GREENHOUSE GASES FROM POWER SECTOR
KEYS TO IMPROVE ESTIMATION

Kotur S. Narasimhan
TYPICAL SOURCE SHARE OF GREENHOUSE GASES

United States

- Electricity: 31%
- Transportation: 27%
- Industry: 21%
- Commercial & Residential: 9%
- Agriculture: 12%

United States CO₂ Emissions (2015):
- Total: 6,740 MMT CO₂
- Electricity: 198 MMT CO₂
- Transportation: 36%
- Industry: 32%
- Commercial & Residential: 17%
- Agriculture: 5%

Virginia

- Electricity: 36%
- Transportation: 32%
- Industry: 17%
- Commercial & Residential: 10%
- Agriculture: 5%
GHG INVENTORY SOURCES

- NATIONAL LEVEL – EPA ANNUAL REPORTS
- STATE LEVEL –
  - STATE INVENTORY TOOL (SIT)
  - INDIVIDUAL STATE DEPARTMENTS

GREENHOUSE GAS REPORTING PROGRAM (GHRP) – Major Sources

SIT also provides an alternate method to estimate GHG based on POWER USAGE
GHG EMISSIONS FROM POWER GENERATION & USAGE

- CARBON DIOXIDE [CO₂]
- METHANE [CH₄]
- NITROUS OXIDE [N₂O]

- METHANE [CH₄]
- NITROUS OXIDE [N₂O]

- SULFUR HEXAFLUORIDE [SF₆]

- ALL THE ABOVE

FROM COMBUSTION OF FOSSIL FUELS

WASTES & BIOMASS

TRANSMISSION & DISTRIBUTION EQUIPMENT

POWER USED BUT NOT GENERATED
DATA SOURCES FOR POWER SECTOR GHG ESTIMATION OF CO$_2$, CH$_4$ & N$_2$O EMISSIONS

ENERGY INFORMATION ADMINISTRATION [EIA]

STATE ENERGY DATA SYSTEM [SEDS]

STATE INVENTORY TOOL [SIT]
STATE LEVEL COMPOSITE DATA

ELECTRICITY SECTION EIA-906/920/926
INDIVIDUAL SOURCES MANDATORY REPORTING
ALSO STATE PROFILES

FUEL TYPE UNIT LEVEL DATA
COMPARISON OF HEAT INPUT DATA

SOLID COLORS: EIA-906

PATTERN: SEDS DATA

Coal
Natural gas
Wastes & Biomass
Petroleum

Heat Input, Billion Btu

YEAR


DEQ

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY
**DATA SOURCES**
FOR POWER SECTOR GHG ESTIMATION
OF SF₆ EMISSIONS

STATE INVENTORY TOOL DOES NOT INCLUDE SF₆ EMISSIONS IN POWER SECTOR BUT CONSIDERS AS PART OF **INDUSTRIAL PROCESSES** EITHER BASED ON PURCHASE OR ON NATIONAL SALE PRORATED TO ELECTRICITY SOLD IN THE STATE

IN THE PRESENT COMPUTATION SF₆ EMISSIONS IS BASED ON THE DOMINION POWER’S GHGRP REPORTS FOR 2011-2015

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Power Sold (Million KWh)</th>
<th>Reported SF₆ (MT CO₂ E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>74,324</td>
<td>116,873</td>
</tr>
<tr>
<td>2012</td>
<td>72,604</td>
<td>47,759</td>
</tr>
<tr>
<td>2013</td>
<td>74,469</td>
<td>46,446</td>
</tr>
<tr>
<td>2014</td>
<td>75,563</td>
<td>75,671</td>
</tr>
<tr>
<td>2015</td>
<td>76,025</td>
<td>53,819</td>
</tr>
</tbody>
</table>
POWER SECTOR GHG EMISSIONS ESTIMATION STRATEGY

- TAKE INTO ACCOUNT ALL ENERGY CONSUMED IN PAST / LIKELY IN FUTURE FOR POWER GENERATION;

- ESTIMATE ALL POWER GENERATED / LIKELY TO BE GENERATED IN THE STATE;

- ESTIMATE ADDITIONAL POWER BY IMPORTS BASED ON TOTAL SALE / DEMAND;

- ESTIMATE CO$_2$, CH$_4$, & N$_2$O BASED ON GENERATION & SF$_6$ EMISSIONS BASED ON TOTAL CONSUMPTION;

- ESTIMATE CORRESPONDING EMISSIONS FOR IMPORTED POWER PRORATED TO GENERATION;
PROJECTING FUTURE GENERATION & DEMAND

PROJECTION TOOL IN SIT IS BASED ON ANNUAL ENERGY OUTLOOK (AEO) OF EIA; LATEST SIT IS BASED ON AEO 2014

CURRENT ASSESSMENT ALSO INCLUDES AEO 2015 & OUTPUT FROM THE TOOL OF EASTERN REGIONAL TECHNICAL ADVISORY COMMITTEE (ERTAC) FOR MAJOR FOSSIL FUEL UNITS

Based on replication of hourly performance of electric grid with reference to a base year subject to availability of old/new units and fuel type;
For units not covered by ERTAC five year running average values are used

DEMAND FOR POWER & RESULTING IMPORTS NEED IS ARRIVED AT TO MAINTAIN CURRENT (2015) PERCAPITA ADJUSTED TO GROWTH IN POPULATION
EMISSIONS –REVISED & SIT ASSESSMENT

CO₂

CH₄

N₂O

SF₆

SOLID LINES: REVISED; DOTTED: SIT VALUES; EMISSIONS IN METRIC TONS EQUIVALENT CO₂
TREND IN EMISSIONS RELATED TO GENERATED POWER AND USAGE
COMPARISON OF REVISED SPECIFIC EMISSIONS RATE, LBS CO₂/KWh, WITH VALUES USED IN SIT

YEAR

Power Usage (Revised)

Power Usage (SIT)

Emission Rate (SIT)

Emission Rate (Revised)
A COMPARISON OF SPECIFIC EMISSIONS RATES BASED ON REVISED ESTIMATES INCLUDES BOTH GENERATED & IMPORTED POWER ARE IN CLOSE AGREEMENT WITH SIT ASSUMPTIONS FOR ESTIMATING EMISSIONS BASED ON USAGE IN THE RECENT PAST.

FOR FUTURE YEARS, THEY ARE FAR APART. REASONS ARE TWO. IN SIT THE ASSUMED RATE IS THE HIGHEST OF THE PAST. IN THE REVISED ESTIMATE, NON-FOSSIL GENERATION, PARTICULARLY CLEAN NUCLEAR & HYDRO AND OTHER EMISSION INEFFECTIVE WASTES & BIOMASS GENERATION ARE GROWN ON FIVE YEAR RUNNING AVERAGE.

ALSO, LOWER RATES ARE COMPARABLE TO RECENT PAST.
SUGGESTIONS FOR A COMPREHENSIVE GHG EMISSIONS ESTIMATION FROM POWER SECTOR

- USE SOURCE BASED DETAILED ENERGY CONSUMPTION DATA (ELECTRICITY SECTION OF EIA);

- INCLUDE EMISSIONS OF SF₆ USED IN T & D EQUIPMENT;

- INCLUDE EMISSIONS DUE TO POWER USED BUT NOT GENERATED;

ALTERNATELY,

- FOLLOW ‘USE BASED’ APPROACH SUGGESTED IN SIT KEY IS TO ASSUME CORRECT RATE VALUE

- EVOLVE RATE ANNUALLY BASED ON NATIONAL INVENTORY FOR USE BASED ON CONSUMPTION
BENEFITS
of accurate emissions estimates

• STRENGTHEN STATE IMPLEMENTATION PLANS

• BETTER APPRECIATION OF RENEWABLE ENERGY IMPACT IN FOSSIL POWER SUBSTITUTE
Acknowledgements:

• Thank You All for Listening;
• EPA/EIC2017 Organizers for the Opportunity;
• MARAMA/VADEQ for Financing;
• Thomas R. Ballou, Director, Air Data Analysis
• Doris MacLeod, VADEQ for ERTAC inputs
• VADEQ.