

# SMR's – Factors to consider on the way forward

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Chief Scientist

# NNL at a Glance

*NNL: Underpinning the UK's national nuclear fission programmes*

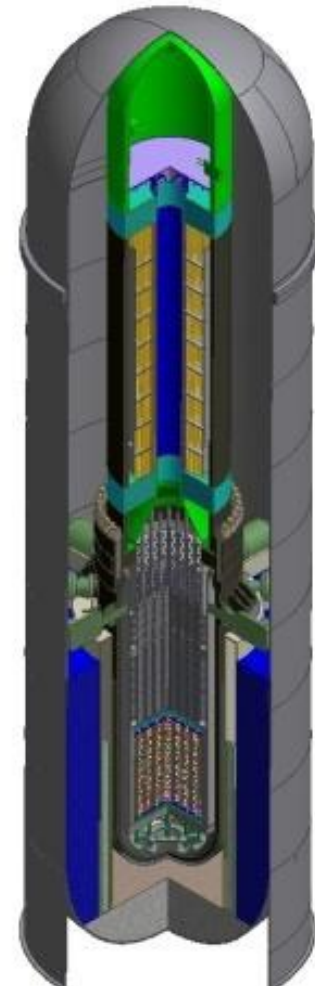
	Key Facts	
<b>Status</b>	GoGo	<ul style="list-style-type: none"> <li>Commercial business model</li> <li>No direct HMG grant funding</li> </ul>
<b>Ownership</b>	BEIS	<ul style="list-style-type: none"> <li>Managed via UKGI (formerly ShEx)</li> </ul>
<b>Revenue</b>	~£100m	<ul style="list-style-type: none"> <li>Sellafield, EdF Energy &amp; MoD</li> </ul>
<b>EBIT</b>	~£10m	<ul style="list-style-type: none"> <li>Reinvested in facilities and R&amp;D</li> </ul>
<b>Headcount</b>	900	<ul style="list-style-type: none"> <li>&gt;60% STEM degrees/PhDs</li> </ul>
<b>Facilities</b>	3 nuclear labs	<ul style="list-style-type: none"> <li>Located on nuclear licenced sites</li> </ul>



Winner  
**RESEARCH & DEVELOPMENT  
Sector Award**  
Winner 2004 - 2008, 2010 - 2011, 2014  
Highly Commended 2009, 2012, 2013



- Various definitions apply
  - IAEA stipulate output <300 MW electrical (MWe) unit size
  - But IAEA also consider <500 MWe as small
  - Designs range from 10 MWe to 600 MWe
    - Lower end range a bit higher than large wind turbines
    - Upper end comparable with existing UK reactors (MAGNOX & AGR)
- Modular deployment
  - Potential applications as single units
  - Or as multiple units making up a large power station



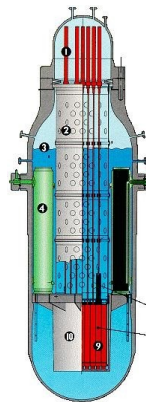
# Range of SMR designs



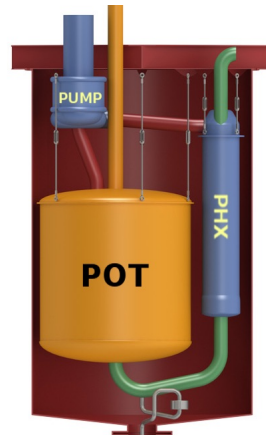
B&W  
mPower



Thorium100  
HTMR100



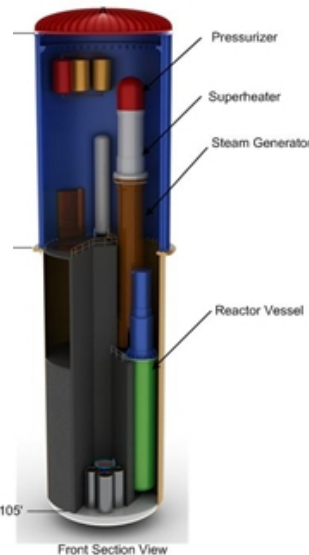
CNEA  
CAREM



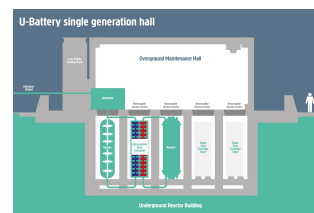
Martingale  
ThorCon



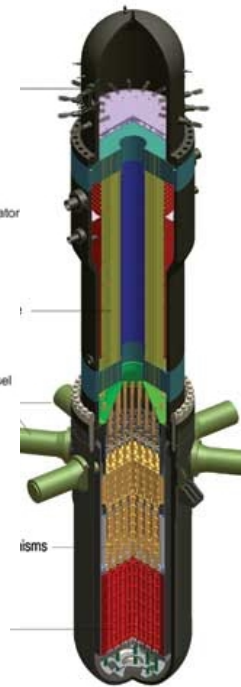
X-Energy  
Xe100



Holtec  
SMR160



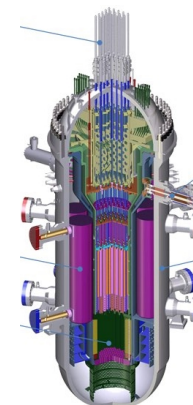
Urenco  
U-Battery



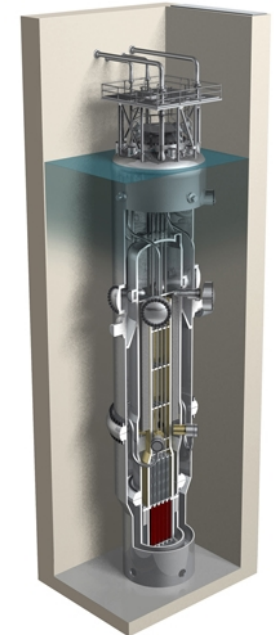
Westinghouse  
SMR



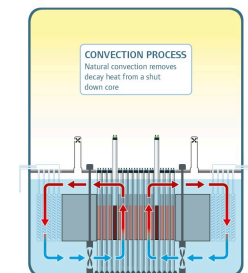
CNNC  
ACP-100



KAERI  
SMART



NuScale

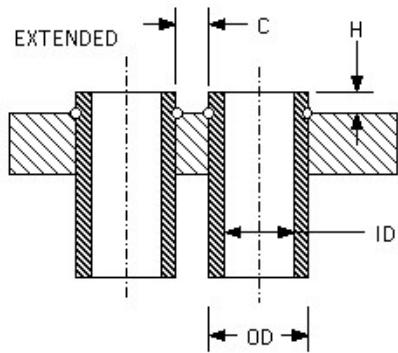


Moltex Energy  
SSR

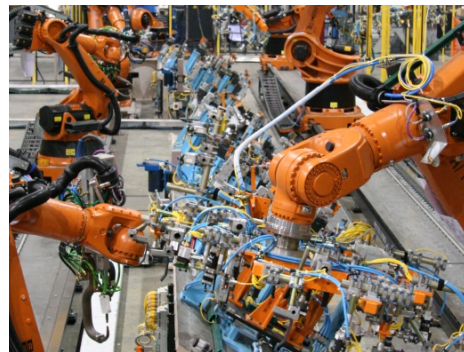
(Not to scale)

# SMRs in the UK – Why?

**Economic driver: opportunity for UK content and IP**



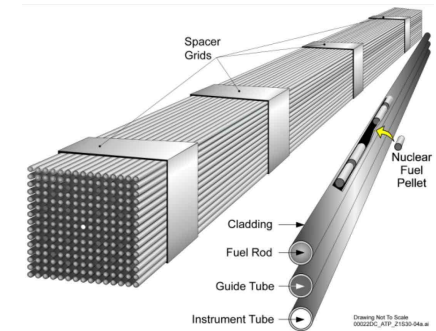
Detailed design



Manufacture



Construction

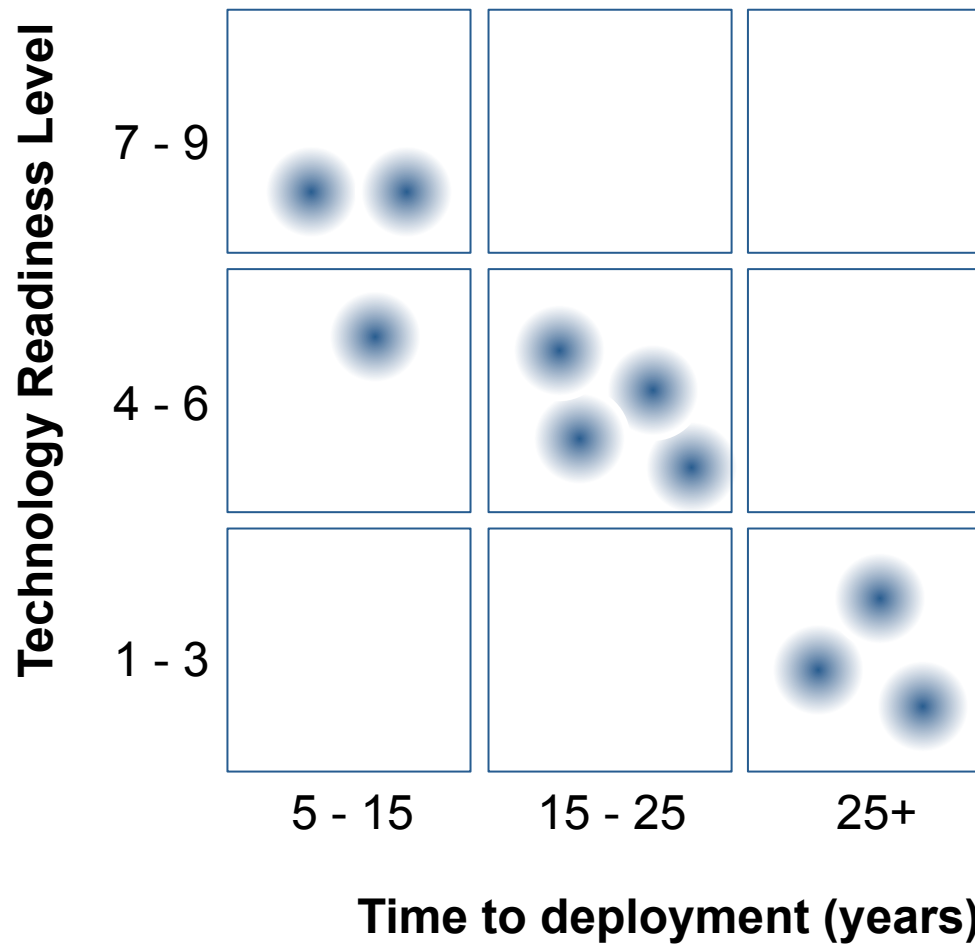


Nuclear fuel

Design for Manufacturing and Assembly (DfMA)

# SMRs in the UK – Why?

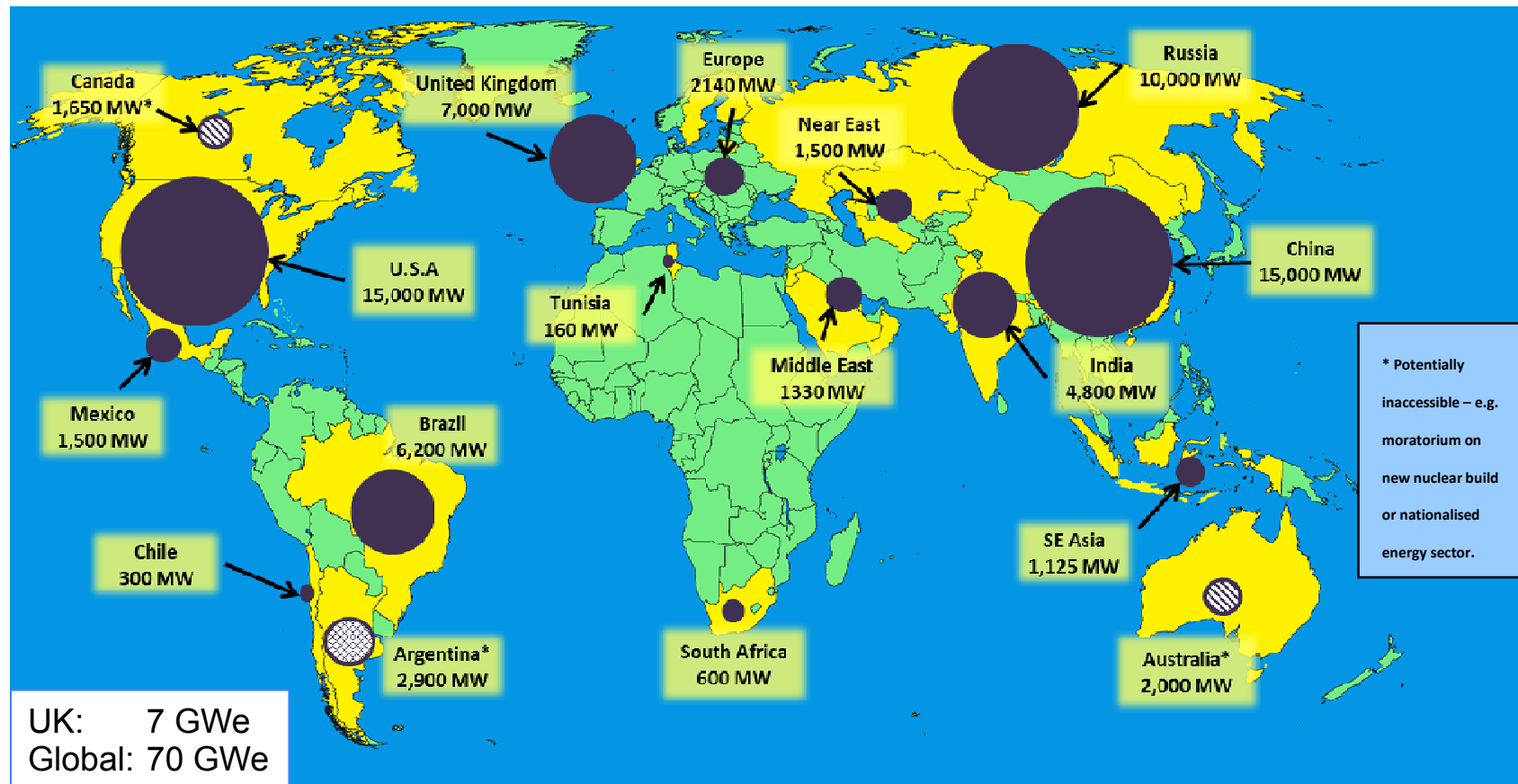
**Economic driver: opportunity for UK content and IP**





# SMRs in the UK – Why?

## Economic driver: international export opportunities



“Small Modular Reactors (SMR) Feasibility Study”, National Nuclear Laboratory, 2014

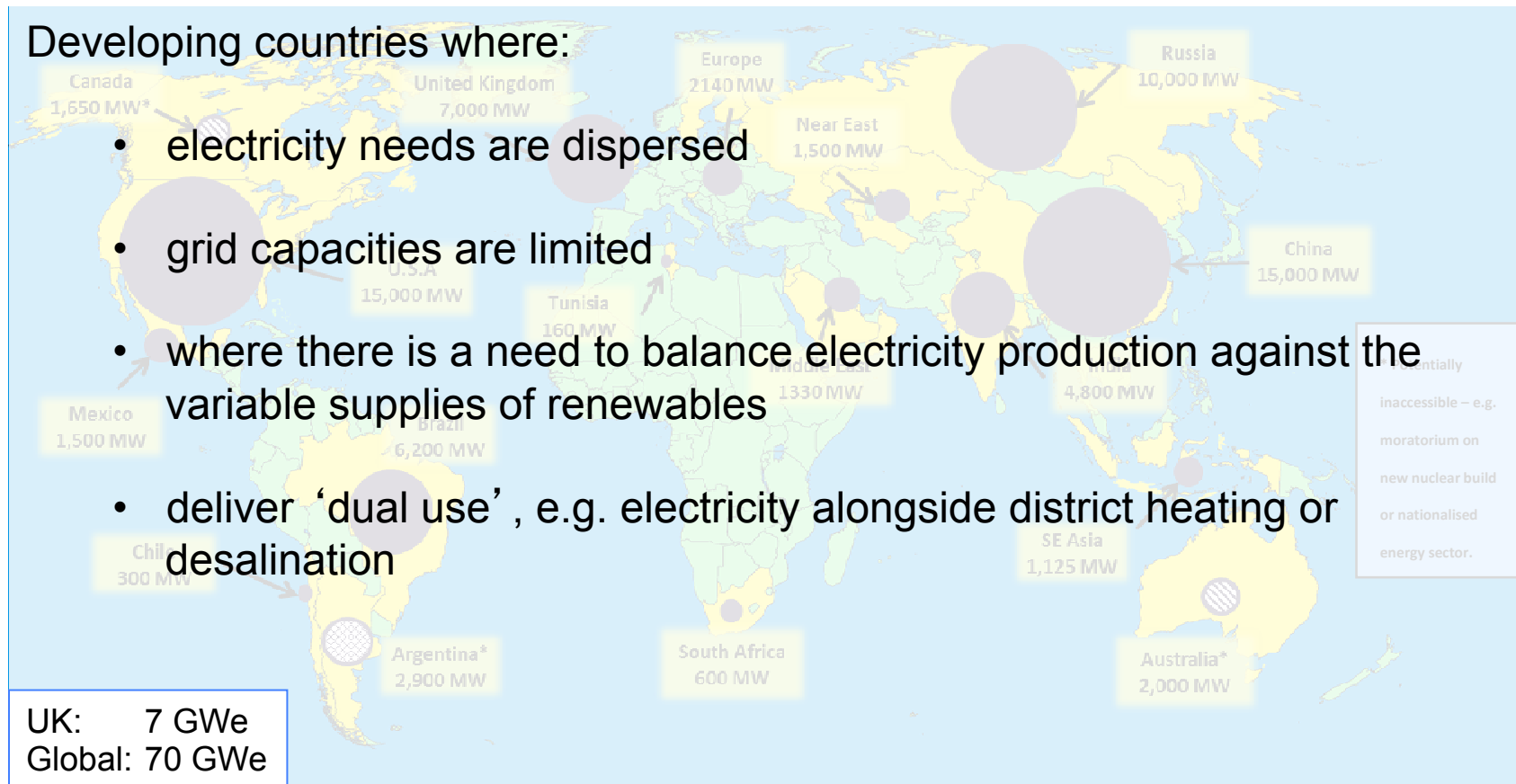
# SMRs in the UK – Why?

## Economic driver: international export opportunities

Developing countries where:

- electricity needs are dispersed
- grid capacities are limited
- where there is a need to balance electricity production against the variable supplies of renewables
- deliver 'dual use', e.g. electricity alongside district heating or desalination

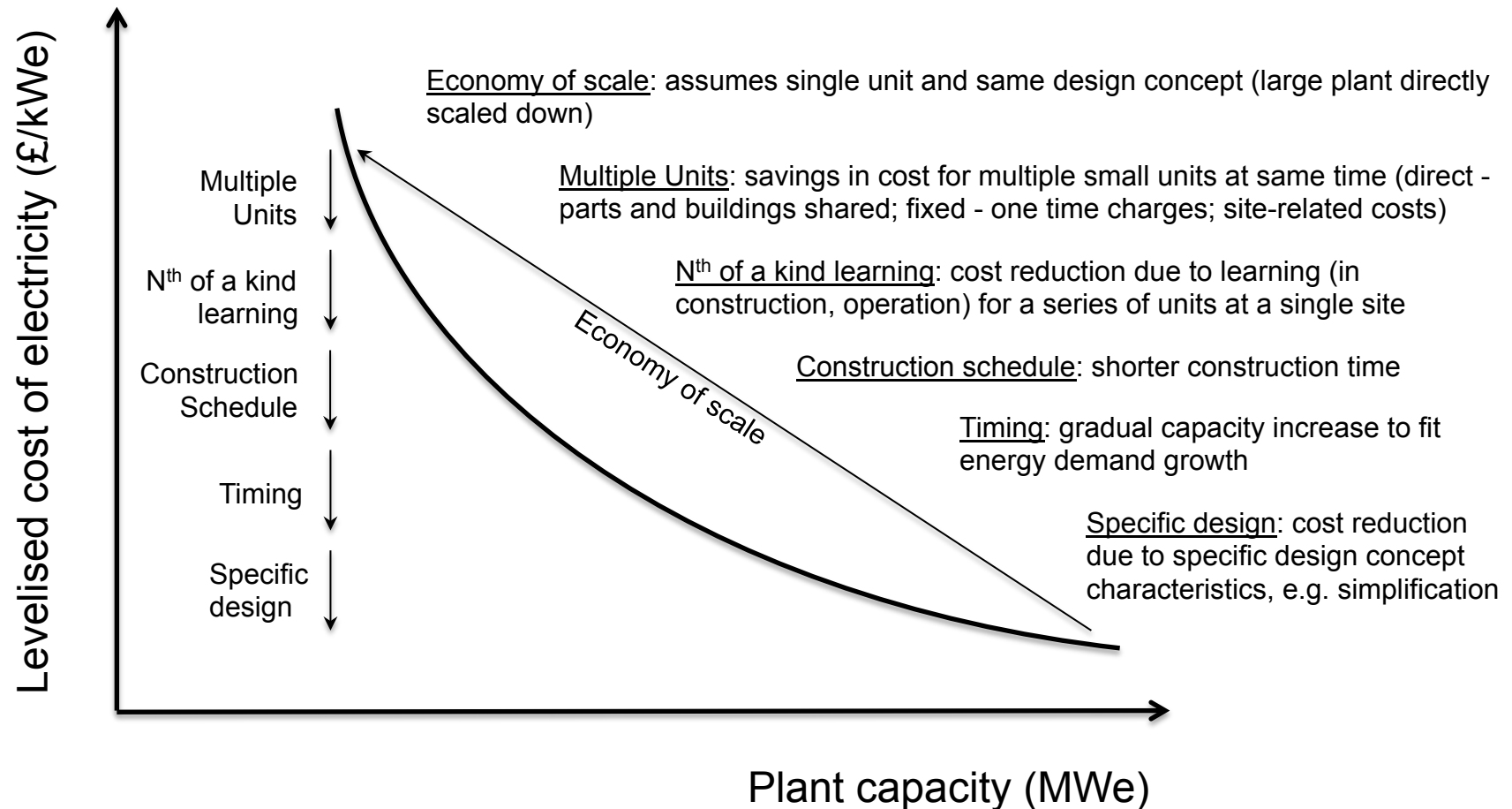
UK: 7 GWe  
Global: 70 GWe





# SMRs in the UK – Why?

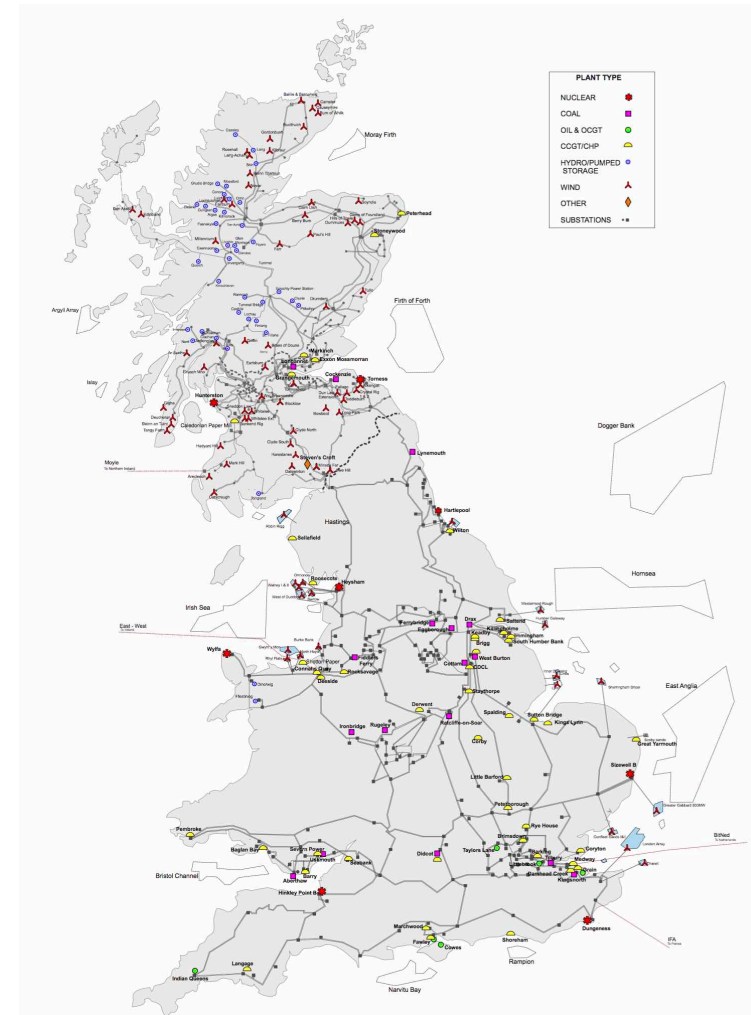
## Energy driver: levelised cost of electricity



# SMRs in the UK – Why?

## Energy driver: fit within the UK energy network

- Siting assessment
  - 250 potential sites
  - Up to ~70GWe
- SMR application
  - Baseload power
  - Variable power (load follow)
  - Dual use (district heating)







- **The UK has missed the boat on large nuclear plants**
  - **There is no established market for SMRs and therefore the opportunity for the UK is to become involved in investment and manufacture**
  - **Need to find the right level of involvement**
  - **The UK licencing process (GDA) is highly regarded and a potential strong point for the UK**
  - **Key areas of potential exploitation are**
    - ✓ **Design, development, innovation and testing**
    - ✓ **Licensing & Construction**
    - ✓ **Operating and maintenance**
- 



- SMRs are no doubt technically viable and could be successfully licensed
- A number of drivers for the UK to engage in SMRS: economic & energy
- Need to recognise that there are multiple design hurdles to overcome that will need significant investment



- The theoretical advantages of SMRs with respect to financing and affordability needs to be balanced against adverse scaling and design trends
- The most difficult aspect will be to strengthen the business case so that the necessary financial investment can be made

# NATIONAL NUCLEAR LABORATORY

