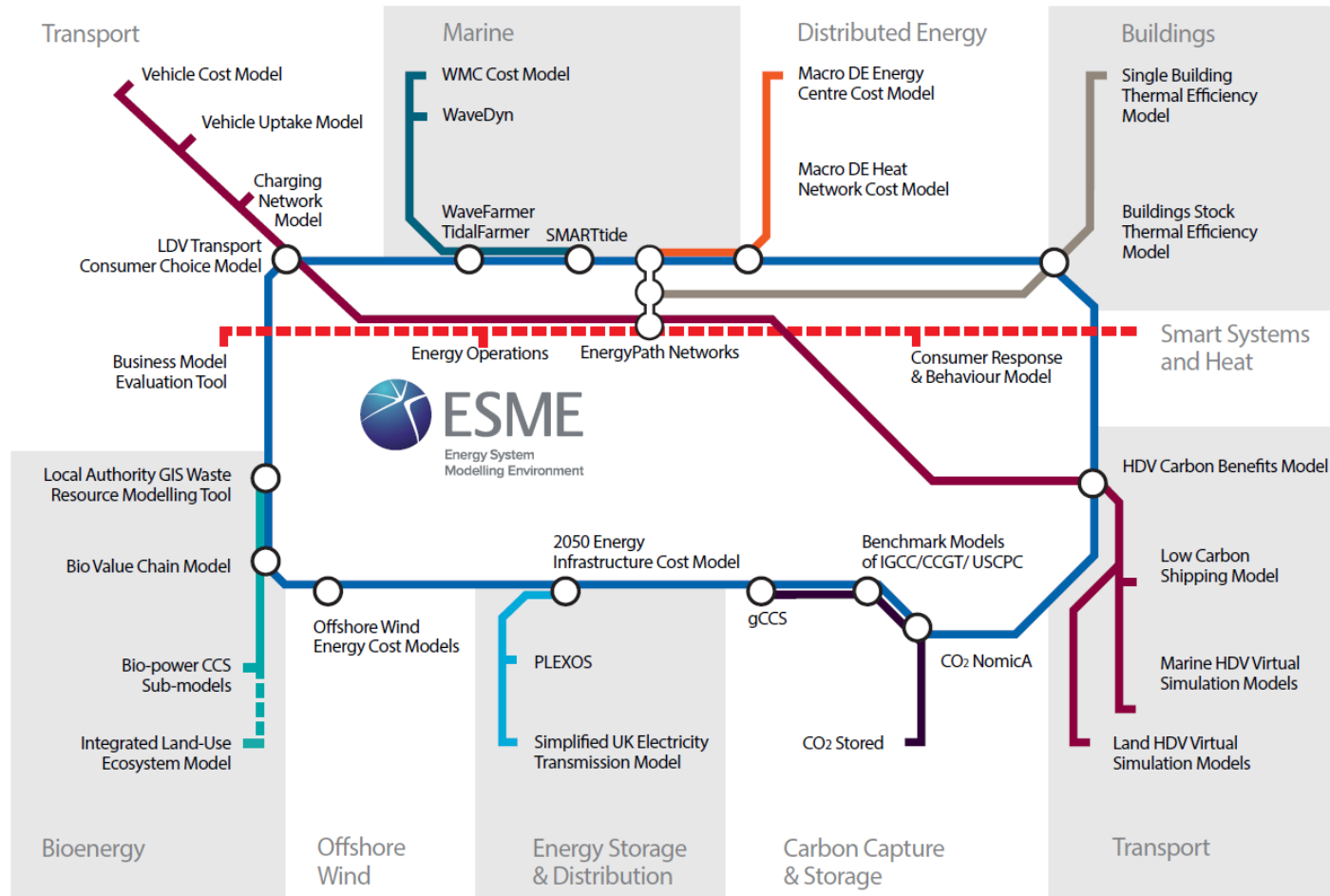


HBR, 1997 Nov-Dec;75(6):66-79, Courtney, Kirkland and Viguerie



Whole system analysis based on sector specific detail

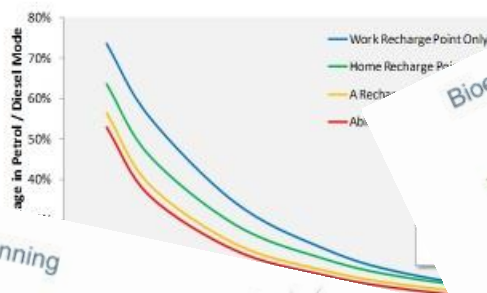
ESME - On track to 2050





Detailed pathway visualisation

Using NTS data to model vehicle technology patterns of use (also building occupancy)



Bioenergy Value Chain Modelling



- Spatial, decadal model for UK out to 2050
- Optimise value chain based on total value (or max energy, min cost, min GHG emissions)
- Test system sensitivities to:
 - Technology cost and performance
 - Resource availability – including imports
 - Build out rates / planting rates

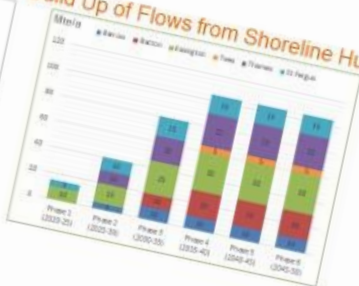
CCS – offshore storage planning

- 2GtE to be appraised by 2025 (7 aquifers)
- Clustering of emitters, limiting the number of shoreline hubs (6) and planning of networks reduces infrastructure costs, by as much as 30-50%

SNS Example Network

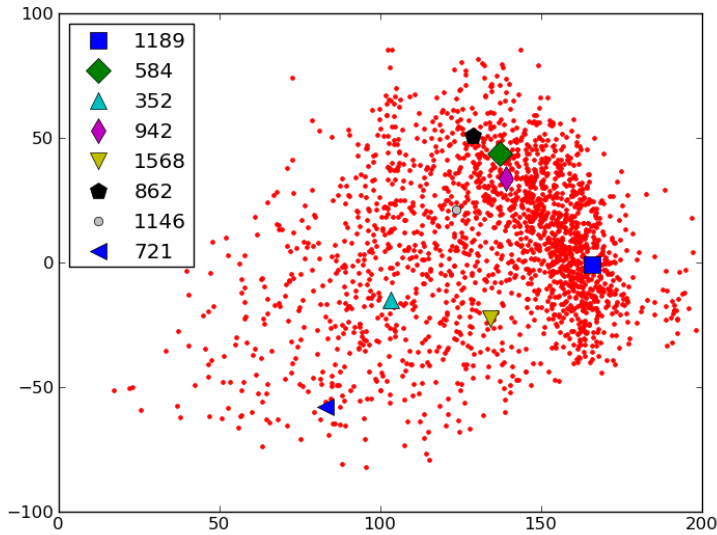


Build Up of Flows from Shoreline Hubs

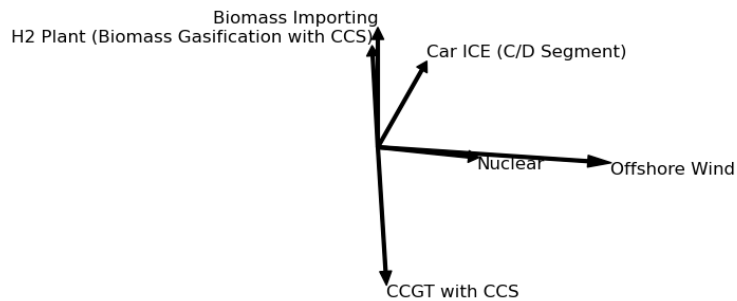




ESME results – optimal pathways



| Cluster No | Cluster Centroid | No of designs | %age representation |
|------------|------------------|---------------|---------------------|
| 1st | 1189 | 747 | 37.4 |
| 2nd | 585 | 245 | 12.2 |
| 3rd | 352 | 134 | 6.7 |
| 4th | 942 | 91 | 4.6 |
| 5th | 1568 | 78 | 3.9 |
| 6th | 862 | 71 | 3.6 |
| 7th | 1146 | 58 | 2.9 |
| 10th | 721 | 41 | 2.0 |





Option Value - abatement cost

Additional cost of delivering 2050 -80% CO2 energy system NPV £ bn 2010-2050

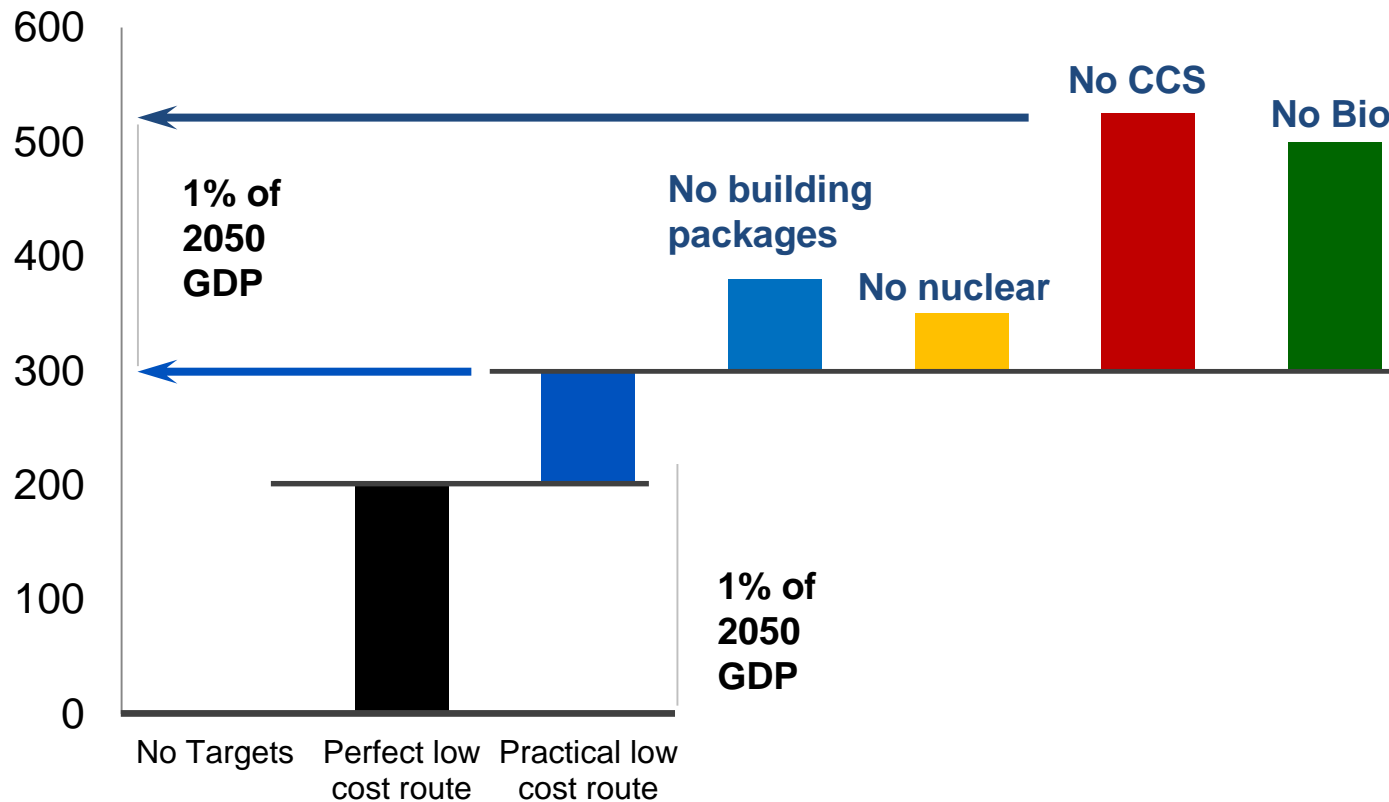


Chart data from case dc14



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