Application: A.24-12-XXX
Exhibit No.:
Witness: Neil Navin

PREPARED DIRECT TESTIMONY OF

NEIL NAVIN

ON BEHALF OF

SOUTHERN CALIFORNIA GAS COMPANY

(CHAPTER 2 – ANGELES LINK

AND SUMMARY OF PHASE 1 STUDIES)

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

December 20, 2024

TABLE OF CONTENTS

PREPARED DIRECT TESTIMONY OF
NEIL P. NAVIN
(ANGELES LINK AND SUMMARY OF PHASE 1 STUDIES)

I. INTRODUCTION/PURPOSE OF TESTIMONY

My name is Neil P. Navin, and I am Senior Vice President, Engineering & Major Projects and Chief Clean Fuels Officer of Southern California Gas Company (SoCalGas or Company). My testimony supports the Application for Authorization to Implement Revenue Requirement for Costs to Enable Commencement of Phase 2 Activities for Angeles Link (Application). As described in the Testimonies of Amy Kitson and Brian Walker, in Phase 2, SoCalGas proposes to (i) identify a preferred system route; (ii) conduct refined and additional analyses (including refined system design, safety, environmental, and related work) to advance Angeles Link to a 30% engineering design; (iii) develop a Class 3 estimate; (iv) conduct programmatic activities (e.g., project governance, workforce, training, and risk management plans, affordability considerations and economic analyses); and (v) continue engaging with stakeholders and communities. In this testimony, I describe (1) Angeles Link, as currently envisioned; (2) the findings of the Phase 1 feasibility studies; and (3) why it is necessary to commence Phase 2 activities promptly.

As described further in this testimony, the Phase 1 studies collectively establish that Angeles Link is viable and cost effective, technically feasible, and could offer substantial public interest benefits. The studies confirm that SoCalGas could design, permit, construct, and operate a safe, efficient, reliable, and scalable pipeline system to connect clean renewable hydrogen production to demand. The Phase 1 studies' findings support progressing to more detailed planning in Phase 2, including the selection of a preferred system route and FEED work. The prompt commencement and execution of Phase 2 activities are needed to support California in meeting its decarbonization goals, as described in the Testimony of Maryam Brown, and to best position SoCalGas to align Angeles Link with the agreement between the U.S. Department of Energy (DOE) and the Alliance for Renewable Clean Hydrogen Energy System (ARCHES) for the California Hydrogen Hub to be operational, which SoCalGas currently understands to be by December 31, 2033.

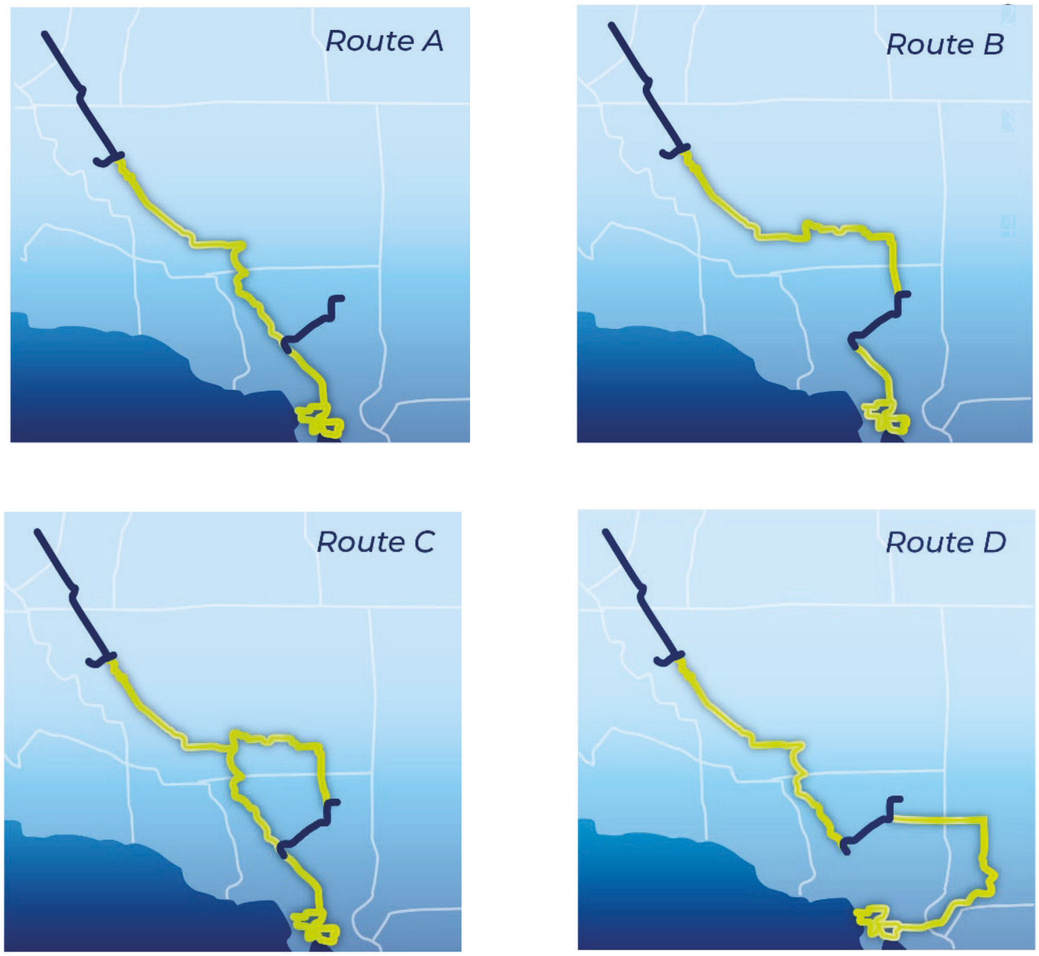
II. ANGELES LINK

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

As described in the Testimony of Maryam Brown, consistent with D.22-12-055 (Phase 1 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 Hydrogen Hub), including up to $1.2 billion in federal funding. ARCHES' submission to DOE included Angeles Link, detailing its San Joaquin Valley and Lancaster pipeline segments (Hub Segments), as a critical part of the California Hydrogen Hub. The San Joaquin Valley pipeline segment is an approximately 80-mile pipeline expected to connect various producers and end users in the San Joaquin Valley in Central California. The Lancaster pipeline segment would run approximately 45 miles from Lancaster to the Los Angeles Basin. The two segments would be connected by the broader Angeles Link system, which would provide open-access infrastructure dedicated to public use to allow the efficient movement of hydrogen at scale to support meeting California's decarbonization goals. Conceptual maps showing the two segments in the California Hydrogen Hub and potential directional route(s) for Angeles Link (which would be further evaluated in Phase 2) are shown below.[1]

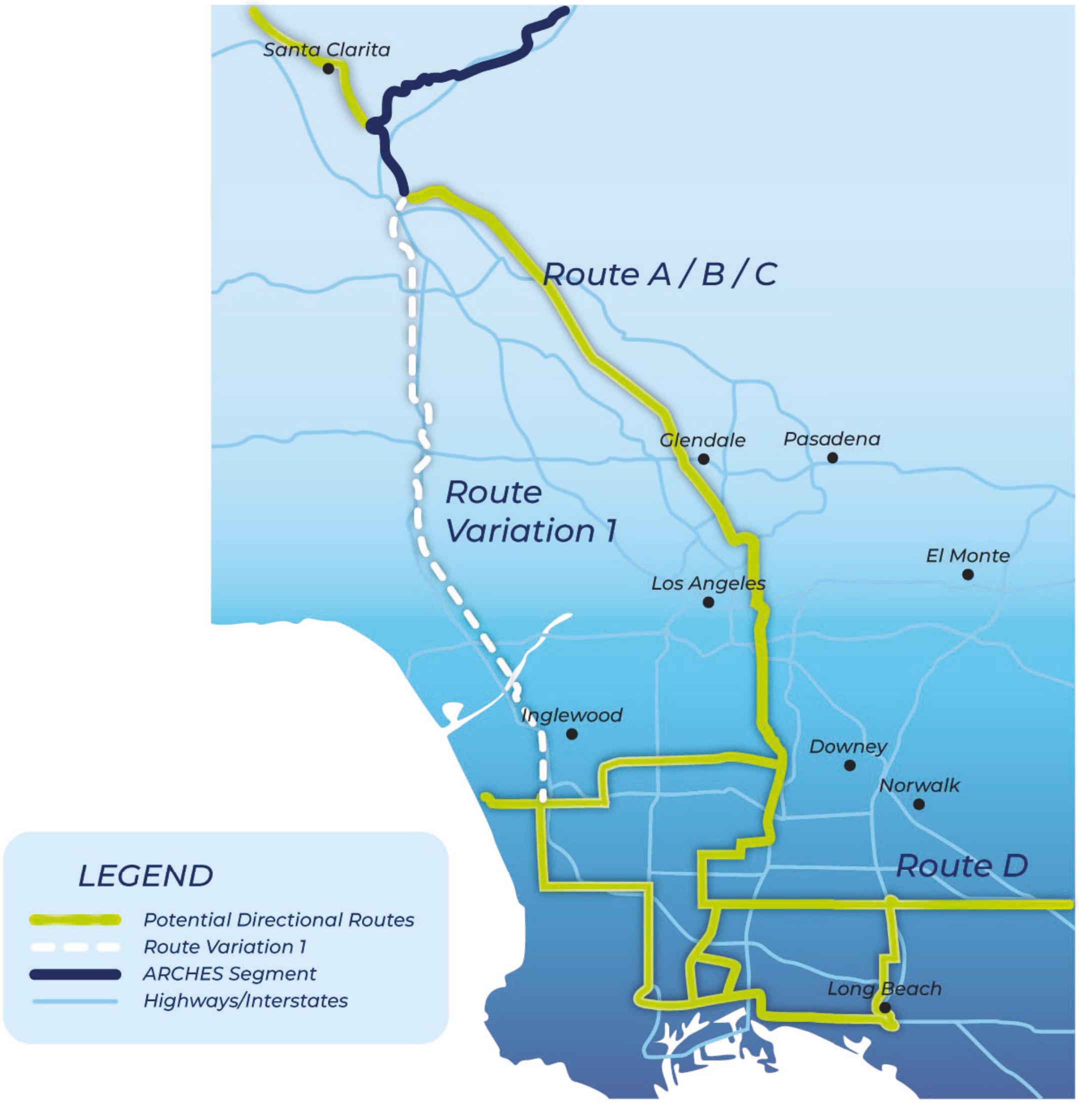
[1] Potential directional Angeles Link system routes are still to be determined and further analyzed in Phase 2. The configurations shown represent high-level preliminary directional pathways of highest potential to connect clean renewable hydrogen production with concentrated areas of demand at the time the analysis was conducted. The potential routes and variation will be evaluated in further detail in the future and are subject to change based on additional information and continued developments in the hydrogen landscape in Central and Southern California.

Figure 1 - Illustration of Potential Directional Routes and Route Variation 1[2]



[2] Consolidated Report at 12-13.

Figure 2 - Illustration of Potential Directional Routes and Route Variation 1[3]



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[3] *Id.*

Considering the estimated projections of demand for clean renewable hydrogen in SoCalGas's service territory by 2045 in the Phase 1 Demand Study (i.e., 1.9 to 5.9 MMTPY [4]) and other longer-term demand projections,[5] Angeles Link is currently envisioned to be sized to support annual throughput of approximately 0.5 to 1.5 MMTPY over time, extend across approximately 450 miles, have pipeline diameters up to 36 inches, and operate at pressures ranging from approximately 200 to 1,200 pounds per square inch gauge (psig).[6] This would serve a portion of the demand estimated for SoCalGas's service territory. A preferred system route will be identified in Phase 2, including consideration of various pipeline configurations, compressor station(s), and other related system components, as further described in the Testimony of Brian Walker.

SoCalGas expects that Angeles Link would be constructed in stages to support alignment with ARCHES' timing expectations for the California Hydrogen Hub to be operational by the end of 2033, with the broader Angeles Link system connecting both initial segments and holistically providing pipeline infrastructure for delivering clean renewable hydrogen in Central and Southern California.

III. PHASE 1 FEASIBILITY STUDIES

A. Background and Approach

The Phase 1 Decision recognized the potential public interest benefits that Angeles Link could bring to the State and especially the Los Angeles area and authorized SoCalGas to record costs associated with the feasibility studies.[7] The primary objective of these studies was to evaluate the feasibility of Angeles Link and inform more detailed analyses in future phases of developing Angeles Link. SoCalGas conducted 16 studies and assessed topics ranging from

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4 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.

5 *See, e.g.,* DOE – Office of Clean Energy Demonstrations, *California Regional H2Hub Community Briefing* (October 25, 2023) at 26, *available at:* https://www.energy.gov/sites/default/files/2023-10/H2Hubs_California_Community_Briefing.pdf; ARCHES H2, *Meet ARCHES* (October 2023), *available at:* https://archesh2.org/wp-content/uploads/2023/10/Meet-Arches_October-2023.pdf.

6 These criteria reflect SoCalGas's current understanding of various factors relevant to siting, including the locations of potential hydrogen producers and end users, and are subject to refinement in Phase 2 as additional information becomes available.

7 Phase 1 Decision at 16.

safety, production and demand, cost-effectiveness, workforce development, greenhouse gas (GHG) and air contaminant emissions, potential leakage, pipeline sizing, route design and configurations, and project alternatives, consistent with the Commission's directives in Ordering Paragraph 6.[8] The studies collectively confirm Angeles Link's viability and cost-effectiveness, technical feasibility, and the potential for public interest benefits.

In addition to the Phase 1 studies, the Phase 1 Decision required SoCalGas to (1) join and support ARCHES in its application for federal funding for the California Hydrogen Hub;[9] (2) conduct quarterly stakeholder engagement meetings and share data with stakeholders;[10] (3) submit quarterly reports to the Commission to provide updates on Angeles Link and the Phase 1 studies and report on any preliminary findings and results;[11] and (4) provide findings on (i) compliance with California law and policies, (ii) consistency with other Commission decisions, policies, and directives, (iii) plans to ensure hydrogen gas meets the clean renewable hydrogen standards set in the Phase 1 Decision, (iv) address and mitigate affordability concerns, and (v) address and mitigate impacts to disadvantaged communities and other environmental justice impacts.[12]

To fulfill the Phase 1 Decision's directives,[13] SoCalGas commissioned several studies which consider affordability concerns as appropriate for the Phase 1 feasibility stage, impacts on disadvantaged communities, consistency with California law and public policies, and stakeholder feedback.[14] The studies also provide information and analysis to support the planning and development of Angeles Link in alignment with ARCHES' operational timing goals. The full studies, including the data analysis to support the studies, are publicly available.[15] An Environmental and Social Justice (ESJ) Community Engagement Plan (ESJ Plan) and a

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[8] *Id.* at 75-77 (Ordering Paragraph (OP) 6).

[9] *Id*. at 74 (OP 3(d)), 77 (OP 6(p)).

[10] *Id*. at 76-78 (OP 6(m), 7, 8).

[11] *Id*. at 74 (OP 3(h)), 77-78 (OP 7-8).

[12] *Id.* at 76 (OP 6(j)-(o)).

[13] *Id.* at 75-77 (OP 6).

[14] *Id.* at 75-77 (OP 6).

[15] The Consolidated Report is available on SoCalGas's website at https://www.socalgas.com/regulatory/angeleslink and is appended to my testimony as NN-Attachment A.

Framework for Affordability Considerations (Affordability Framework) were developed, with stakeholder feedback, to comply with the Phase 1 Decision. The Angeles Link Phase 1 Studies Consolidated Report (Consolidated Report), attached to my testimony as Attachment A, distills the key findings of the Phase 1 studies and concisely describes what they collectively convey about Angeles Link.

In accordance with Ordering Paragraphs 6(n) and 6(o), the Phase 1 studies consider compliance with California environmental laws and public policies along with consistency with other Commission decisions, policies, and directives, including the Order Instituting Rulemaking R.20-01-007, Long-Term Gas Planning Order Instituting Rulemaking (Long-Term Gas Planning OIR) and R.13-02-008, Biomethane Standards and Requirements and Pipeline Open Access Rules Order Instituting Rulemaking. Multiple studies demonstrate how Angeles Link will comply with and further California's environmental laws, directives, and policies, including those of the Commission. For example, the Environmental Analysis evaluates potential environmental impacts of possible pipeline routes and configurations and finds that Angeles Link can be constructed and operated in accordance with environmental laws and public policies. It further concludes that Angeles Link is being undertaken in furtherance of the State's climate goals, as outlined in Assembly Bill (AB) 32 Climate Change Scoping Plan to "scal[e] up new options such as renewable hydrogen for hard-to-electrify end uses and biomethane where needed"[16] and Governor's Executive Order to develop California's Hydrogen Market Development Strategy.[17] The High-Level Feasibility Assessment & Permitting Analysis (Permitting Analysis) analyzed the potential regulatory and permitting requirements under California environmental laws, including potentially required authorizations from various state agencies. The GHG Emissions Evaluation (GHG Study) conducted an initial evaluation of overall GHG benefits associated with Angeles Link to demonstrate how clean renewable hydrogen could support environmental laws and public policies.

Furthermore, the ESJ Plan was developed with the Commission's Environmental and Social Justice Action Plan goals in mind. The Production Planning & Assessment (Production

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[16] CARB, *2022 Scoping Plan for Achieving Carbon Neutrality* (November 16, 2022) at 1, *available at:* https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp-es.pdf.

[17] State of California – Office of Governor Gavin Newsom, *Executive Order N-79-20* (September 23, 2020), *available at:* https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf.

Study) evaluates clean renewable hydrogen production potential and uses the definition of clean renewable hydrogen that is consistent with other CPUC decisions, policies, and directives, including the Long-Term Gas OIR and the Biomethane OIR. As stated in the recent Order Instituting Rulemaking to Establish Policies, Processes, and Rules to Ensure Safe and Reliable Gas Systems in California and Perform Long-Term Gas System Planning, R.24-09-012, the successor proceeding to the Long-Term Gas Planning OIR, "the primary purpose of gas transition planning is to facilitate decarbonization activities over time in a way that supports equity, safety and affordability, and mitigates reliability challenges, commodity price spikes and other potential adverse outcomes."[18] The High-Level Economic Analysis and Cost Effectiveness study (Cost Effectiveness Study) helps further this goal by comparing Angeles Link with other decarbonization methods, such as other hydrogen delivery alternatives, electrification, and carbon capture and sequestration (CCS).

Angeles Link aims to establish an open-access, non-discriminatory pipeline system dedicated to public use, facilitating the transportation of clean renewable hydrogen, defined in accordance with CPUC proceedings, in furtherance of California's decarbonization goals and enhancing energy system reliability and resiliency.

B. Stakeholder Engagement and Feedback

In its prior application A.22-02-007, SoCalGas proposed activities to engage stakeholders in the Angeles Link planning process, including establishing a Planning Advisory Group (PAG) for technical advice and collaboration on Angeles Link's design and development, holding periodic workshops, and submitting interim reports to the Commission and the public regarding Angeles Link status and updates.[19] Robust stakeholder engagement can promote transparency and alignment with needs and expectations, inform planning, help identify areas of interest and improvement, increase awareness and trust, and support innovation. The Commission agreed that active engagement with stakeholders is in the public interest, and that the data and analyses that SoCalGas planned to share with stakeholders resulting from the Phase 1 studies would be

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[18] R.24-09-012, Order Instituting Rulemaking to Establish Policies, Processes, and Rules to Ensure Safe and Reliable Gas Systems in California and Long-Term Gas System Planning (October 4, 2024) at 2, *available at*: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M542/K029/542029029.PDF.

[19] A.22-02-007, Application of Southern California Gas Company for Authority to Establish a Memorandum Account for the Angeles Link Project (February 17, 2022) at 29-30, *available at:* https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M451/K500/451500036.PDF.

beneficial to the development of the clean renewable hydrogen industry.[20] Accordingly, the Commission ordered SoCalGas to conduct certain stakeholder activities, including establishing the PAG, involving participation from community-based organizations—particularly disadvantaged and environmental social justice (ESJ) communities—that could be impacted by Angeles Link, and holding at least quarterly meetings to discuss project updates and gather feedback.[21] In addition, the Commission directed SoCalGas to make the results and findings of the Phase 1 studies available to the public.[22]

In accordance with the Phase 1 Decision, SoCalGas engaged with the Commission to create a 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.[23] SoCalGas continually updated the stakeholder engagement process based on feedback from participants and extended the length of Phase 1 to allow for additional engagement. Based on requests from the PAG and CBOSG for information to be shared more frequently, SoCalGas added additional workshops in between quarterly meetings. Ultimately, SoCalGas held 27 meetings and workshops with the 70 participating organizations from the PAG and CBOSG, as well as over 30 one-on-one meetings with members to solicit their feedback on the Phase 1 feasibility studies and PAG and CBOSG process. These stakeholder meetings included topics such as hydrogen safety, the hydrogen market, technical feasibility, environmental impacts, environmental justice, project design and study development updates. In response to requests from PAG and CBOSG members, SoCalGas invited a third party to present a "Hydrogen 101" educational presentation and the potential impacts and benefits of hydrogen at a July 2023 meeting.

Additionally, 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," or methodology for conducting each study, (3)

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[20] Phase 1 Decision at 29-31.

[21] *Id.* at 77 (OP 8).

[22] *Id.* at 31.

[23] In accordance with Ordering Paragraph 8(c), SoCalGas coordinated with the Energy Division to devise a plan and set of procedures to compensate CBOs. Details are provided in the Detailed Plan and Set of Procedures for Community Based Organization Compensation approved in Advice Letter No. 6146G.

preliminary findings based on initial data and results from the analysis, and (4) draft report.[24] These milestones were selected because they represented critical points at which relevant feedback could meaningfully influence the Phase 1 studies or inform future considerations. To facilitate this process, upon the distribution of materials at each milestone, PAG and CBOSG members were typically provided a minimum four-week comment period to provide feedback.[25] Stakeholder feedback was addressed in the Phase 1 quarterly reports, and feedback was incorporated into the studies as appropriate.

C. Findings and Benefits of Angeles Link

1. Executive Summary

As described by Ms. Brown, SoCalGas can play a crucial role in supporting the State in achieving its decarbonization goals. ARCHES has recognized that open-access pipelines will be critical for the efficient movement of hydrogen from production to end use.[26] Open-access pipeline infrastructure can enable the transport of low-cost, high-volume hydrogen throughout the region as the hydrogen economy scales and expands.[27] The Phase 1 studies, based on information available and known at the time, confirm the benefits that an open-access clean renewable hydrogen pipeline system can bring to Central and Southern California and SoCalGas ratepayers. They demonstrate Angeles Link could offer significant public interest benefits, including reduced GHG emissions, improved air quality and public health benefits (as described further in the Testimony of Dr. Sonja Sax), new employment opportunities, and supporting enhanced reliability and resiliency of the electric grid.

The Phase 1 Decision requires SoCalGas to provide certain findings from the feasibility studies before proceeding to Phase 2;[28] the studies are each discussed below. Collectively, the

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

[25] Members also had two weeks to review and provide feedback on the draft Affordability Framework and six weeks to provide feedback on the draft ESJ Plan.

[26] OCED – Regional Clean Hydrogen Hubs Program, *California Hydrogen Hub (ARCHES)* (July 2024) at 2, *available at:* https://www.energy.gov/sites/default/files/2024-07/H2Hubs%20ARCHES_Award%20Fact%20Sheet.pdf.

[27] ARCHES H2, *Technical Submission to DOE – April 2023* at 28, *available at:* https://archesh2.org/wp-content/uploads/2024/08/ARCHES-Technical-Volume-Redacted.pdf.

[28] Phase 1 Decision at 75-77 (OP 6).

Phase 1 studies, conducted with stakeholders providing input along the way, demonstrate that Angeles Link is viable and cost-effective, technically feasible, and in the public interest due to the substantial benefits Angeles Link could offer to ratepayers and the broader communities SoCalGas serves. They indicate that the design, permitting, and construction of a safe, reliable, and scalable pipeline system to connect third-party clean renewable hydrogen producers to end users is feasible. Some of the key findings of Phase 1 include:

- Demand for clean renewable hydrogen in SoCalGas's service territory could range from 1.9 MMTPY in the conservative scenario to 5.9 MMTPY in the ambitious scenario.

- Third parties can produce clean renewable hydrogen that meets the Commission's clean renewable hydrogen production standards and the projected demand to be served by Angeles Link over time.

- 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.

- Angeles Link's routes can be designed to connect potential third-party hydrogen production areas with end users.

- Clean renewable hydrogen transported by Angeles Link can be a cost-effective decarbonization pathway.

- Angeles Link is the most feasible and cost-effective hydrogen delivery option at scale across Central and Southern California, outperforming alternatives such as a localized hydrogen hub and trucking in terms of scalability, transport distances, and overall cost effectiveness.

- Angeles Link, as envisioned, could provide significant public interest benefits to ratepayers and the broader community. For example:

- Angeles Link could support significant decarbonization and air quality benefits, including the potential reduction of 4.5 to 9 MMTPY of carbon dioxide equivalent (CO_2e) (the equivalent of the annual GHG emissions of removing approximately 725,000 to 1 million gasoline passenger vehicles off the roads per year), and approximately 5,200 tons per year of Nitrogen Oxides (NO_x) emissions by 2045.

- Angeles Link has the potential to create nearly 53,000 direct construction-related jobs and nearly a total of 75,000 jobs when considering indirect and induced jobs[29]— offering opportunities to SoCalGas's existing workforce and others.

The studies' findings underscore the necessity and timeliness of further developing a clean renewable hydrogen system to help California meet its decarbonization goals. Accordingly, the Phase 1 studies' results support advancing to more in-depth planning and design activities in Phase 2.

2. Viability and Cost Effectiveness

The Phase 1 studies demonstrate the viability and cost effectiveness of an open-access, non-discriminatory pipeline system to connect clean renewable hydrogen production sites with demand and potential end users. The Demand Study identifies significant potential demand over time for clean renewable hydrogen. The Production Study and Water Resources Evaluation confirm the ability of third-party producers to produce sufficient clean renewable hydrogen, backed by water resources, to meet anticipated demand. Further, the Project Options & Alternatives Study (Alternatives Study), in conjunction with the High-Level Economic Analysis & Cost Effectiveness Study (Cost Effectiveness Study), indicate that using pipeline transportation, like Angeles Link, for clean renewable hydrogen can achieve economies of scale, making it a cost-effective solution for hard-to-electrify sectors.

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[29] Direct construction-related jobs are those specific to the actual construction and administration of the construction of Angeles Link, such as laborers. Indirect and induced impacts refer to jobs and economic output deriving from Angeles Link's construction needs and direct job creation. *See* Angeles Link Phase 1 Workforce Planning & Training Evaluation (Workforce Study), Appendix A, Employment Impact Analysis.

a. Demand Study

In accordance with Ordering Paragraphs 6(a) and (c), the Demand Study evaluated future potential clean renewable hydrogen demand and end uses across three major hard-to-electrify sectors: mobility (i.e., transportation), power generation, and industrial, including both existing and future SoCalGas ratepayers who would be potential end-users of Angeles Link. The evaluation process included defining sub-sectors, researching potential hydrogen end-users, developing models and scenarios, estimating demand volumes, and conducting validation interviews with industry peers and reviewers.[30]

The Demand Study evaluated the potential demand for clean renewable hydrogen in SoCalGas's service territory under three scenarios reflecting conservative, moderate, and ambitious assumptions of hydrogen adoption. The study estimates that demand could range from 1.9 MMTPY in the conservative scenario to 5.9 MMTPY in the ambitious scenario. Demand comes primarily from the mobility sector in the conservative scenario, driven by heavy-duty vehicles. In the moderate and ambitious scenarios, the power and industrial sectors play an increasingly large role with power becoming the largest sector by demand volume.[31] The demand estimates served to inform a projected throughput range for Angeles Link of approximately 0.5-1.5 MMTPY.[32]

The data from the throughput scenarios were used to inform various Phase 1 studies, such as the GHG Study, NOx and other Air Emissions Assessment (NOx Study), Production Study, Pipeline Sizing & Design Criteria (Design Study), Preliminary Routing and Configuration Analysis (Routing Analysis), Alternatives Study, and Cost-Effectiveness Study.

The Demand Study also identified potential existing natural gas end users who could take service from Angeles Link. These include heavy-duty vehicle operators, bus fleet operators, power generation facilities, metal fabrication shops, manufacturing/processing facilities, food and beverage facilities, and other industrial end uses. Potential future customers who are not

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[30] Analysis was based on the latest market and technology information and was peer reviewed by experts at third parties, including National Renewable Energy Lab (NREL), South Coast Air Quality Management District (SCAQMD), University of California Los Angeles (UCLA), UC Irvine (UCI), and UC Davis (UCD). *See* Demand Study at 86.

[31] *Id.* at 7.

[32] *Id.* at 77-78.

currently served by SoCalGas and could use clean renewable hydrogen transported by Angeles Link include additional zero-emission vehicle mobility/transportation end users, such as commercial harbor craft operators, ocean-going vessel operators, and locomotive operators.[33] As described by Ms. Kitson, continued analysis in Phase 2 will further identify and refine potential customers of Angeles Link.

In compliance with the Phase 1 Decision, the Demand Study estimated potential clean renewable hydrogen demand by 2045 and identifies potential current and future end-users, including current natural gas customers and future customers. A portion of the potential demand in SoCalGas's service territory could be served by Angeles Link. This study also denoted that clean renewable hydrogen is a viable decarbonization solution that can accelerate and support the State's broader decarbonization goals.

b. Production Planning and Assessment (Production Study)

In accordance with Ordering Paragraphs 6(b) and (j), the Production Study identified potential third-party sources of hydrogen production, estimated costs of third-party hydrogen production,[34] and addressed plans for ways to ensure the hydrogen transported by Angeles Link meets the clean renewable hydrogen standards set forth in the Phase 1 Decision.

The Production Study reviewed various clean renewable hydrogen production technologies. The study identified solar generation paired with Proton Exchange Membrane (PEM) electrolyzers as the primary renewable energy source and technology likely to be used for clean renewable hydrogen production at scale for transport by Angeles Link, due to its maturity, cost-effectiveness, and the abundance of solar irradiance in SoCalGas's service territory.[35] The study also considered other renewable energy sources and technologies that are suitable for production of clean renewable hydrogen, but on a smaller scale, due either to current resource limitations in Central and Southern California or design and operational requirements.

The study conducted a preliminary analysis of the potentially available land for hydrogen production. Potential production locations included the San Joaquin Valley, Lancaster, and Blythe. The study determined that these locations could alone, or in some combination

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[33] *Id.* at 18.

[34] As discussed in the Production Study, SoCalGas does not intend to own or operate hydrogen production facilities for Angeles Link.

[35] *See* Production Study at 2.

(depending on the throughput levels), meet the 0.5-1.5 MMTPY Angeles Link throughput range.[36]

The Production Study also included an initial evaluation of hydrogen storage technology. SoCalGas assessed hydrogen storage proximity to the Central and Southern California region and both aboveground and underground technologies. The study found storage could play an important role in balancing hydrogen supply with demand as the hydrogen market scales because of the intermittent nature of renewables and the expected demand profiles of the power generation, mobility, and industrial sectors.[37] Angeles Link could provide storage in the pipeline system via line pack and looping and could support the transportation of hydrogen from producers, in and out of third-party storage, and to demand locations.[38]

Capital and operating costs to third-party producers to meet the throughput scenarios projected for Angeles Link were estimated at \$3,700/kW and \$38/kW (annual expense), respectively. These estimated production costs provided inputs for the Cost Effectiveness Study, which estimated the levelized delivered cost of hydrogen (i.e., total cost inclusive of third-party production, transport, etc.) based on throughput.

The Production Study outlined several potential measures that SoCalGas could take to confirm that hydrogen transported by Angeles Link meets the clean renewable hydrogen standards identified in the Phase 1 Decision, such as on-going monitoring of industry guidance and certification standards, developing contractual arrangements with third-party certification agencies, developing appropriate tariffs and interconnection requirements, and requiring quality

[36] To support a production volume of 1.5 MMTPY, approximately 240,000 acres of land would be required, which represents approximately 12% of the land identified as potentially available for hydrogen production from all three production areas. For the 1.5 MMTPY case, just under 15% of the land area within the Lancaster and San Joaquin Valley production areas would be required in a scenario assuming production from only those two production areas. *See* Production Study at 43.

[37] *Id.* at 2-3.

[38] Storage volumes would be dependent on various factors, such as the type of renewable power source used to make hydrogen, the anticipated hourly demand profiles for power generation, mobility, and industrial sectors, and the system hydrogen demand volumes. Depending on the volume required, storage could be provided in a number of manners, including line pack (e.g., storage within the pipeline), construction of a parallel pipe in a portion or portions of the pipeline system, on-site storage at third-party clean renewable hydrogen producers or end users, and/or dedicated above-ground or underground storage. *Id*. at 3.

terms applicable to any SoCalGas procurement of hydrogen.[39] Other measures such as inquiries, surveys, examination of records, and inspections could also serve as verification tools.[40] These practices can help establish a rigorous framework that supports the integrity of Angeles Link and confirms the transportation of clean renewable hydrogen.

The Production Study denoted the viability of clean renewable hydrogen production in SoCalGas's service territory, identifies a potential framework to enable adherence to clean renewable hydrogen standards, and indicates a potential market whereby Angeles Link could deliver clean renewable hydrogen from production areas to demand areas.

c. Water Resources Evaluation

In accordance with Ordering Paragraph 6(b), the Water Resources Evaluation identified the potential sources and costs of water required by third parties to produce clean renewable hydrogen. The study included a high-level analysis of potential water supply sources, water quality requirements for electrolyzers, the associated costs for acquisition and treatment of those water sources, and the challenges and opportunities related to water supply development.

The Water Resources Evaluation concluded that the water required for third-party clean renewable hydrogen production to meet the estimated 2045 hydrogen demand across SoCalGas's service territory represents a small fraction (approximately 0.02 to 0.10 percent) of California's total annual water usage. Multiple existing water supplies, such as surface water, treated wastewater, groundwater, brine line flows, and urban stormwater capture could be utilized, and new supplies could be developed if necessary. Third-party producers have multiple mechanisms to secure water supplies, such as through exchange agreements, local water agencies (e.g., purchasing available supply), water markets (e.g., adjudicated groundwater rights), or through land purchases with water rights. The potential water supply sources available to feed specific clean renewable hydrogen production projects are expected to be further evaluated and developed by third parties on a case-by-case basis as more details on specific clean renewable hydrogen production projects are developed.

The Water Resources Evaluation noted that PEM electrolyzer technologies require treated water. The evaluation identified high-level cost estimates for water supply development

[39] *Id.* at 9-10.

[40] *Id.* at 9.

that included estimated costs for water treatment, concentrate management, conveyance, and water acquisition.[41]

d. Project Options and Alternatives (Alternatives Study) and High-Level Economics and Cost Effectiveness Study (Cost Effectiveness Study)

In accordance with Ordering Paragraph 6(d), the Alternatives Study evaluated potential hydrogen delivery alternatives (e.g., truck delivery, localized hydrogen hubs) and non-hydrogen alternatives (e.g., electrification and carbon capture and storage (CCS)) to Angeles Link using a multi-step evaluation framework. The first steps identified potential alternatives and assessed them against the following criteria: state policy, range, ease of implementation, scalability, reliability, and resiliency. Then, the alternatives selected were advanced to the Cost Effectiveness Study for cost analysis and the Environmental Analysis for a high-level environmental assessment. The final step gathered the results from the Cost Effectiveness Study and Environmental Analysis and then evaluated each alternative for its ability to meet the objective and purpose for Angeles Link.

Considering all the criteria, the Alternatives Study 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 CCS and electrification.

With respect to hydrogen delivery alternatives, the studies identified economies of scale provided by an open-access hydrogen pipeline system, such as Angeles Link, which helps support meeting the projected clean renewable hydrogen demand in Central and Southern California, including in the Los Angeles Basin and the ports of Los Angeles and Long Beach. While other hydrogen delivery alternatives could serve a portion of the estimated clean renewable hydrogen demand, none of the delivery alternatives evaluated had the ability to meet the throughput volumes, transport distances, or cost-effectiveness of a pipeline system at the scale needed to help meet California's decarbonization targets.[42] For example, due to the

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[41] The estimated combined costs for water supply development projects would range from $436 million to 1,308 million, inclusive of construction costs and net present value (NPV) operation and maintenance (O&M) costs for 30 years of operation.

[42] Alternatives Study at 11.

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.

With respect to non-hydrogen alternatives, the studies concluded that Angeles Link is well-suited to meet the operational requirements of certain end uses, including heavy-duty transportation, dispatchable power generation, and hard-to-electrify industrial customers. In particular, Angeles Link was identified as a key contributor to support electric grid reliability and resiliency by supporting dispatchable, clean firm generation and serving the hard-to-electrify sectors while providing decarbonization benefits. Further, the Alternatives Study identified that long-haul, high payload, high-duty cycle hydrogen fuel cell electric vehicles (FCEVs) such as long-range trucks and buses are better suited to purpose than battery electric vehicles (BEVs).[43] While CCS has the potential to contribute to the decarbonization of certain industrial sectors, the study found that CCS may present location-specific infrastructure, development, and operational challenges to adoption in the power generation sector. CCS also is not a technically feasible solution for capturing tailpipe emissions in the mobility sector.[44]

The 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. 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.

The Cost Effectiveness Study used available information to assess Angeles Link's cost effectiveness as compared to those alternatives identified in the Alternatives Study. 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

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[43] Notably, Angeles Link would support both FCEVs and BEVs by providing clean renewable hydrogen for direct use by FCEVs and supporting the electric grid for use by BEVs.

[44] Alternatives Study at 12.

hydrogen into the Los Angeles Basin at scale.[45] The study found 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 CCS.[46] In the mobility and power generation sectors, hydrogen delivered via Angeles Link was found to be overall competitive with electrification.

3. Technical Feasibility

Several Phase 1 studies assessed the technical feasibility of Angeles Link through a series of detailed evaluations and assessments, including safety, engineering and design studies, compliance with applicable permitting and environmental review requirements, mitigation plans for potential hydrogen leakage, and environmental analysis. Safety is foundational at SoCalGas, and therefore a focus of Phase 1 was to establish that Angeles Link can be designed, constructed, operated, and maintained safely.

a. Evaluation of Applicable Safety Requirements

In accordance with Ordering Paragraph 6(f), this evaluation identified safety concerns involved in pipeline transmission, storage, and transportation of hydrogen and applicable safety regulatory requirements and industry standards for employees, contractors, infrastructure, and public safety. The evaluation also considered how SoCalGas can refine and expand its existing operations and maintenance procedures and safety practices to support Angeles Link. At SoCalGas's request, and in response to stakeholder feedback, the Center for Hydrogen Safety's

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[45] To compare Angeles Link with the hydrogen delivery alternatives, the study used the estimated cost to produce clean renewable hydrogen from the Production Study and the pipeline cost from the Design Study to determine the Levelized Cost of Delivered Hydrogen (LCOH) for Angeles Link.

[46] The cost effectiveness of Angeles Link relative to non-hydrogen alternatives was measured using a set of industry-standard cost metrics customized to each end use across the mobility, power generation, and industrial sectors. The comparison in the power sector used the levelized cost of electricity (LCOE), which represents the average revenue per unit of electricity generated that would be required to recover the return on capital related to costs of building and operating a generating plant. The comparison in the mobility sector used the total cost of ownership (TCO), a metric representing a lifetime dollar per mile and includes initial purchase cost, maintenance and repairs, operations, fuel cost, and taxes and subsidies. The comparison in the industrial sector used the fuel (or electricity) costs associated with operating the equipment in the respective end use case.

Hydrogen Safety Panel conducted a third-party review of the draft evaluation.[47] The Hydrogen Safety Panel's recommendations, including identifying areas for further assessment as Angeles Link is advanced, were incorporated as appropriate into the final evaluation.

As detailed in the evaluation, existing regulations (e.g., Title 49 Code of Federal Regulations (CFR) Part 192) and industry standards (e.g., American Society of Mechanical Engineers (ASME) B31.12 and National Fire Protection Association (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, leak detection and monitoring programs, emergency response procedures, and public awareness plans. Lessons learned from prior industry and third-party experience with hydrogen was also considered. The evaluation reviewed SoCalGas gas standards and specifications to identify potential impacts, required updates, and/or new processes to be created to accommodate a clean renewable hydrogen pipeline system, highlighting SoCalGas's ability to refine and expand its existing safety practices, including existing emergency response and public awareness plans and training for employees and contractors.

The safety evaluation demonstrates that SoCalGas is well positioned to safely design, build, operate, and maintain a clean renewable hydrogen pipeline system.

b. Pipeline Sizing and Design Criteria (Design Study)

To support the identification and comparison of possible routes and configurations for Angeles Link in accordance with Ordering Paragraph 6(i), the Pipeline Sizing and Design Criteria Study established a preliminary engineering and design basis for the transport of clean renewable hydrogen via pipeline. This study assessed potential pipeline sizes for the pipeline route from production to end use, identified potential materials for the pipeline system, evaluated compression characteristics and options, and used preliminary estimated cost(s) of the Angeles Link pipeline system.

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 pipeline configurations were assessed to maintain functional flexibility to allow for

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[47] 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.

fluctuating or growing demand. The Design Study findings include that pipe sizes could range from 16-inch to 36-inch in nominal diameter and, to maintain system efficiency and reliability, two or three compressor stations may be required to achieve the target delivery pressure to the Ports of Los Angeles and Long Beach. Select pipeline segments were hydraulically modeled for flexibility, resiliency, and capacity considerations. 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. The American Petroleum Institute (API) 5L X52 pipe, which is one that SoCalGas and the industry already uses today, was recommended based on preliminary calculations and operating parameters.

The Design Study demonstrates the feasibility of designing a safe, reliable, resilient, and cost-effective pipeline system to support transportation of clean renewable hydrogen from producers to end users.

c. Preliminary Routing/Configuration Analysis (Routing Analysis)

In accordance with Ordering Paragraph 6(i), this study evaluated potential routing and configuration options for Angeles Link. The study identified several preliminary conceptual preferred routes for the system, considering various factors such as engineering requirements and environmental and social impacts. The study examined existing pipeline corridors, designated federal energy corridors, as well as the need for new rights-of-way. The process was inherently iterative, as it required the integration of information received from various sources and other Phase 1 studies over the duration of this study. The study considered initial route configurations that 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.

The Routing Analysis identified four potential directional routes, depicted in Figures 1 and 2 above, and, in response to stakeholder feedback, discussed a potential route variation which reduces route mileage through disadvantaged communities. These routes aim to connect potential regional producers and end users as identified by the Production and Demand studies, including throughput of up to 1.5 MMTPY. They also aim to connect potential ARCHES production and offtake sites, including by incorporating the Hub Segments.[48] The route configurations reflect understanding as of the time of analysis 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.

d. Hydrogen Leakage Assessment (Leakage Study)

In accordance with Ordering Paragraph 6(g), the Hydrogen Leakage Assessment assesses the potential for hydrogen leakage associated with new infrastructure, as well as opportunities to mitigate the potential for hydrogen leakage.

The study evaluated available literature regarding potential hydrogen leakage associated with general hydrogen infrastructure (compression and transmission, as well as third-party production and third-party storage), and potential leakage associated specifically with Angeles Link infrastructure (i.e., transmission of hydrogen via pipeline, including compression). The study found that the potential for leakage depends on various factors such as the type and quantity of equipment used, infrastructure design and engineering, pipeline placement and routing, and operating and maintenance practices.

The study estimated the potential leakage for Angeles Link infrastructure to be between 850 metric tons per year (MT/yr) for the low throughput scenario to 4,065 MT/yr for the high throughput scenario. The study 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. Strategies to minimize leakage include in the design and engineering of new infrastructure, effective operating and maintenance procedures, and the use of sensor technologies for early leak detection and conducting prompt repairs. The study found that operating 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 percent from assumed leakage rates in the literature.[49]

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[48] The study also compared the costs of the evaluated routes, based on cost estimates developed in the Design Study discussed in Section 6 (Cost Estimates). *See* Design Study at 61-66.

[49] Leakage Study at 4-26.

e. High-Level Feasibility Assessment & Permitting Analysis (Permitting Analysis)

To further support the identification and comparison of potential directional routes and configurations for Angeles Link in accordance with Ordering Paragraph 6(i), SoCalGas conducted a high-level assessment of potential environmental and regulatory approvals that may be required, including federal and state environmental permitting and regulatory approvals, and an assessment of regulatory approval timing. Key permitting considerations also included identification of the likely federal National Environmental Protection Act (NEPA) and state California Environmental Quality Act (CEQA) lead and cooperating or responsible agencies that may be involved in project permitting and review. As a preferred route for Angeles Link is refined, additional authorizations may be identified. Permitting timelines, based on current regulations and past experiences, could range from months to several years, but these may change if permit streamlining legislation impacting clean hydrogen projects like Angeles Link is adopted.

f. Environmental Analysis

In accordance with Ordering Paragraphs 6(i) and 6(n), the Environmental Analysis provides a desktop assessment of potential environmental impacts of Angeles Link as well as specified alternatives identified in the 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 would be short-term and temporary and 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; however, some necessary aboveground facilities (e.g., valve and compressor stations) would create permanent impacts. As Angeles Link progresses, a complete environmental review of Angeles Link and project alternatives would be conducted in compliance with relevant laws and policies, including CEQA and/or NEPA, as applicable, by the public agencies considering applications for discretionary permits.

4. Angeles Link Is in the Public Interest

The Phase 1 Decision identified that Angeles Link could offer public interest benefits to the Los Angeles Basin and the State of California, specifically that "the public interest is served if SoCalGas studies whether Angeles Link is feasible, cost-effective, and viable."[2] The Phase 1 studies confirm that Angeles Link, as envisioned, could provide significant public interest benefits to ratepayers and the broader community. Accordingly, the further pursuit of Angeles Link, as proposed for Phase 2, is in the public interest.

a. GHG Emissions Evaluation (GHG Evaluation)

In accordance with Ordering Paragraph 6(n), the GHG Evaluation assessed the potential GHG emissions reductions associated with displaced emissions from end users in the mobility, power generation, and hard-to-electrify industrial sectors as well as potential GHG emission increases associated with new hydrogen infrastructure (i.e., third-party production and storage, and pipeline transmission) to estimate overall GHG emission reductions. The analysis showed that in 2045, based on anticipated throughput scenarios, the Angeles Link system could result in a reduction of between 4.5 to 9 MMTPY of carbon dioxide equivalent (CO2e).[50] These reductions are primarily attributable to the mobility sector, followed by the power generation and hard-to-electrify industrial end-user sectors. GHG reductions in the mobility sector are equivalent to removing from the road 725,000 and more than 1 million gasoline passenger vehicles for the low and high throughput scenarios, respectively.

In response to stakeholder feedback, the evaluation incorporated a preliminary high-level volumetric estimate of potential leakage and assessed its impact on projected GHG reductions. While Angeles Link infrastructure would have associated emissions, the evaluation highlighted that they are small in comparison to the estimated GHG reductions associated with end users. The evaluation concluded that the overall impact of potential leakage on estimated GHG reductions is likely to be less than 1 percent.

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[50] The estimates account for emissions from third-party production and storage, and pipeline transmission of clean renewable hydrogen.

b. Nitrogen Oxides and Other Air Emissions Assessment (NOx Study)

In accordance with Ordering Paragraph 6(h), the NOx Study evaluated potential emissions associated with Angeles Link, including appropriate controls to mitigate such emissions. The assessment evaluated potential emissions reductions associated with end users in the mobility, power generation, and hard-to-electrify industrial sectors, as well as potential NOx emissions associated with new hydrogen infrastructure to estimate overall anticipated emissions reductions. To do this, the NOx Study estimated the quantities of diesel and gasoline displaced by hydrogen fuel cells in the mobility sector, and natural gas displaced by clean renewable hydrogen in the power generation and hard-to-electrify industrial sectors, that corresponded to the Angeles Link throughput scenarios and assumptions from the Demand Study.[51] The analysis showed that the Angeles Link system could result in a reduction of approximately 3,800 to 5,200 tons per year of NOx emissions in 2045, primarily due to fuel displacement in the mobility sector, and particularly from heavy-duty vehicles. 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. Comparing the spatial evaluation to a geographic depiction of environmental justice communities demonstrates the potential air quality benefits for disadvantaged communities (DACs) in California.

The study also found that potential NOx emissions associated with clean renewable hydrogen infrastructure are relatively small compared to the reductions resulting from end users' use of clean renewable hydrogen. The study also evaluated existing and emerging emissions reduction technologies and identified emissions control equipment that could effectively mitigate NOx emissions.

[51] Demand Study at 23-30.

c. Workforce Planning & Training Evaluation

In accordance with Ordering Paragraph 6(e), the Workforce Planning & Training Evaluation estimated the potential job creation and workforce development associated with Angeles Link.[52]

With respect to job creation, the evaluation demonstrated that Angeles Link can create at peak nearly 53,000 direct construction-related jobs and a total of approximately 75,000 jobs when considering indirect and induced jobs that occur through wage earners spending income.[53]

With respect to workforce development, the evaluation discussed how SoCalGas's existing workforce planning programs can be refined to support hydrogen infrastructure, leveraging the company's longstanding experience in safely and reliably operating and maintaining a pipeline system. The evaluation recommended training and qualifications necessary for the workforce to operate and maintain hydrogen infrastructure. The evaluation also analyzed operations and maintenance protocols for utility workers regarding hydrogen infrastructure and workforce needs. This evaluation identified skills necessary to execute those operational and maintenance tasks, including leak survey, integrity management, and risk mitigation. The evaluation also identified potential changes for technologies and systems, work processes, and personnel resources for hydrogen infrastructure, along with education/training, operator qualifications, and job classification considerations.

The evaluation demonstrated that SoCalGas's existing workforce planning and training programs, models, and philosophies can be adapted to apply to Angeles Link. Given the similarities between natural gas and hydrogen pipeline construction, operations, and maintenance, there are existing similar job classifications and skill sets that are readily transferable to Angeles Link. The evaluation confirmed that Angeles Link workforce development can support the local economy while constructing, operating, and maintaining Angeles Link safely.

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[52] The workforce includes personnel responsible for operating and maintaining the Angeles Link infrastructure, including field employees, management personnel, and engineering and technical staff.

[53] Direct construction-related jobs are those specific to the actual construction and administration of the construction of Angeles Link, such as laborers. Indirect and induced impacts refer to jobs and economic output deriving from Angeles Link's construction needs and direct job creation.

d. Affordability Framework

In accordance with Ordering Paragraphs 5(a) and 6(k), the Affordability Framework described how Angeles Link's planning process considered and identified opportunities to mitigate affordability concerns. The framework (1) described the CPUC's general regulatory framework for evaluating affordability and approving rates; (2) discussed California's projected decarbonization costs more broadly to provide context for the proposed investment in Angeles Link; (3) summarized the Phase 1 work SoCalGas conducted on cost-effectiveness as a building block to consider the affordability of Angeles Link and consider stakeholder feedback; and (4) identified potential strategies for addressing cost-effectiveness and affordability in Angeles Link's development in Phase 2 and beyond, including in coordination with the CPUC and stakeholders on matters that extend beyond SoCalGas's control (e.g., exploration of potential non-ratepayer funding, potential need for legislative action, or CPUC approval).

As part of the efforts described in the framework, SoCalGas is considering affordability on both a system-wide basis and individual basis for customers. The Affordability Framework is part of the ongoing process to timely address and mitigate affordability concerns in the development of Angeles Link.

e. Environmental and Social Justice Community Engagement Plan (ESJ Plan)

In accordance with Ordering Paragraph 6(l), the ESJ Plan supports the Commission's directive to address and mitigate impacts to disadvantaged communities and other environmental concerns. The ESJ Plan also responds to stakeholder 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 utilize for ESJ stakeholder engagement during Phase 2. Additionally, the plan described how SoCalGas's engagement strategies align with the goals of the CPUC's Environmental and Social Justice Action Plan, such as 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. 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 identified in Phase 1. Of the 564 census tracts that would be crossed by the 1,300 miles of potential directional pipeline routes, the plan identified 373 census tracts with a DAC designation, as defined in the ESJ Plan. The ESJ Screening information and feedback from stakeholders led to the development of Route Variation 1, discussed above in connection with the Preliminary Routing/Configuration Analysis, which is a potential directional routing option that reduces pipeline mileage through DAC areas, for further consideration in Phase 2.

IV. TIMELY ADVANCEMENT TO PHASE 2 SUPPORTS ALIGNMENT WITH DOE AND ARCHES' TIMELINE FOR THE CALIFORNIA HYDROGEN HUB

Building on the findings in the Phase 1 Studies, as described by Ms. Kitson and Mr. Walker, the next stage of Angeles Link would include, among other things, 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.

Phase 2 activities must be commenced promptly to best position SoCalGas and Angeles Link to support meeting ARCHES' timeline for the California Hydrogen Hub to be operational. As described by Ms. Brown, ARCHES and DOE have signed an agreement for up to $1.2 billion in federal funding for the California Hydrogen Hub. As discussed below, DOE's funding for the California Hydrogen Hub is contingent on certain project milestones being met in accordance with a set timeline, and ARCHES envisions facilities and infrastructure—including portions of Angeles Link—to begin being operational by December 31, 2033.

In September 2022, DOE issued Funding Opportunity Announcement DE-FOA-0002779 (FOA) to solicit applications for six to ten regional clean hydrogen hubs (H2Hubs) to receive federal funding from the 2021 Infrastructure Investment and Jobs Act (IIJA). The stated purpose of this program is to "catalyze investment in the development of H2Hubs that demonstrate the production, processing, delivery, storage, and end-use of clean hydrogen, in support of the goal to achieve a carbon-free electric grid by 2035 and a net-zero emissions economy by 2050."[54]

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[54] DOE, *FOA* (September 22, 2022) at 6, *available at:* https://oced-exchange.energy.gov/FileContent.aspx?FileID=40a1ff87-622d-4ef5-8d7c-89bfe089fd11.

Seventy-nine applicants submitted concept papers to DOE for potential hydrogen hubs and DOE issued notices of encouragement to 33 of those projects. At least 20 potential hubs submitted full applications to DOE and ultimately ARCHES was one of the 7 selected in this highly competitive solicitation.

According to the FOA, DOE funding for the H2Hubs is divided in a four-phased structure that is intended to manage scope, schedule, deliverables, and budget for each hub. DOE Phase 1 involves "detailed project planning" and encompasses initial planning and analysis activities to ensure that the overall H2Hub concept is technologically and financially viable. Deliverables for this first phase include front-end engineering and design (approximately 30%) and a Class 3 cost estimate. DOE has stated that applicants should plan approximately 12-18 months for DOE Phase 1, depending on the extent of advanced planning and analysis each team has already completed.[55] DOE Phase 2 is the "project development, permitting, and financing" phase where H2Hubs will finalize engineering designs and business development, site access, labor agreements, permitting, offtake agreements, and community engagement activities. DOE expects that DOE Phase 2 activities will take up to 2 to 3 years.[56] DOE Phase 3 is the "installation, integration, and construction" phase. DOE expects that DOE Phase 3 activities may take approximately 2 to 4 years, but applicants may propose shorter or longer lengths as long as the overall H2Hub project length is no longer than 12 years.[57] Finally, DOE Phase 4 is the "ramp-up and sustained operations" phase, where H2Hubs are intended to reach full operation including data collection to analyze the H2Hub's operations, performance, and financial viability. DOE expects that DOE Phase 4 activities may take approximately 2 to 4 years but may extend longer depending on H2Hub-specific characteristics, including factors such as the rate of production ramp-up.[58]

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[55] *Id.* at 20.

[56] *Id*. at 20-21.

[57] *Id*. at 21.

[58] *Id*. at 22.

DOE has committed to fund up to $30 million for DOE Phase 1 activities.[59] Additional funding for subsequent phases will require successful completion of a "Go/No-Go" review at the end of each phase. Specific Go/No-Go criteria are negotiated with each selected H2Hub project for transitions between each phase. DOE has indicated that funding for the H2Hubs (or portions of a H2Hub) may be discontinued at any of the Go/No-Go decision points if the Go/No-Go criteria, project, and/or program requirements are not met.[60]

As Ms. Brown describes in her testimony, Angeles Link is an integral part of the California Hydrogen Hub. Accordingly, SoCalGas aims to align timing expectations and sharing of other relevant market, community, or technical information with ARCHES to support the California Hydrogen Hub to best leverage federal funds for the benefit of all Californians and unlock the hydrogen economy.

The following timeline overlays the DOE phases with SoCalGas's expected schedule to conduct future activities to advance Angeles Link. This schedule shows the activities that must occur for the Hub Segments to be operational by the end of 2033.

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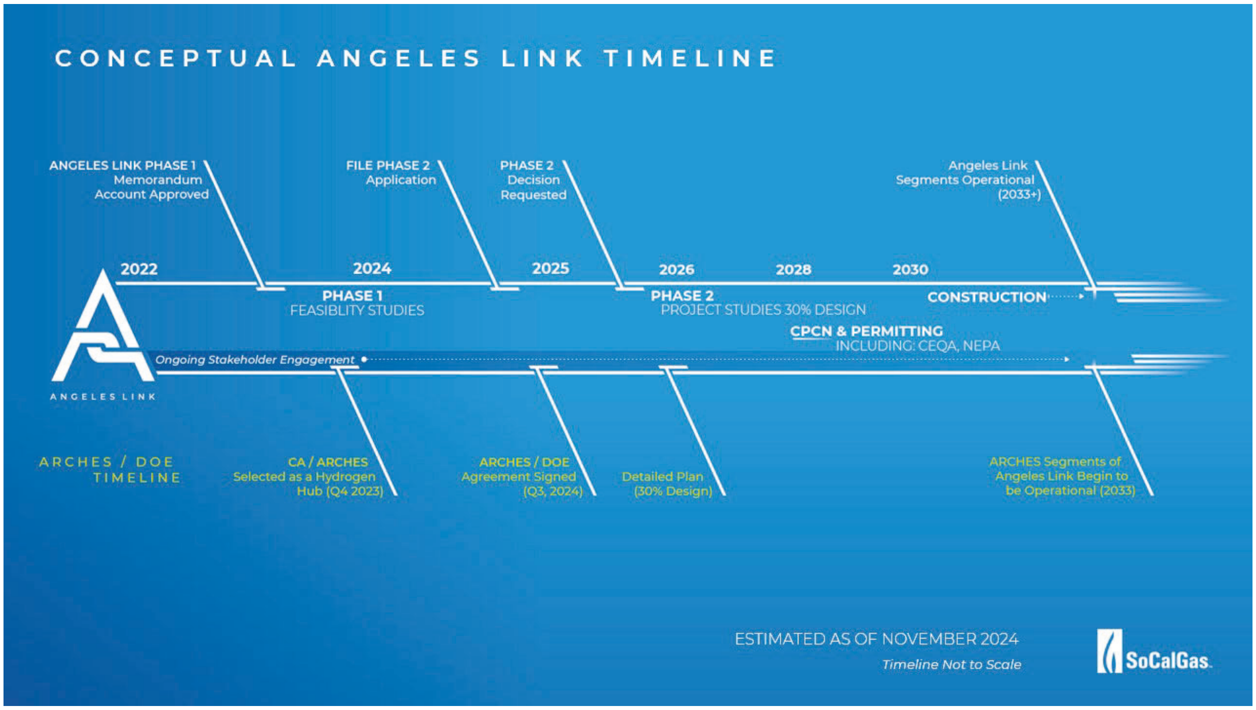
59 OCED – Regional Clean Hydrogen Hubs Program, *California Hydrogen Hub (ARCHES) Awardee Fact Sheet* (July 2024) at 2, *available at:* https://www.energy.gov/sites/default/files/2024-07/H2Hubs%20ARCHES_Award%20Fact%20Sheet.pdf.

60 DOE, *FOA* (September 22, 2022) at 22-23, *available at:* https://oced-exchange.energy.gov/FileContent.aspx?FileID=40a1ff87-622d-4ef5-8d7c-89bfe089fd11.

Figure 3 - Conceptual Angeles Link Timeline



The Public Advocates Office recently analyzed the development timelines of approved and commissioned electric transmission projects to understand development bottlenecks and found "the average project took over a decade to be built and a comparatively short period was spent on physical construction."[61] It found further, "The majority of the project development time was attributable to planning and review, by both oversight agencies and project developers. For example, project developers spent a notable amount of time outside of official regulatory review processes to conduct detailed engineering, business development, and environmental analyses. These activities are necessary to complete project application for the California Public Utilities Commission-led economic and environmental reviews."[62] This is also consistent with my experience with linear projects. Accordingly, in order for SoCalGas to be positioned to meet ARCHES' operational goal of December 31, 2033 for the California Hydrogen Hub, and assuming permitting reform, SoCalGas would need to commence Phase 2 activities at the start of 2026.

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[61] State of California – The Public Advocates Office, *Transmission Project Development Timelines in California* (June 12, 2023) at 1, *available at:* https://www.publicadvocates.cpuc.ca.gov/press-room/reports-and-analyses/transmission-project-development-timelines-in-california.

[62] *Id.*

V. CONCLUSION

This concludes my prepared direct testimony.

VI. QUALIFICATIONS

My name is Neil P. Navin. I am the Senior Vice President, Engineering and Major Projects, and Chief Clean Fuels Officer for SoCalGas. My business address is 555 West Fifth Street, Los Angeles, California 90013. I graduated from McGill University in 1991 with a Bachelor of Science degree in Chemical Engineering. I joined SoCalGas in 2014 and since that time, I have held numerous positions with increasing levels of responsibility including Vice President of Construction, Vice President of Gas Transmission & Storage, Director of Major Projects and Controls, Director of Project Management and Construction, and Director of Storage Risk Management. In my current position, my responsibilities include overseeing SoCalGas's engineering, system integrity, and capital project execution, in addition to the company's comprehensive portfolio of clean energy strategies, innovations, and projects. Prior to joining SoCalGas, I served as a project manager on several multi-billion-dollar mega-projects. Throughout my career, my roles have included project management, engineering management, and start-up for projects in refineries, oil and gas processing facilities, biofuels, fuel cells, chemical weapons destruction facilities, and petrochemical plants. Project scopes included conceptual engineering, technology licensing, basic engineering, front-end engineering, program management, and detailed engineering and design, procurement and construction efforts. I worked at Fluor in various project management positions of increasing responsibility and Parsons Corporation, first as a Process Engineer, then in various project management positions of increasing responsibility. I have over 30 years of domestic and international experience in various energy industries.

I have previously testified before the Commission.

ATTACHMENT A

ANGELES LINK PHASE 1 STUDIES CONSOLIDATED REPORT

ANGELES LINK

PHASE 1
STUDIES CONSOLIDATED REPORT

SoCalGas

TABLE OF CONTENTS

I. INTRODUCTION

ANGELES LINK

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 (CO2e) 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 (NOx) 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.

[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.

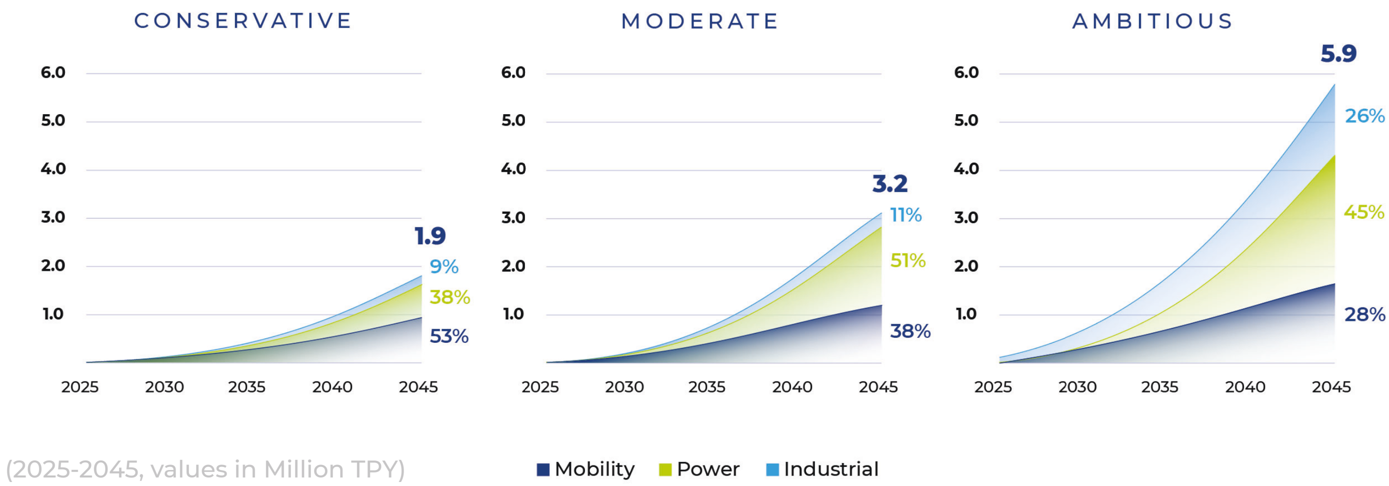

Figure 1. Clean Renewable Hydrogen Demand Forecast in SoCalGas's Service Territory, by Scenario[12]

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.

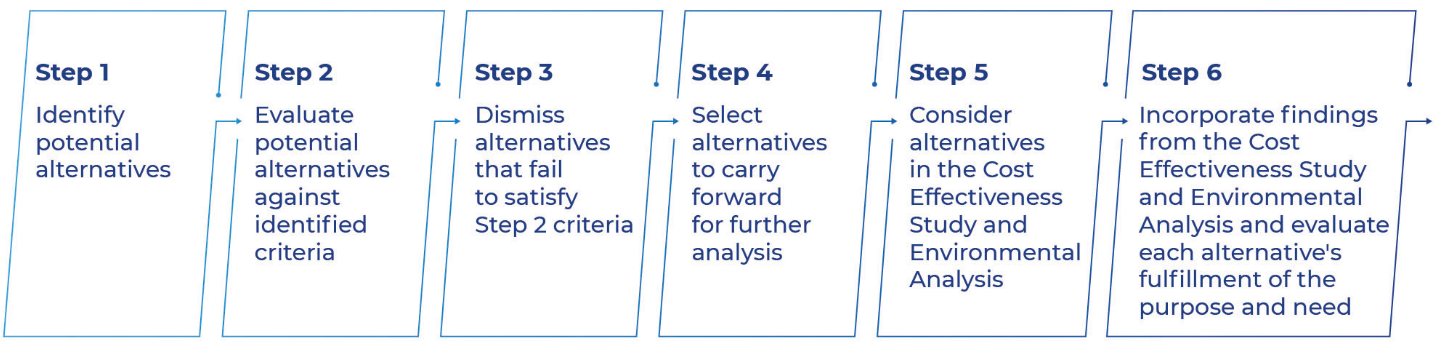

Figure 2. Overview of Six-Step Evaluation Process

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.

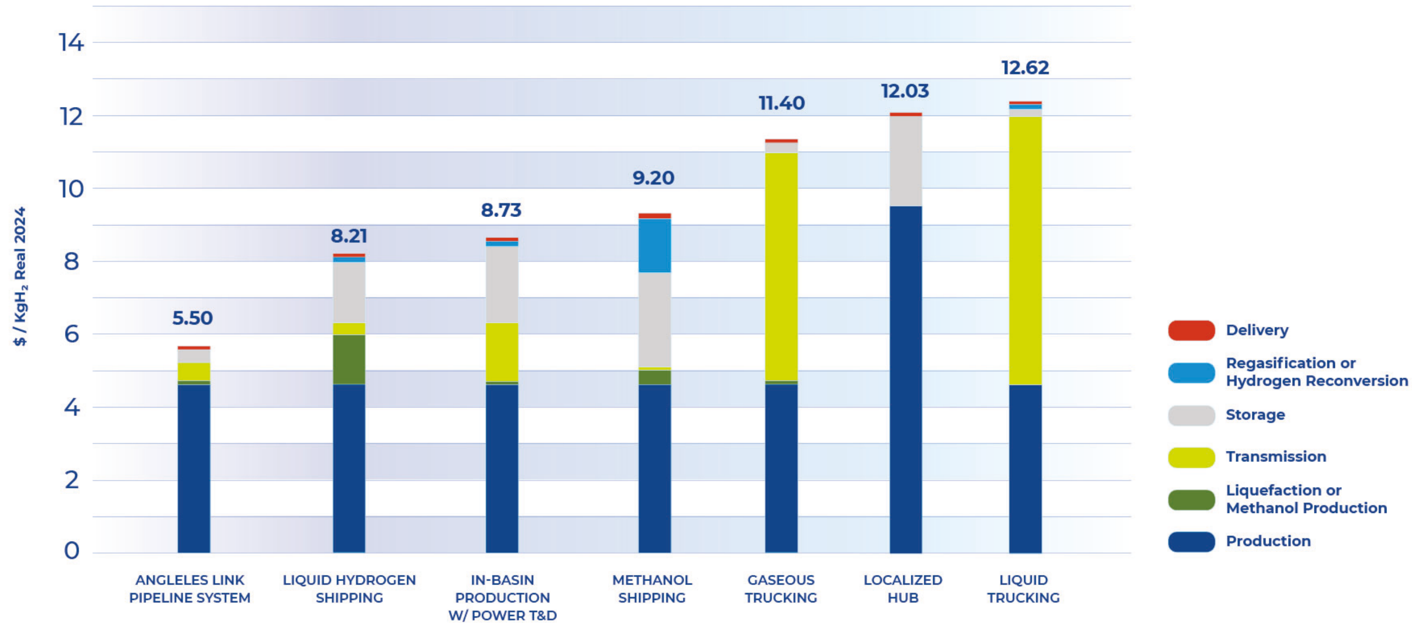

Figure 3. Cost Effectiveness of Angeles Link versus Hydrogen Delivery Alternative[15]

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.

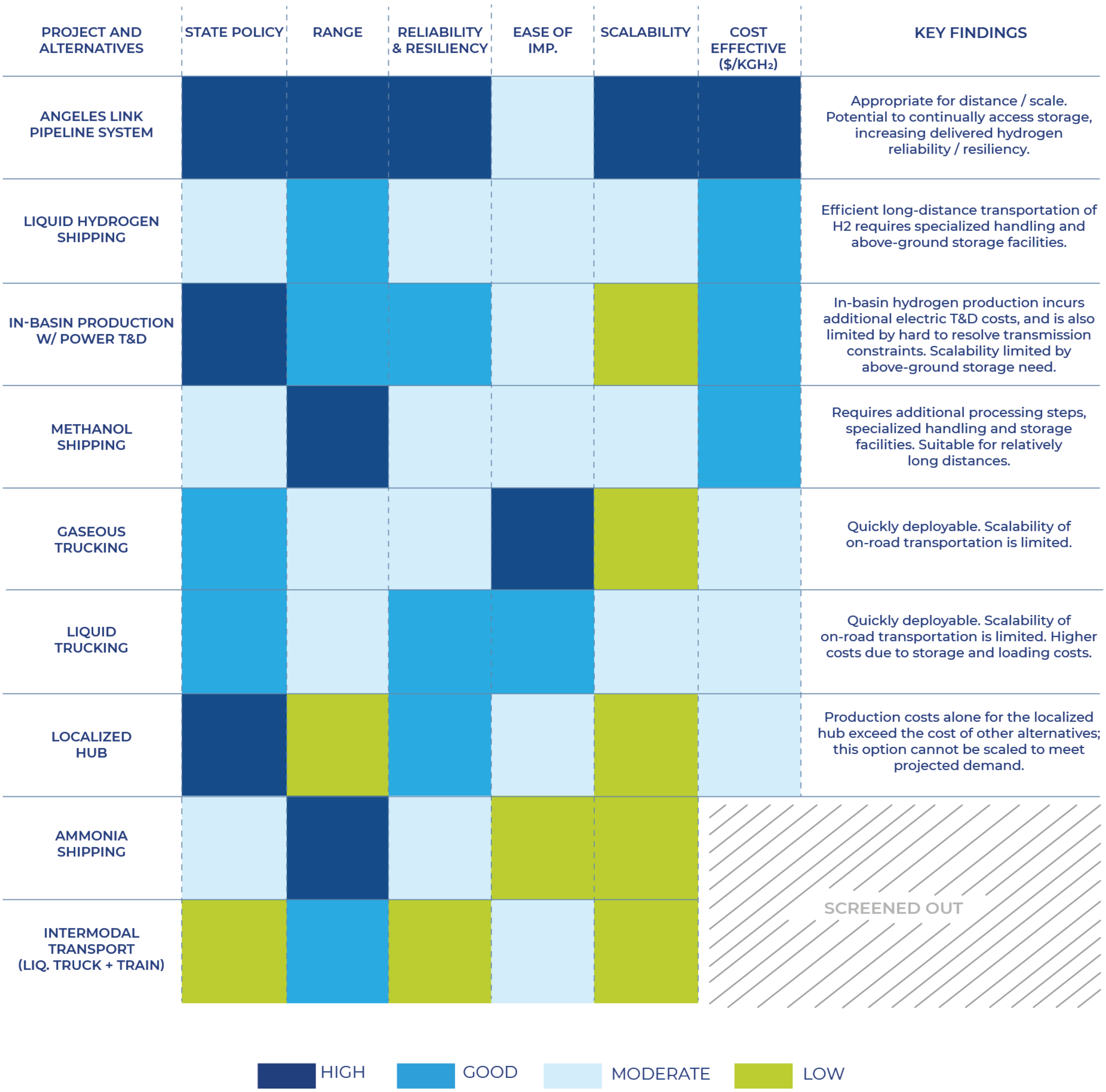

Figure 4. Hydrogen Delivery Alternatives Comparison[16]

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.

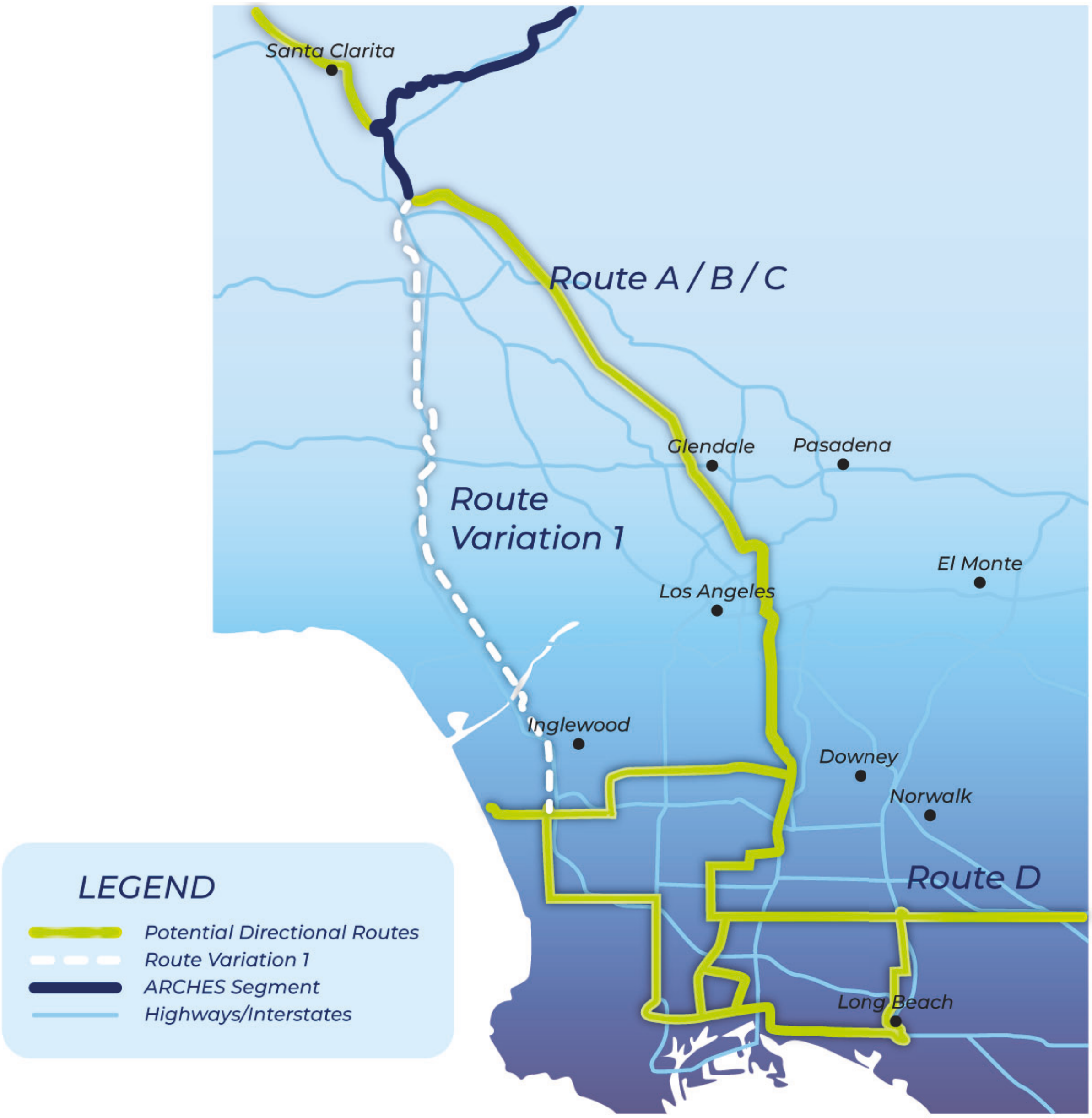

Figure 5. Illustration of Potential Directional Routes and Route Variation 1[19]

[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.

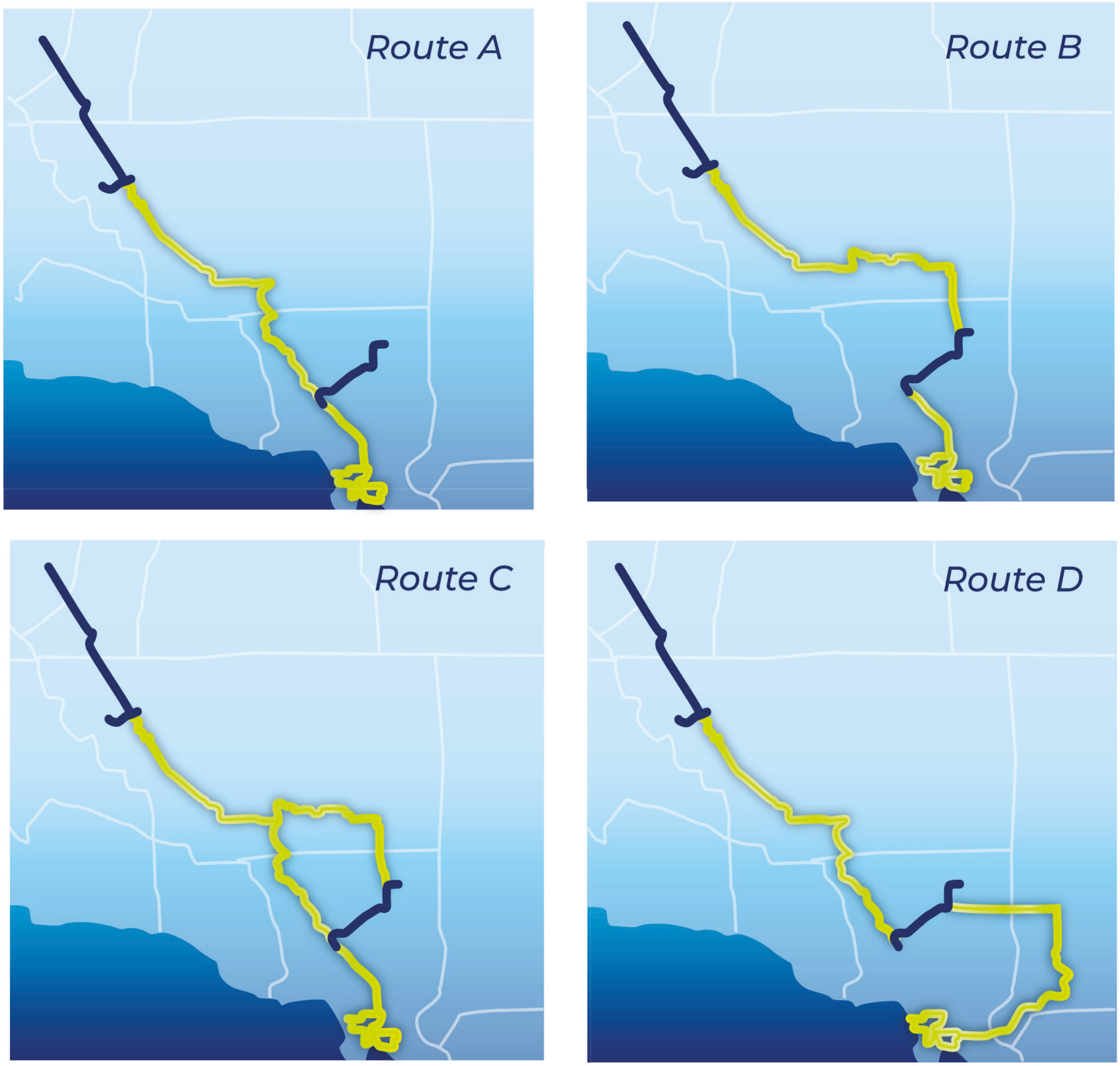

Figure 6. Potential Directional Routes[20]

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.

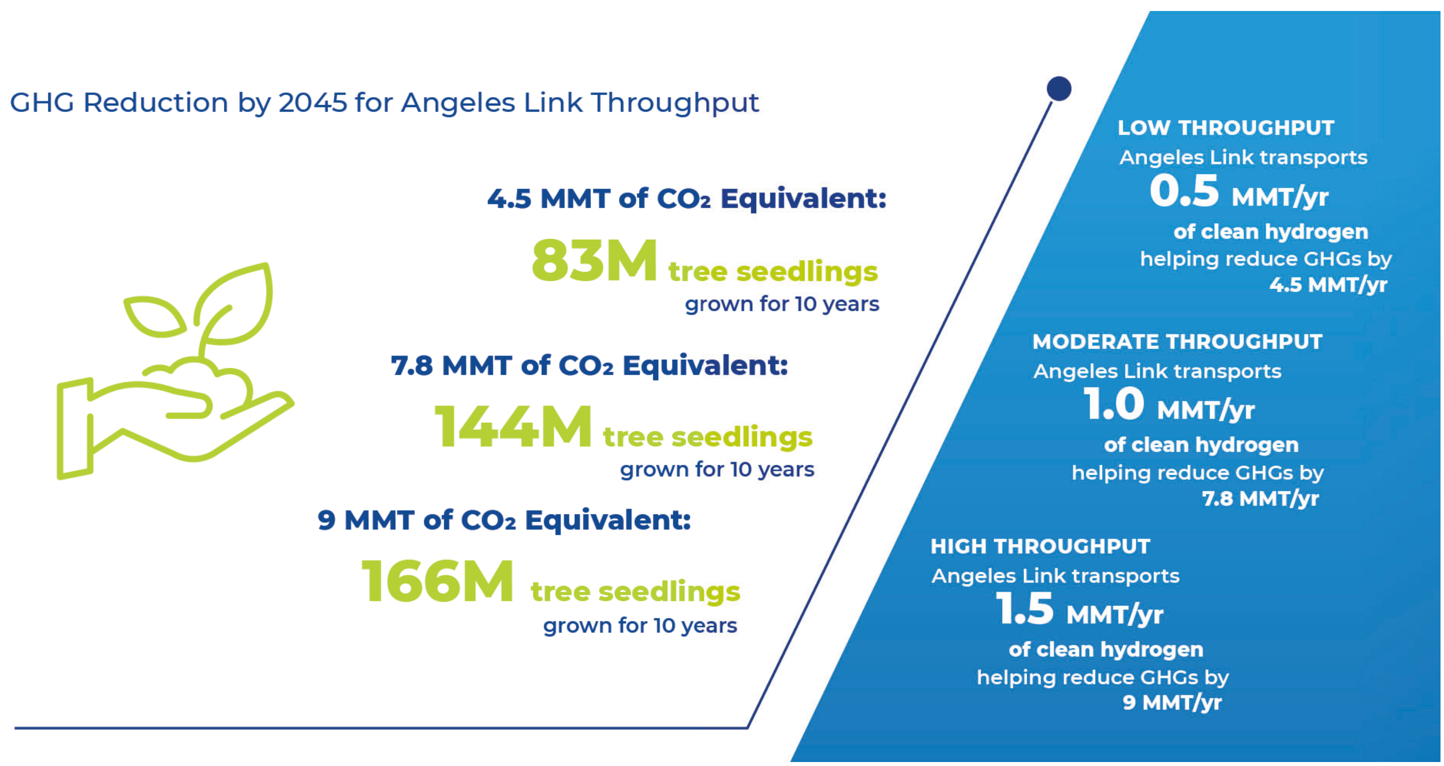

Figure 7. Visualizing the Impact: GHG Reductions Through Angeles Link[24]

[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

ANGELES LINK

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

ANGELES LINK

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.

VIII. ANGELES LINK PHASE 1 STUDIES

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