What will shape US energy policy?

**Technologies**
Maturity, costs

**Security of supply** – oil imports

**Availiability of resources**
Oil, gas, wind, solar...

**Environmental target** –
GHG, SOx, NOx ...

**Costs to rate payers** -
Power, natural gas, fuel

**Overall competitiveness**
Direct energy costs, cost of living

**Competitive dynamic**
Who can invest

**Jobs (green or not)** – new investment, operations, fuel value chain
What's the starting point – emissions?

CO2 Energy emissions USA

Mt CO2 eq


- 1,000 2,000 3,000 4,000 5,000 6,000 7,000

Industry

Transportation

Electricity generation

Source: Inventory of U.S. Greenhouse Gas / EPA

+21% +11%

33%

31%

38%

41%
What's the starting point – energy independence?

Total US energy consumption and production

Quadrillion Btu

Consumption

Import

Source: EIA AEO

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Where will the US be in 2030?

- **Mid term:** 2020
- **Long term:** 2030
- **Beyond:** 2050

**CO₂ intensity**
- **Today:**
- **Energy independence**
- **High**
- **Medium**
- **Low**

Today is positioned in the high CO₂ intensity and medium energy independence quadrant.
Will we (always) keep the light on?
... in a context where utilities face numerous uncertainties

**Policy uncertainties**
- Retail, market design
- Cyber
- CO₂
- Transmission
- Decoupled rates
- Energy policy
- Rate design
- CSAPR, MACT, 316(b), HAPS, etc.
- RPS
- NERC

**Technology uncertainties**
- Renewables
- EV/storage
- Smart meters
- "Smart grid"
- HAN/smart appliances
- Superconducting FCL

**Commodity price uncertainties**
- Coal (global links)
- EV costs (storage)
- EPC equipment
- Natural gas (shale)

**Generation uncertainties**
- Fukushima repercussions
- New-build technologies
- Renewable costs
- Sustainability of merchant markets
- Coal retirements

**Grid uncertainties**
- Transmission upgrades
- NERC CIP Compliance (Cyber)
- "Distribution 2020"

**Economic uncertainties**
- GDP/demand growth
- Capital market access
- Interest rates & allowables

**Customer behavior uncertainties**
- "Smart home" acceptance
- Retail switching
- Social media
- DR/EE uptake

**Expectations**
- **Customers**
  - Flat rates
  - Higher reliability
  - Lower emissions
  - More renewables
  - New products/services
  - Customer service

- **Shareholders**
  - Higher earnings
  - Stable to growing dividends
  - Quality credit
  - **Other**
    - Community service
    - Attractive employer
When can renewable be a meaningful part of the solution?

Average electricity price for households in 2012 in $/kWh

 Iso-LCOE curves at a PV system price¹ of

- 4.50 $/Wp (2012)
- 3.20 $/Wp (2012 w/ 30% ITC)
- 2.50 $/Wp (2017)
- 2.25 $/Wp (2017 w/ 10% ITC)

1. For 10kWp roof-mounted system; electrical storage not included; year end prices; does not account for accelerated depreciation benefit

Note: Assumptions: Performance ratio of PV system 85%; lifetime 20 years; discount rate 5%; annual OPEX as percentage of initial CAPEX 1%; assumed electric prices grow at inflation

Source: Solar Electricity Handbook (online); IEA Electricity Information 2011; LBNL; NREL database; BCG analysis

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What about Natural Gas?

1. Natural Gas heavy generation portfolio constructed from maintaining current share of nuclear and renewable generation and replacing all other generation with natural gas.

Gigatonnes of CO₂ caused by electricity generation

- **Today**
- **1990**

Year:
- 2011
- 2030
- 2050

Legend:
- BAU
- Gas
- Low emissions
Sufficient cheap gas exists to supply US for 50 years at <6$/MMBtu

- US consumes ~25 Tcf per year
- 900 Tcf of gas <$4 /mmbtu
- 1200 Tcf of gas <$6/mmbtu marginal cost
- Enough gas <$6 to supply US for roughly 50 years at level of 2011 demand

Source: EIA, Deloitte
Where will the US be in 2030?

- **CO2 intensity**
  - Low
  - High

- **Energy independence**
  - Medium
  - High

**Today**
- Brown out?
- Gas/RPS
- Renewable breakthrough

**Mid term: 2020**
- Gas/RPS
- Renewable breakthrough

**Long term: 2030**
- Gas/RPS
- Renewable breakthrough

**Beyond: 2050**
- Renewable breakthrough
Are technologies already available?

Direct emissions by sector

Key levers and technologies

- Electrification and fuel switching
- Bio fuel (1st and 2nd generation)
- Advanced ICE, PHEV
- Energy efficiency
- Wind, solar
- Nuclear

Electric Generation  Industrial  Transportation  Residential & Commercial

☆ Administration's goals
... but how much are willing to pay?

Cash flow compared to BAU

Cumulative Cash Cost ($B, 2009)

-1,000
-2,000
0
1,000
2,000
3,000

Cumulative Discounted Cost ($B, 2009)

-1,000
-2,000
0
1,000
2,000
3,000

Long term savings through reduced consumption and lower fuel and operational costs
Up-front investments in energy efficiency and decarbonizing generation

Peak funding of approximately $1T

Present value of savings compared to BAU

Cumulative Discounted Cost ($B, 2009)

3 percent
5 percent
7 percent

Real discount rate

Note: Present value discounted to 2010 using a 3, 5, or 7% real discount rate, as shown
Can we be rationale about energy policies?

<table>
<thead>
<tr>
<th>KPI</th>
<th>Units</th>
<th>BaU</th>
<th>EE &amp; RES</th>
<th>Advanced Thermal</th>
<th>Diversified</th>
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<td>GHG emissions</td>
<td>M tons</td>
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<td>2.231</td>
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<td>RES in energy demand</td>
<td>%</td>
<td>21.5</td>
<td>43.3</td>
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<td>Energy Price</td>
<td>€/MWh</td>
<td>105</td>
<td>124</td>
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<td>Energy weight in GDP</td>
<td>%</td>
<td>8.1</td>
<td>10.0</td>
<td>9.8</td>
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<td>Employment</td>
<td>Millions</td>
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<td>1.7</td>
<td>1.3</td>
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<td>Export potential</td>
<td>Qualitative</td>
<td>Limited</td>
<td>Medium</td>
<td>High</td>
<td>Very High</td>
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<td>Imports volume</td>
<td>M toe</td>
<td>1375</td>
<td>789</td>
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<td>Foreign bill</td>
<td>Bn €</td>
<td>635</td>
<td>422</td>
<td>532</td>
<td>444</td>
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<td>Ease of implementation</td>
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<td>n.a.</td>
<td>Very Difficult</td>
<td>Medium</td>
<td>Difficult</td>
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<td>Risk of not achieving results</td>
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<td>n.a.</td>
<td>Very High</td>
<td>High</td>
<td>Moderate</td>
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Source: E3MLab – Primes model; BCG analysis

The Boston Consulting Group
Can we effectively aligned stakeholders?

White House

DOE: Security, safety and innovation

State Public Utility Commissions
• Deregulation
• Utility rate case

State
• Local energy policy
• RPS, EE etc.

ARRA – 2009
Energy policy Act - 2005

Congress: Energy legislation

FERC: interstate, transmission, reliability

State
• Local energy policy
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Dept. of Interior: Land use and wide life

Nuclear regulatory

DOE: Security, safety and innovation

Environmental groups

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So what's next and beyond?

- **Beyond: 2050**
  - 80/80
  - Gas and renewable

- **Long term: 2030**
  - Renewable breakthrough

- **Mid term: 2020**
  - Gas/RPS
  - Muddle through
  - Brown out?

**Low CO2 intensity**

**High CO2 intensity**