

The Innovation Imperative for MSRs from an Environmental Perspective

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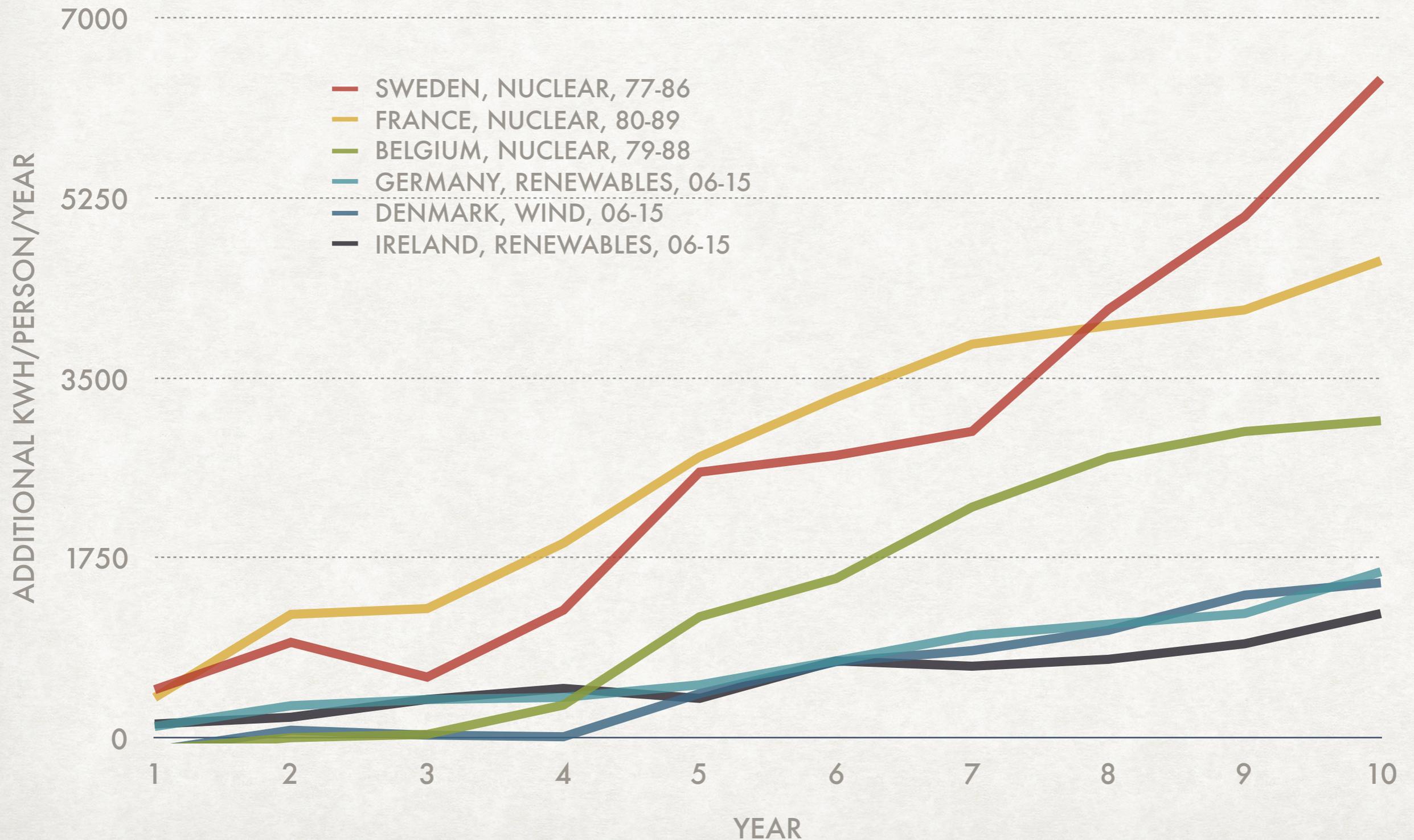
THIRTY SECONDS: THE NUCLEAR IMPERATIVE

THE OBVIOUS

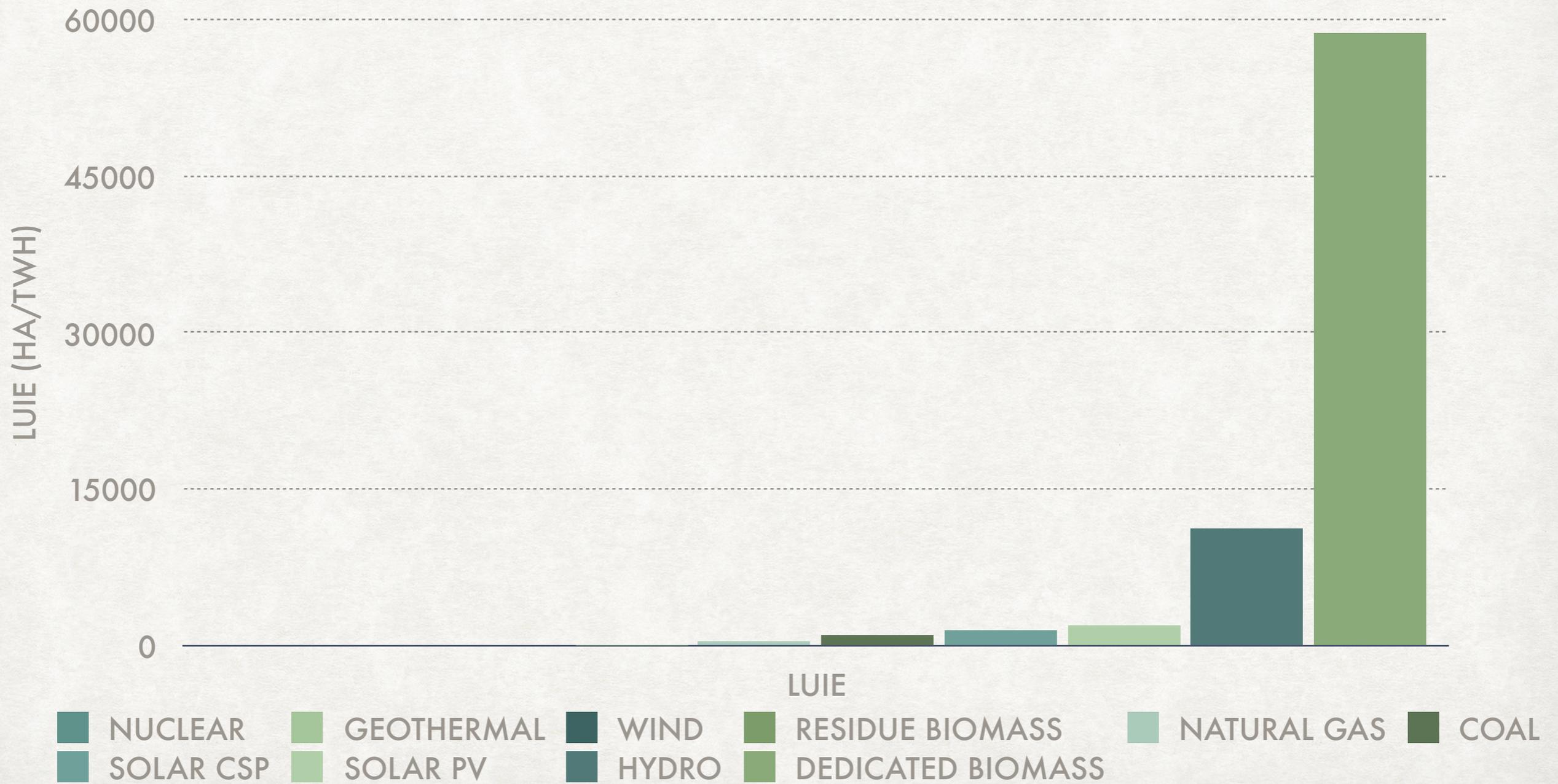
- Need large amounts of carbon-free energy to mitigate climate change.
- Difficult to meet even moderate decarbonization goals like Clean Power Plan and COP 21 IDNC without additional nuclear
- Decarbonization Scenarios
 - Williams, J.H., B. Haley, F. Kahrl, J. Moore, A.D. Jones, M.S. Torn, H. M. Pathways to Deep Decarbonization in the United States. (2014)
 - IEA. World Energy Outlook 2015
 - MacDonald et al. Future cost-competitive electricity systems and their impact on US CO2 emissions. *Nature Climate Change* 6, 526–531 (2016)

SPEED OF CLEAN ENERGY DEPLOYMENT

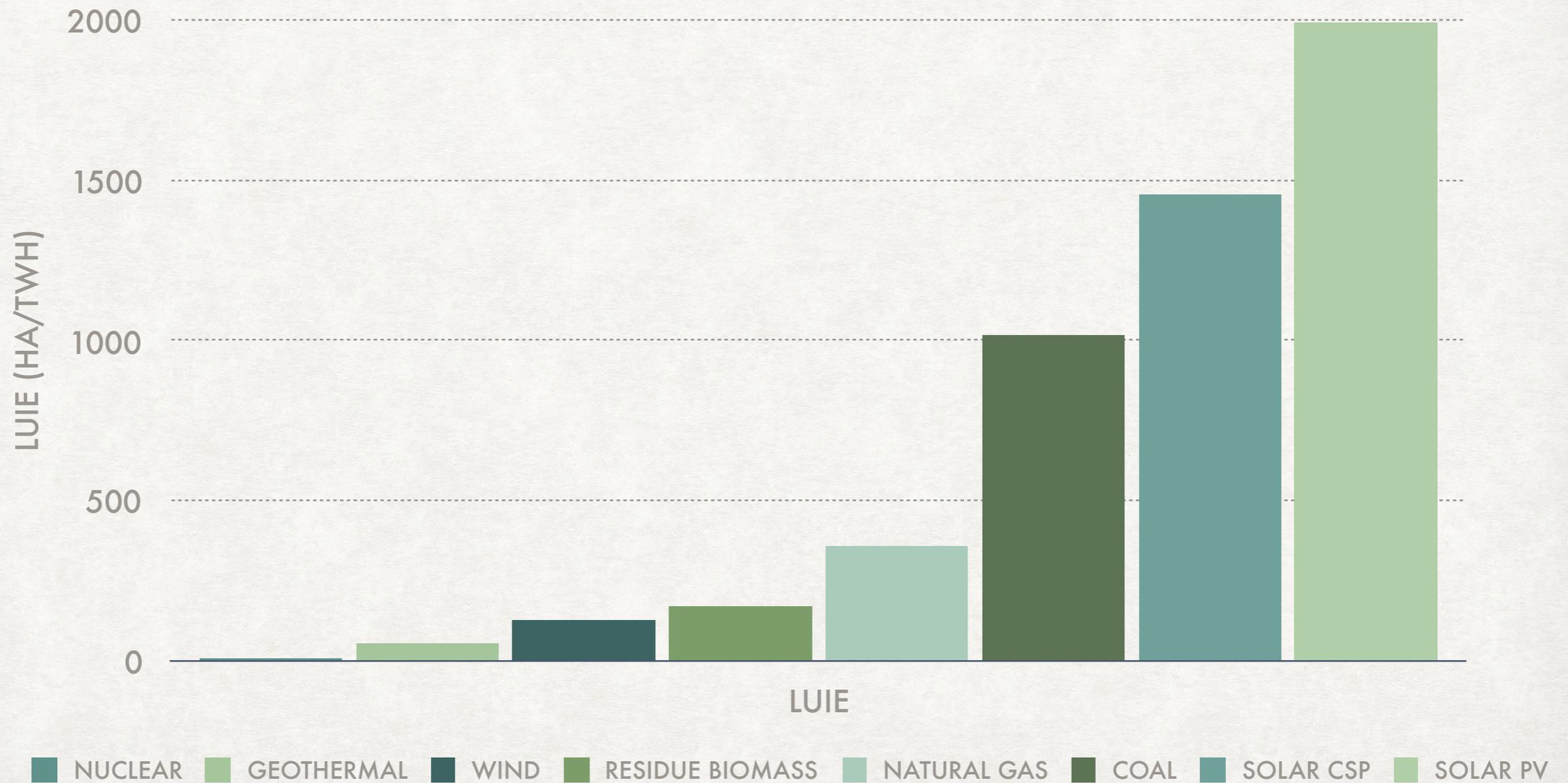
ENERGY ADDED PER PERSON IN A DECADE



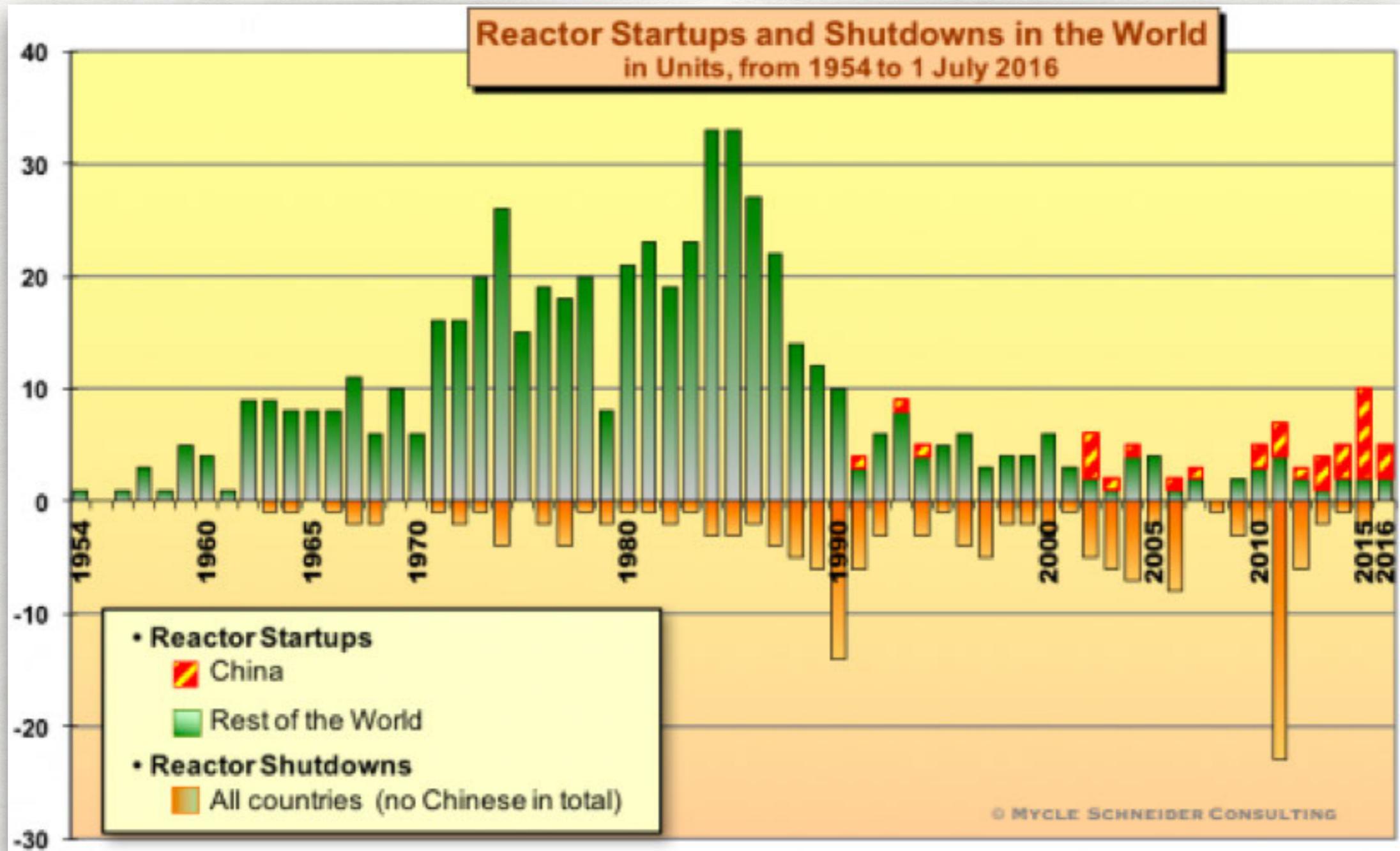
LAND USE INTENSITY OF ELECTRICITY PRODUCTION



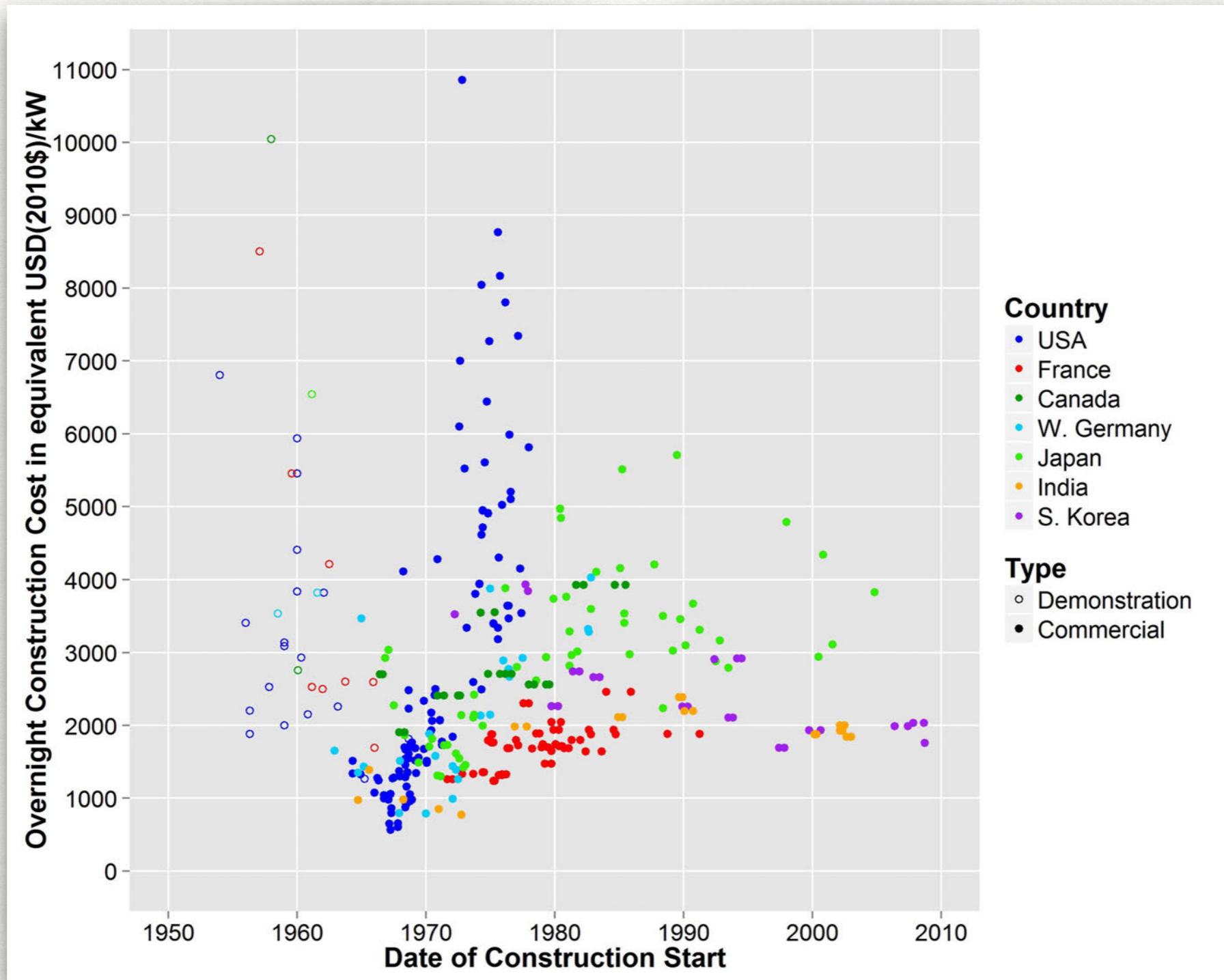
LAND USE INTENSITY OF ELECTRICITY PRODUCTION



THE INNOVATION IMPERATIVE



HISTORICAL CONSTRUCTION COSTS



Lovering, J. R., Yip, A. & Nordhaus, T. Historical construction costs of global nuclear power reactors. *Energy Policy* 91, 371–382 (2016).

HOW TO MAKE NUCLEAR CHEAP

2013 REPORT

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HOW TO MAKE NUCLEAR CHEAP



SAFETY, READINESS,
MODULARITY, and EFFICIENCY

TED NORDHAUS, JESSICA LOVERING,
AND MICHAEL SHELLENBERGER

- Inherent or Intrinsic Safety
- Technological Readiness
- Modular Fabrication
- Efficiency

BENEFITS OF MOLTEN SALT REACTORS

- Compact design and ambient pressure lends itself well to full modularization
- TRISO fuel or liquid fuel cuts down development time.
- Inherent safety can reduce EPZ and staffing requirements
- Depending on the design: can use off-the-shelf technology and materials, can recycle or manage spent-fuel on site.
- High Temperatures!
 - Process heat applications (decarbonize industry)
 - Hydrogen production
 - Combined heat and power
 - Desalination

URANIUM MINING

SMALL PHYSICAL FOOTPRINT, BIG EMOTIONAL FOOTPRINT



MODERN INNOVATION SYSTEM

- Need early input from customers: the utilities or industries
- Start public engagement now, get people excited
- Global supply chain: big potential benefits, big challenges
- Role for Federal Government
 - Create Demand Pull (price on carbon, clean energy standard, ITC, PTC)
 - Streamline licensing and regulation
 - Support export opportunities

CASE STUDY: AIRCRAFT MANUFACTURING

- Airlines deregulated in 1970s
- Aircraft manufacturers consolidated, now a duopoly in large aircraft production
- Innovation focused on reducing operating costs and increasing value of product
 - Fuel Efficiency
 - Reduced maintenance
 - Customizable, Flexible designs
 - Globalized Supply Chain



CASE STUDY: COMMERCIAL SPACE FLIGHT

- Two major disasters, retirement of shuttles
- Change in NASA's mission and objectives
- NASA announced Commercial Orbital Transportation Services (COTS) in early 2006, with later Cargo Resupply Services (CRS)
- Dozens of applicants, first awards go to new entrants, not the large incumbents
- First delivery of cargo to ISS in 2012





THANK YOU!

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