energy technologies institute

www.eti.co.uk

# Nuclear Institute SMR 2016 - 8th and 9th June 2016

# The Role For Nuclear In A UK Low Carbon Economy – Large Reactors and Small Modular Reactors

Mike Middleton – Strategy Manager for Nuclear

# Introduction to the ETI

The Energy Technologies Institute (ETI) is a public-private partnership between global industries and UK Government

Delivering...

Targeted development, demonstration and de-risking of new technologies for affordable and secure energy

Shared risk

## ETI members

bp

CATERPILLAR®

EDF ENERGY

Rolls-Royce

EPSRC
Pioneering research and skills

Department of Energy & Climate Change

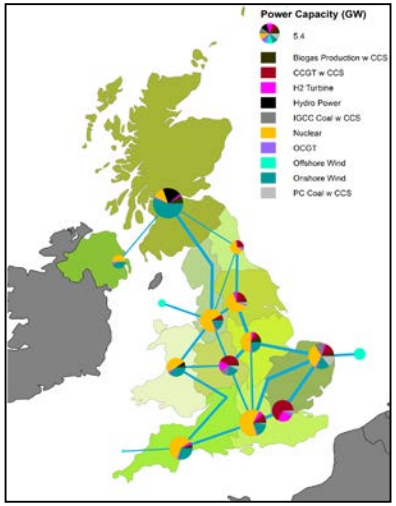
Department for Business Innovation & Skills

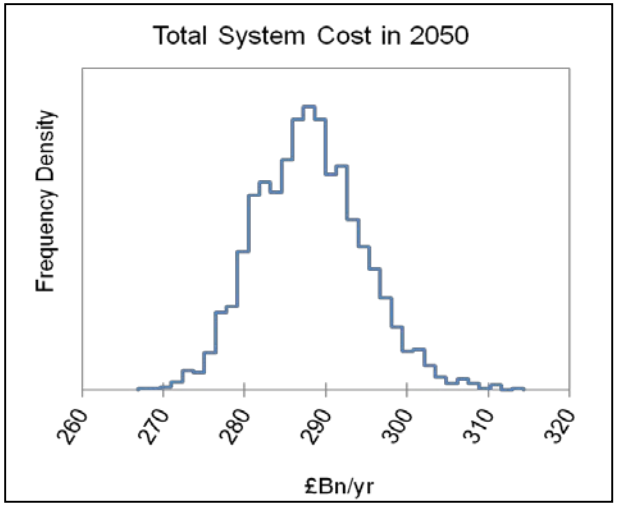
Innovate UK
Technology Strategy Board

## ETI programme associate

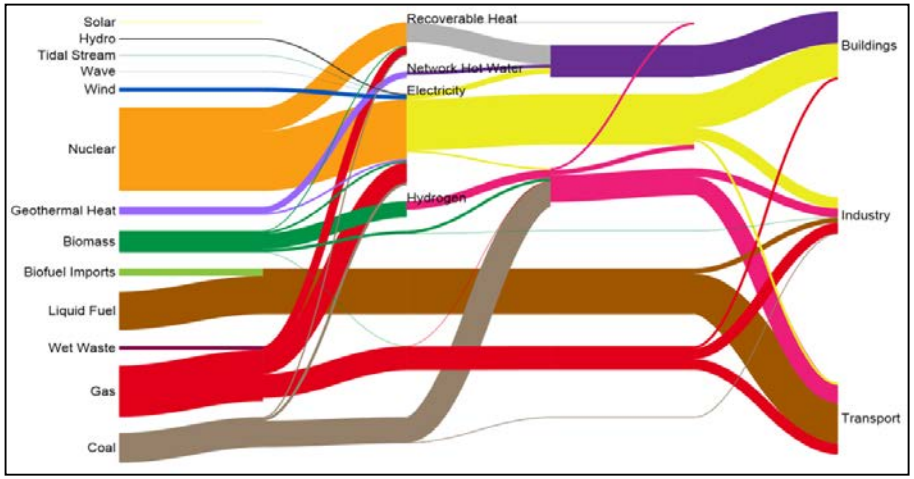
HITACHI
Inspire the Next

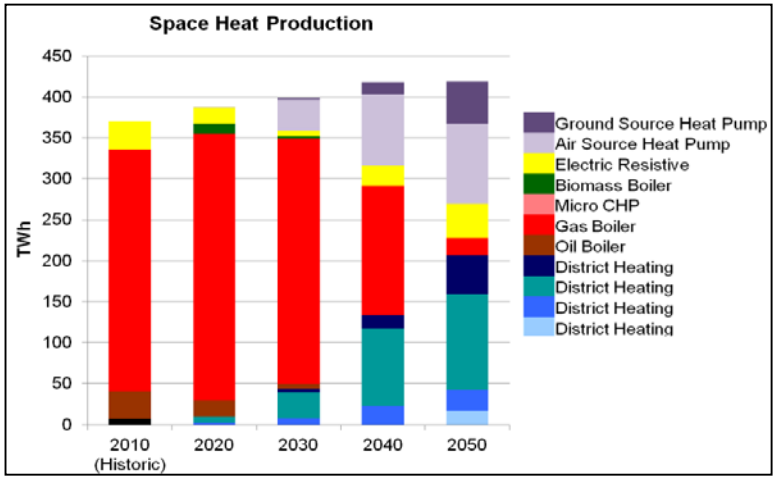
# Typical ETI modelling system outputs



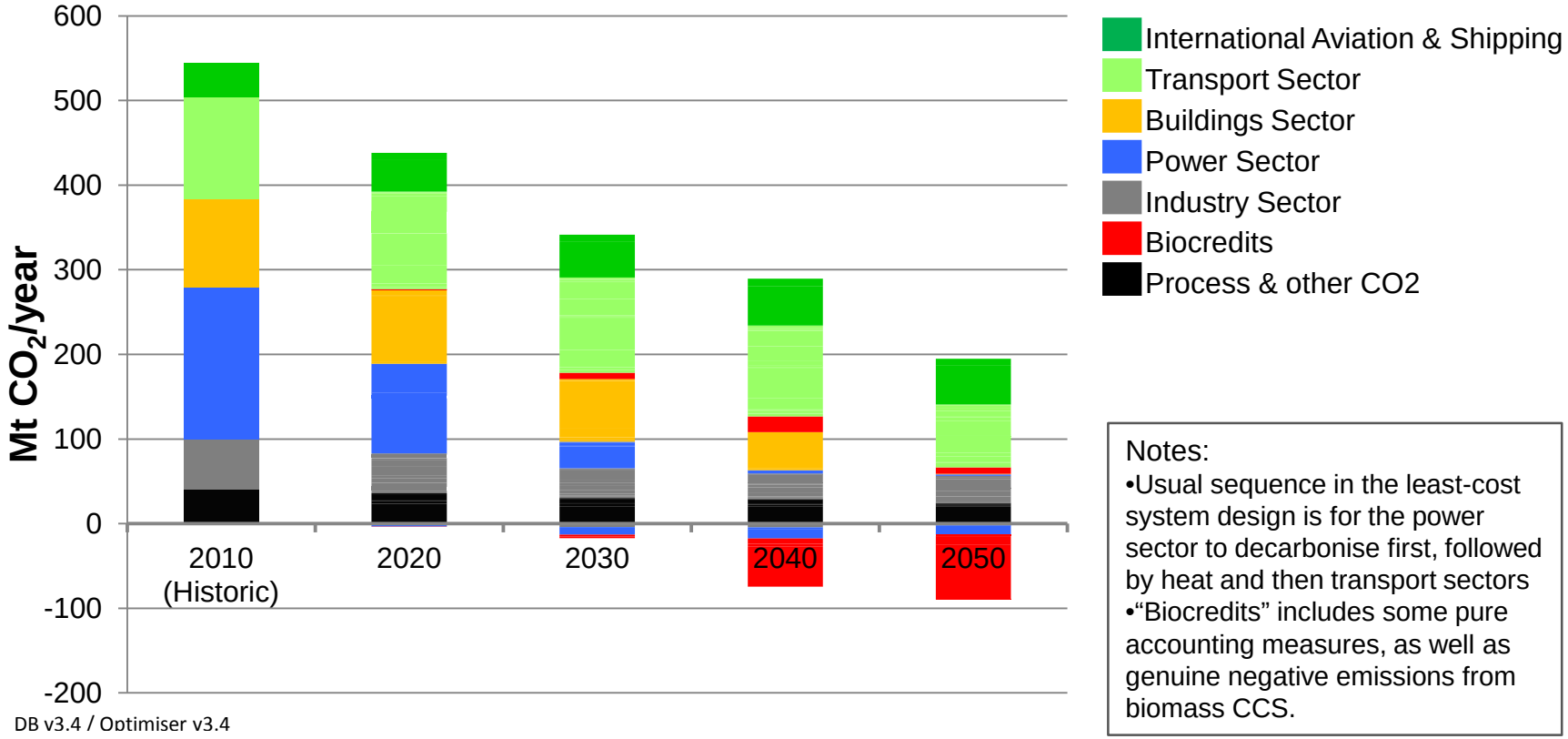

Energy
System
Modelling
Environment



# Net UK $CO_2$ emissions

## Typical ETI Transition Scenario



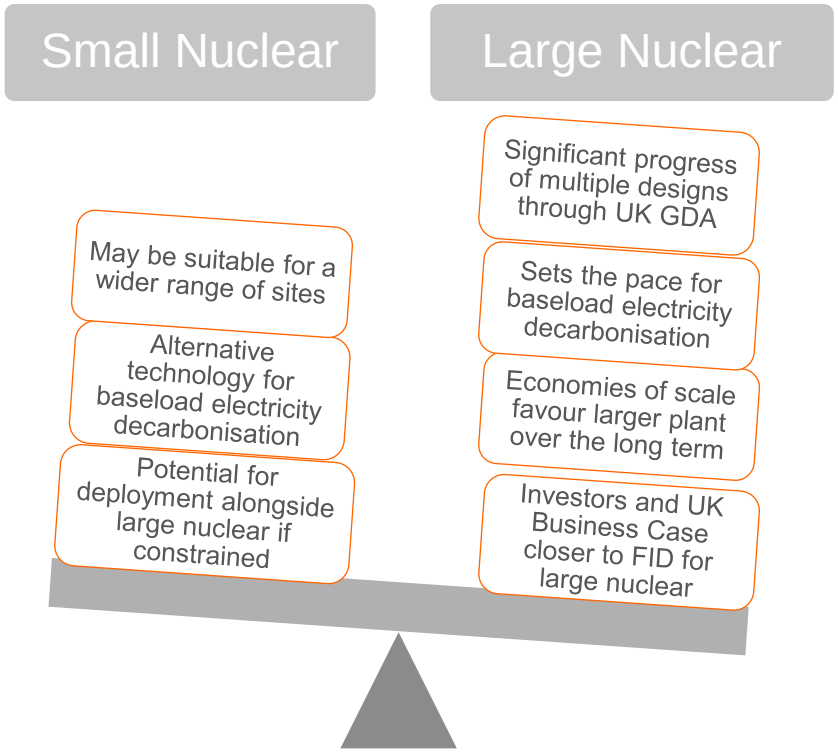

DB v3.4 / Optimiser v3.4

Notes:
- Usual sequence in the least-cost system design is for the power sector to decarbonise first, followed by heat and then transport sectors
- "Biocredits" includes some pure accounting measures, as well as genuine negative emissions from biomass CCS.

# Can Small Modular Reactors find a niche?

**For SMRs to be deployed in UK:**

- technology development to be completed
- range of approvals and consents to be secured
- sufficient public acceptance of technology deployment at expected locations against either knowledge or ignorance of alternatives
- deployment economically attractive to
    - o reactor vendors
    - o utilities and investors
    - o consumers & taxpayers

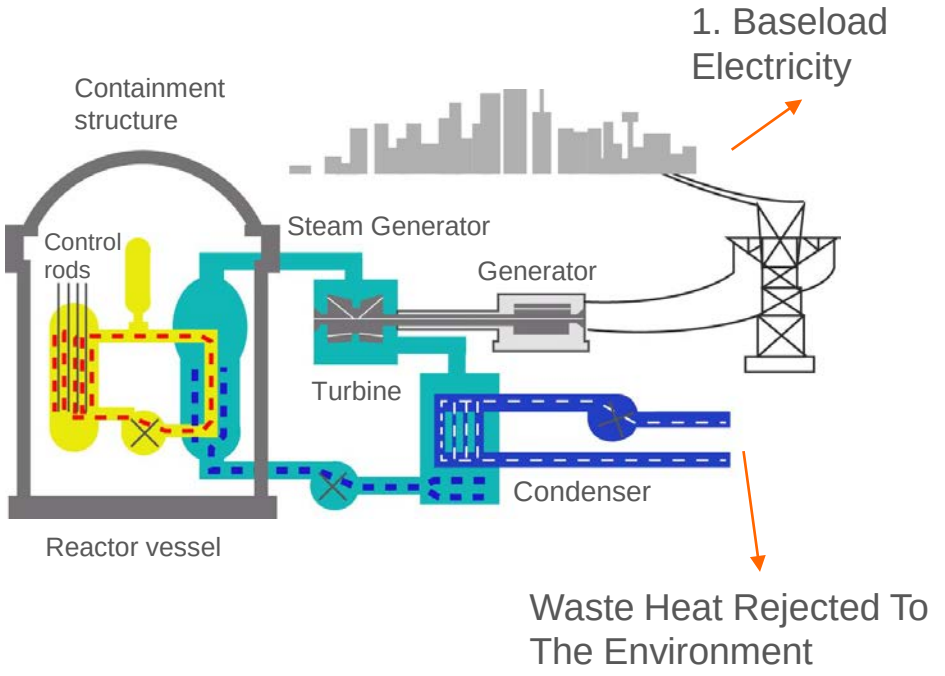


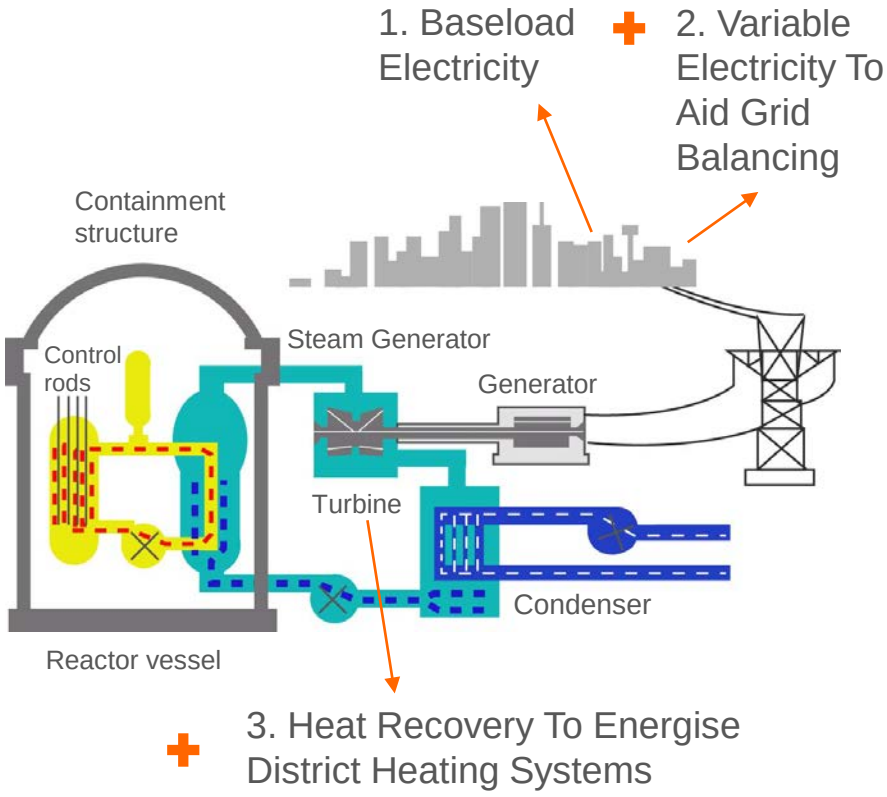

**Realistic objective for SMRs to be economically attractive to all stakeholders**

# Can SMRs find a market niche in the UK?

## Single Revenue Stream

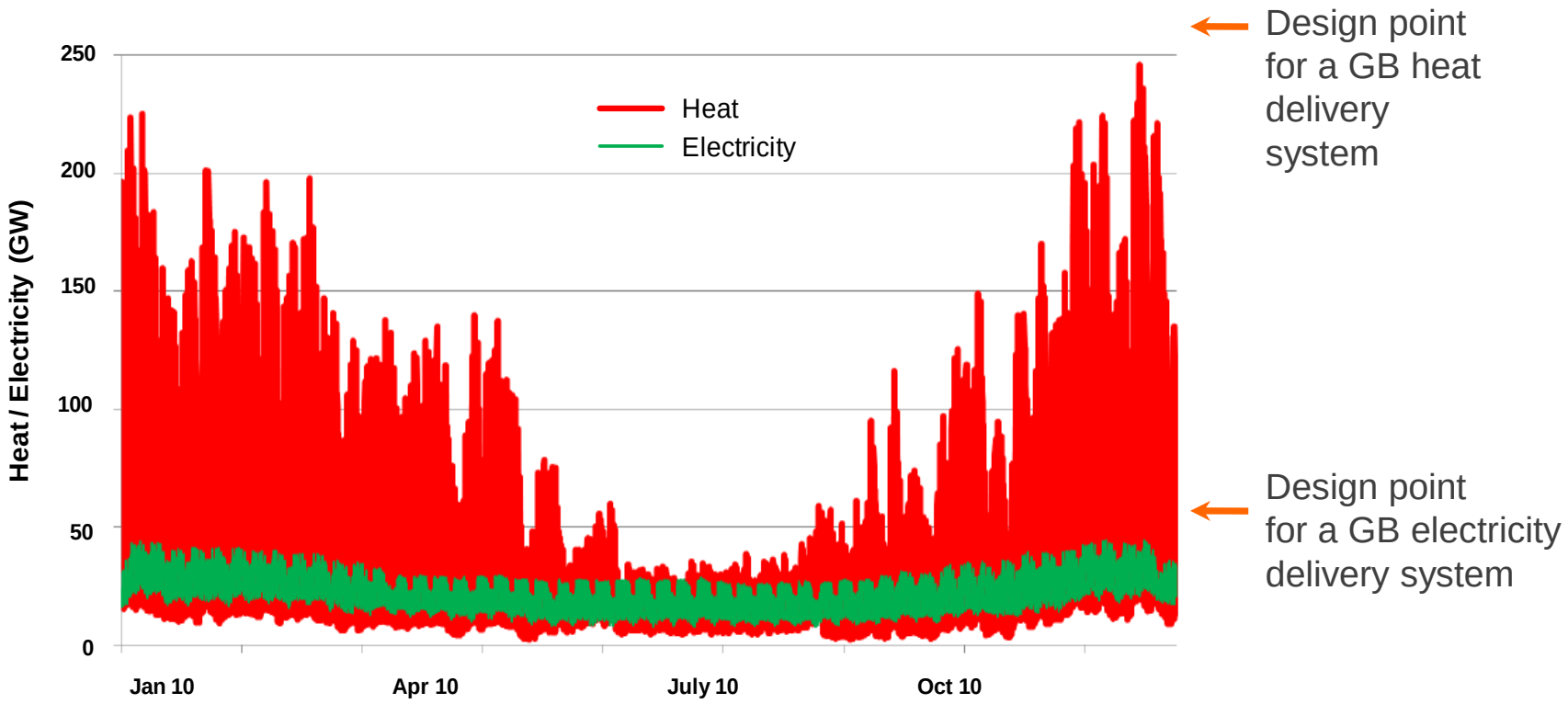
## Multiple Revenue Streams



# Decarbonising heat is challenging in the UK

## Heat demand variability in 2010 – Unattractive to electrify it all




GB 2010 heat and electricity hourly demand variability - commercial & domestic buildings
R. Sansom, Imperial College

# ETI Projects Delivered

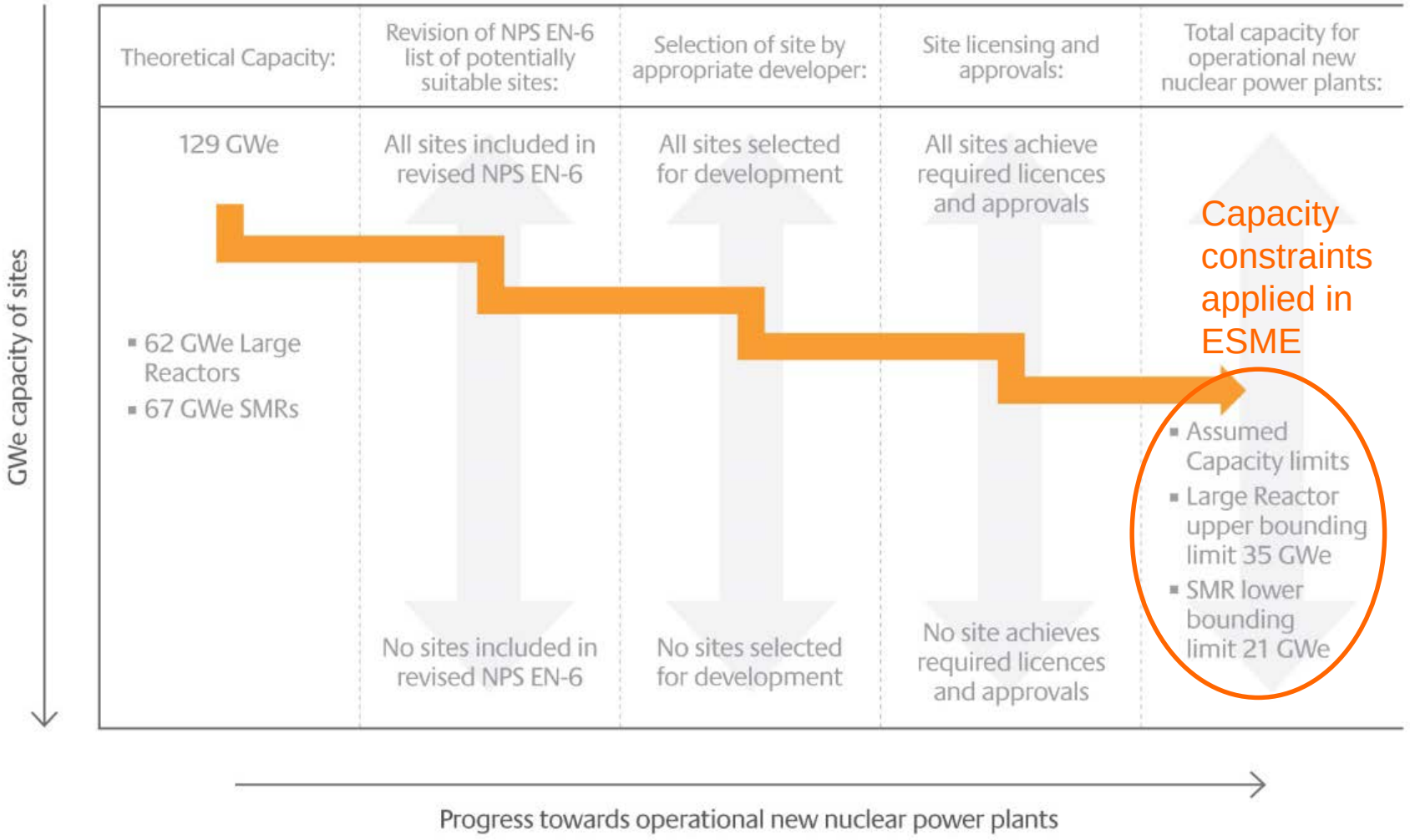
## Power Plant Siting Study

- Explore UK capacity for new nuclear based on siting constraints
- Consider competition for development sites between nuclear and thermal with CCS
- Undertake a range of related sensitivity studies
- Identify potential capacity for small nuclear based on existing constraints and using sites unsuitable for large nuclear
- Project schedule June 2014 to Aug 2015
- Delivered by Atkins for ETI following competitive open procurement process

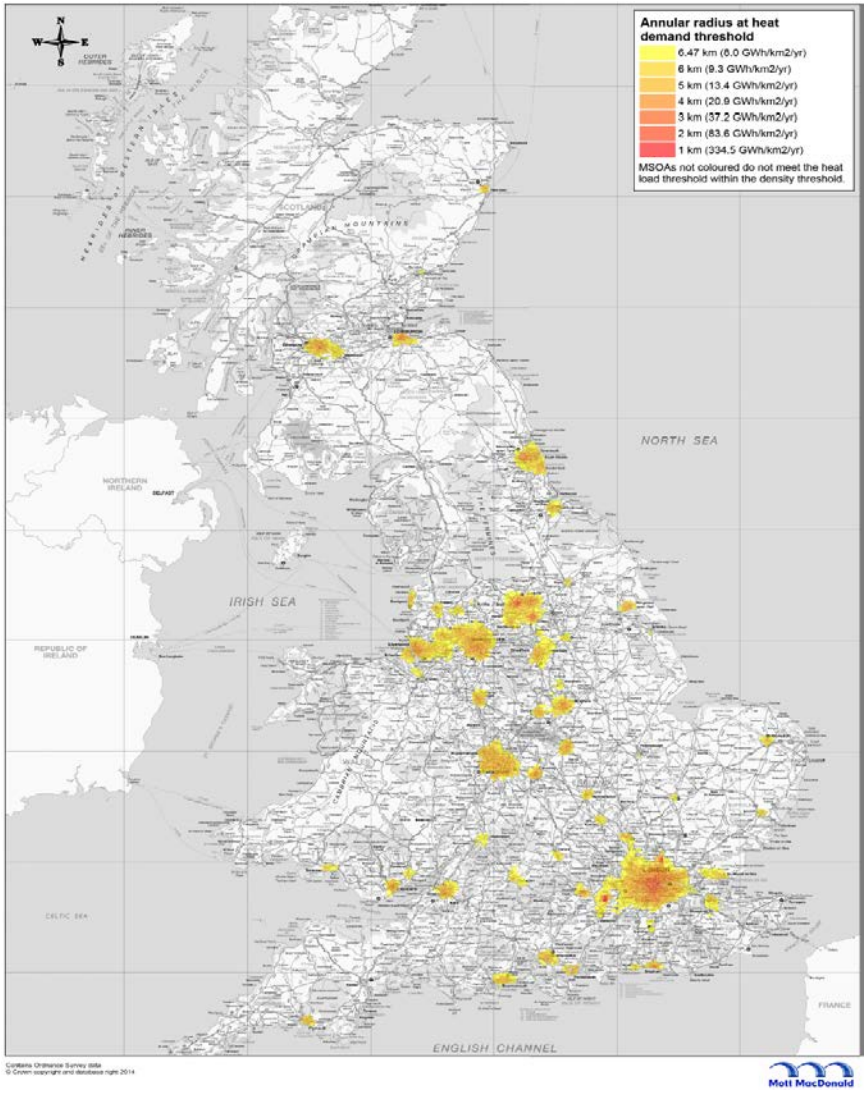
## System Requirements For Alternative Nuclear Technologies

- Develop a high level functional requirement specification for a “black box” power plant for
  - baseload electricity
  - heat to energise district heating systems, and
  - further flexible electricity to aid grid balancing
- Develop high level business case with development costs, unit costs and unit revenues necessary for deployment to be attractive to utilities and investors
- Project schedule August 2014 to Aug 2015
- Delivered by Mott MacDonald for ETI following competitive open procurement process
- Outputs to be used in ETI scenario analysis to determine attractiveness of such a “black box” power plant to the UK low carbon energy system

# Siting Data Applied In ESME



# Future Heat Networks




- Almost 50 GB urban conurbations with sufficient heat load to support SMR energised heat networks
- Would theoretically require around 22 GWe CHP SMR capacity

# Conclusions from published ETI insights

## 10 YEARS TO PREPARE for a low carbon transition

New nuclear plants can form a major part of an affordable low carbon transition

with potential roles for both large nuclear and small modular reactors (SMRs)

Large reactors are best suited for baseload electricity production

analysis indicates an **upper capacity limit** in England & Wales to 2050 from site availability of

**35 GWe**

Actual deployment will be influenced by a number of factors and could be lower. Alongside large nuclear, SMRs may be less cost effective for baseload electricity production

SMR's could fulfil an additional role in a UK low carbon energy system by delivering combined heat and power

a major contribution to the decarbonisation of energy use in buildings

but deployment depends on availability of district heating infrastructure

SMR's offer more flexibility with deployment locations that could deliver heat into cities via hot water pipelines up to

**30 km** in length

Assessed deployment capacity of at least **21 GWe** limit could be higher

Total nuclear contribution in the 2050 energy mix could be around 50 GWe; SMRs contributing nuclear capacity above 40 GWe will require flexibility in power delivery to aid balancing of the grid

Future nuclear technologies will only be deployed if there is a market need

and these technologies provide the most cost effective solution



A decision is required now

**10 years**

whether to begin 10 years of enabling activities leading to a final investment decision for a first commercially operated UK SMR

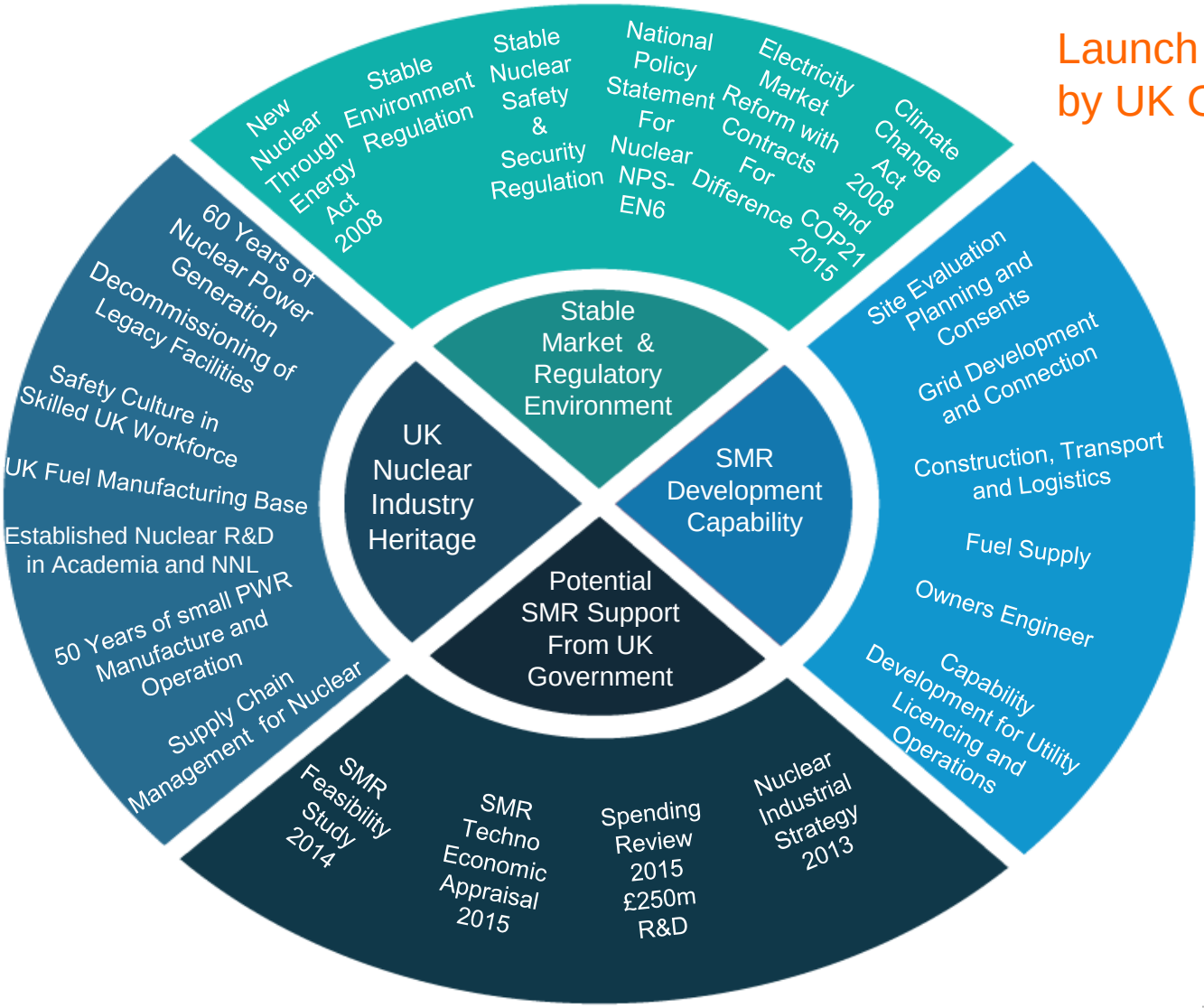
earliest operational date around **2030**

A strategic approach to reactor siting together with public consultation

will be important in determining the extent of deployment of both large nuclear and SMR's

http://www.eti.co.uk/the-role-for-nuclear-within-a-low-carbon-energy-system/

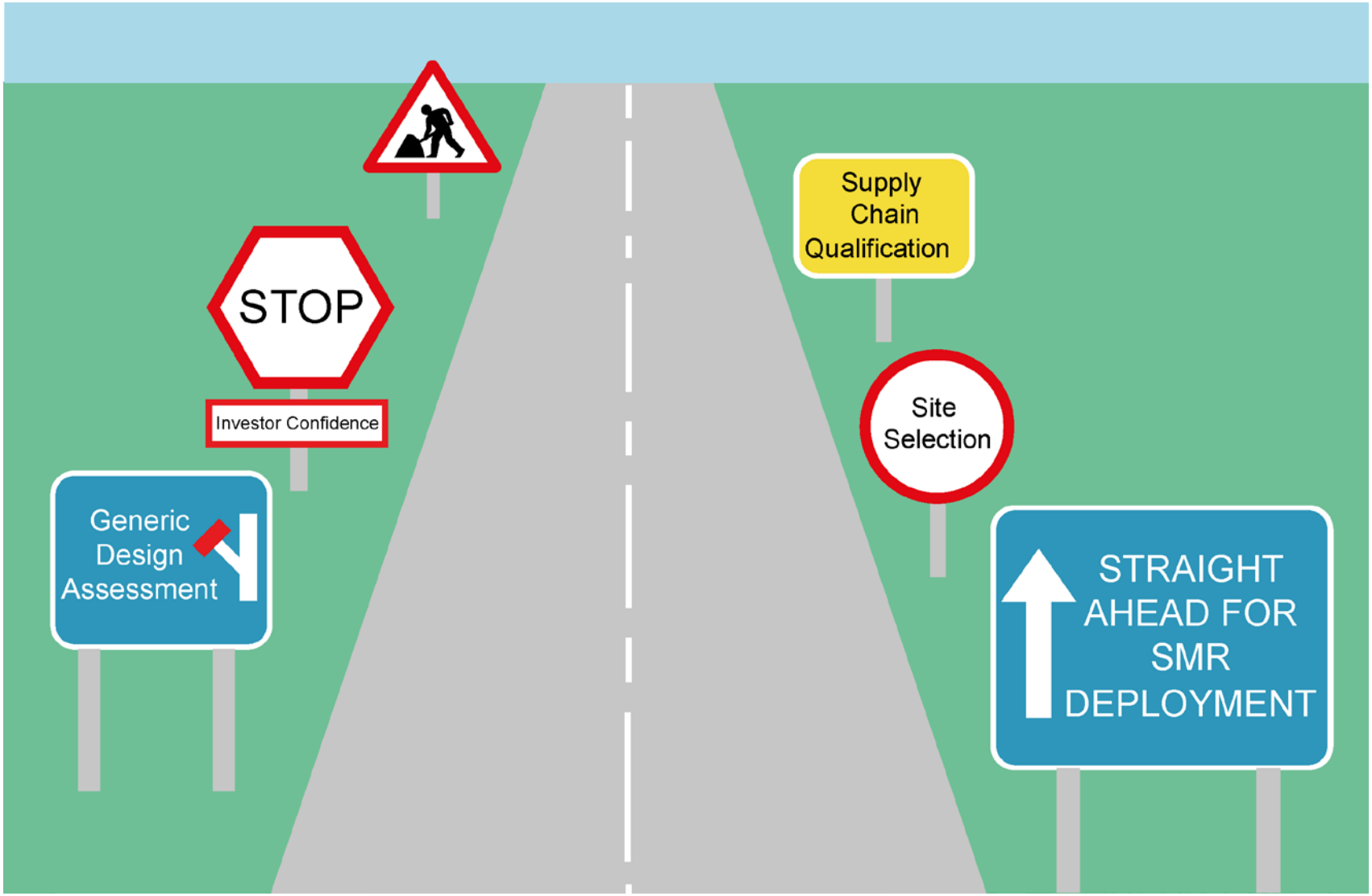
# UK capability to support SMR deployment




## Launch of SMR competition by UK Government:

- Expressions of interest until 6th May
- Phase 1 dialogue late May until autumn 2016

# Less than 10 years to prepare to deploy a UK Small Modular Reactor



# Further ETI Projects Relevant To UK SMRs

What is the range of locations suitable for early SMR deployment and is there an obvious front runner for a First Of A Kind (FOAK) SMR site?

- Power Plant Siting Study Phase 3

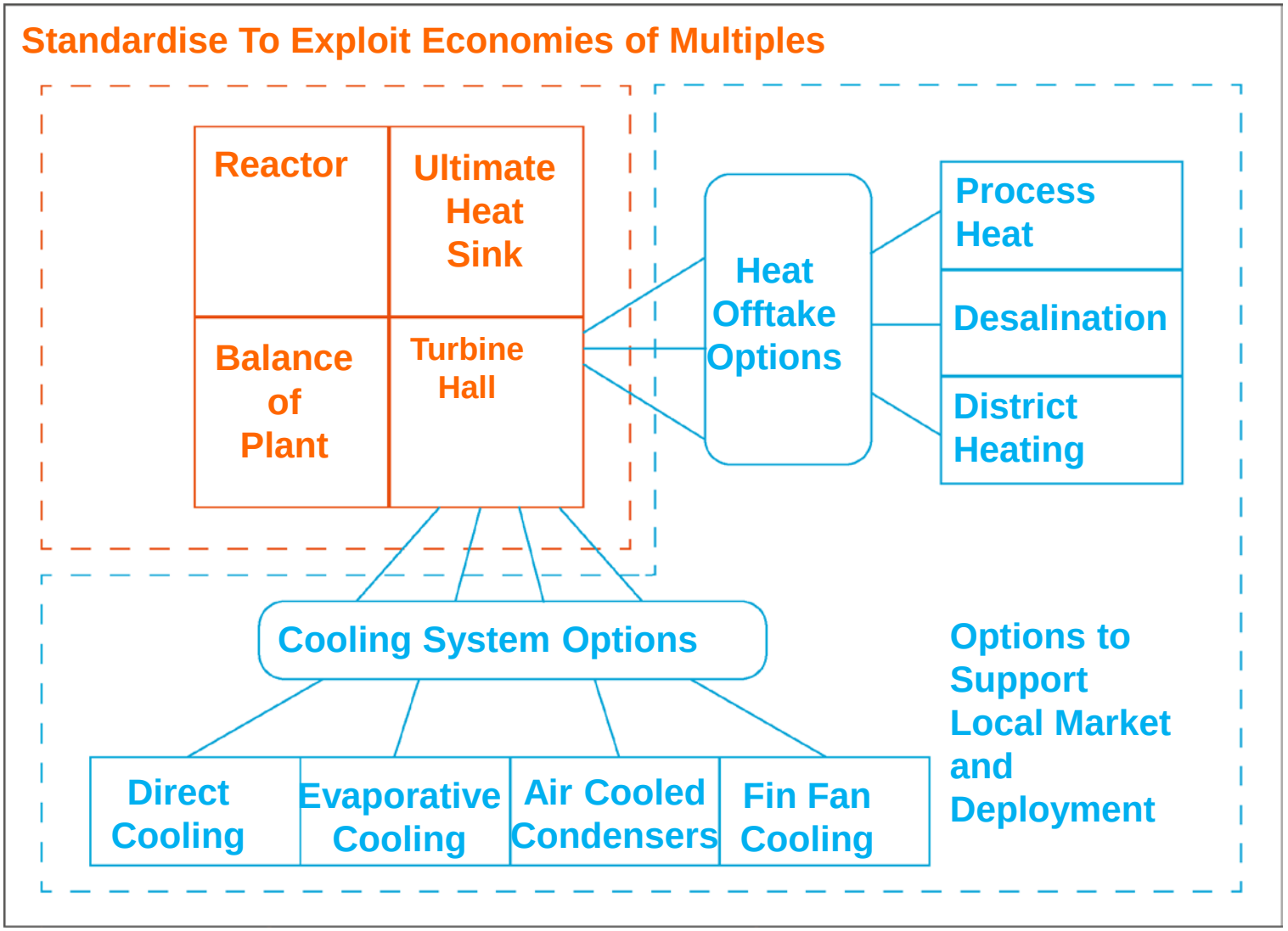
What are the design, cost and operational implications of committing to a plant which is CHP ready when built? What are the potential cooling system choices and economic impacts if unconstrained access to cooling water becomes more difficult?

- System Requirements For Alternative Nuclear Technologies Phase 3

What are the enabling activities in the first five years of an SMR programme necessary to support potential operations of a first UK SMR by 2030?

- SMR Deployment Enablers Project

# Exploiting The Economies Of Multiples – UK GDA and Coping With Variants




Scope of Design To Be Assessed Through Generic Design Assessment

# SMR Deployment Enablers
# Work In Progress

Scope:

- Development of scope for first 5 years of a UK SMR programme
- Integrated schedule for first 5 years, which could support ops by 2030
- Identify necessary capability development  of SMR developer/operator

Key Assumptions:

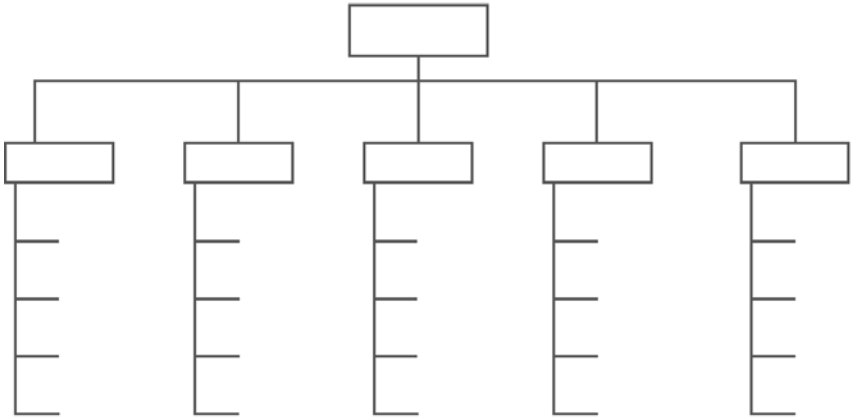
- Vendor and developer/operator have already been identified at start
- Developer/operator is new to the UK; UK capability generation required
- The UK FOAK site is not currently included in NPS – EN6

Context compared with the UK Giga watt reactor new build programme:

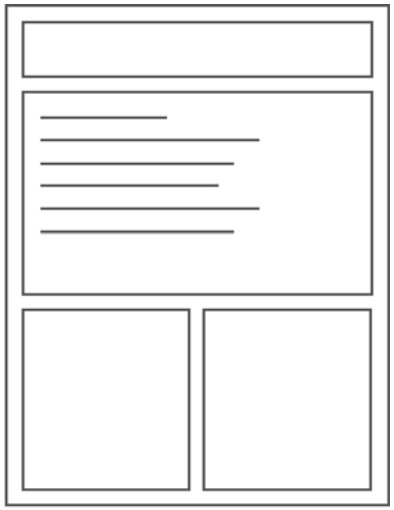
- Faster programme to deployment compared with Giga watt reactors
- UK Government policy for SMRs still being developed
- Proposition not yet commercially proven to potential investors

# Approach To Delivering The SMR Deployment Enablers Project

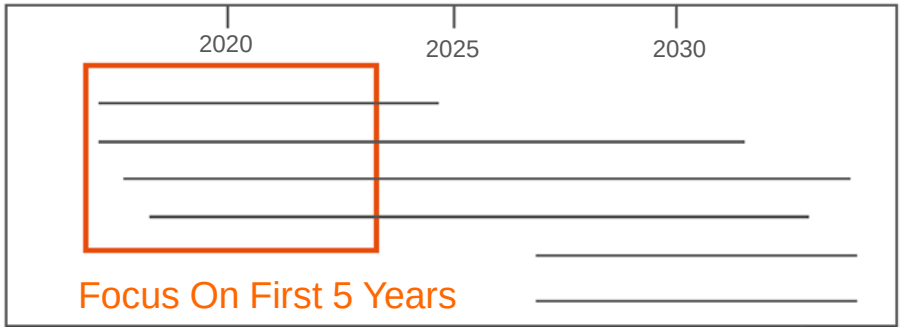
Work Breakdown Structure



One Page Scope Description Per Element



Integrated Schedule



# Conclusions from published ETI insights (1) – More in summer 2016 – "preparing to deploy"

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