

Great Lakes Energy Institute: Addressing the World's Most Pressing Energy Issues

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3 topics in 30 minutes

Historical lessons

Energy trends

Vignettes in future energy trends



LESSONS LEARNED FROM PAST ENERGY SYSTEMS

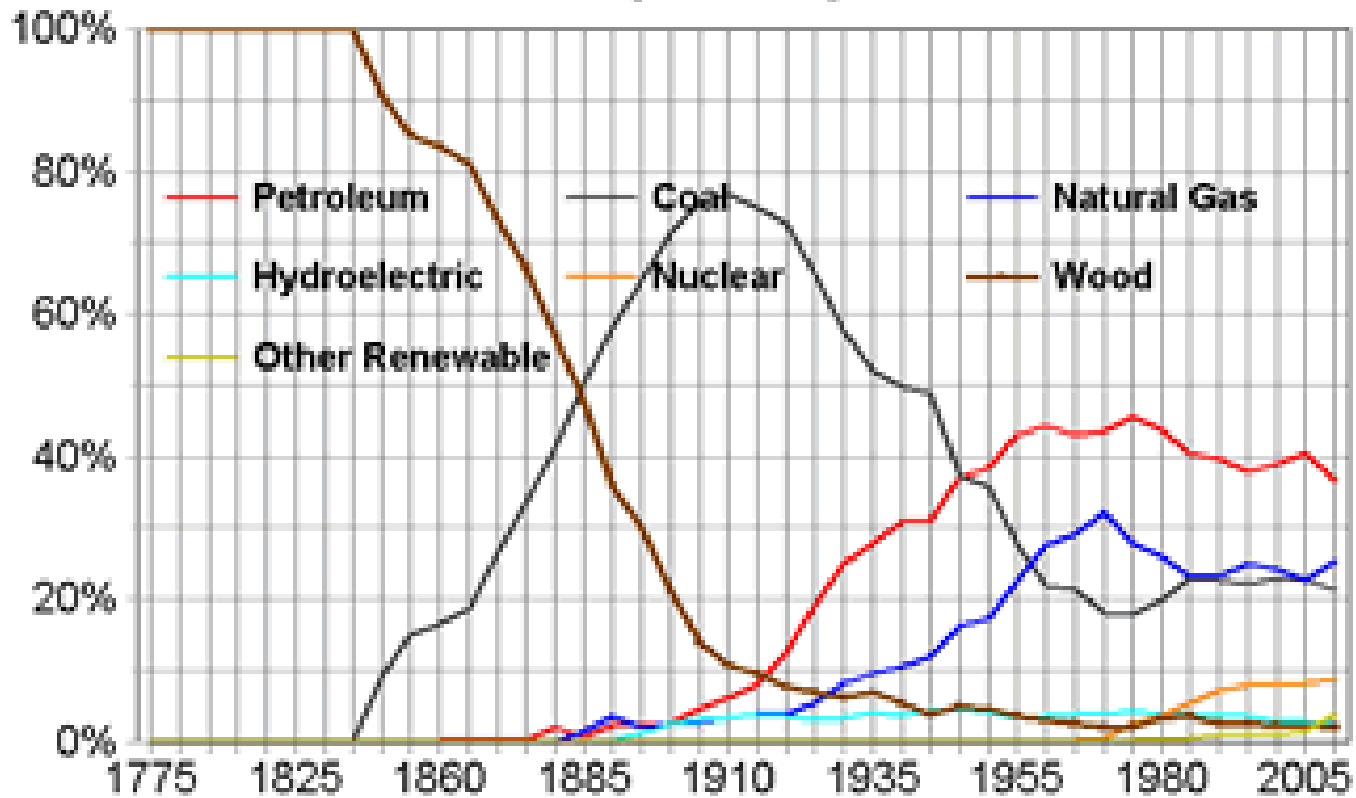
- Collaboration necessary
- Systems include more than infrastructure, e.g. markets, policy, etc.
- Energy policy can work at a federal level

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TECHNOLOGY ADOPTION CURVES CHANGING

Market Share - Energy Consumption By Primary Fuel



1775 - 2010 Source: EIA

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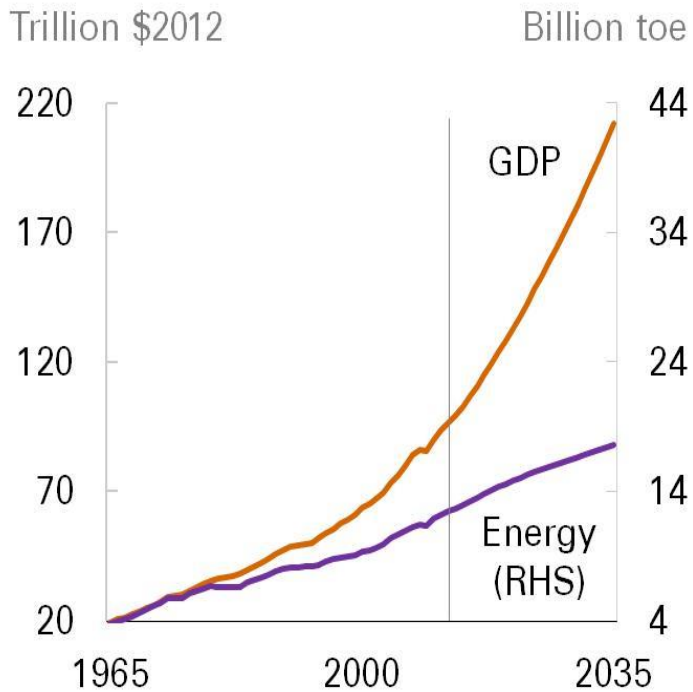


NATURAL GAS REPLACING COAL AND OIL

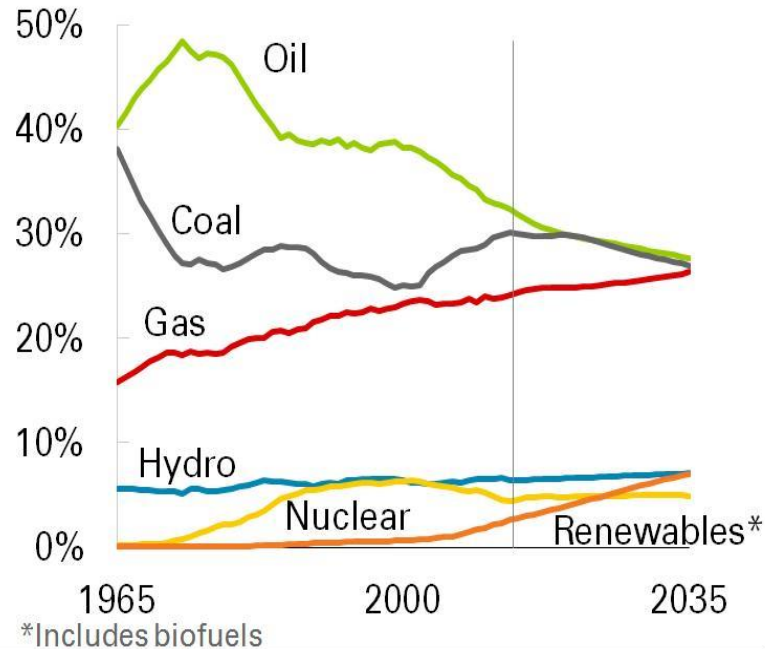
Energy decouples from GDP and fuel mix evolves



GDP and energy



Shares of primary energy



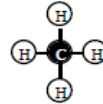
Energy Outlook 2035

© BP 2014



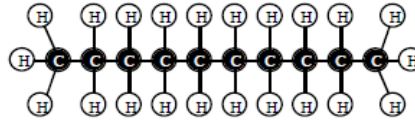
Carbon-Hydrogen Composition of Fossil Fuels

Methane Gas



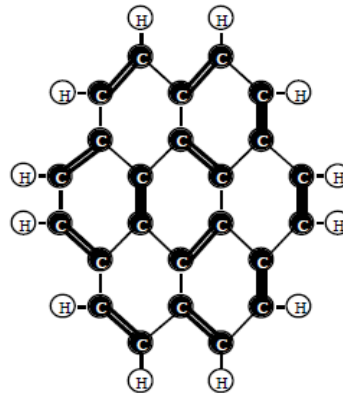
C:H = 1:4

Typical Oil



C:H = 1:2

Typical Coal



C:H = 2:1

Source: Ausubel 1996, after Marchetti 1985

Data sources IIASA, BP (1965-2001), CDIAC http://cdacesdomigovtrends/emis/em_cont.htm

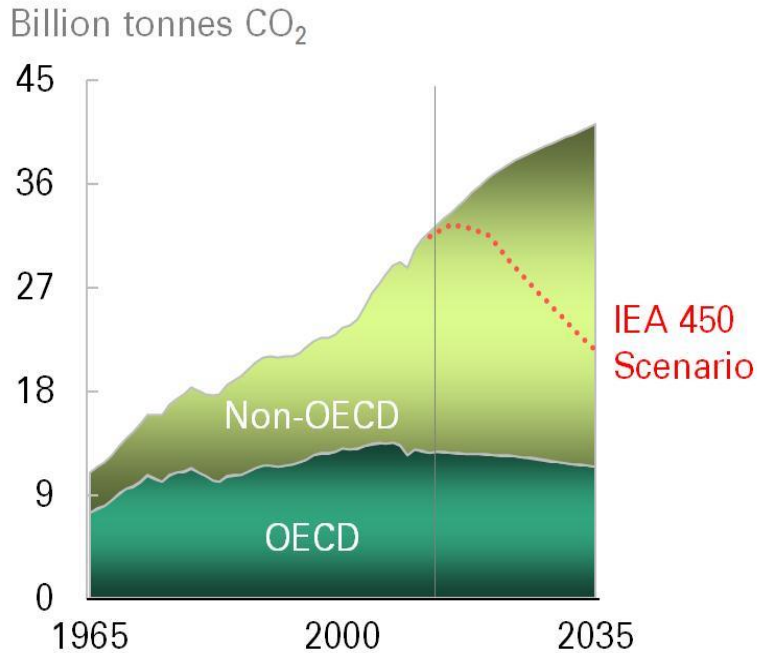


CARBON EMISSIONS ARE RISING

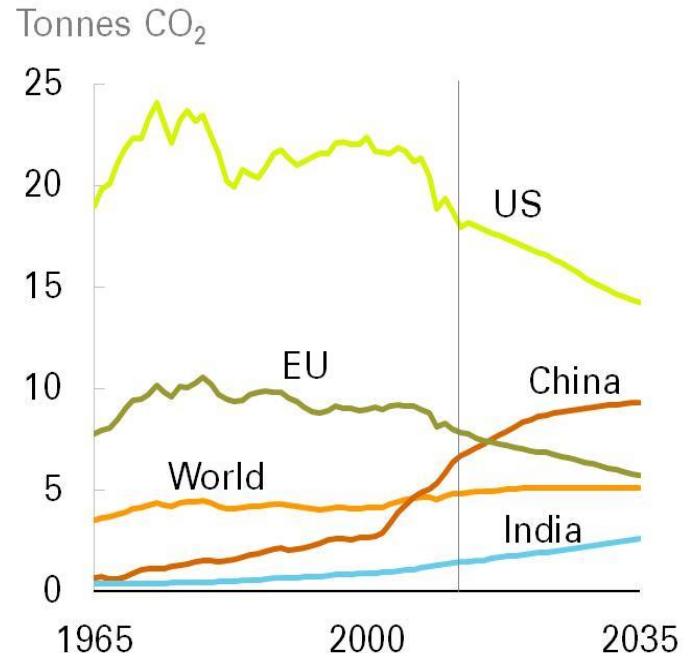
CO₂ emissions from energy use continue to rise



Emissions by region



Emissions per capita



Energy Outlook 2035

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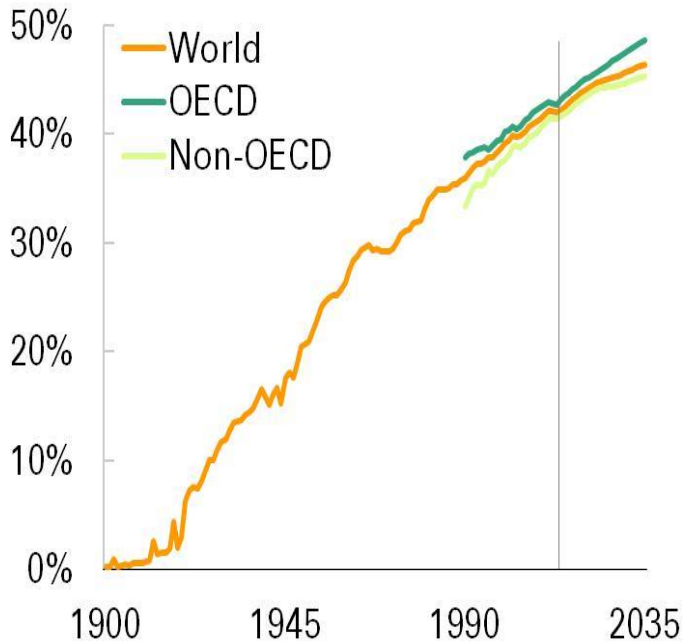


GROWTH AND DIVERSITY OF SUPPLY IN THE POWER SECTOR INTENSIFIES

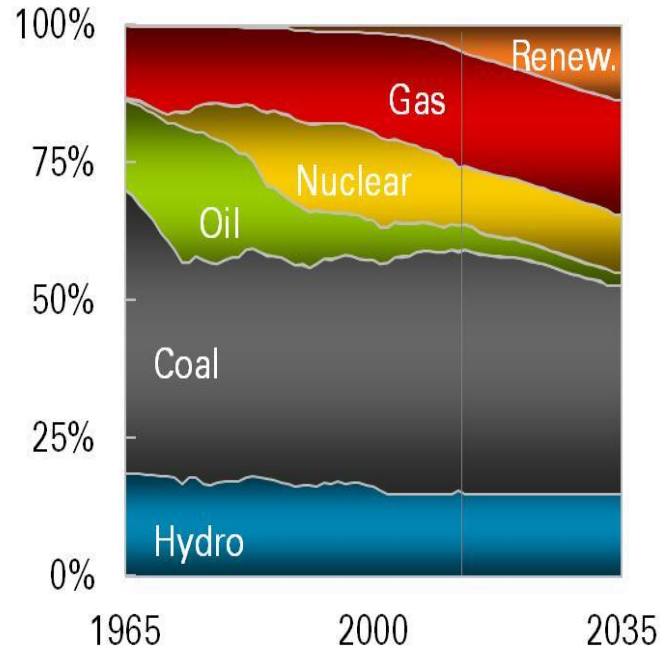


The power sector takes an increasing share of energy

Inputs to power as a share of total primary energy



Primary inputs to power



AGENDA

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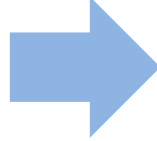


ELECTRICITY SYSTEMS IN TRANSITION

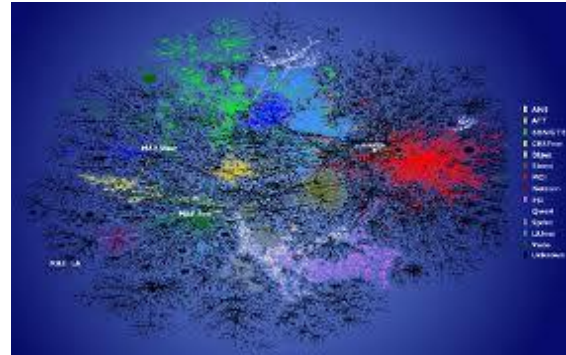
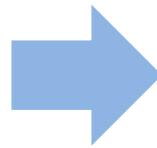


Central to
distributed

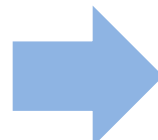
Intermittent



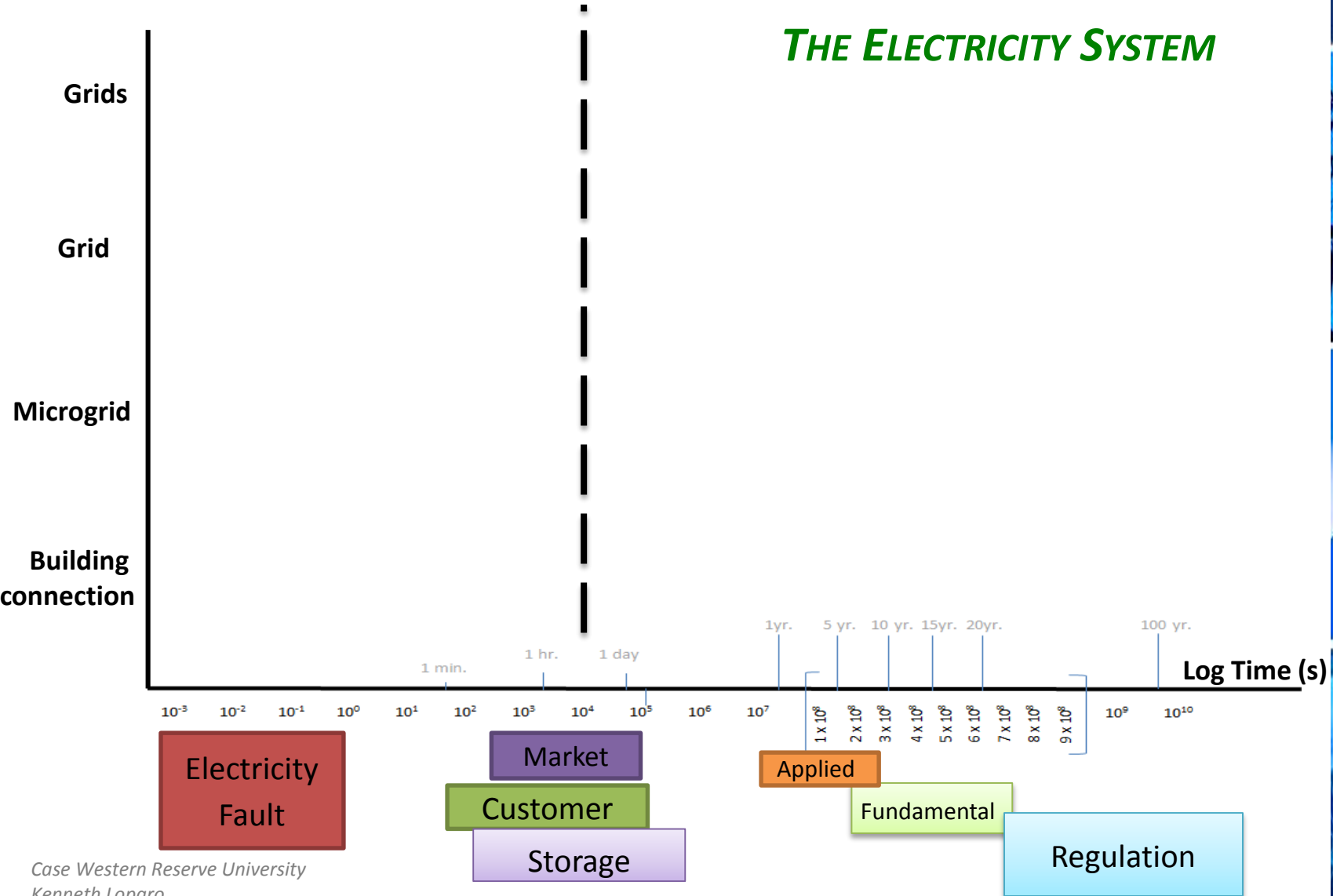
Plumbing to
Internet



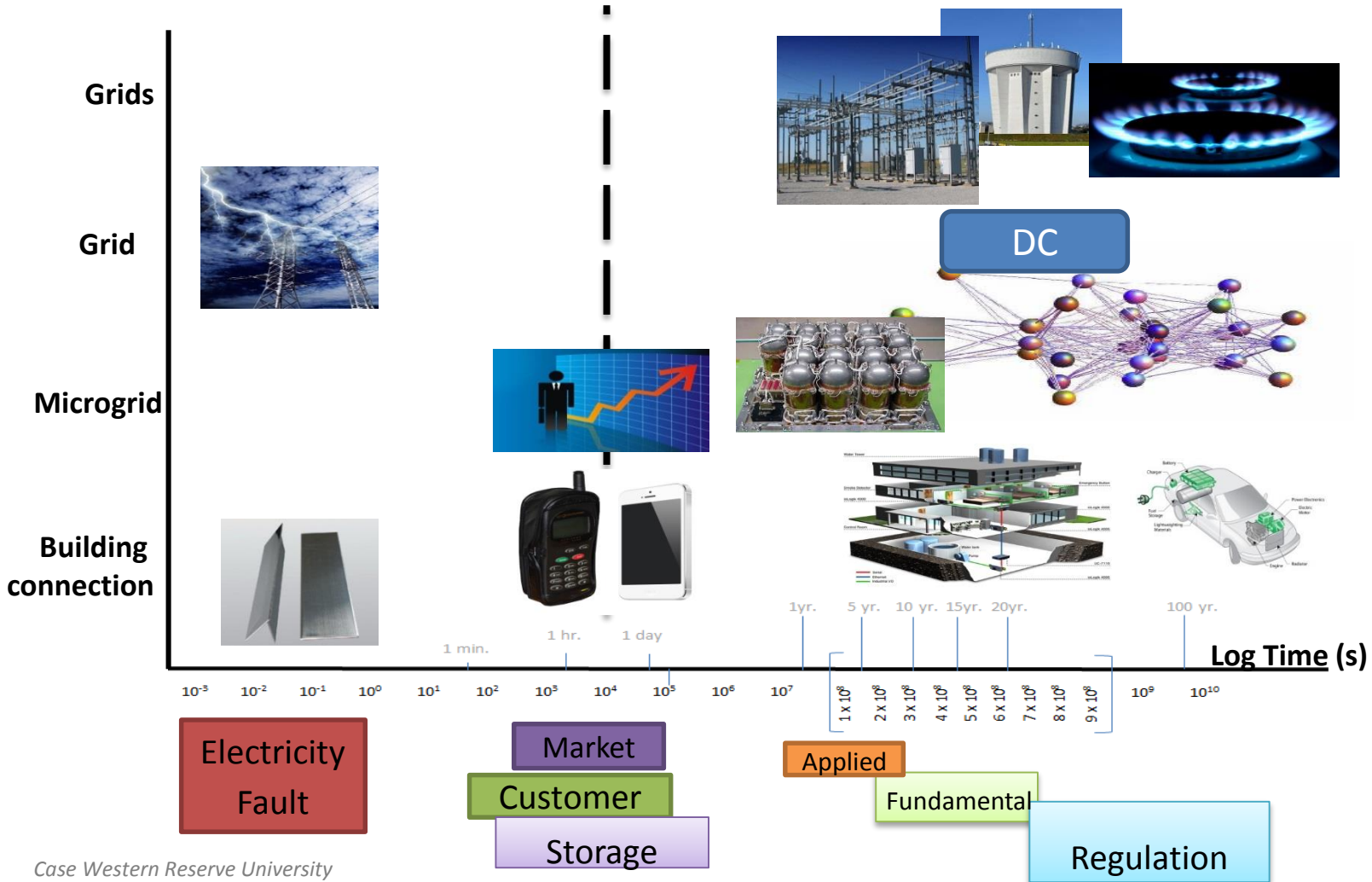
Predictable to
Smart &
customer
intervention



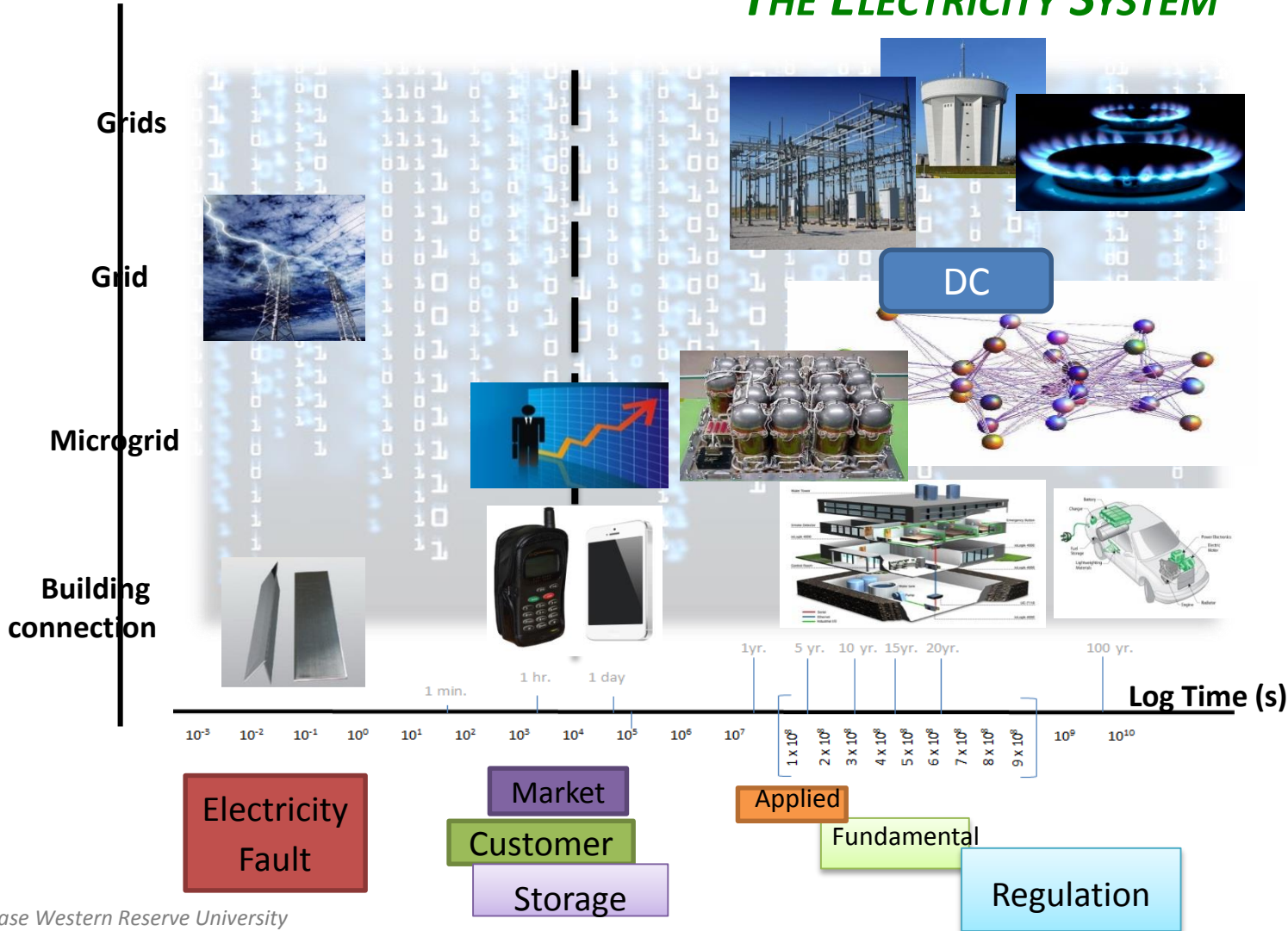
SYSTEMS OF SYSTEMS *THE ELECTRICITY SYSTEM*



SYSTEMS OF SYSTEMS THE ELECTRICITY SYSTEM

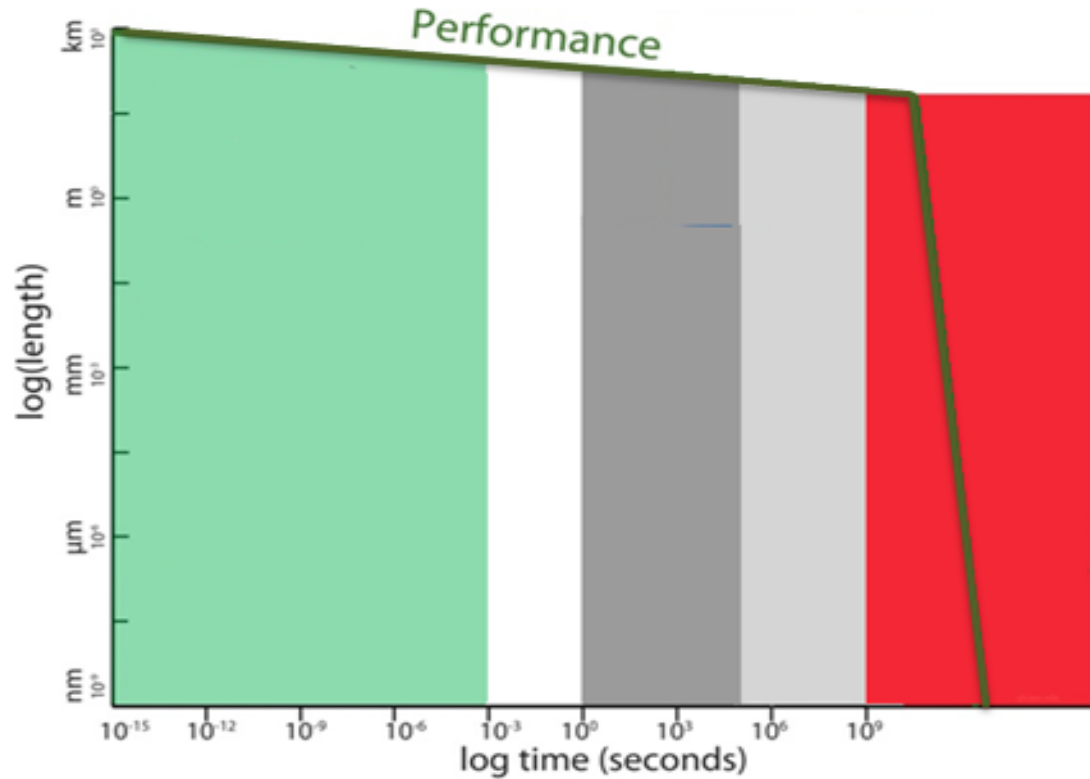


SYSTEMS OF SYSTEMS THE ELECTRICITY SYSTEM



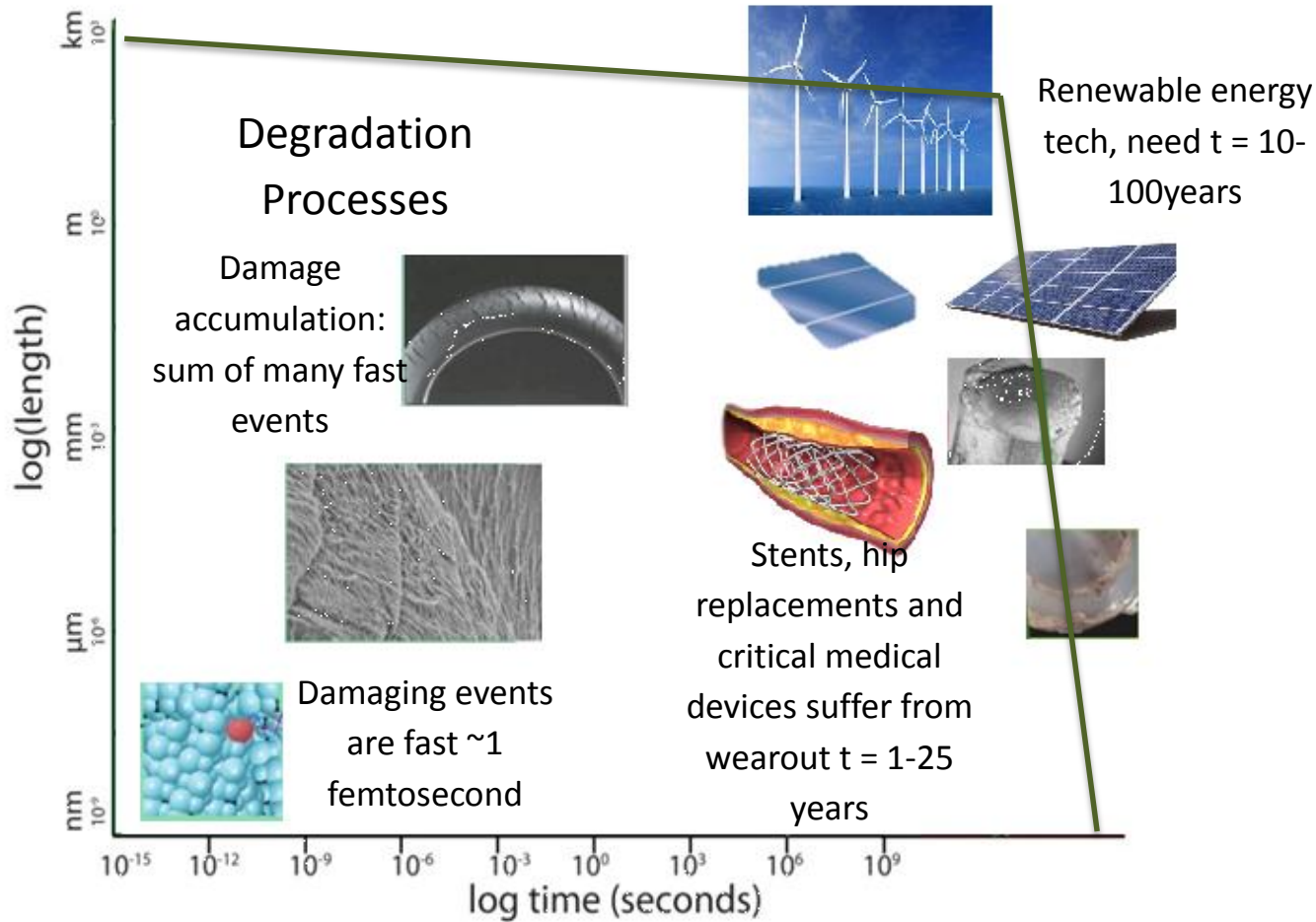
SYSTEM OF SYSTEMS

SCIENCE OF LIFETIME AND DEGRADATION



SYSTEM OF SYSTEMS

SCIENCE OF LIFETIME AND DEGRADATION



WHAT ROLE CAN YOU PLAY IN ENERGY'S FUTURE

- **Playwright** Framework of future energy
- **Producer** Support for energy standards and policy
- **Director** Collaboration creators
- **Actresses/Actors** Advocates
Researchers
Funders
Customers
- **Critics** Risk management & unintended consequences

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