The Average Displaced Emissions Rate (ADER) Approach to Estimating Environmental Impacts of Clean Energy Technologies

Presented by

Juanita M Haydel

Commission for Environmental Cooperation
Technical Meeting on Approaches to Estimating Environmental Benefits of Renewable Energy and Energy Efficiency
17-18 July 2003

powered by perspective

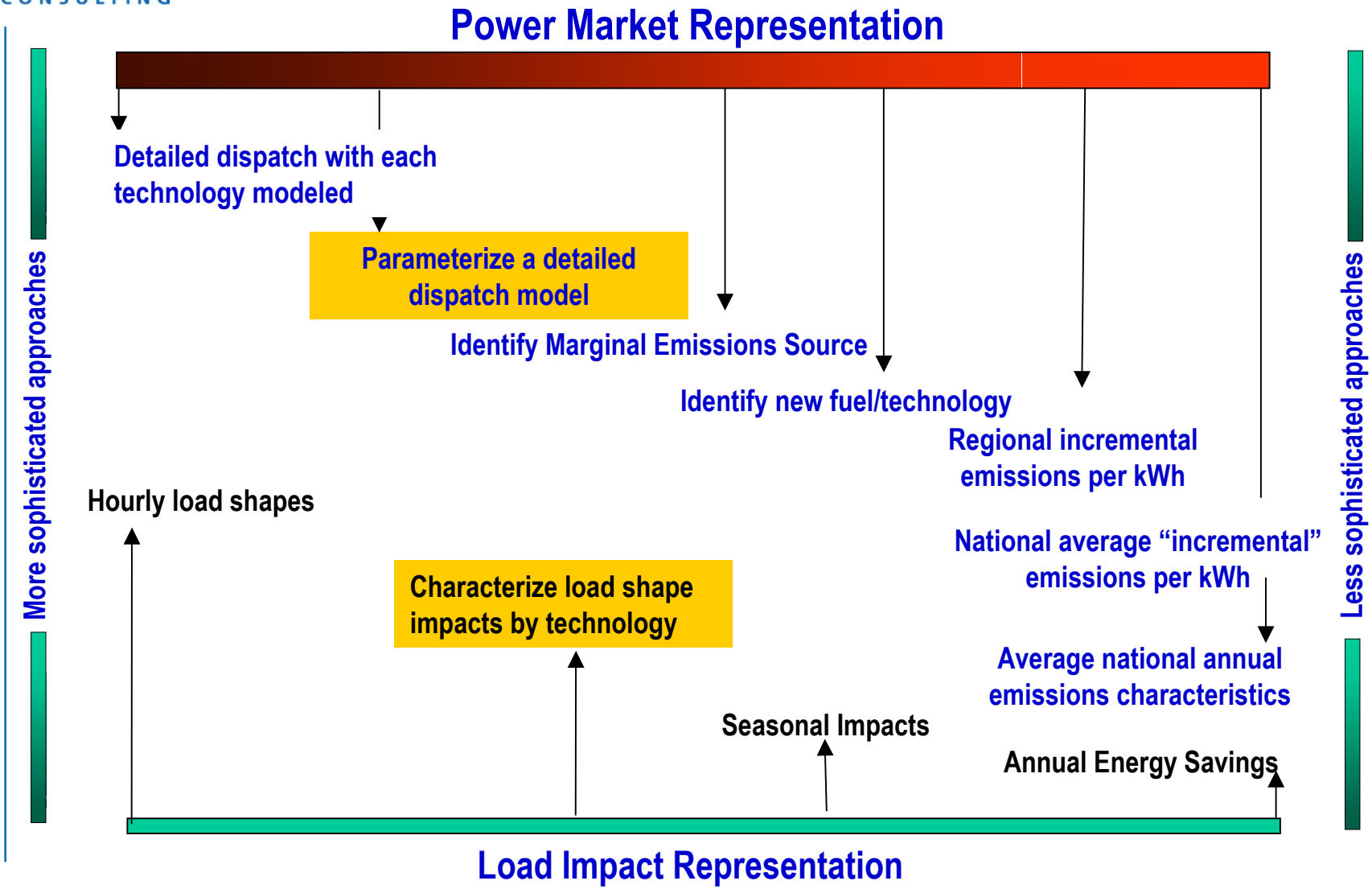
The Problem

- How do you estimate the emissions (and other) impacts on the power system of end use or supply technologies that have the potential to be cleaner than other resources?
- Power system is complex
  - Highly integrated geographically
  - Forward looking decision making
  - Integrated with fuel and emissions markets
  - Economic, not environmental dispatch

Key Issues

- Key issues are
  - (1) How do you capture the response of the power (and inter-related markets) to changes in resources?
  - (2) How do you capture the geographic and temporal patterns of efficiency, renewables or other energy supply impacts?
- Broad range of methodologies in terms of complexity

Range of Methodologies Applied



Average Displaced Emissions Rate (ADER) Methodology

- Parameterize a detailed, regional dispatch and capacity expansion model (ICF's Integrated Planning Model (IPM®)
- Identify the impacts on the power system resulting from changes in load for series of unique "hour blocks"
- Hour blocks -- periods of time that are grouped because

  (1) power system characteristics are similar,

  (2) similarly affected by energy efficiency programs.

Hour Blocks Modeled

	Winter			Summer		
	Weekday	Peak Day	Weekend	Weekday	Peak Day	Weekend
12 AM - 1 AM	1	1	1	6	6	6
1 AM - 2 AM	1	1	1	6	6	6
2 AM - 3 AM	1	1	1	6	6	6
3 AM - 4 AM	1	1	1	6	6	6
4 AM - 5 AM	1	1	1	6	6	6
5 AM - 6 AM	4	4	1	9	9	6
6 AM - 7 AM	4	4	1	9	9	6
7 AM - 8 AM	2	2	5	7	7	10
8 AM - 9 AM	2	2	5	7	7	10
9 AM - 10 AM	2	2	5	7	7	10
10 AM - 11 AM	2	2	5	7	7	10
11 AM - 12 PM	2	2	5	7	7	10
12 PM - 1 PM	3	3	5	8	8	10
1PM - 2 PM	3	3	5	8	8	10
2 PM - 3 PM	3	3	5	8	8	10
3 PM - 4 PM	3	3	5	8	8	10
4 PM - 5 PM	3	3	5	8	8	10
5 PM - 6 PM	3	3	5	8	8	10
6 PM - 7 PM	3	3	5	8	8	10
7 PM - 8 PM	4	4	5	9	9	10
8 PM - 9 PM	4	4	5	9	9	10
9 PM - 10 PM	4	4	5	9	9	10
10 PM - 11 PM	1	1	1	6	6	6

ADER Methodology

- National model with regional detail
  - Explicitly captures inter-regional interactions
- Dynamic, long-term planning model
  - Forward looking
- Explicitly handles environmental/emissions and fuel markets
  - Cap and trade and other constraints and feedbacks modeled

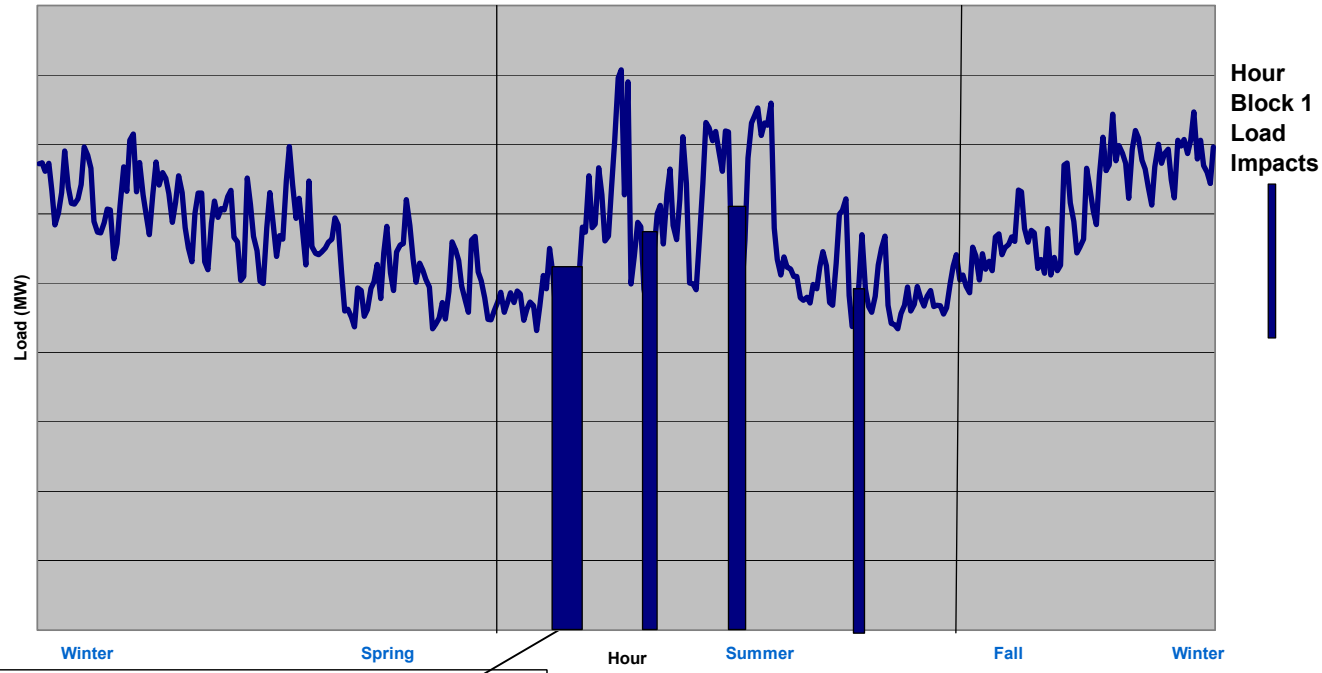
Hour Blocks Representation

- Example: 10 pm to 5 am on winter week- and peak days + winter weekends 10 pm am through 7am comprise unique hour block;
- Comparable hours in summer comprise a second unique hour block
- Any number of hour blocks could have been done; 11 unique hour blocks were examined to limit runs
- Hour block impacts were examined in isolation, one region at a time – five regions x 11 hour blocks = 55 runs of the model
- Renewables, CHP, modeled directly.

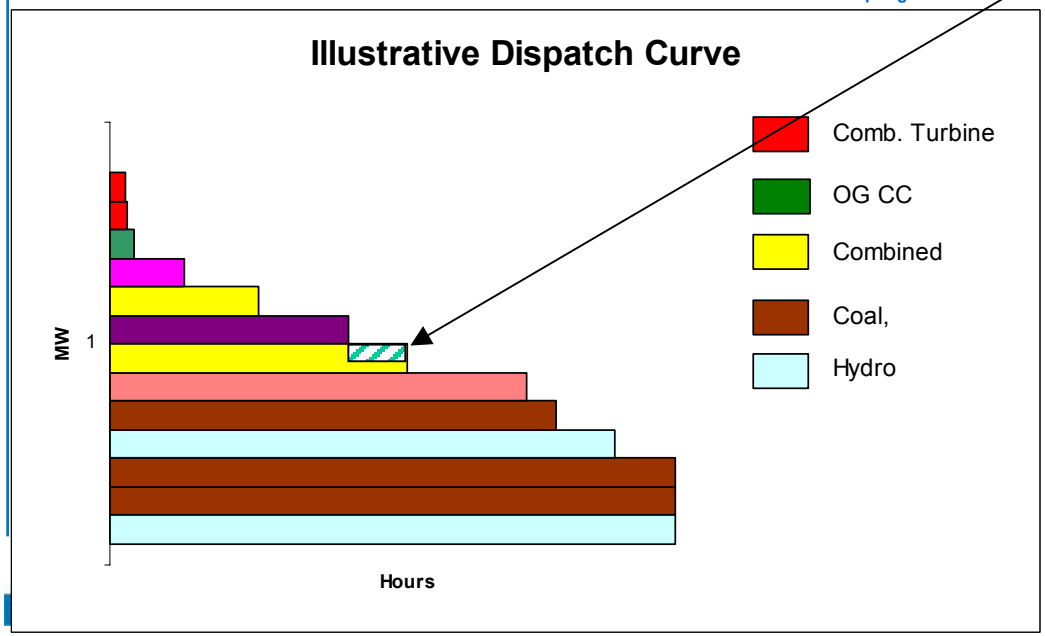
Using ADER: Load Shape Representation

- DOE2 - developed representative load shapes by climate zone. Any load shapes can be used
- Pair ADER factors (e.g, lbs/kWh) with load shape data by hour blocks
- $\sum_{REG} \sum_{HB} \{MWh_{HB} * ADER\ lbs/MWh_{HB}\}$ = Annual Emissions Impact
- Impacts are 2 part –
  - In the region of penetration),
  - All other regions,
  - Sum represents national impacts

Illustrative Load Shape Impact Curve



Illustrative Dispatch Curve



- Entire dispatch adjusts, including infra-marginal units
- Inter-regional interactions captured
- Emissions market considerations are factored in
- Response reflects longer term considerations

Observations

- Marginal rates vs. “displaced” emissions
- Load shape impacts
- Operating constraints (e.g., environmental regulations)
- Regional resolution and degree of impact; other programs/regional activities
- Baselines
- Methods to estimate the potential impacts in the face of emissions caps