Decarbonisation and Electricity System Security Scenarios for the UK in 2050

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Context

he UK Energy White Paper - Goal of 60% emissions cut by 2050
ecommended by Royal Commission on Environmental Pollution

ummer 2003 power blackouts: Many causes, many theories.
ut focused minds on importance of system security

hetoric about ‘Rewiring Britain’: Focus on action now, with first
noves to revitalise innovation in electricity networks

lready clear that fundamental change necessary to
lecarbonise electricity *and* retain/improve system security

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Security of Decarbonised Electricity Systems (2002-2004)

Collaboration of UMIST, SPRU and Warwick Business School

Aim is to explore the security of a decarbonised electricity system in the UK, with a focus on 2050:

- Develop alternative scenarios for electricity system in 2050
- Model the security of these scenarios on an hourly, daily, seasonal and annual basis
- Investigate economic and environmental consequences
- Examine policy and regulatory approaches to support the development of these systems

Applying the Royal Commission Scenarios to Electricity

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Royal Commission Scenarios

Four energy scenarios for 2050 to explore different ways of achieving a 60% cut in UK carbon emissions:

1. Demand remains at 1998 level. Electricity from renewables and nuclear power stations (or fossil fuel stations with sequestration)
2. 36% demand reduction. Electricity from renewables with some fossil stations for balancing and peaking; no nuclear.
3. 36% demand reduction. Electricity from renewables and nuclear power stations (or fossil fuel stations with sequestration)
4. 47% demand reduction. Electricity from renewables with some fossil stations for balancing and peaking; no nuclear.

In all scenarios, transport and some of heat demand met by oil and natural gas.

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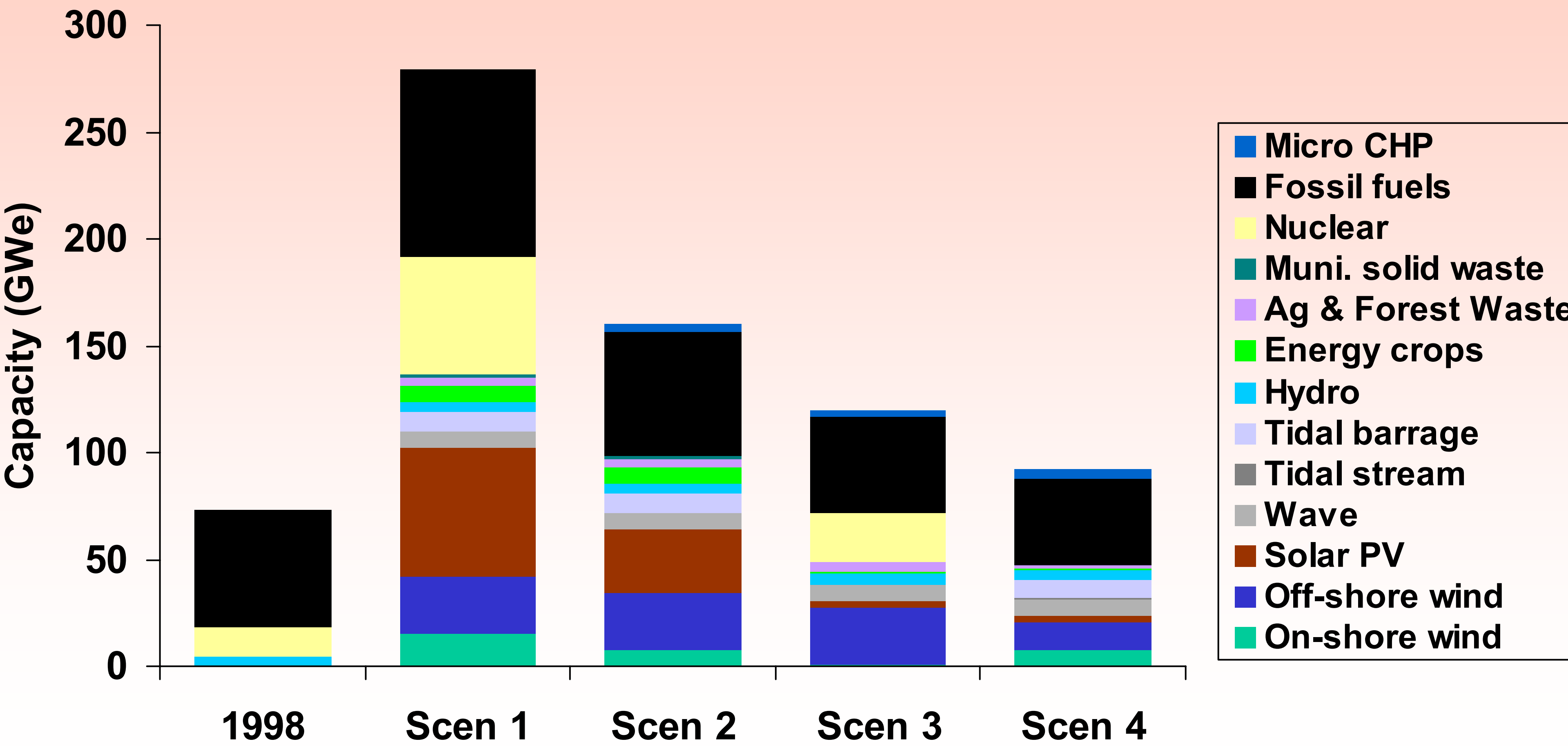
Generation Capacity



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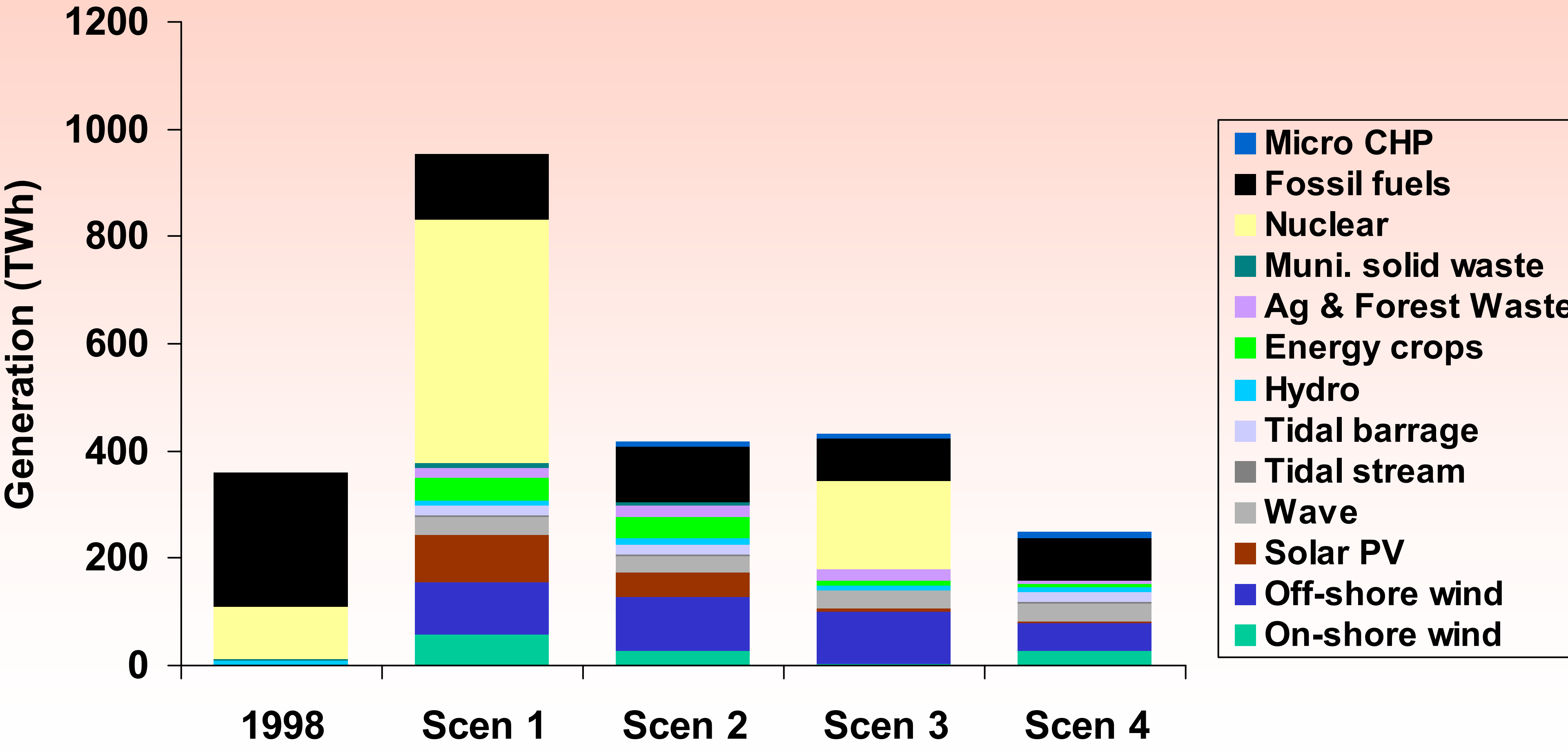
Annual Electricity Generation



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Observations

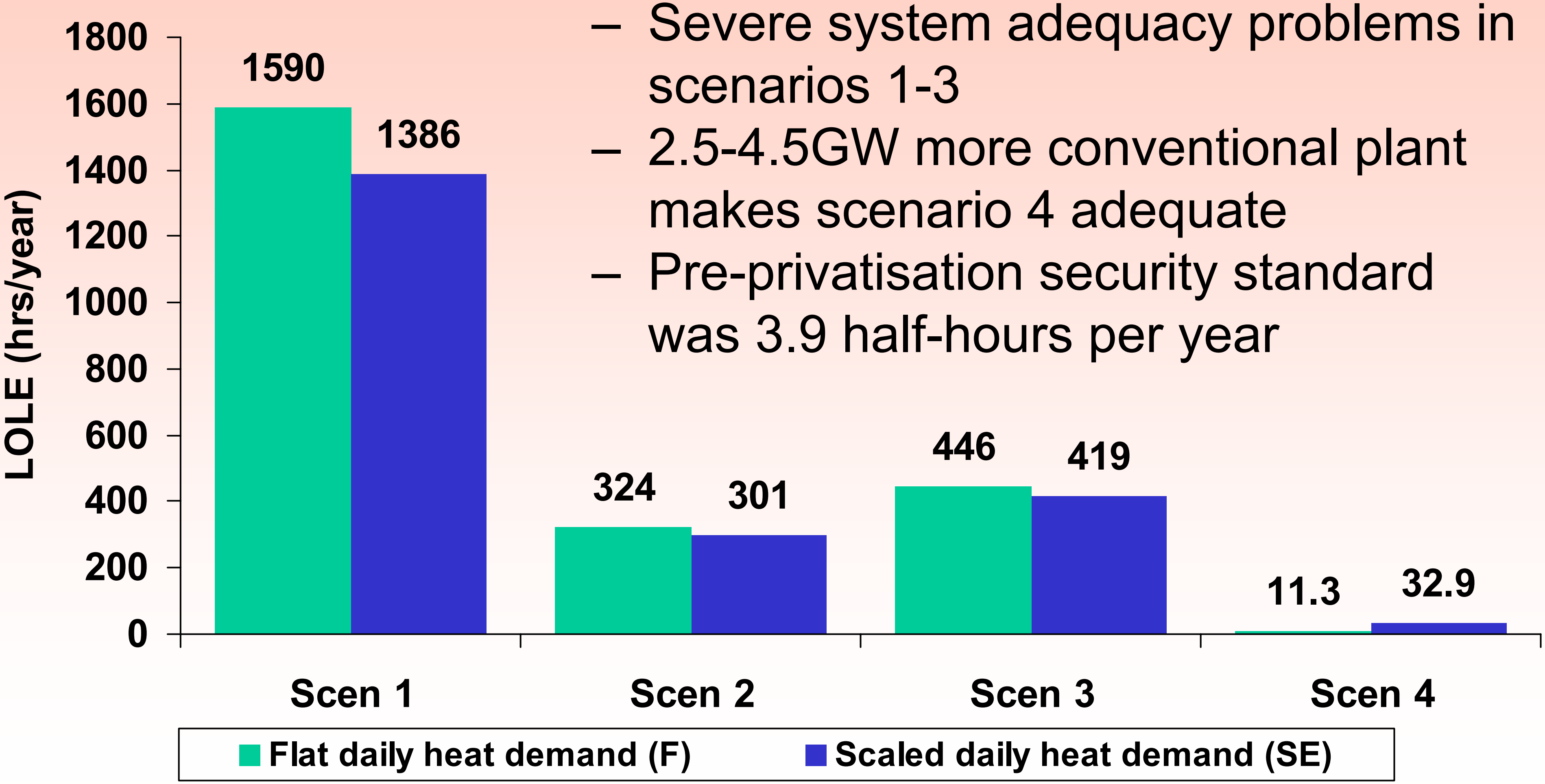
- \ lot of electricity for heat production, particularly in scenario 1
- Reduced role for fossil, but significant capacity is still required
- scenarios have significant nuclear or fossil/sequestration nvestment programme - issues of acceptability and cost
- .arge improvements in energy efficiency - contrary to historical rend
- Vhere are the new supply/network technologies ?
  - Little for the hydrogen enthusiast
  - Tidal and wave not seen as important, even in the long term
  - No wild cards - today's dominant technology (the CCGT) was unheard of in 1950
- 3ut scenarios are a good start to test limits of system security.

Analysis of System Security

Methodology

- **Focus on system adequacy: Is there enough generation to satisfy load in each half-hour of a typical year ?**
- **Used Monte Carlo simulations and analytical techniques**
- **Generation:**
  - Typical daily profiles for renewable technologies
  - A two state model for 500MW fossil and nuclear stations
- **Demand:**
  - Daily and seasonal electricity demand profiles from National Grid Transco (public data)
  - Estimated seasonal heat demand (no public data), with two possible daily profiles - flat and scaled from electricity

Results - Loss of Load Expectation



- Severe system adequacy problems in scenarios 1-3
- 2.5-4.5GW more conventional plant makes scenario 4 adequate
- Pre-privatisation security standard was 3.9 half-hours per year

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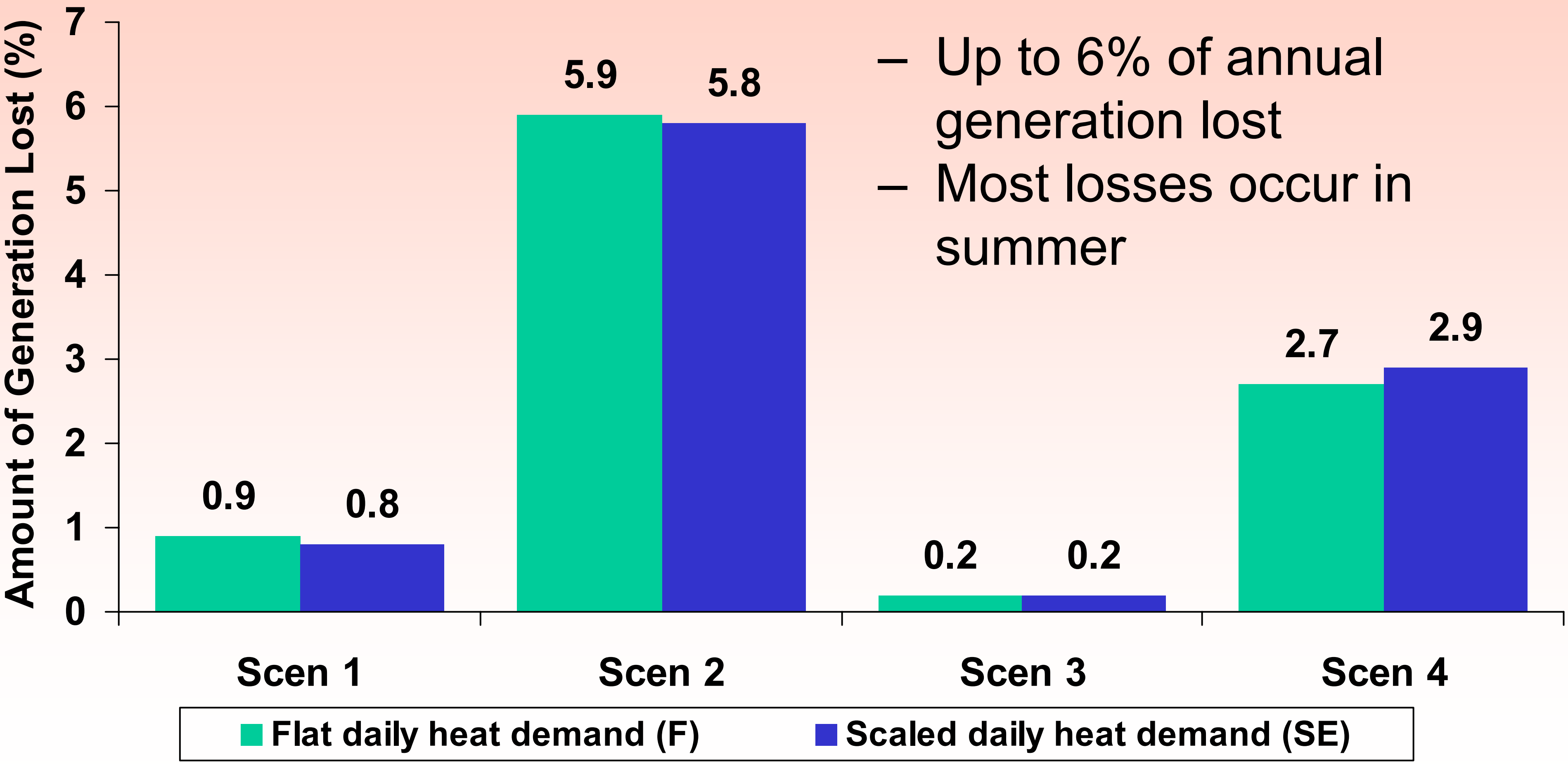
Results - Renewable Electricity Lost



- Up to 6% of annual generation lost
- Most losses occur in summer

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Conclusions

Results highlight major security issues:

- Scenarios 1-3 have severe adequacy problems
- Scenario 4 is adequate if a few more conventional units added
- Curtailment of renewable generation significant, particularly in scenario 2

But:

- Do these scenarios test limits of system security? What is impact of more micro-CHP or different renewables? Can fossil and nuclear technologies provide necessary services?
- More accurate heat demand profiles would help validate results
- Data does not allow analysis of controversial 'no wind day' issue

Some Implications

- **Vhat kind of security standard should be used for this kind of nalysis? Is state-owned CEGB standard useful any more?**
- **leed economic incentives for balancing and back-up plant - the eturn of the capacity payment?**
- **Costs of new infrastructure as well as costs of new generation, ut dispute over figures:**
  - 6GW of wind in Scotland: £5bn of transmission investment
  - 26GW of wind in UK: £1.7-3.3bn of transmission investment
- **ctive networks with control and IT technologies could change conomics - towards *economies of system***