Is Natural Gas “the” Answer?

Environmental Issues in the Potential Transition from Coal to Unconventional Gas Resources

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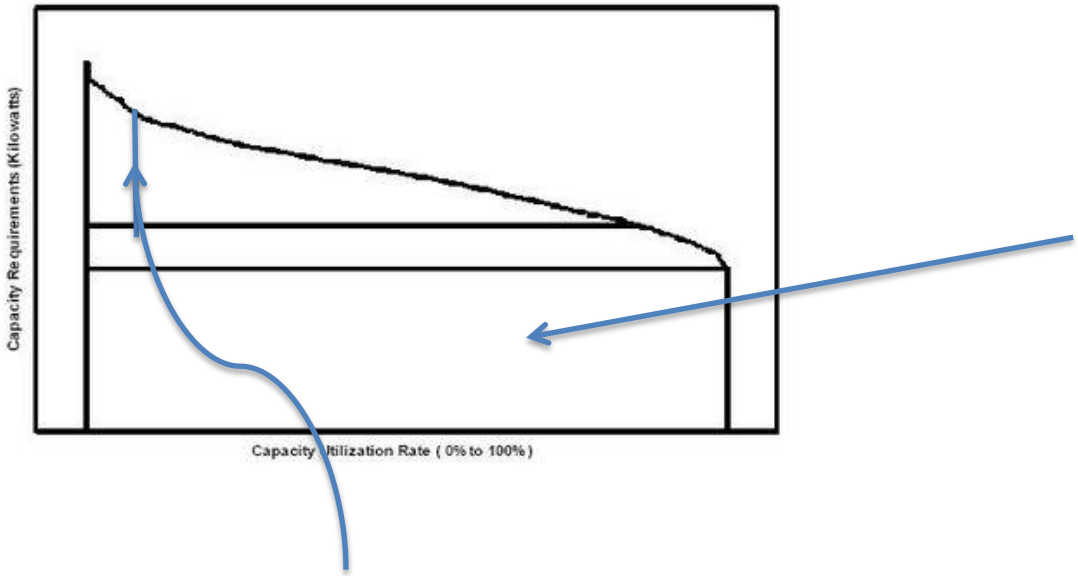
The World of Demand Satisfaction and electricity dispatch

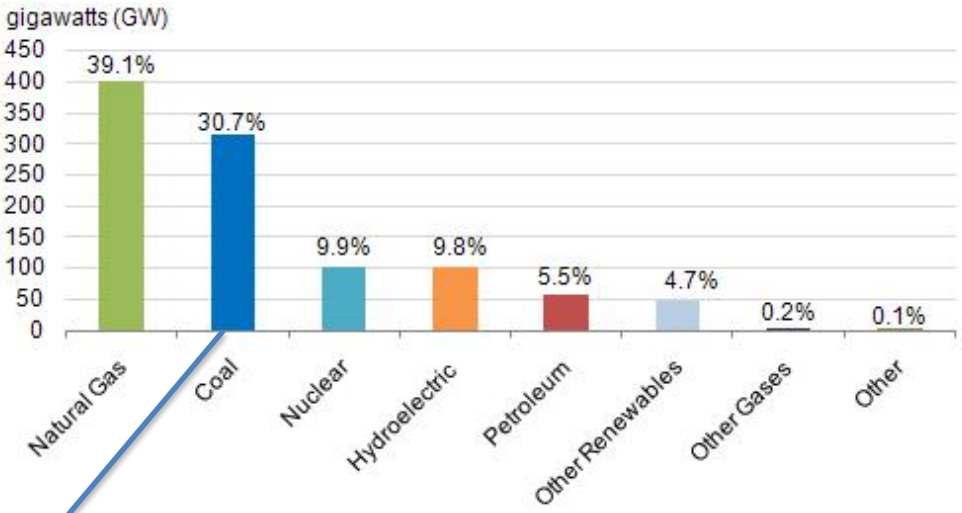


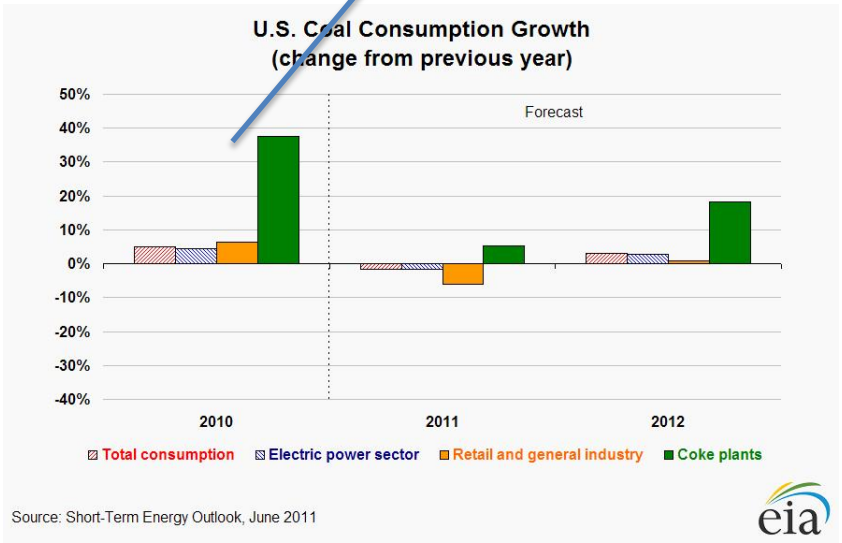
Baseload Energy (currently coal, nuclear, geothermal)

Runs in the background
High cost of capital
Low fuel cost
Low maintenance and overhead
Long lifespan

Gas for Peaking Resources

The Current Electricity Mix in North America

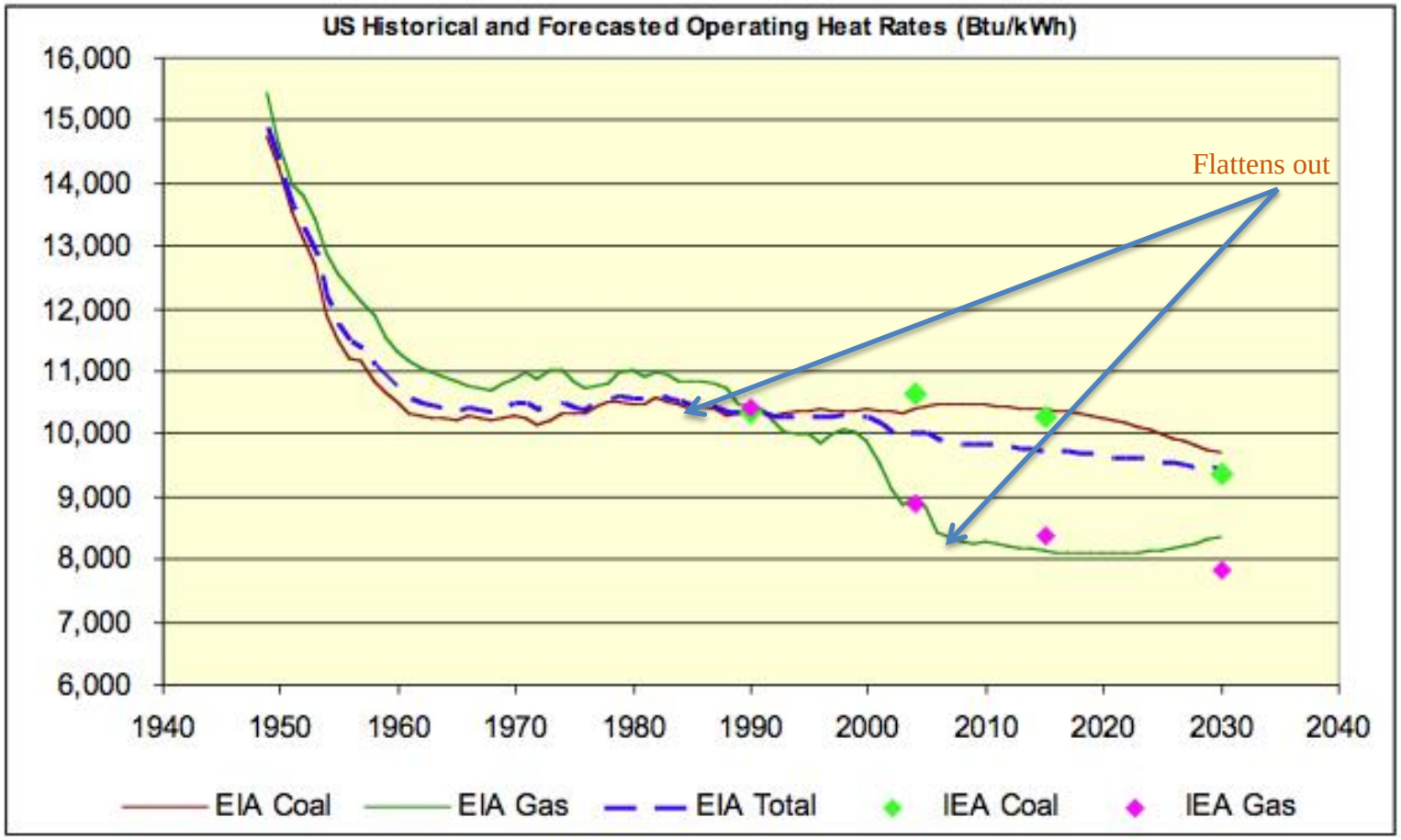




Change is coming based on:

Expected lifespan
Environmental regs
Cost of natural gas

Efficiency Gains as function of "heat rate"

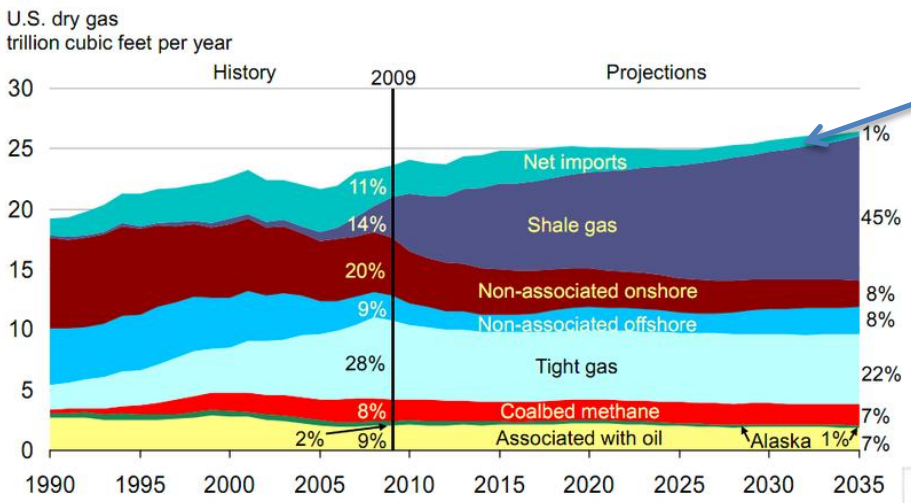


Why Gas is at the “Margin”

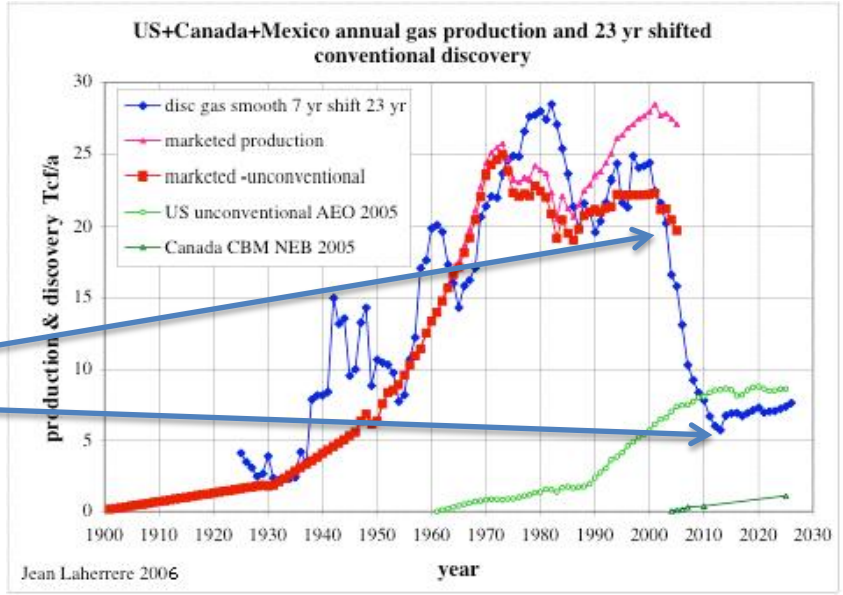
- Dispatch
  - Speed
  - Rules
  - Cost
  - Utilization
    - Coal - 80%
    - Nuclear - 90+ %
    - CCGT - 50%
    - SCGT - 10%
    - Wind - 30%
    - Solar - 25%

GasWorld?

Import Displacement



Shifts in Discovery Rates



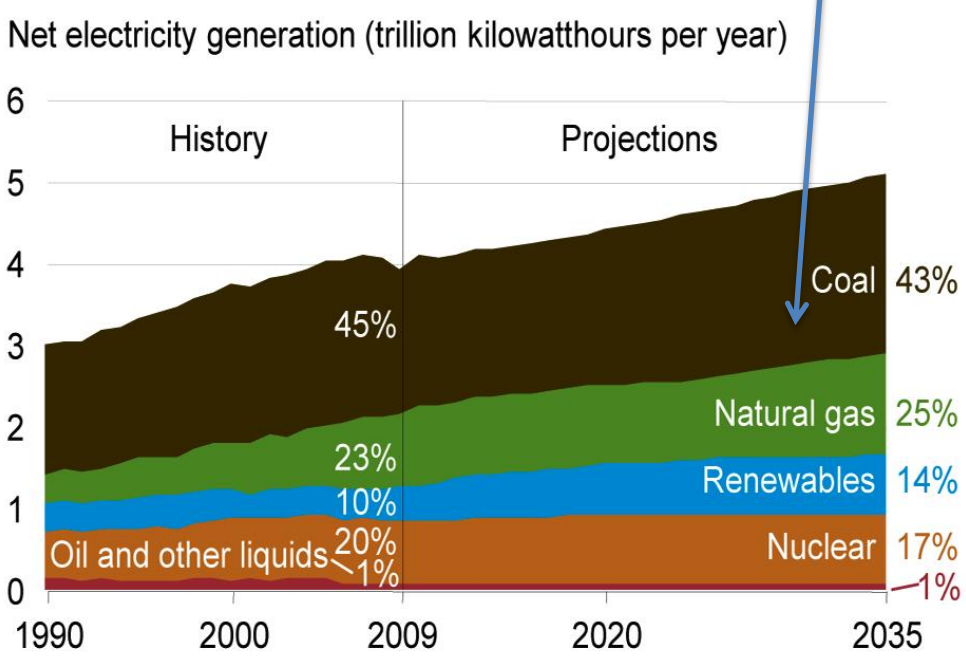
Gas and *Renewable* Energy Resources

- Gas in *normal* market operations (load following and peaking)
  - Costs
  - Environmental footprint
- Gas as *firming*
  - Speed
  - Enabling
  - PPA's and Reliable Renewable Use
- Renewables and Integration
  - Intermittancy
  - Storage
  - Comparative costs

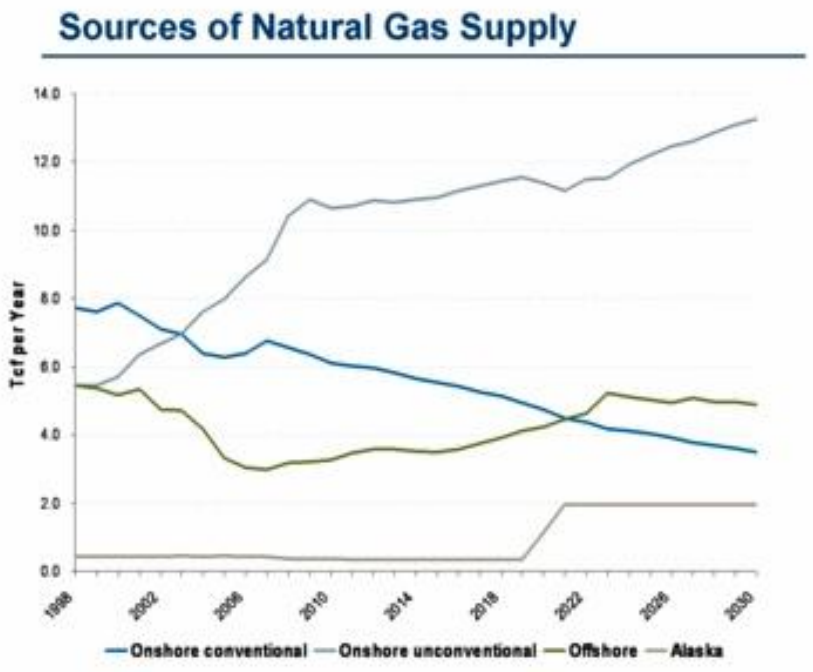
Forecast

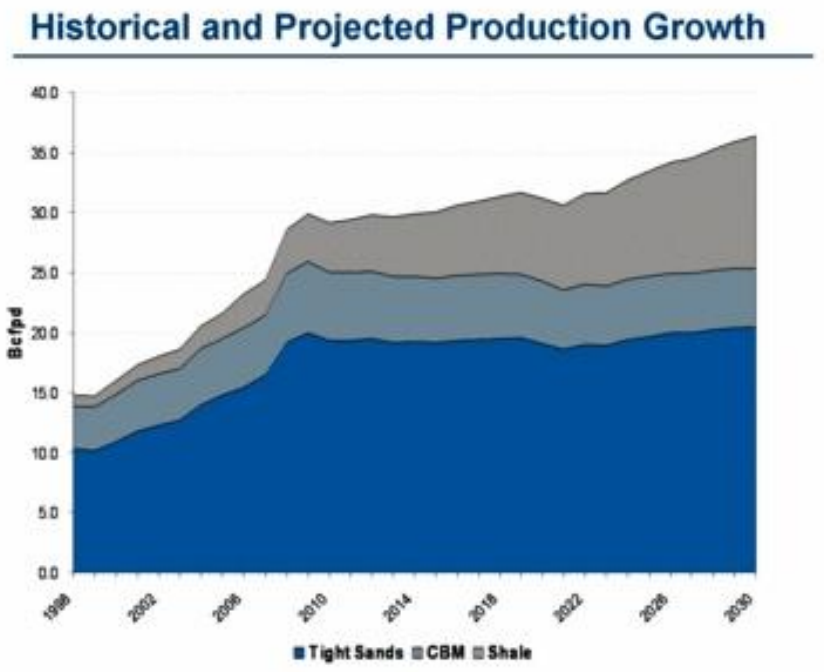
- The future electricity supply of countries is highly dependent upon making choices under uncertainty.
- The lifetime of a thermal power plant is about 20 years and can range up to 60 years, so investments reflect a commitment of fuels, dispatch need, characteristics and land use.
- Ultimately, the costs of fossil fuel or nuclear power plant inputs is difficult to forecast
- Similarly is it difficult to forecast the decline in costs of renewable energy.

Declines in coal, inc in gas reflecting "lower" C options

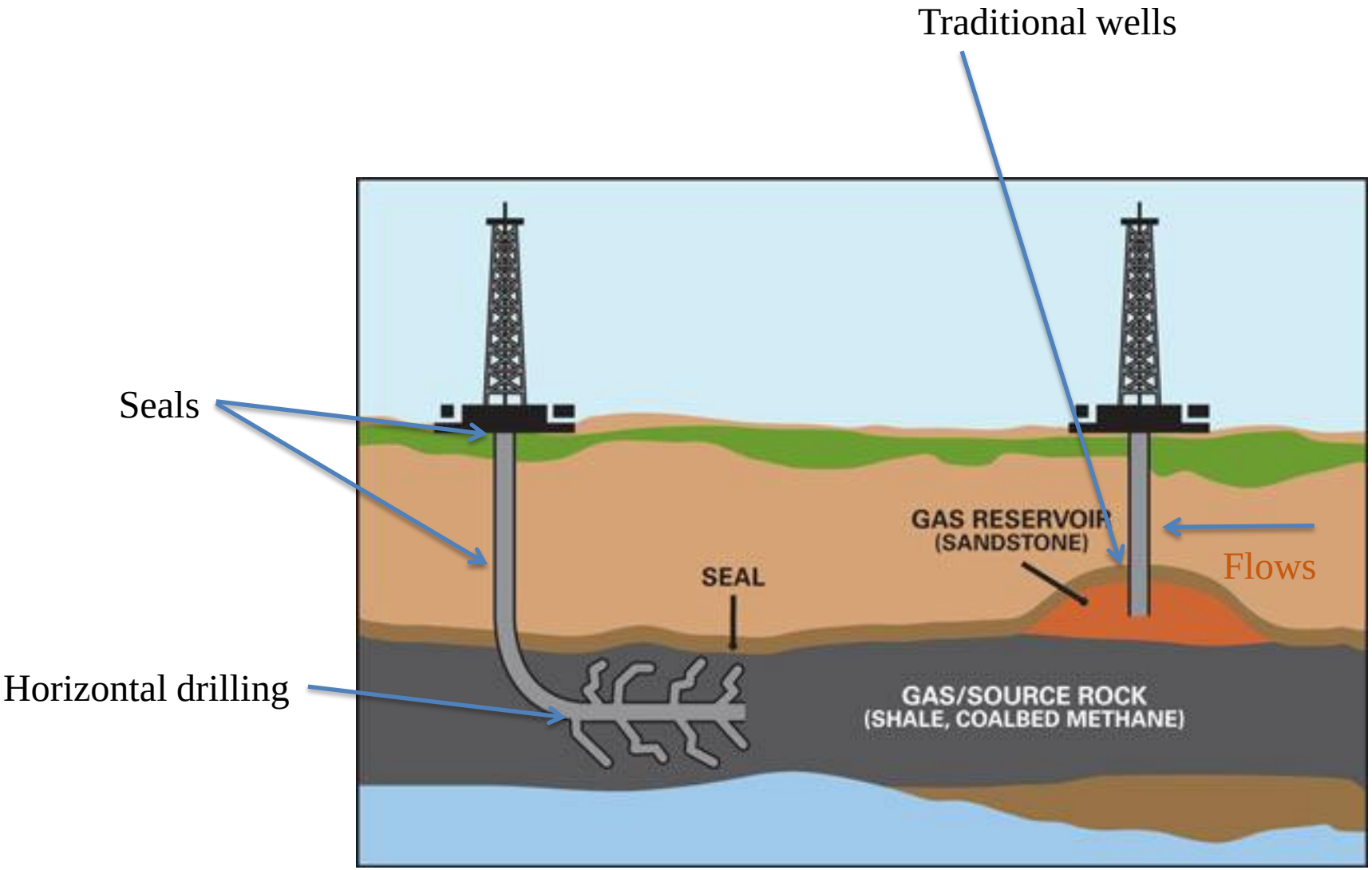


A Paradygm Shift in Sources with long roots



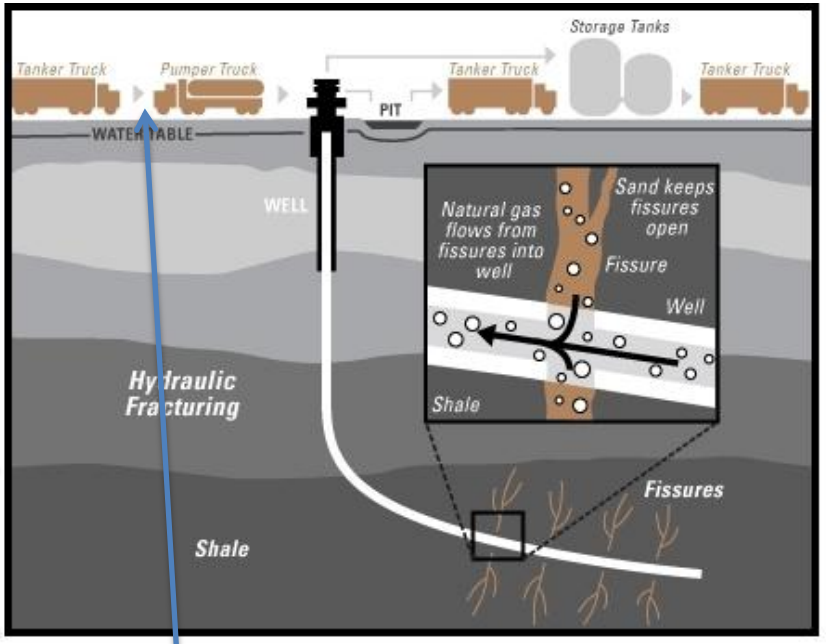


Fracing, Fracking or Stimulation



Fracking Technology Up Close

Source: electrictreehouse.com



Locations can be remote and may require trucked in resources

The Economics are improving

- LCOE
  - Coal
  - Hydro
  - CCGT
- Natural gas (traditional) per gj
- Unconventional- per gj

The Environmental Tradeoff

- Moving from coal to gas *can* reduce greenhouse gas emissions
- The carbon content of natural gas per unit of primary energy content is only 60% of that of coal.
- Efficiency improved for natural gas turbines compared to older coal-fired power plants. This is a possible source of up to 30% in emissions reduction.
- Beyond CO2, natural gas use may reduce methane emissions. Switching from coal to gas would reduce methane emissions from coal mining, but increase natural gas-related emissions.
- Beyond GHGs, the combustion of coal can release high levels of SO2. SO2 oxidises to sulfuric acid, then condenses onto cloud droplets and aerosol particles to as sulfate aerosols, which tend to cool the Earth's surface. Alternatively, C_{black} from coal-fired power plants, may have a short-lived warming effect on the atmosphere.
- The long atmospheric lifetime of CO2 in comparison with aerosols means that coal-to-gas switching will always result in a net long-term climate mitigation benefit.

The Risks

- Volume and decline rates
- Drilling costs and permits
- Shipping capacity and cost
- Water supplies and injection
- Water disposal
- Chemical residues
- Seismicity
- Subsidence
- Casing leaks

Future Issues

- Displacement of existing generation
  - Thermal
  - Renewable
- Transmission Investment
- Carbon footprint
- Supply estimates (recoverable resource)
- “Green” goals