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# The Rapid Transformation of the Electric Grid:

## Implications for Technologies that Provide Flexibility, Resiliency, and Connectivity

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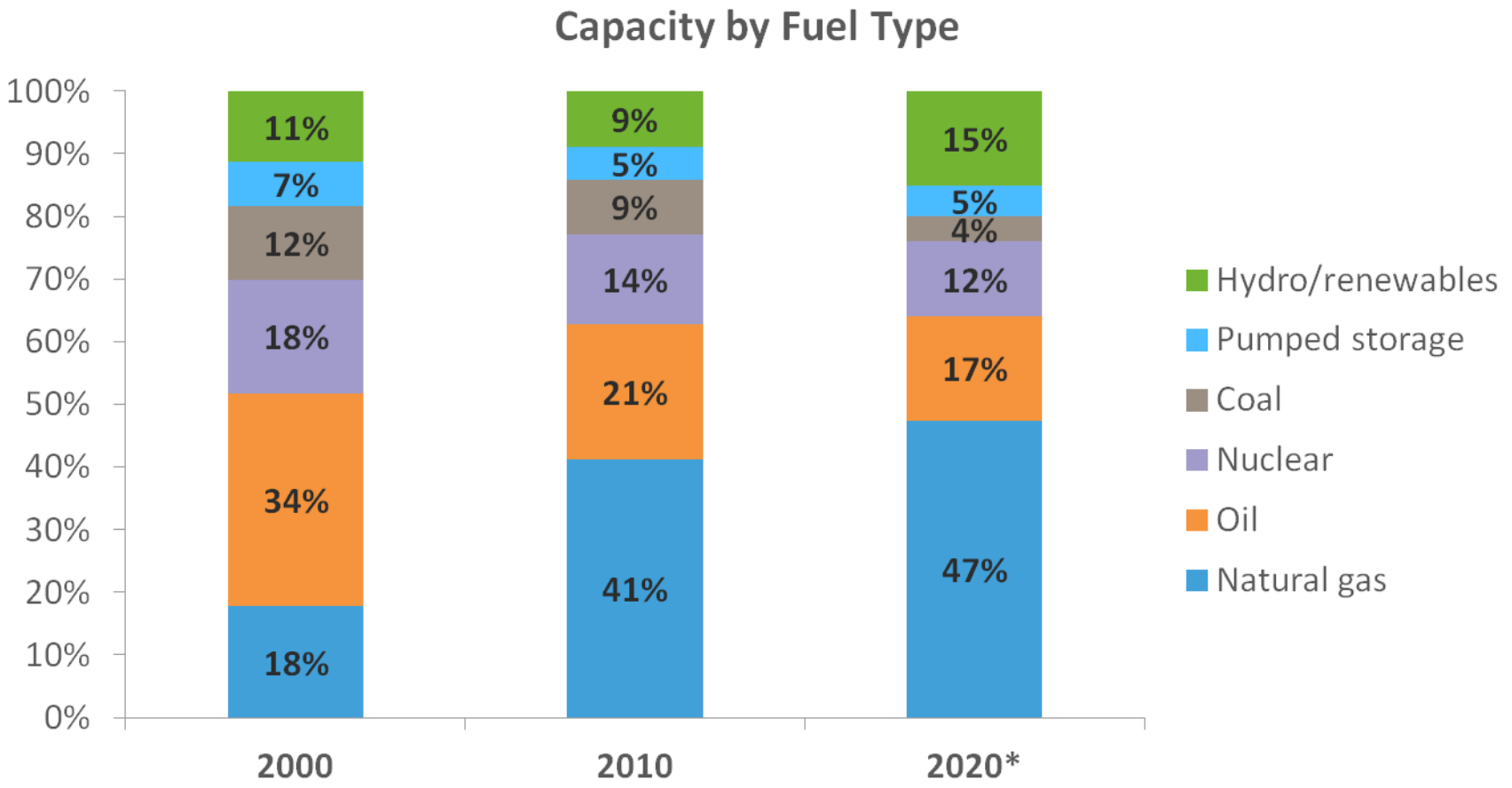
# Electric grid is undergoing rapid transformation

*Generation shifting from oil, coal and nuclear to natural gas and renewables*
*Public policy driving energy efficiency and "behind the meter" DG investment*




* Resources in 2020 assume approx. 5,000 MW of new resources proposed in the ISO Queue as of April 2013 (primarily natural gas and wind); and approx. 3,200 MW of non-price retirement requests for coal, oil and nuclear resources as of October 2013.

# Technology exists to enhance performance/flexibility, but market incentives will affect investment

*Need to deploy advanced automation and decision support systems to manage the operational complexity*

## New resources, and loads

- Natural gas-fired generation
- Energy efficiency
- Distributed generation
- Price-responsive demand, including energy management and smart appliances
- Renewable sources of energy
- Transmission to access remote hydro and wind power sources
- Energy storage
- Transition of transportation sector to electric vehicles
- Other emerging technologies

## Impacts to the grid, industry

- Increasing complexity for planners and operators as the system shifts from a few hundred resources to many thousands of resources
- Shifting to small, distributed generation resources connected to the distribution system
- Shifting to more resources that lack control over their energy source (wind, solar); need to balance increasing variability
- Forecasting load and supply become more challenging as more resources are controlled by end-use customers, and renewable resources are affected by the weather