Chapter 5

Ridership and Revenue

Introduction

As is the case with many transportation programs, the forecasts of ridership and revenue for the California high-speed rail (HSR) system continue to be the subject of extensive review. Areas of focus and scrutiny include the model used to generate the forecasts, the assumptions and data used as inputs to the model, and the results of the modeling. In preparing the forecasts for the Revised 2012 Business Plan (Revised Plan), a number of steps have been taken to respond to questions and comments and to continue to improve the reliability of the forecasts. Those steps are presented in this chapter and include the following:

- Further findings and recommendations of the independent Ridership Peer Review Panel based on the August—December 2011 review period have been included.
- Inputs to the model have been updated and refined to use recent data and to reflect a broader range of scenarios, including recent gasoline price forecasts from the Energy Information Administration (EIA).
- A wider range of ridership and revenue forecasts have been introduced to better incorporate possible outcomes presented in three ridership/revenue scenarios developed for the Business Plan—High, Medium, and Low.
- Post-model adjustments have been eliminated to reduce the potential for error, bias, or inconsistency.
- The model has been tested against actual conditions and external forecasts and demonstrated its reliability.

> **The Peer Review Panel reviewed the inputs used in these different runs and endorses the ... reports as providing a good perspective on the reasons for the difference in the expected CHSR ridership compared to the Acela-NEC ridership. The panel endorses this report as a excellent indication that the ridership estimates ... in support of the 2012 Business Plan are reasonable, possibly even conservative.**
>
> *Frank S. Koppelman, Chair Ridership and Revenue Peer Review Panel, January 17, 2012*

An important step forward in demonstrating the viability of the model and the reliability of its outputs was to use it to test actual circumstances in the Northeast Corridor. To do that, the Authority developed a California HSR scenario that has service levels comparable to those offered by Acela service between Washington D.C. and Boston. The model forecasts 2.7 million annual interregional riders on California HSR with Acela-like service in 2008, which is 79 percent of the ridership on the Acela in 2008. A comparison of mega-region population shows that the California HSR corridor had 76 percent Northeast Corridor population in 2000. The outcome therefore could be explained by the difference in population between the corridors.

Another important aspect that has been considered is the actual performance of high-speed rail and other systems against their forecasts. A 2003 Cambridge University report identified some common elements in projects that failed to reach forecast results, such as an optimistic assumption of a particular event that would lead to higher ridership. To mitigate the risks related to optimistic bias and variations in the system environment, a wider range was defined for the Business Plan scenarios that were developed for the Revised Plan.

These and other lessons were considered in developing the ridership and revenue modeling for the California HSR program. Accordingly, there is no such reliance on singular and unsubstantiated factors such as an assumed spike in gasoline prices. Key inputs that are drivers of ridership, such as fuel prices, airline ticket prices, and population, are all conservative and based on external sources.

Additional information on the ridership estimates in this Revised Plan is available in the Technical Memoranda *California High-Speed Rail 2012 Business Plan, Ridership and Revenue Forecasting* and the *California High-Speed Train Ridership and Revenue Model Development, Application, and Project-Level EIR/EIS Forecasts,* which can be accessed at www.cahighspeedrail.ca.gov/business_plan_reports.aspx.

Approach/methodology

Ridership and revenue forecasts have been the focus of extensive discussion and debate. To provide independent assessment of the modeling and to improve the reliability of the forecasts, the Authority convened a panel of international experts in travel forecasting to examine and guide the forecasting effort. The Peer Review Panel (Panel) directly reports to the Authority's Board of Directors and its members are under no contractual relationship with other Authority consultants involved in ridership in order to guarantee their free judgment and independence. The Authority commissioned the Panel to perform three basic functions:

- First, the Panel evaluated data collection and model development used to support the forecast work performed to date that supported past planning and environmental work. Due to the level of debate surrounding forecasting (including model development and data collection), a rigorous review was conducted on issues of potential concern.
- Second, the Panel focused on guiding further work being performed to produce a range of scenarios to be used in the current Revised Plan forecasts. As a normal process, forecasting depends on continued refinement of data and modeling function to address increasingly complex needs.
- Third, as a next step, the Panel is providing advice on further improvements to the forecasting model to support future decision making on initial operating sections and public–private investment strategies. These improvements will provide greater levels of detail but will not impact the overall results presented in this Revised Plan.

> **The California High Speed Rail Authority established a Peer Review Panel for travel demand forecasting in January 2011. It was broadly charged with providing a detailed and independent appraisal of the ridership and revenue forecasting process used by the Authority and to guide its evolution. Since then the Panel has critically reviewed scores of documents and working papers, forecasting results, and their interpretations. Careful attention has been paid to issues identified by the Panel during its first meeting. The Panel's principal findings have been documented in three reports issued since their formation. As documented in its second and third reports, the panel found that the modeling system is satisfactory for the system wide and IOS ridership forecasts, the most recent of these being the development of forecasts supporting the evolving 2012 Business Plan. Some data and methodological issues have been identified for enhancement; many of these have already been addressed by the contractor. There is no evidence that the remaining issues pose significant risks to the forecasts or plans developed using them.**
>
> *Ridership Peer Review Panel—April–December 2011 Review Period*

Charged with leaving "no stone unturned," the Panel first met in January 2011 to review the initial data collection and model development, as well as assumptions about future travel conditions. It was important to consider recent critiques by others, and the Panel initiated its own rigorous assessment of potential deficiencies or areas deserving further consideration. As a result, the Panel developed an extensive list of issues to be investigated and requested complete documentation of inputs and model validation results.

In response to the Panel's list of issues, detailed documentation on the behavior of the existing model was provided as it continued work through July 2011. During this six-month period, thousands of hours were invested by the Panel, Authority staff, and the consultant team to support this effort. As a consequence of this very detailed testing and review, the Panel concluded in its April–July 2011 Review Period Report that the existing model:

- Behaves reasonably
- Produces results within expected ranges
- Is suitable for use in preparing environmental documents and current business planning

In the August—December 2011 review period, the Panel focused on the use of the model in forecasting by examining some of the key inputs and assumptions and assessing the sensitivity of the model to changes in them. This examination was made within the context of the forecasts used to support the

Draft 2012 Business Plan (Draft Plan) and the Revised Plan. The Panel has also carefully considered the criticisms published by others and researched those aspects of the model more closely.

The Panel supported the work in updating the state travel data in the following areas:

- Airfares and frequencies were updated to reflect the expansion of low-cost airlines to nearly all of the state's major markets.
- Recent long trip-making patterns in the current slow economic conditions were inventoried through a 15,000 person on-line survey in May 2011.
- The price of gasoline and fuel efficiency assumptions have been revisited, including a very low U.S. government gasoline price forecast in the range of the Business Plan scenarios.
- Conventional rail service was updated to reflect current fares and schedules.

Other adjustments made in preparing the forecasts included the following:

- Based on advice from European, Japanese, and South Korean operators and government agencies, the train frequencies were reduced to maintain higher load factors on the remaining trains and[1] to reflect capacity constraints in shared corridors.
- Socioeconomic data were updated with post-recession state forecasts using well established financial sources such as Woods & Poole and Moody's analytics.
- The impact of adding dedicated, high-quality bus coach feeder service to Merced from Sacramento and from Bakersfield to the Los Angeles area, and various service changes to improve operational load factors were added.

Ridership Peer Review Panel Members represent an independent international panel of respected experts.

Dr. Frank Koppelman, (Chair) Northwestern University, Professor Emeritus, Department of Civil Engineering

Dr.-Ing. Kay Axhausen, Swiss Federal Institute of Technology, Zurich, Institute for Transport Planning & Systems, Full Professor & Director; Editor-in-chief "disP" 2008–11, Editor "Transportation" 2005-present; current editorial board member of "Transportation Research" and "Journal of Choice Modelling"

Dr. Eric Miller, University of Toronto, Professor, Department of Civil Engineering; Chair, International Association of Travel Behaviour Research, 2008-Present; Editorial board member of "Journal of Transport and Land Use" and of "Transport Reviews," 2008-Present

Dr. Kenneth Small, U.C. Irvine, Professor Emeritus, Department of Economics; Current Fellow, Resources for the Future: Editorial board member of "Journal of Urban Economics," "Journal of Transport Economics and Policy," and "Transportation"

Through its extensive analysis, the Panel concluded that the model is appropriate for business planning purposes and provides a sound basis for additional model development to support future forecasting needs. This represented a significant milestone in validating the integrity of the present forecasting model and establishes the current model system as a reliable and valuable tool for the state in its assessment of the high-speed rail program.

With the guidance resulting in a much higher degree of confidence in the model's function, ridership forecasts were prepared using the updated assumptions. As described below, and consistent with statutory requirements associated with the Business Plan, High, Medium, and Low forecasts were prepared. The Business Plan High and Low forecasts resulted from model runs with optimistic and conservative entry parameters, respectively. These forecasts thus represent reasonable High and Low Scenarios. The Business Plan Medium forecast was derived from the average of these two model runs, rather than a separate run of the model with more moderate assumptions. Consistent with the implementation plan described in Chapter 2, The Implementation Strategy: Blending, Phasing, Investing in Early Benefits, forecasts were prepared for each of the implementation steps up through Step 4, the completion of the Phase 1 Blended system.

The model was set up to produce ridership projections for 2030 for each implementation step. To support financial planning efforts associated with this Business Plan, the 2030 forecasts were decreased by 1 percent per year to produce estimates for the years 2022 to 2029. To produce forecasts for the years 2031 to 2060, the 2030 forecasts were increased by 0.5 percent per year. These rates are based on the changes in results among three test forecasts using post-recession population and demographic information for the years 2020, 2030, and 2050. For each implementation step, a ramp-up assumption was developed to reflect the time it would take to reach full market potential.

Scenarios and specific assumptions

A 2003 Cambridge University report[2] revealed that ridership forecasts frequently exceed actual observed demand. In almost all cases, the gap between actual and forecasted demand was due to the inability to predict variations in the following model parameters:

- Overall passenger market (i.e., the population and socioeconomic data)
- Response from competitive modes on price (e.g., budget airlines)
- Changes in gasoline price and subsequent cost of driving
- General level of service (e.g., frequency, accessibility, connectivity, comfort, and reliability)

To mitigate the risks related to market estimation issues and optimism bias, it is best practice to develop a set of scenarios (High, Medium, and Low) that provide a range of assumptions derived from key input variables. In addition, a significant step has been taken for the Revised Plan to reduce the potential for error, bias, and inconsistency. Adjustments that previously had been made post-model run (population adjustment, service plans, contingencies, etc.) have been included in the ridership and revenue model or are now part of the input range.

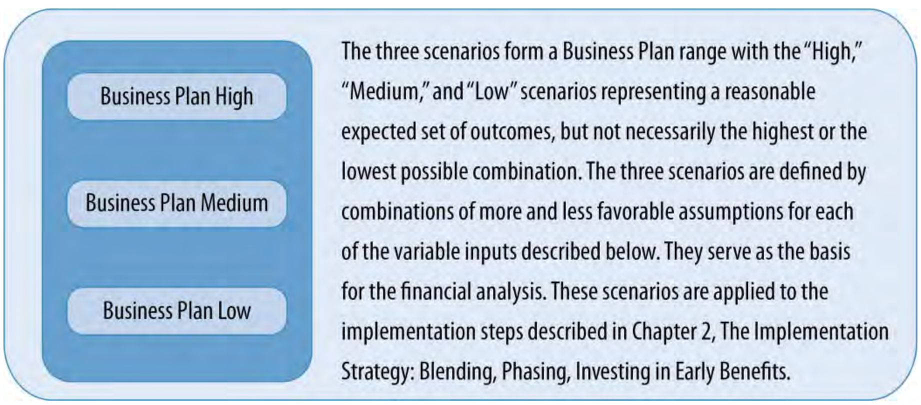
The High range of the forecast presents an optimistic but realistic prediction of the model entry parameters, while the low range depicts a very conservative but realistic view of how input parameters could evolve in the forecasting horizon.

This section describes the specific inputs and assumptions used to prepare the ridership and revenue forecasts. It also includes the scenarios developed for testing their sensitivity to a range of key inputs and assumptions, including the following:

- Socioeconomic data
- Trip-making patterns/types of trips taken (e.g., long/short, commute/recreation)
- Gasoline prices and auto fleet efficiency
- Airfares

The three ridership and revenue scenarios shown in Exhibit 5-1 were created to develop a reasonable range of forecasts under a range of inputs and assumptions. As described below, the modeling work conducted for this Revised Plan takes a deliberately conservative approach. This was done to minimize the risk of inflated results for use in the financial plan.

Exhibit 5-1. Ridership and revenue scenarios



Key inputs

Socioeconomic projections

The recession of 2007–2009 dampened expectations regarding future socioeconomic growth. State and local agencies are currently developing updated 2035 forecasts that will reflect the downturn in the economy, but those forecasts are not yet available.

The forecasting work developed for this Revised Plan is based on socioeconomic projections that reflect the best readily available information from independent sources. Population and household growth and employment growth are the two factors used in the model to reflect future socioeconomic variations. Two forecasts were developed—one representing higher potential ridership conditions based on stronger socioeconomic growth and one representing lower ridership conditions based on more conservative socioeconomic growth. The basis for these forecasts is as follows:

- Business Plan High—Based on 2030 Woods & Poole Forecasts
- Business Plan Low—Based on 2030 Moody's Analytics Forecast
- Business Plan Medium—Scenario lies midway between the Low and the High

Exhibit 5-2 presents the growth predicted by both sources for household and employment in 2030.

Exhibit 5-2. Summary of socioeconomic projections for Business Plan Scenarios

2030 Forecasts	Households Forecasts (in millions)	Employment Forecasts (in millions)
Pre-recession Forecast	16.9	22.6
Woods & Poole	16.8	21.3
Moody's Analytics	15.5	17.3

Trip-making patterns in California

Patterns in trip-making are also a key input into the ridership and revenue forecasts. Assessments are made as to what kinds of trips are taken, with what frequency, and by what mode. This information is used with other factors to project future travel patterns and to distribute trips among various modes of transportation. How often long-distance trips are made and for what purpose have been estimated for both before and after the recession. The results of the May 2011 online survey indentified changes in trip patterns. The *proportion* of long-distance commuter trips was significantly lower in the post-recession survey, whereas there was an increase in personal and "other" trips.

This change in trip pattern resulted in a lower HSR forecast since personal and other trips, unlike business trips, tend to be made by groups who prefer to drive. It is unclear whether this trend represents a long-term change or is a product of the current economic climate.

To fully test input assumptions, the Business Plan High Scenario uses the *pre*-recession mix of trips, which is characterized as "favorable" to high-speed rail. The Business Plan Low Scenario uses the *post*-recession 2011 results and is characterized as "unfavorable." The Business Plan Medium Scenario lies midway between.

Driving costs, gas prices, and fuel efficiency

The cost of driving is significantly influenced by the price of gasoline, which has been extremely volatile in the last several decades. In turn, the cost of driving has a significant impact on what mode of transportation people take. The less expensive, the more likely they are to drive; the more expensive, the more likely they are to take alternative transportation.

The U.S. Energy Information Administration (EIA) provides updated motor gasoline forecasts out to year 2035 for three different scenarios in its 2011 Annual Energy Outlook. The spread between the Low and High forecast for 2030 is considerable—from $2.34 for the Low Scenario to $5.49 for the High Scenario in 2011 dollars—which is a spread of over three dollars. This spread is greater than those developed by other sources, such as the California Energy Commission which forecasts a range of about $3.23 to $5.00 in 2011 dollars. Historically, California retail gasoline prices have been 12 percent higher than the U.S. average as noted by the EIA.

In response to earlier comments and suggestions to include a very conservative price of gasoline in the range of the ridership and revenue forecasts, a projection of California gasoline prices was developed by taking the EIA 2030 High and Low forecasts and increasing them by 12 percent to reflect California's historically higher prices. Exhibit 5-3 shows the prices expressed in 2011 dollars.

Exhibit 5-3. Forecast 2030 gasoline price in California (2011 dollars)

Description	Low	Reference	High
Gasoline Price Forecast	$2.60	$4.23	$6.11

Source: EIA Forecast for 2030 and Analysis of California Prices

The EIA also provides projections on fuel economy (miles per gallon (mpg)) for light-duty vehicles (LDV) through year 2035 for a Reference case plus two other cases based on faster growth variations of the Corporate Average Fuel Economy (CAFE) Standards. These last two forecasts assume a faster achievement of the CAFE Standards and are referred to as CAFE +3 percent and CAFE +6 percent. (CAFE Standards are regulations intended to improve the average fuel economy of cars and light trucks (trucks, vans and sport utility vehicles) sold in the United States.

Exhibit 5-4 shows the fuel economy projections for the Reference, CAFE3, and CAFE6 cases, as well as an average between CAFE3 and CAFE6 for the entire fleet of vehicles (not just new vehicles).

Exhibit 5-4. Projections of fuel economy of light-duty vehicles

	Light-Duty Stock[1] (mpg)			
	Reference	3% LDV fuel economy growth	6% LDV fuel economy growth	Average of 3% and 6% Fuel Economy Growth
2015	22.1	22.1	22.1	22.1
2025	25.7	28.6	30.2	29.4
2030	**27.0**	**31.8**	**35.3**	**33.6**
2035	27.9	34.0	39.4	36.7

Source: Annual Energy Outlook 2011, Transportation Sector Key Indicators and Delivered Energy Consumption

[1]Combined "on-the-road" estimate for all cars and light trucks

The 2030 auto operating cost estimates for the High, Medium, and Low Business Plan Scenarios incorporate the fuel component described above and a non-fuel component representing normal wear and tear associated with the operation of a car (tires, maintenance, etc). The non-gasoline operating costs are likely to be less volatile than fuel prices, so it is reasonable to keep this as a constant amount, modified only by inflation over time. Exhibit 5-5 presents the range of auto operating costs used to develop the High, Medium, and Low Scenarios for this Revised Plan, including both fuel and non-fuel components. The Low Scenario includes the very conservative EIA gasoline price forecast of $2.60 in 2030.

Exhibit 5-5. 2030 auto operating cost assumptions for Revised Plan (2011 dollars)

Business Plan Scenario	Low	Medium	High
Motor gasoline	$2.60	$4.23	$6.11
Fuel efficiency (mpg)	27.0	30.3	33.6
Gas operating cost ($/mile)	$0.10	$0.14	$0.18
Non-gasoline operating cost ($/mile)	$0.10	$0.10	$0.10
2030 auto operating cost ($/mile)	**$0.20**	**$0.24**	**$0.28**

Based on these assumptions, the Revised Plan Scenarios include a wide range of auto operating costs—from $0.20 to $0.28 per mile in 2030. The incorporation of this broader range in the ridership and revenue forecasts responds to comments and questions received regarding the forecasts developed for the Draft Plan and is intended to ensure that they are more reliable and conservative. The midpoint is slightly below the current statewide average for gasoline in California.

Airfares

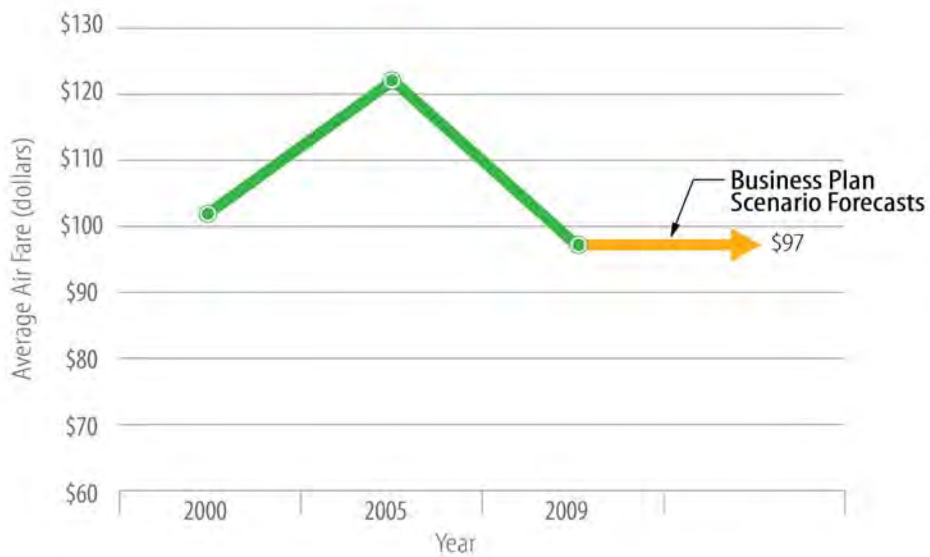
The potential range of airfares used to develop the ridership forecasts was based on an industry expert review by Aviation System Consulting, LLC, of recent and long-term trends in airfares in California markets, expected fuel costs, and historical changes as airports face capacity constraints. Key observations include the following:

- With low-cost air carriers (Southwest, Virgin America, and JetBlue) heavily present in all airport pairs, airfares are unlikely to decrease significantly.
- Capacity constraints on the region's airports and continued growth in long-distance demand will shift many airlines' priority to trans-continental and international flights, adding premiums to the remaining shorter distance intrastate flights.
- Air travel will become less predictable as weather and other delays are exacerbated by airport capacity constraints, despite additional planned investment in modern air traffic control systems.
- Jet fuel accounts for more than 30 percent of the operating costs for domestic U.S. airlines, but increases in fuel efficiency will offset price increases.

> **We believe that California is a market very well suited to High-Speed Rail (HSR) as it has several major population centers which could be connected by faster end-to-end train journey times than are possible by car. On some routes it would also provide a good alternative to air travel. The ridership potential and the scope to make a significant contribution to CO2 reduction are therefore substantial.**
>
> *Virgin Rail Group (RFEI submission)*

Exhibit 5-6 shows past trends in the average airfare between the San Francisco Bay Area and the Los Angeles Basin and the fare assumed in the scenarios.[3] Sensitivity analyses were undertaken using the high and the low airfare variations. Aviation System Consulting determined a low fare scenario with a 9 percent reduction in real fares from the 2009 level, and a high fare scenario of 16 percent over the 2009 level. It was determined that using the range of scenarios presented in the referenced aviation report resulted in an upward bias. That is, it drove the Medium Scenario to be on the optimistic side. To be conservative, it was therefore decided that all three Business Plan Scenarios assume that airfares stay constant at 2009 levels. This has the effect of making air more competitive with high-speed rail and thereby constraining projected HSR ridership levels.

Exhibit 5-6. Average airfare: Los Angeles Basin to San Francisco Bay Area (2011$)



For purposes of evaluating the three Business Plan Scenarios (High, Medium, and Low), airfares are assumed to remain constant at 2009 levels. The 2009 airfare was inflated to 2011 prices for consistency in the year price shown in the Business Plan.

Summary of Business Plan Scenarios

All three Business Plan Scenarios assumed that airfare between Los Angeles and San Francisco will be $97 (one way in 2011$). Gasoline prices and fuel efficiency have been integrated in the range. Two separate sets of socioeconomic data—one more favorable to HSR and one less favorable to HSR—are used as part of the High and the Low Scenarios. In sum, the variable inputs used for the Business Plan Scenarios are summarized as follows:

- **Business Plan Low Scenario**—Assumes a very conservative driving cost equivalent to $2.60 gasoline price per gallon, $0.10 non-gasoline operating cost per mile, and a 27 mpg fuel efficiency in 2030. Socioeconomic forecasts from Moody's Analytics generating lower ridership conditions and less favorable trip-making patterns derived from the June 2011 trip survey.
- **Business Plan High Scenario**—Assumes a high driving cost equivalent to $6.11 price per gallon of gasoline, $0.10 non-gasoline operating cost per mile, and a 33.6 mpg fuel efficiency in 2030 derived

from the EIA forecast. Socioeconomic forecasts from Woods & Poole generating higher ridership conditions and favorable trip-making patterns derived from the initial trip survey.

- **Business Plan Medium Scenario**—Derived from the average of the High and Low Scenarios rather than a separate run of the model using intermediate assumptions.

Assumptions common to all scenarios and phased implementation steps

Total trips

In 2000, about 500 million trips were made each year among regions in California, the majority of them by car, with 20 million trips by air and 4 million by existing intercity rail services. With population growth and changes in demographics, overall inter-regional trip making is expected to continue to grow by approximately 64 percent to 2030, reaching 900 million trips.[4] Over the same period, the rate of growth in highway capacity is not projected to keep pace with travel demand, which will make long-distance trips made by car slower with less reliable travel times.

Rail passenger fares and speeds

For the purposes of this analysis, existing intercity Amtrak passenger rail fares and travel speeds are assumed to remain at 2011 levels.

High-speed rail fares

Fare levels are assumed to be comparable to those of other HSR services world-wide—somewhat below current airfares in the longer distance travel markets and well above the out-of-pocket cost of driving in the shorter distance travel markets. A comparison of international HSR system fares would not provide a sound basis to set the California HSR system pricing, as too many structural factors inherent in the HSR system make a "like-for-like" comparison very complex. The appropriate fare level will need to consider direct competition from air and road travel, as well as system service costs (see chapter 6, Operating and Maintenance Costs). The ridership forecast assumes a HSR average fare at 83 percent of 2009 airfare levels between Los Angeles and San Francisco, which reflects the maturity of the California air market in terms of passenger capacity and the number of airlines and budget airlines. A comparison of HSR fare levels in Spain, France, Germany, and Japan relative to airfares indicates that this assumption is reasonable and most likely to accurately project market behavior. The primary objective associated with the assumed fare structure is to maximize passenger revenues and the net cash-flow from operations.

As is the case with high-speed rail service around the world today, and is the case with airfares as well, California high-speed rail fares will vary by the following:

- **Time of day**—Peak vs. off-peak
- **Class of service**—First class vs. coach
- **Travel time**—Express/limited-stop vs. "making all stops" service
- **Timing**—How far in advance tickets are purchased[5]

Just as with flying today, high-speed rail travelers with more flexible schedules or limited budgets could save money by booking well in advance or traveling in the middle of the day when trains are less crowded. Travelers who have to make last-minute bookings and need to take express trains or travel during peak periods will typically pay a higher fare.

Exhibit 5-7 illustrates how fares might vary around the average fare that was assumed for all forecasts within the model. HSR fares for stations such as Sacramento or San Diego that are not directly served in Phase 1 Blended include the cost of rail or dedicated feeder service to reach the HSR system at the most convenient station.

Exhibit 5-7. Example of HSR fares (2010$ one-way)

Station-to-Station	Buy-ahead, Off-peak, and/or Multi-stop Train	Average Fare Assumed in Forecast	Last-minute, Peak, and/or Express Train
San Francisco–Los Angeles	52	81	123
San Jose–Anaheim	52	81	123
Fresno–Millbrae	41	64	97
Sacramento–Fresno	45	71	107
Los Angeles–Kings/Tulare	42	66	100
Bakersfield–Merced	39	62	93
Palmdale–San Diego	46	57	73

To generate more conservative forecasts, the expected positive effects on revenues of this type of flexible “capacity management pricing” are not included in this forecast. Future upgrades of the ridership and revenue model will allow closer approximation of capacity management pricing to better capture potential positive net operating profit opportunities.

HSR schedules and travel times

Along with fares, the most important factors affecting the forecast relate to the quality of the service. This service focuses primarily on the travel time (how long the trip takes) and schedule (how frequent is the service). The forecasts for each implementation step are based on a schedule of train departures and a pattern of station stops that determine the frequency of service and how long the trip will take.

For the Phase 1 Blended service, up to four trains per peak hour are assumed to operate between Los Angeles and San Francisco. Two additional trains per hour would run between San Jose and Los Angeles as well as two trains between Merced and Los Angeles. In total, eight trains per hour circulate between north and south California in the peak hours.

This schedule allows one train per hour to operate as an “express/non-stop” from Los Angeles to San Francisco. This service level also assumes that there are other limited-stop trains that run express between other major markets.

The remaining "regional/local" trains would serve a multiplicity of intermediate points to maximize connectivity. Hourly service is also assumed in the forecast between Merced, Los Angeles, and points in between. In the off-peak hours, service is less frequent.

For the initial operating segment and the Bay to Basin, the schedules are less frequent because of lower expected travel demand.

For the Phase 1 Full Build service, if constructed, one additional train in the peak would run between Los Angeles and San Francisco. On the south end, three of the nine trains would continue past Los Angeles to Anaheim.

Ridership "ramp-up" period

Whenever high-speed rail systems are implemented, it takes time to reach their full market potential. (i.e., ridership grows or ramps-up over time), as shown in Exhibit 5-8. In developing its ramp-up assumption for the ridership forecast, the Authority learned from international experience (see additional discussion below). For the California HSR forecast, a five-year ramp-up of ridership and revenue was assumed after each of the implementation steps is opened for revenue service according to the following schedule:

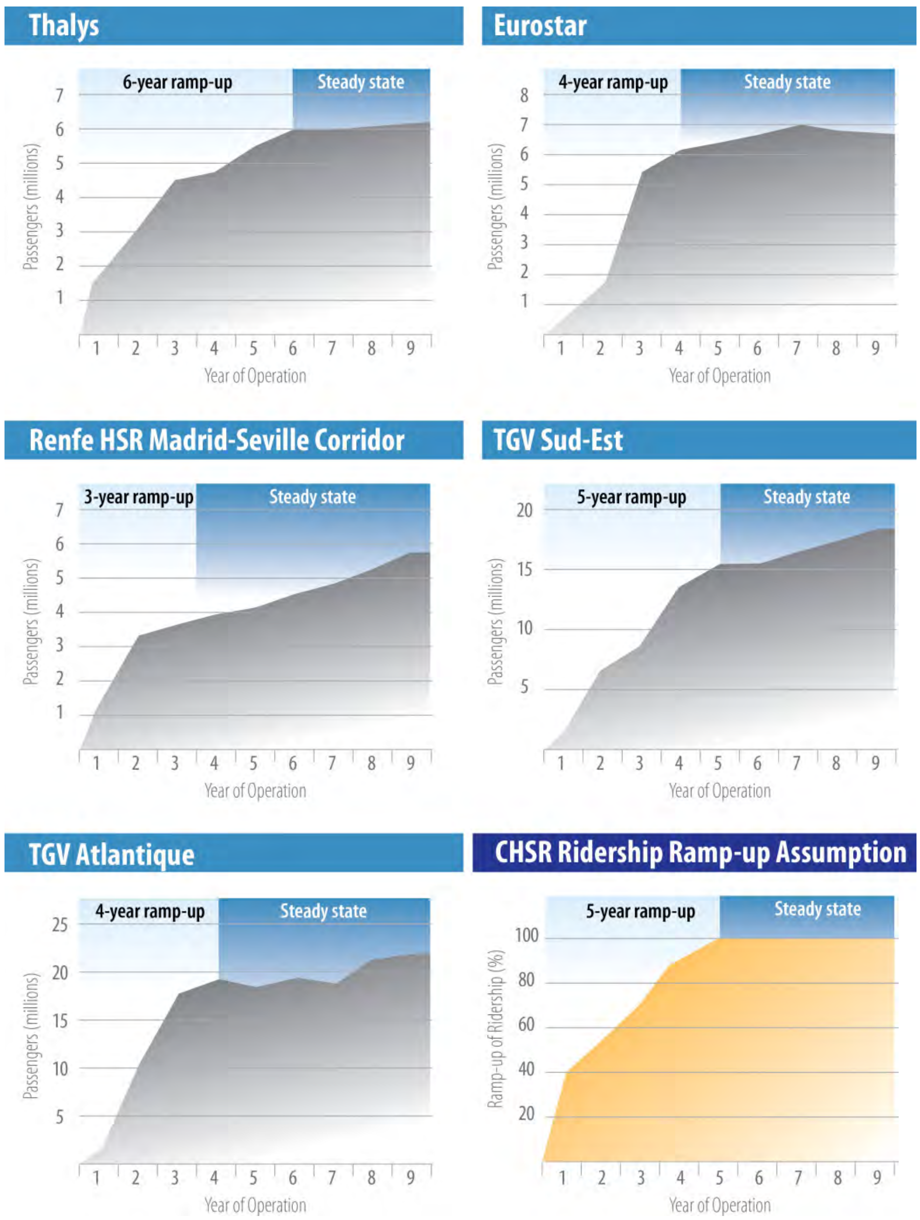
- 40 percent of the long-term ridership potential is achieved in year 1
- 55 percent in year 2
- 70 percent in year 3
- 85 percent in year 4
- 100 percent in year 5

Results

Given the importance of ridership and revenue to the underlying financial plan and the ability to accurately project operating performance and attract private-sector capital, a principle of conservative choices has been used to develop the forecasts for the Business Plan. The use of an independent peer-review panel builds transparency and validation for model development. The use of post-recession population growth and trip-making patterns reflected today's economic realities. In developing this Revised Plan, an even more conservative gasoline price forecast from the EIA has been incorporated to provide a wider range of results and to develop a Low Business Plan Scenario that allows for greater uncertainty in future conditions. Simply put, the goal was to use approaches, methodologies, scenarios, and assumptions that improve the level of confidence and reduce financial risks.

It is important to be able to consider the ridership projections in context. California's large population creates tremendous demand for mobility, and the usage levels of the state's many and diverse transportation systems demonstrates this fact. Some perspective on the ridership projections for California can be gained by comparing the markets that the statewide high-speed rail system will serve with markets being served by systems around the world. The Spanish HSR system serves cities with a combined population of 7.9 million people and has annual ridership of 10 million; the French system serves a combined 15.1 million people and generates 31 million annual riders. California's system will serve a population base projected to be over 49 million in Phase 1 Blended. This comparison is not, in and of itself, dispositive, but it uses actual data to show the ridership levels that can be generated from given population levels.

Exhibit 5-8. Examples of ridership growth (ramp-up) in European HSR systems



Another perspective can be gained by considering the ridership levels of existing public transportation systems in California. Exhibit 5-9 shows 2010 ridership levels for various transit systems throughout the state in areas that will be served by the statewide HSR system. These results show clearly that there is very high demand for and usage of public transportation in California, both in metropolitan regions and in the Central Valley, in spite of difficult economic times.

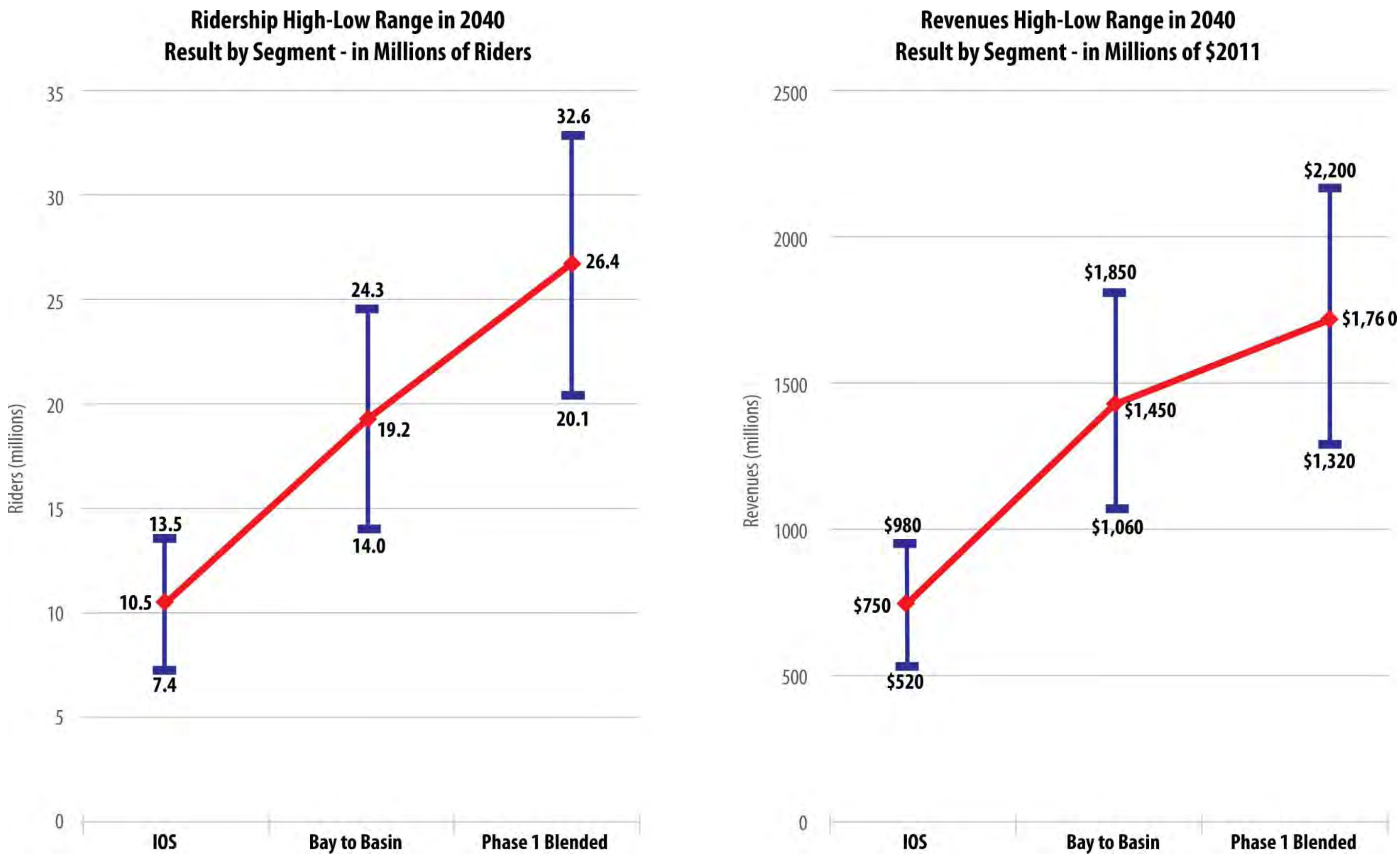
Exhibit 5-9. California transit systems 2010 ridership (in millions of riders)

Transit Agency	2010 Ridership
Los Angeles County Metropolitan Transportation Authority (LA Metro)	453.8
San Francisco Municipal Railway (Muni)	209.5
San Francisco Bay Area Rapid Transit District (BART)	108.3
San Diego Metropolitan Transit System	79.0
Orange County Transportation Authority	53.8
Santa Clara Valley Transportation Authority	42.1
Santa Monica Big Blue Bus	20.2
Sacramento Regional Transit District	14.4
San Mateo County Transit District	13.7
Fresno Area Express	13.3
Peninsula Joint Powers Authority Board (Caltrain)	12.2
North Coast Transit District, San Diego	11.1
Southern California Regional Railroad Authority (Metrolink)	10.5
Golden Gate Bridge, Highway and Transit District	8.6
Golden Empire Transit District	7.0
Visalia City Coach	1.5

Source: Public Transportation Ridership Report, Fourth Quarter 2010. American Public Transportation Association. www.apta.com/resources/statistics/Documents/Ridership/2010_q4_ridership_APTA.pdf)

Exhibit 5-10 shows the annual Low and High ridership and revenue forecasts for each of the implementation phases starting with the Initial Operating Section (IOS), advancing to the Bay to Basin system, and finally to the Phase 1 Blended system between San Francisco and Los Angeles/Anaheim. The results are shown for year 2040 and the revenues are shown in 2011 dollars.

Exhibit 5-10. Ranges of ridership and revenue across all Business Plan Scenarios and phases



Why are the Business Plan ridership forecasts different than the ridership forecasts in the Draft Environmental Impact Report/Draft Environmental Impact Statements (EIR/EIS)?

The ridership forecasts presented in this chapter represent a cautious view of future use of the HSR system for purposes of developing a conservative investment-focused business plan. The Draft EIR/EISs, on the other hand, present a more optimistic view of future use of the HSR system for purposes of the environmental analysis. As discussed in more detail at the end of this chapter, these two different purposes for ridership forecast lead to different results.

Ridership and revenue projections

This section illustrates the projected ridership and revenues of the system. For the purpose of the cash-flow analysis presented in Chapter 7, Financial Analysis and Funding, the ridership and the revenue projections are presented from IOS through Phase 1 Blended. The High, Medium, and Low ridership and revenue scenarios are illustrated. The segments are placed into operation as shown on the schedule in Exhibit 5-11.

Revenue projections are presented in 2011 dollars and in Year-of-Expenditure (YOE) dollars to show the effect of growth and the impact of inflation. HSR ticket prices are assumed constant and are only increasing with inflation over time.

Exhibit 5-12 shows the projected ridership for the High, Medium, and Low Ridership Scenarios in millions from IOS through Phase 1 Blended.

Exhibit 5-11. Schedule by section

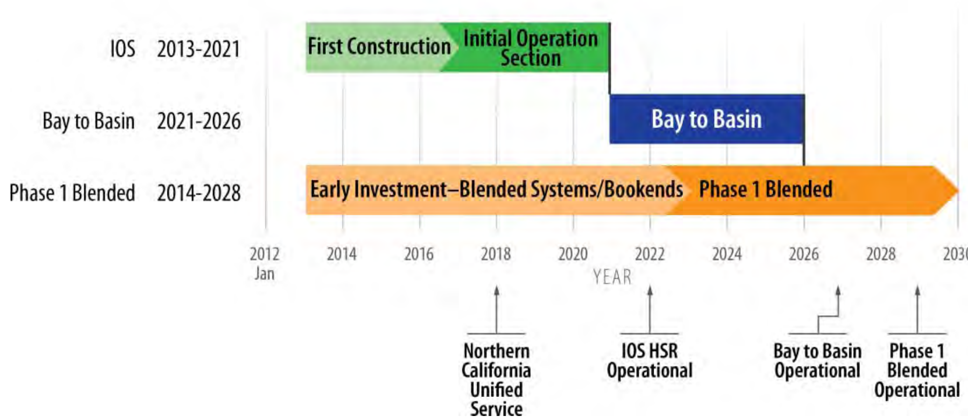


Exhibit 5-12. Ridership, IOS through Phase 1 Blended (in millions)

Ridership	2025	2030	2035	2040	2045	2050	2055	2060
High	10.5	26.8	31.8	32.6	33.4	34.3	35.1	36.0
Medium	8.1	21.4	25.7	26.4	27.0	27.7	28.4	29.1
Low	5.8	16.1	19.6	20.1	20.6	21.2	21.7	22.2

All revenues were provided in 2011 dollars. Inflation for 2012 is assumed to be 1 percent, 2013 through 2015 is 2 percent per year, and 3 percent per year is used for 2016 forward. These rates have been estimated based on multiple sources, including the California inflation forecast data provided by California Department of Finance, ENR Construction Cost Index historical and forecast indexes, and medium/long-term federal inflation targets.

In addition to revenue from ridership, rail and transit systems around the world generate additional revenue from ancillary services and uses of assets. For the California HSR, such revenues will relate to stations, advertising, and use of right-of-way for services such as cell phone towers. Much of the station revenue will be controlled by cities and local governments. However, several categories of revenue will be available to help fund HSR operations and capital needs. These include retail, naming rights, renewable energy, cell towers, and advertising.

Other international high-speed services collect actual ancillary revenues ranging from 1 percent to 37 percent with an average of 13 percent of revenues. Based on review of the potential revenues in California, the Planning Case includes 1 percent of revenues from ancillary sources.

Exhibit 5-13 shows the projected revenues for the High, Medium, and Low Scenarios in 2011 dollars from IOS through Phase 1 Blended.

Exhibit 5-13. Revenues, IOS through Phase 1 Blended (2011 dollars in millions)

Ridership	2025	2030	2035	2040	2045	2050	2055	2060
High	$761	$1,808	$2,147	$2,202	$2,257	$2,314	$2,373	$2,432
Medium	$586	$1,432	$1,717	$1,761	$1,805	$1,851	$1,897	$1,945
Low	$410	$1,057	$1,287	$1,320	$1,353	$1,387	$1,422	$1,458

The Medium Scenario, which is used as the planning case in Chapter 7, Financial Analysis and Funding, generates approximately 25 percent less projected revenue than the High Scenario, with a similar incremental difference to the Low Scenario. Consistent with the results in other countries that experienced significant ridership growth at the commencement of operations, a four-year ramp-up period is assumed into the projections.

Under the IOS Medium Ridership Scenario, the projected revenues are $586 million (2011$) in 2025, which is the fourth year after completion of the IOS to the San Fernando Valley. Revenues rise to $1.4 billion (2011$) in 2030, the fourth year after completion of Bay to Basin. This represents a 145 percent increase in revenue as a result of the increased ridership once Bay to Basin is completed. Revenues rise to $1.7 billion (2011$) in 2035, seven years after completion of Phase 1 Blended and the 14th year of operations.

Exhibit 5-14 provides the projected revenues for the High, Medium, and Low Ridership Scenarios in YOE dollars from IOS through Phase 1 Blended.

Exhibit 5-14. Revenues, IOS through Phase1 Blended (YOE dollars in millions)

Ridership	2025	2030	2035	2040	2045	2050	2055	2060
High	$1,096	$3,019	$4,157	$4,941	$5,872	$6,979	$8,295	$9,859
Medium	$844	$2,392	$3,324	$3,951	$4,696	$5,581	$6,634	$7,885
Low	$591	$1,765	$2,492	$2,961	$3,520	$4,183	$4,972	$5,910

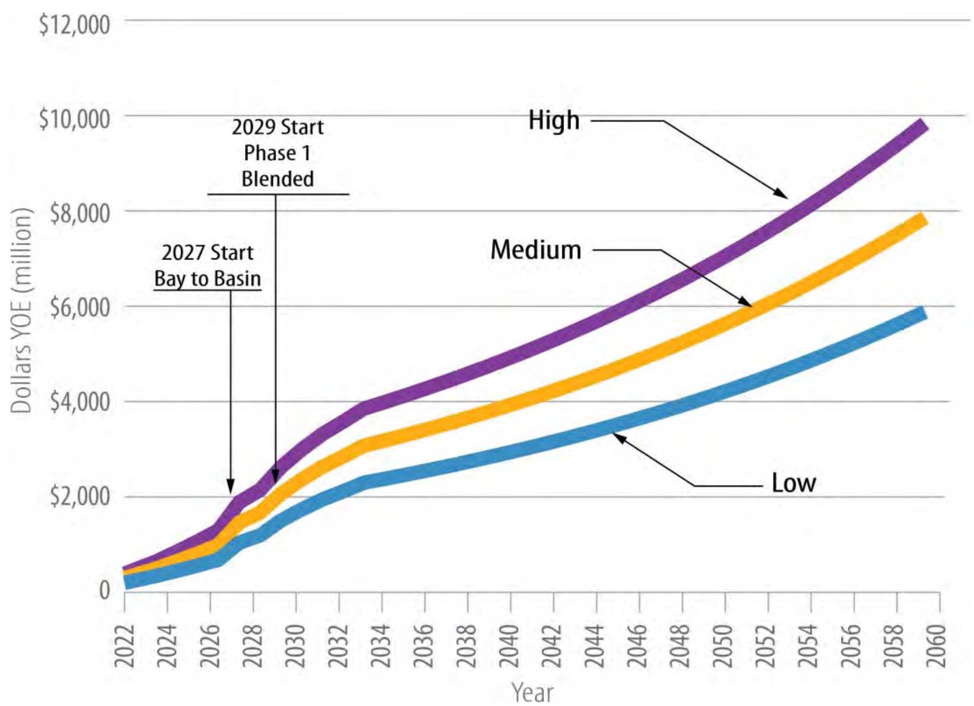
Under the IOS Medium Ridership Scenario, the projected revenues are $844 million in 2025, which is the fourth year after completion of the IOS to the San Fernando Valley. Revenues rise to $2.4 billion in 2030, the fourth year after completion of Bay to Basin, and to $3.3 billion in 2035, seven years after the completion of Phase 1 Blended and the 14th year of operations.

If Phase 1 Full Build was constructed, the projections would show an increase in ridership of 7.7 million riders in the Medium Scenario in 2040, representing a 29 percent increase over Phase 1 Blended.

The projected revenues for Phase 1 Full Build would reach just over $2 billion ($2011) in the Medium Scenario or an equivalent of $4.7 billion in year of expenditure. This represents an increase of only 18 percent over Phase 1 Blended, thus demonstrating the early benefits achieved with Phase 1 Blended.

Exhibit 5-15 illustrates projected revenue growth from IOS through Phase 1 Blended for all three scenarios—Low, Medium and High.

Exhibit 5-15. Revenue growth, IOS through Phase1 Blended (YOE dollars in millions)



Different purposes for HSR ridership forecasts lead to different results

This Business Plan presents a range of ridership forecasts for the HSR system in 2040, with a focus on Phase 1 Blended ridership. These forecasts differ from those presented in the Merced-to-Fresno and Fresno-to-Bakersfield Draft EIR/EISs, which forecast ridership for the HSR system in 2035, with a focus on full system ridership. The forecasts differ because they were developed for distinct purposes and are based on different assumptions.

The ridership forecasts for this Business Plan support the state's financial and investment planning for the HSR system. Most importantly, the orientation of the Business Plan is to assess potential positive cash flow from the operation of the HSR system to help estimate private-sector investment. To do this, HSR fares are assumed to be relatively high (83 percent of airfare), reducing potential ridership but increasing the net revenue that can attract a private operator and its private-sector funding. Other assumptions that contribute to reducing potential ridership include conservative assumptions about future population growth and trip-making patterns.

The Draft EIR/EIS ridership forecasts support the Authority's environmental analysis. The orientation of the Draft EIR/EIS forecasts is to identify reasonable, higher levels of ridership on the HSR system to ensure the environmental documents adequately identify and disclose potential environmental impacts and identify mitigation measures. The forecasts are based on more optimistic assumptions about future population growth than the Business Plan forecasts. In addition, the Draft EIR/EISs present a range of forecasts based on the relatively higher HSR ticket prices as assumed in this Business Plan (83 percent of airfare), as well as a lower fare assumption (50 percent of airfare) that generates more riders. The lower fare assumption forecast used in the environmental analysis ensures adequate and complete disclosure of the potential for environmental impacts from the HSR system.

Exhibit 5-16 compares the Draft EIR/EIS ridership forecasts in 2035 with the Business Plan Phase 1 Full Build Medium Scenario forecasts in 2040, reduced to a 2035 forecast year for comparison purposes in this discussion. These results and comparisons are not used elsewhere in the Business Plan.

Exhibit 5-16. Business Plan and Draft EIR/EIS ridership forecast comparison (year 2035)

Ridership Forecast Purpose and Type	Phase 1 Full Build[1]	Full System[1]
EIR/EIS Low forecast (HSR ticket price = **83%** of airfare levels)	40.2	69.3
Business Plan Medium Ridership Scenario (HSR ticket price = **83%** of airfare levels)	33.0	50.0
EIR/EIS High forecast (HSR ticket price = **50%** of airfare levels)	57.0	98.2
Business Plan Medium Ridership Scenario[2] (HSR ticket price = **50%** of airfare levels)	50.0	75.0

Source: Table 2-14 in Merced to Fresno Section Draft EIR/EIS; Table 2-16 in Fresno to Bakersfield Section Draft EIR/EIS; and Exhibit 5-10 in the 2012 Business Plan.

[1] 2012 Business Plan 2040 forecasts have been reduced by 0.5% per year to create 2035 forecasts for comparison purposes.

[2] Preliminary estimate of Business Plan Medium Ridership Scenario assuming 50% of airfare—provided for illustrative purposes only.

Exhibit 5-16 illustrates that the different assumptions about fares in this Business Plan and the impact analysis in the Draft EIR/EISs (83 percent of airfare versus 50 percent of airfare) create a substantial difference in ridership forecasts. For example, the Business Plan Medium Scenario assuming 83 percent of air fare for Phase 1 Full Build is 33 million riders annually, and the correlating Draft EIR/EIS forecast for Phase 1 Full Build using 83 percent of air fare is 40.2. If a 50 percent of air fare assumption is applied, the Draft EIR/EIS forecast for Phase 1 Full Build is 57 million riders annually. As discussed above, some of the difference is attributable to updated and more conservative assumptions about the pace of population and travel growth in the next several decades, but the fare assumption is the strongest factor.

Another important distinction is that the environmental analysis in the Draft EIR/EISs uses 2035 forecasts assuming the entire HSR system is constructed (98.2 million riders annually assuming 50 percent of airfare), whereas the numbers presented for the Business Plan are based on Phase 1 Full Build ridership (33 million riders annually assuming 83 percent of airfare). A comparison of the most closely correlating forecasts for Phase 1 Full Build and Full System, using consistent assumptions about HSR ticket prices, shows that the EIR/EIS forecasts are somewhat higher than those for the Business Plan, but the difference is reasonable in light of the distinct purposes for which the forecasts have been developed.

Comparison of CHSR ridership with Acela Express in the Northeast Corridor (NEC)

To address the recurring issue of comparing the CHSR ridership forecast to the denser and more transit-friendly Acela Express service in the Northeast Corridor (NEC), the Authority analyzed the difference in the train services in both corridors. Acela is much slower, and much less frequent and fares are far more expensive than the proposed CHSR service. In addition, the California forecast is 20 years in the future, so a comparison to today's Acela ridership is inappropriate. To create a better comparison, the Authority developed and modeled a CHSR scenario that has service levels comparable to those offered by Acela service in the NEC between Washington, D.C. and Boston. The model forecasts 2.7 million annual interregional riders on CHSR with Acela-like service in 2008, which is 79 percent of the ridership on the Acela in 2008 and 10 percent of the forecast 2030 CHSR ridership under the Phase 1 operating plan forecast. The primary cause of the difference is the greater population in the Northeast Corridor. The CHSR Ridership and Revenue Panel reviewed the analysis and the results and endorsed the findings in support of the 2012 Revised Business Plan.

Comparisons with international systems

Existing HSR corridors in other countries provide several useful points of comparison to gauge the reasonableness of California's HSR forecast. These comparisons covered adjusting service frequencies, comparing fare levels, and developing ridership ramp-up assumptions.

A key lesson learned from international experience is that whenever high-speed rail systems are implemented it takes time to reach full market potential.

Exhibit 5-8 earlier in this chapter shows the growth in ridership for six European services from France (TGV), Britain (Eurostar), Spain (Madrid–Seville), and Belgium (Thalys).

- The fastest ramp-up was in the Madrid–Seville line with an increase over two years to a steady growth in ridership.
- The next fastest was the TGV between Paris and the Atlantic Coast regions, reaching “steady state” ridership in the third to fourth year, followed by a steady period, and then more growth reflecting further line improvements.
- At the slower end, the Thalys system—among Belgium, Holland, western Germany, and France—took six years to reach a fairly steady point.

Exhibit 5-17 compares the ridership *forecast* for the Phase 1 Blended system (San Francisco/Merced to Los Angeles) 2040 to *actual* ridership on both the Madrid–Seville corridor and the Paris-Lyon/ Mediterranean TGV corridor.

To compare the attributes of the California system to these two international systems, the exhibit compares the future *projected* population of the specific California cities along the corridor in 2040 (of approximately 27 million for purposes of comparison), to the *existing* population of the Spanish and French high-speed rail corridors. The total *statewide* population is projected to be higher—more than 44 million—which is the basis for the ridership forecast. The forecast population of the California HSR cities is almost twice the size of the French population served by the Mediterranean TGV line. Compared to the Madrid-Seville corridor, the California cities shown are forecast to have almost 4 times the population. Based on these and other comparisons, it would appear that the California forecasts are along the lines of international experience.

Exhibit 5-17. Population and ridership comparison of existing and forecast ridership

HSR Systems	Distance (miles)	Corridor Population (millions)	Riders (millions)
Madrid–Seville (Spain) High Speed Rail	295	7.3[1]	10.0[1]
Paris–Marseilles (France) High Speed Rail	490	15.0[2]	31.0[2]
California High Speed Rail Phase 1 Blended	520	26.9[3]	20.1–32.6[3]

[1] 2009
[2] 2008
[3] 2040 forecasts

End Notes

[1] *Sources:*

"California High-Speed Train Project Operations and Maintenance Peer Review," TUC Rail, November 16, 2010 (Belgium)
"Operational and Maintenance Peer Review—Introductory Material," Ferrovie dello Stato Group (Italy)
"Review on Operations and Maintenance Report of California High-Speed Train," East Japan Railway Company (JR East), November 30, 2010 (Japan)
"California High-Speed Train Project Operations and Maintenance Peer Review," Republic of Korea Ministry of Land, Transport, and Maritime Affair, December 7, 2010
"California High-Speed Rail Project Peer Review Report of Operation and Maintenance," The Third Railway Survey and Design Institute Group Corporation, November 2010 (People's Republic of China)
"California High-Speed Train Project Operation and Maintenance Peer Review," MEDDTL, January 13, 2011 (France)
"California High-Speed Train Project Peer Review of Current Planning on Operations and Maintenance Comments by Renfe Operandora," Renfe, February 2011 (Spain)

[2] *Source:* "Megaprojects and Risks: An Anatomy of Ambition," Bent Flyvbjerg, Cambridge University Press, 2003.

[3] *Source: California High-Speed Rail 2012 Business Plan Ridership and Revenue Forecasting.*

[4] *Source: California High-Speed Rail 2012 Business Plan Ridership and Revenue Forecasting.*

[5] European and Asian HSR operators use the same "yield management" techniques to manage the price of seats as U.S. airlines, and in some cases the same service providers (e.g., SABRE); Amtrak has expanded similar flexible pricing from its Northeast Corridor services to the San Joaquin services in the Central Valley and the Los Angeles-San Diego services.