Impacts of Plug-In Hybrid Vehicles and Grid Generation Mix on Air Quality in the South Coast Air Basin

OVERVIEW

In this work, the South Coast Air Basin's electricity grid is resolved both spatially and temporally using historical data. A dispatch model is then developed that calculates electricity demand for different future scenarios and determines each individual power plant's electricity generation on an hourly basis.

By calculating each power plant's hourly generation, hourly emissions corresponding to each facility can be determined. These emissions can then be used as inputs to air quality models to determine the air quality effects of each scenario using the Spatially and Temporally Resolved Energy and Environment Tool (STREET).

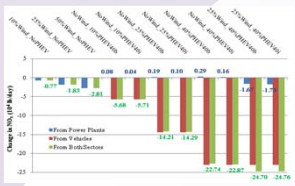
GOALS

- Develop a temporally and spatially resolved electricity dispatch model for the SoCAB
- Study future grid mix and transportation scenarios
- Delineate the impacts of Plug-In Hybrid Electric Vehicles (PHEVs) on the utility grid and overall emissions
- Integrate the dispatch model into STREET
- Determine the air quality effects of different scenarios using spatially and temporally resolved criteria pollutant emissions

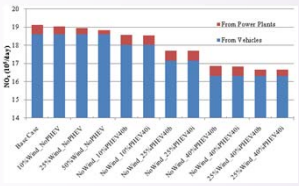
RESULTS

The dispatch model developed was validated by successfully reproducing the 2005 California Air Resources Board emissions inventory. Based on this validation, the model was used to study several future grid mix and transportation scenarios. These scenarios encompass a combination of different renewable wind energy penetrations and PHEV penetrations.

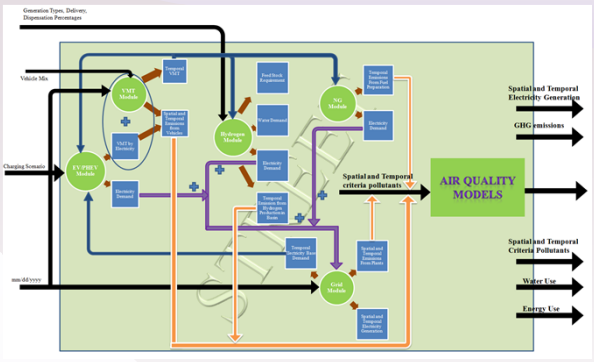
The outcome of each scenario consists of spatially and temporally resolved criteria pollutant emissions which will ultimately be used to determine the air quality impacts of the each scenario.



Daily NO_x Variation from the Base Case



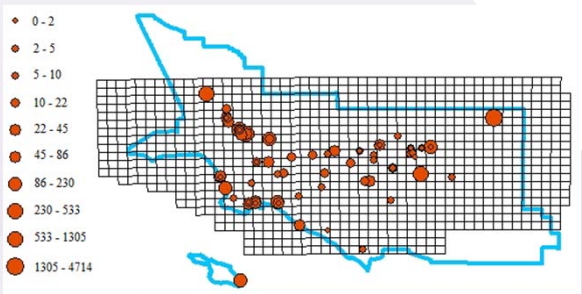
Daily NO_x Emissions



Flow chart of STREET modeling methodology

RESULTS (continued)

The results demonstrate that adding PHEVs to the vehicle fleet increases the emissions from power plants; however, the increase is small compared to the emissions reduction from the transportation sector. Increasing the PHEV penetration further reduces the overall emissions. It is also concluded that integrating renewable wind energy into the electricity grid and deploying PHEVs simultaneously can have significant effects on reducing emissions. The effects are further enhanced by utilizing excess wind for vehicle charging, especially at times when the base electricity demand is low.



2050 Base Case NO_x Emissions at 5 pm

RECENT PUBLICATIONS

Jansen K.H., Brown T.M., Samuelsen G.S., 2010. Emissions impacts of plug-in hybrid electric vehicle deployment on the U.S. western grid, *Journal of Power Sources*. 195, 5409-5416

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