Integrating New Technologies

How much and how incented

Kevin Leahy - Environmental & Energy Policy Director

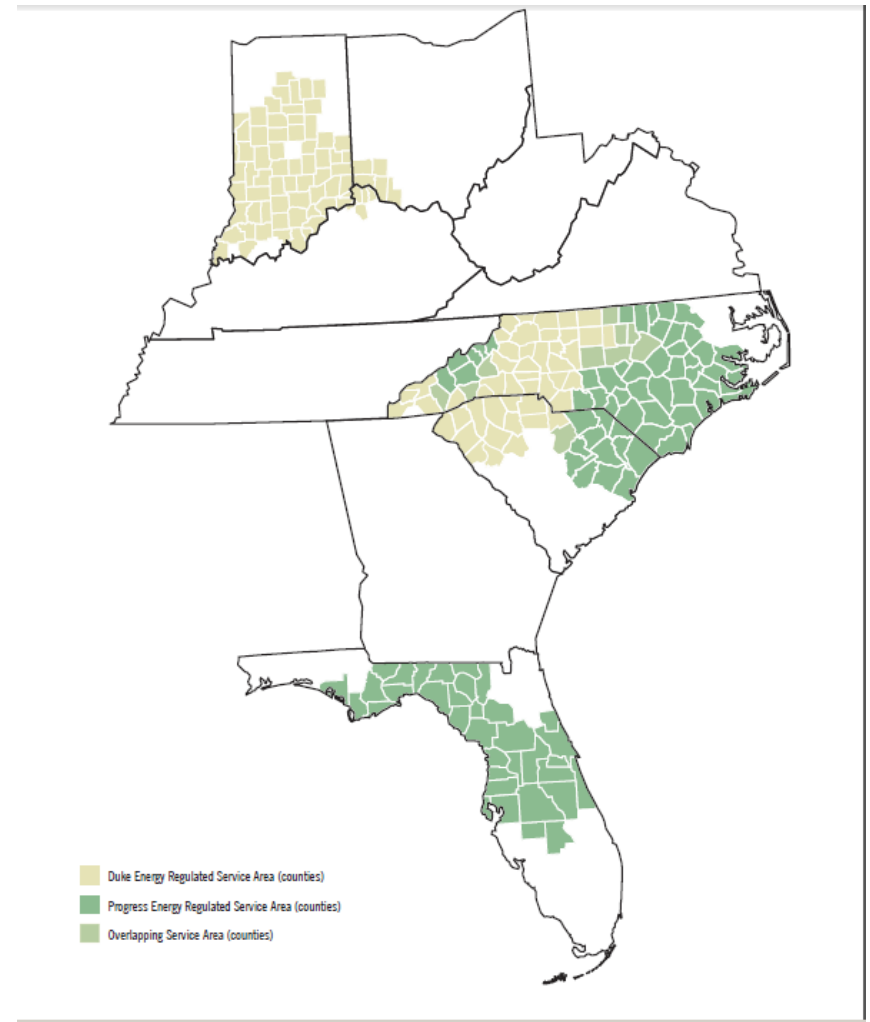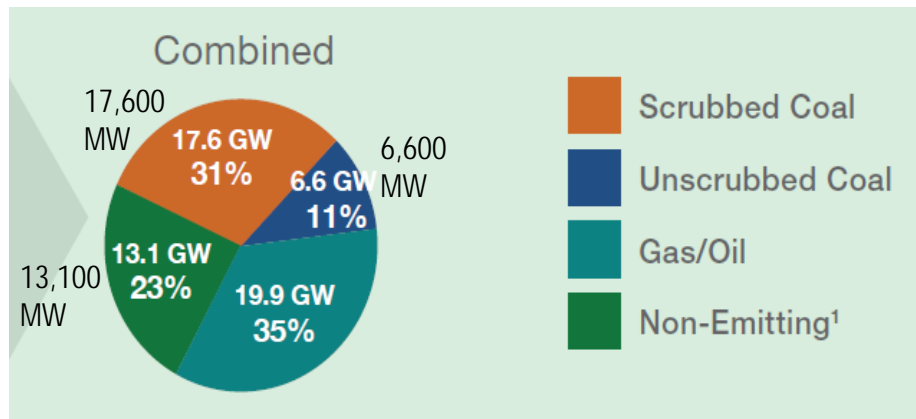EPRI-IEA Challenges in Electricity Sector Decarbonization

Sept. 28, 2015

Disclaimer

- Speaking for myself – not Duke Energy

- In some instances numbers are approximations and some data is old.

- Translating from other's work to put forward the generalized views.

- Before citing anything – go to original sources.

What is Duke Energy?

- Serve 22 million people

- 57,700 MW in US

- 4,900 MW in Latin America

- 29,250 employees

- $100 B of assets

Combined

17,600 MW — 17.6 GW 31% Scrubbed Coal
6,600 MW — 6.6 GW 11% Unscrubbed Coal
19.9 GW 35% Gas/Oil
13,100 MW — 13.1 GW 23% Non-Emitting[1]

Duke Energy Regulated Service Area (counties)
Progress Energy Regulated Service Area (counties)
Overlapping Service Area (counties)

Duke Energy Renewables

Wind

- Business model: develop/acquire, build, own and operate utility-scale wind power facilities throughout the U.S.
- 19 operating facilities totaling 1,627 MW

Solar

- Business model: develop/acquire, build, own and operate solar projects throughout the U.S.
  - Primary focus on utility-scale PV projects
  - Also distributed-scale projects through INDU Solar Holdings joint venture with Integrys Energy Services
- 32 operating facilities totaling 189 MWac (net)

And lots of Energy Efficiency

How Much?

- Intermittent renewables have terrific value

- In U.S., value similar to that of natural gas contract that delivers when wind/sun available

- ## The market limit question

- Good thinking by

  Lion Hirth at neon-energie.de

- Lower penetration-easy

- Higher penetration

  Requires multiples of capacity

The value drop continues: model results
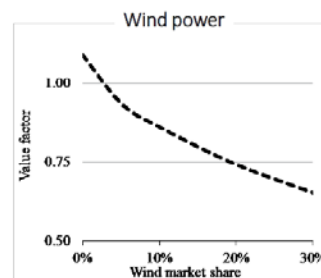
The value factor of wind power decreases from ~1.1 at low penetration to ~0.65 at 30% market share (1.5 points per point market share).
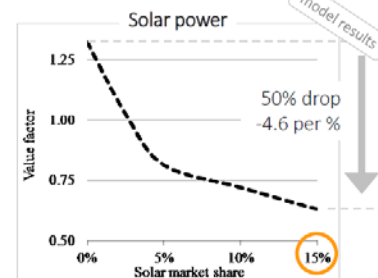
The value factor of solar power decreases from ~ 1.3 at low penetration to ~ 0.6 at 15% market share: (4.6 points per point market share).

How Incentivize?

- Markets or Mandates

- What is objective?

  – Low emissions & low cost

  – Higher quantities of popular technologies

- Mandates may attempt to break through power market limitations regardless of cost

Other policy objectives may be perfectly justified

- Local Air Quality?

- Promote local industry/construction?

- Traffic Congestion?

- Hidden industrial subsidy?

- Political expediency? *If can't achieve support for a market without them, then they become part of "least cost solution"*

Letting the market work
(yellow highlights are reductions pursued)

- Select the least costly options until reduction target hit. In this example, 1000 tons.

- Adding up the total cost: $10+$20+$30+$40 … +$100 = $550

- Market clearing price for reductions = $100

Cost	Tons Reduced
$10	100
$20	200
$30	300
$40	400
$50	500
$60	600
$70	700
$80	800
$90	900
$100	1000
$110	1100
$120	1200
$130	1300
$140	1400
$150	1500
$160	1600
$170	1700
$180	1800
$190	1900
$200	2000

Emissions Reductions Supply Curve
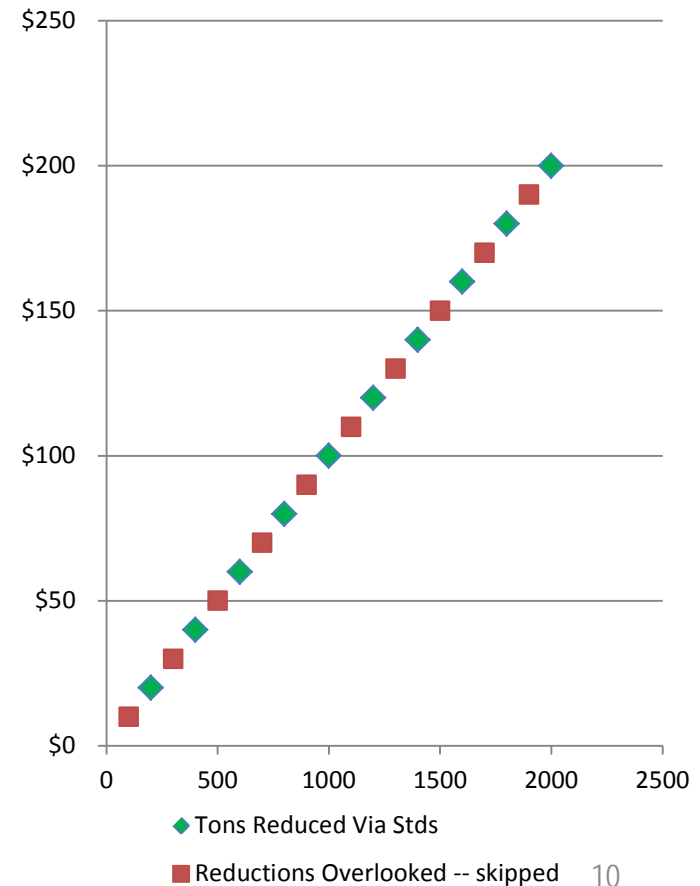
Emission Cap

Number of tons reduced
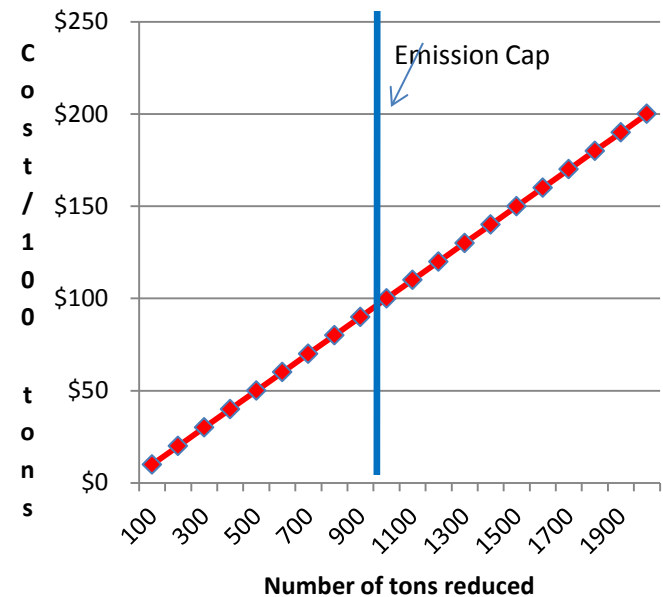
Now, same target, using <u>only</u> mandates

- Arbitrarily select reduction options via perf standards – because lack perfect info, every other one (in yellow)

- Total cost: 20+40+60+80+100+120+ 140+160+180+$200=$1,110

- Market clearing price for reductions = $0 (no market)

- Similar results to Cap with No Trade

Cost	Tons Reduced
$10	100
$20	200
$30	300
$40	400
$50	500
$60	600
$70	700
$80	800
$90	900
$100	1000
$110	1100
$120	1200
$130	1300
$140	1400
$150	1500
$160	1600
$170	1700
$180	1800
$190	1900
$200	2000

Standards Only Approach Means Missing Low Cost Choices

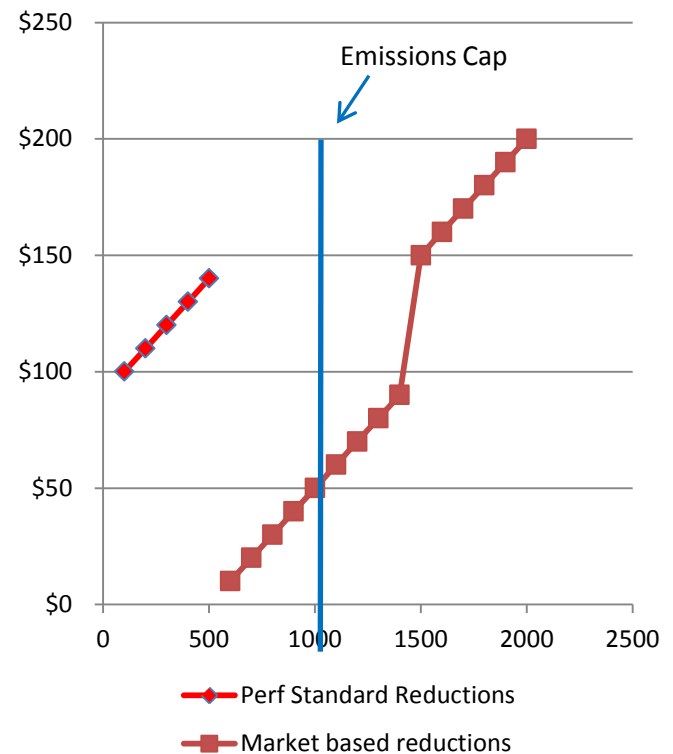- ◆ Tons Reduced Via Stds
- ■ Reductions Overlooked -- skipped

Now, same target, using emissions trading and technology mandates

- Same 1000 ton cap

- Complementary policies – mandate some action via standards (some from middle of supply) for 500 tons of reductions

- The market will go after the remaining 500 tons required to hit emissions limit

- Total cost (from yellow highlighted reductions): 100+110+120+130+ 140+10+20+30+40+50=$750

Cost	Tons Reduced
$10	100
$20	200
$30	300
$40	400
$50	500
$60	600
$70	700
$80	800
$90	900
$100	1000
$110	1100
$120	1200
$130	1300
$140	1400
$150	1500
$160	1600
$170	1700
$180	1800
$190	1900
$200	2000

Perf Stds and Market Together

Emissions Cap

— Perf Standard Reductions
— Market based reductions

Now, same target, using emissions trading and technology mandates

- Same 1000 ton limit
- Complementary policies – mandate some action via standards (some from middle of supply) for 500 tons of reductions
- The market will go after the remaining 500 tons required to hit limit
- Total cost (from yellow highlighted reductions): 100+110+120+130+ 140+10+20+30+40+50=$750

- Market clearing price for reductions = $50
- Standards increase total costs while lowering CO2 price

Cost	Tons Reduced
$10	100
$20	200
$30	300
$40	400
$50	500
$60	600
$70	700
$80	800
$90	900
$100	1000
$110	1100
$120	1200
$130	1300
$140	1400
$150	1500
$160	1600
$170	1700
$180	1800
$190	1900
$200	2000

Perf Stds and Market Together

Emissions Cap

Could have had these instead!

Perf Standard Reductions

Market based reductions
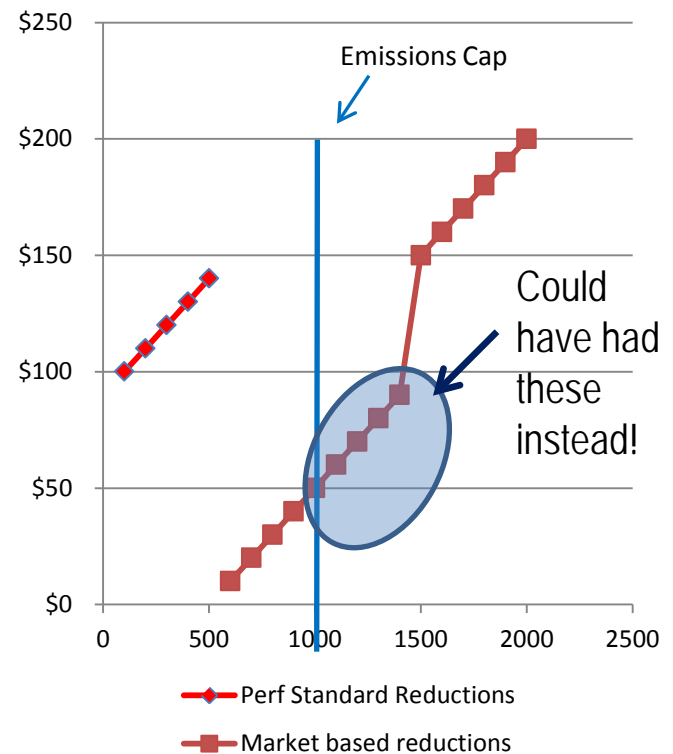
What is your policy objective?

- Keep CO2 prices low? (There are less costly/lower risk ways to do so.)

- Promote favored technologies?

- Drive even greater CO2 reductions at lowest cost?

Policy Choice	Tons Reduced	CO2 Price	Total Cost	"Hidden Cost"
Performance Standards	1000	$0	$1,100	$1,100
"Complementary" Policies + emissions trading	1000	$50	$750	$200
Emissions trading Only	1000	$100	$550	$0