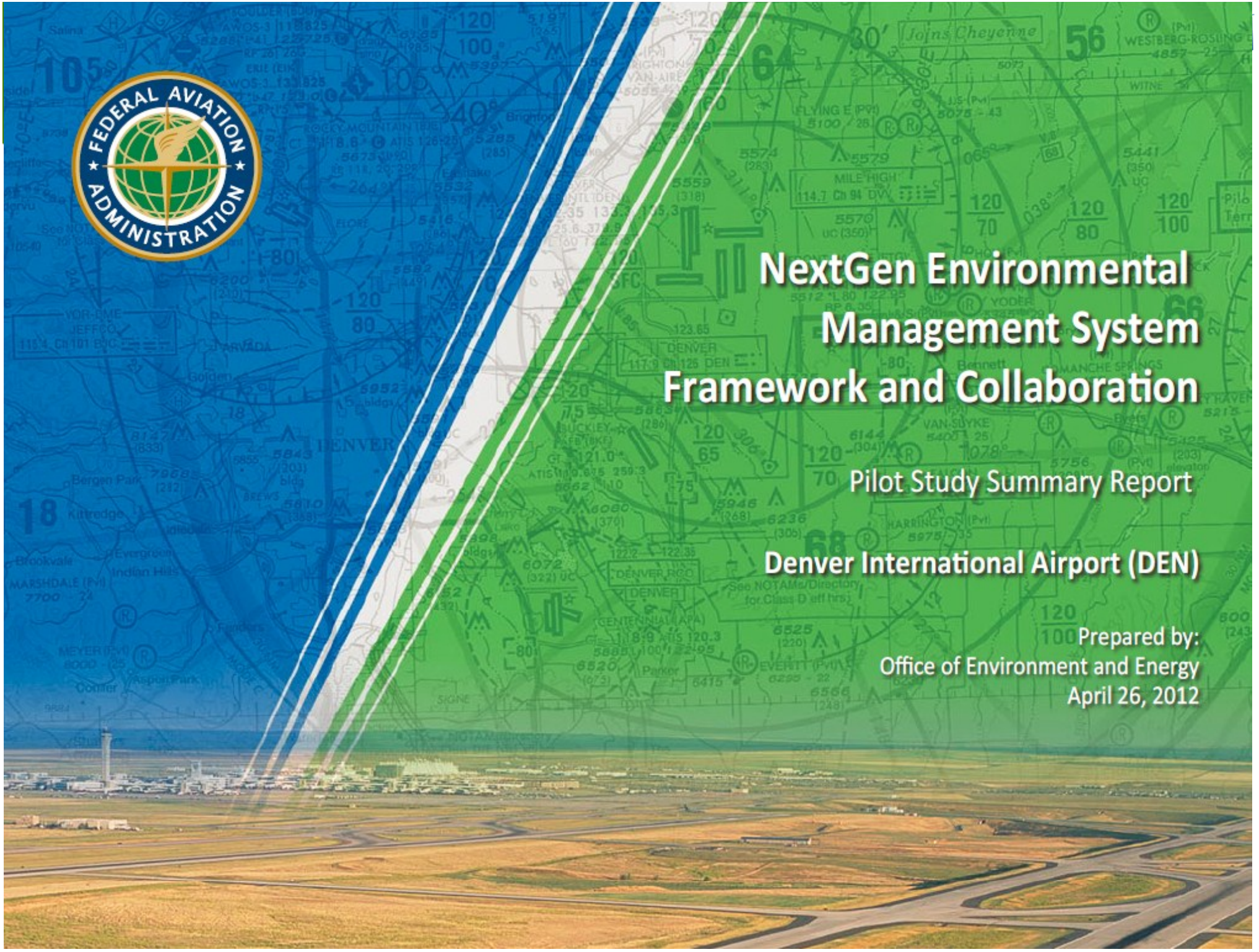

NextGen Environmental Management System Framework and Collaboration

Pilot Study Summary Report

Denver International Airport (DEN)

Prepared by:
Office of Environment and Energy
April 26, 2012

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Introduction

NextGen EMS

Introduction

NextGen is an umbrella term for the ongoing transformation of the National Airspace System (NAS). At its most basic level, NextGen represents an evolution from a ground-based system of air traffic control to a satellite-based system of air traffic management. This evolution is vital to meeting future demand, to avoiding gridlock in the sky and at our nation's airports, and to improving the environmental performance of the NAS.

The environmental vision for NextGen is to provide environmental protection that allows sustained aviation growth. Because noise, air quality, climate, energy, and water quality are the most significant potential environmental constraints to increasing aviation capacity, efficiency, and flexibility, the FAA has established goals for each aspect. The goal for each aspect included in this pilot study will be presented on the following pages.

NextGen EMS Framework and Collaboration

The NextGen Environmental Management System (EMS) Framework and Collaboration is a strategic approach to address the five environmental aspects. The goal of the framework is to ensure that environmental benefits of NextGen are maximized, while constraints to mobility (i.e., increasing efficiency and capacity) are reduced or avoided. This framework will establish the overarching means of collaboration for stakeholders (e.g., Air Carriers, Airports, Manufacturers, Local Community). To achieve broad system-level aviation environmental and energy goals, it will provide approaches, tools, and performance assessments to help stakeholders address the important issues specific to their organization, and it will support more efficient and effective planning and decision making.

NextGen EMS Framework and Collaboration Pilot Study

The NextGen EMS Framework and Collaboration Pilot Study aims to foster collaboration between FAA and aviation's principal stakeholders (e.g., Air Carriers, Airports, Manufacturers, Local Community).

It aims to further define their role in NextGen EMS Framework and Collaboration and identify opportunities to address environmental challenges. The objective of this pilot study is to evaluate which environmental issues have the potential to constrain the mobility of the aviation system and the possible effects of future technology and operational changes.

Pilot study information is used to develop NextGen EMS Framework and Collaboration approaches and tools that will help stakeholders identify strategic environmental issues, address these issues, and track improvements.

The *Denver International Airport Master Plan Update Studies Phase II Baseline Activity Projections* report was used for the operational forecast for this study. For the DEN Pilot Study, 2010 was chosen as the base year.

NextGen Airport Pilot Study Goals

1. Develop, test, and refine NextGen EMS Framework and Collaboration approaches
2. Identify environmental issues at the study location, such as those that could constrain mobility.
3. Evaluate the potential for NextGen solutions to offset environmental issues. The solutions examined include aircraft/engine technology, operational procedures, and alternative fuels.
4. Review other potential approaches to reduce or avoid environmental issues identified at the pilot study location.

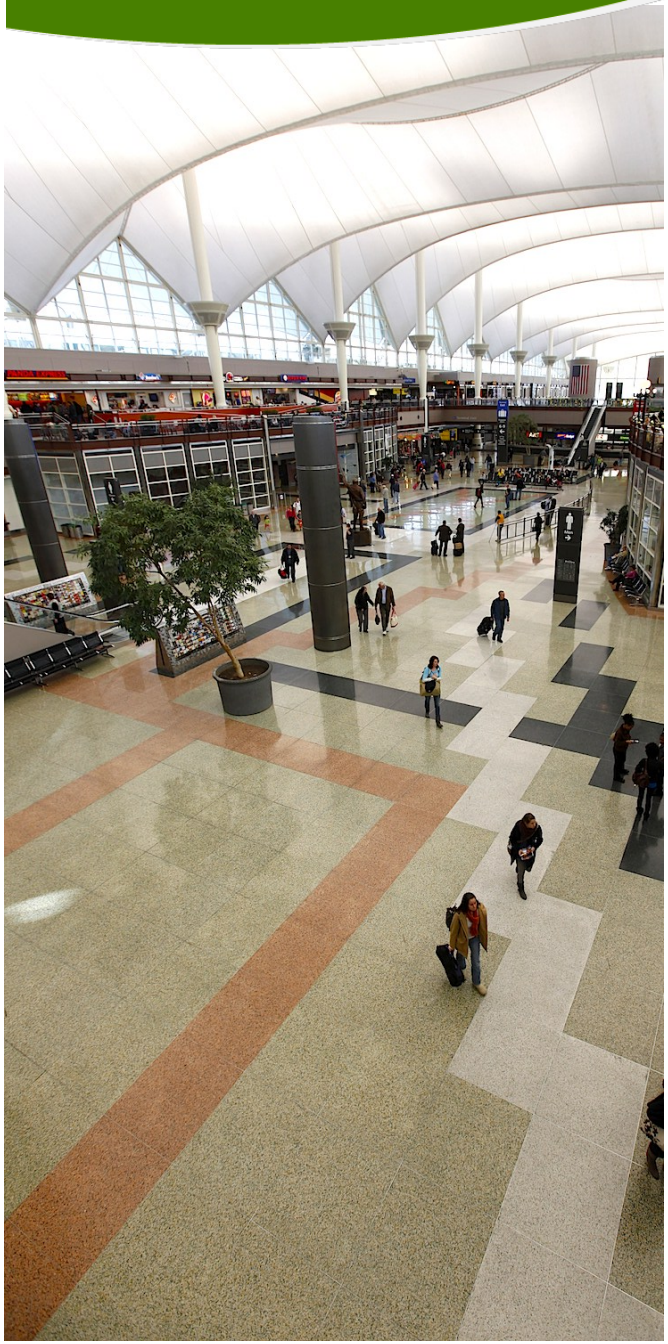
Results

The results of this pilot study are being used to inform the development of NextGen EMS Framework and Collaboration. By leveraging detailed examples and case studies, as well as direct stakeholder involvement during the development process, the implementation of NextGen EMS Framework and Collaboration will be compatible with on-going stakeholder environmental programs and initiatives, while encouraging the stakeholder community to collaborate and meet the environmental goals.

10-Step Pilot Study Approach

Through a 10-step technical approach, data were collected and analyzed to establish baselines for air quality, climate, energy, noise, and water quality. Using forecast data, and assuming no NextGen technologies and operations were incorporated, future scenarios were then calculated for each aspect to identify environmental issues that could constrain NextGen implementation. Next, several new technology and operational concepts were evaluated to determine those that could mitigate the environmental impacts.

Denver International Airport



DEN Overview and Statistics

Denver International Airport (DEN) is located 23 miles northeast of downtown Denver, Colorado. The airport is owned and operated by the City and County of Denver.

The airport encompasses 53 square miles and is the largest international airport in the United States and the third largest airport in the world in terms of surface area after King Fahd International Airport and Montreal-Mirabel International Airport.

DEN served 14 commercial passenger airlines and to more than 170 destinations in 2011. DEN is also the main hub for Frontier Airlines (24% of annual passenger traffic) and the second largest hub for United Airlines (41% of annual passenger traffic), and a focus city for Southwest Airlines (23% of annual passenger traffic).

In 2011, DEN had approximately 53 million arriving and departing passengers, and was ranked 3rd among U.S. airports in terms of scheduled departures.

The airport has six runways (Runway 16R/34L, at 16,000 feet, is the longest public use runway in the U.S.), a main terminal with three concourses, an Automated Guideway Transit System (AGTS) people mover system, emergency services, and other public services. In addition, the airport is serviced by several local bus charters.

Environmental Initiatives

DEN has sponsored a number of environmental initiatives aimed at better managing environmental performance and reducing the environmental impact of the airport. For example, DEN has installed several solar panel farms on airport property through three projects. The details of the Solar Projects are:

1. A single-axis flat tracking system with 2 megawatts DC (peak AC power is approximately 1.8 MW AC; generates approximately 3.5 million kilowatt-hours annually).

2. A fixed-tilt system constructed adjacent to the airport's fuel farm that produces 1.6 megawatts DC (peak AC power is approximately 1.4 MW AC; generates approximately 2.7 million kilowatt-hours annually).

3. A fixed-tilt system, larger in size than the other two solar installations combined. The power output is 4.4 megawatts DC (peak AC power approximately 3.8 MW AC; will generate approximately 6.7 million kilowatt-hours annually).

The combined total power output of DEN's solar facilities is enough to power more than 1,000 homes annually. These systems produce about 6% of DEN's total 2010 electrical energy requirements. The output makes DEN the largest distributed generation photovoltaic energy producer in the state of Colorado.

DEN is the only international airport in the U.S. to have designed and implemented an ISO-14001 certified EMS encompassing the entire airport (as of December 2011).

The Colorado Department of Public Health and Environment (CDPHE) named the airport as a Gold Leader in the CDPHE Environmental Leadership Program for its excellent environmental records and commitments to continual improvement and sustainability. In 2006, DEN was the first airport accepted into EPA's former National Environmental Performance Track Program.

Air Quality

Introduction

Air pollutants, generated from airport and aircraft operations, can impact local and regional air quality. Aircraft and airports can contribute up to 5% of the emissions regulated under State Implementation Plans compared to other transportation and point/area sources which make up 40% to 55%, respectively. The FAA has initiated programs to reduce emissions from aircraft and airports even as aircraft operations and enplanements are forecasted to increase in the future.

NextGen Air Quality Goal

Achieve an absolute reduction of significant air quality health and welfare impacts attributable to aviation, notwithstanding aviation growth. NOTE: FAA's system level goals are not applied directly to airports, but can be used as a guide to contextualize emissions from airports such as Denver International Airport.

Current State

Approach: Criteria pollutant emissions from the following sources were examined: *Stationary Sources (Boilers, Emergency Generators, Incinerators, and Paint Booths); Non-aircraft Mobile Sources (Ground Access Vehicles and Ground Support Equipment); and Aircraft Operations (Landing and Take Off Operations).* Using the DEN 2005 emissions inventory, criteria pollutant emissions estimates were made using the following methodologies for each source.

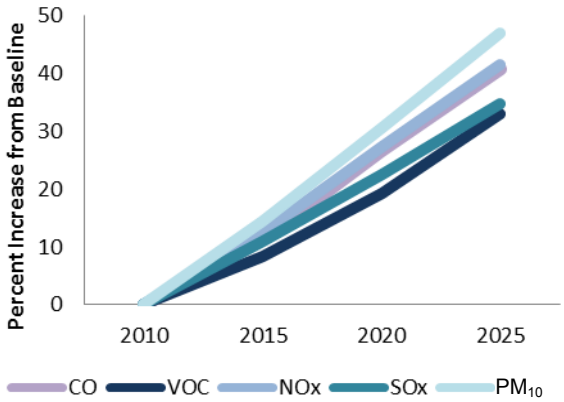
- *Stationary:* The City and County of Denver Department of Aviation developed a baseline and Air Emissions Inventory (AEI) in 2005 for DEN airport operations. The baseline and future years' emissions for the various stationary sources at the airport were estimated by prorating the 2005 AEI emission estimates using the same growth rate used in that inventory. The growth factors used in the 2005 AEI were largely based on aircraft operations or domestic / international enplanements.
- *Non-aircraft Mobile*: FAA's Emissions and Dispersion Modeling System (EDMS) model was used in the 2005 AEI to estimate emissions from Ground Support Equipment and Ground Access Vehicles. For this analysis, the emissions for the baseline (2010) from the 2005 AEI were prorated based on the number of aircraft operations estimated in the DEN Airport Master Plan.
- *Aircraft:* Baseline and future aircraft emissions were estimated using Beta 1c of the FAA's Aviation Environmental Design Tool (AEDT). This tool enables aircraft performance to be modeled during various phases of flight to produce fuel burn, emissions, and noise estimates.

Key Trends: From 2001 to 2010, total Carbon Monoxide (CO) operational emissions increased from 12,631 tons to 16,703 tons, PM_{10} total emissions increased from 482 tons to 543 tons, total Sulfur Oxides (SO_X) emissions increased from 333 tons to 386 tons, Volatile Organic Compounds (VOC) emissions increased from 956 tons to 1,178 tons, and Nitrogen Oxide (NO_X) emissions increased from 3,546 tons to 4,178 tons.

Future State

Approach: For each source category, calendar year 2010 was chosen as the baseline inventory year; and assuming no incorporation of NextGen technologies and operations, emissions were forecasted for 2015, 2020, and 2025 for consistency with Master Plan projections. Future emissions estimates were then compared to the baseline to examine potential increases or decreases from the baseline for each criteria pollutant.

Projected Stationary Criteria Pollutants



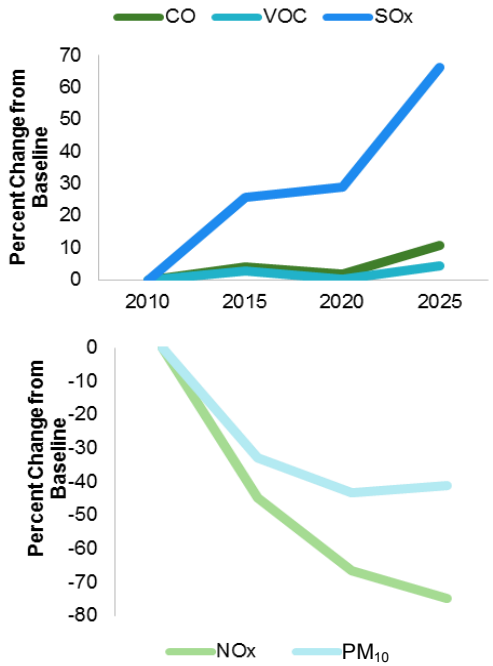
Stationary Sources

Key Trends: Criteria pollutants are expected to steadily trend upward in the future. Projections indicate that emissions will increase as aircraft operations and passenger enplanements increase. VOC are expected to increase by 33% by 2025, and Particulate Matter (PM_{10}) by 47% by 2025.

Air Quality

Ground Access Vehicles

Projected Ground Access Vehicle Criteria Pollutants

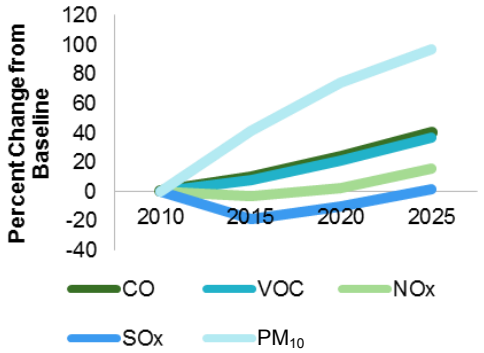


Key Trends: CO and VOC vehicle emissions are estimated to increase from 2010 to 2025 by 4% and 11% respectively. SO_x emissions are estimated to increase by over 65% which equates to 0.14 tons per year. Emissions of NO_x and PM_{10} are expected to decrease from 2010 levels.

Ground Support Equipment (GSE)

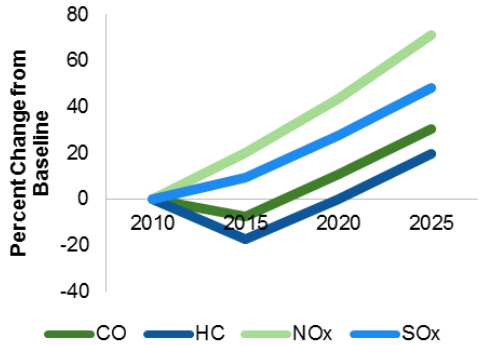
Key Trends: Criteria pollutants are estimated to increase between 2010 and 2025. NO_x and PM_{10} emissions are expected to increase by 15% and 100% respectively. SO_x emissions are estimated to decrease initially and trend upward ultimately increasing by 1.6% between 2010 and 2025.

Projected GSE Criteria Pollutants



Aircraft

Projected Aircraft Criteria Pollutants



Key Trends: Criteria pollution emissions are expected to decrease between 2010 and 2015, due to fleet mix changes (e.g., the mix of aircraft operating at DEN), then increase after 2015. Emissions of CO, Hydrocarbons (HC), NO_x, and SO_x are estimated to increase by 31%, 20%, 71%, and 48%, respectively, by 2025.

Potential NextGen Solutions

Two potential solutions to reduce emissions from airport and aircraft operations at DEN include the Voluntary Airport Low Emission Program (VALE) and the Continuous Lower Energy, Emissions and Noise (CLEEN) Program.

- *VALE*: The program aims to reduce the amount of criteria pollutants generated by mobile sources and infrastructure at airports. The program provides financial and regulatory incentives for airports to invest in low-emission technology and non-petroleum based alternative fuels to reduce emissions.
- CLEEN: The FAA is working to develop and demonstrate new technologies, procedures, and sustainable alternative jet fuels that will reduce noise, emissions, and fuel burn, enabling the aviation industry to expedite integration of these technologies into current and future aircraft. Specific goals for technology development include: reduce fuel burn by 33% and reduce cumulative noise by 32 decibels, and reduce emissions of NOx during takeoff and landing by 60% below the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP-6) standards.

Potential Airport Improvement Opportunities

1) Encourage air carriers to adopt electric GSE

2) Investigate ways to reduce bus movements at the airport

3) Encourage use of sustainable alternative fuels for aircraft and mobile / stationary sources

4) Investigate ways to improve surface flow management

Climate

Introduction

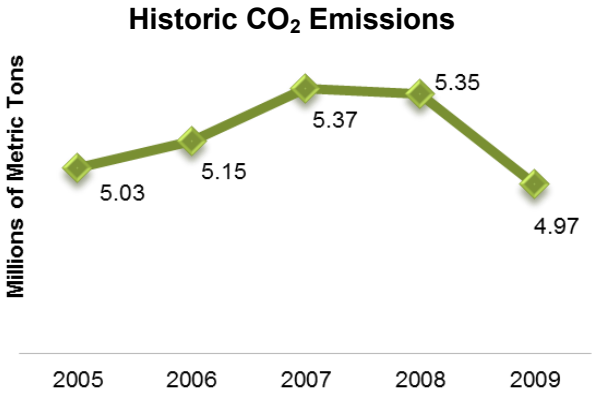
Airport greenhouse gas emissions (GHG) are generated by aircraft operations, on- and off-airport vehicles, electricity consumption, boilers, and incinerators. While aircraft operations are known to be the most significant contributor of aviation GHG, airports generally have greater control over other airport sources.

NextGen Climate Goal

Limit the impact of aircraft Carbon Dioxide (CO_2) emissions on the global climate by achieving carbon neutral growth by 2020 compared to 2005 and net reductions of all aviation emissions that impact climate over the longer term (by 2050). NOTE: FAA's system level goals are not applied directly to airports, but can be used as a guide to contextualize emissions from airports such as Denver International Airport.

Current State

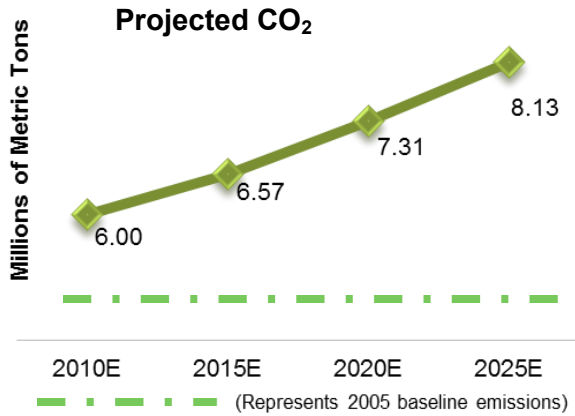
Approach: DEN's comprehensive 2010 GHG inventory was used as the baseline for this analysis. It consisted of the following sources: aircraft operations; facilities; fire training; ground access vehicles; ground support equipment; municipal solid waste; oil and gas facilities; on- and off-airport vehicle travel; and refrigerants. For aircraft, the DEN GHG inventory calculations used fuel uplift as the source for aircraft GHG emissions.



Key Trends: DEN's historical CO2 emissions varied less than 4% from 2005 to 2008, with an 8% drop in 2009. Emissions increased by 2% and 4% in 2006 and 2007 respectively. They decreased slightly in 2008 (less than 1%) and by 8%, in 2009. The five largest sources of emissions (largest to smallest) were: 1) aircraft operations; 2) off-airport vehicle travel; 3) on-airport vehicle travel (CNG, diesel, and gas); 4) electricity; and 5) boilers and incinerators (natural gas). Jet A Fuel burned from aircraft operations made up approximately 73% of total CO_2 emissions in 2009.

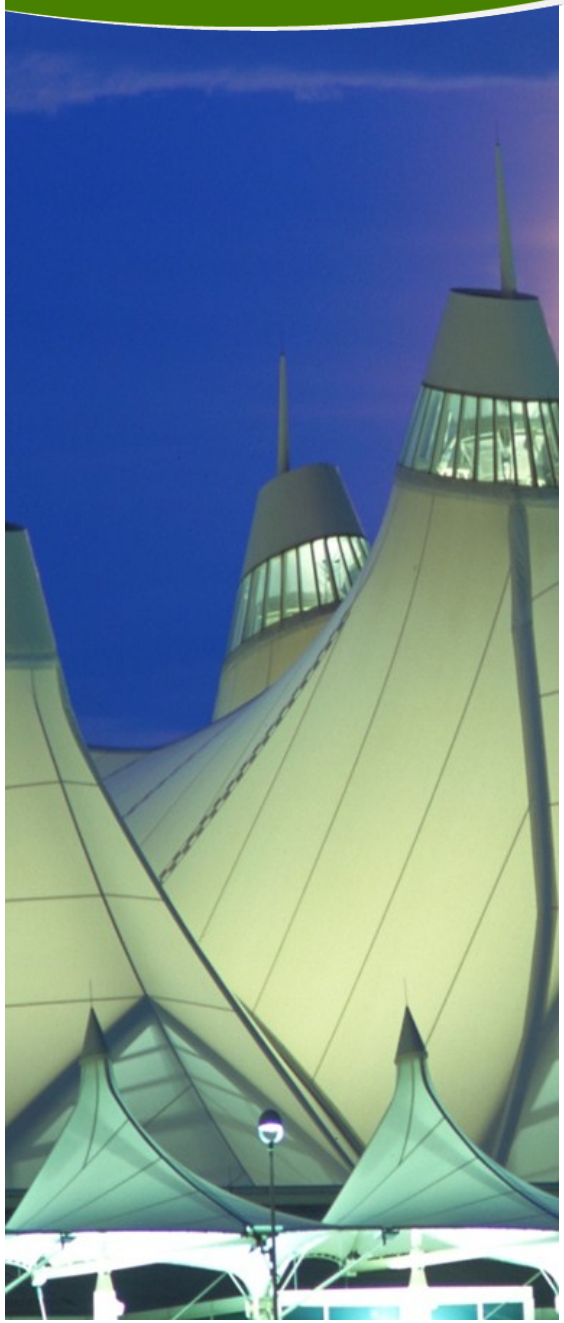
Future State

Approach: Assuming no incorporation of NextGen technologies or operations, GHG emissions for DEN were estimated for the years 2015, 2020 and 2025 based on forecasted operations and energy use. A forecast GHG inventory was created for all emission sources using different methods for each emission source. The methodologies included performing regression analyses for historical fuel use data and finding correlations with operational projections to obtain estimated future fuel use. Additionally, some energy forecasts were obtained by using average percent changes in historical years and applying those changes to future years.



Key Trends: CO_2 emissions are projected to increase in the future. From 2010 to 2015 emissions are estimated to increase by 9%, then increase by 10% in 2020 and 10% by 2025. Overall, CO_2 emissions are estimated to increase from approximately 5 million metric tons in 2005 to 8 million metric tons in 2025, an increase of 38%. Aircraft operations are predicted to continue to be the largest contributor to future GHG emissions with 76% of CO_2 emissions estimated to be from jet fuel in 2025.

Climate

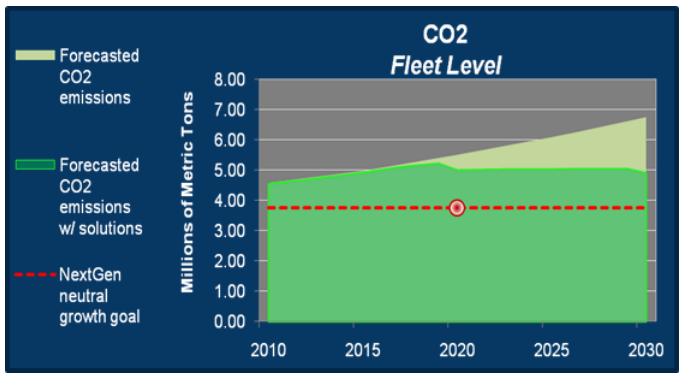


Potential NextGen Solutions

Approach: The pilot study included an analysis of potential future environmental impacts of NextGen solutions at DEN. The FAA investigated the potential for CO_2 emissions reduction from applying three solutions (i.e., changes in aircraft operations, airframe/engine technology, and alternative fuels) to aircraft operations. The analysis focused on changes in demand and the potential impacts of NextGen solutions as well as impacts caused by delays of solution implementation.

Key Trends: Aircraft operations are expected to continue to be the most significant source of CO_2 emissions at DEN.

The figure provides an illustrative example of how CO_2 emissions could be reduced if all three solutions were implemented. It indicates that new operations, technology, and alternative fuels could plateau CO_2 levels—so they are no longer increasing despite growth—by 2020.



Conclusion: DEN emissions in 2020 will not be carbon neutral when compared with a 2005 baseline. However, DEN emissions are expected to stabilize and should not increase in the years 2020 and beyond. Aircraft operations will continue to be the most significant contributor of CO_2 emissions at DEN in the future and are expected to exceed the system level climate goal. Below are several options that FAA and DEN can use to help reduce CO_2.

Potential Airport Improvement Opportunities

1) Develop airport specific goals for reducing CO_2 emissions

2) Investigate ways to reduce bus movements at the airport

3) Accelerate adoption of electric GSE

4) Further leverage ramp control tower through stakeholder Collaborative Decision Making (CDM) on surface movement/flow management to reduce delays

5) Increase use of sustainable alternative fuels in airport operations

Energy

Introduction

Airports commonly consume several different types of energy to support their operations including: electricity, unleaded gas, diesel, and natural gas. In addition, aircraft also consume energy, the most significant being Jet-A fuel. Energy consumption at DEN is closely tied to GHG and criteria pollutant emissions; therefore a reduction in energy consumption has the potential to reduce the impact to climate and air quality.

NextGen Energy Goal

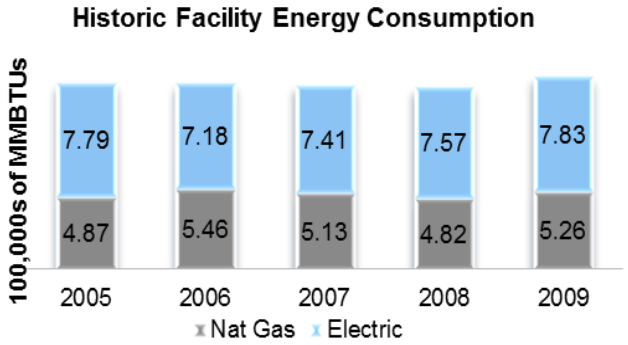
Improve National Airspace System efficiency by at least two percent per year, and develop and deploy alternative jet fuels for commercial aviation. NOTE: FAA's system level goals are not applied directly to airports, but can be used as a guide to contextualize energy use from airports such as Denver International Airport.

Current State

Energy Approach: Historical fuel data was gathered from DEN's EMS report and other airport energy consumption databases that the airport uses to track energy use. Energy analysis for DEN looked for patterns and trends in DEN's energy consumption for electricity, natural gas, and vehicle fuel.

Facilities

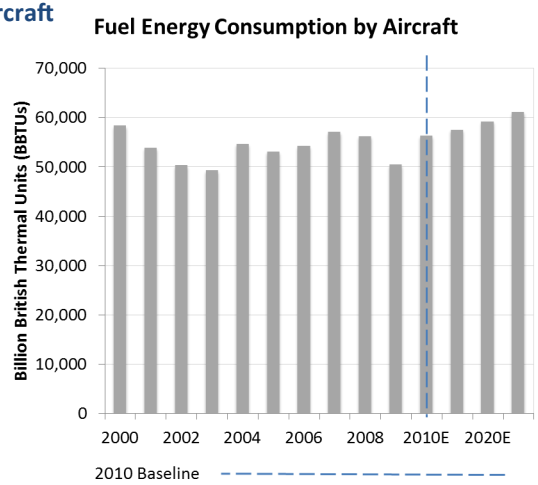
Key Trends: Over the period 2001-2009, roughly 60% of facility energy use stemmed from electricity and 40% came from natural gas for heating. Total annual energy consumption from that period ranged from 1.2 – 1.3 trillion BTU.



Ground Access Vehicles

Key Trends: The volume of fuel consumed from 2000-2009 averaged 0.05 gallons per passenger.

Aircraft

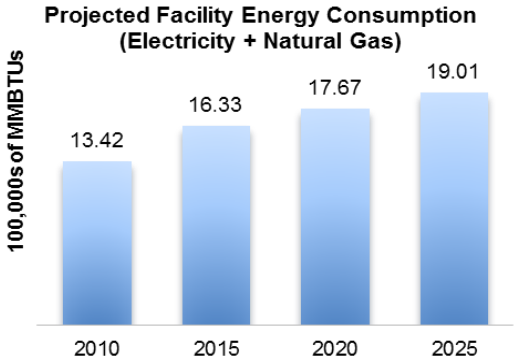


Key Trends: Aircraft fuel energy consumption, which includes Jet-A and AvGas, has remained relatively consistent and totaled 47,900 BBTU in 2009.

Future State

Facilities

Approach: Building size, building usage profiles, operations, and number of passengers were used to predict DEN's future energy consumption through 2025. DEN provided estimates on expected operations and passengers through 2025, along with anticipated changes to DEN's terminal square footage. As the size of DEN's terminal increases over the next five years, operations and enplanements are expected to increase as well.

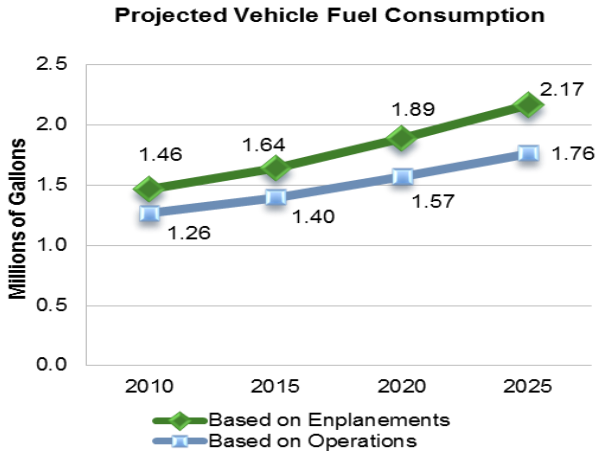


Key Trends: Electricity and natural gas consumption is expected to grow 22% from 2010 to 2015, as a result of the increased facility footprint, to 1,633,067 MMBTU. The overall energy consumption is anticipated to grow 8% from 2015 to 2020 and again 8% from 2020 to 2025.

Energy

Ground Access Vehicles

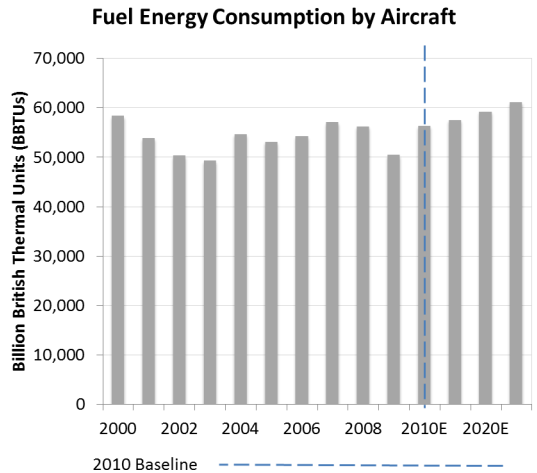
Approach: Airport support vehicle fuel was found to be correlated with the number of DEN passengers and aircraft operations. The average fuel consumption per passenger was 0.05 gallons or about two gallons per flight. The projections were calculated using DEN projections for passengers and operations and assumed that the rate of fuel consumption remained constant.



Key Trends: Vehicle fuel use is projected to steadily increase through 2025.

Aviation

Approach: The aircraft fuel consumption historical data and the forecast that was prepared for the GHG inventory, assuming no incorporation of NextGen technologies or operations, was used to calculate the fuel energy consumed by aircraft at DEN. Fuel consumed was then multiplied by the Department of Energy's Transportation Energy Data Book factor for energy found for Jet-A and AvGas.



Key Trends: Fuel energy consumption by aircraft is expected to increase as enplanements and operations increase. Aircraft fuel energy consumption, which includes Jet-A and AvGas, is projected to increase from approximately 47,900 BBTUs in 2009 to 58,100 BBTUs in 2025 based on the projected increase in enplanements for the same period.

Potential NextGen Solutions

Two potential solutions to reduce energy consumption from airport and aircraft operations at DEN include the Voluntary Airport Low Emission Program (VALE) and Continuous Lower Energy, Emissions and Noise (CLEEN) Programs.

VALE: The program aims to reduce the amount of energy consumed and criteria pollutants generated by mobile sources and infrastructure at airports. The program provides financial and regulatory incentives for airports to invest in low-emission technology and non-petroleum based alternative fuels to reduce emissions.

CLEEN: The FAA awarded contracts to develop and demonstrate new technologies to reach FAA goals of reducing fuel consumption of aircraft. CLEEN strives to accelerate technology maturation resulting in commercial products and increase use of sustainable alternative fuels by 2018.

Potential Airport Improvement Opportunities

DEN has invested in and committed to both energy efficiency and renewable energy solutions. In 2008, DEN completed the *DEN Energy Feasibility Study*, which recommended several facility improvement measures, many of which the airport has implemented or plans to implement, which will help to reduce overall life-cycle energy related costs. Energy solutions DEN should continue to pursue include:

1. Energy management awareness and training
2. Encourage use of additional renewable energy and sustainable alternative fuels
3. Building Commissioning/Recommissioning
4. Encourage the use of new and efficient support vehicle technology

Noise

Introduction

While noise exposure is directly caused by aircraft, airports are the stakeholders that actively address its impacts on the surrounding community. As part of the original DEN airport planning process and Environmental Impact Statement (EIS), several unique noise restrictions were developed by the airport operator and local municipalities under the 1988 Denver-Adams County InterGovernmental Agreement (IGA) and the Noise Exposure Performance Standards (NEPS):

- Annually, DEN must track noise levels at 101 "NEPS Points."
- Annually, DEN must track the 65 DNL contour to ensure it stays within the contours boundaries set in the IGA.
- Every 2 years, DEN must develop Noise Exposure Maps (NEMs) that comply with 14 CFR Part 150 guidelines.

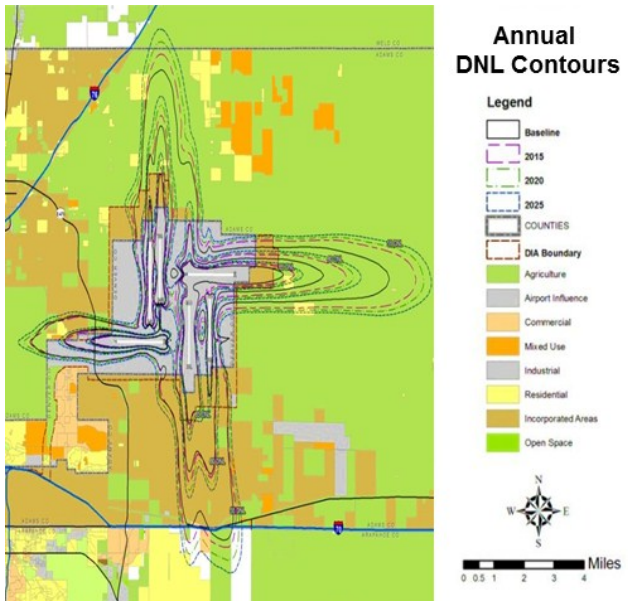
NextGen Noise Goal

Reduce the number of people exposed to significant noise around U.S. airports in absolute terms, notwithstanding aviation growth, and provide additional measures to protect public health and welfare and our national resources. Note: FAA's system level goals are not applied directly to airports, but can be used as a guide to contextualize noise from airports such as Denver International Airport.

Current State

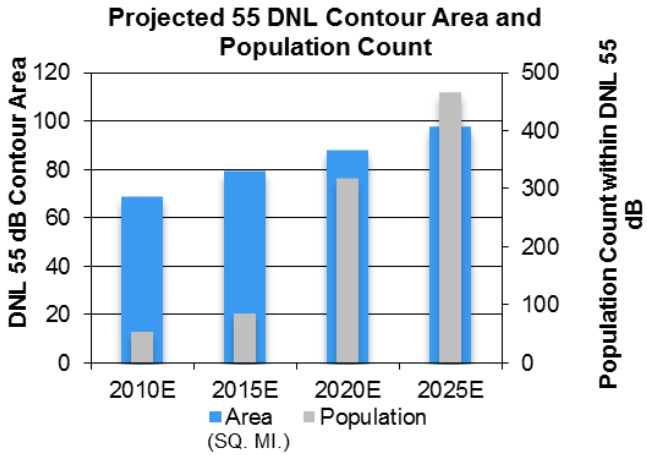
Approach: FAA Order 5050.4B, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Projects*, provides guidance for the consistent application of NEPA for airport projects. FAA Order 1050.1E, *Environmental Impacts: Policies and Procedures*, sets forth guidance on environmental impacts and the environmental review process. This Order specifies that noise exposure above a Day-Night Level (DNL) of 65 decibels (dB) or greater is considered to be a "significant impact."

Noise modeling analysis for the EMS Framework and Collaboration Pilot Study was conducted using two data sources. The primary data source was Integrated Noise



Model (INM) input data files used in the preparation of the *Denver International Airport 2010 IGA Noise Release Study.* This data included INM scenarios for baseline years 2009 and 2010, with relevant flight tracks, operations, fleet mix, and other INM input parameters. The secondary data source was the *Denver International Airport Master Plan Update Studies Phase II Baseline Activity Projections* report. The activity projections in this report were used as a comparison point to the 2010 IGA INM files. INM version 7.0b was used to compute DNL contours for the baseline year 2010.

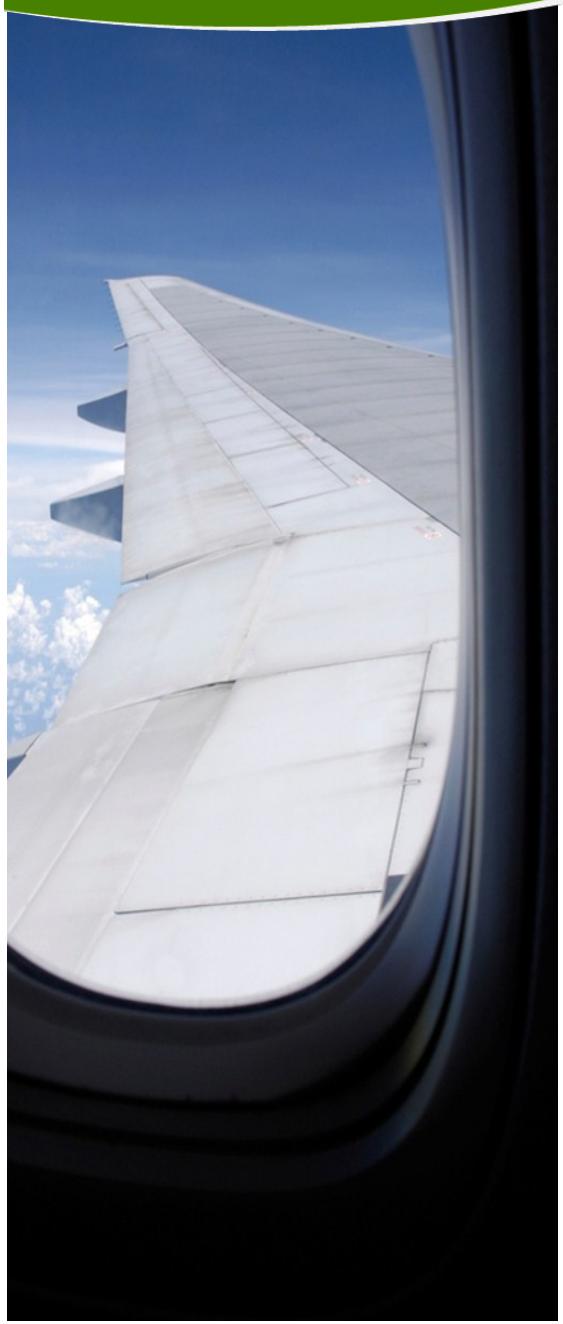
Key Trends: In the past 5 years, the population exposed to significant (above 65 DNL) noise at DEN has remained at zero. Because the population exposed to 60 and 65 DNL was low or none, the 55 DNL contour was added to show any noticeable trends.



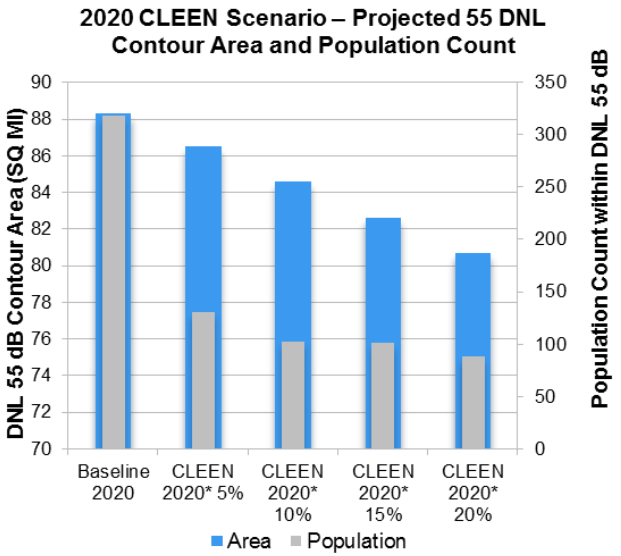
Future State

Approach: In order to define projected noise conditions for each of the years 2015, 2020, and 2025, assuming no incorporation of NextGen technologies or operations, Master Plan operations and fleet mix projections were applied to the 2010 baseline INM study. This process involved mapping the 22 generalized aircraft categories found in the Master Plan to the 59 specific aircraft types found in the INM study fleet mix. Using the DNL contours and underlying land use shown in the noise exposure map, the corresponding noise contour areas and population counts were determined using a Geographic Information Systems (GIS) analysis and Census population data. The Future State analysis assumes that the IGA remains in effect through this study period.

Noise



Potential NextGen Solutions



Approach: NextGen technologies evaluated for the pilot study were limited to CLEEN aircraft technology, assuming a 32 dB cumulative noise reduction at an aircraft level is achieved. The goal of this analysis was to investigate potential noise exposure reduction under several scenarios, reflecting different fleet insertion percentages of CLEEN technology.

Key Trends: CLEEN technologies have the potential to reduce the population exposed inside the 55 DNL contour in 2020 from 318 people to 88 people (with a lesser improvement in 2025 assuming no new runways are constructed).

Scenario Illustration: The bar graph illustrates a scenario in which up to 20 percent of the fleet at DEN has adopted CLEEN technologies in 2020. Note that impacts were calculated for the 55 DNL contour due to minimal to no population exposure at higher noise levels (60 to 65 DNL).

Potential Airport Improvement Opportunities

Population exposure above 65 DNL is projected to remain zero at DEN under all assessed scenarios; however, continued compliance with IGA and NEPS noise requirements are an increasing challenge given projected operations growth. Projected increases in noise exposure have the potential to lead to IGA and NEPS violations. Although NextGen will provide aircraft noise-reduction improvements via the CLEEN program, additional measures will be necessary to reduce noise impacts. These include continued FAA and industry efforts to advance new technologies and operational procedures as well as airport specific activities to address aviation noise. Airport specific measures can include:

1) Manage land-use encroachment via the established Noise Overlay District and local jurisdictions' compatible land use planning initiatives.

2) Continue to utilize public outreach (e.g. to prepare for ATM changes

3) Work with operations to develop and follow noise abatement practices

4) Continue to be involved in the development of Performance-Based Navigation (PBN) procedures.

5) Explore possible noise benefits of additional PBN routes.

Conclusion

Conclusion

Four NextGen environmental aspects were analyzed to determine their potential for contributing to NextGen Aviation Environmental and Energy goals and/or Federal, State, or Local requirements. Water quality was not studied in detail due to a lack of information from the Denver Metro Wastewater Reclamation District. The study findings include data from sources beyond those addressed in existing Aviation Environmental and Energy goals (i.e., it includes sources beyond the aircraft for climate and energy). The inclusion of this information and supporting analysis does not imply that other sources or environmental issues may be included in the Aviation Environmental and Energy goals where they are not already. A brief overview of aspect findings is listed below.

Air Quality: Potential constraints that may impact DEN in the future include the Clean Air Act permit that covers airport operations and conformance with the Colorado State Implementation Plan (SIP).

Climate: A combination of technology, alternative fuel, and operational improvement solutions are needed to mitigate anticipated increases in CO_2 emissions.

Energy: DEN will continue to be able to procure the energy for operations through 2025; however, emphasis should be placed on improved efficiency wherever practicable.

Noise: NextGen will provide aircraft noise-reduction improvements via the CLEEN program, but additional measures may be necessary to reduce noise impacts to comply with locally-specific noise constraints associated with the IGA.

Results

The results of this study are being used to inform the development of NextGen EMS Framework and Collaboration. By leveraging detailed examples and case studies, as well as direct stakeholder involvement during the development process, the implementation of NextGen EMS Framework and Collaboration will be compatible with on-going stakeholder environmental programs and initiatives, while encouraging the stakeholder community to collaborate and meet the Aviation Environmental and Energy goals.

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- Environmental Services
- Construction
- Operations
- Planning
- Noise
- Energy
- Geographic Information Systems
- Communications
- Engineering
- Commercial Air Service Development
- Real Estate

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Acronyms

ACRP – Airport Cooperative Research Program
AEDT – Aviation Environmental Design Tool
AEI – Air Emissions Inventory
ATM – Air Traffic Management
AvGas – Aviation Gas used in reciprocating piston engine aircraft
BMP – Best Management Practice
BTU – British thermal unit (a measurement of thermal energy)
CAA – Clean Air Act
CAAA-90 – Clean Air Act Amendments of 1990
CAEP – Committee on Aviation Environmental Protection
CLEEN – Continuous Lower Energy, Emissions and Noise
CNG –Compressed Natural Gas
CO – Carbon Monoxide
CO_2 – Carbon Dioxide
CO_2e – Carbon Dioxide Equivalent (represents all greenhouse gases converted into an equivalent of carbon dioxide using a Global Warming Potential (GWP) factor as designated by how much a specified gas heats the atmosphere relative to CO_2)
EDMS – Emissions and Dispersion Modeling System
dB – Decibel
DEN – Denver International Airport
DNL – Day/Night Average Sound Level
EMS – Environmental Management System
GAV – Ground Access Vehicle
GHG – Greenhouse Gas
O&G – Oil and Gas Facilities
O&G – Oil and Gas Facilities
GSE – Ground Support Equipment
HC – Hydrocarbons
ICAO – International Civil Aviation Organization
IGA – 1988 Denver-Adams County Intergovern-mental Agreement on a New Airport
INM – Integrated Noise Model
Jet A – Kerosene-based fuel used in jet and turbo -prop aircraft
kWh – kilowatt hours
LTO – Landing and Takeoff Operation
MMBTU – Represents one million Btu
Metro – Denver Metro Wastewater Reclamation District
MSW – Municipal Solid Waste
NAAQS – National Ambient Air Quality Standards
NEM – Noise Exposure Maps
NEPA – National Environmental Policy Act
NEPS – Noise Exposure Performance Standards
NextGen – Next Generation Air Transportation System
NOx – Nitrogen Oxides
O&G – Oil and Gas Facilities
PBN – Performance-Based Navigation
PM_{10} – Particulate Matter less than 10 micrometers in diameter
PG – Propylene Glycol
POTW – Publicly Owned Sewage Treatment Works
SIP – State Implementation Plan
SOx – Sulfur Oxides
VALE – Voluntary Airport Low Emissions Program
VOC – Volatile Organic Compounds