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EPIC Emissions Calculator

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Purpose of the Emissions Calculator

- Calculate changes in emissions from EPIC projects that:
  - Increase the use of renewable electricity in California;
  - Reduce overall demand for electricity;
  - Reduce peak demand for electricity;
  - Shift demand for electricity; or
  - Reduce consumption of gas and oil through various electrification measures.
- Estimated emission impacts can be valued using other tools:
  - EPIC Air Quality Health Benefits Calculator (criteria air pollutants)
  - EPIC Social Cost of Carbon Calculator (greenhouse gases)

EPIC Context

CALCULATOR MODULE	PATHWAY	RELEVANT EPIC RESEARCH AREAS
Fuel Mix	Increased use of renewables	Energy & Environment, Microgrids, Renewable Grid Integration, Industrial Agriculture and Water
Energy Efficiency	Reduced electricity demand	Building Energy Efficiency, Industrial Agriculture and Water
Load Shifting	Peak load shifting (not net reduction)	Industrial Agriculture and Water, Demand and Response, Vehicle Grid Integration
Peak Load Reduction	Reduced electricity demand during peak times	Building Energy Efficiency, Industrial Agriculture and Water, Demand and Response
Electrification	Electric vehicles and reduced residential and commercial gas consumption	Energy and Environment, Microgrids, Renewable Grid Integration, Vehicle Grid Integration, Building Energy Efficiency

Emissions Calculator Outputs and Inputs

- **Calculator Outputs**
  - Changes in criteria air pollutant (NO_X, SO_2, $PM_{2.5}$) emissions
  - Changes in greenhouse gas (CO_2, CH_4, N_2O) emissions
  - By year (up to 2050) and by California Air Basin
- **User Inputs per Scenario**
  - Inputs from EPIC applicants/grantees (applications, mid-term/final reporting) or the expert elicitation process
  - Required data inputs vary by module
- Other required data inputs rely on default data included in the calculator.

Emissions Calculator: Summary of Approach

- Allocate projected changes/shifts in electricity generation or demand by:
  - (1) Region in CA
  - (2) Season
  - (3) Time slice in a season
  - (4) Generating technology type
    - Reliance on a given technology type varies by region, season, and time slice.
- Apply technology- and pollutant-specific emissions factors to the changes/shifts in electricity generation.
- Sum emissions by year and pollutant.
- Distribute changes in emissions to California Air Basins.

Reference Data

- Emissions impacts depend on the generation mix displaced by renewables, energy efficiency, or peak reduction/shifting.
- The calculator's sources for such data include:
  - **Electricity generation projections from Energy Information Administration (EIA) National Energy Modeling System (NEMS)**
    - Composition of electricity generation by region (Northern and Southern CA), season (summer, winter, shoulder) and time slice within each season (3 per season)
  - **EIA Annual Energy Outlook (AEO)**
    - Projected electricity imports into Northern and Southern California through 2050.
  - **US EPA Integrated Planning Model (IPM)**
    - Sourcing of imports by season.
    - IPM load duration curves used to distribute imports across seasonal time slices.
  - **EPA's Emissions & Generation Resource Integrated Database (eGRID)**
    - Average emission factors by fuel type.

Example Outputs

Results by Year– Choose Air Basin

Results by Air Basin– Choose Year

Module 1: Fuel Mix (renewable generation)

- Structure/Calculations:
  - **Step 1**
    - Determine where and when (time of day/year) EPIC-related renewables will be produced.
  - **Step 2**
    - Determine the mix of generation displaced by these renewables.
    - Displaced generation reflects the mix during times when renewables are produced.
  - **Step 3**
    - Determine the emissions associated with the displaced generation.
- Emissions impacts estimated as a range (related to Step 2)

Module 2: Energy Efficiency

- Structure/Calculations:
  - **Step 1**
    - Allocate foregone generation (MWh) across regions, seasons, time slices, and fuel types in proportion to baseline for a given year.
  - **Step 2**
    - Estimate emission effects using pollutant and technology specific average emission factors derived from eGRID
- Key Difference Relative to Renewables Module:
  - Renewable effects dependent on when renewables generated (e.g., daytime hours for solar). Efficiency effects spread across all time periods.

Energy Efficiency Inputs

Analysis Parameters		
Parameter	**Input**	**Units**
Reduction Type (% or MWh reduction)	MWh	*Select MWh or % Reduction*
Percent reduction in electricity		*Percent (constant over year)*
MWh reduction in electricity consumption	*Enter per year values in the "Energy Efficiency Per Year Inputs" table below.*	
Start year		*year (2020-2050)*
End year		*year (2020-2050)*

Module 3: Peak Load Reduction

- Structure/Calculations:
  - **Step 1**
    - Identify peak generation for each of the three seasonal peaks in each region
  - **Step 2**
    - Allocate the reduction in peak generation (by region, year, and season) to individual fuel/technology types. Based on generation profile between time slices to get at marginal emissions.
  - **Step 3**
    - Estimate the emissions impacts by fuel/technology type based on emissions factors derived from eGRID

Peak Reduction			
	Reduction Type (% or MWh reduction)		*Select MWh or % Reduction*
	Percent reduction in peak electricity consumption		*Percent (constant over year)*
	MWh reduction in peak electricity consumption		*MWh per year*
	Start year		*year (2020-2050)*
	End year		*year (2020-2050)*

Module 4: Peak Load Shift

- Structure/Calculations:
  - Similar to peak reduction but with one added step: adding in generation/emissions for non-peak periods.

Same as for Peak Reduction

  - Step 1
    - Identify peak generation for each of the three seasonal peaks in each region
  - Step 2
    - Allocate the reduction in peak generation (by region, year, and season) to individual fuel/technology types. Based on generation profile between time slices to get at marginal emissions.
  - Step 2B
    - Allocate shifted generation to non-peak period and distribute proportionately across generation resources for that period, based on generation profile between time slices.
  - Step 3
    - Estimate the emissions impacts by fuel/technology type based on emissions factors derived from eGRID

Module 5: Electrification

- Structure/Calculations:
  - Building Electrification:
    - Step 1
      - Estimate direct emission impacts of reduced fuel use (EPA AP-42 emission factors)
      - Distribute to air basins in proportion to population
    - Step 2
      - Offset by emission impacts of increased demand for electricity
      - Distribute to air basins in proportion to baseline power sector emissions
  - Electric Vehicles
    - Step 1
      - Convert EV miles to kWh calculate associated emissions
      - Distribute to air basins in proportion to baseline power sector emissions
    - Step 2
      - Apply vehicle emissions factors to miles to estimate emissions avoided
      - Distribute to air basins in proportion to population

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Questions?

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