U.S. Experience in Estimating Displaced Emissions

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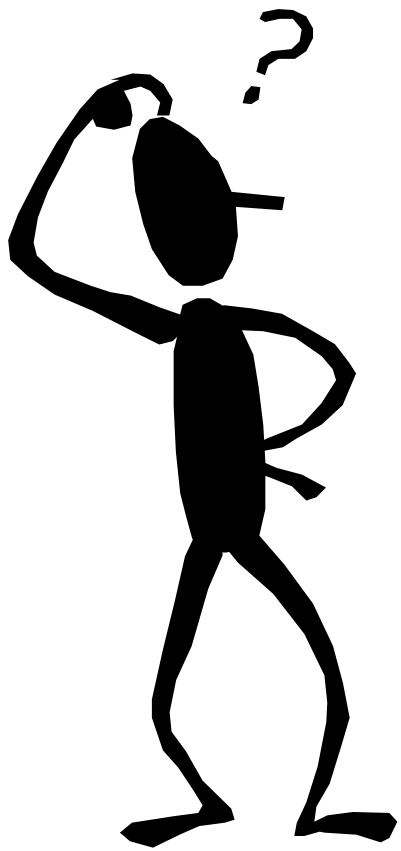
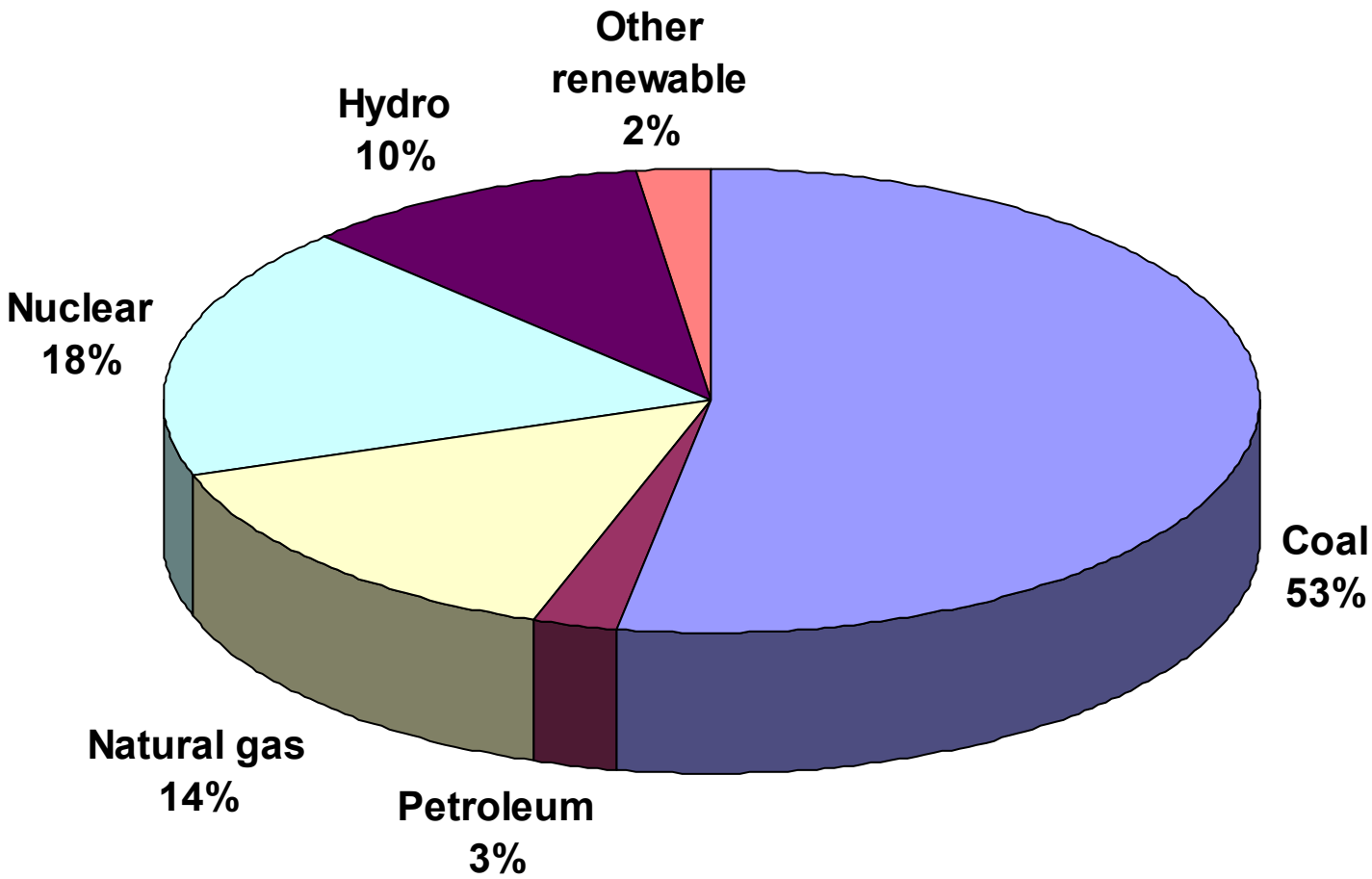
Estimating Emissions Displaced by Clean Energy

How do you measure something that isn't there?

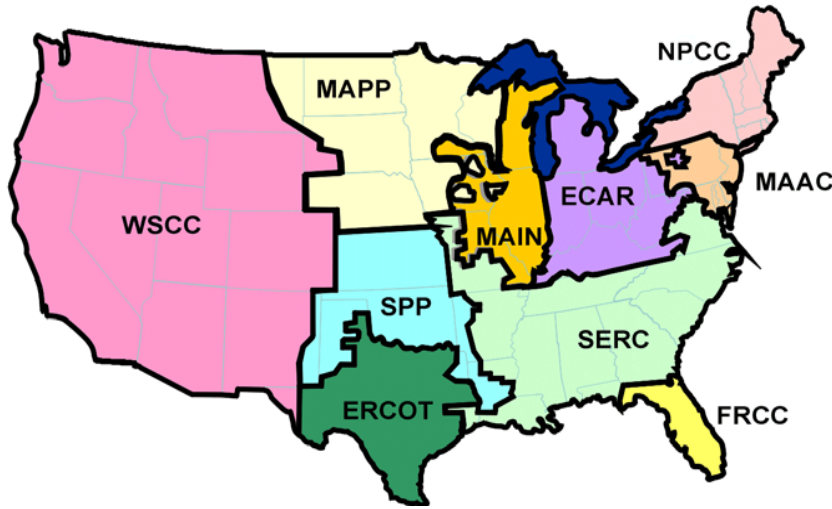


Average System Mix as a Proxy



System Average Output Emission Rates, 2000 (lbs/MWh)

NERC region	NOX	SO2	CO2
ECAR	4.70	12.51	1913
ERCOT	2.24	2.96	1408
FRCC	3.28	5.54	1390
MAAC	2.47	7.65	1098
MAIN	2.95	5.53	1342
MAPP	3.98	5.54	1839
NPCC	1.48	3.97	942
SERC	3.04	7.06	1345
SPP	3.79	4.77	1960
WECC	1.79	1.54	1014
U.S. avg.	**2.96**	**6.04**	**1392**



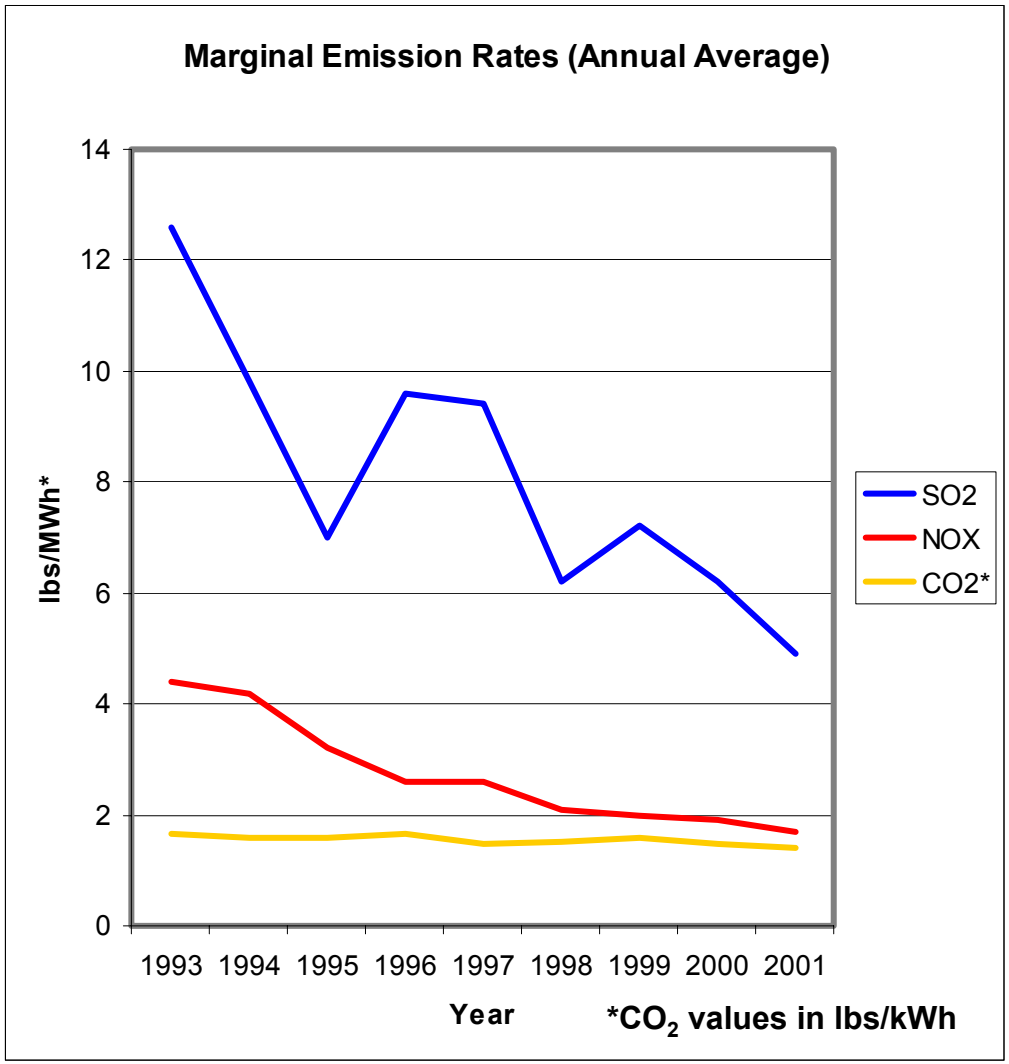
Source: eGRID2002, Version 2.01: *www.epa.gov/cleanenergy/egrid*

- **Advantage: Data readily available**
- **Disadvantage: Poor representation of displaced emissions**

Approaches for Estimating Marginal Emission Rates

- **Dispatch models**
  - preferred method for a analyzing a regional electric system
  - very accurate for short-term analysis
  - expensive and labor intensive
- **Planning models**
  - well suited for national perspective
  - can examine multiple time frames
- **Manual/spreadsheet models**
  - flexible, transparent and inexpensive

Dispatch Model Example
ISO-NE's Marginal Emissions Analysis



- Calculations based on dispatch model (PROSYM™)
- Short-term analysis assumes capacity is fixed
- Source: *www.iso-ne.com*

More Dispatch Model Examples

- **OTC* Emission Reduction Workbook**
  - seasonal peak/off-peak emission factors for 3 Northeast regions through 2020
  - includes NO_X, SO_2, CO_2, Hg
  - source: www.sso.org/otc (pubs)
- **STAPPA**/ICLEI*** Planning Tool**
  - avoided emission factors for 13 regions through 2020
  - includes NO_X, SO_2, CO_2, PM_{10}
  - source: www.4cleanair.org/presentation-Software.pdf

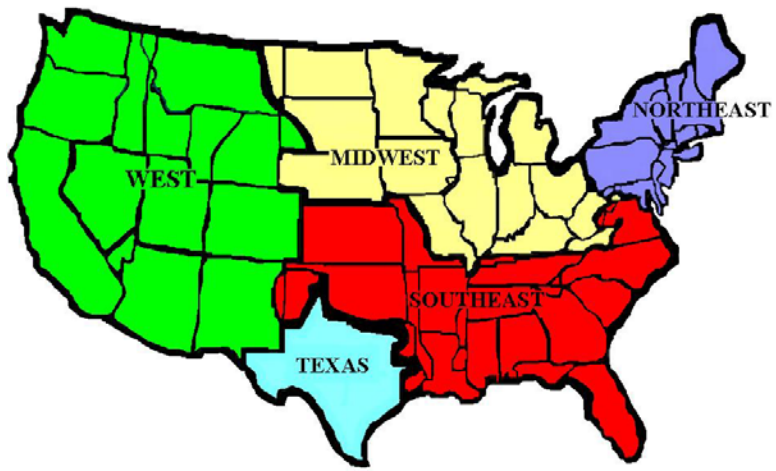
*Ozone Transport Commission

**State & Territorial Air Pollution Program Administrators

***International Council of Local Environmental Initiatives

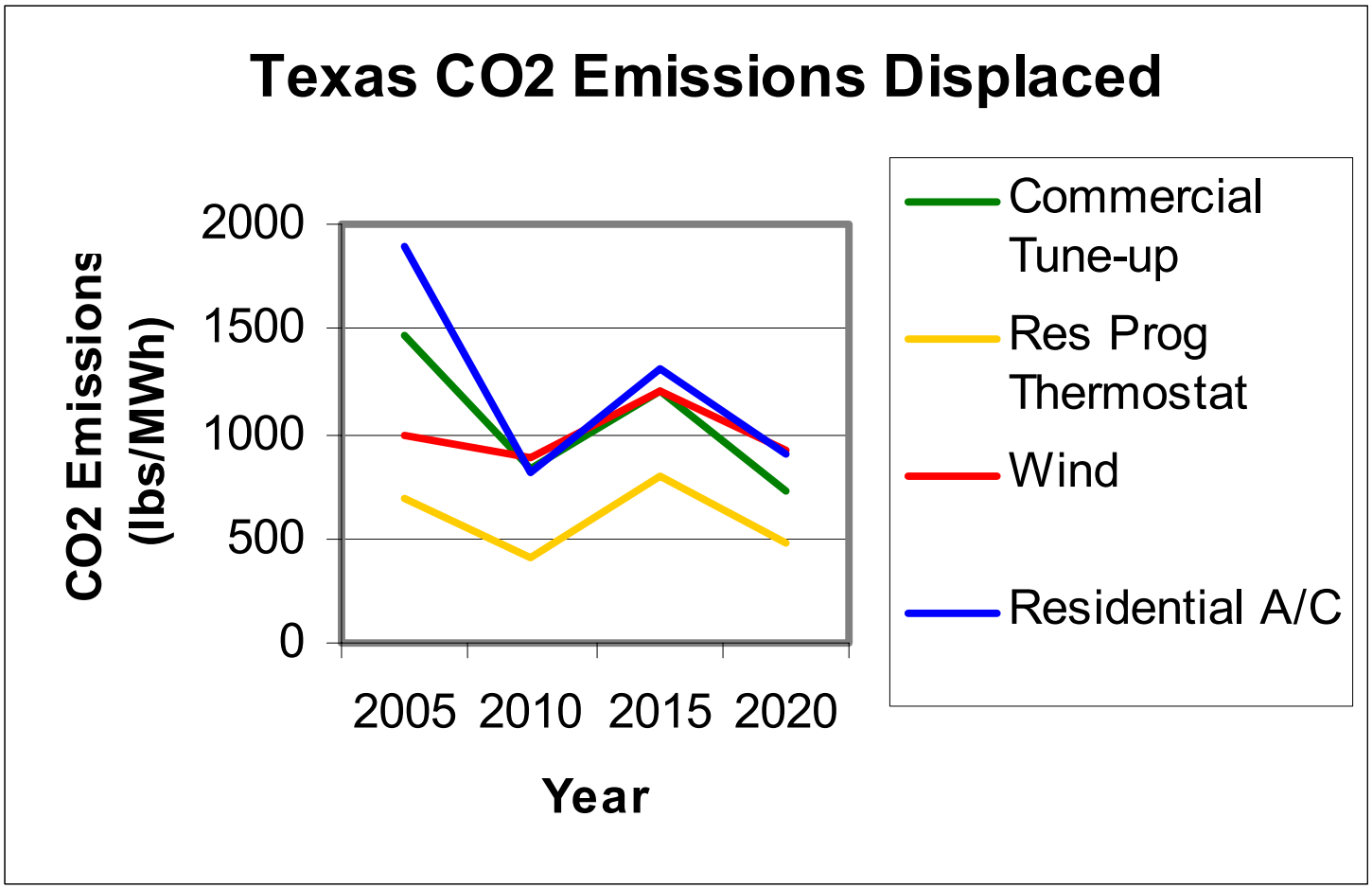
Planning Model Example
U.S. EPA's ADER* Project

- **Goal: a robust methodology for evaluating displaced CO_2 emissions from clean energy technologies & energy efficiency**
- **Utilizes ICF's IPM model**
- **Technology-specific results vary by loadshape**
- **Results cover four time frames, five regions:**
  - **2005, 2010, 2015, 2020**



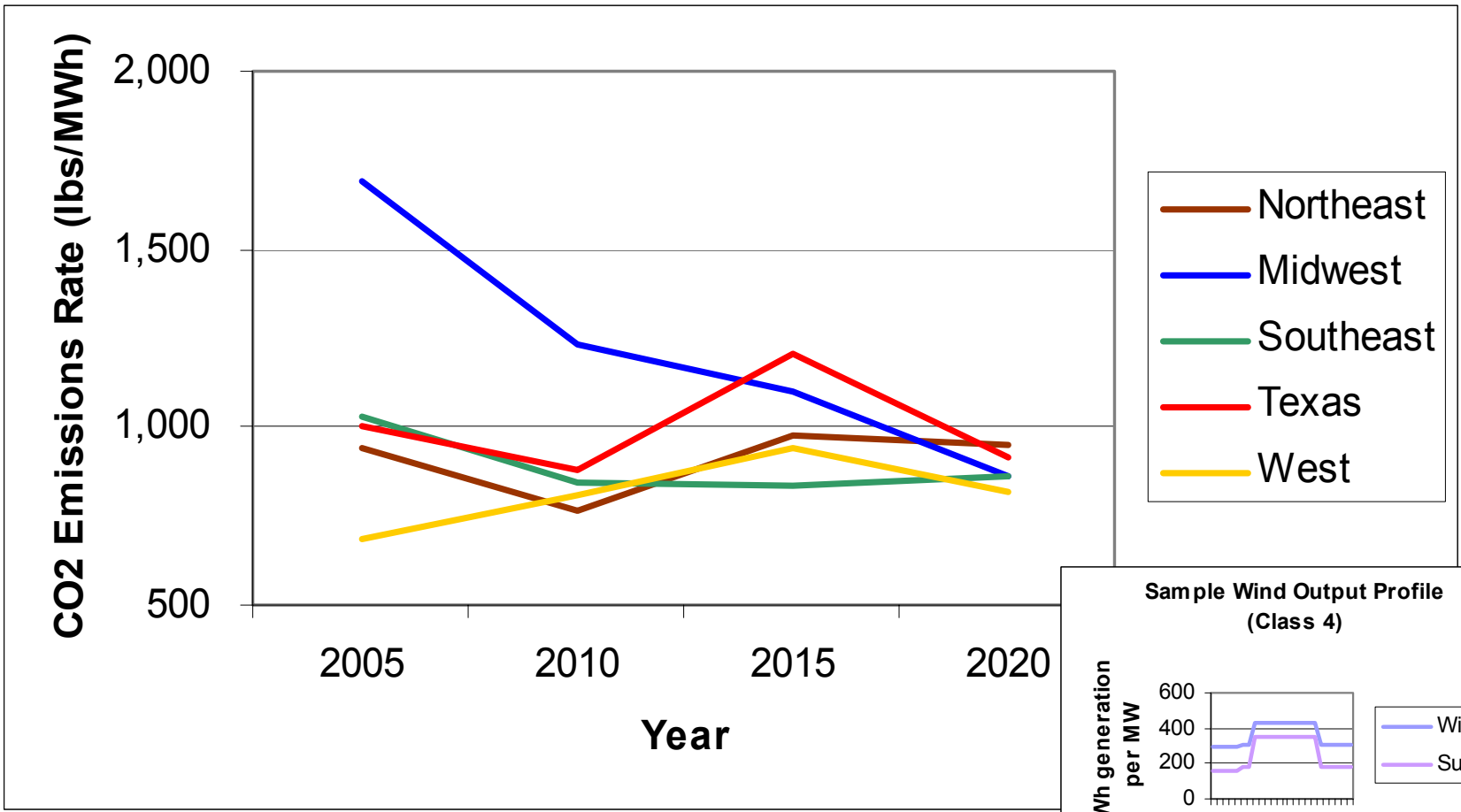
**Average Displaced Emission Rate*

Emissions Displacement Is Technology-Specific*



*Source: Preliminary ADER Data

Displaced CO_2 Emission Rates for Wind*



*Source: Preliminary ADER data

Spreadsheet Method Example
ERT's* Dispatch Ranking Protocol

- Identify individual generating units on the margin when renewables expected to operate
- Obtain actual hourly generation & emissions data for displaced units (from CEM data reported to EPA)
- Determine net reductions f/ renewables by time period
- Produces short-term marginal emissions rates
- Contact: Alden Hathaway; ahathaway@ert.net

Other manual/spreadsheet examples:

- EPA Texas methodology (diem.art@epa.gov)
- MIT PV assessment (connorsr@mit.edu)

*Environmental Resources Trust

Challenges for Modelers of Displaced Emissions

- **Methodological trade-offs**
  - regional vs. national focus
  - short-term vs. long-term
- **Sensitivity to assumptions about the future**
  - demand & economic growth
  - relative fuel prices
  - cost & performance of new units
- **Resolution vs. robustness**
  - geographic scope
  - variation in loadshape
- **Modeling capped emissions**

Modeling Capped Emissions

- **U.S. emission caps**
  - SO_2 capped nationwide*
  - NO_X cap expanding to ~19 eastern states + DC
- **Dilemma for modelers**
  - emission reductions likely to be traded away
  - models should account for emissions trading & banking
  - "potential" benefits may be estimated by relaxing cap constraint

* except Alaska, Hawaii

Conclusion