Climate READi

EPRI's Climate Resilience and Adaptation Initiative for the Power Sector

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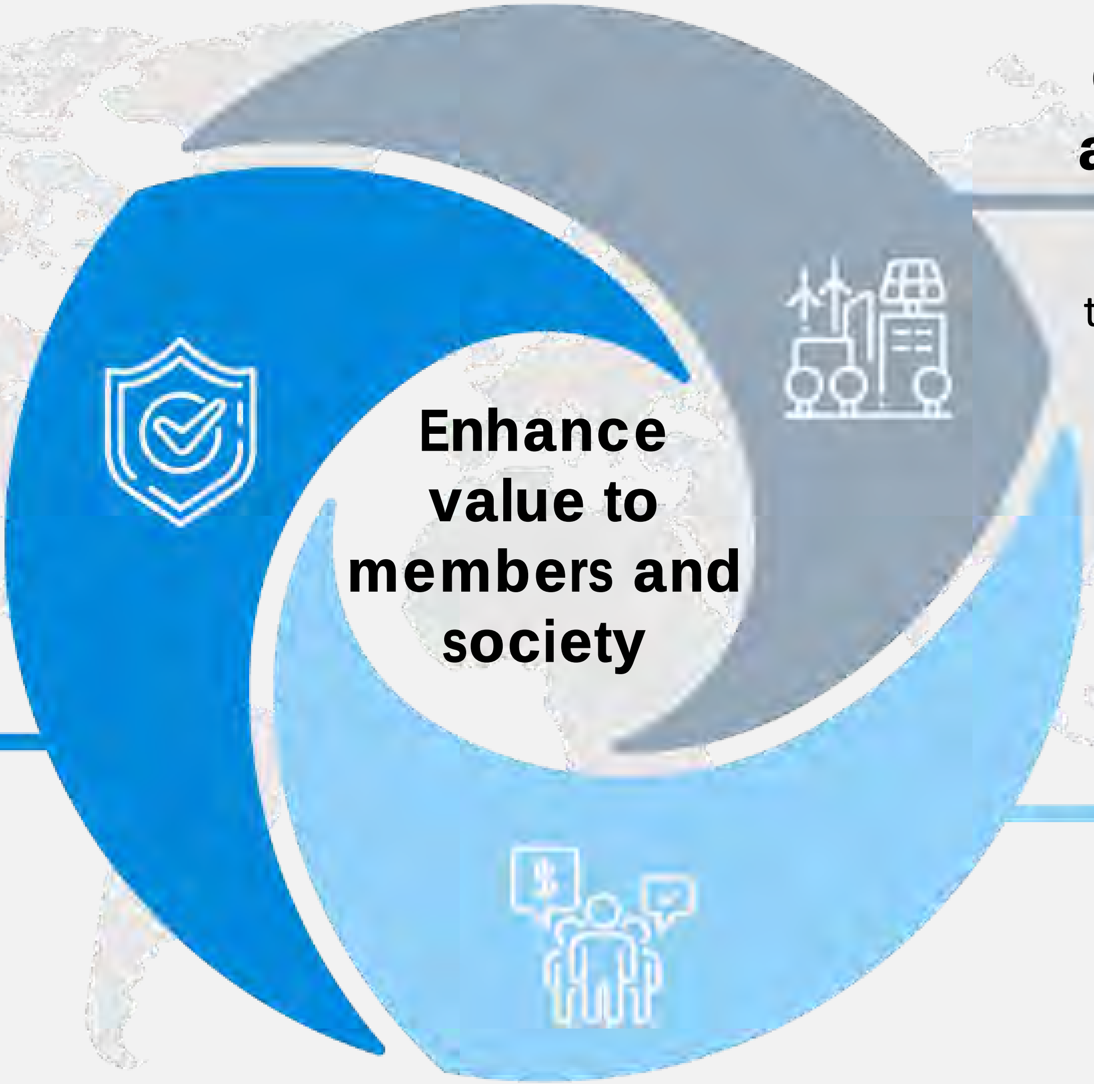
CESM Workshop
June 16, 2022

EPRI’s Role



Guiding climate and grid strategy

Economy-wide modeling to optimize sustainability, reliability, and resiliency solutions

Pushing the technological frontier

Develop and evaluate solutions while engaging national labs, technical partners, and international stakeholders

A trusted source of information

Industry, lawmakers, policymakers, thought leaders, regulators, financial community

Strategic Research

Low-Carbon Resources

End-Use/ Economy-Wide Carbon Reduction

Electric System Reliability/Resilience

Electric System Flexibility

Market Transformation/ Policy/Regulatory Education

Information Needs for Analyzing the Climate Impact on The Electric Power System

- Improved understanding of risks presented by weather phenomena in the present climate to the present system
- Documented and vetted means of estimating the change in risks due to predictable changes in climate (due to the predictable component of decadal variability and to anthropogenic forcing)
- Justifiable projections of the change in risks due to the expected changes in the electrical system (due to technological change, climate change mitigation efforts, and other policies)

CLIMATE READi
RESILIENCE AND ADAPTATION INITIATIVE

EPRI Climate Resilience and Adaptation Initiative (READi)

- **COMPREHENSIVE:** Develop a *Common Framework* addressing the entirety of the power system, planning through operations
- **CONSISTENT:** Provide an informed approach to climate risk assessment and strategic resilience planning that can be replicated
- **COLLABORATIVE:** Drive stakeholder alignment on adaptation strategies for efficient and effective investment

Workstream 1

Physical Climate Data & Guidance

- Identify climate hazards and data required for different applications
- Evaluate data availability, suitability, and methods for downscaling & localizing climate information
- Address data gaps

Workstream 2

Energy System & Asset Vulnerability Assessment

- Evaluate vulnerability at the component, system, and market levels from planning to operations
- Identify mitigation options from system to customer level
- Enhance criteria for planning and operations to account for event probability and uncertainty

Workstream 3

Resilience / Adaptation Planning & Prioritization

- Assess power system and societal impacts: resilience metrics and value measures
- Create guidance for optimal investment priorities
- Develop cost-benefit analysis, risk mitigation, and adaptation strategies

Deliverables: Common Framework "Guidebooks"

- Climate data assessment and application guidance
- Vulnerability assessment
- Risk mitigation investment
- Recovery planning
- Hardening technologies
- Adaptation strategies
- Research priorities

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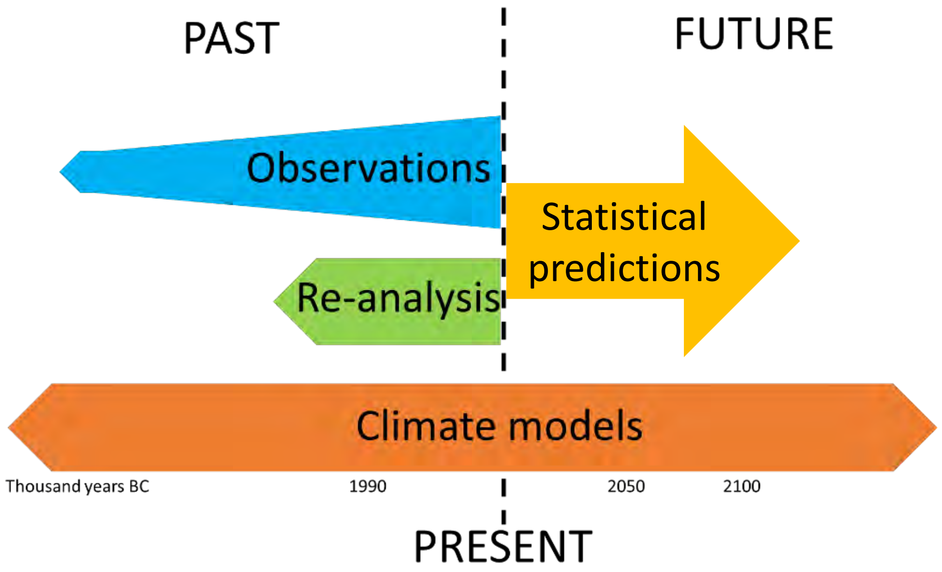
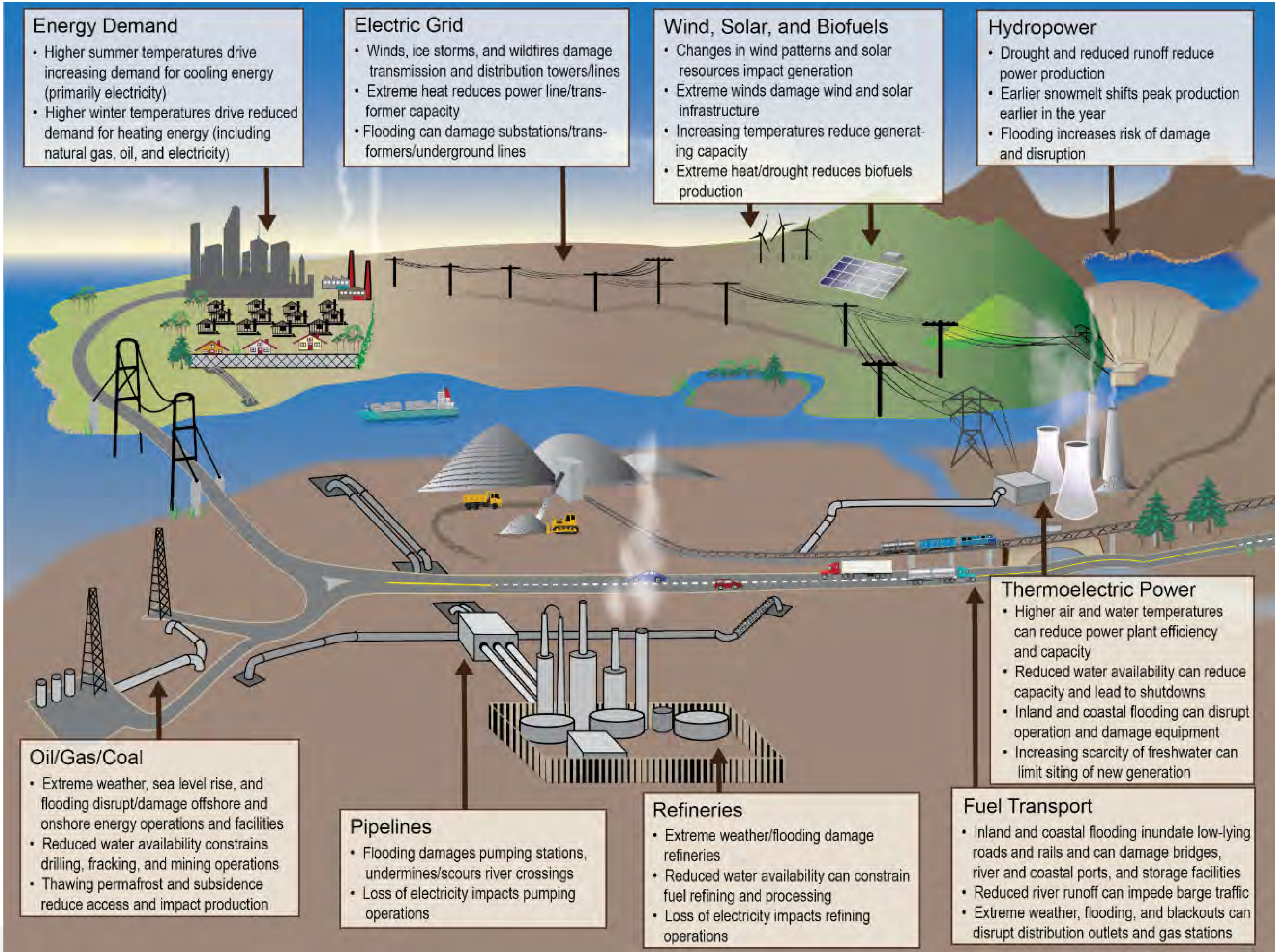
Characterizing hazards due to climate change

- Data-based approaches
- Climate system model output
- Downscaled climate system model output
  - Statistical downscaling
  - Dynamical downscaling



Power system exposure to climate risks



Power system exposure to risks

- Variables of interest for assessment of hazards to the electrical power system include:
  - *Temperature, humidity, and wind speed* near the earth's surface impact:
    - Electrical demand
    - Thermal power generation
    - Photovoltaic generation
    - Transmission
  - *Downwelling solar radiation* and its *direct* and *diffuse* components impact
    - PV generation
    - Electrical demand
  - *Wind speeds* at 50 - 150 m impact
    - Wind generation
  - *Ice and snow accumulation* impact
    - Transmission, distribution
    - Wind and solar generation
  - *Lightning and vegetation dryness* relate to *wildfires* that impact
    - Transmission & distribution
  - *Precipitation and Evaporation* changes impact
    - Hydrological generation and storage potential
    - Biomass production potential

Nota bene: We need hourly data!

Characterizing risks due to climate change

- Resource Adequacy
  - Summer warming increases peak loads
  - Warming, drought reduce efficiency of thermal power plants that rely on evaporative heating
  - Electrification of heating increases winter loads, may shift peak load to winter, but climate warming makes these increases smaller than they would otherwise be
  - Changing diurnal profiles of load and generation
- Loss of Load
  - Ice storm/wind storm/tree fall risks to distribution lines
  - Enhancement of wildfire risk – interaction of transmission lines and wildfire fuels; cutting off of remote generation from load centers

Climate Impacts & Electric System Planning – 3 Takeaways

- **1. Electric company system planning needs and motives to explore climate risks vary**
  - Motivation ranges from past experiences (e.g., Sandy) with resiliency threats to shareholder resolutions
  - Much heterogeneity (e.g., regional differences, regulatory environment, market structure)
  - Climate considerations can no longer be handled in "isolation" – integrated resource planning is increasingly complex (e.g., evolution of end-use devices and services, power markets, DERs, clean energy policies, variable renewables, fuel supply)

- **2. Climate and climate change mitigation policies are two of several factors driving change in electric sector**
  - Technological changes unrelated to climate policy has its own dynamics (for example, the fall of gas prices during the fracking boom, electrification of transportation for performance and quality reasons)
  - Pollution control apart from greenhouse gas emissions is driving changes in many electrical markets, with resulting climate feedbacks
  - Regulatory environments and market structures have a large impact on transmission deployment and siting of various power generation infrastructure

- **3. Planning for what? Incremental/chronic change vs. acute/extreme events vs. variability**
  - Means vs. extremes, chronic vs. acute events, intra- vs. inter-annual variability, spatial variability
  - Assessment methodologies differ – deterministic vs. stochastic approaches
  - Extremes matter most for adaptation planning: max (min) temp drives peak cooling (heating) demand, max storm surge drives extent of coastal protection, etc.

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