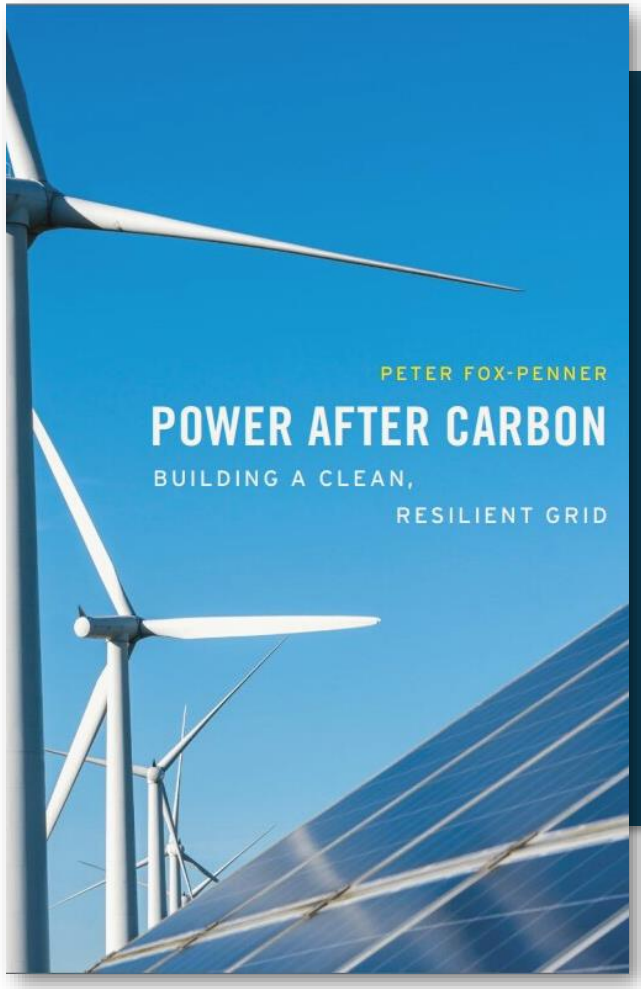


PETER FOX-PENNER

POWER AFTER CARBON

Building a Smart, Clean and Resilient Power Industry

Presented to:

OMS/MGA Transmission Policy Summit

November 18, 2020

BU
Boston University Institute for Sustainable Energy

Part I

Electricity's Role in Climate Solutions

The Climate Crisis

At the current rate of warming of 0.2°C per decade, the planet will likely reach the lower target of 1.5°C by as early as 2030

Arctic warming 2-3x faster than global average;
its sea ice is declining at a rate of 12.8% per decade

US CO_2 emissions from fossil fuel combustion rose 2.7% in 2018, fell 1.9% in 2019

Power sector emissions are down 29% from 2005 levels

Energy-Climate Strategy for the Developed World: Efficiency + Clean Electricity + Clean Fuels

Accelerate energy efficiency

Electrify most transportation

Electrify most building heat

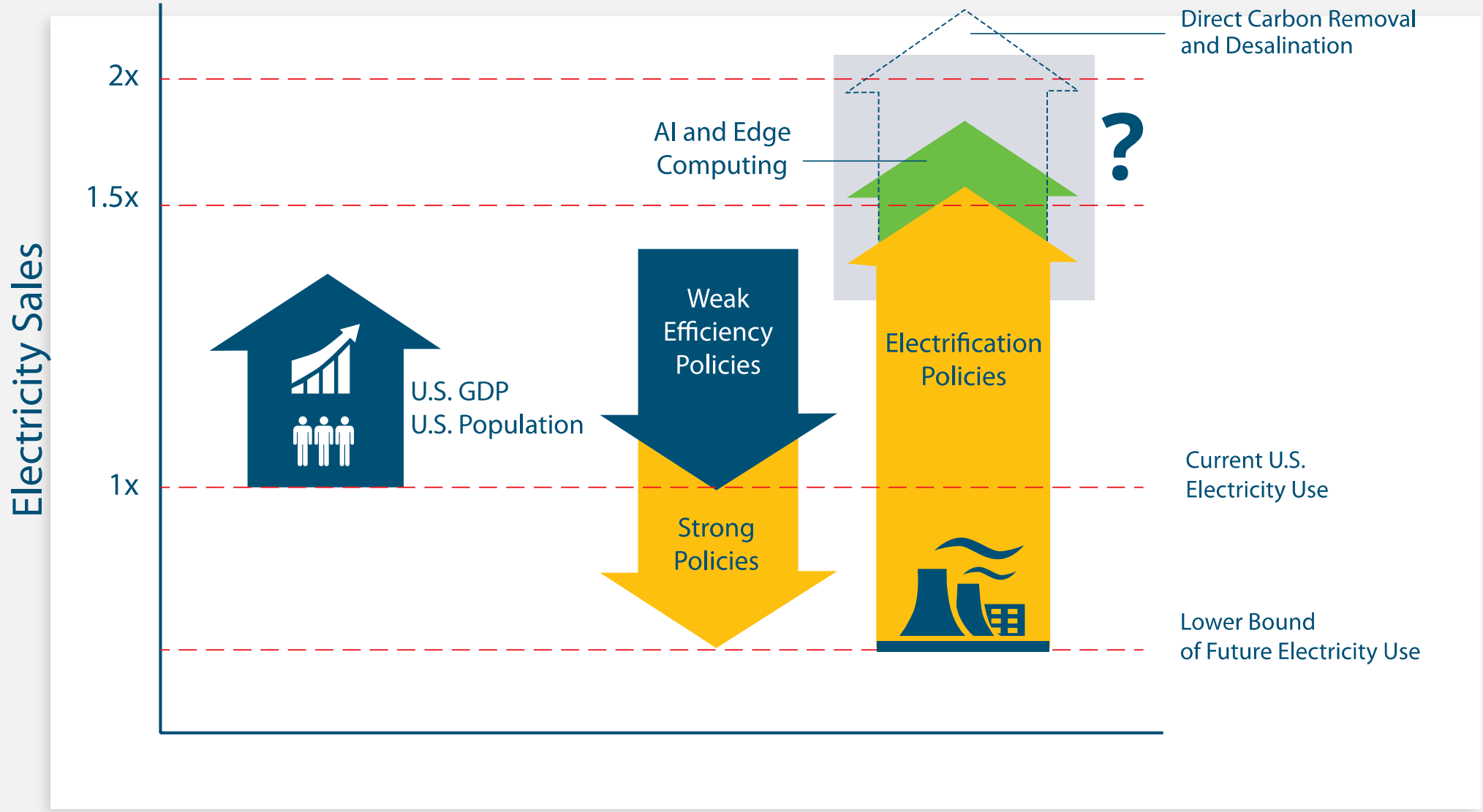
Electrify some industrial processes

And the key:

A large enough power system
-- and clean gas/liquid fuels

- ✓ No carbon
- ✓ High resilience and reliability
- ✓ Affordable and financially feasible

How Much Power Will We *Really* Need?



Electrification: An Essential Frontier

- **Transportation electrification: Strong market support**
- **Building Thermal Decarbonization: Public and private capital and strong policies**
- **Industry – specific RD&D collaboratives**

NEMA Launches Railroad Electrification Council

REWIRING AMERICA

ROCKY MOUNTAIN INSTITUTE

ACEEE

EPRI ELECTRIC POWER RESEARCH INSTITUTE

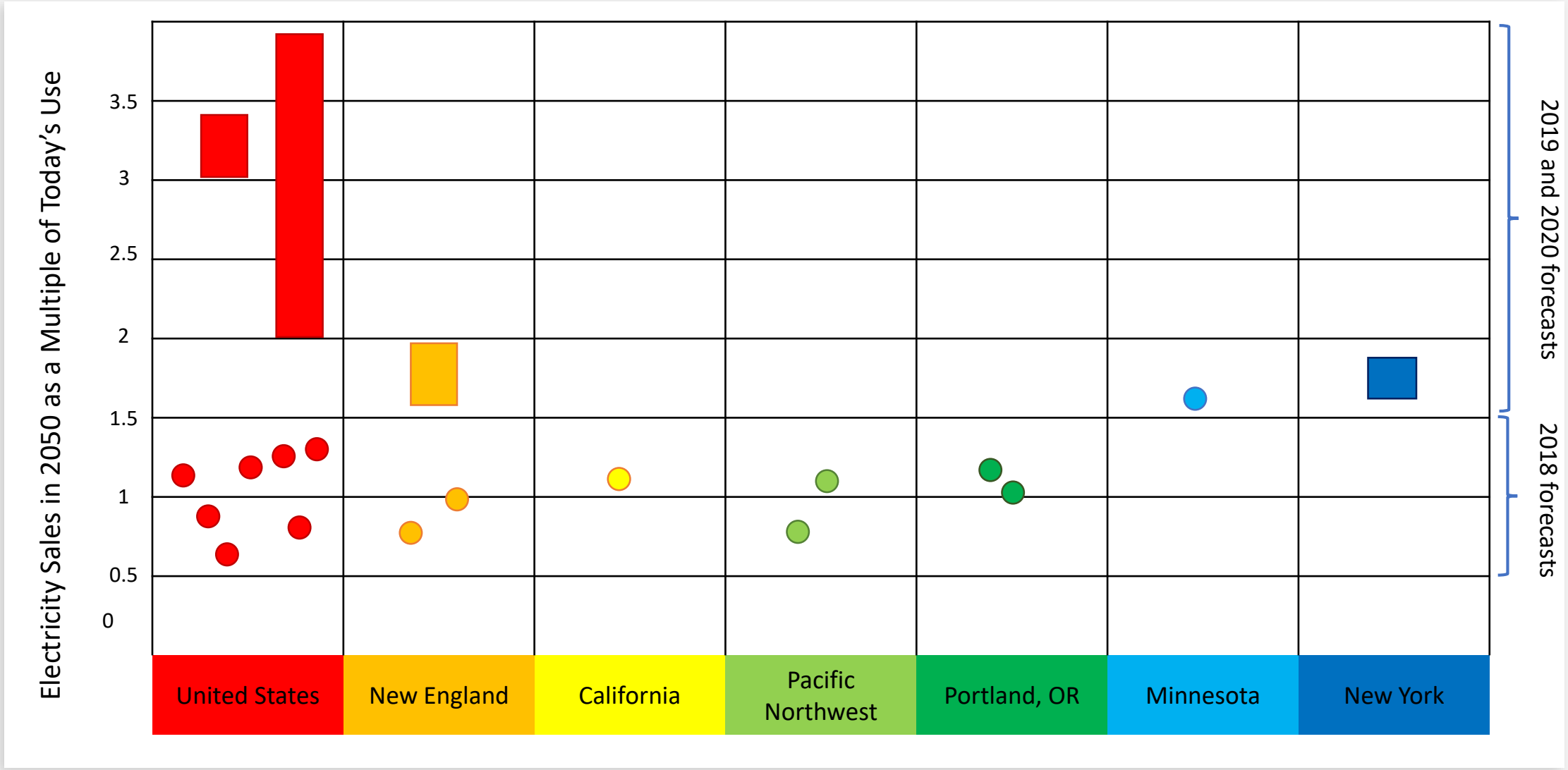
The Edison Foundation INSTITUTE for ELECTRIC INNOVATION

Smart Electric Power Alliance

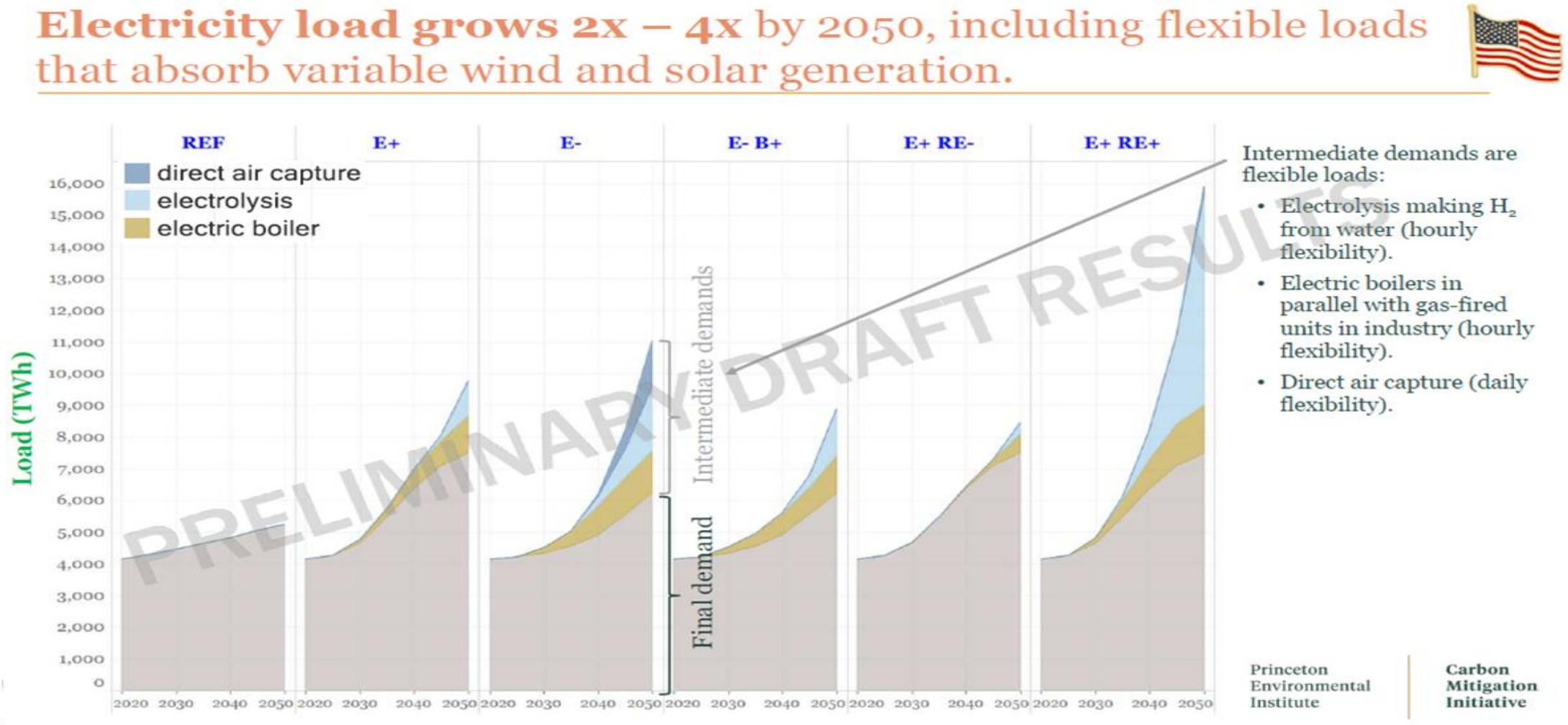
Alliance for Transportation Electrification

EDTA Electric Drive Transportation Association

Power Increases in Deep Decarbonization Studies

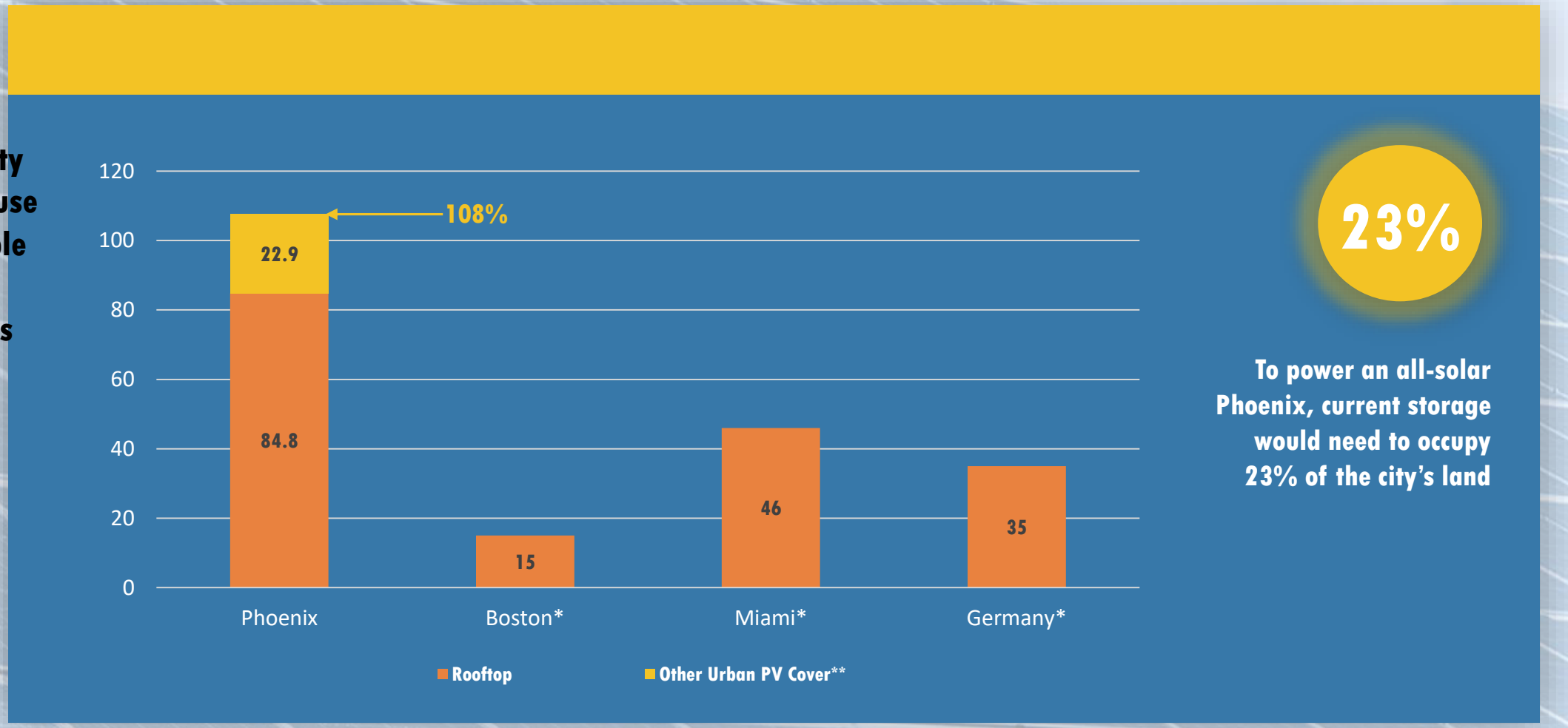


New Preliminary Electric Demand Results from Princeton Study



Source: Net Zero America Project Briefing 9/9/20 Princeton Environmental Institute

How Much Electricity Can Distributed Sources Contribute?



Source for Germany: Mainzer et al, Solar Energy 105:715-731, p. 726.

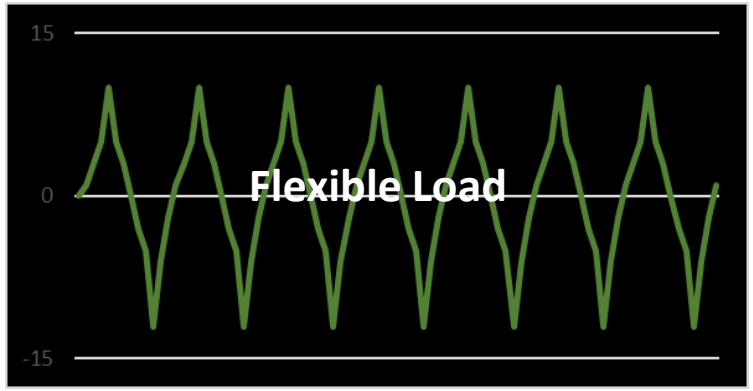
Solar Beyond the Rooftop?

Source: sunew.com.br/en used by permission

Part II

The Big Grid

Supply Side of A Carbon-Free Big Grid



What's Not Working Well Enough on the Big Grid?

- **More Large Storage Needed.** Hydroelectricity challenged; Battery and hydrogen storage too expensive → Continue R&D and diversify options
- **Demand response** potential is huge but highly variable and mechanics are complex → Market and regulatory reforms
- **Transmission** is underplanned and underbuilt → Regional energy planning
- **The financial mechanisms** for getting Big Grid facilities built aren't working well enough to meet carbon targets → Reform power markets

Solving the Climate Crisis – House Select Committee Report
Electricity Planning Provisions

- **Modernize the National Interest Electric Transmission Corridors Program**
  "Congress should direct FERC, working with DOE and the National Labs, to develop a comprehensive, long-range electric infrastructure strategy that would achieve 100% clean electricity by 2040, and any state policies that establish more stringent standards."
- **Establish a National Policy on Transmission**
  "Congress should establish a National Transmission Policy to provide guidance to state and local officials and reviewing courts to clarify that it is in the public interest to expand transmission to facilitate a decarbonized electricity supply…[and] also encourage broad allocation of costs."
- **Improve Cost Allocation and Interregional Planning**
  FERC Rulemaking to require better regional/interregional planning by "emphasizing assessment of the multiple benefits…harmonizing the planning processes and models of different regions, and encouraging broad cost allocation…"
- **Consider "Macro RTOs" to do Planning and Cost Allocation**

https://climatecrisis.house.gov/sites/climatecrisis.house.gov/files/Climate%20Crisis%20Action%20Plan.pdf

Biden Clean Energy Plan – Big Grid Provisions

- Carbon-Free power sector by 2035
- "Marshall an historic investment in EE, clean energy, electrical systems and line infrastructure that makes it easier to electrify transportation, and new battery storage and transmission infrastructure that will address bottlenecks and unlock America's full clean energy potential…"
- "…prioritize repowering of lines that already exist with new technology…take advantage of existing rights-of-way…and cut red tape to promote faster and easier permitting."
- AND A CLEAN ENERGY STANDARD PAIRED WITH INVESTMENT
  - Energy Efficiency and Clean Electricity Standard (EECES)
  - Little-noticed phrase: "*Paired with his historic, front-loaded investments* in the power sector, Biden's EECES will…achieve carbon-free…electricity…by 2035"

Fleshing Out Biden Plan – One Idea

- **Three-Part Approach:**
  Clean Energy Standard, State/Regional Plan, Federal Energy Infrastructure Fund

1. **Clean Energy Standard** – Smith/Lujan Bill and 30 state RPS rules
2. **Required State/Regional Plans**
   - Option 1: Strengthen and Expand FERC Processes
   - Option2: New state-led process, like Clean Power Plan
3. **Federal Energy Infrastructure Fund**
   - Partially fund projects in plan that are out-of-market or of broad regional benefit – like EU Projects of Common Interest
   - Variety of financial mechanisms possible
   - Complementary to RD&D funding and tech-specific financial supports
   - Natural Part of Build Back Better Infrastructure Funding

Summary

A completely clean power industry ~ 50 to 100% larger is necessary and achievable

Energy efficiency should be maximized, with major investments in housing, buildings, standards

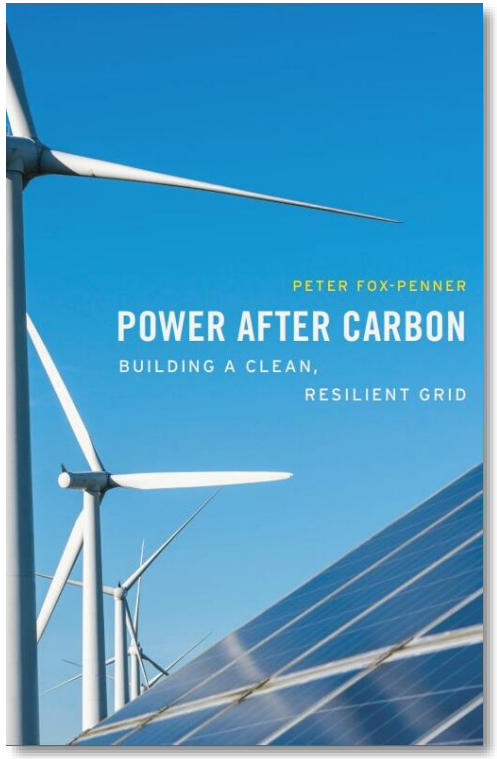
Big Grids need storage, regional planning and reformed markets.
Biden plan +: EECES, planning, and energy infrastructure fund

The downstream sector needs PBR, new business models and dynamic pricing

Cost-effective electrification of transport, heat, and industry needs immediate, sustained action – longest part of the journey

This is a 20-year project. Full speed ahead!

Thank You!



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CONFLICT OF INTEREST DISCLOSURE

Dr. Fox-Penner holds equity in Energy Impact Partners, a utility-backed energy investment and innovation firm, and consults for Energy Impact Partners and The Brattle Group on energy technologies. Dr. Fox-Penner also conducts research in areas of interest similar to the business interests of Energy Impact Partners and The Brattle Group. The terms of this arrangement have been reviewed by Boston University in accordance with its financial conflicts of interest in research policies.

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