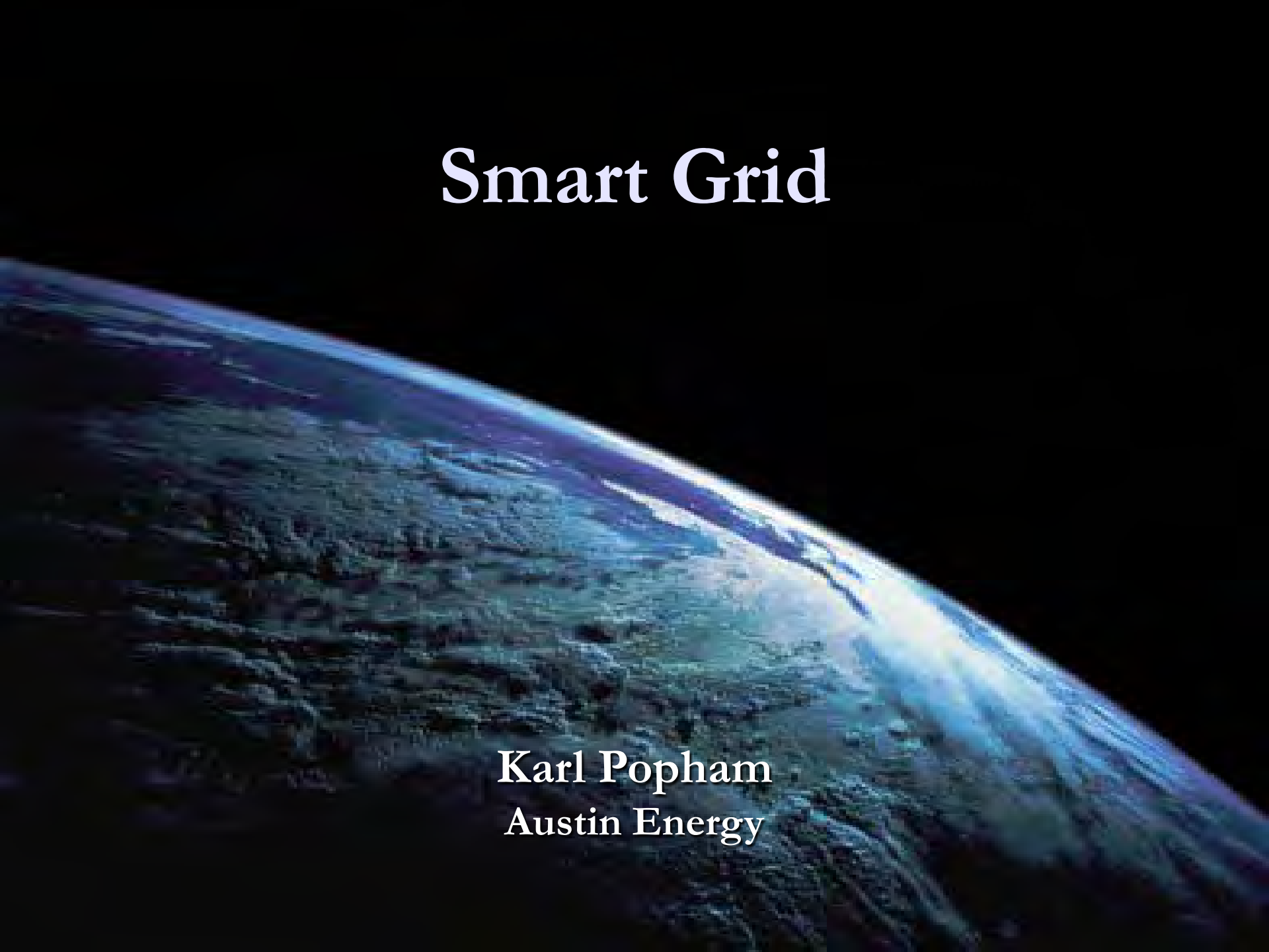
Smart Grid



Karl Popham
Austin Energy

Global Context & Challenges

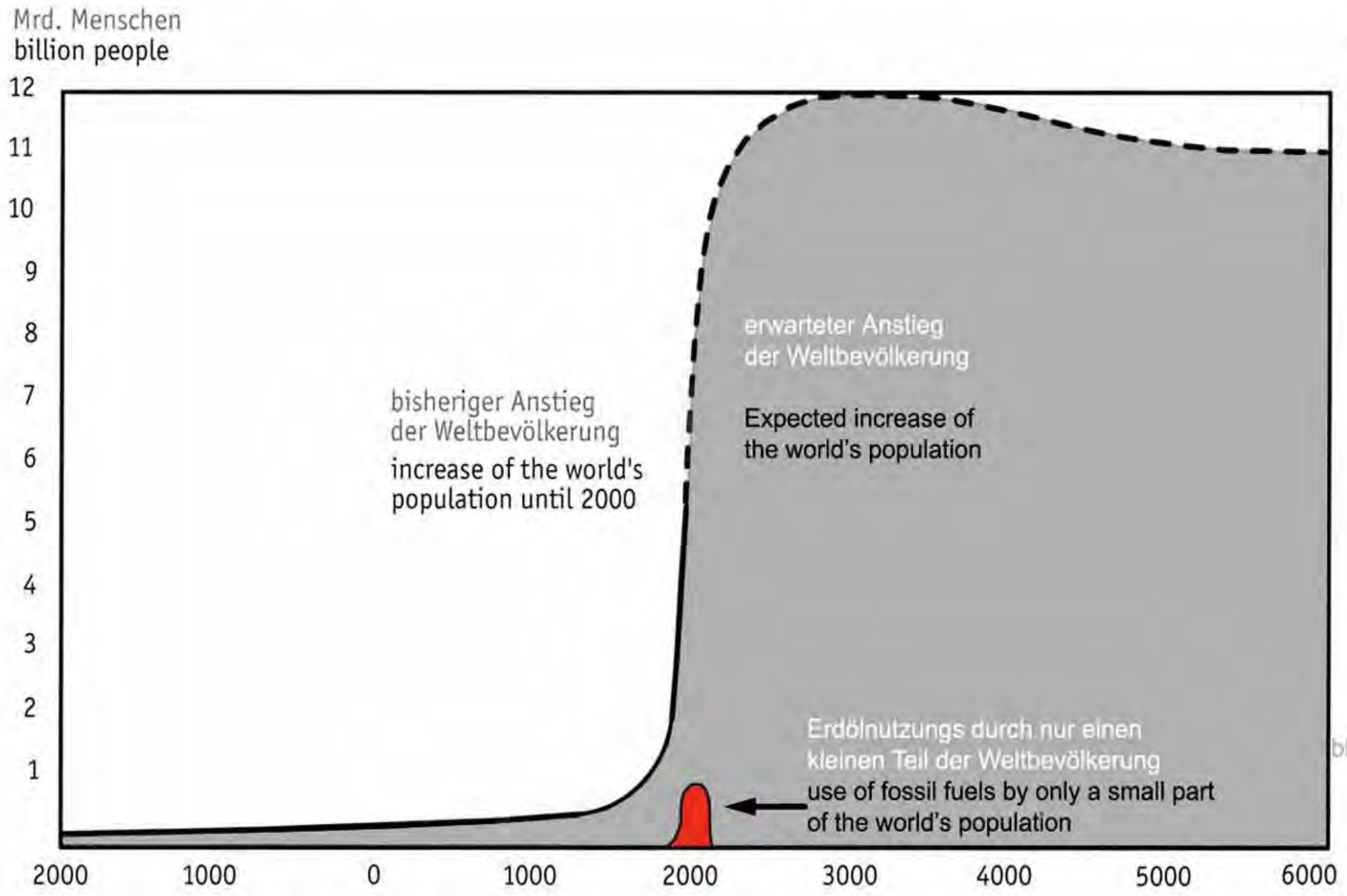
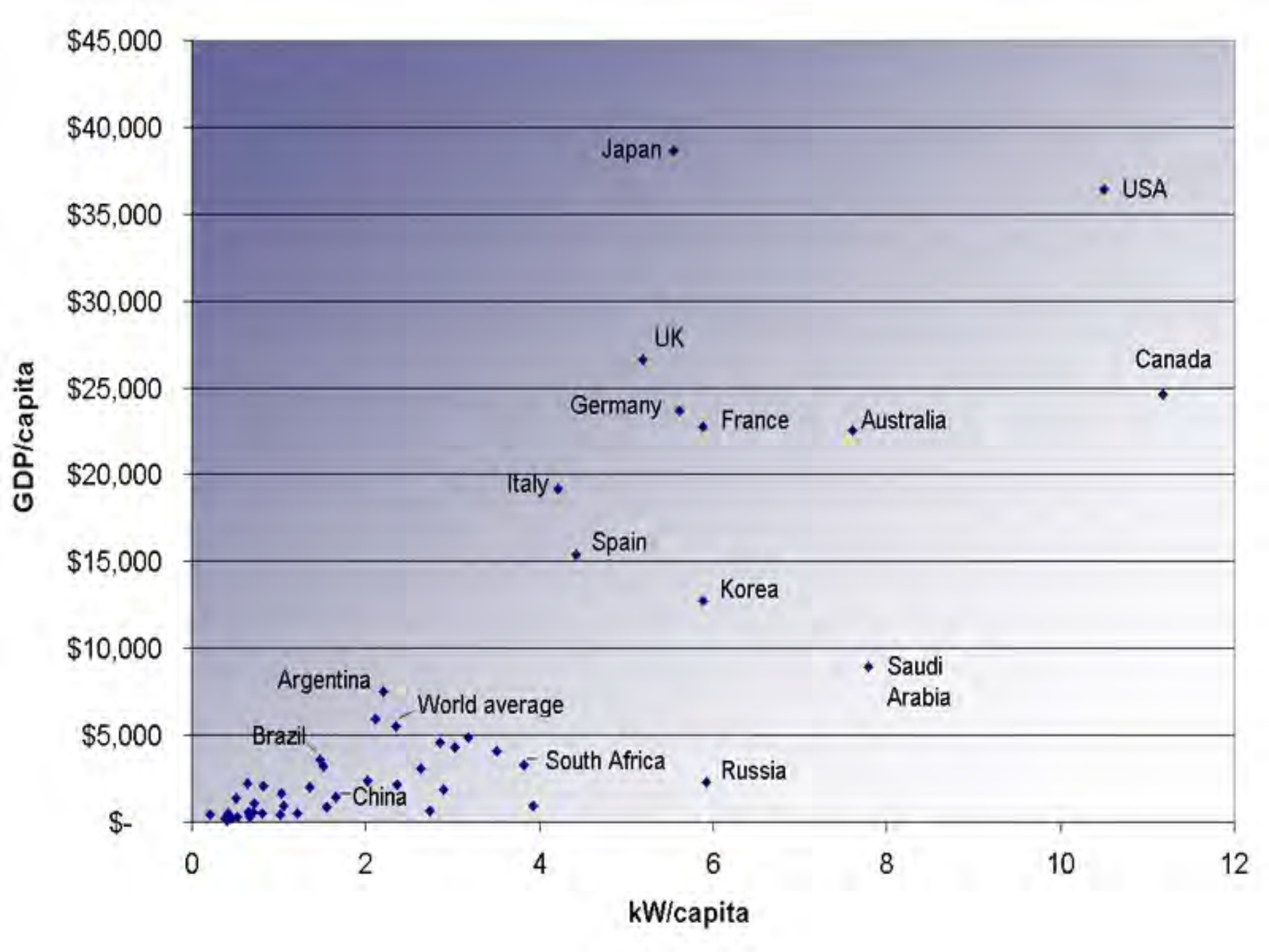


Abb. 2 Wachstum der Weltbevölkerung und Erschöpfung der Ölreserven

Ill. 2 **Growth of world population and depletion of oil resources**

Source: *Time*, "What the World Eats" $1.23/week

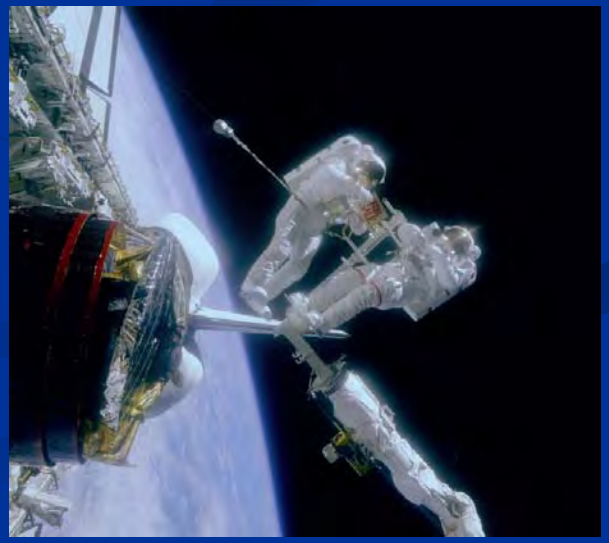
Source: *Time*, "What the World Eats" $341.98/week

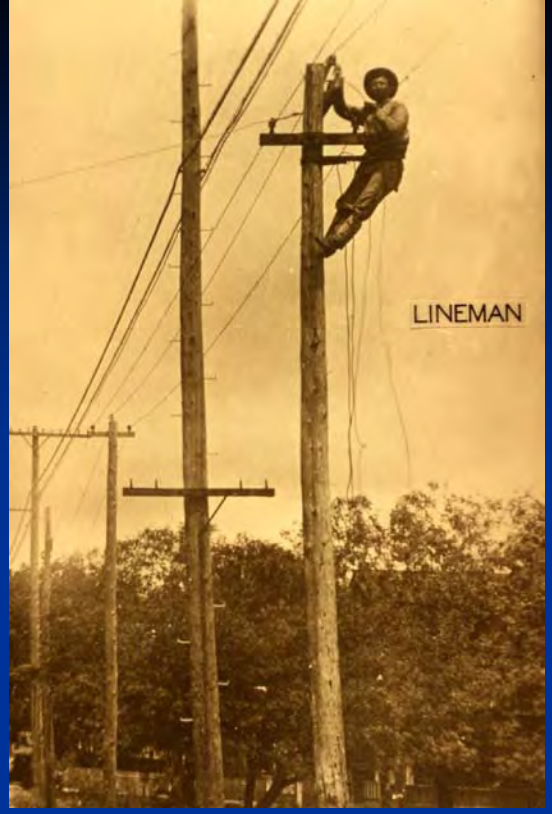

$45,000
$40,000
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$-
GDP/capita
0
2
4
6
8
10
12
kW/capita
Japan
USA
UK
Canada
Germany
France
Australia
Italy
Spain
Korea
Saudi Arabia
Argentina
World average
Brazil
South Africa
Russia
China

A Time of Change


palm
Treo


CAUTION
FIBER OPTIC CABLE




LINEMAN

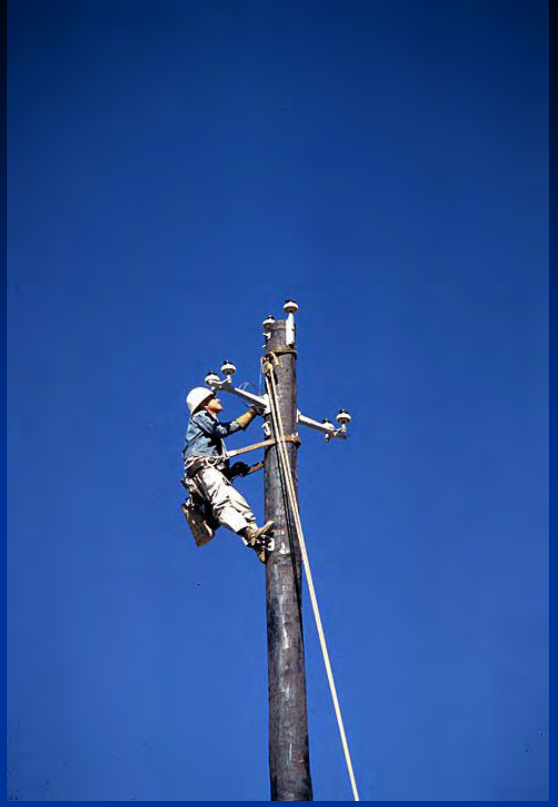
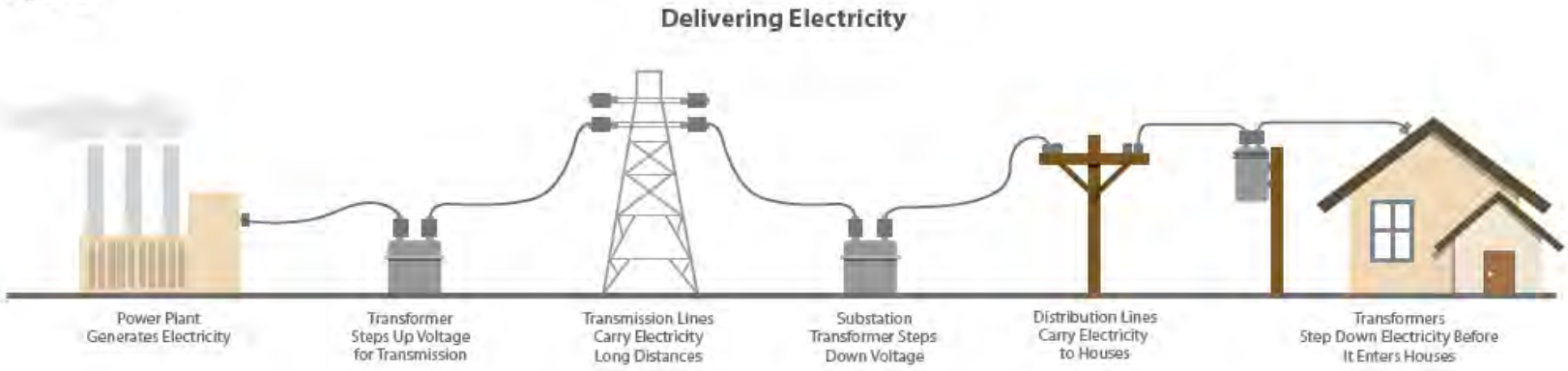
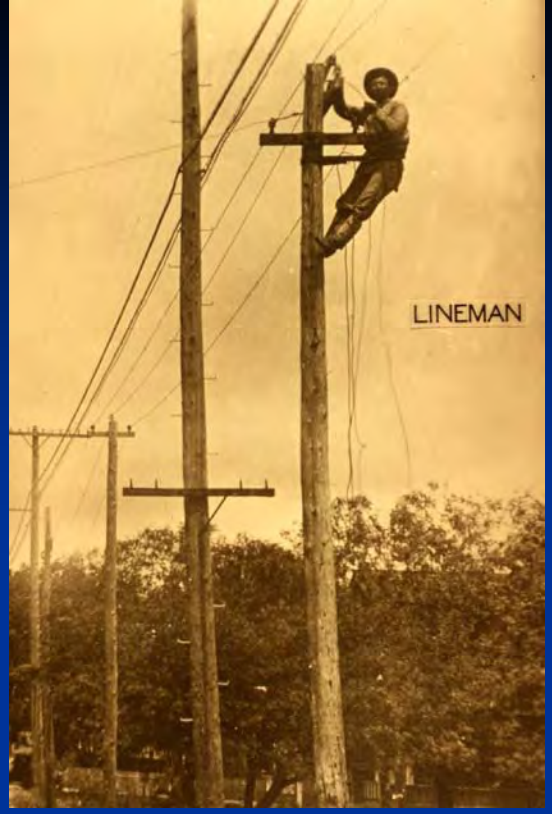


Figure 3


Delivering Electricity
Power Plant Generates Electricity
Transformer Steps Up Voltage for Transmission
Transmission Lines Carry Electricity Long Distances
Substation Transformer Steps Down Voltage
Distribution Lines Carry Electricity to Houses
Transformers Step Down Electricity Before It Enters Houses



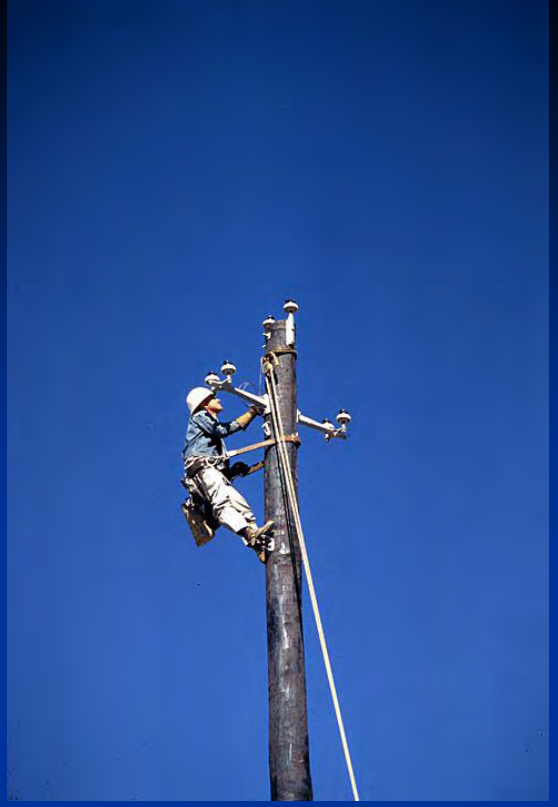
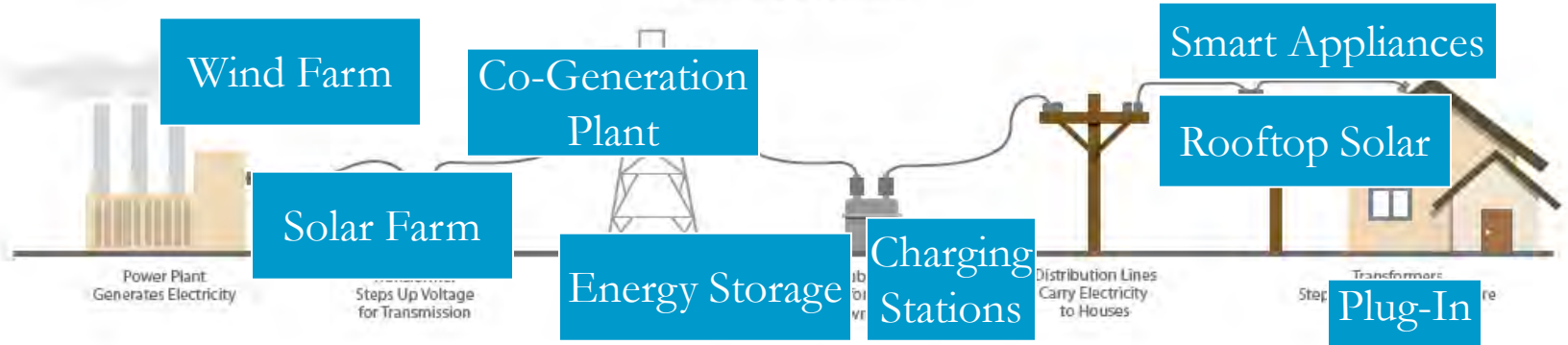


Figure 3

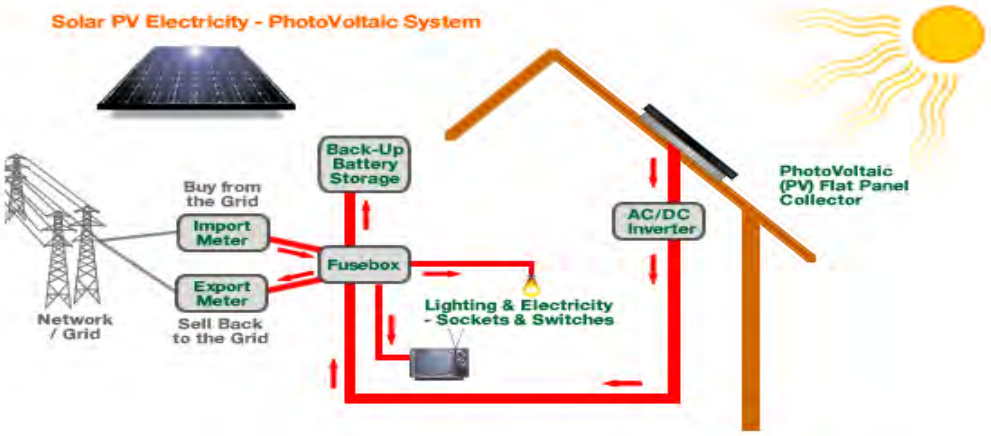
Delivering Electricity



Opportunity or Threat?

Solar Power PV Systems & the Electricity Network

Solar Power PV Systems can be connected to the National Grid or as a stand-alone installation. Your system options are outlined below.

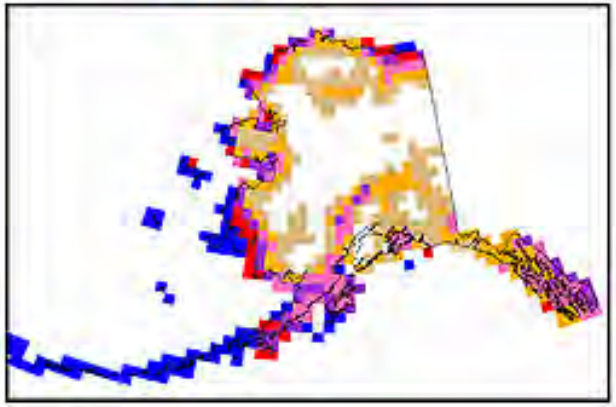


Texas Wind Day - March 5th, 2010

Wind Resources and Transmission Lines

NREL Updated Maps:
Arizona (2003)
California (2002)
Colorado (2004)
Connecticut (2001)
Delaware (2002)
Hawaii (2004)
Idaho (2002)
Illinois (2001)
Indiana (2004)
Maine (2001)
Maryland (2002)
Massachusetts (2001)
Michigan (2004)
Missouri (2005)
Montana (2002)
Nebraska (2005)
Nevada (2003)
New Jersey (2002)
New Hampshire (2001)
New Mexico (2003)
North Carolina (2002)
North Dakota (2000)
Ohio (2004)
Oregon (2002)
Pennsylvania (2002)
Rhode Island (2001)
South Dakota (2001)
Texas mesas (2000)
Utah (2003)
Vermont (2001)
Virginia (2002)
Washington (2002)
West Virginia (2002)
Wyoming (2002)

The remaining states use data from the 1987 "Wind Energy Atlas of the United States".



Transmission Lines
Voltage (kV)
345 - 499
500 - 699
700 - 799
1000 (DC)

Source: POWERmap, powermap.platts.com, ©2007 Platts, a division of the McGraw-Hill Companies

Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed [a] at 50 m m/s	Wind Speed [a] at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

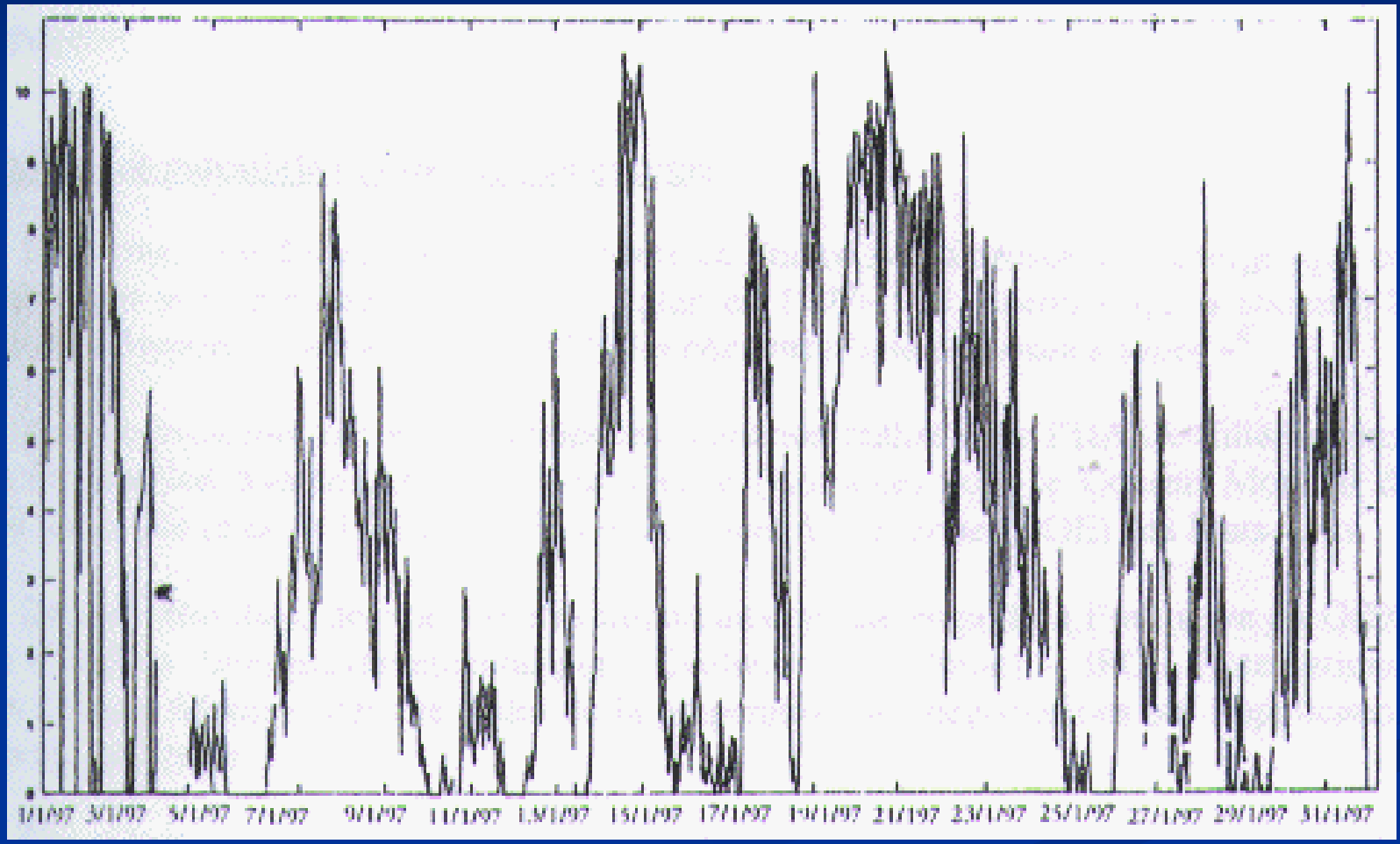
[a] Wind speeds are based on a Weibull k value of 2.0

U.S. Department of Energy
National Renewable Energy Laboratory

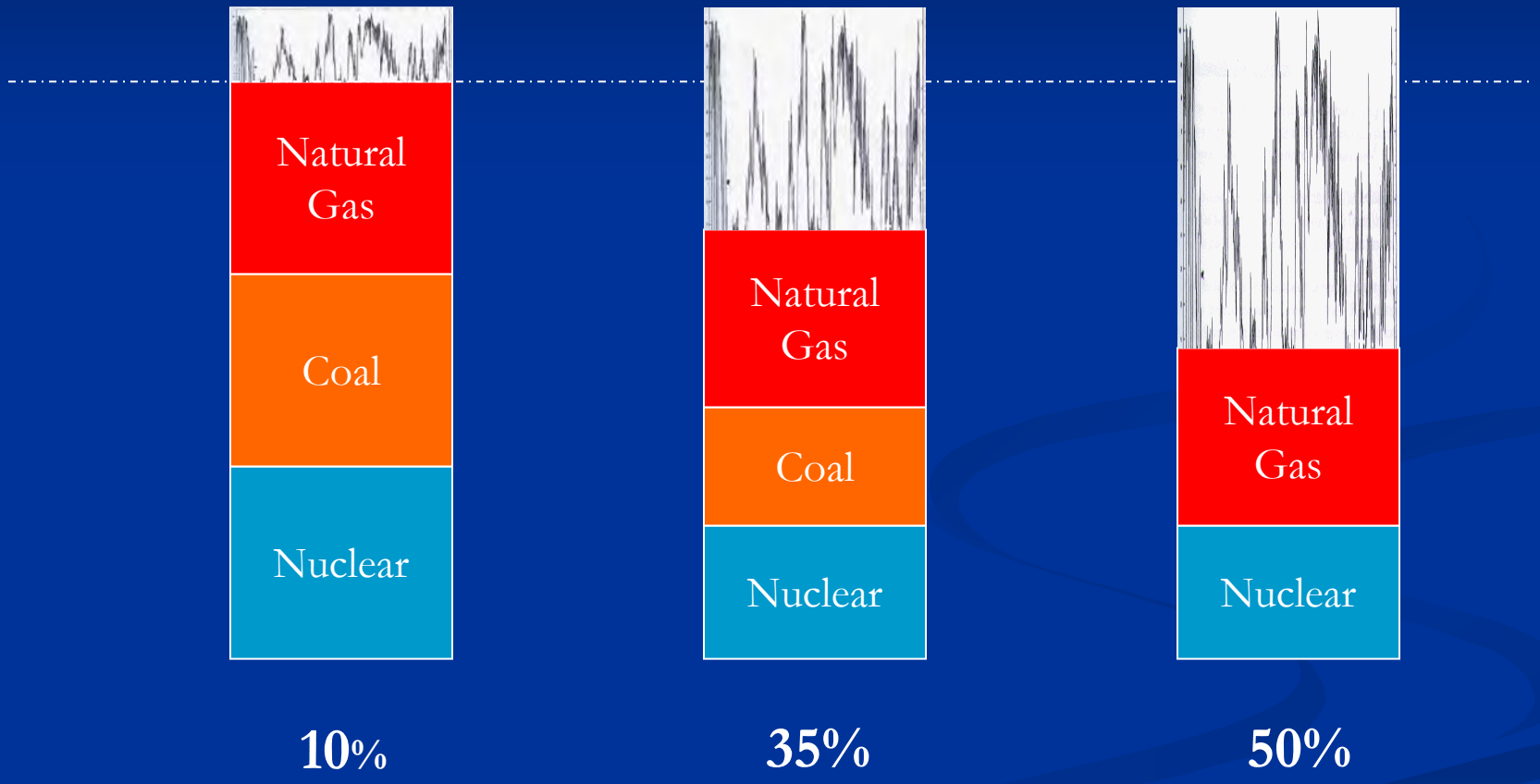
NREL

19-APR-2007 15:59

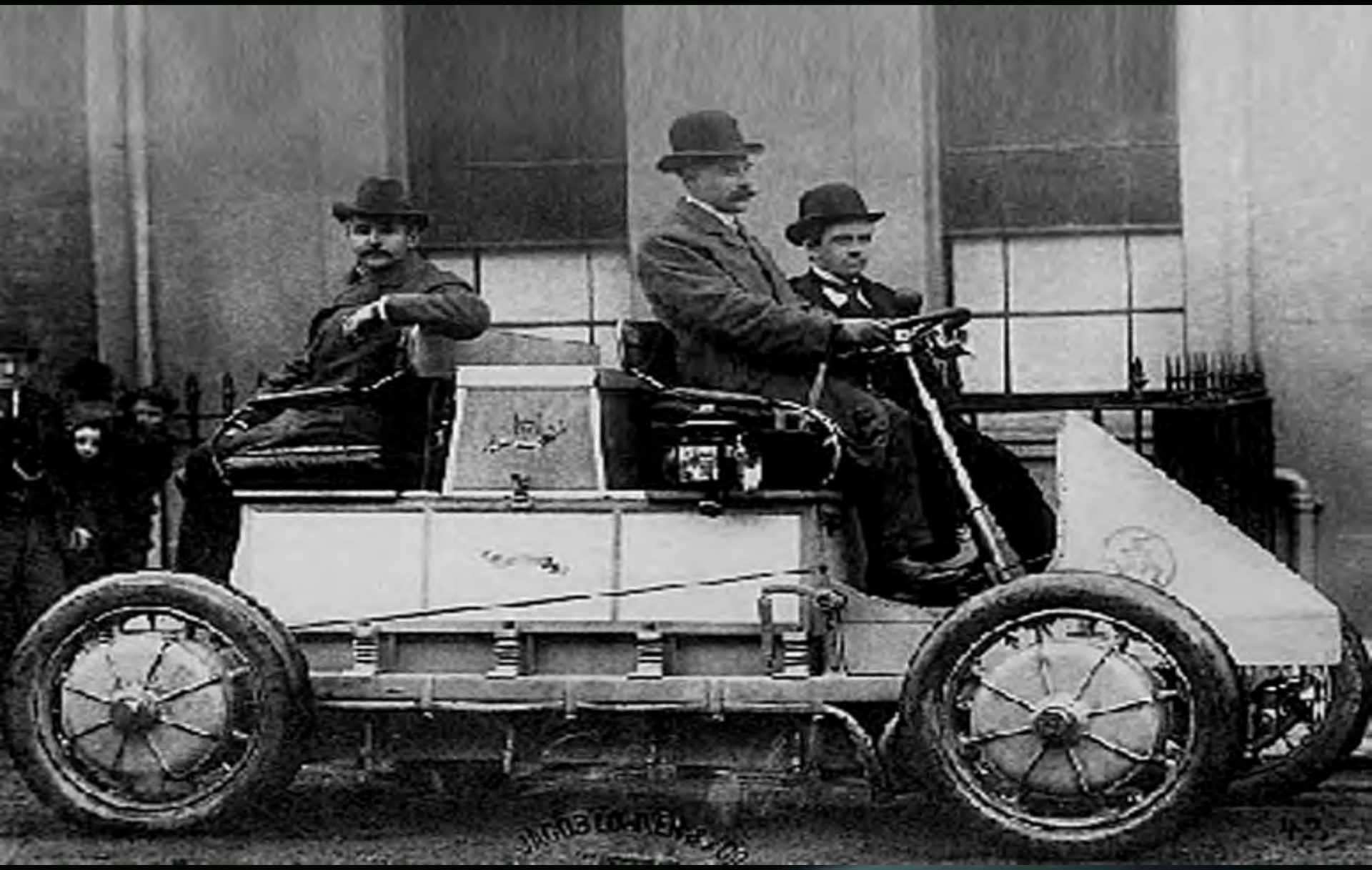
10 Minutes of Wind Production



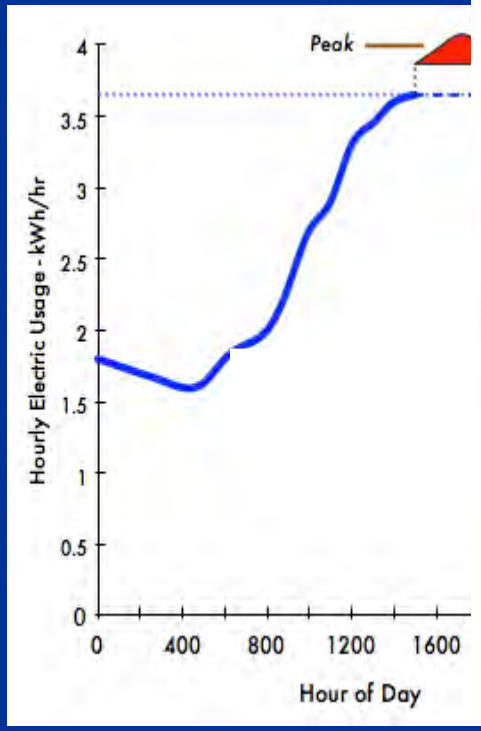
Generation Stack

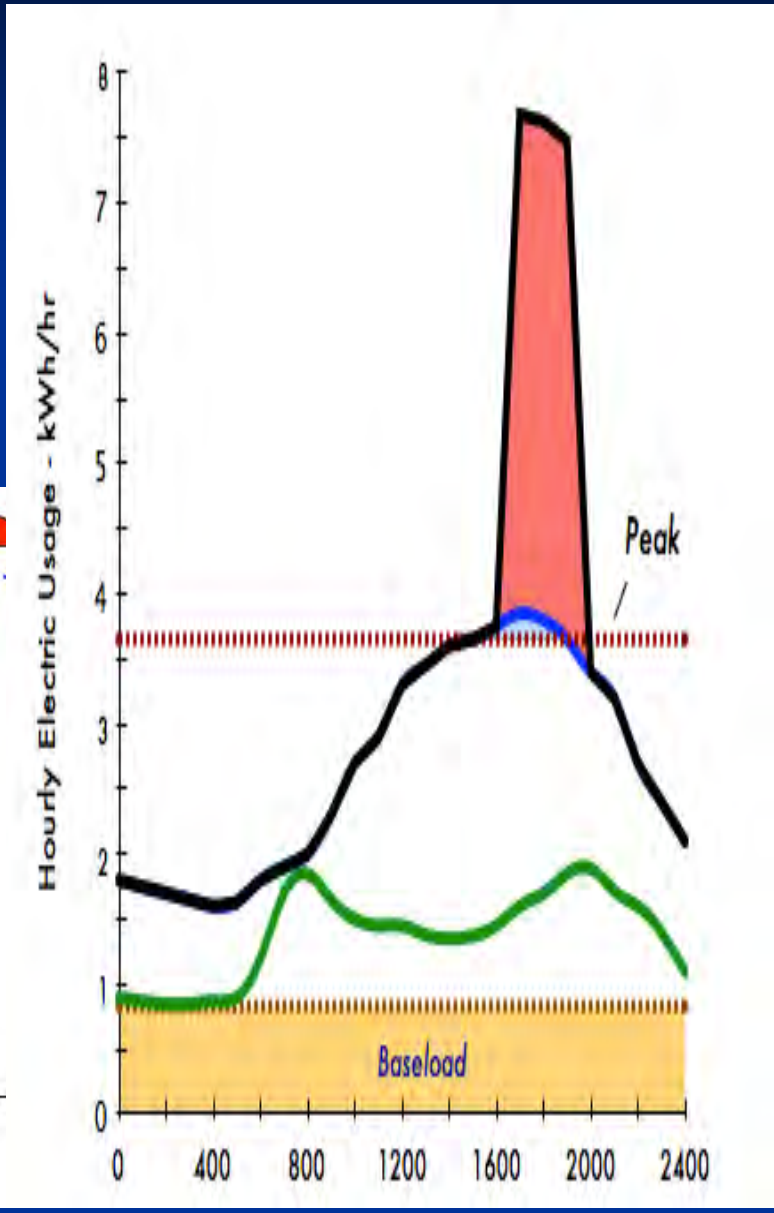


The Electric Vehicle



Peak Load


Peak
Hourly Electric Usage - kWh/hr
4
3.5
3
2.5
2
1.5
1
0.5
0
0
400
800
1200
1600
Hour of Day

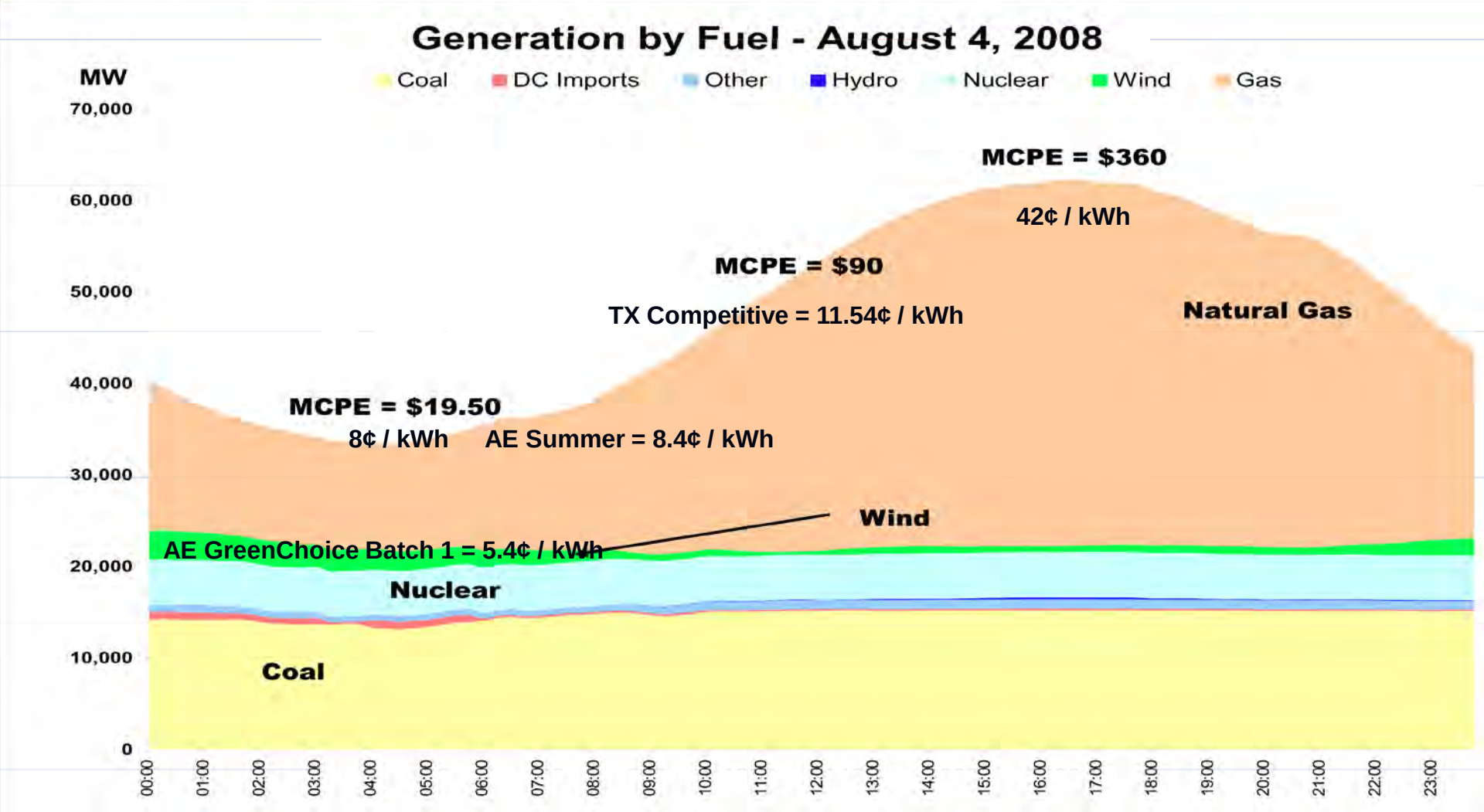

Hourly Electric Usage - kWh/hr
8
7
6
5
4
3
2
1
0
Peak
Baseload
0
400
800
1200
1600
2000
2400

Options & Solutions

Today and into the future

Buy

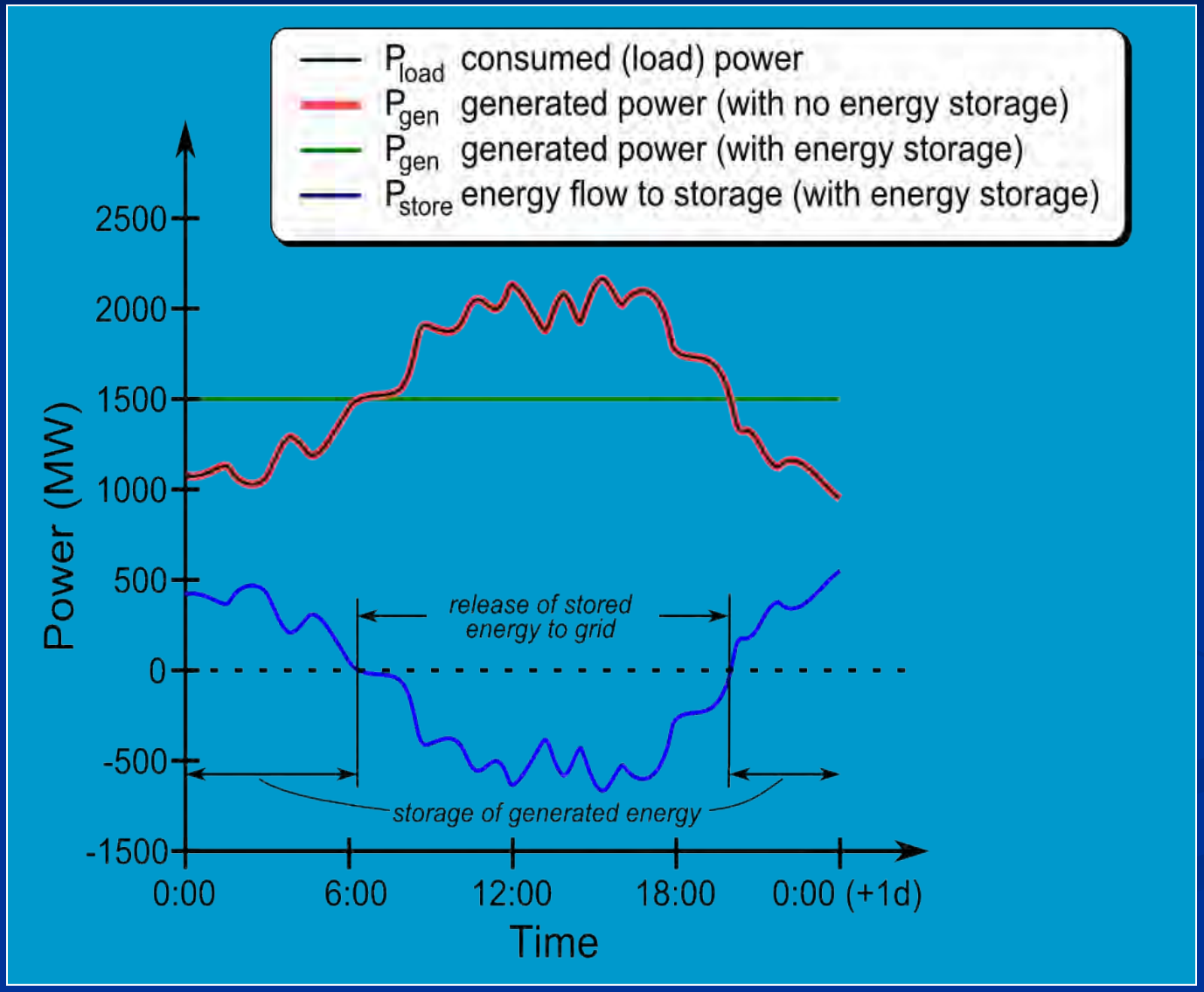
Summer Day Load Shape with Fuel Mix

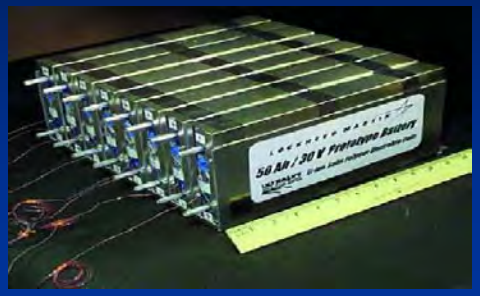


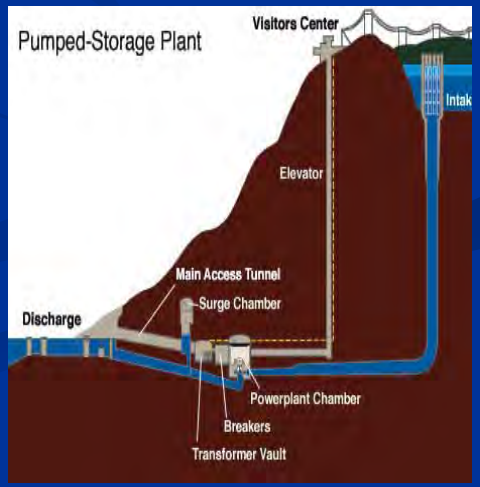
Build Centralized Generation

Energy Efficiency

Energy Storage







Other Creative/Regional Ideas

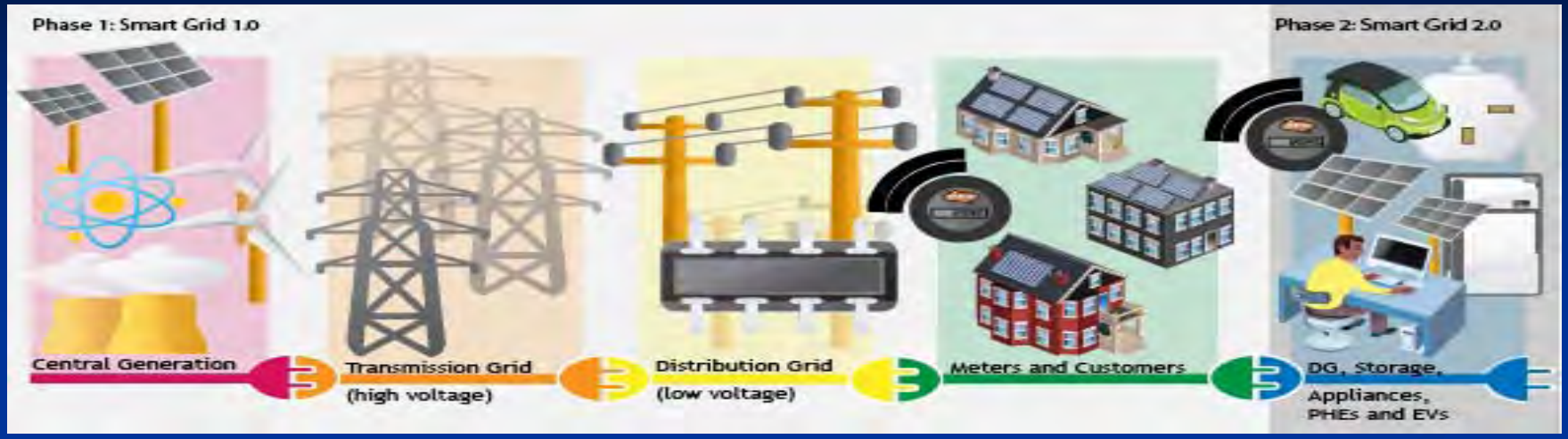
The Smart Grid

Smart Transportation

Smart Generation and Delivery

Smart Homes

AE Smart Grid Project Architecture



Energy Hedging Sys

Wholesale Scheduling and Settlement Sys

Generation Management Sys

Distributed Control Sys

Emissions Mgmt Sys

Lab Mgmt Sys

Distribution Management System

EMS / SCADA

Load Planning Sys

Vegetation Mgmt System

Outage Portal / Storm Center

Enterprise Service Bus (ESB)

Online Payment / Web Svcs

Call Centers (Utility and 311)

Customer Care & Billing (New CIS)

Energy Effic Prog & Comp

Demand Response Sys

Customer Web, Portals, and Social Media

Smart Meters / Meter Data Mgmt System (MDMS)

IHDs

Smart Appliances

Sub-Metering Sys

Smart Charging Sys

DG Mgmt Sys

Storage Mgmt Sys

LAN/PAN/HAM

GIS / Materials Mgmt / Inventory & Asset Mgmt / Facilities Mgmt

CAD / CAE Applications and Modeling Tools

Workforce and Workflow Management

Portfolio Management / Project Management / Data-Mining / Dashboards

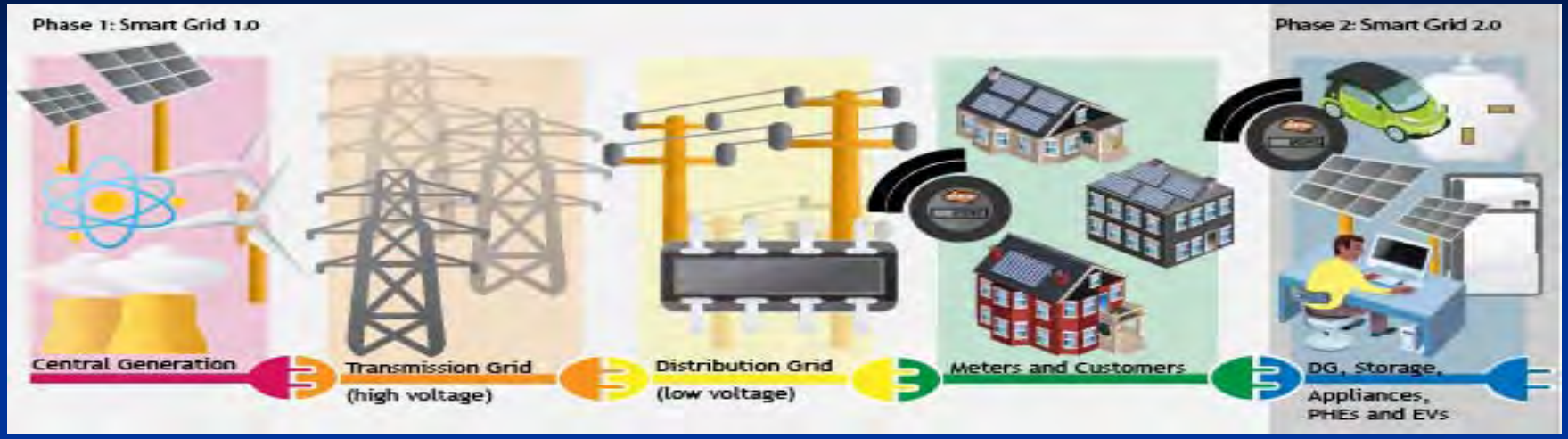
PDAs / Smartphones / PCs / Servers / IT Management Systems / Email / MS Office / App Servers

Voice and Data Network(s)

Field Force and AMI Networks

Cyber Security, Privacy Protection, & Regulatory Compliance

AE Smart Grid Project Architecture



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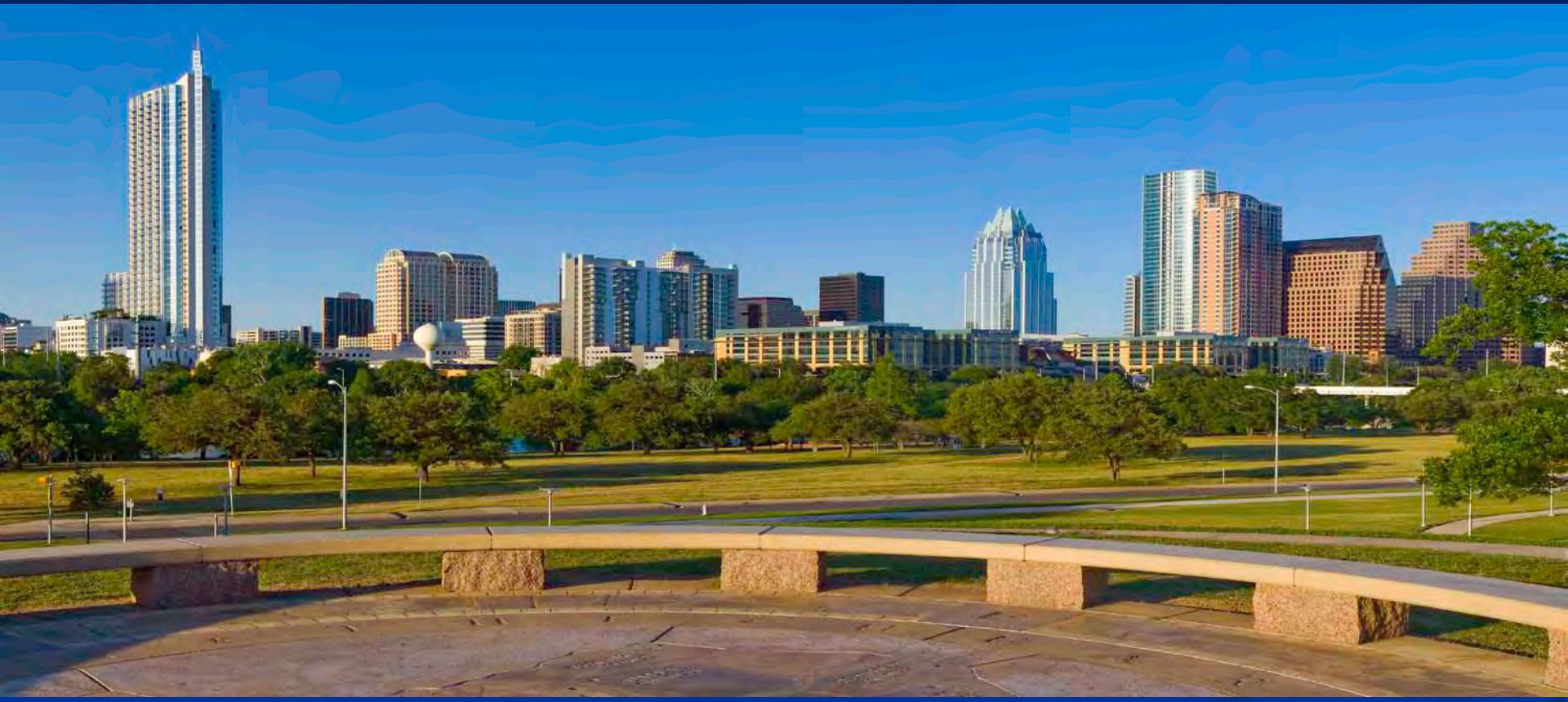
Vision Summary

The 20th Century Electric Grid		The 21st Century Electric Grid
Generation: Centralized & reliance on finite fuels	→	Focus on decentralized & reliance on sustainable energy sources
Delivery: Generation during time of demand	→	Generation during most economical conditions, leverage storage
Pricing: Relatively flat, kW/hr pricing	→	Reflect consumer demands/costs and provide options for individual needs
Grid Management: Reactive, mechanical controls	→	Proactive & Self-Healing. Leverage power of Smart Grid/Homes

Questions & Discussion



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