Recent trends in the Texas market

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Outline

- Wind integration:
  - Electricity and wind in the European Union versus the USA.
  - The curious case of Texas and ERCOT.
- Network planning,
- Generation capacity adequacy:
  - Effect of wind on wholesale markets.
  - Generation portfolio mix.
- Conclusion.

European Union versus USA

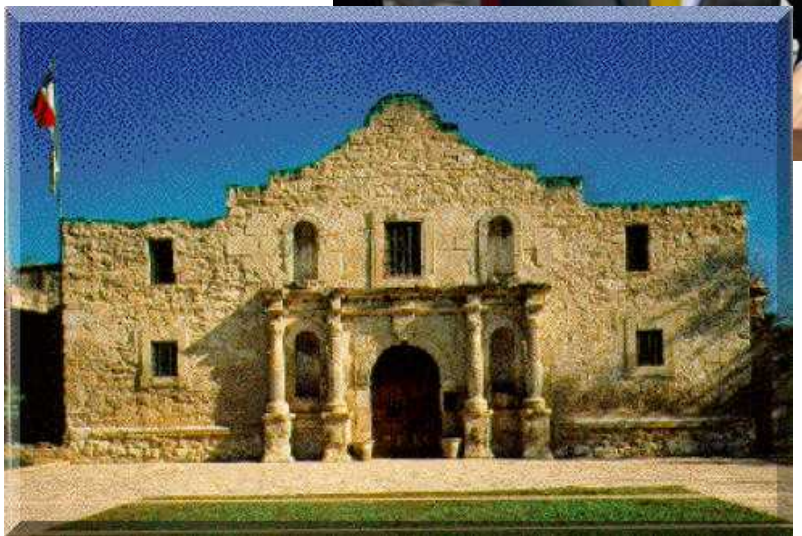
- Total EU installed power generation capacity approximately 932 GW (EWEA 2013),
- Total EU installed wind power generation capacity approximately 106 GW, **11.4%** (EWEA 2013),
- EU wind energy production as fraction of electric energy consumption approximately **7%** (EWEA 2013).

- Total USA installed power generation capacity, approximately 1,050 GW (USEIA 2013a),
- Total USA installed wind power generation capacity approximately 60 GW, **5.7%** (USEIA 2013c),
- USA wind energy production as fraction of electric energy consumption approximately **3.2%** (USEIA 2013a).

European Union versus USA

- Greater penetration of wind by capacity and energy in EU is unsurprising given:
  - Higher fossil fuel energy costs in Europe,
  - Acceptance of need to mitigate greenhouse emissions because of climate change,
  - Encouragement of clean technology sector,
  - Significant amount of flexible hydroelectric and pumped storage hydroelectric resources.
- EU overall slightly behind 2012 target penetrations in “National Renewable Energy Action Plans” (EWEA 2013).

Europe versus Texas



The curious case of Texas

- In contrast to Europe, Texas has:
  - Low fossil energy costs, low taxes on fossil fuels,
  - Extreme skepticism amongst elected officials about climate change: “I do believe that the issue of global warming has been politicized…I think there are a substantial number of scientists who have manipulated data so that they will have dollars rolling into their projects,” Texas Governor Rick Perry,
  - Traditional emphasis on fossil fuel sector,
  - Very little hydro and no pumped storage.

The curious case of Texas.

- Expect lack of enthusiasm for renewables!

- Santa Rita No. 1: first proven oil in West Texas (on University of Texas land; rig now on Austin campus).

The curious case of Texas

- Yet, Texas has, by far, the most wind capacity and highest wind energy production in the USA!
  - More than double the capacity of California.
- Most of Texas is covered by the Electric Reliability Council of Texas (ERCOT).

ERCOT

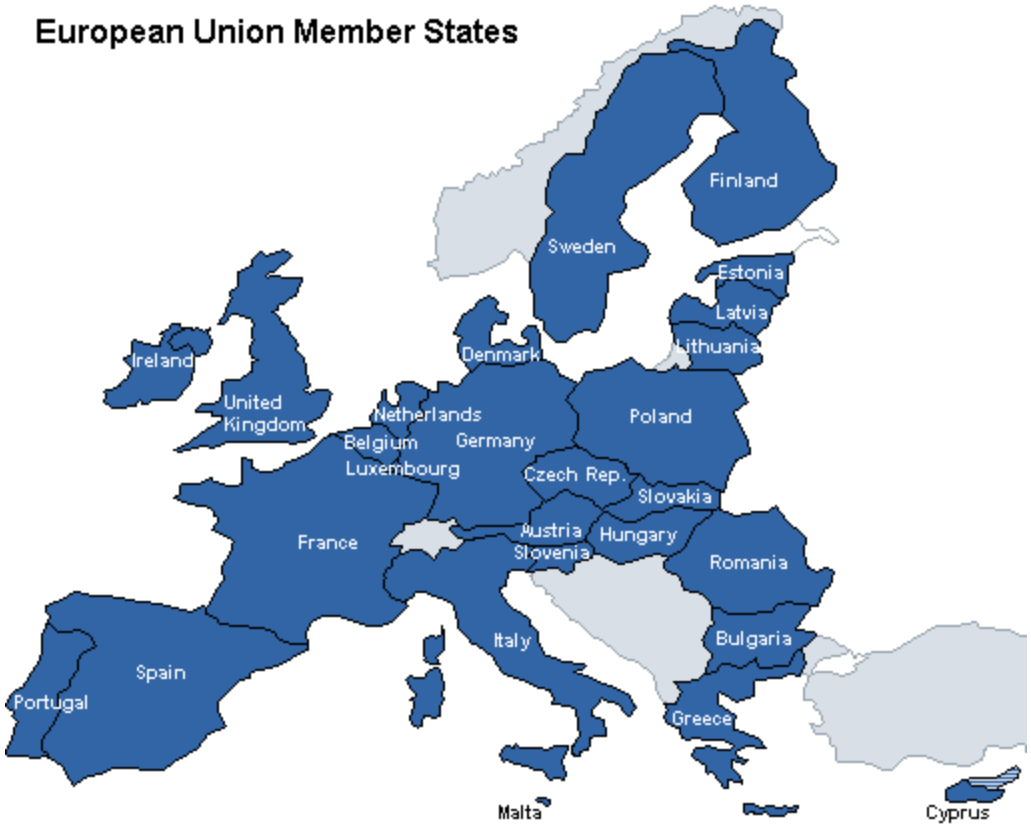
- One of five main synchronous interconnections in North America,
- The smallest of the three synchronous interconnections in contiguous USA,
- Covers most of the area and accounts for most of the electric consumption in Texas,
- ERCOT Independent System Operator (ISO) operates market and coordinates operation of transmission.

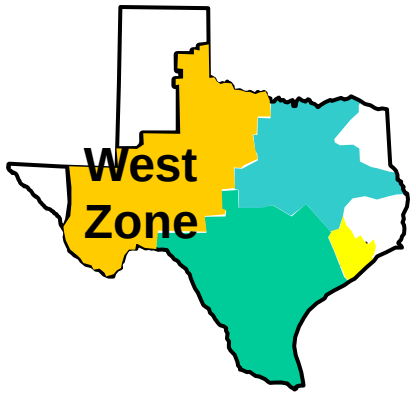
The curious case of Texas

- ERCOT (Potomac 2012; ERCOT 2013):
  - Total installed power generation capacity around 85 GW; Peak demand approximately 68 GW,
  - Total installed wind power generation capacity over 10 GW, **13%**, (compares to 11.4% in EU, 30% in Denmark, 20% in Germany, and 10% in Sweden),
  - Wind energy production as a fraction of electric energy consumption around **9.2%**, (compares to 7% in EU, 27.1% in Denmark, 10.8% in Germany, and 5% in Sweden).

The curious case of Texas

- High wind penetration in Denmark is well-known.
- Wind in Denmark has analogies with wind in West Zone of ERCOT.

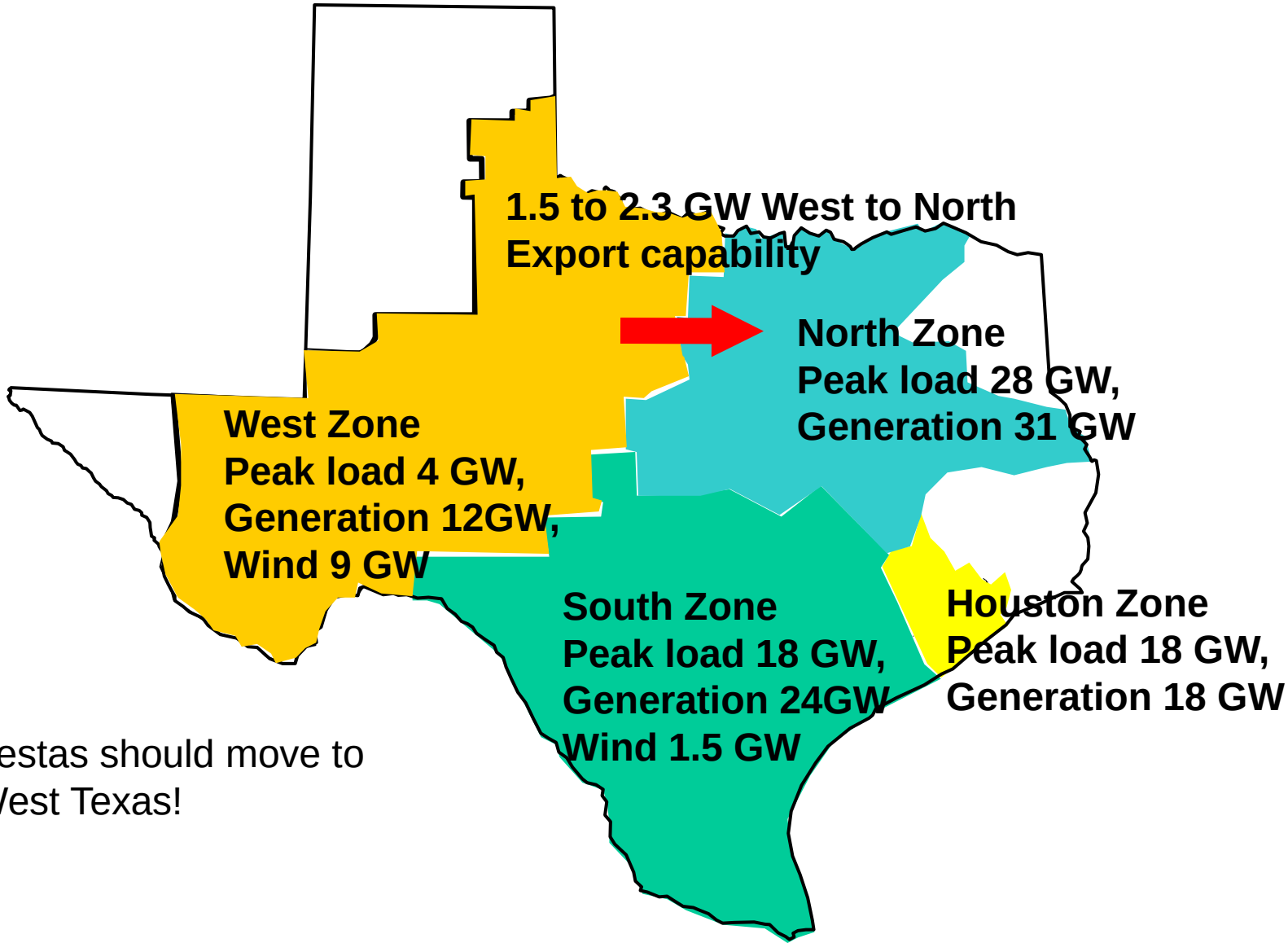




West zone ERCOT

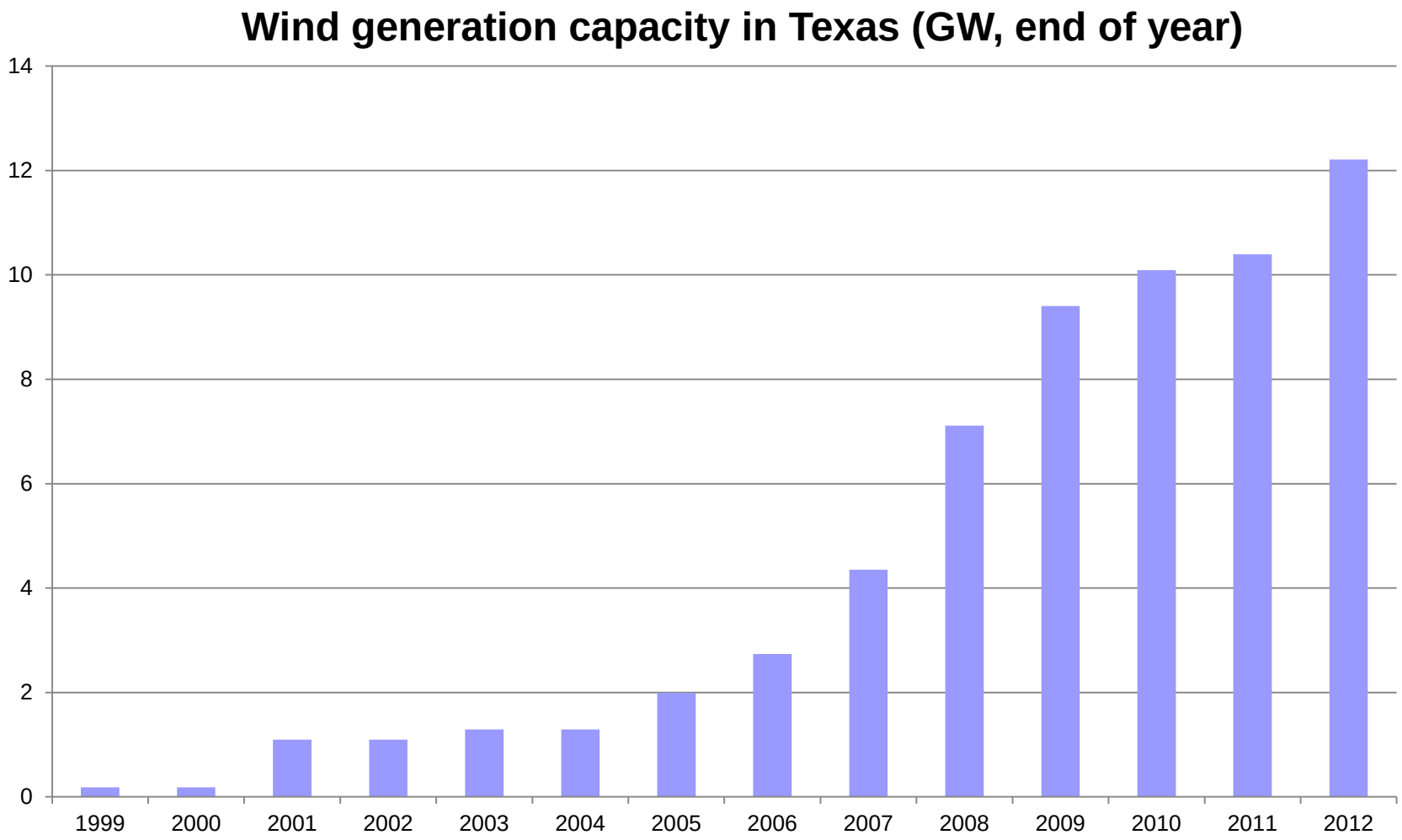
- Total installed power generation capacity in West zone around 12 GW, (compares to 14 GW in Denmark),
- Total installed wind power generation capacity in West zone around 9 GW, **75%**, (compares to 4GW of wind and 30% in Denmark),
- Annual wind energy production in West zone as a fraction of electric energy consumption is more than **85%**, (compares to 27.1% in Denmark),
- Monthly wind energy production in West zone above **100%** in some months.

The curious case of Texas.



Vestas should move to West Texas!

The curious case of Texas.



Source: USEIA 2013c.

The curious case of Texas

- Huge growth of wind in Texas, despite lack of obvious motivations in terms of:
  - high energy prices (except for expectations of growing natural gas prices around 2005—2006),
  - climate change policy directives,
  - clean technology industry (except in Austin).
- Yet, Texas state legislature has mandated renewable energy requirements:
  - So much wind has been built that state mandates are no longer binding!
  - Texas wind capacity exceeds 2025 target!

The curious case of Texas

- Drivers of renewable growth in ERCOT:
  - Federal subsidies around $30/MWh,
  - Robust wholesale market, operating since 1996, retail open access since 2002,
  - New generation entry, including wind, facilitated by uniform interconnection agreement mediated by ERCOT ISO,
  - Good wind resources in West Texas (and along Gulf coast),
  - State level desires to foster rural/West Texas economic development.

The curious case of Texas

- Drivers of renewable growth in ERCOT:
  - Landowners willing to sign wind leases,
  - Little not-in-my-backyard opposition to turbines and transmission,
  - Transmission in West Texas traditionally constrained in import direction,
  - Transmission and Ancillary Services (AS) costs are socialized.
- Greenhouse and climate change issues not typically articulated in public policy about wind in Texas!

The curious case of Texas

- Initial development 1999 through circa 2007:
  - Existing bulk transmission system allowed for considerable West Zone wind with only modest local transmission upgrades, since system was built for *importing* energy *into* West Zone,
  - Wind ramping events such as wind die-offs involved changes in wind production smaller than the spinning reserves carried for the largest thermal generation (2.3 GW),
  - Thermal generation portfolio relatively unchanged, despite changes to operations.

The curious case of Texas

- Significant wind has been built, benefitting from a favorable (and unique) combination of:
  - wind,
  - transmission,
  - landowner attitudes,
  - market design,
  - relatively flexible thermal portfolio,
  - Federal subsidies,
  - mostly no requirement for Federal National Environmental Policy Act reviews, and
  - single state regulator having jurisdiction over wholesale and retail market and transmission.

Network planning

- As mentioned, some local transmission upgrades were necessary to support West Texas wind even in the period from 1999 to 2007.
- By 2005, it was realized that significant further growth would require major upgrades of bulk transmission.
- Texas legislature initiated a process to designate “Competitive Renewable Energy Zones” (CREZ) and build transmission.

Network planning

- ERCOT Independent System Operator (ISO) planned general routing of lines:
  - Final adopted plan to allow for approximately 11 GW more wind, to allow for 18 GW total,
  - Plan has approximately 180 new lines, total length over 5000 km,
  - Anticipated completion in 2014,
  - Total costs around $7 billion.
- Design of plan was accomplished primarily by “trial and error” and without reference to detailed geographical information.

Network planning

- Why no use of systematic decision support tools?
  - Despite academic development, there are no commercial optimization tools for transmission network planning,
  - Compressed timetable for developing plan,
  - Difficulty of encoding all geographical and planning issues into optimization framework.

Network planning

- Traditional emphasis in network planning has been “reliability requirements” to meet peak demand.
- ERCOT ISO also been somewhat unique in US in arranging for “economic” upgrades that deliver low cost energy to demand centers.
- CREZ and similar expansions such as “Sunrise Powerlink” in California are “policy” upgrades driven by renewable policy.

Network planning

- Network planning methodologies (and optimization) need to evolve:
  - Representation of various demand and wind levels, not just, for example, peak demand conditions and “reliability requirements,”
  - Consideration of policy and economic drivers,
  - Better representation of information from geographical information systems.
- Research in my group aims at developing practical, but systematic network planning tools.

Effect of wind on wholesale markets

- US Federal “production tax credit” (PTC) subsidies make effective marginal production cost negative,
- ERCOT has always required almost all transmission-connected wind to offer into the market, (in contrast to being “must take” or receiving a “feed-in tariff”).

Effect of wind on wholesale markets

- Electricity prices are negative in the West zone when transmission constraints are binding, occasionally negative throughout ERCOT when thermal generation is at minimum:
  - Completion of CREZ transmission in 2014 will increase this occurrence,
- Allows for market-based curtailment,
- Reduces profitability of generation investment, particularly wind and baseload.

Generation portfolio mix

- Because net load with high wind is “peakier,” expect portfolio to eventually adapt towards less baseload and more flexible peakers:
  - But low gas prices currently, and other issues, contributing to lack of significant new investment,
  - Expect tight capacity under peak demand conditions in Summer 2014.
- ERCOT system and market will need to adapt to various challenges due to nature of large scale wind integration.

Generation portfolio mix

- Long-term adaptation of thermal system portfolio to net load requires less baseload and more agile peaking generation:
  - Lower capacity factors, more provision of ancillary services,
  - More agility to cope with wind die-offs,
  - Compensation for reduced inertia of system,
  - Greater variation between on- to off-peak wholesale prices.
    - Research in my group aims at understanding the effects on future generation portfolios.

Conclusion

- Texas has experienced huge growth in wind generation almost despite a lack of environmental motivations for renewable integration.
- Initial very favorable circumstances for integration of wind have now given way to relatively higher integration costs for transmission and ancillary services.
- Several challenges associated with further expansion of wind in Texas.

References

- European Wind Energy Association (EWEA) 2013, “Wind in power 2012: European statistics,” February 2013, Available from: http://www.ewea.org/fileadmin/files/library/publications/statistics/Wind_in_power_annual_statistics_2012.pdf, Accessed May 20, 2013.

References

- US Energy Information Administration (USEIA) 2013a, “Electric Power Annual 2011,” January 2013, Available from: http://www.eia.gov/electricity/annual/, Accessed May 20, 2013.
- USEIA 2013b, “International Energy Statistics,” Available from: http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=2&pid=2&aid=7&cid=CG1,&syid=2006&eyid=2010&unit=MK, Accessed May 20, 2013.

References

- USEIA 2013c, “Wind Powering America,” Available from: http://www.windpoweringamerica.gov/wind_installed_capacity.asp, Accessed May 20, 2013.
- Potomac Economics, 2012, “2011 State of the Market Report for the ERCOT Wholesale Electricity Markets,” Available from: http://www.potomaceconomics.com/markets_monitored/ERCOT, Accessed May 20, 2013.

References

- ERCOT 2013, “ERCOT—Challenges and Opportunities,” March 7, 2013, Available from www.ercot.com, Accessed May 20, 2013.