ANGELES LINK

PHASE 1

STUDIES CONSOLIDATED REPORT

SoCalGas

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ANGELES LINK

I. INTRODUCTION

A. Background

Angeles Link is envisioned as a non-discriminatory, open-access pipeline system dedicated to public use, transporting up to 1.5 million metric tons per year of clean renewable hydrogen[1] from regional third-party production and storage sites to end users across Central and Southern California, including the Los Angeles Basin and the Ports of Los Angeles and Long Beach.

In December 2022, the California Public Utilities Commission (CPUC) authorized SoCalGas to record costs associated with conducting preliminary engineering, design, and environmental feasibility studies to evaluate a variety of topics, including supply, demand, end uses, pipeline configurations and storage solutions, and to analyze project alternatives. The CPUC's Decision emphasized the potential public interest benefits that Angeles Link could bring to the Los Angeles Basin and the State of California. The CPUC concluded that "the public interest is served if SoCalGas studies whether Angeles Link is feasible, cost-effective, and viable."[2] In Phase 1, SoCalGas conducted over a dozen studies confirming, in particular, Angeles Link's viability, feasibility, cost effectiveness, and potential public interest benefits to ratepayers and the broader community. SoCalGas also produced an Environmental and Social Justice (ESJ) Community Engagement Plan (ESJ Plan) and a Framework for Affordability Considerations (Affordability Framework) (collectively, the Phase 1 Studies).[3]

Through information developed during Phase 1, the vision for Angeles Link and its relationship to the State's commitments to reduce GHG emissions has come into greater focus. At the beginning of Phase 1, SoCalGas examined a broad range of possible configurations of a clean renewable hydrogen energy transport system into the Los Angeles Basin. A more specific project description was then developed, including a range for pipeline throughput, and a handful of potential directional routes were identified based on: (1) potential end use sectors (e.g., hard-to-electrify industries and heavy-duty transportation), (2) potential third-party hydrogen production locations in SoCalGas's service territory, and (3) insights gathered through coordination with the Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES) and other stakeholders.

The CPUC's direction to SoCalGas to join the ARCHES[4] led to ARCHES including two pipeline segments of Angeles Link in its California Hydrogen Hub Application: one located in the San Joaquin Valley and one from Lancaster into the Los Angeles Basin. Available information and developments related to ARCHES informed or were incorporated into the Phase 1 Studies. For example, the Preliminary Routing/Configuration Analysis considered routes that include the two pipeline segments described above. Similarly, ARCHES's projections of the California Hydrogen Hub's substantial environmental benefits, including significant reductions in local

[1] D.22-12-055 defines clean renewable hydrogen as "hydrogen that does not exceed a standard of four kilograms of carbon dioxide-equivalent produced on a lifecycle basis per kilogram of hydrogen produced." D.22-12-055, Decision Approving the Angeles Link Memorandum Account to Record Phase One Costs (Dec. 20, 2022) ("Decision") at 66 (Finding of Fact (FOF) 35).

[2] *Id.* at 68 (Conclusion of Law 4).

[3] In compliance with the Decision, SoCalGas made reports of the results and data of the Phase 1 Studies available to the public. The Decision recognized that sharing this information "should be beneficial to the development of the clean renewable hydrogen industry and thus serve the public interest." (Decision at 62.) The Phase 1 reports are available at https://www.socalgas.com/regulatory/angeleslink.

[4] The CPUC's decision ordered SoCalGas to undertake a stakeholder engagement process throughout Phase 1 and join ARCHES, a statewide public-private partnership in support of the State of California's Department of Energy (DOE) clean hydrogen hub application.

air pollution, the creation of an estimated 220,000 new jobs, and approximately $2.95 billion per year in economic value from better health and health cost savings,[5] are aligned with Angeles Link's public interest benefits described further below.

B. Purpose

The purpose of this consolidated report is to distill the Phase 1 Studies by providing an overview of what they collectively convey about Angeles Link. This report also discusses key findings developed during Phase 1 of Angeles Link that will guide future considerations and activities. The Phase 1 Studies collectively span over 2,500 pages and cover a wide range of topics, including safety requirements, demand estimates, production planning, economic analysis, environmental analysis, pipeline design, and stakeholder engagement. Given the extensive nature of these individual reports and plans, this consolidated report provides a summary of the critical insights and conclusions.

C. Key Findings

The Phase 1 Studies collectively establish that Angeles Link is technically feasible, viable, cost-effective, and could offer public interest benefits. The studies show that third parties could produce clean renewable hydrogen that meets the CPUC's clean renewable hydrogen production standards[6] and the projected demand to be served by Angeles Link over time (a throughput range of 0.5–1.5 million metric tons per year (MMTPY)[7]). The studies also confirm that SoCalGas could design, permit, construct, and operate a safe, reliable, and scalable pipeline system to connect clean renewable hydrogen producers to end users.

The Phase 1 Studies show that **Angeles Link can be safely designed, constructed, operated, and maintained;** and that its **routes can be designed to connect potential third-party hydrogen production areas with end users.**

Additionally, the studies demonstrate that **Angeles Link would offer a viable hydrogen delivery system,** also showing that clean renewable hydrogen transported via Angeles Link can be a competitive alternative to other potential decarbonization pathways. The studies indicate that **Angeles Link is the most feasible and cost-effective** hydrogen delivery option at scale across Central and Southern California compared to alternatives such as a localized hydrogen hub and trucking in terms of scalability, transport distances, and overall cost effectiveness.

The studies also demonstrate that Angeles Link, as envisioned, **could provide significant public interest benefits to ratepayers and the broader community.** For instance, Angeles Link could support significant decarbonization and air quality benefits, including the potential reduction of 4.5 to 9 million metric tons of carbon dioxide equivalent (CO_2e) per year (the equivalent of the annual greenhouse gas (GHG) emissions of removing approximately 725,000 to more than 1 million gasoline passenger vehicles off the roads per year), and approximately 5,200 tons per year of Nitrogen Oxide (NO_x) emissions by 2045. The studies also demonstrate that Angeles Link can potentially create nearly 53,000 direct construction-related jobs and nearly a total of 75,000 jobs when considering indirect and induced jobs. The work performed in Phase 1 also considers disadvantaged communities (DACs), provides a screening of potentially impacted disadvantaged communities, and includes a plan to guide future engagement in DACs.

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[5] State of California – Office of Governor Gavin Newsom, *California launches world-leading Hydrogen Hub* (July 17, 2024), *available at:* https://www.gov.ca.gov/2024/07/17/california-launches-world-leading-hydrogen-hub/.

[6] The Decision restricts the hydrogen transported via Angeles Link to "clean renewable hydrogen that is produced with a carbon intensity equal to or less than four kilograms of carbon dioxide-equivalent produced on a lifecycles basis per kilogram and does not use any fossil fuel in its production processes." (Decision at 42.)

[7] The units "metric tons" and "tonnes" are equivalent but different from "tons," i.e., "U.S. tons." One metric ton, or tonne, is equivalent to 1.10 ton, or U.S. ton.

The Phase 1 Studies' findings, based on information available and known at the time, support progressing to more detailed planning in Phase 2, including the selection of a preferred system route and front-end engineering design. These findings holistically demonstrate that Angeles Link is viable, technically feasible, and has the potential to be a cost-effective solution for delivering clean renewable hydrogen at scale and all the benefits that would entail, including significantly contributing to decarbonization efforts, enhancing air quality, and generating jobs.

D. Stakeholder Feedback

In accordance with the requirement to hold at least quarterly stakeholder meetings throughout Phase 1, SoCalGas coordinated with the CPUC to create a Planning Advisory Group (PAG), composed of representatives from industry, labor, academia, tribal governments, and environmental organizations, and a Community Based Organization Stakeholder Group (CBOSG), composed of community-based organizations. Based on requests from the PAG and CBOSG for more frequent information sharing, SoCalGas added additional workshops in between quarterly meetings. Ultimately, in Phase 1, SoCalGas held a total of 27 meetings and workshops with the 70 participating organizations from the PAG and CBOSG, as well as 32 one-on-one meetings with members to solicit their feedback on the Phase 1 feasibility studies and PAG and CBOSG process.

SoCalGas presented opportunities for the PAG and CBOSG to provide feedback at four key milestones in the course of conducting each study: (1) draft description of the scope of work, (2) draft technical approach, (3) preliminary findings and data, and (4) draft report.[8] These milestones were selected because they represented critical points at which relevant feedback could meaningfully influence the Phase 1 Studies.

Through this process, SoCalGas incorporated stakeholder input during the development and conduct of the work on the Phase 1 Studies. For example, in response to stakeholder feedback, a route variation was identified for further consideration that could potentially minimize impacts to DACs. Additionally, to address the concerns of community stakeholders, an ESJ Plan was developed that can be implemented in future phases of Angeles Link to engage DACs near potential preferred routes. SoCalGas also requested the Center for Hydrogen Safety[9] to conduct a third-party review of the draft Evaluation of Applicable Safety Requirements.

[8] SoCalGas also provided opportunities for the PAG and CBOSG to provide feedback on drafts of the ESJ Plan and the Affordability Framework.

[9] The Center for Hydrogen Safety is a global non-profit organization dedicated to promoting hydrogen safety and best practices as an industry leader providing guidance, education, and collaboration to help realize the successful and transformative benefits of hydrogen. *(See* Center for Hydrogen Safety, *available at*: https://www.aiche.org/chs.*)* The Hydrogen Safety Panel, a part of the Center for Hydrogen Safety, was created to address concerns about hydrogen as a safe and sustainable energy carrier and its principal objective is to promote the safe operation, handling, and use of hydrogen and hydrogen systems. (*See* Center for Hydrogen Safety, *Hydrogen Safety Panel*, *available at:* https://www.aiche.org/chs/hydrogen-safety-panel; Hydrogen Tools, *Hydrogen Safety Panel, available at:* https://h2tools.org/hsp.*)*

II. KEY FINDINGS FROM PHASE 1 STUDIES

The Phase 1 Studies demonstrate that Angeles Link is viable and cost-effective, technically feasible, and could be beneficial to ratepayers and the broader community.

A. Angeles Link is Viable and Cost-Effective

As the CPUC's Decision recognizes, clean renewable hydrogen is one of the few viable carbon-free energy alternatives for the hard-to-electrify industry and the heavy-duty transportation sectors.[10] The Phase 1 Studies confirm that (1) there is sufficient potential market demand for clean renewable hydrogen to warrant a clean renewable hydrogen pipeline system to connect producers and end users; (2) there are potential sources of renewable energy and water supplies to enable third-party production of clean renewable hydrogen and serve the projected demand over time; and (3) pipeline transportation of hydrogen via Angeles Link could provide economies of scale that make clean renewable hydrogen a cost-effective decarbonization alternative for multiple categories of end users. Key findings evaluating and supporting commercial viability can be found in the Demand Study, Production Planning & Assessment, Water Resources Evaluation, High-Level Economic Analysis & Cost Effectiveness, and Project Options & Alternatives.

1. Sufficient Potential Market Demand for Clean Renewable Hydrogen

The Demand Study evaluated potential clean renewable hydrogen demand across the mobility, power generation, and industrial sectors within SoCalGas's service territory through 2045. The study projects demand growth, ranging from 1.9 MMTPY in the conservative scenario to 5.9 MMTPY in the ambitious scenario. Specifically, the mobility sector could require between 1.0 and 1.7 MMTPY, driven by heavy-duty vehicles due to the Advanced Clean Fleets regulation. The power generation sector could require between 0.7 and 2.7 MMTPY, driven by regulations like Senate Bill 100, which mandates that 100% of all retail electricity sales come from carbon-free sources by 2045. The industrial sector's demand is projected to range from 0.2 to 1.5 MMTPY. These projections estimate the potential market for clean renewable hydrogen, a portion[11] of which could be served by Angeles Link.

[10] Decision at 2.

[11] Angeles Link's projected throughput range is approximately 0.5 – 1.5 MMTPY.

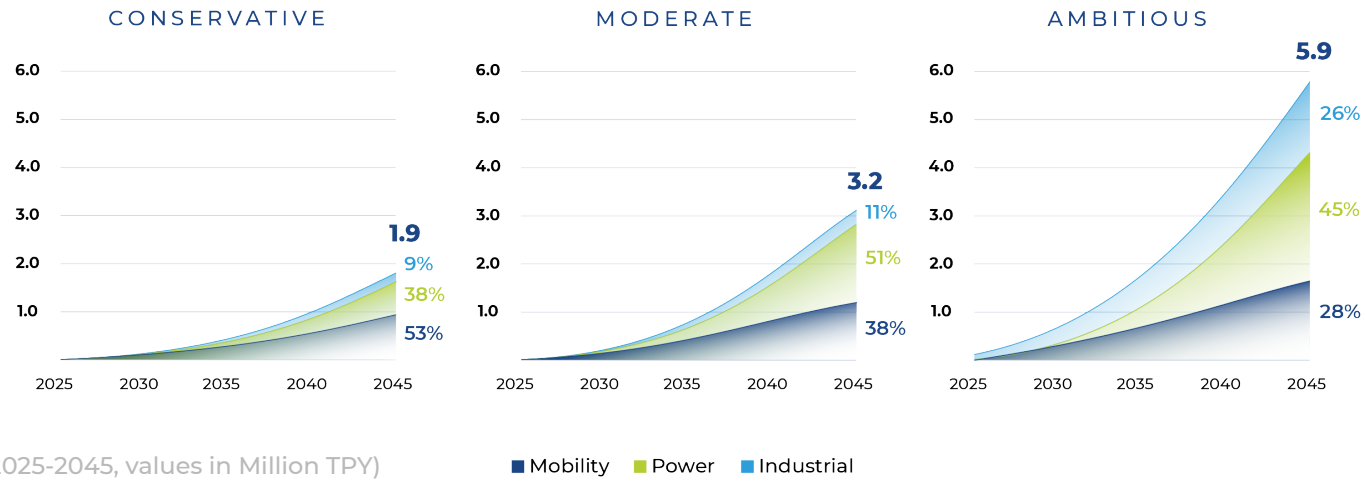

Figure 1. Clean Renewable Hydrogen Demand Forecast in SoCalGas's Service Territory, by Scenario[12]

2. Sufficient Potential Renewable Energy and Water Supplies to Support Clean Renewable Hydrogen Production by Third Parties

The Production Planning & Assessment Study assessed potential sources of clean renewable hydrogen production from renewable sources such as solar and wind, and identified three primary production areas within SoCalGas's service territory that could potentially produce between 0.5 to 1.5 MMTPY of clean renewable hydrogen by 2045: San Joaquin Valley, Lancaster, and Blythe. These locations could alone, or in some combination (depending on the throughput levels), meet the projected 0.5 – 1.5 MMTPY Angeles Link throughput range.

The study highlighted that solar power paired with electrolyzers is a preferred production method due to its maturity, cost-effectiveness, and the abundance of solar irradiance in SoCalGas's service territory. The assessment also noted that 2 million acres of land are potentially available for clean renewable hydrogen production, with only 12-15% of this land needed to meet anticipated maximum throughput scenarios.

The Water Resources Evaluation assessed the availability of water resources necessary for clean renewable hydrogen production and found that the water required to meet the potential demand for clean renewable hydrogen production within SoCalGas's service territory represents a small fraction (0.02-0.10%) of California's annual water usage. Multiple existing water supplies, such as surface water, treated wastewater, groundwater, and urban stormwater capture, could be utilized, and new supplies could be developed if necessary. Potential water supply sources were not considered to be available for third-party production at this feasibility stage if those water resources were: (1) fully allocated or planned for use in meeting existing or anticipated water needs for a given area; (2) part of existing or planned water recycling reuse projects; (3) part of sustainable management of local groundwater resources; or (4) already accounted for in long-term planning water management plans. The study also outlined potential water acquisition methods for third parties to pursue to address water needs for production, such as through exchange agreements, local water agencies (e.g., purchasing available supply), and water markets (e.g., adjudicated groundwater rights), or through land purchases with water rights.

Additionally, the Production Planning & Assessment Study found that various storage options, such as line pack (e.g., storage within the pipeline), construction of a parallel pipe in

[12] Angeles Link Phase 1 Demand Study at 8.

a portion or portions of the pipeline system (i.e., dual run), on-site storage at third-party clean renewable hydrogen production sites or end use locations, and/or dedicated above-ground or underground storage, could help to balance supply and demand.

3. Economies of Scale, Cost Effectiveness, and Viable Compared to Alternatives

The Project Options & Alternatives Study identified certain hydrogen delivery alternatives and non-hydrogen delivery alternatives based on the technical requirements provided in the Decision, geographic alignment with ARCHES's hydrogen infrastructure development within California, and a high-level alignment with Angeles Link's purpose and objectives. From the initial alternatives identified, the Project Options & Alternatives Study advanced certain hydrogen-delivery alternatives and non-hydrogen delivery alternatives to be evaluated for cost effectiveness and potential environmental impacts based on criteria described in the study. The criteria included evaluating several factors as applicable to certain alternatives, including alignment with state policy, distance or range of deliverability, reliability and resiliency, ease of implementation, scalability, technical maturity, and end-user requirements. The Project Options & Alternatives Study also incorporated findings from the High-Level Economic Analysis & Cost Effectiveness Study and the Environmental Analysis (discussed below) to evaluate each alternative's fulfillment of the purpose and objectives of Angeles Link. Figure 2 below demonstrates the six steps that informed the study's methodology.

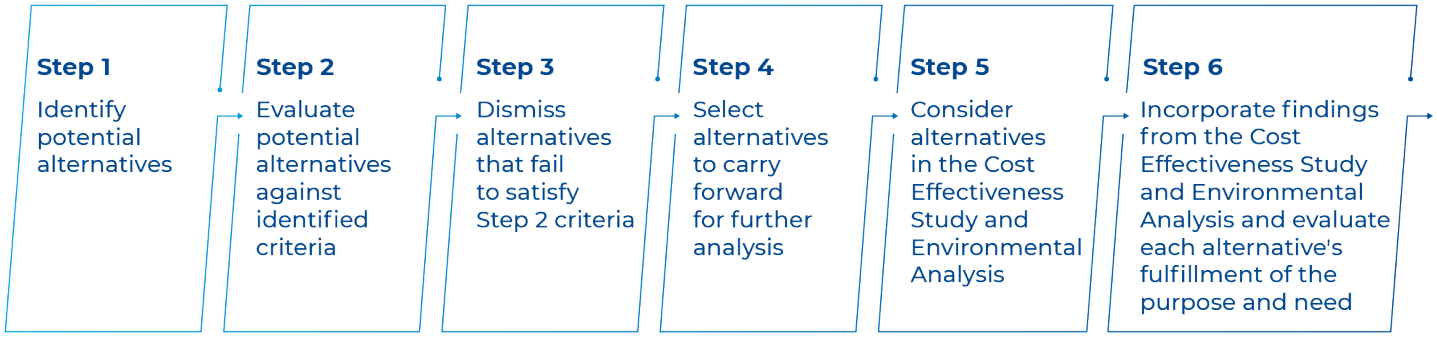

Figure 2. Overview of Six-Step Evaluation Process

As depicted in Figure 2, the High-Level Economic Analysis & Cost Effectiveness Study assessed Angeles Link's cost effectiveness as compared to those alternatives identified for further study in the Project Options & Alternatives Study based on available information. The cost effectiveness analysis demonstrated that among the hydrogen delivery alternatives, such as trucking and power transmission and distribution (T&D) with in-basin production,[13] clean renewable hydrogen transported via Angeles Link is the most cost-effective means to deliver hydrogen into the Los Angeles Basin at scale. Figure 3 from the evaluation, shown below, illustrates that Angeles Link can deliver clean renewable hydrogen at a cost that is lower than the next most cost-effective hydrogen delivery alternative, liquid hydrogen shipping, which has high inherent costs due to liquefaction. The third most competitive hydrogen delivery alternative, power T&D with in-basin production, has high inherent costs due to electric infrastructure and storage needs. Angeles Link was also found to be cost-effective for certain end uses when compared to non-hydrogen alternatives like electrification[14] and carbon capture and sequestration. In the mobility and power sectors, hydrogen delivered via Angeles Link was found to be competitive with electrification.

[13] The power T&D with in-basin production alternative assumes that hydrogen production would occur in-basin, and renewable energy for that production would be transmitted as electrons through multiple 500 kV AC electric power lines to the LA Basin.

[14] The electrification alternative is a non-hydrogen alternative where a combination of technology changes was analyzed to assess their ability to support growing electric demand.

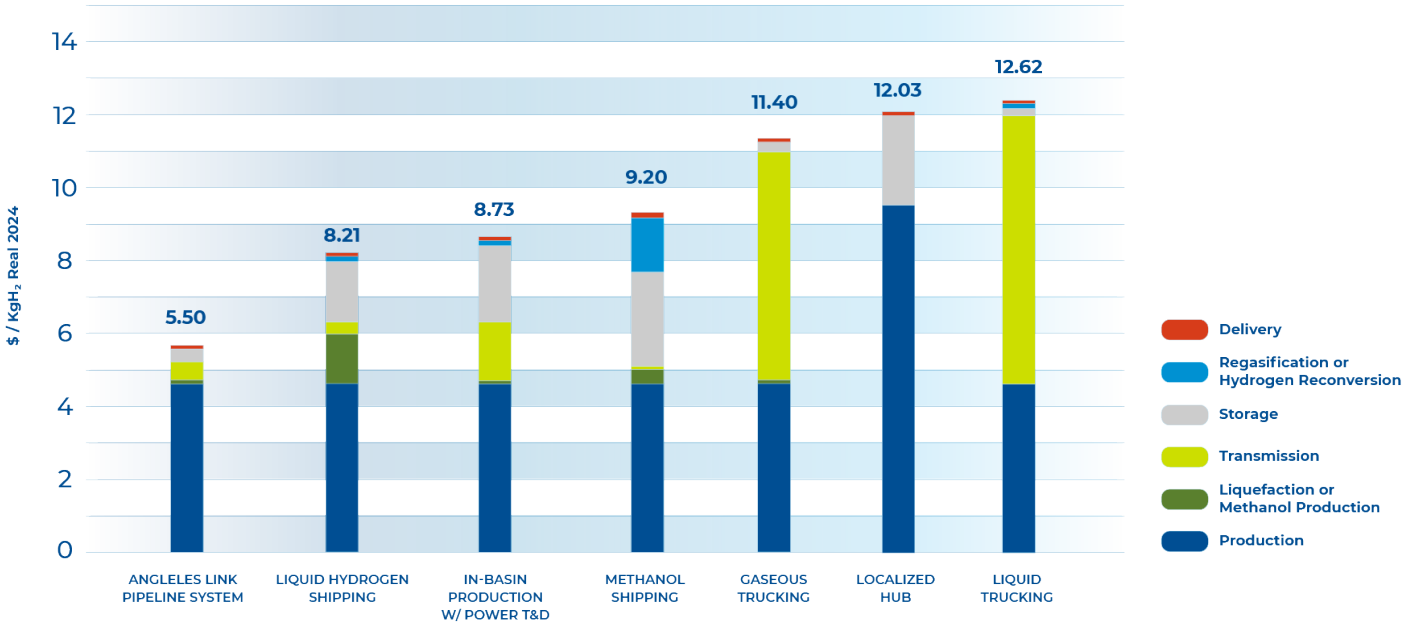

Figure 3. Cost Effectiveness of Angeles Link versus Hydrogen Delivery Alternative[15]

The Project Options & Alternatives concluded that (i) pipeline delivery of hydrogen, as proposed by Angeles Link, is the most feasible and cost-effective hydrogen delivery option at scale across Central and Southern California; and (ii) clean renewable hydrogen could be a viable alternative to other non-hydrogen decarbonization pathways, such as carbon capture and sequestration (CCS) and electrification. The study incorporated supporting analysis from the High-Level Economic Analysis & Cost Effectiveness Study. With respect to hydrogen delivery alternatives, the study identified economies of scale provided by a pipeline system that can transport clean renewable hydrogen over long distances to support meeting the projected clean renewable hydrogen demand in Central and Southern California. Those findings for the hydrogen delivery alternatives are summarized in Table 15 of the study, excerpted below. For example, due to the limitations to build dedicated renewable electricity resources within the Los Angeles Basin, clean renewable hydrogen production costs alone for the localized hub exceed the cost of other hydrogen delivery alternatives and have inherent limitations to scale. In addition, certain non-hydrogen delivery alternatives (e.g., CCS and electrification) are less viable and/or not cost-effective alternatives for a number of end users due to their higher costs and limited applicability in certain sectors. In contrast, Angeles Link can support up to 1.5 MMTPY of hydrogen and address sectors that are difficult to electrify.

Moreover, Angeles Link was found to be the most reliable and resilient hydrogen delivery alternative due to its less complex infrastructure requirements (as compared to in-basin production with power transmission) and its potential to integrate storage access via multiple routes. For example, in the power generation sector, hydrogen was shown to be more reliable, resilient, and well suited to address seasonal variability and multi-day intermittency due to its ability to be stored and used to generate firm dispatchable power when needed.

The Project Options & Alternatives Study also concluded that clean renewable hydrogen could work synergistically with electrification to support the State's decarbonization goals, providing additional benefits, such as the GHG and air quality benefits discussed below.

[15] Angeles Link Phase 1 High-Level Economic Analysis & Cost Effectiveness at 35.

This analysis shows that Angeles Link aligns with the California Air Resources Board (CARB) Scoping Plan, which analyzes a portfolio of pathways, including electrification and clean renewable hydrogen, to achieve the state's decarbonization goals.

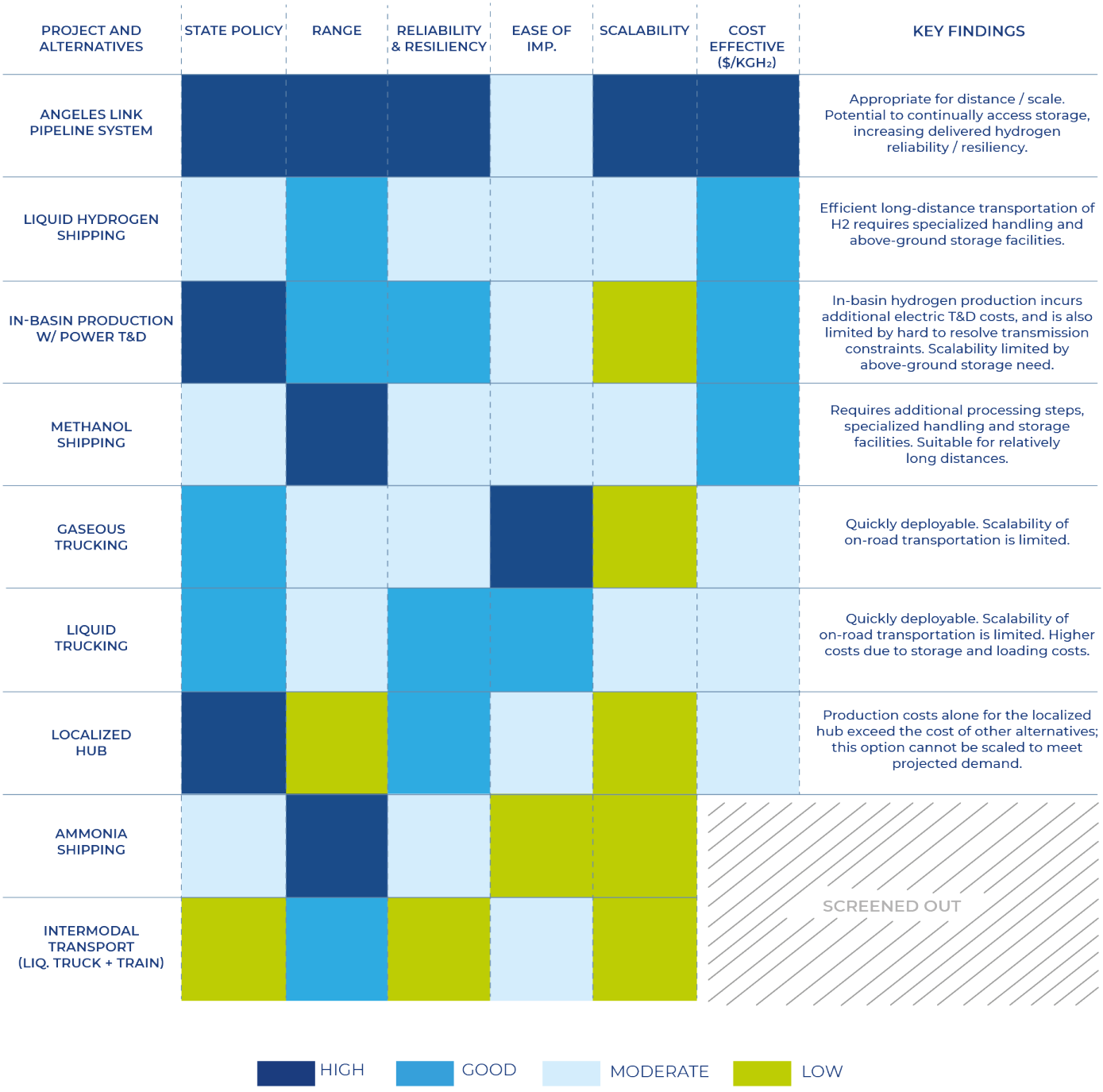

Figure 4. Hydrogen Delivery Alternatives Comparison[16]

B. Angeles Link is Technically Feasible and Can Be Designed and Implemented to Minimize Impacts

Angeles Link has been evaluated for its technical feasibility—i.e., whether it can be designed, constructed, and operated safely and reliably—with key findings from various studies

[16] Angeles Link Phase 1 Project Options & Alternatives at 102-104. Note: Ammonia shipping and intermodal transport were initially assessed to determine whether those alternatives would meet initial assessment criteria. Because it was determined that these alternatives would not meet the criteria, they were not carried forward for further analysis.

confirming that a hydrogen pipeline delivery system connecting producers and end users in Central and Southern California is feasible. The studies also highlight that Angeles Link can be designed and implemented in a way that minimizes environmental and social impacts, with considerations for safety, reliability, and communities throughout its development and operation.

1. Comprehensive Safety Measures

The Evaluation of Applicable Safety Requirements demonstrated that there are limited regulatory differences between hydrogen and natural gas pipeline transportation, and SoCalGas's expertise in natural gas pipeline construction, operation, and maintenance can be leveraged to safely design, construct, operate, and maintain a hydrogen pipeline system. This includes adapting existing safety regulations and industry standards to suit the specific properties and characteristics of hydrogen and developing new standards and practices specific to the transport of hydrogen. As detailed in the evaluation, existing regulations (e.g., 49 CFR Part 192) and industry standards (e.g., ASME B31.12 and NFPA 2) can be leveraged to safely design, construct, operate, and maintain a hydrogen pipeline system. The evaluation identified safety requirements ranging from material selection, pipeline design, fire protection strategies, leak detection, and monitoring programs to emergency response procedures and public awareness plans. It also considered lessons learned from prior industry and third-party experience with hydrogen. The evaluation described SoCalGas's ability to adapt and expand its existing safety practices, including existing emergency response and public awareness plans and training for employees and contractors, to accommodate a pure clean renewable hydrogen pipeline system. The evaluation also detailed how safety considerations can be incorporated into Angeles Link's design (including the determination of preliminary pipeline sizing, compression requirements, and pipeline material selection) and, subsequently, how construction, operation, and maintenance requirements can be developed and implemented. Given the foundational nature of safety to Angeles Link, and in response to stakeholder feedback, SoCalGas requested a third-party review of the draft evaluation by the Hydrogen Safety Panel.[17] The Panel's recommendations, including identifying areas for further assessment as Angeles Link is advanced, were incorporated into the final evaluation, where appropriate.

2. Safe, Reliable, and Scalable Pipeline Design

The Pipeline Sizing & Design Criteria evaluated the potential range of pipeline size(s), materials, pressures, and maintenance operations required to safely design, construct, and maintain Angeles Link. The study identified a range of pipeline diameters and pressure profiles, as well as specifications for suitable equipment, logistics, and materials of construction. Multiple sizing options and both single and dual-run pipeline configurations were assessed to maintain functional flexibility to allow for fluctuating or growing demand. The system is expected to utilize pipelines with diameters ranging from 16 to 36 inches and, to maintain system efficiency and reliability at maximum throughput, two or three compressor stations may be required. These findings support that Angeles Link can be designed and developed as a safe, reliable, and scalable pipeline system capable of transporting clean renewable hydrogen from producers to end users. The study also explored a range of potential material specifications to address key aspects of physical pipeline properties, such as wall thickness and metallurgical composition, and considered maintenance practices to improve pipeline and equipment safety and longevity. As discussed in more detail in Production Planning & Assessment, the study highlighted that, as Angeles Link is further designed and developed, and in alignment with the development of system requirements, the role of storage to support regional hydrogen producers and end users over time should be considered.

[17] The Hydrogen Safety Panel was founded by the U.S. Department of Energy to develop and implement guidance, procedures, and best practices that would support safety in the operations, handling, and use of hydrogen and hydrogen systems.

3. Routing and Configuration, Including Minimizing DAC Impacts

The Preliminary Routing/Configuration Analysis identified several potential directional routes for the system, considering various factors such as engineering requirements and environmental and social impacts. The study examined existing pipeline corridors, rights-of-way, franchise rights, and designated federal energy corridors, as well as the need for new rights-of-way. Based on current information, the analysis identified four potential directional routes and, in response to stakeholder feedback, discussed a potential route variation that reduces traversing through DACs.[18] When combined, these initial route configurations traversed a total of approximately 1,300 miles, providing a wide range of options within which to narrow down the route for the Angeles Link system, which is anticipated to be approximately 450 miles.

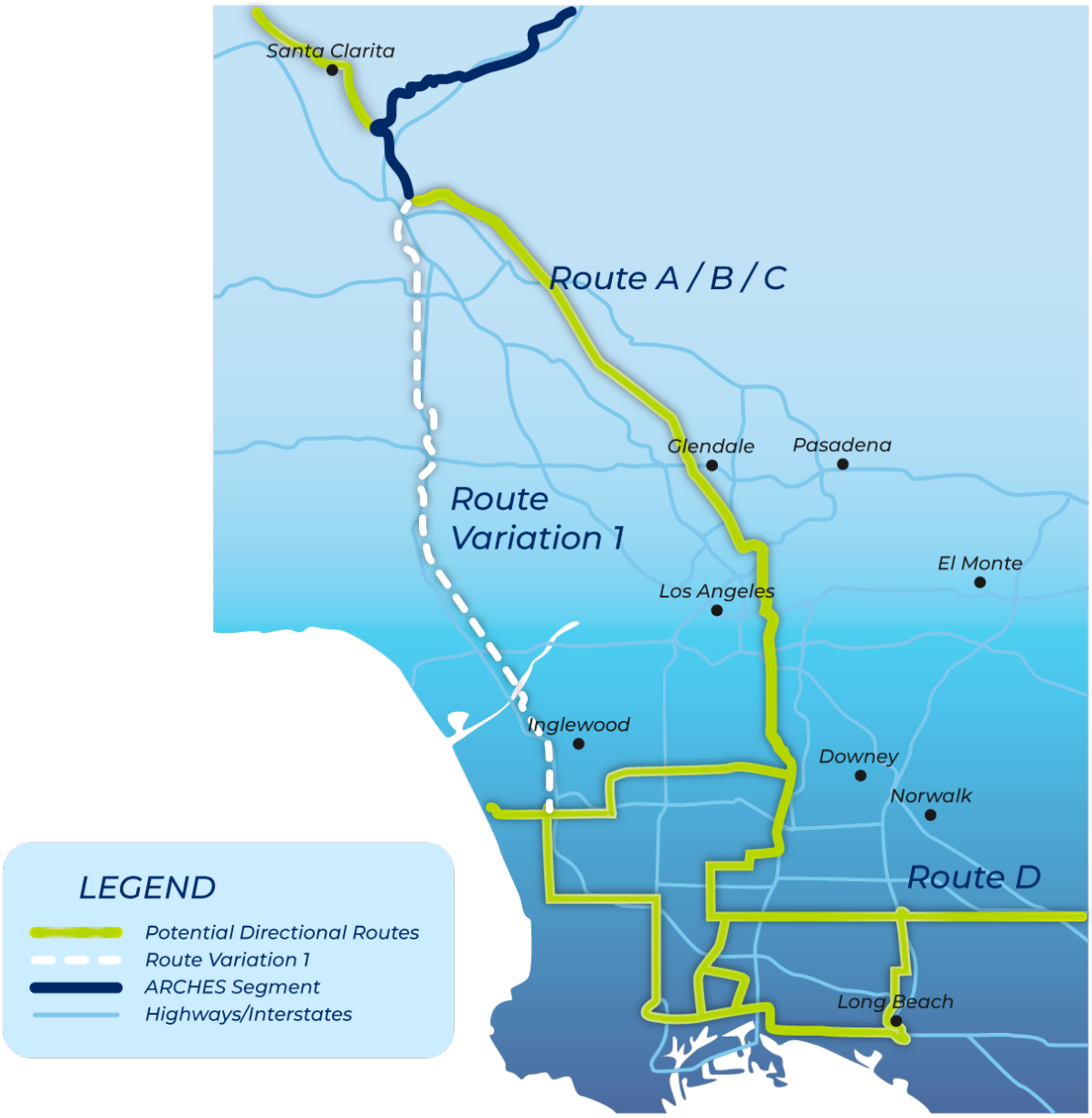

Figure 5. Illustration of Potential Directional Routes and Route Variation 1[19]

[18] Angeles Link Phase 1 Preliminary Routing/Configuration Analysis at 45-47. These potential directional routes reflect current understanding of various factors relevant to siting, including the locations of potential hydrogen producers and offtakers, and are subject to refinement in Phase 2 as additional information becomes available.

[19] Angeles Link Phase 1 Preliminary Routing/Configuration Analysis at 47.

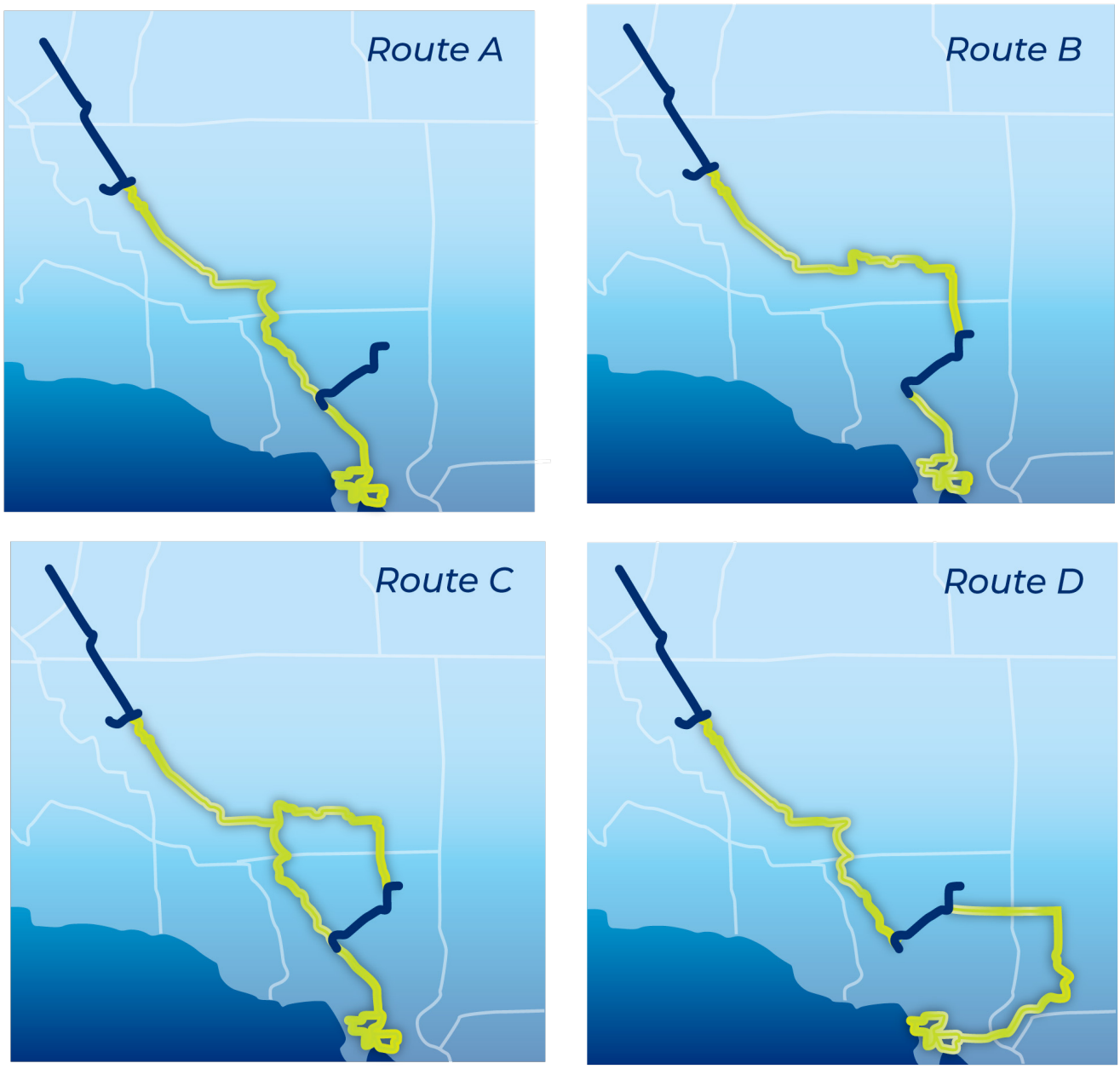

Figure 6. Potential Directional Routes[20]

4. Feasible Permitting Pathway

The High-Level Feasibility Assessment and Permitting Analysis evaluated the potential environmental and regulatory approvals required to construct Angeles Link. The study analyzed the 1,300 miles of conceptual pipeline routes considered in the Preliminary Routing/Configuration Analysis and included a high-level review of federal, state, and local jurisdictional lands and waters, military bases, existing transportation corridors, highway and railroad crossings, state and federally protected plants and wildlife, and land owned by special districts. Permitting is anticipated to involve multiple federal agencies like the Bureau of Land Management and U.S. Fish and Wildlife, and state agencies like the CPUC and California Department of Fish and Wildlife. The study found that permitting timelines potentially range from months to several years and suggested that timelines could be reduced if permit streamlining legislation is adopted.

[20] Angeles Link Phase 1 Preliminary Routing/Configuration Analysis at 46. These renderings illustrate potential directional routes for Angeles Link. The routing of the pipeline system will be optimized through further detailed siting analysis, considering environmental, social, and technical factors to minimize impacts and enhance operational efficiency.

5. Hydrogen Leakage Mitigation

The Hydrogen Leakage Assessment evaluated potential hydrogen leakage associated with general hydrogen infrastructure (compression and transmission, as well as third-party production and third-party storage), as well as potential leakage associated specifically with Angeles Link infrastructure (i.e., transmission of hydrogen via pipeline, including compression). The assessment included a preliminary high-level volumetric estimate of the potential for leakage associated with general hydrogen infrastructure to be between 1,200 metric tons per year (MT/yr) and 13,800 MT/yr. For leakage associated with Angeles Link infrastructure, the assessment estimated the potential to be between 850 MT/yr and 4,065 MT/yr for the throughput scenarios.[21] The study also highlighted mitigation measures in the design and engineering of new infrastructure, such as leak detection systems on compressors, leakage capture and return mechanisms, purge systems, and dry seals. The study identified specific leak detection and measurement methods with emerging tools and technologies. It found that operational and maintenance practices such as leak detection and repair programs using high-performance hydrogen gas sensors can further minimize leakage and, collectively with other mitigation measures, reduce potential leakage from Angeles Link by 90%.[22]

6. Minimizing Environmental Impacts

The Environmental Analysis evaluated the potential environmental impacts of Angeles Link as well as specified alternatives identified in the Project Options & Alternatives Study. The study demonstrated that while there will be potential construction, operation, and maintenance impacts associated with Angeles Link, including potential impacts related to air quality, GHG emissions, biological resources, cultural resources, energy, hazards, hydrology, and land use, many of these impacts can potentially be minimized or avoided through established best management practices and avoidance measures. The analysis also highlighted that undergrounding most of the infrastructure would minimize certain permanent impacts. As Angeles Link progresses, a proposed project and the project alternatives will be further evaluated in compliance with relevant laws and policies, including the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA).

7. Environmental and Social Justice

The ESJ Plan was developed in response to feedback to engage directly with DACs along potential preferred hydrogen pipeline corridors and solicit their input on Angeles Link. The ESJ Plan identified engagement approaches or mechanisms recommended by CBOSG members for SoCalGas to draw upon in Phase 2 to support ESJ stakeholder engagement efforts. The ESJ Plan also included an ESJ community screening assessment (ESJ Screening), which provided baseline DAC designation information and other demographic information for the potential directional routes evaluated in Phase 1. Additionally, the ESJ Plan discussed how Angeles Link supports applicable CPUC ESJ goals, including: enhancing public participation; increasing investment in clean energy resources to benefit ESJ communities; improving local air quality and public health; and promoting high-road career paths and economic opportunities for residents of ESJ communities.

[21] To prepare a preliminary high-level estimate of the potential for leakage associated with general hydrogen infrastructure, the leakage estimates provided in literature were compiled. For general infrastructure, which is composed of production, compression, storage, and transmission, the median and mean of the leakage estimates were calculated and determined to be 0.24% and 0.92%, respectively. For estimates of Angeles Link infrastructure, which include only the compression and transmission categories, the median and mean of the leakage estimates were calculated and determined to be 0.17% and 0.27%, respectively. This is compared to the EPA estimate of natural gas leakage rate of 2%-3%.

[22] The Angeles Link Phase 1 Hydrogen Leakage Assessment did not analyze hydrogen leakage associated with end users as information was not available.

C. Angeles Link Can Offer Public Interest Benefits

In the Decision, the CPUC acknowledged that Angeles Link could bring public interest benefits to the State because clean renewable hydrogen has the potential to decarbonize the State and the Los Angeles Basin's energy future and bring economic opportunities and new jobs to the region.[23] The Phase 1 Studies confirm that Angeles Link could offer environmental and other public interest benefits to ratepayers and communities. In particular, the findings from various studies demonstrate that Angeles Link can deliver substantial GHG reductions, improved air quality, and job creation.

1. Meaningful Greenhouse Gas Reductions

The GHG Emissions Evaluation demonstrated the potential GHG benefits that could be provided by Angeles Link. The analysis shows that in 2045, based on throughput scenarios, the Angeles Link system could result in a reduction of between 4.5 to 9 million metric tons of carbon dioxide equivalent (CO2e) per year. These reductions are primarily attributable to the mobility sector, followed by the power generation and hard-to-electrify industrial end user sectors. The GHG reductions are equivalent to removing approximately 725,000 and over 1 million gasoline passenger vehicles from the road, respectively, for the low and high throughput scenarios. While Angeles Link infrastructure would have associated emissions, the study highlights that they are small in comparison to the estimated GHG reductions associated with end users. In response to stakeholder feedback, the Study incorporated a preliminary high-level volumetric estimate of potential leakage and assessed its impact on projected GHG reductions. The Study concluded that the overall impact of potential leakage on estimated GHG reductions is likely to be less than 1 percent for Angeles Link infrastructure.

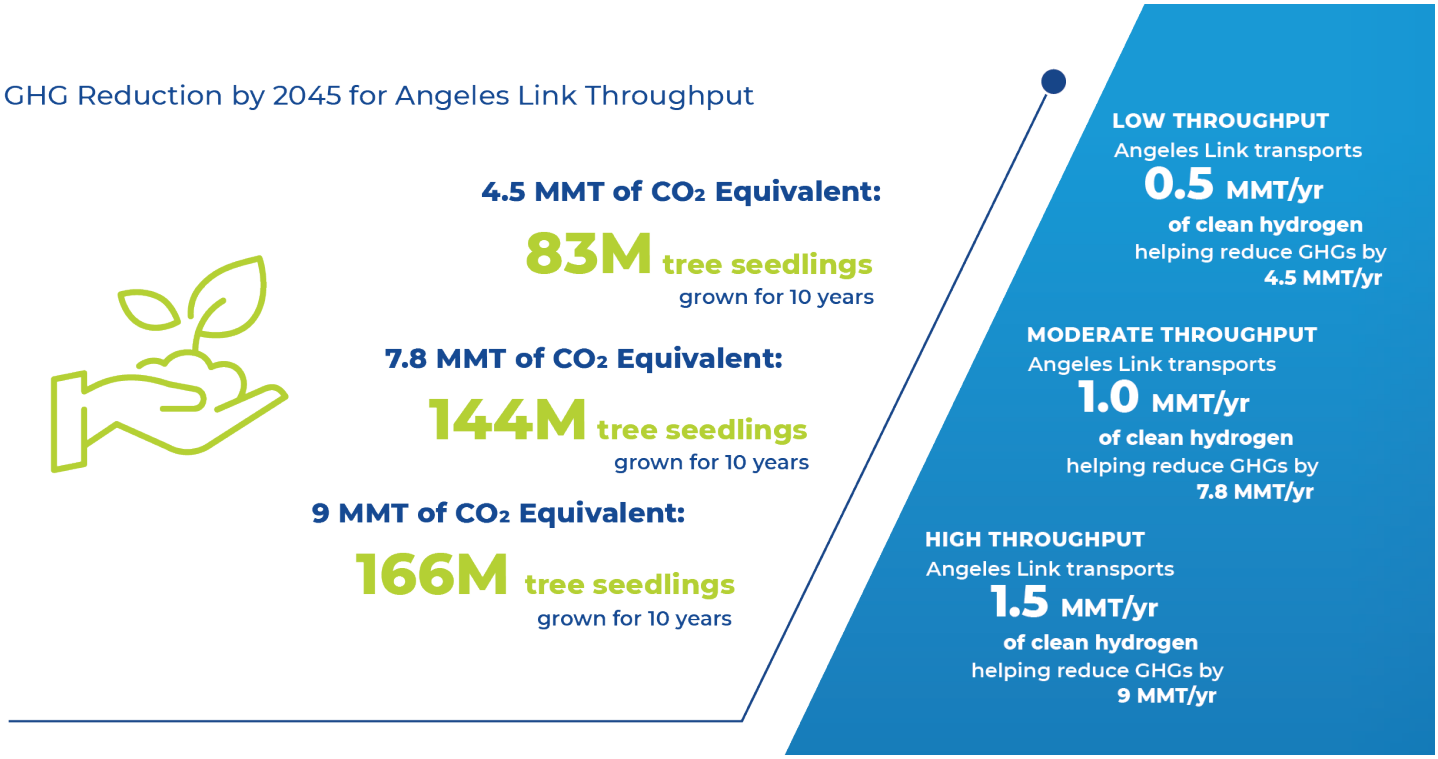

Figure 7. Visualizing the Impact: GHG Reductions Through Angeles Link[24]

[23] Decision at 61 (FOF 1). To request Commission authority to record costs for Phase 2 activities, the Final Decision requires SoCalGas to present findings related to public benefits including compliance with California environmental law and public policies, air quality emissions, workforce planning and training and plans for addressing and mitigating affordability concerns. Decision at 75-77 (Ordering Paragraph 6).

[24] Angeles Link Phase 1 GHG Emissions Evaluation at 1.10.

2. Air Quality and Community Benefits

The NOx and Air Emissions Assessment evaluated the potential NOx emissions reductions associated with Angeles Link. The analysis showed that in 2045 the Angeles Link system could result in a reduction of up to 5,200 tons per year of NOx emissions, primarily due to fuel displacement in the mobility sector. This value is equivalent to approximately 90% of the NOx reductions that the South Coast Air Quality Management District has proposed to be achieved by 2037 for total stationary (i.e., not mobile) commercial and large combustion source NOx control measures in their 2022 Air Quality Management Plan. The study also included a spatial evaluation of estimated NOx emissions reductions geographically and demonstrated that many of the potential air quality benefits will accrue in DAC communities.

3. Job Creation and Economic Growth

The Workforce Planning & Training Evaluation assessed the potential job creation and workforce development associated with Angeles Link. The study discussed how SoCalGas's existing workforce planning programs can be adapted to support hydrogen infrastructure, leveraging the company's longstanding experience in safely and reliably operating and maintaining a pipeline system. The evaluation also demonstrated that Angeles Link can create nearly 53,000 direct construction-related jobs at peak and a total of approximately 75,000 jobs at peak when considering indirect (i.e., jobs generated in related industries that support the project) and induced jobs that occur through wage earners spending income. Angeles Link workforce development can support the local economy while constructing, operating, and maintaining Angeles Link safely.

4. Affordability for Ratepayers Considered in Planning Process

The Affordability Framework described how Angeles Link's planning process has considered and identified opportunities to mitigate affordability concerns. The document described the CPUC's framework for evaluating affordability; discussed projected costs of decarbonization more broadly to provide context for the potential investment in Angeles Link; summarized the work SoCalGas has conducted to date on cost effectiveness as a building block to consider the affordability of Angeles Link and address stakeholder feedback about affordability concerns received to date; and identified potential strategies for addressing affordability in the development of Angeles Link during Phase 2 and beyond. As part of the efforts described in the framework, SoCalGas is considering affordability on both a system-wide basis and individual basis.

III. COORDINATION WITH AND SUPPORT OF ARCHES

Consistent with the Decision, SoCalGas joined ARCHES. The DOE and ARCHES recently signed a landmark $12.6 billion agreement to build a clean, renewable Hydrogen Hub in California (California H2Hub), including up to $1.2 billion in federal funding. This made the California H2Hub the first of seven Hydrogen Hubs in the country to sign a funding agreement with DOE. The California H2Hub will facilitate a network of clean renewable hydrogen production sites and end users connected by transmission systems. The California H2Hub aims to cut fossil fuel use throughout California, with the ultimate goal of decarbonizing public transportation, heavy-duty trucking, and port operations by 2 million metric tons per year—equivalent to the annual emissions of 445,000 gasoline-fueled cars. [25]

ARCHES's submission to DOE included two segments of Angeles Link as an integral part of the California H2Hub: one in the San Joaquin Valley and another extending from Lancaster to the Los Angeles Basin. These segments are part of the broader Angeles Link system, facilitating the transition to a hydrogen-based economy and California's sustainable future.

Just as the benefits of Angeles Link are anticipated to be substantial, so are the expected benefits of the California H2Hub. As Governor Gavin Newsom stated, "We're going to use clean, renewable hydrogen to power our ports and public transportation—getting people and goods where they need to go, just without the local air pollution."[26] ARCHES expects the California H2Hub will create an estimated 222,400 new jobs, including 130,000 in construction and 90,000 permanent jobs, and generate approximately $2.95 billion per year in economic value from better health and health cost savings. [27]

As stated in an ARCHES press release, "at least 40% of the benefits from [ARCHES] projects will flow to disadvantaged communities through community-directed investments, workforce training, and family-supporting jobs." [28]

[25] DOE, *California Hydrogen Hub (ARCHES) Fact Sheet, available at:* https://www.energy.gov/sites/default/files/2024-07/H2Hubs%20ARCHES_Award%20Fact%20Sheet.pdf.

[26] State of California – Office of Governor Gavin Newsom, *California launches world-leading Hydrogen Hub* (July 17, 2024), *available at:* https://www.gov.ca.gov/2024/07/17/california-launches-world-leading-hydrogen-hub/.

[27] *Id.*

[28] *Id.*

IV. STAKEHOLDER PROCESS

SoCalGas created a comprehensive stakeholder engagement process involving the PAG and the CBOSG. This process was continually refined based on feedback from participants to promote transparency and inclusivity.

1. Engagement with CPUC's Energy Division

SoCalGas engaged with (i) the CPUC's Energy Division to establish a stakeholder engagement framework that included the PAG and CBOSG and (ii) staff to devise a plan and set of procedures to compensate CBOs for their participation in the Phase 1 stakeholder engagement process. Throughout Phase 1, SoCalGas maintained regular scheduled touchpoints with staff to discuss and refine the stakeholder engagement process.

2. Meetings and Workshops

SoCalGas has collectively held 27 meetings and workshops, as well as 32 one-on-one meetings with PAG and CBOSG members. These sessions were designed to solicit input and foster meaningful dialogue about the Angeles Link Phase 1 activities.

3. Diverse Input Channels

Stakeholder input was received through various channels, including verbal comments during in-person and virtual meetings (both large meetings and one-on-ones), discussions at workshops, and written feedback via email. This multi-faceted approach was designed to allow all voices to be heard and considered.

4. Living Library

To facilitate access to information, SoCalGas created a "Living Library" that hosted a wide range of documents. This library included 75 informational documents (e.g., preliminary findings, draft feasibility studies, etc.), 27 presentations, 27 meeting recordings, 27 meeting transcripts from PAG/CBOSG quarterly meetings and workshops, 2 PAG/CBOSG rosters, and 65 comment letters received from stakeholders during Phase 1 activities. The library was accessible to all PAG and CBOSG participants on demand, promoting transparency and ease of engagement.

5. Milestones for Input

As described above, SoCalGas presented opportunities for the PAG and CBOSG to provide feedback at four key milestones.

V. STAKEHOLDER FEEDBACK

SoCalGas has addressed feedback from stakeholders and incorporated relevant and appropriate feedback into the planning for and execution of the Phase 1 Studies. Certain stakeholder feedback received will inform future phases of Angeles Link.[29] The following are select examples of the impacts of stakeholder feedback on various studies:

1. Third-Party Review of Evaluation of Applicable Safety Requirements

The evaluation underwent a third-party review by the Center for Hydrogen Safety's Hydrogen Safety Panel, and key feedback was incorporated.

2. Routing Analysis

The Preliminary Routing/Configuration Analysis added a route variation for consideration along with the four potential directional routes to minimize impacts to disadvantaged communities.

3. ESJ Plan

The ESJ Plan serves as a framework for engaging ESJ communities and identifies engagement mechanisms recommended by CBOSG members for SoCalGas to draw upon to support ESJ community stakeholder engagement efforts. The plan aims to engage communities living near potential preferred routes and create opportunities for community input.

4. GHG Evaluation

The study used the range of preliminary high-level volumetric estimates of the potential for leakage from the Hydrogen Leakage Assessment to predict a range of potential impacts to the estimated overall GHG reductions associated with each of general new hydrogen infrastructure and Angeles Link infrastructure. This analysis used the values provided in the study which are a summary of the ranges of estimated Global Warming Potential (GWP) 100 and GWP 20 for hydrogen available in the literature.

5. NOx and Air Emissions Assessment

The assessment refers to maps depicting potential NOx emission reductions geographically that are included in Appendix C of the NOx and Other Air Emissions Assessment.

6. Water Resources Evaluation

The study included a desktop analysis of potential GHG emissions associated with water treatment and conveyance to provide more information about the potential environmental impacts related to water use for third-party clean renewable hydrogen production.

7. Hydrogen Leakage Assessment

The study included preliminary high-level volumetric estimates of the potential for leakage based on the range of values available from the literature for both general hydrogen infrastructure and Angeles Link infrastructure.

[29] All feedback received is included, in its original form, in the quarterly reports, which also contain the responses to feedback and are submitted to the CPUC and published on SoCalGas's website. Certain comments identified in the quarterly reports were not incorporated into final studies due to reasons such as being out of scope, anticipated to be addressed in Phase 2, requiring third-party actions beyond SoCalGas's control, or raising issues better suited for third parties other than SoCalGas.

PHASE 1 STAKEHOLDER ENGAGEMENT

Received
100+
COMMENT LETTERS
from PAG and CBOSG

Reviewed and responded to
1,000+
PAGES
of comments

FEASIBILITY STUDIES

Conducted
16
STUDIES
includes multiple feasibility studies, an Affordability Framework, and an ESJ plan

which collectively span
2,500+
PAGES
covering a wide range of topics

70 **PARTICIPATING ORGANIZATIONS**

PLANNING ADVISORY GROUP (PAG) offers technical advice and feedback

42
PAG

+

COMMUNITY BASED ORGANIZATION STAKEHOLDER GROUP (CBOSG)
provides community feedback

28
CBOSG

TOP FIVE STAKEHOLDER PRIORITIES BASED ON FEEDBACK

- SAFETY
- HEALTH
- COST
- WORKFORCE DEVELOPMENT
- ROUTING / ENVIRONMENTAL

27 **TOTAL MEETINGS**

14 Quarterly Meetings

13 Workshops

VI. FUTURE CONSIDERATIONS

As described above, the Phase 1 Studies demonstrate that Angeles Link is technically feasible, viable and cost-effective. It could offer meaningful benefits to ratepayers and the broader community while supporting California's decarbonization goals. Building on the findings in the Phase 1 Studies, the next stage of Angeles Link would include the selection of a preferred route, the development of a 30% design (Front End Engineering Design (FEED)), and the execution of further technical, economic, and environmental analysis. Upon completion of Phase 2 activities, SoCalGas may apply to the CPUC for a Certificate of Public Convenience and Necessity (CPCN) and obtain other necessary permits for Angeles Link's construction and operation.

In addition, the Phase 1 Studies have identified several areas for further consideration and collaboration with stakeholders.

1. Enhanced Stakeholder Engagement

SoCalGas plans to enhance its stakeholder engagement efforts in Phase 2 by adding additional representation to its PAG from other sectors and regions and conducting both in-person and virtual meetings to solicit input from communities along preferred routes at key project milestones. These efforts aim to increase transparency and garner more community participation and input into the Angeles Link development process.

2. Demand Evaluation and Economic Analysis

Future phases will involve a geographic demand analysis focused on potential end users to help inform the preferred route with more precision and defined throughput. SoCalGas plans to utilize available information to build on the Demand Study, such as incorporating hydrogen pricing into the demand curve, assessing demand associated with potential market subsectors that were not specifically evaluated in Phase 1, and updating the demand forecast based on new market information. SoCalGas will also incorporate updated information from ARCHES on end users and demand as more information becomes available. Economic modeling will also be refined to account for expected future declines in hydrogen costs and increases in current fuel costs due to carbon pricing. An economic analysis will build upon Phase 1 results that estimated the levelized cost of clean renewable hydrogen delivered by Angeles Link, incorporating more detailed hydrogen market data and cost estimates from the preferred route.

3. Engineering and Safety Considerations

Future phases will refine assumptions regarding the design of the Angeles Link system. Detailed hydraulic modeling, including transient hydraulic analysis, will be conducted so that the pipeline system can be designed to accommodate dynamic flow conditions and maintain safety and efficiency while supporting energy system reliability and resiliency. As the development of Angeles Link progresses, SoCalGas will continue to incorporate safety considerations and requirements into the design basis, and will

leverage applicable safety specifications, standards, and plans. New hydrogen-specific specifications, standards, training, operator qualifications and plans and procedures will be developed, as appropriate.

4. Routing Optimization

The routing of the pipeline system will be optimized to minimize impacts and enhance operational efficiency. This will result in further detailed siting analysis, considering environmental, social, and technical factors of a preferred route and 30% engineering design. Future analysis will include a street-level alignment evaluation to refine the preferred route, taking into account stakeholder feedback and potential route variations (including by conducting a DAC analysis of the route variation identified in Phase 1). This iterative process will help design a pipeline route that meets current and future energy needs while minimizing environmental and community impacts.

5. Affordability

SoCalGas will explore recommendations from stakeholders and others on how to manage the costs of decarbonization projects like Angeles Link, including potential programs to promote affordability for its ratepayers. Future phases will involve monitoring and participating in legislative and regulatory proposals concerning affordability, as appropriate.

VII. CONCLUSION

The Phase 1 Studies—conducted with the valuable perspectives and contributions of stakeholders—provide a comprehensive demonstration that Angeles Link warrants advancing to the next phase. The studies conclude that Angeles Link is viable and cost-effective, technically feasible, and can offer significant decarbonization and other public interest benefits to ratepayers and the broader community. Even more, the studies provide a comprehensive analysis that contributes to and advances the understanding of the role of clean renewable hydrogen in supporting decarbonization efforts.

As SoCalGas moves forward, the findings from Phase 1 provide a solid foundation for subsequent phases, positioning Angeles Link to substantially contribute to California's decarbonization efforts, progress the development of the California H2 Hub, enhance air quality, create jobs, and provide a safe, reliable, and cost-effective clean energy solution.

Demand Study
Environmental Analysis
Environmental Social Justice (ESJ) Community Engagement Plan and ESJ Screening
Evaluation of Applicable Safety Requirements
Framework for Affordability Considerations
Greenhouse Gas (GHG) Emissions Evaluation
High-Level Economic Analysis & Cost Effectiveness
High-Level Feasibility Assessment and Permitting Analysis
Hydrogen Leakage Assessment
Nitrogen Oxides (NOx) and Other Air Emissions Assessment
Pipeline Sizing & Design Criteria
Preliminary Routing/Configuration Analysis
Production Planning & Assessment
Project Options & Alternatives
Water Resources Evaluation
Workforce Planning & Training Evaluation