PennState

Energy Transitions—Shale Gas at the Convergence with Renewables

Source: Lightsourcebp

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Penn State's MCOR

Outreach

- Science-based information
- Rapid response
- Localized outreach
- Rapid evolution of info
- Broad range of views
- Positive link between stakeholders, researchers, industry, and elected officials

"Translational Outreach"

--Creating advocates of science w/**Energy Transitions**

Research Interests

- Above and below ground
- Geoscience/engineering
- Technical
- Environmental/land use
- Economic/workforce
- Social, community impacts
- Governance
- Regulatory
- Baseline assessments
- Convergence of shale and renewables

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New U.S. Energy Paradigm

- Shifting energy dynamic and energy transitioning
- New price advantages
- Political realities
- Changing cultural expectations on energy
- Low carbon future
- Economic realities
- New business demands on energy

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Energy Transition Drivers

- Societal change
  - What do people want
  - Realistic or not
- Political forces
  - Four-year cycles
- Market
  - Investment trends
- Global climate metric
  - Localized impacts
  - Global ramifications
- Where is the energy technology??

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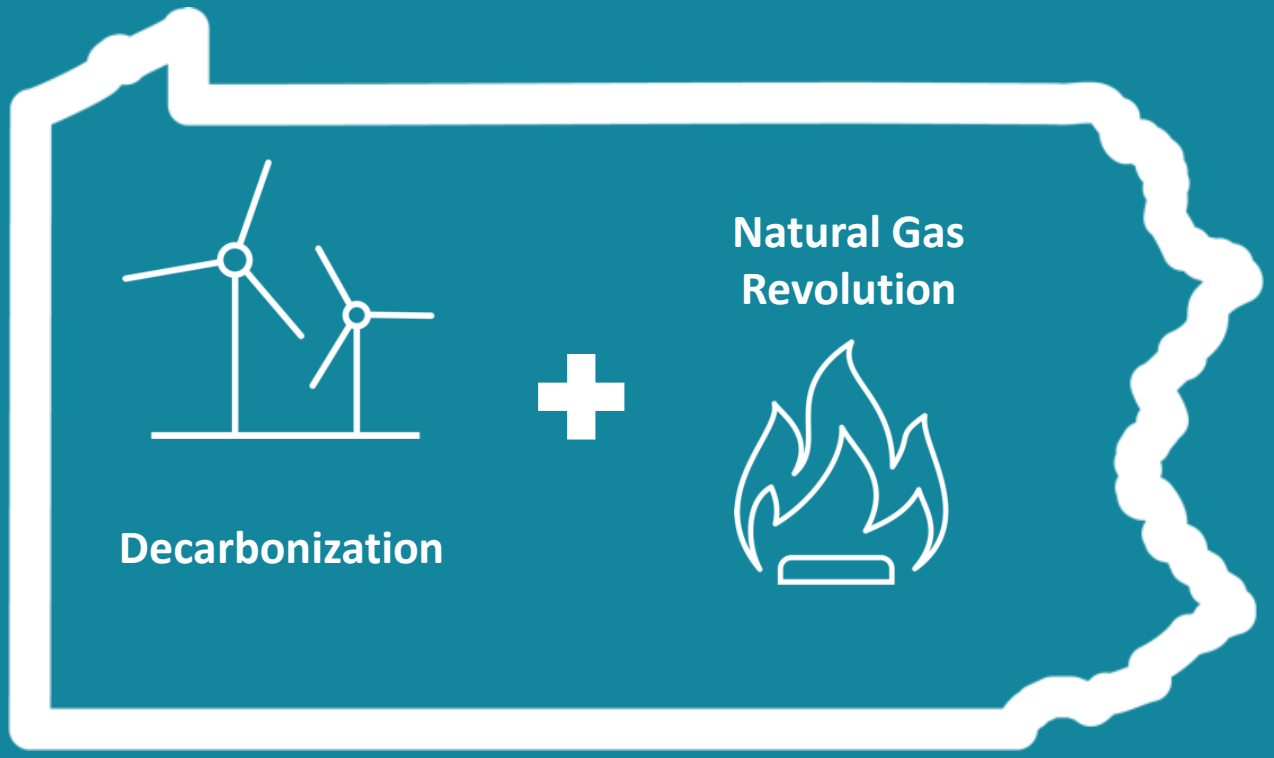
PENNSYLVANIA ENERGY HORIZONS

DEVELOPING SCENARIOS TO INFORM PENNSYLVANIA'S ENERGY STRATEGY

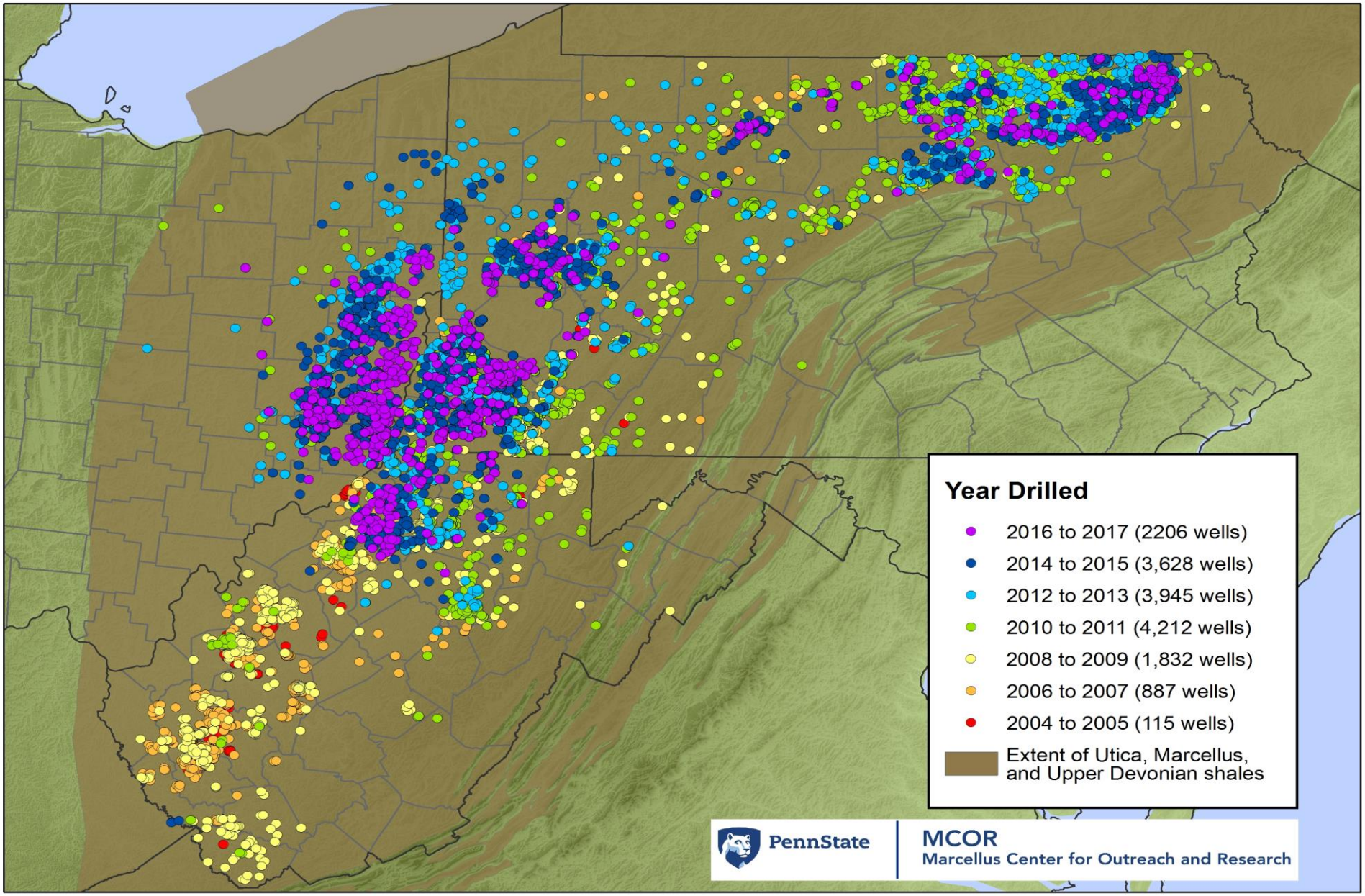
How might Pennsylvania's energy system evolve in the next 25 years, and what might that mean for Pennsylvanians?

Pennsylvania's Convergence of Energy Transitions



WWW.PAENERGYHORIZONS.ORG

Unconventional Wells Drilled by Year



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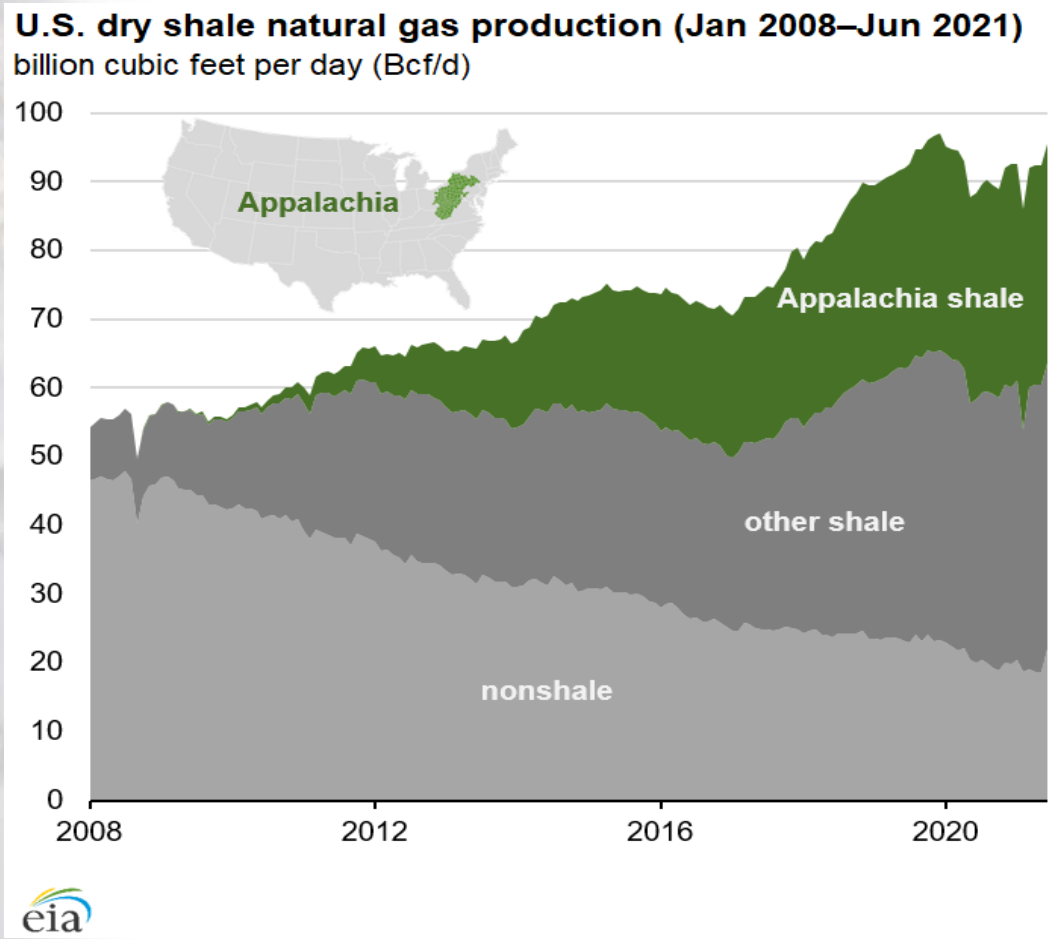
Marcellus/Utica Production



- 32+ Bcf/d in basin
- 34% of U.S. production
- Third largest producer behind Russia and remainder of U.S.
- Expanding domestic markets
- Increasing LNG options

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Evolving Energy Questions

Different energy resources, similar concerns:

Wind/Solar/Gas/Hydrogen

- Transmission lines
- Pipeline ROW
- Infrastructure
- Revenue generation
- Community impacts
- Environmental issues
- Local economic benefit

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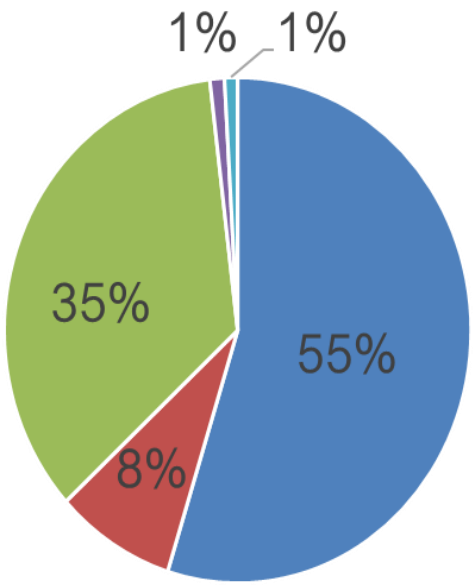
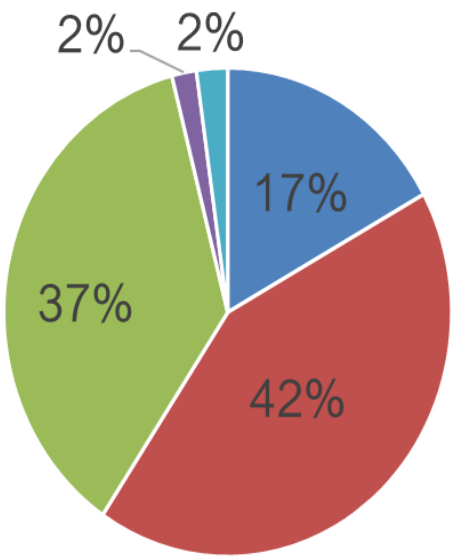
Pennsylvania - Net Electricity Generation 2007



Pennsylvania - Net Electricity Generation 2019



Source: EIA Net Generation Pennsylvania Electric Power Annual

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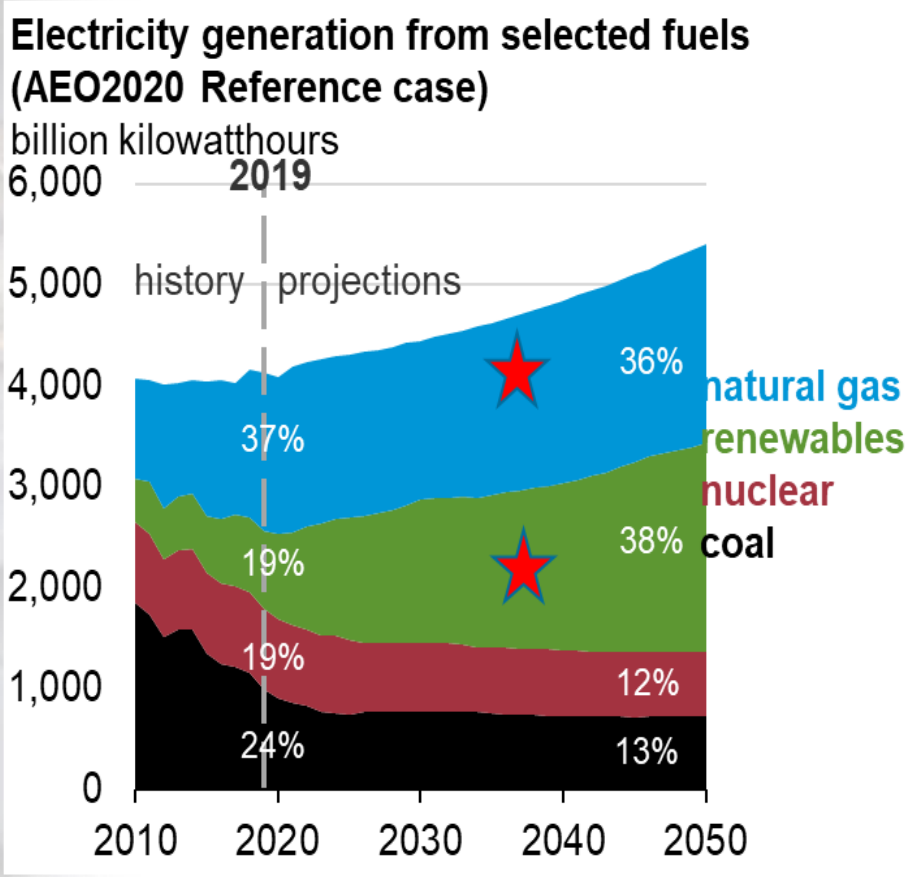
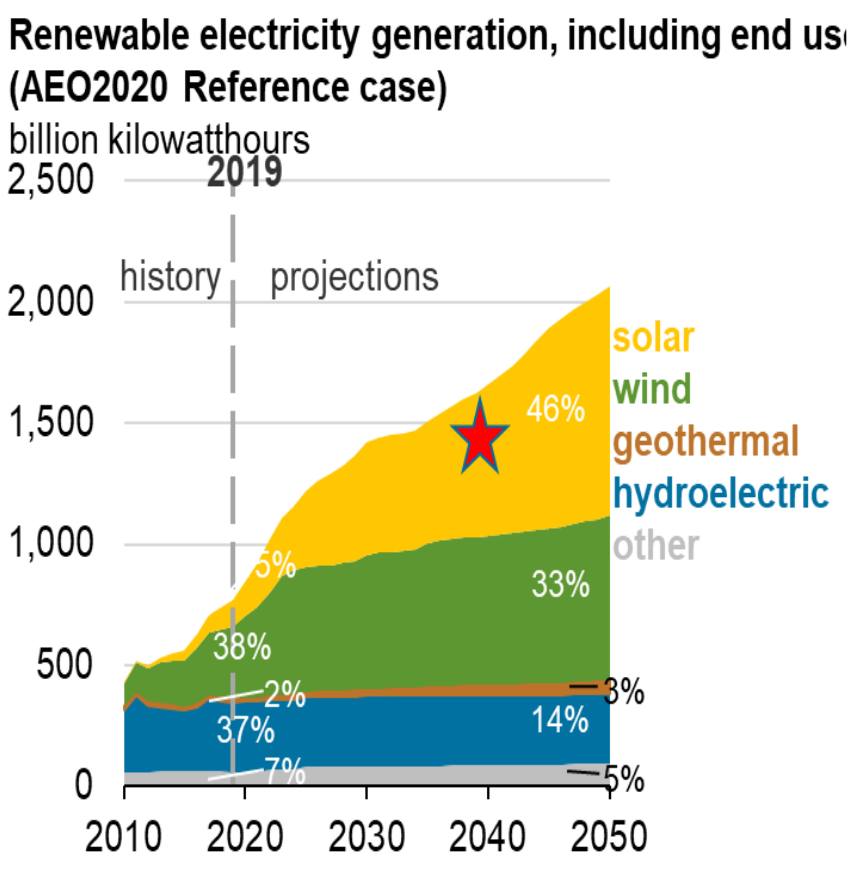
EIA ANNUAL ENERGY OUTLOOK 2020





Electricity generation from natural gas and renewables increases as a result of lower natural gas prices and declining costs of solar and wind renewable capacity, making these fuels increasingly competitive

Source: EIA

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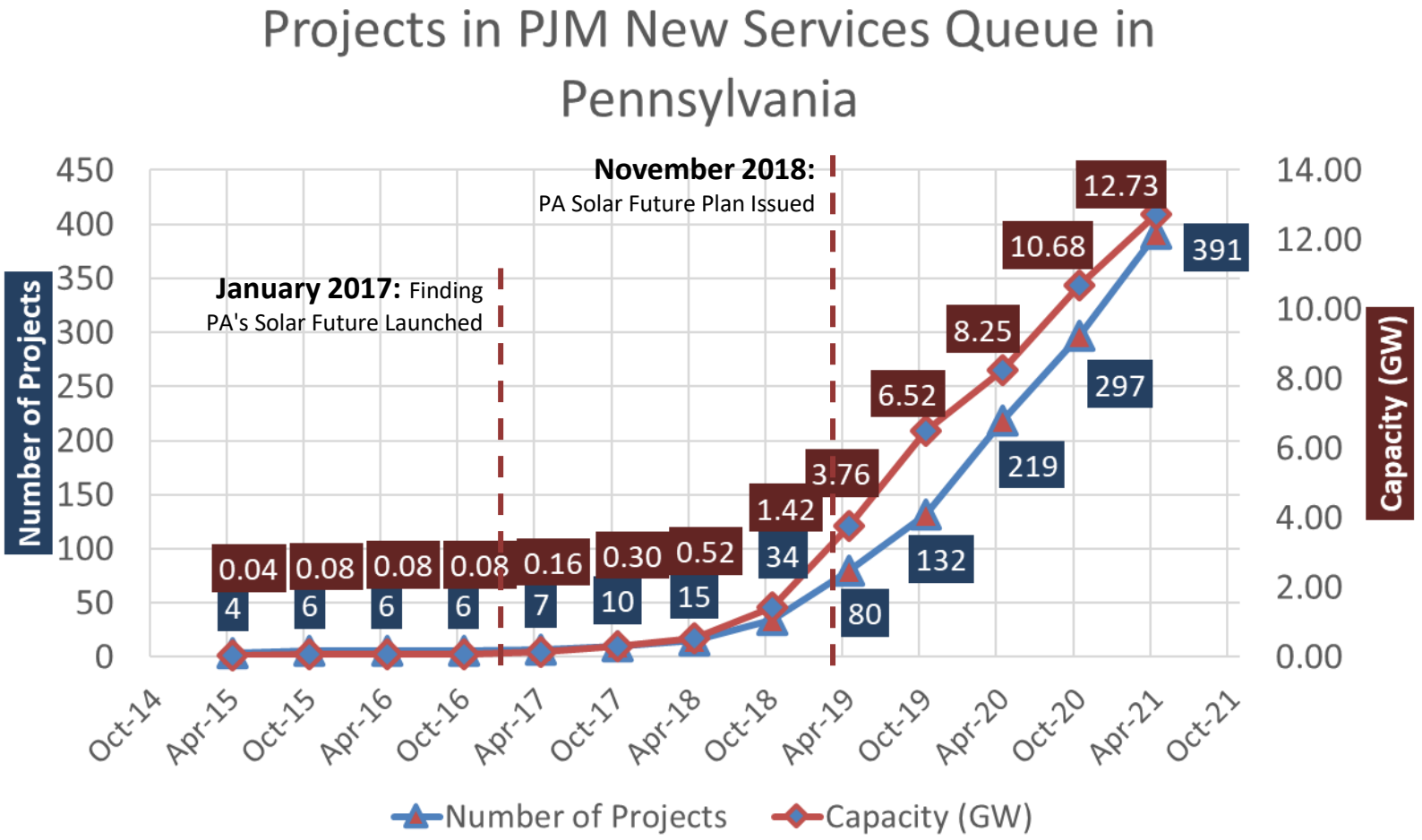
Growth of Grid-Scale Solar Proposals



Based on data from PJM, graphic by DEP 8.21

Why Solar in PA

- Not the best location in the U.S. for sun
  - But… …400+ projects in PJM queue
- PA is large electric generator and export state
- Abundant electrical infrastructure
  - transmission
- Generally favorable political/policy support
  - 80K acres anticipated
- Investor support --$13B by 2030??
  - $1.13M/MW (approx. 6 acres/MW)
- Central location to markets
- New storage technology and declining costs

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Statewide Development Potential

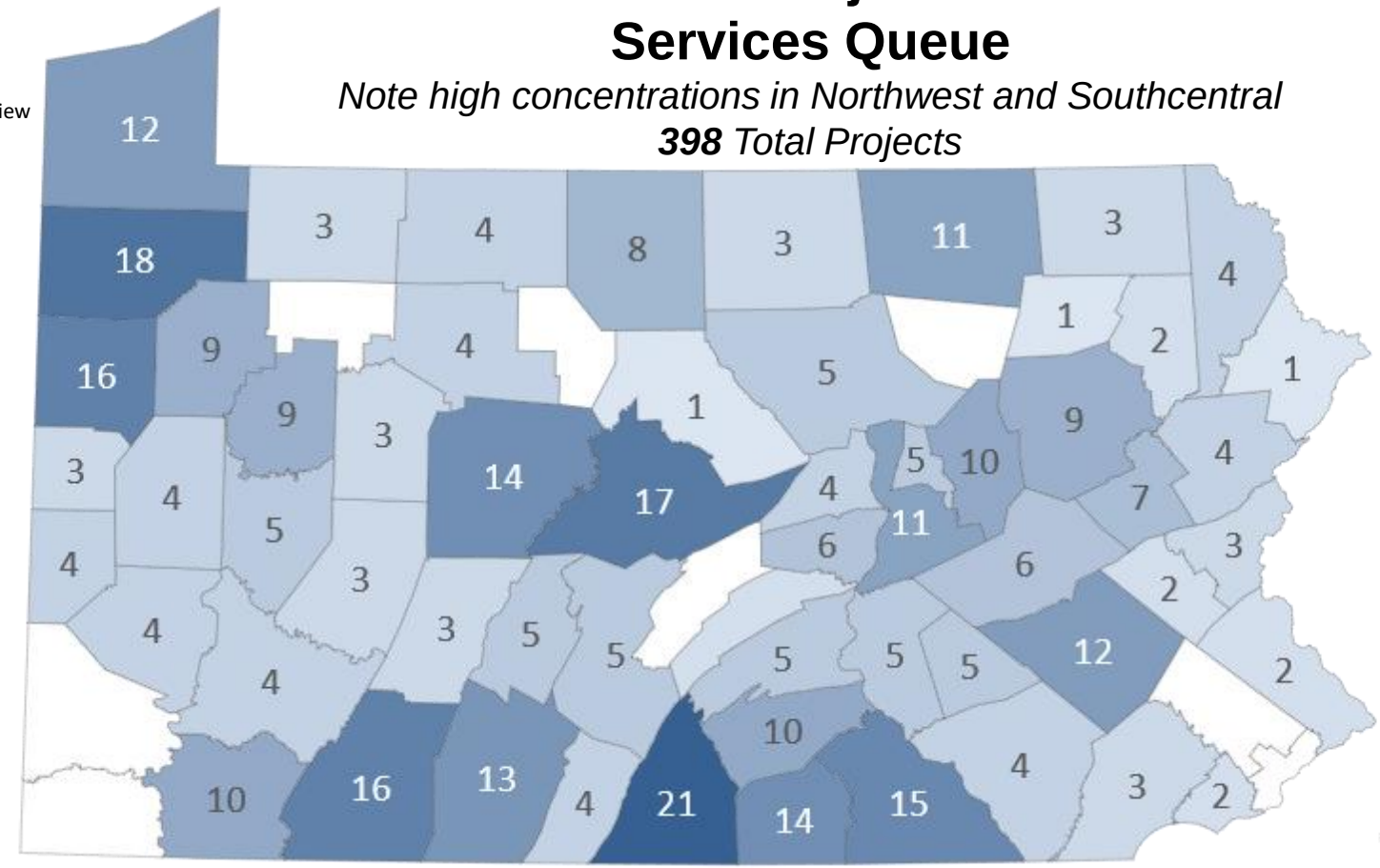
Total Number of Projects in PJM New Services Queue

Note high concentrations in Northwest and Southcentral

***398** Total Projects*

Review Phase:

181	Initial Review
133	Advanced Review
77	Project Design
7	Operations



Based on data from PJM, graphic by DEP 8.21

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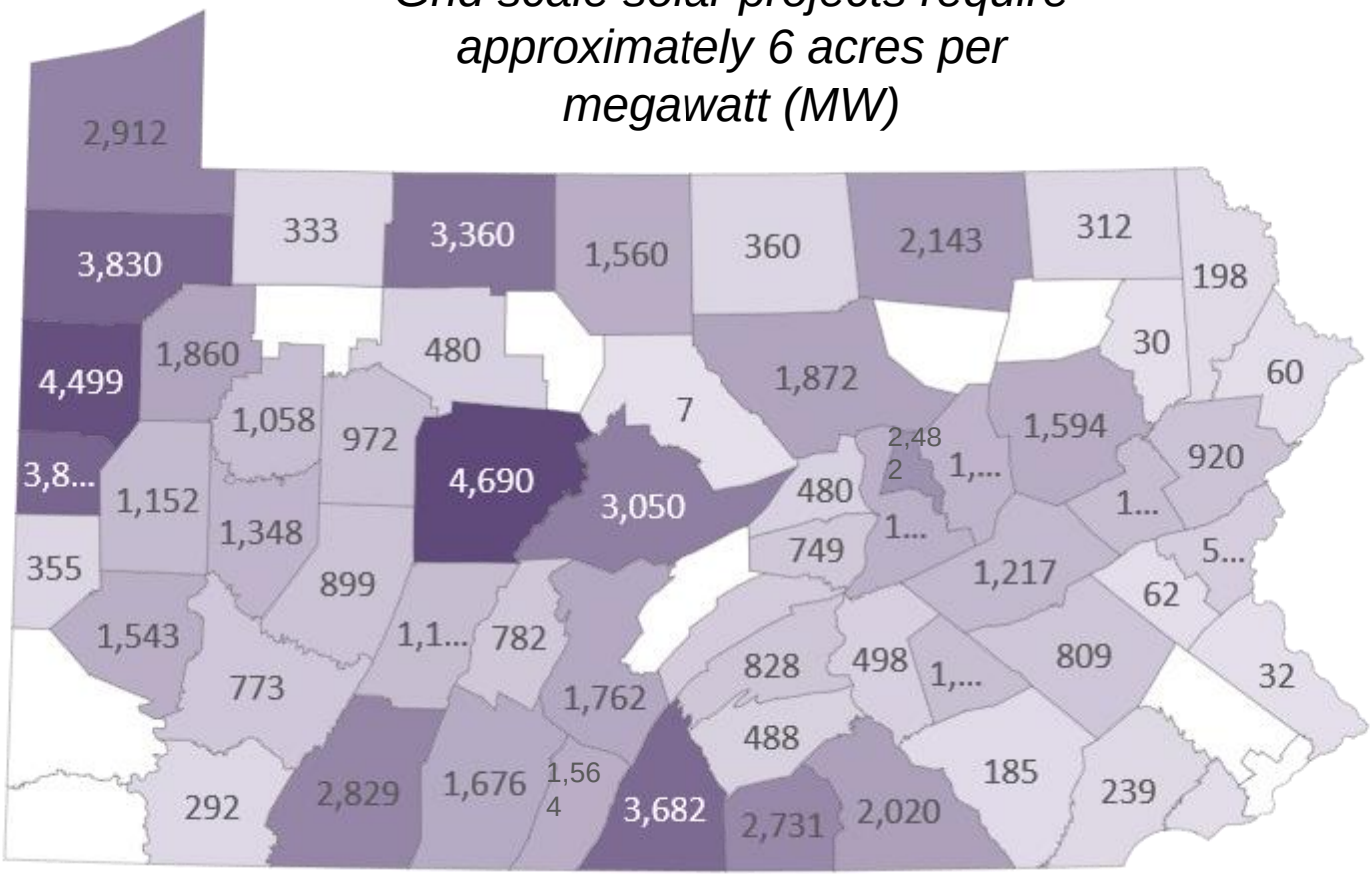
Land Use Impact

Acres Needed for Project Development

Grid scale solar projects require approximately 6 acres per megawatt (MW)



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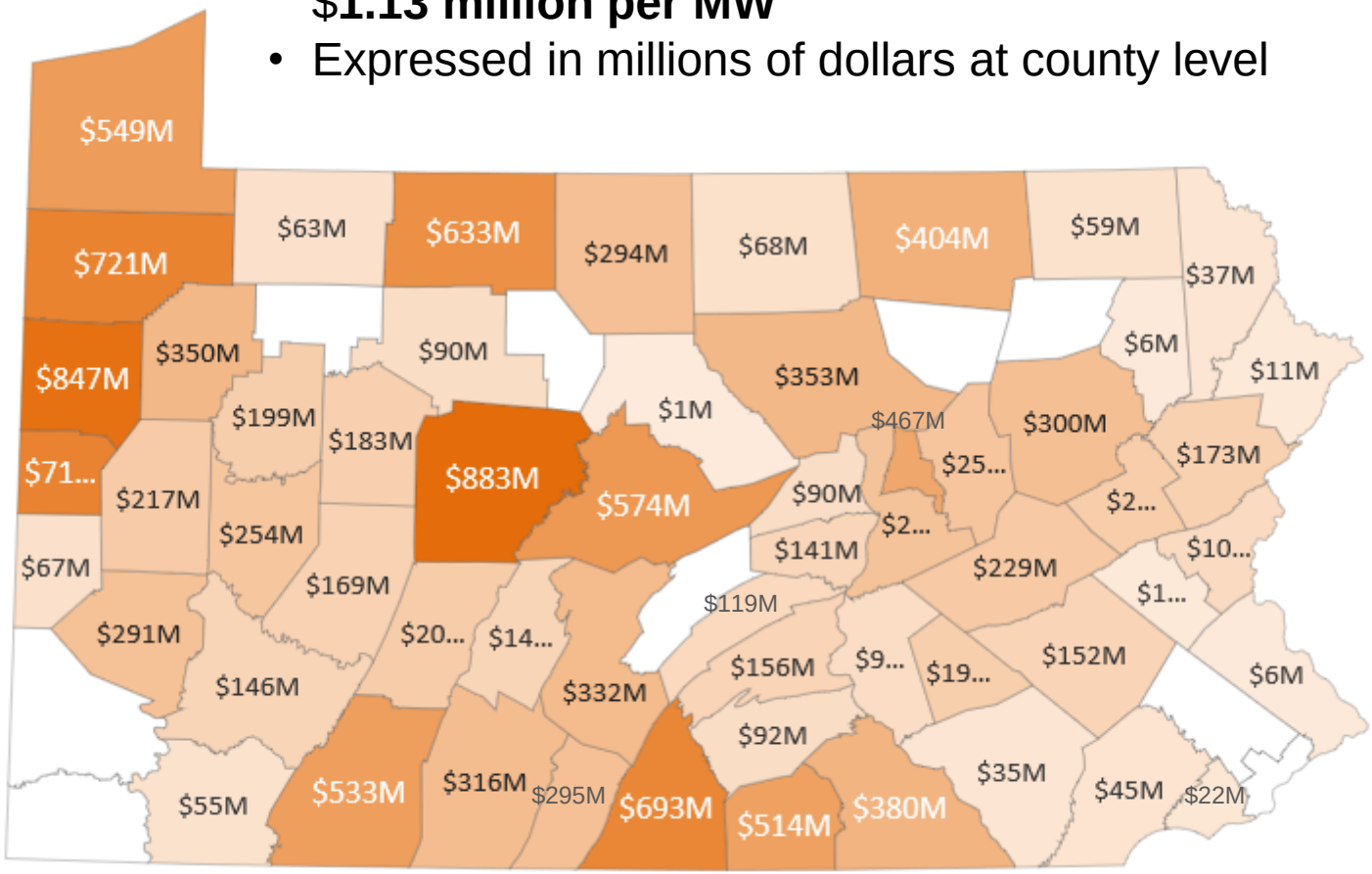
Project Investment Potential

- Total cost based off an estimated construction cost of $**1.13 million per MW**
- Expressed in millions of dollars at county level



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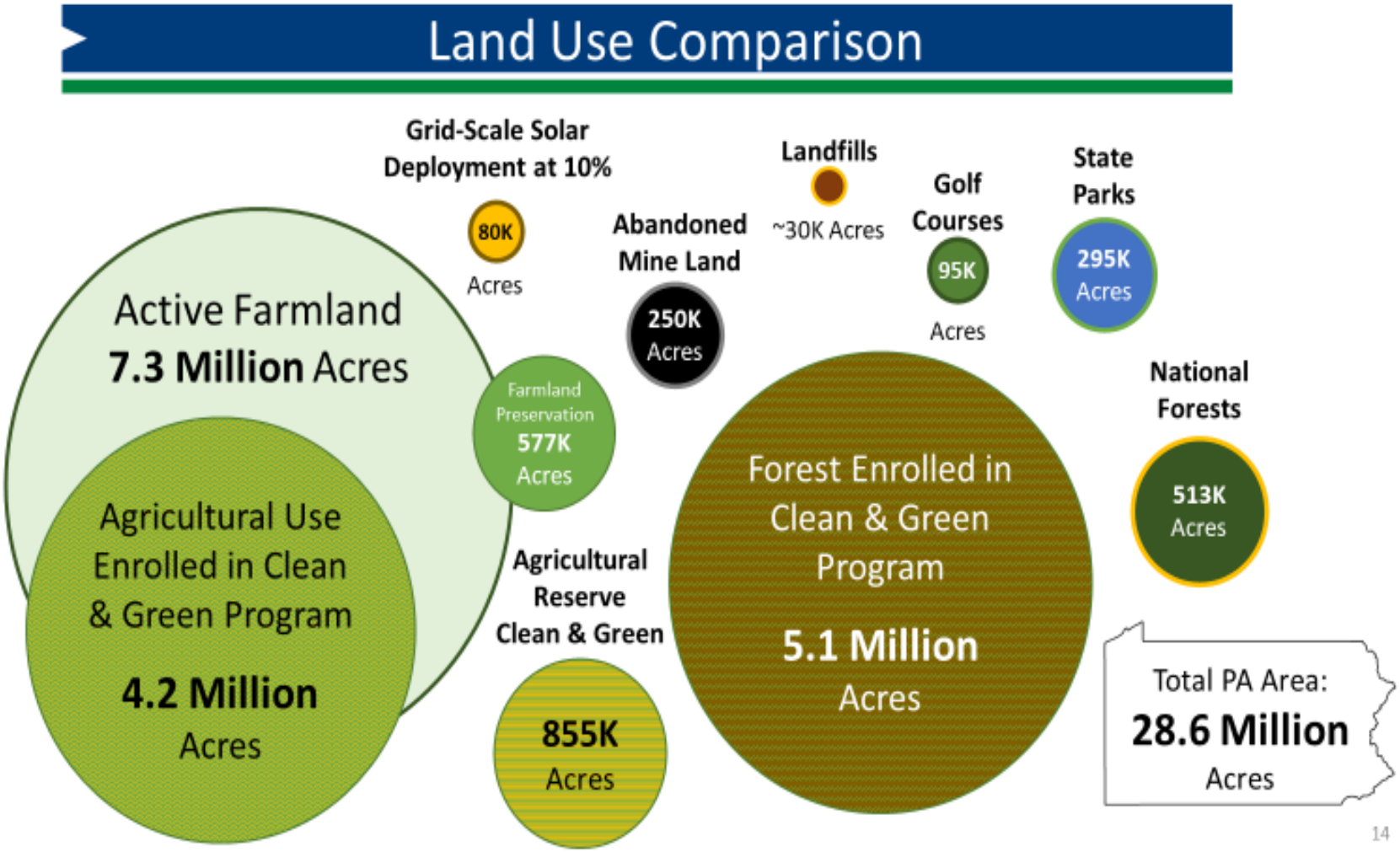


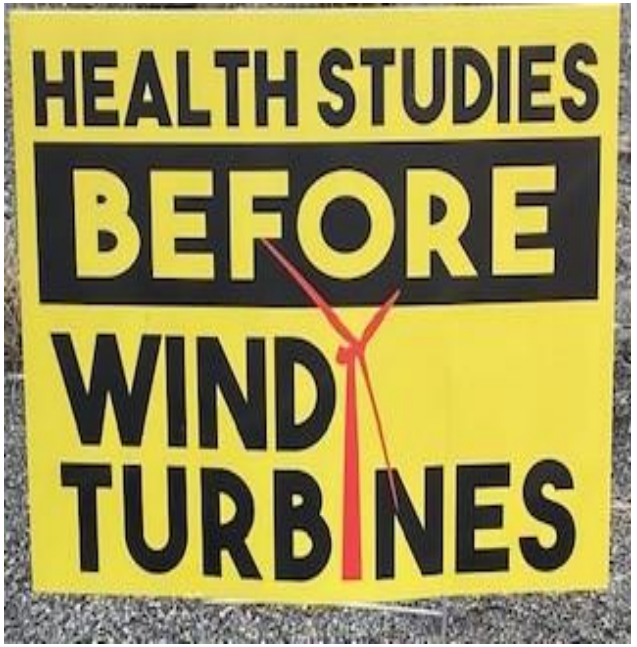
Graphic by DEP 8.21

Hot Issues

- Siting Considerations/**Land Transitions**
  - Brownfields vs. agland
- Environmental impacts
  - Baseline testing/water
- Stormwater/impervious surfaces
- Agrivoltaics
- New technology trends and efficiency improvements
- Co-location of energy storage/hydrogen
- Decommissioning
  - Lifespan/bonding/recycling/disposal -- who and where??
- Land restoration

What to Expect

- More legal challenges by all sides
- Increased NIMBYism
  - All energy types
- Emerging markets influenced by legislation/policy
  - Widespread EV adoption??
- New energy technology
  - Hydrogen (Blue, Green, etc)
  - CCUS options
  - Fugitive methane assessment and control
- New investment trends
  - Particularly towards lower carbon options
  - New "Exxons" in renewables



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