RAP | Energy solutions for a changing world

Module 3
Characterizing Renewable Energy and Its Benefits

Electric Energy Training
for Air Regulatory & Planning Staff
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Renewable Energy (RE): Topics Covered by this Module

- Definition
- Examples of policies and measures
- Differences between energy efficiency (EE) and RE
- Development of RE policies
- RE policies implemented at local, state and federal level
- Benefits of RE
- Challenges in RE integration
- Tracking & enforcing RE polices
- Calculating benefits & including in SIPs
- Clean Energy Standards

What is Renewable Energy?

- A RE resource is an energy source that is naturally replenished
  - If properly managed, regeneration can be sustained indefinitely
- Examples include:
  - Wind
  - Solar
  - Biomass
  - Geothermal
  - Hydro

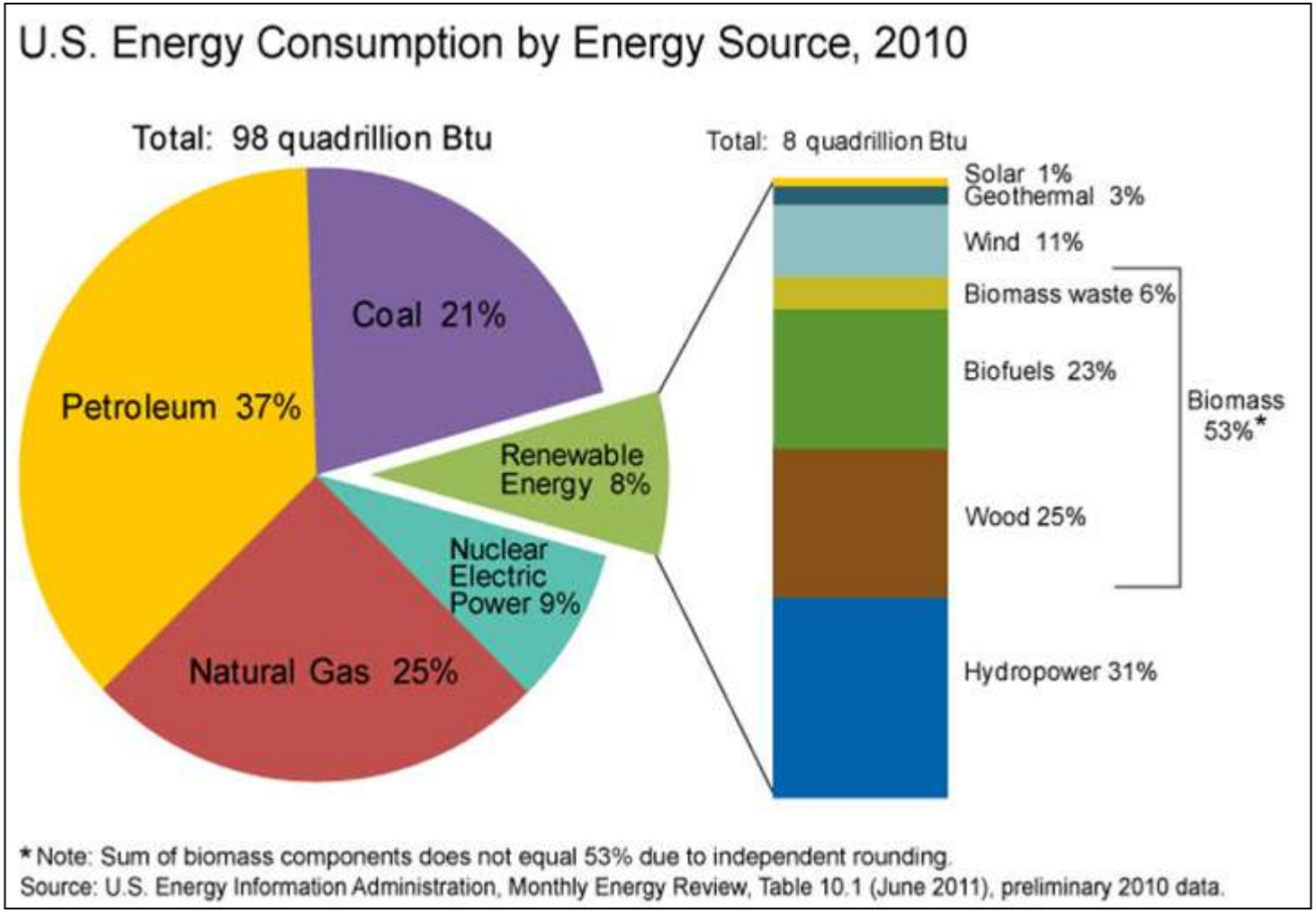
RE vs. EE: Similarities

- Both reduce the need to operate marginal or peaking fossil generation, especially on high electric demand days (HEDD)
  - Reduces emissions and electricity prices
- RE can be sized and deployed to meet customer requirements
  - Variable size; dispersed or concentrated, etc.
  - Technology hinges on availability of underlying natural resources

RE vs. EE: Differences

- **Renewable Energy**
  - RE generation can be directly measured
  - Like power plants, projects must be 100% complete before output occurs
  - RE can be transmitted across long distances
  - Some forms of RE create emissions (e.g., biomass combustion)
- **Energy Efficiency**
  - EE benefits require auditing and statistical sampling to determine energy savings
  - EE benefits begin as soon as the first measure is installed
  - EE can defer or avoid the need to upgrade or construct new transmission

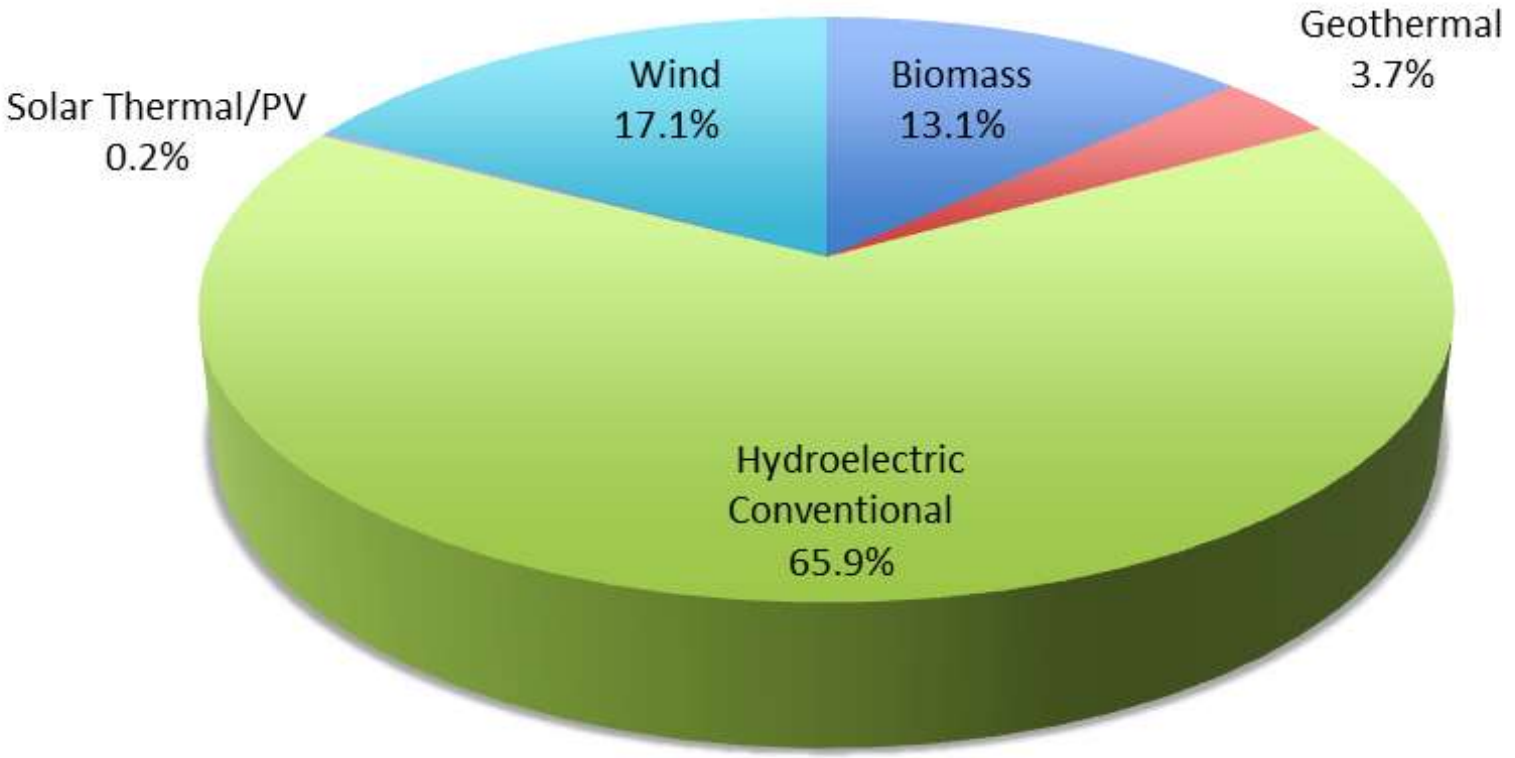
U.S. Energy Sources Overall



U.S. Net Electricity from RE, 2009

Total: 413,246,300 MWh

http://www.eia.gov/cneaf/alternate/page/renew_energy_consump/table3.html



Development of RE in the U.S.

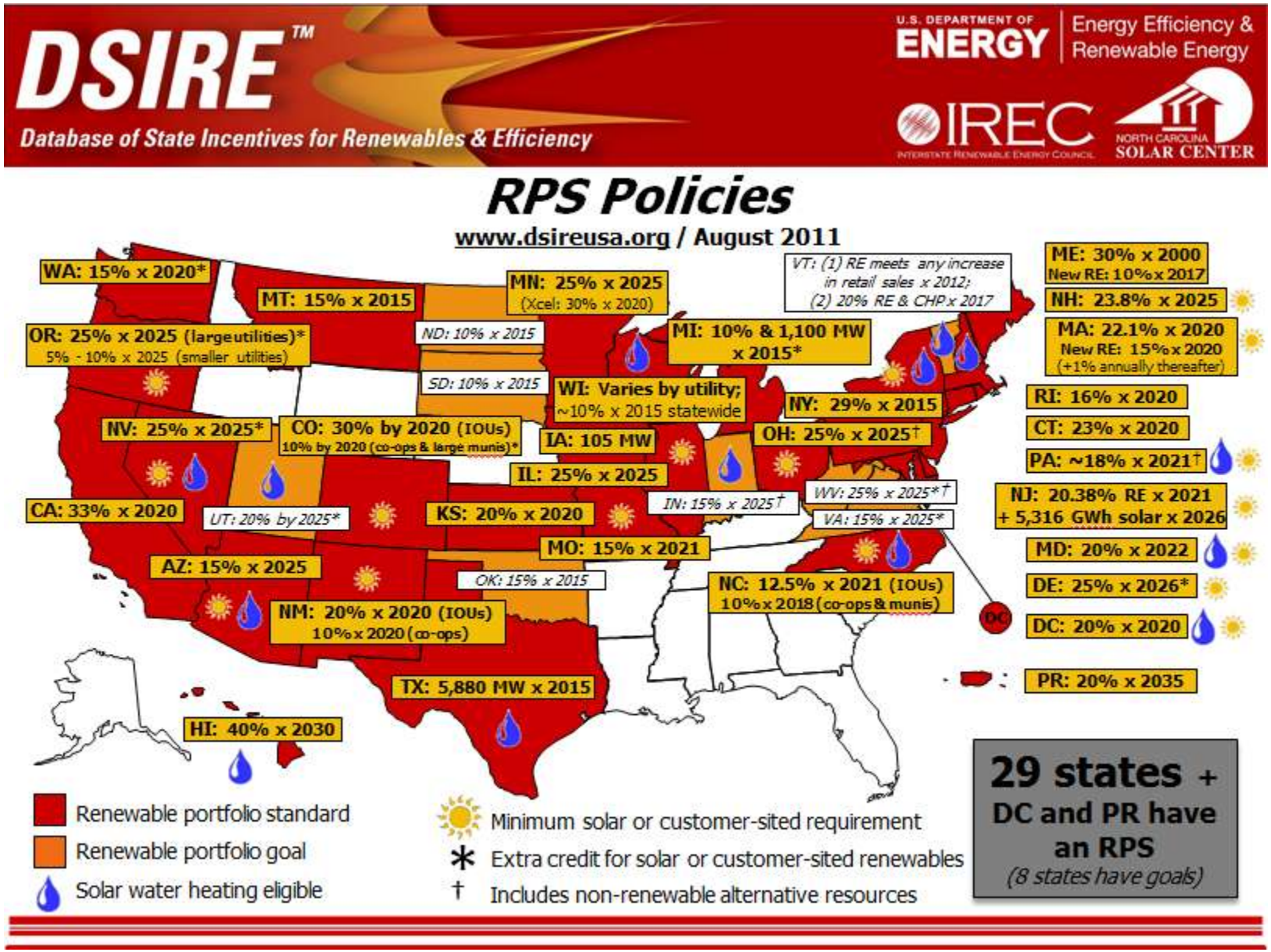
- Three "phases":
  - 1978-1990: PURPA required utilities to purchase power from "qualifying facilities (QFs) at "avoided cost"
  - 1990-~1997: Stagnancy due to restructuring, low natural gas prices, repeal of incentives, etc.
  - 1997-On: New era; states start adopting RPS, enacting SBC/PBF, net metering, financial incentives (rebates, etc.); green power choice, federal PTC/ITC, etc.

Numerous State & Local Approaches In Use Today

- **Non-Financial:**
  - RPS Policies
  - Solar/DG RPS "Carve-Outs"
  - Net Metering Policies
  - Interconnection Policies
  - 3rd-Party PPA Policies
- **Financial:**
  - RE Grant Programs
  - RE Loan Programs
  - Rebate Programs
  - SBC/PBF Funding
  - Feed-In Tariffs
  - PACE Financing Policies
  - Property, Sales & Other Tax Incentives
  - Tax Credits

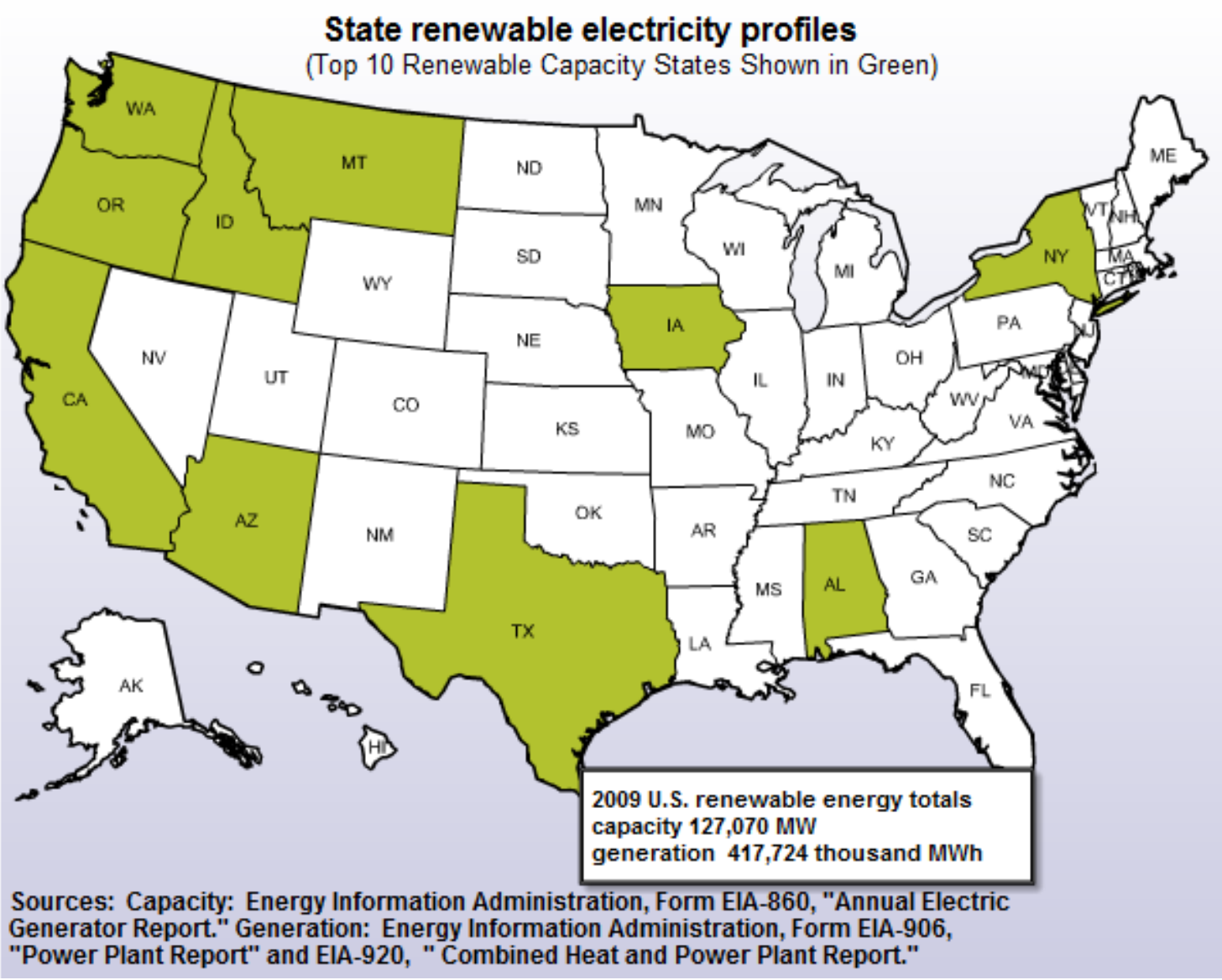
Significant Federal Financial Incentives

- American Recovery and Reinvestment Act: $1.5 billion for RE
- Production Tax Credit (PTC): 2.2¢/kWh for wind, geothermal, closed-loop biomass for first 10 years of operation
- Investment Tax Credit: 10-30% of expenditure
- Clean Renewable Energy Bonds (CREBS) and Renewable Energy Production Incentive (REPI) for co-ops
- Others…


DSIRE™
Database of State Incentives for Renewables & Efficiency
U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy
IREC
INTERSTATE RENEWABLE ENERGY COUNCIL
NORTH CAROLINA SOLAR CENTER
RPS Policies
www.dsireusa.org / August 2011
WA: 15% x 2020*
MT: 15% x 2015
OR: 25% x 2025 (large utilities)*
5% - 10% x 2025 (smaller utilities)
ND: 10% x 2015
SD: 10% x 2015
MN: 25% x 2025
(Xcel: 30% x 2020)
MI: 10% & 1,100 MW x 2015*
WI: Varies by utility; ~10% x 2015 statewide
NV: 25% x 2025*
CO: 30% by 2020 (IOUs)
10% by 2020 (co-ops & large munis)*
IA: 105 MW
IL: 25% x 2025
CA: 33% x 2020
UT: 20% by 2025*
KS: 20% x 2020
MO: 15% x 2021
AZ: 15% x 2025
OK: 15% x 2015
NM: 20% x 2020 (IOUs)
10% x 2020 (co-ops)
TX: 5,880 MW x 2015
HI: 40% x 2030
VT: (1) RE meets any increase in retail sales x 2012; (2) 20% RE & CHP x 2017
NY: 29% x 2015
OH: 25% x 2025†
IN: 15% x 2025†
WV: 25% x 2025*†
VA: 15% x 2025*
NC: 12.5% x 2021 (IOUs)
10% x 2018 (co-ops & munis)
DC
ME: 30% x 2000
New RE: 10% x 2017
NH: 23.8% x 2025
MA: 22.1% x 2020
New RE: 15% x 2020
(+1% annually thereafter)
RI: 16% x 2020
CT: 23% x 2020
PA: ~18% x 2021†
NJ: 20.38% RE x 2021
+ 5,316 GWh solar x 2026
MD: 20% x 2022
DE: 25% x 2026*
DC: 20% x 2020
PR: 20% x 2035
Renewable portfolio standard
Renewable portfolio goal
Solar water heating eligible
Minimum solar or customer-sited requirement
* Extra credit for solar or customer-sited renewables
† Includes non-renewable alternative resources
29 states + DC and PR have an RPS
(8 states have goals)

Fastest Growing Segment

- Generation: Non-hydro RE grew 14.4% in 2009; 19.8% in 2008.
  - Wind 33.5%; solar 3.1%
  - Non-hydro RE up 87% since 1998
  - Vs. overall generation at -4.1%; coal -11.6%
- Capacity: RE gained 10,647 MW in 2009
  - Mostly wind (9,645 MW) – 39% over 2008, and 63% of all 2009 capacity adds (natural gas only 3,812 MW)
  - Solar (83 MW) – 15.5% over 2008; new plants large (~20 MW), 300-400 MW installations planned.


State renewable electricity profiles
(Top 10 Renewable Capacity States Shown in Green)
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
ME
VT
NH
MA
CT
AK
HI
2009 U.S. renewable energy totals
capacity 127,070 MW
generation 417,724 thousand MWh
Sources: Capacity: Energy Information Administration, Form EIA-860, "Annual Electric Generator Report." Generation: Energy Information Administration, Form EIA-906, "Power Plant Report" and EIA-920, " Combined Heat and Power Plant Report."

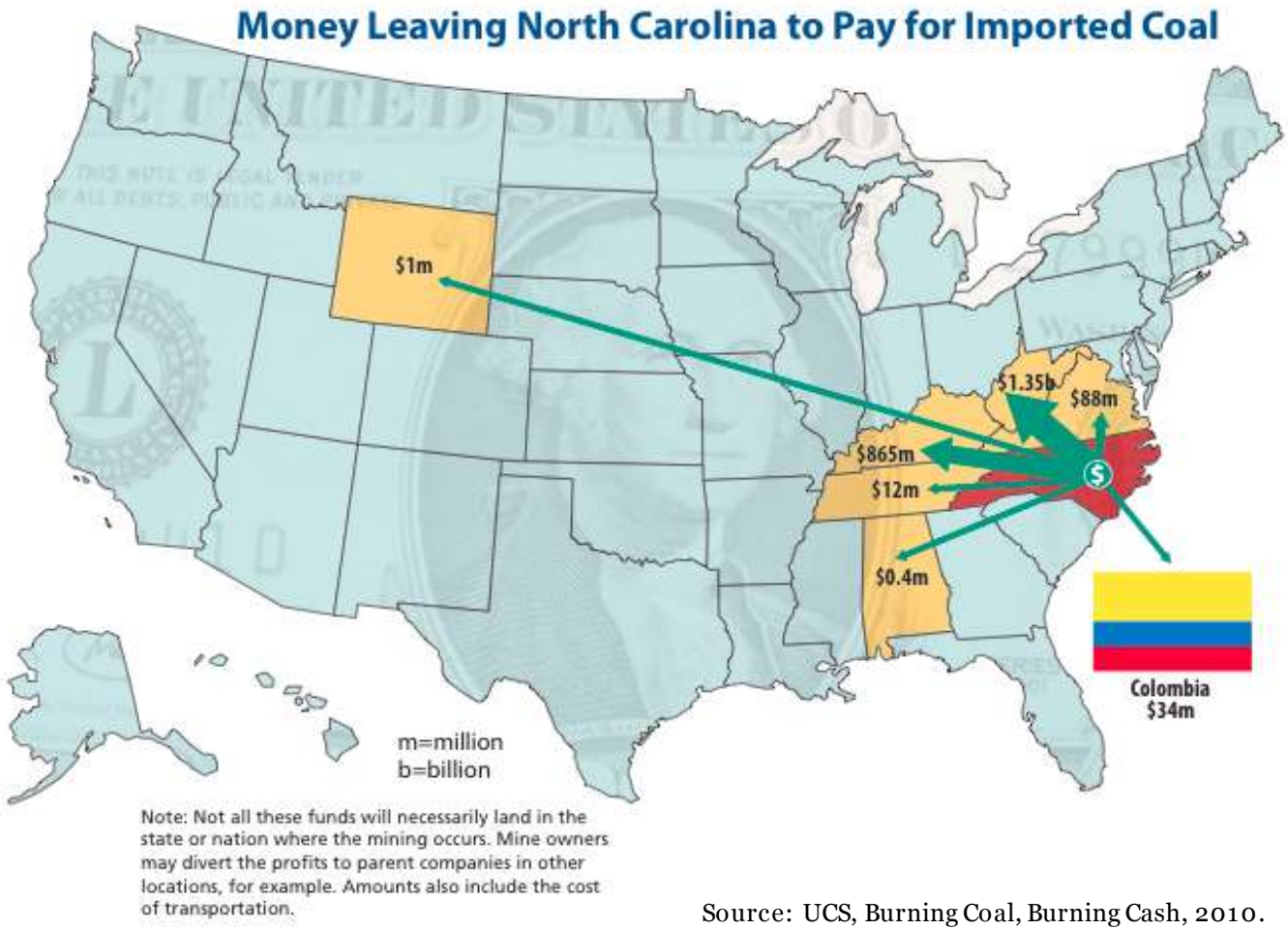
Multiple Benefits of RE (1)

- Environmental
  - Apart from biomass combustion, little or no air pollution
    - After manufacture of the devices
  - Less or no water, land, thermal pollution
    - But many exceptions, e.g., land disturbance with conventional hydro and CSP, etc.
  - Reinforces importance of:
    - Communication between environmental and energy agencies
    - Consideration of externalities in all cases

Multiple Benefits of RE (2)

- Energy Security & Reliability
  - More distributed supply sources can reduce risk, T&D
  - Greater resource diversity
- National Security
  - Less vulnerable to supply/price volatility & risk
- Economic
  - Using local resources keeps jobs, money close to home

NC Imports All Its Coal, Sends $2.35 Billion Out of State Annually



Compared with other states, North Carolina:

- Spent the 2nd most on total net imports: $2.35 billion
- Spent the 3rd most on net imports per person: $254
- Spent the 4th most on net imports relative to gross state product: 0.59 percent
- Imported the 7th most in net weight: 29.4 million tons
- Is the 10th most dependent on net imports as a share of total power use: 57 percent

Source: UCS, Burning Coal, Burning Cash, 2010.

Energy Supply & Jobs

Scenarios (to meet 20% of current US electricity demand)	Construction, Manufacturing, Installation	O&M and Fuel Processing	Total Jobs	Ratio Over "BAU"
1. 20% RPS by 2020 85% biomass, 14% wind, 1% PV	52,533	111,136	163,669	1.89
2. 20% RPS by 2020 60% biomass, 37% wind, 3% PV	85,008	91,436	176,444	2.04
3. 20% RPS by 2020 40% biomass, 55% wind, 5% PV	111,879	76,139	188,018	2.18
4. Fossil Fuels as Usual to 2020 50% coal, 50% natural gas	22,711	63,657	86,369	1.00
5. 20% Gas Intensive by 2020 100% natural gas	22,023	61,964	83,897	0.97

a) "Across a broad range of scenarios, the renewable energy sector generates more jobs than the fossil fuel-based energy sector per unit of energy delivered (i.e., per average megawatt)."

b) "Supporting renewables within a comprehensive energy policy that includes EE and sustainable transportation will yield far greater employment benefits than supporting 1-2 of these sectors separately."

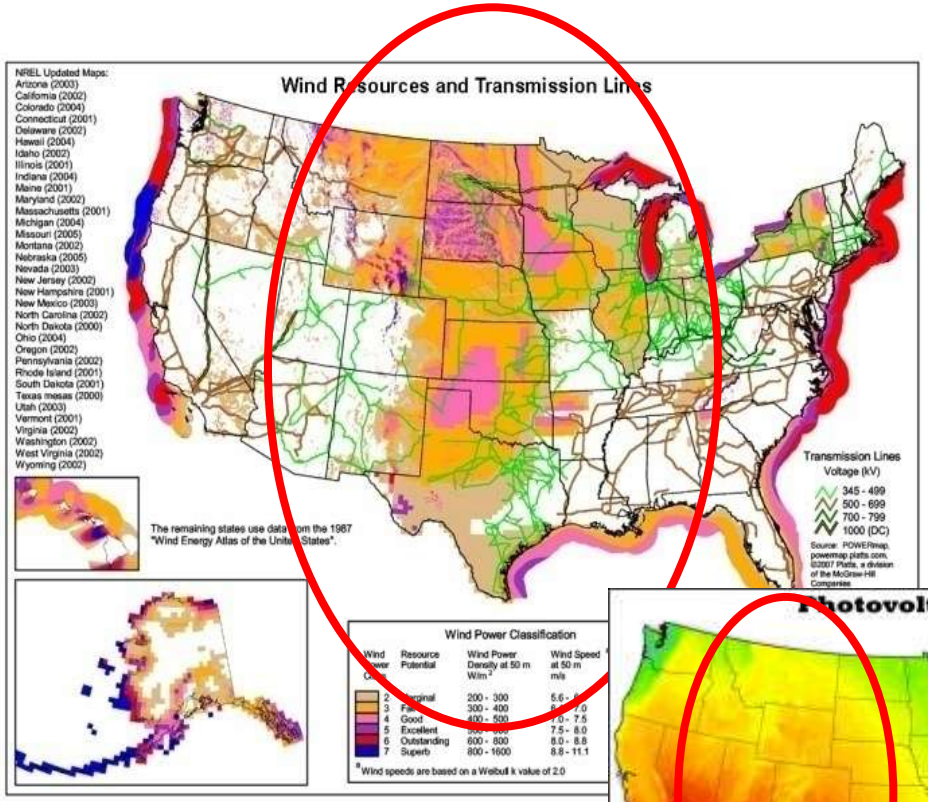
c) More effort => more jobs.

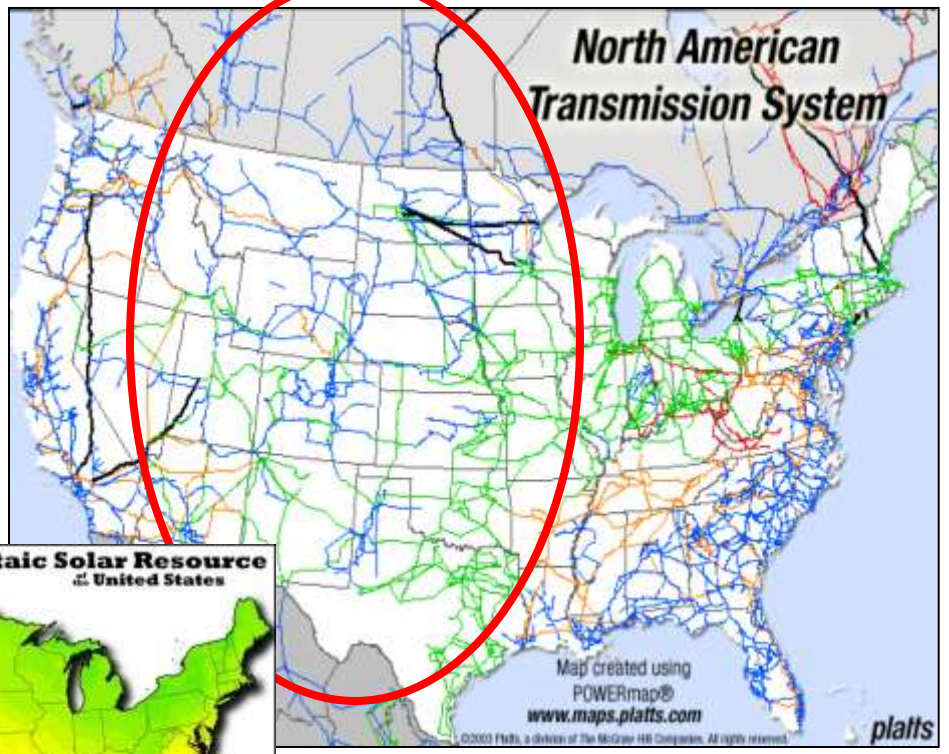
Source: Daniel Kammen et al, UC Berkeley, Putting Renewables to Work, April 2004.

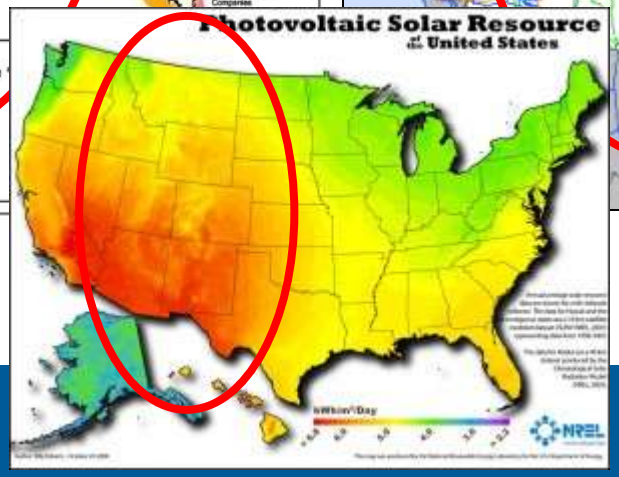
Challenges Integrating RE into the Grid

- **Variability**: Wind and solar variability presents problems for ISO schedulers; delivery deviations can result in penalties
- **Matching RE with Load**: Onshore, wind often blows strongest at night and in the winter, while electricity demand peaks on summer days
- **Transmission**: Lines may be unavailable or of insufficient capacity to move power to demand centers
- **Interconnection**: Upfront processing costs & prioritization schemes can discourage new RE entrants
- **Pricing**: Distance-based transmission pricing mechanisms (or those based on service territories crossed) can discourage remote RE generation

The Grid is Weakest Where Wind and Solar Resources Are Best

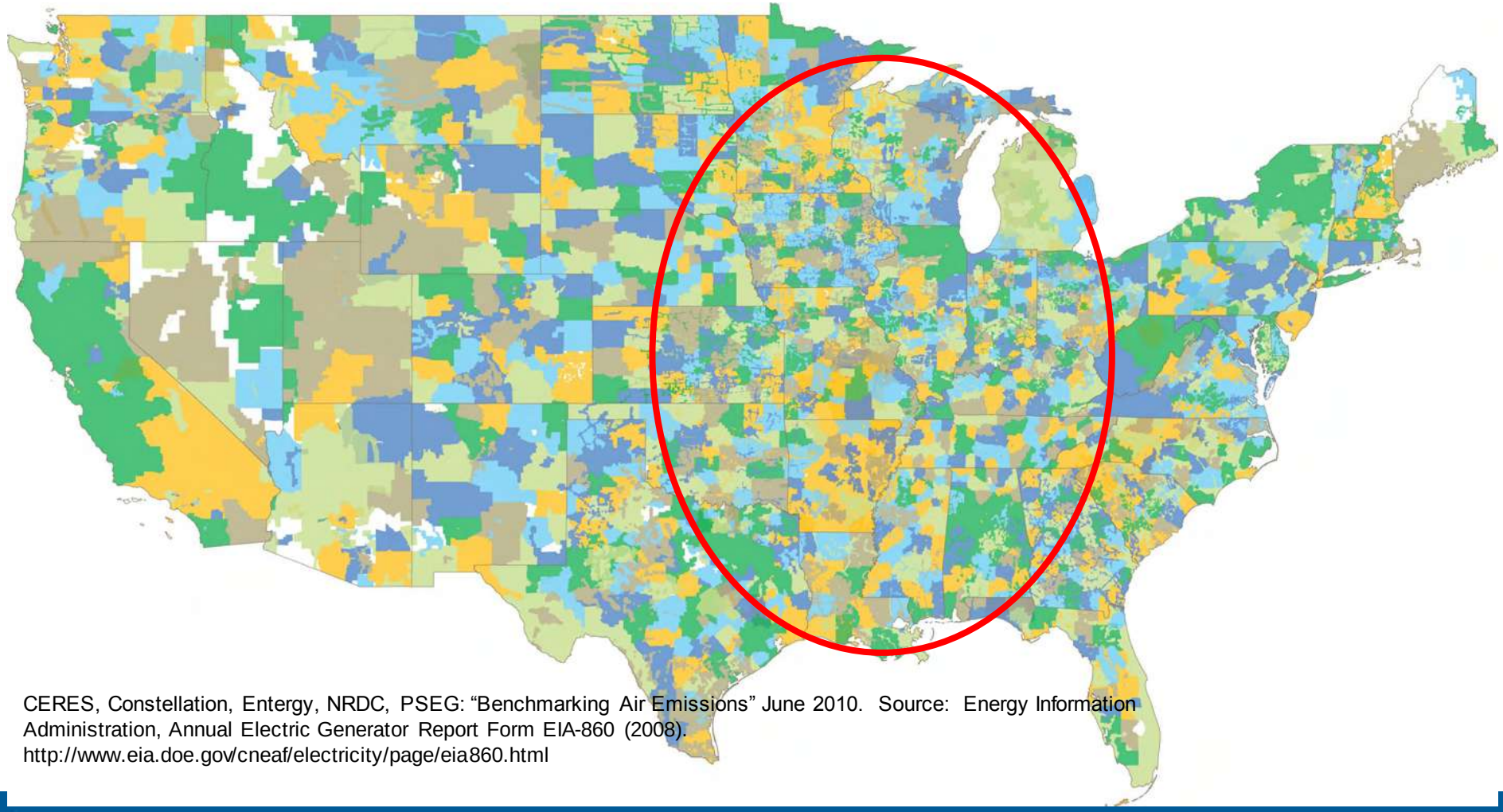






Source of maps: NREL, Platts

New Transmission to Connect Wind Resources Has to Cross Many Electric Utility Service Areas

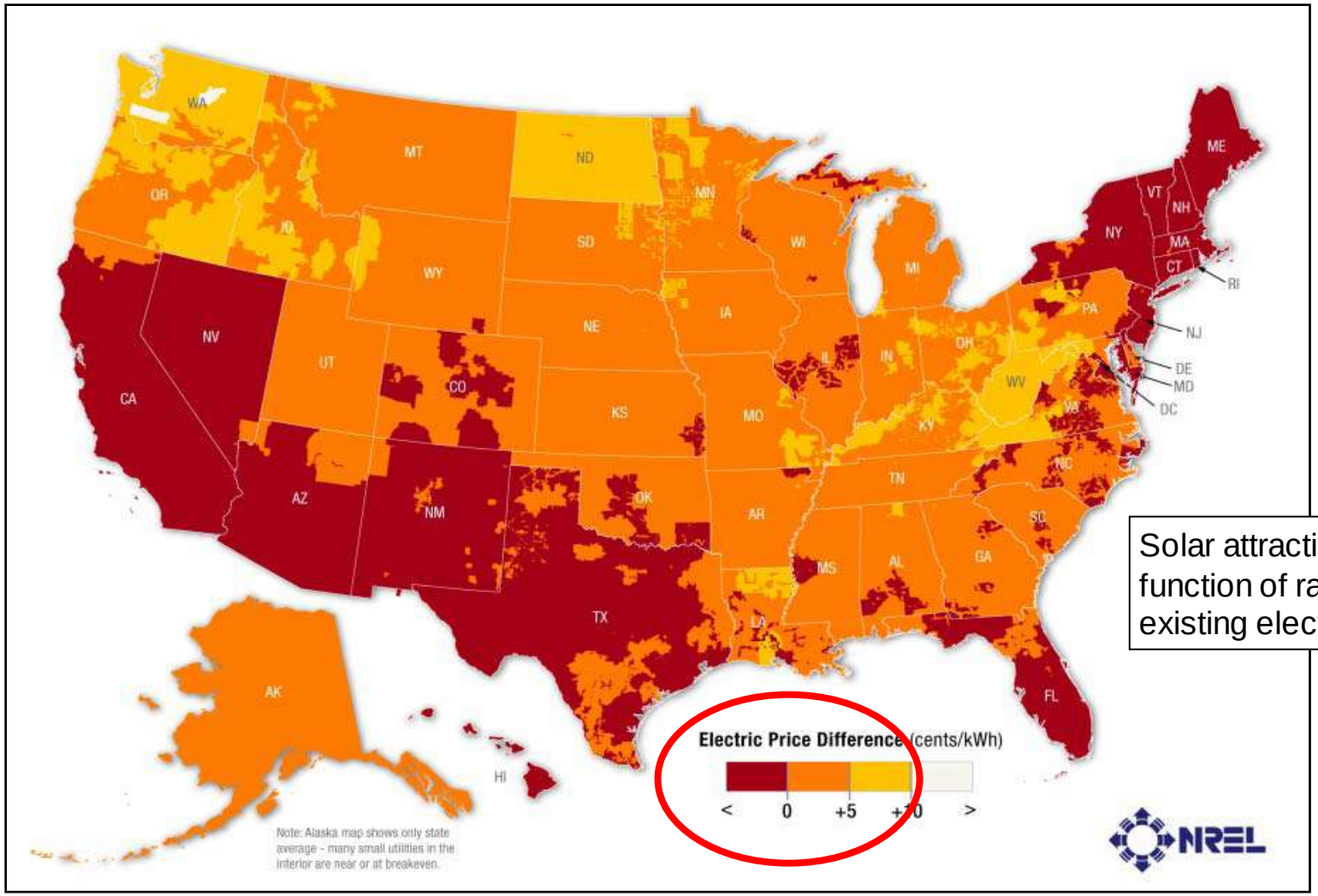


CERES, Constellation, Entergy, NRDC, PSEG: "Benchmarking Air Emissions" June 2010. Source: Energy Information Administration, Annual Electric Generator Report Form EIA-860 (2008).
http://www.eia.doe.gov/cneaf/electricity/page/eia860.html

Some Challenges May Be Waning…

- Electricity storage technologies are advancing rapidly
  - Will mitigate RE intermittency and load matching, perhaps enable peak response
- Smart Grid infrastructure will reduce cost, facilitate other issues
  - Load matching, pricing, etc.

Other Reasons for Optimism (1): Economic Solar Potential



Solar attractiveness is a function of radiation and existing electricity prices

Source: "Solar Energy Industry Forecast: Perspectives on U.S. Solar Market Trajectory," Presentation by the U.S. Department of Energy Solar Energy Technologies Program, May 27, 2008; solar radiation map, WGA.

Other Reasons for Optimism (2):

- Forthcoming EPA EGU regulations are reducing externalities, leveling costs
- Need for coal generation to maintain grid reliability is increasingly suspect
  - Example: 50% of Western coal can be retired and grid reliability maintained (Synapse & Western Grid Group)
- FERC Order 1000 (2011)
  - Must include "policy considerations" in planning

U.S. RE Competitiveness Is At Risk

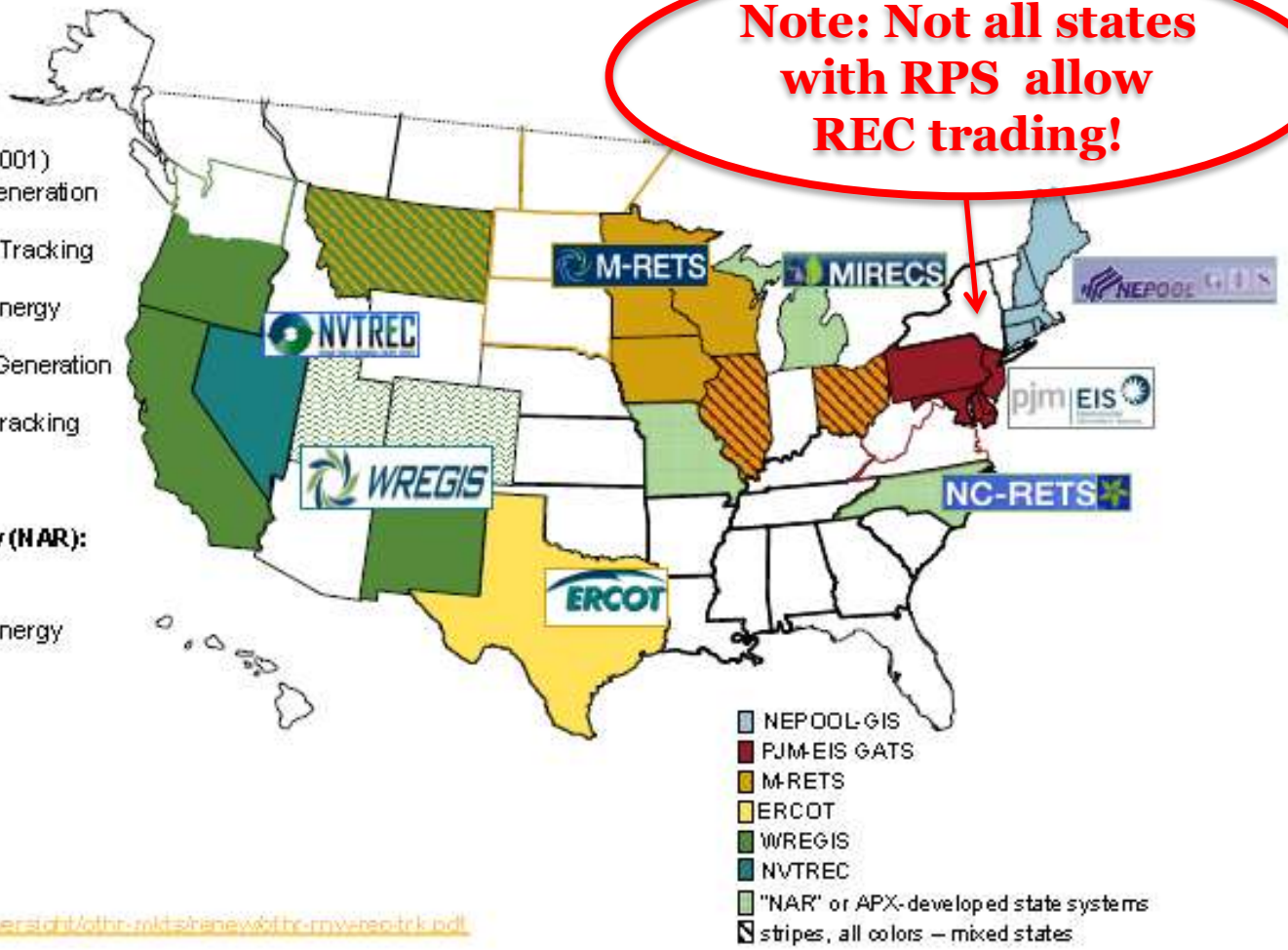
- 2009 – China overtook U.S. in RE investment for first time ($35 billion vs $19 billion)
- 2010 – U.S. fell to 3rd, after China & Germany
- U.S. 11th out of G20 in %GDP invested in clean energy
- "The money follows the market." (NuWire Investor)

Renewable Energy Tracking Systems Operating in North America

Tracking Systems: (year operational)

- **ERCOT:** Texas REC Trading System (2001)
- **NEPOOL – GIS:** New England Pool - Generation Information System (2002)
- **PJM – GATS:** PJM-Generator Attribute Tracking System (2005)
- **NVTREC:** Nevada Tracks Renewable Energy Credits (2007)
- **WREGIS:** Western Renewable Energy Generation Information System (2007)
- **M-RETS:** Midwest Renewable Energy Tracking System (2007)
- **MIRECS:** Michigan Renewable Energy Certification System (2009)
- **North American Renewables Registry (NAR):** non-market facilities or states (2009)
  - Missouri (2010)
- **NC-RETS:** North Carolina Renewable Energy Tracking System (2010)

Note: Not all states with RPS allow REC trading!



Updates at: http://www.ferc.gov/market-oversight/othr-mkts/renew/othr-mny-rec-trk.pdf

Renewable Energy Certificate (REC) Tracking Systems (1)

- REC tracking systems began as quasi-governmental regional entities, created as accounting systems to issue, track, and retire RECs under states' Renewable Portfolio Standard (RPS) rules.
- RECs allow regulators to track compliance with mandatory RPS targets and to verify progress in voluntary state renewable programs.
- Each MWh of generation is issued a REC with a unique identification number to prevent double-counting.

Renewable Energy Certificate (REC) Tracking Systems (2)

- Each REC includes attributes such as generator location, capacity, fuel-type and source, owner, and date operational. Records are tagged by program eligibility.
- Subject entities, such as utilities, comply with RPS targets by owning RECs from RE generation or purchasing RECs from other RE generators. In some jurisdictions they can make "Alternative Compliance Payments (ACP)."
- Where necessary, systems track conservation or energy efficiency credits for states with combined RPS and Energy Efficiency Resource Standard (EERS).

Renewable Energy Certificate (REC) Tracking Systems (3)

- Most systems have added attributes to support other state, provincial, or regional programs or requirements such as various REC classifications (e.g., solar set-asides), voluntary utility green-power programs, or emissions tracking.
- Differences in intra-regional rules include whether RECs can be banked for use in future years and for how long; which renewable technologies are eligible; and whether some fuels or technologies are granted multiple credits.

REC Pros and Cons

- Principal Upside of Regional REC Systems: Broader, more liquid market makes compliance with RE goals cheaper and easier.
- Principal Downside: State policymakers cannot readily ensure that REC money goes to RE projects within their state borders.

Calculating Benefits of RE Policies (1)

- What is driving RE:
  - RPS: voluntary or mandatory?
  - RPS definition: What's included? Are there different classes or categories?
  - Local/county level requirements?
  - Investment or production tax credits? Expiry date(s)?
- Type of RE resource: Centralized or dispersed?
  - Wind farms, concentrating solar, large biomass
  - Residential PV, solar thermal hot water, small scale biomass

Calculating Benefits of RE Policies (2)

- Output from RE resources is directly measured
- RE units < 1 MW may not be tracked or accounted for in information systems or transmission operators, or in EIA's Annual Energy Outlook
- Dispersed RE, like EE, may focus in urban areas, and have greater emissions benefits than the power pool average or state regulatory emissions limits

Including RE Benefits into SIPs (1)

- Assess state policies
- Type of RE resource and characteristics?
  - Coincidence of RE output with electricity demand and pollutant concentrations
    - On-shore wind behaves differently from off-shore wind
    - Wind on ridge tops behaves differently than wind in valleys
    - Solar PV output has good coincidence with summer peak demand and ambient ozone levels

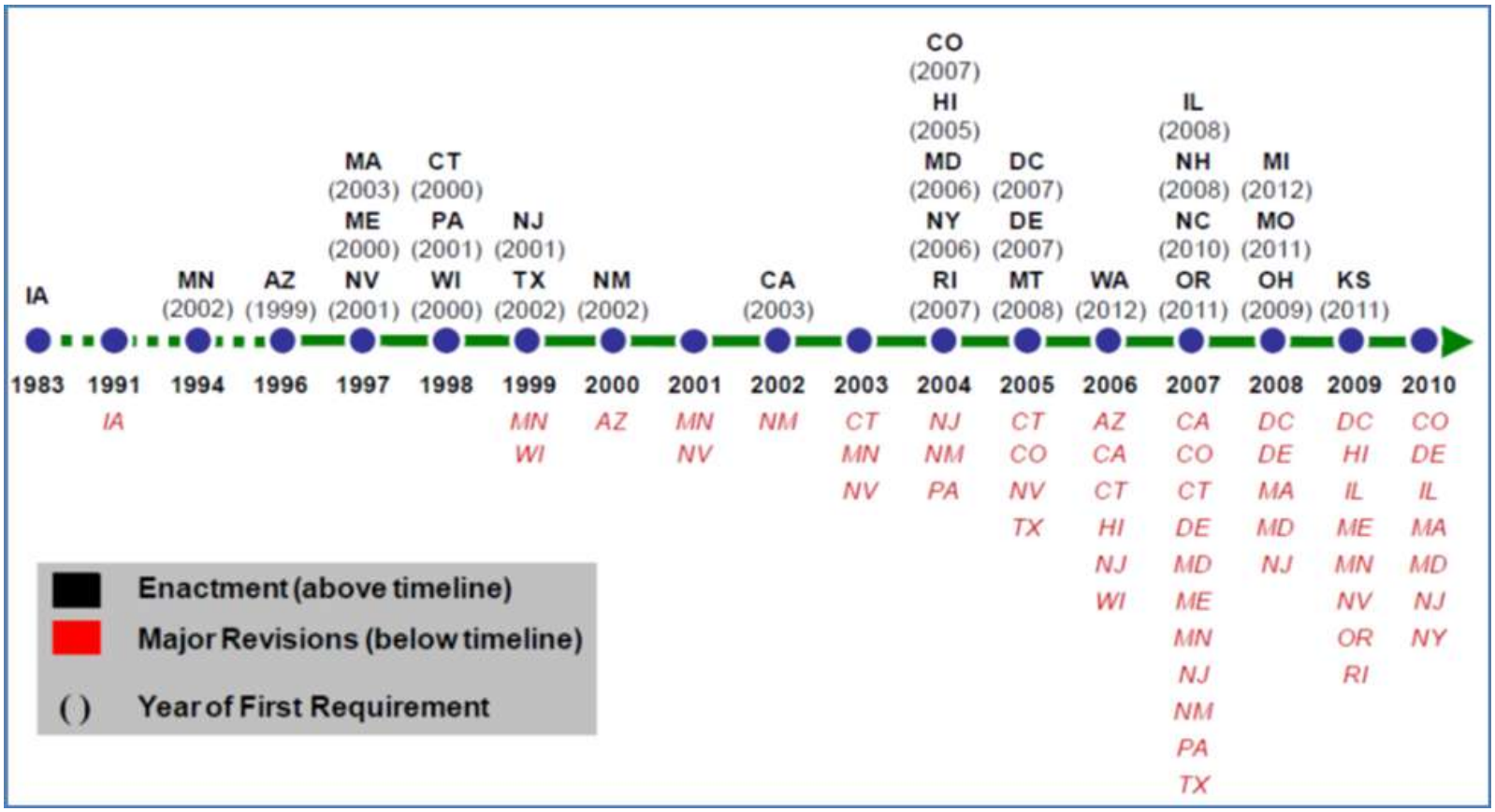
Including RE Benefits into SIPs (2)

- RE resources whose output coincides with peak electricity demand and higher pollution levels have excellent air quality benefits
  - Note that coincidence periods can be any hours of a day; some AQMA have high PM and ozone levels at night

Including RE Benefits into SIPs (3)

- Determine future RE penetration and resource type
- Include local/county requirements that result in additional RE resources (above and beyond RPS)
- Details on different options available to include RE resources into SIPs are provided in Module 7

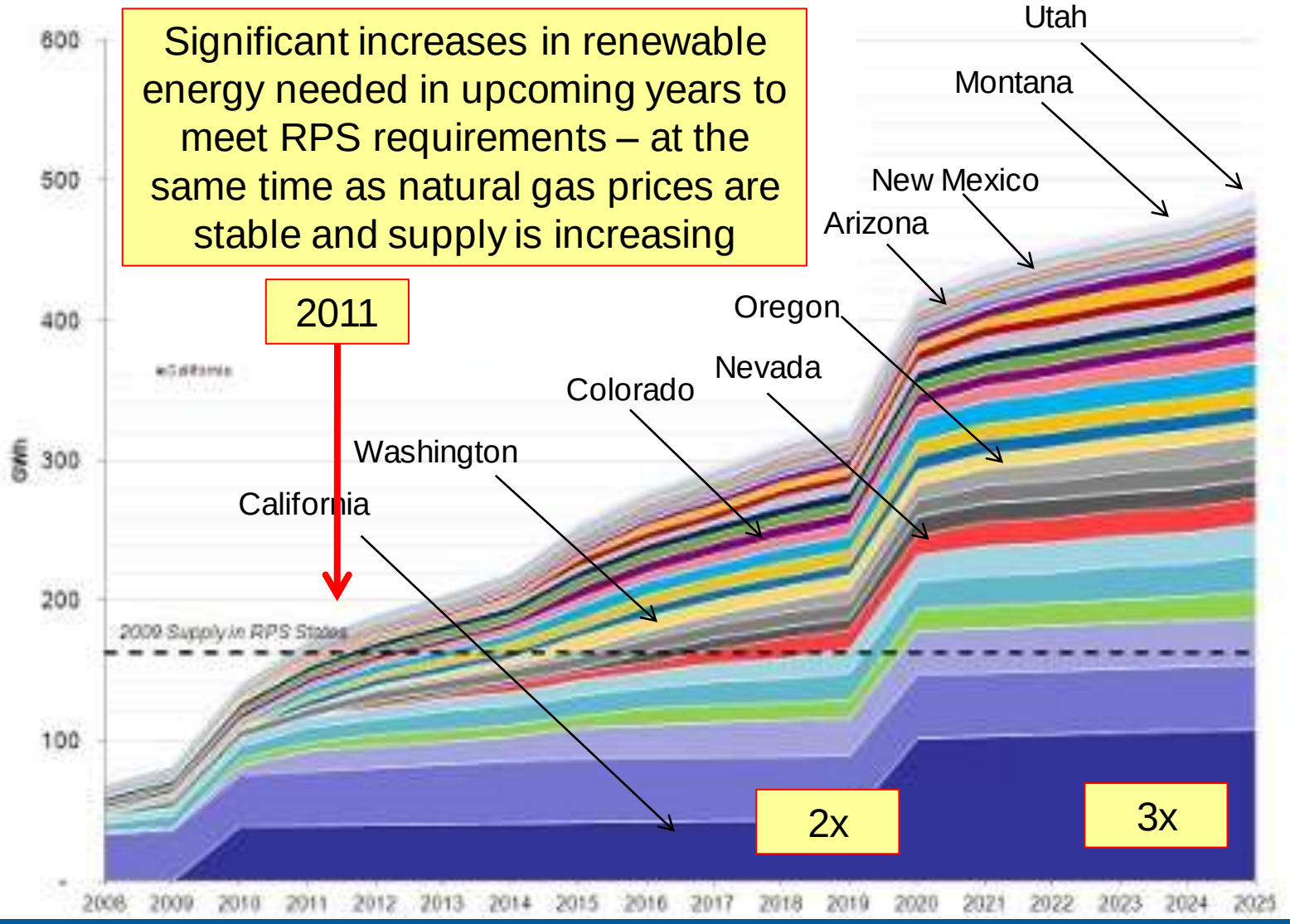
Timeline of State RPS/CES Adoption



More than Just Renewable Electricity in RPS Laws

- Credit for Energy Efficiency/Savings (7):
  - WV, MI, OH, PA, NC, HI, NV
- Credit for Solar Thermal Energy (14):
  - WV, PA, HI, AZ, NV, CO, KS, WI, NC, DC, MD, NY, VT, NH
- Levels being increased in some states
- Biomass thermal also being considered in some states

Outlook for RE? Enthusiasm or Fatigue?



Source: Analysis Group.

Clean Energy Standards (CES) (1)

- How different from RPS or EERS?
  - An electricity portfolio standard (setting aggregate sales targets for utilities)
  - Provide greater flexibility by defining clean energy more broadly than just renewables
  - A promising option for states where narrowly defined renewable electricity policies have less appeal.
  - A handful of states have already enacted electricity portfolio standards with CES attributes

Clean Energy Standards (2)

- Pennsylvania (enacted in 2004):
  - Coal bed methane, waste coal, coal IGCC
- Michigan (2008):
  - Coal with CCS, gasified coal
- Ohio (2008):
  - Coal with CCS, Gen III nuclear

Clean Energy Standards (3)

- West Virginia (2009):
  - Coal bed methane, waste coal, coal with CCS, coal gasification or liquefaction, natural gas, synthetic gas, and GHG offset projects
- Indiana (2011) – VOLUNTARY:
  - Coal bed methane, nuclear power, natural gas from a new facility in Indiana which displaces electricity generation from an existing coal-fired facility

Bipartisan Interest in a Federal CES?

- 2011
  - President Obama's Proposal
  - Senate: Bingaman/Murkowski White Paper
- 2009-2010
  - Sen. Lugar: Diverse Energy Standard (S.3464)
  - Sen. Graham: Clean Energy Standard (S.20)

NOTE: RAP and the Pew Center on Global Climate Change will soon release a comprehensive new paper:
Clean Energy Standards: State and Federal Policy Options

Implications for Air Modeling

- When we combine EE, RE, thermal, and "clean" fossil fuel generation, it could become much harder to forecast emission impacts
- Some of these technologies (e.g. some variations on coal with CCS) could potentially *increase* emissions of some pollutants

Question & Answer Period

- Thank You!

About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

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