Southern California Freight Railroad Lines and Renewable Energy Transmission

Concept Paper

Union Pacific intermodal train passes Palm Springs station, with San Gorgonio wind farms in the background (Photo by Brian Yanity, 1/14/2017)

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The routing of new transmission lines along freight railroad rights-of-way in Southern California is a concept worthy of study. This concept could be a new source of revenue for the railroads, increase the amount of renewable energy used in California, and improve power grid reliability.

A potential win-win for railroad and electric utility companies, installing overhead power transmission lines along rail lines has long been common around the world for electrified tracks. Such lines have overhead catenary wires used to power trains, along with higher-voltage power transmission lines suspended further above the catenary. In recent years, the electrification of passenger and freight railroads in Southern California has been studied. The use of a rail corridor for power transmission is possible whether or not the tracks themselves are electrified with overhead catenary, as shown below in Fig. 1. For electrified railways, support structures for the catenary wire can be combined with transmission line structures, as shown below in Fig. 2. Route-specific feasibility and design studies are needed to determine what size transmission lines could be safely accommodated on a particular railroad right-of-way.

Fig. 1: Existing Anaheim Public Utilities transmission and distribution lines, with voltages shown, sharing a section of the 100'-wide Los Angeles-San Diego Amtrak "Surfliner" LOSSAN double-track rail corridor (Photo by Brian Yanity, 2/2/2017)

Fig. 2. SEPTA train on Northeast Corridor, under catenary supported by structures which also carry overhead transmission lines (Photo by jpmueller99, https://commons.wikimedia.org/w/index.php?curid=4007886 **)**

This concept paper mainly consists of maps showing selected freight railroad lines in Southern California, overlaid on transmission line and renewable energy project maps. The selected geographic areas mapped in this paper roughly follow several of the California potential transmission constraint areas, and Transmission Assessment Focus Areas (TAFAs), described in the high-level *Renewable Energy Transmission Initiative (RETI) 2.0 Plenary Report* from December 2016[1]. The coastal "Surfliner" rail corridor between San Luis Obispo and San Diego was not chosen for this analysis because of poorer solar, wind, and geothermal energy resources which exist along the coastal corridor, compared in the inland desert areas of Southern California.

All-electric locomotives have many advantages over diesel locomotives, including being zero-emissions, quieter, lower maintenance and having greater overall energy efficiency. While a tried-and-true technology, the disadvantages of electric railways include the high capital cost of installing catenary wires over the tracks, as well as the need for long-distance freight trains to change locomotives from conventional diesel-electric to all-electric locomotives where the catenary wire ends. California's Class I railroads, Union Pacific (UP) and Burlington Northern Santa Fe (BNSF), have no stated plans for electrification of track or locomotives. Short line freight railroads in Southern California discussed in this

[1] *Renewable Energy Transmission Initiative 2.0 Plenary Report, Public Review Draft*, California Natural Resources Agency, with participation from California Public Utilities Commission, California Energy Commission and California Independent System Operator, December 16, 2016: http://docketpublic.energy.ca.gov/PublicDocuments/15-RETI-02/TN214835_20161216T110654_Renewable_Energy_Transmission_Initiative_20.pdf

paper, such as the Baja California Railroad, San Diego & Arizona Eastern Railway, the Arizona & California Railroad, and the Trona Railway could offer opportunities to be electrified before long-haul routes of the Class I railroads. The operational nature of these short-haul railroads, with short engine districts, largely avoids the need for locomotive exchanges. Selected freight rail corridors in Southern California are shown below in Fig. 3, overlaid on a California Energy Commission transmission lines and substations map.

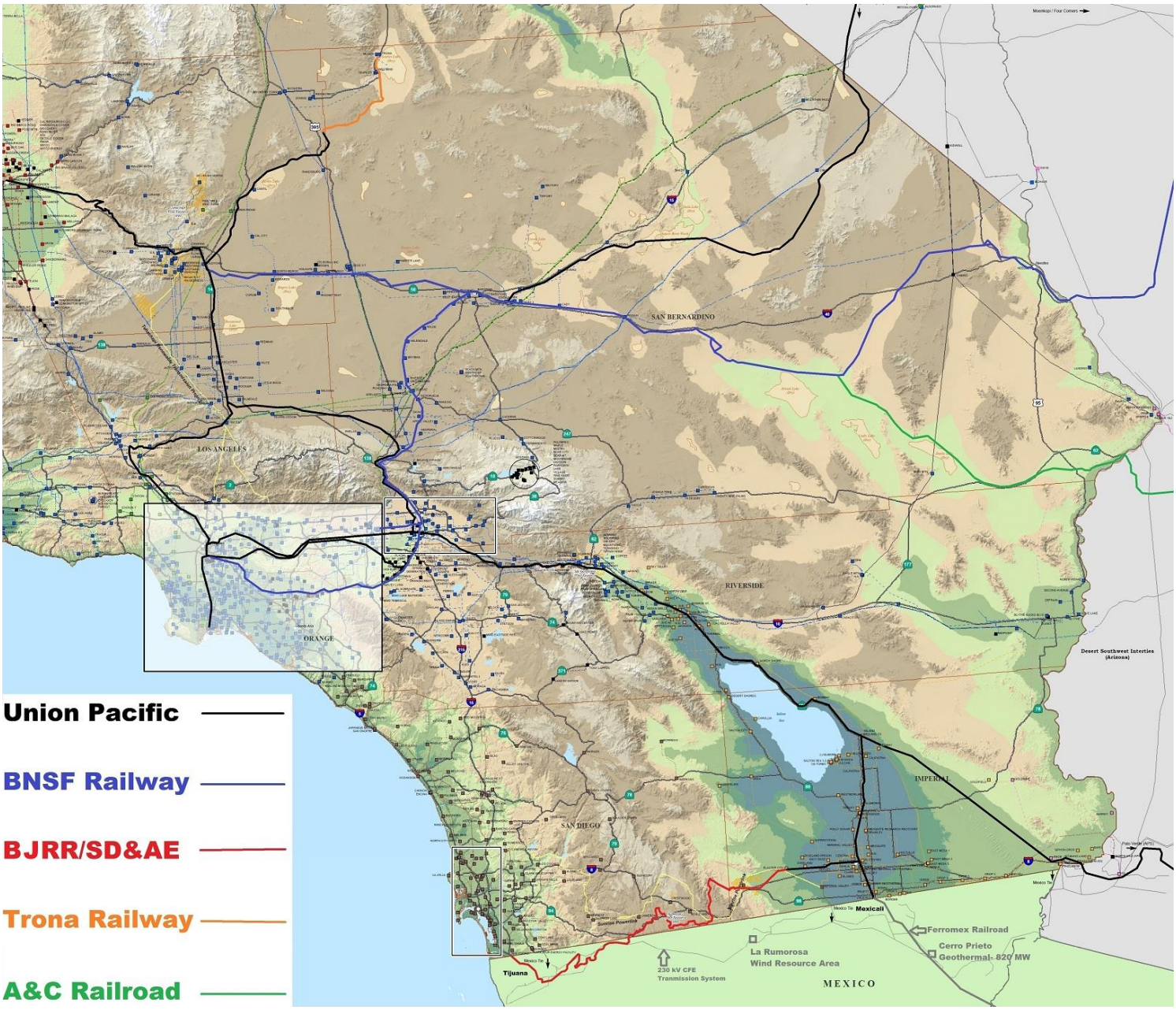

Fig. 3. Selected freight rail corridors, overlaid on *California Transmission Lines & Substations*
(Background map: California Energy Commission)

Railroad corridors and renewable energy development:

California has some of the most ambitious goals for renewable energy development and carbon emissions in the nation, and improvements to the electricity transmission grid are vital for these goals. The state leads the nation in solar energy development, with an installed electric generating capacity of 12,000 MW as of mid-2016. According the California Energy Commission, solar (both PV and solar thermal) represented about 10% (20,000 GWh) of the state's total electrical energy generated in-state in 2016 (198,000 GWh), not including roof-top solar projects on homes and small businesses. Wind contributed about 7% (13,500 GWh) and geothermal contributed about 6% (12,000 GWh)[2].

More than 20,000 MW of solar energy capacity is in various stages of development in the state, including large-scale projects in the deserts. However, a number of these large-scale projects have been scrapped or delayed due to lack of transmission capacity, or due to regulatory and environmental opposition to the solar field development or transmission line construction in previously undisturbed areas of the desert. To help address these concerns, the Desert Renewable Energy Conservation Plan (DRECP), a collaboration of the Bureau of Land Management (BLM) and other federal, state and local agencies in California, identified "preferred development focus areas" for solar energy developments that would have the least environmental impacts. Phase I of the DRECP was approved in September 2016.[3] Fig. 4 below shows selected freight railroad corridors (dark blue), overlaid on 2015 Renewable Energy Projects in Development map by the California Energy Commission, which also shows BLM-preferred renewable energy development areas as identified by DRECP.

Co-deployment of power transmission lines along electrified railroad corridors offers many advantages, as described in the *Solutionary Rail* book:[4]

> Important cost savings can be realized through coordinated efforts to codeploy rail electrification infrastructure and transmission lines for the interregional sharing of renewable energy. Rail electrification will require high- voltage transmission lines with capacity of 115 to 345 kV, and substations every 20 to 50 miles to transfer power from the transmission grid to the overhead catenary lines that supply power to trains. In more remote areas, the railroad will not be able to tap into the local grid, and will have to provide its own transmission lines. Most railroad right-of-ways are 100 feet or more wide. This allows for multiple tracks and high voltage transmission towers that could carry far more energy than is required by trains.
>
> Many of the ownership and environmental impediments that slow approval of new transmission lines can be avoided by using transcontinental rail corridors. These lines occupy lands that are owned by a single entity and have served industrialized uses for more than a century. By dealing with a single landowner instead of hundreds, new transmission could be erected in a far shorter timeframe. Utilities would also have a new customer immediately underneath their wires.
>
> The railroads could choose to go into the electrical transmission business. But Solutionary Rail envisions public financing of publicly-owned electrification infrastructure, which would relieve railroads of property tax burdens and the need to develop a set of new competencies in power grid management. A public authority could contract with utilities already skilled in that area. They could operate lines and sell power to the railroads.

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[2] California Energy Commission, California Electrical Energy Generation statistics page: http://www.energy.ca.gov/almanac/electricity_data/electricity_generation.html

[3] http://www.blm.gov/ca/st/en/prog/energy/DRECP.html

[4] *Solutionary Rail: How to Jumpstart Rail Electrification in the U.S.*, by the Backbone Campaign Solutionary Rail Team, 2016, pgs. 47-49.

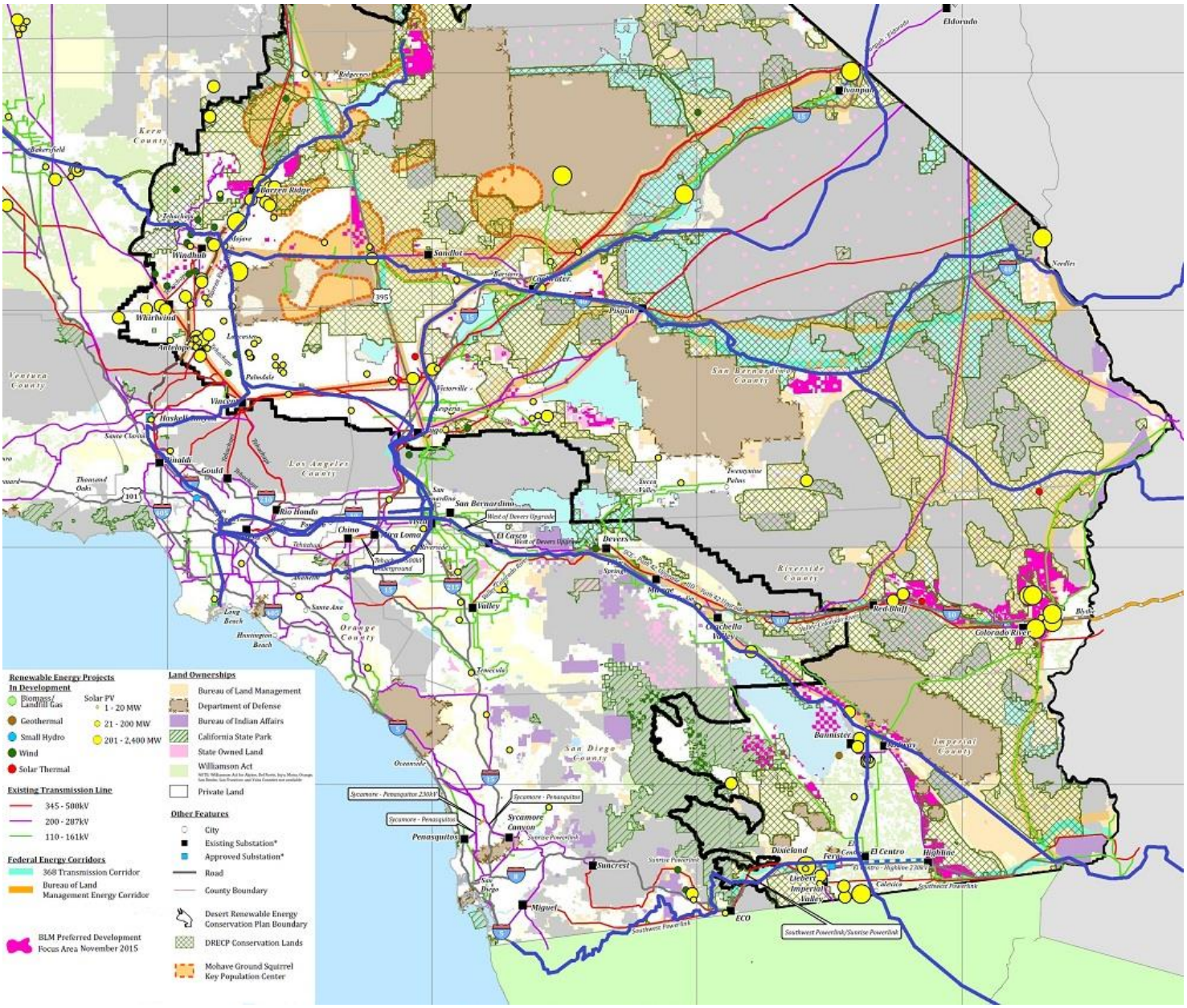

Fig. 4. Selected freight railroad corridors (dark blue) in Southern California, overlaid on transmission line and renewable energy project developments. (Background map: California Energy Commission- Renewable Energy Projects in Development 12/17/2015) Background map of public land designations, transmission line corridors, designated renewable energy development areas, and renewable energy projects both existing and under development- yellow circles for solar PV, red circles for solar thermal, green circles for wind, and brown circles for geothermal. The reddish-purple areas are BLM-preferred focus areas for future renewable energy development, as identified in the Desert Renewable Energy Conservation Plan (DRECP)

Area A (Mojave High Desert Region):

The Mojave High Desert region, show below in Fig. 5 and Fig. 6, is loosely defined as including the Antelope Valley, the Tehachapi Pass area, the Indian Wells Valley and Searle Valley to the north, and the Barstow-Victorville corridor to the east. The Antelope Valley and Tehachapi Pass areas have an enormous amount of solar and wind capacity installed and under development, and a large amount of existing transmission capacity to carry renewable energy to the greater Los Angeles area. However, in the future more transmission capacity could be required with the scale of potential renewable energy capacity which could be developed. Existing railroad lines parallel many identified transmission constrained transmission corridors in the Mojave High Desert, and the BSNF Cajon subdivision runs next to the major substations Lugo, owned by Southern California Edison (SCE) and Victorville, owned by Los Angeles Department of Water and Power (LADWP).

Railroads-

- The BNSF Cajon Subdivision between San Bernardino and Barstow (part of the Southern Transcon).
- BNSF Mojave Subdivision connects from Barstow to Mojave.
- UP Mojave Subdivision between Hesperia, Palmdale, Mojave and Bakersfield.
- UP/Metrolink Valley Subdivision connects Los Angeles to Palmdale.
- BNSF Lucerne Valley Subdivision connects from the BNSF Cajon Subdivision in Hesperia to cement plants at Cushenbury.
- UP Lone Pine Subdivision travels north from Mojave to connect to the Trona Railway, alongside a number of large solar project under development, as well as LADWP's Barren Ridge substation and wind generation area.
- Trona Railway is a 30.5 mile short-line railroad owned by Searles Valley Minerals, which Interchanges at Searles with the UP Lone Pine Subdivision.
- CEMEX operates a 14-mile short-line railroad between its Black Mountain quarry to the BNSF Cajon Subdivision in Victorville.

Renewable energy-

Tehachapi wind resource energy area has over 3,300 MW of wind generating capacity installed, with an eventual buildout planned of up to 4,500 MW. South of Tehachapi, in the western part of the Antelope Valley, more than 1,500 MW of solar power generating capacity is installed or under construction. Kern County is promoting renewable energy development in the Indian Wells Valley, and just to the east the Trona- Searles Lake area has large solar energy potential, on 'brownfield' ex-mining land.

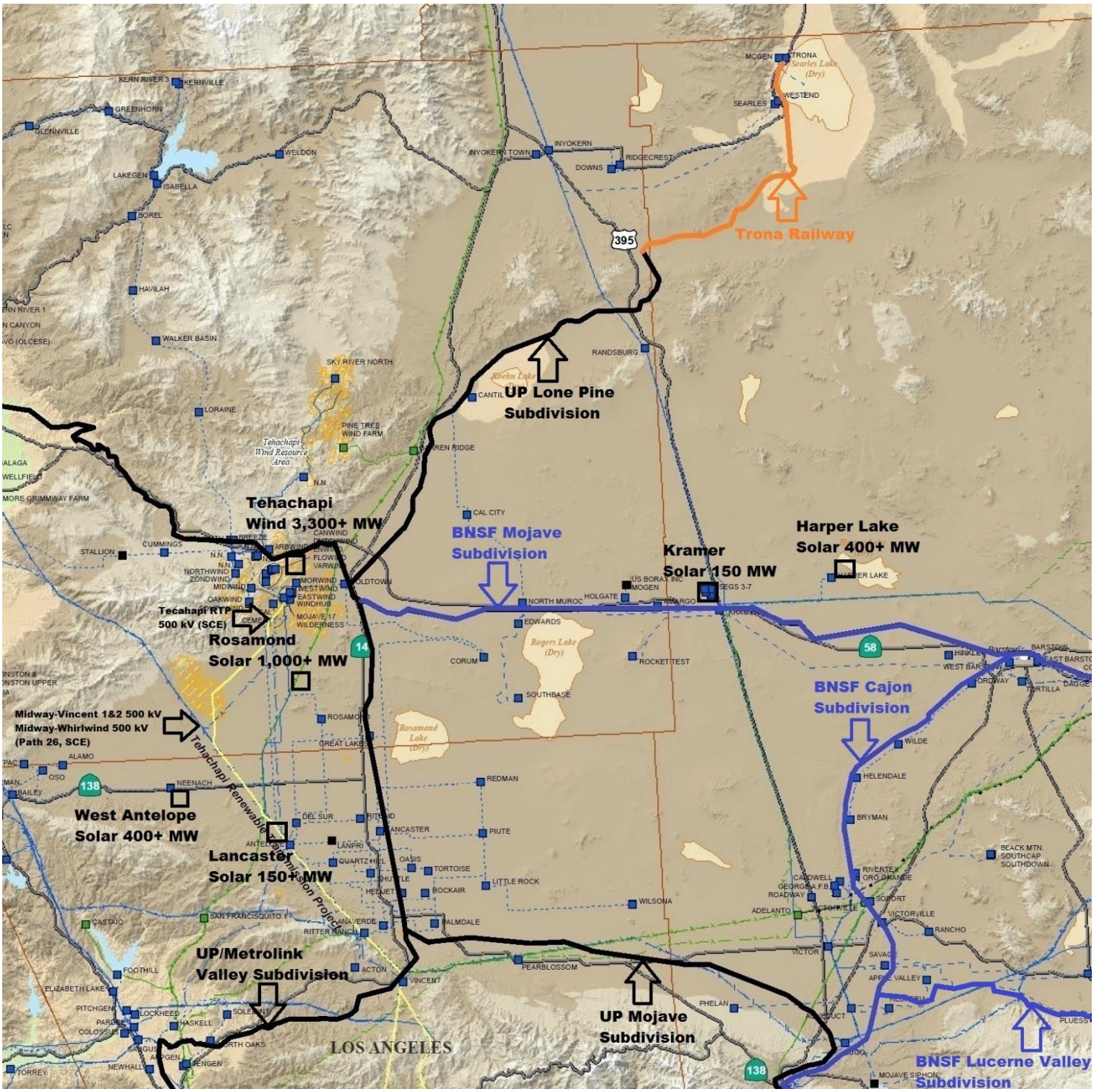

Fig. 5. Freight rail corridors and existing renewable capacity in Area A overlaid on *California Transmission Lines & Substations* (Background map: California Energy Commission)

Transmission infrastructure-

RETI 2.0 TAFAs (Hypothetical Study Ranges of renewable energy potential):

- Tehachapi (~5,000 MW)
- Victorville/Barstow (~5,000 MW)

Recent and proposed transmission projects of note in Area A:

- The multi-line 500-kV, 173-mile Tehachapi Renewable Transmission project, energized in December 2016, can carry up to 4,500 MW from the Tehachapi wind resources area to the LA Basin (SCE).
- Proposed new Kramer-Llano, 40-mile 500 kV line south to the existing Lugo-Vincent transmission corridor (SCE).
- Proposed upgrade to 500 kV Lugo-Victorville (Path 61), jointly owned by SCE and LADWP.
- Barstow-Victorville transmission constraint (Section 368 Corridor 27-266), passes primarily through BLM-managed land. SCE had proposed a new 34-mile 220 kV Coolwater-Lugo line, but was dismissed by the CPUC in 2015 after encountering significant local opposition.

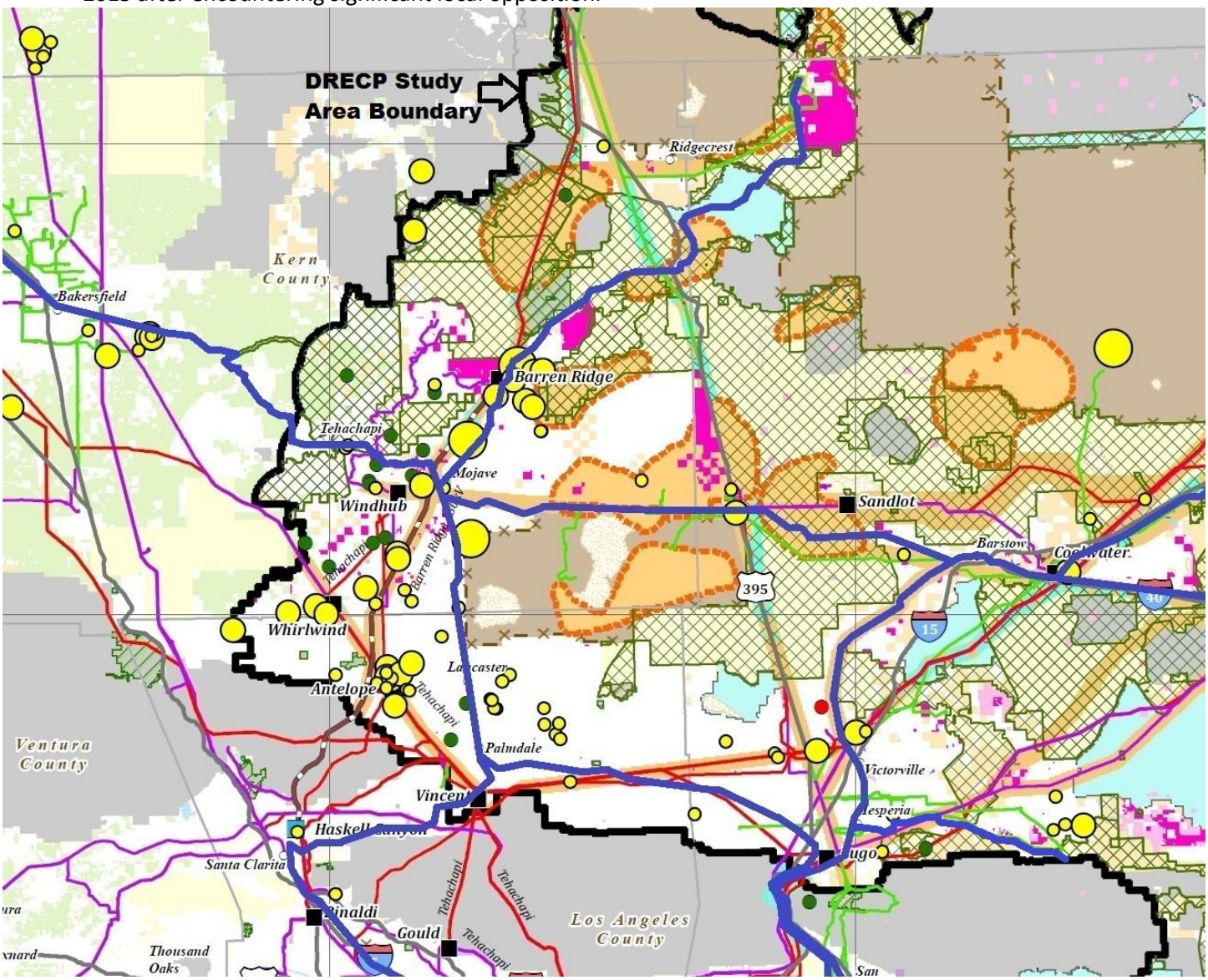

Fig. 6. Selected freight railroad corridors (dark blue) in Area A, overlaid on transmission line and renewable energy project developments. (Background map: California Energy Commission- Renewable Energy Projects in Development 12/17/2015)
Background map of public land designations, transmission line corridors, designated renewable energy development areas, and renewable energy projects both existing and under development- yellow circles for solar PV, red circles for solar thermal, green circles for wind, and brown circles for geothermal. The reddish-purple areas are BLM-preferred focus areas for future renewable energy development, as identified in the Desert Renewable Energy Conservation Plan (DRECP).

Area B (Eastern San Bernardino County):

Railroads-

- UP Cima Subdivision, between Yermo, California and Las Vegas, Nevada (largely within the Mojave National Preserve).

- BNSF Needles Subdivision between Barstow and Needles (part of the Southern Transcon).

- The Arizona & California (A&C) Railroad is a 190-mile short line than runs from Cadiz, California to Matthie, Arizona, connecting to the BNSF Southern Transcon at Cadiz, and to the BNSF mainline between Phoenix and the Southern Transcon at Williams.

Renewable energy-

Despite the region's abundant solar energy potential, the only California large solar project online in Area B is the 392 MW Ivanpah solar thermal project. The proposed 150 MW Rice solar thermal project is near the A&C Railroad corridor.

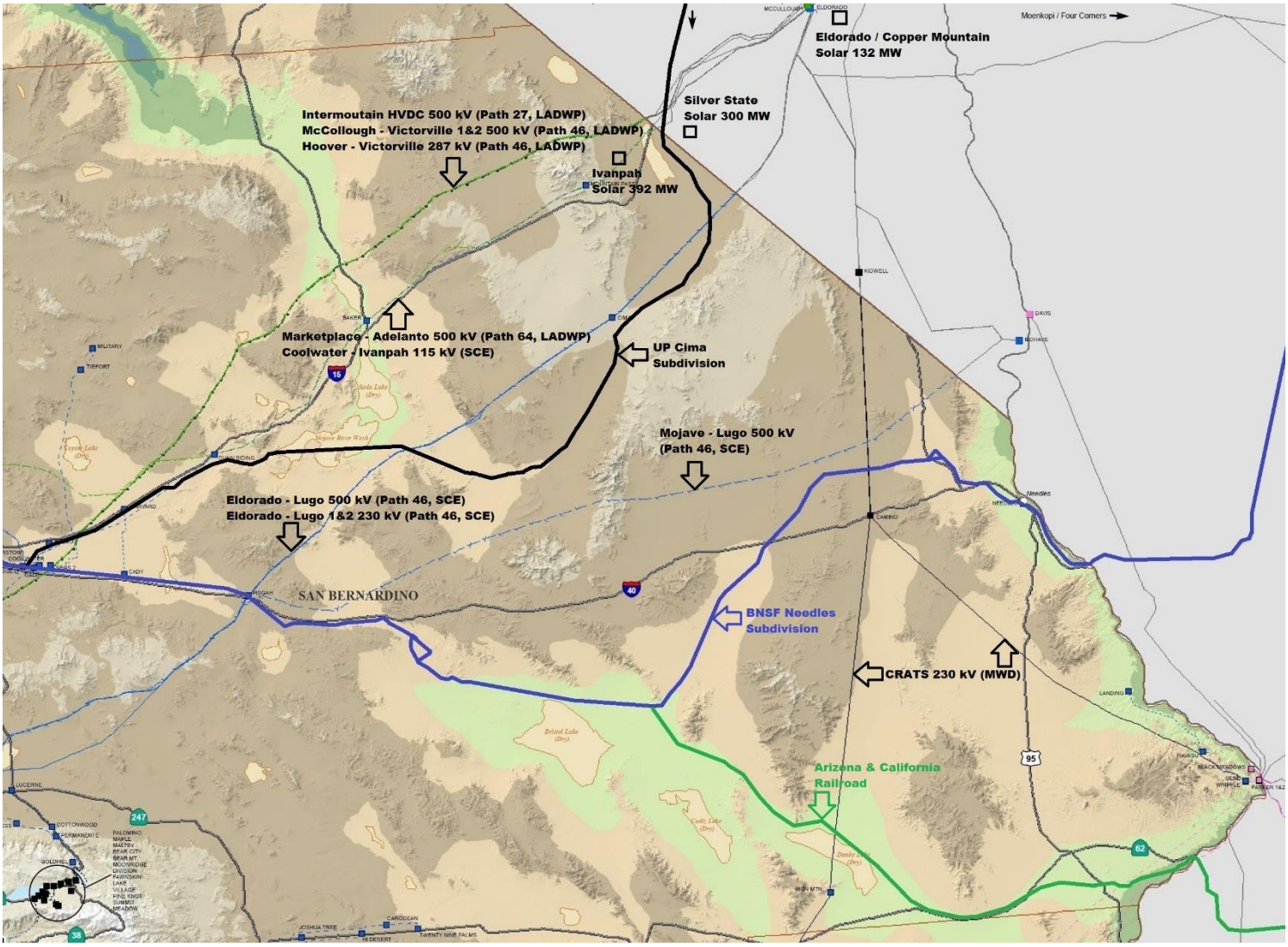

Fig. 7. Freight rail corridors and existing renewable capacity in Area B overlaid on *California Transmission Lines & Substations* (Background map: California Energy Commission)

Transmission infrastructure-

RETI 2.0 TAFAs (Hypothetical Study Ranges of renewable energy potential):

- Import – Eldorado/Marketplace (~3,000 MW)

Eastern San Bernardino county is traversed by multiple 500 kV and 230 kV transmission line corridors that are part of Path 46 (both SCE and LADWP), and 500 kV Path 64 (LADWP), which connect Southern California to Nevada, and on to Arizona.

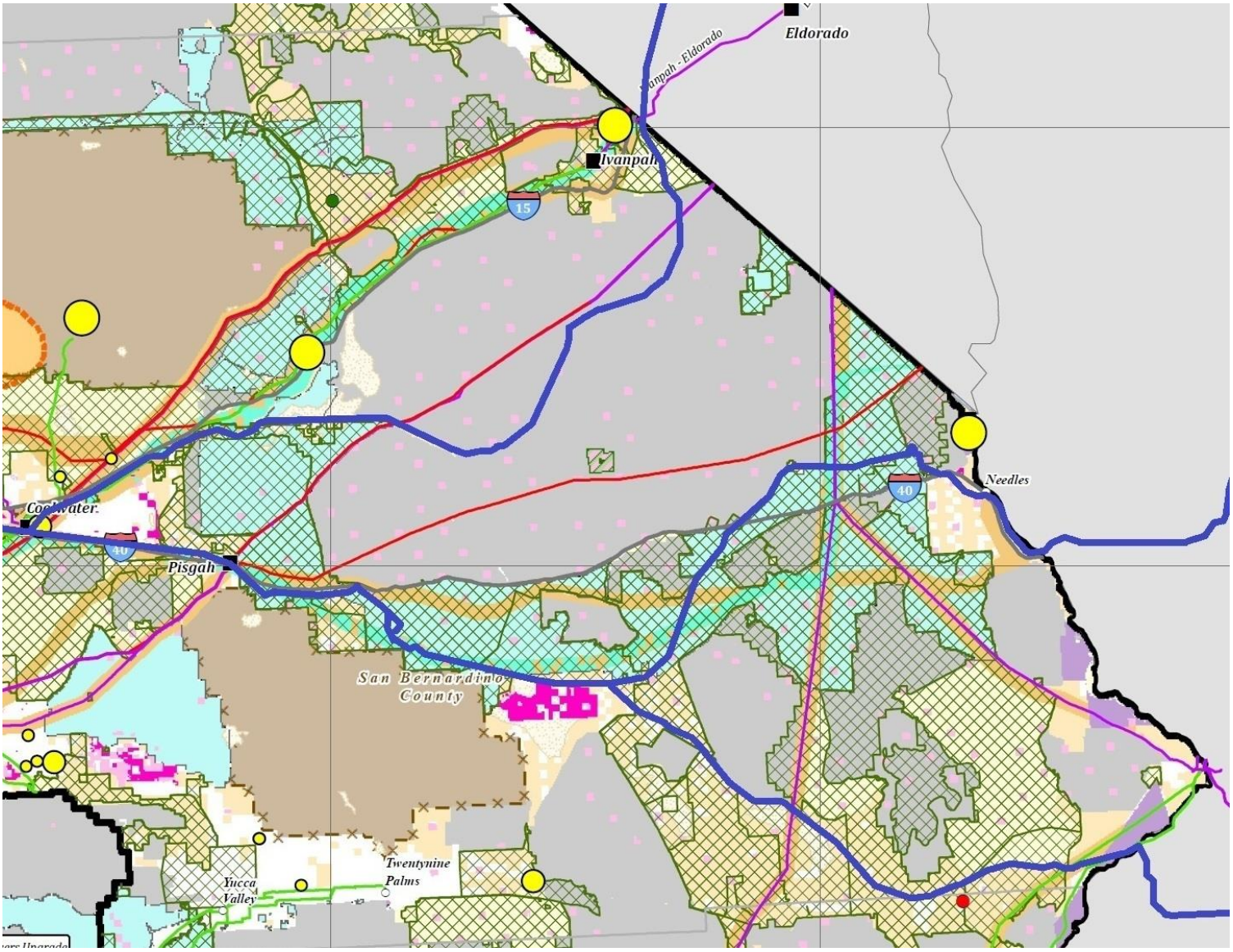

Fig. 8. Selected freight railroad corridors (dark blue) in Area B, overlaid on transmission line and renewable energy project developments. (Background map: California Energy Commission- Renewable Energy Projects in Development 12/17/2015)
Background map of public land designations, transmission line corridors, designated renewable energy development areas, and renewable energy projects both existing and under development- yellow circles for solar PV, red circles for solar thermal, green circles for wind, and brown circles for geothermal. The reddish-purple areas are BLM-preferred focus areas for future renewable energy development, as identified in the Desert Renewable Energy Conservation Plan (DRECP)

Amboy-Cadiz example of railroad right-of-way enabling solar energy development-

A particularly interesting example of a potential solar development area identified in the DRECP is located alongside the BNSF Needles Subdivision corridor, between the former railroad stops of Amboy and Cadiz (see Fig. 9 below). The potential solar development area is at least 20 square miles in size, representing perhaps up to 1,000 MW of solar PV power generating capacity. Located in one of the sunniest parts of the United States, the average annual potential solar PV resource is more than 6 kWh/m^2 per day. The closest existing transmission lines are more than 20 miles away.

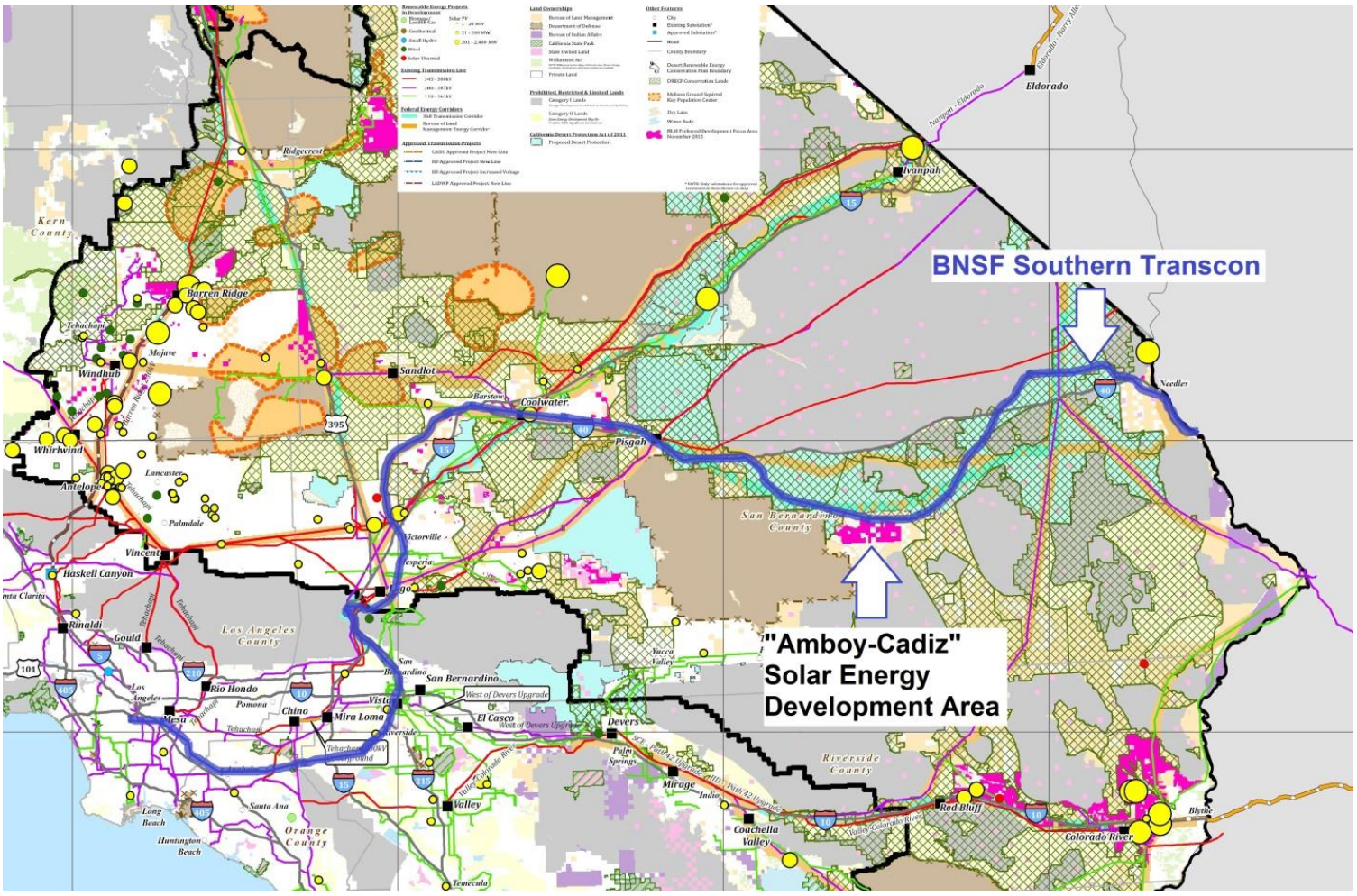

Fig. 9. Route of Southern Transcon in California, adjacent to "Amboy-Cadiz" solar energy development area
Background map (California Energy Commission- Renewable Energy Projects in Development 12/17/2015)of public land designations, transmission line corridors, designated renewable energy development areas, and renewable energy projects both existing and under development- yellow circles for solar PV, red circles for solar thermal, green circles for wind, and brown circles for geothermal. The reddish-purple areas are BLM-preferred focus areas for future renewable energy development, as identified in the Desert Renewable Energy Conservation Plan (DRECP).

This potential "Amboy-Cadiz" solar development area is adjacent to and overlapping, the "brownfield" of Bristol Dry Lake salt evaporators owned by Tetra Technologies on the west side, and to the east farm lands of Cadiz, Inc., which owns water rights under about 45,000 acres of land in the area. For many years Cadiz, Inc. has planned to extract large quantities of water from an underground aquifer in the desert, and sell it to the cities of Southern California via a new pipeline that would connect to the Metropolitan Water District of Southern California's existing Colorado River Aqueduct. This controversial plan has attracted intense opposition, largely due to environmental concerns.[5] Even if the

[5] "How one man plans to make billions selling Mojave desert water", *The Guardian*, January 3, 2016:

commercial water supply plan does not materialize, however, solar energy production could be a beneficial use of Cadiz, Inc.-owned land. The company has already estimated that up to 20,000 unused acres of its land could be used for large-scale solar energy development.[6]

The Mojave Trails National Monument was created by President Obama in 2016, which surrounds much of the Needles Subdivision corridor between Barstow and Needles, including the potential Amboy-Cadiz solar development area. The creation of this monument is certain to make development of transmission line development on public lands more difficult. Building transmission lines to this solar development area is also constrained by previously existing BLM Wilderness Areas to the north, east and south, as well as military land to the west. However, the BNSF Railway right-of-way along the Needles Subdivision offers a possible path for a transmission line corridor to access the 'stranded' Amboy-Cadiz solar energy area, while respecting the integrity of the Mojave Trails National Monument.

Area C (San Gorgonio Pass and Coachella Valley):

Railroads-

- UP- Yuma Subdivision (part of the Sunset Route) is the only railroad corridor in Area C.

Renewable energy-

The Gorgonio Pass wind energy area has about 680 MW of existing wind generation capacity, which may be increased in the future. Large solar energy development areas are possible along the shores of the Salton Sea.

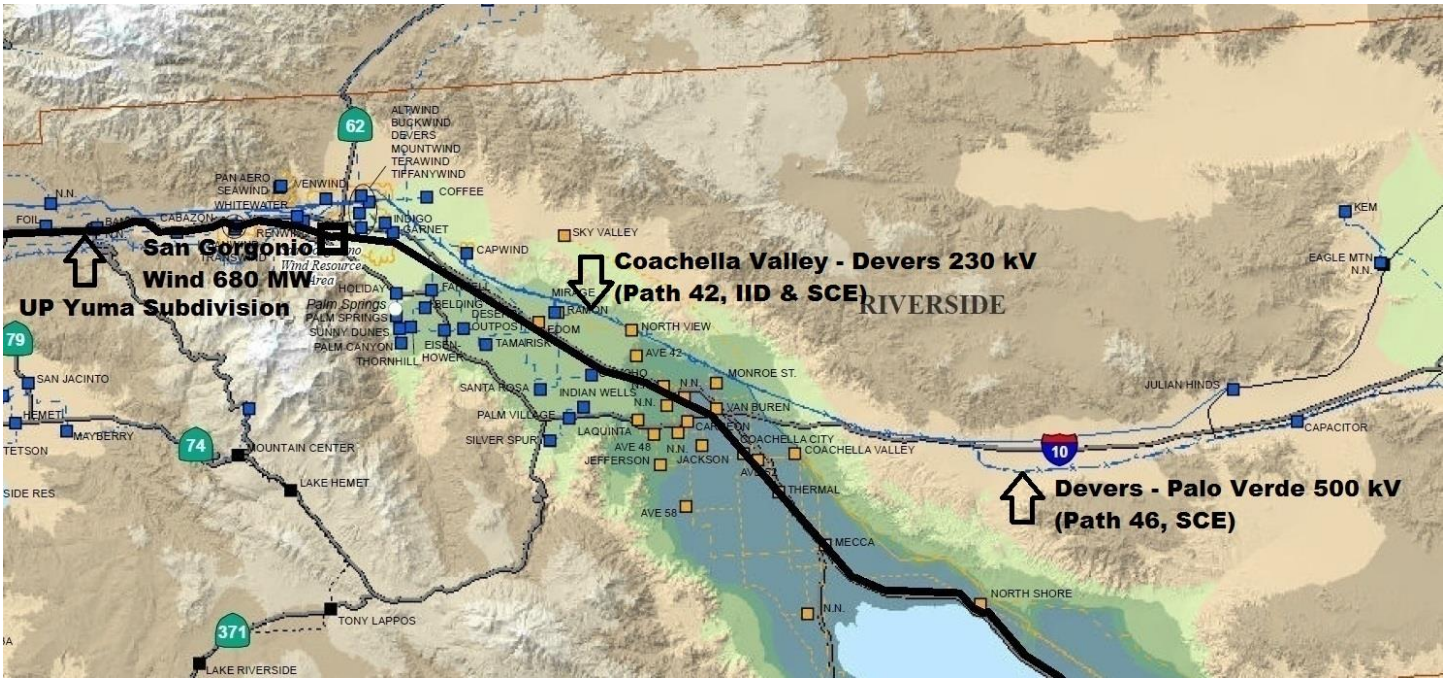

Fig. 10. Freight rail corridor and existing renewable capacity in Area C overlaid on *California Transmission Lines & Substations* (Background map: California Energy Commission)

https://www.theguardian.com/us-news/2016/jan/03/scott-slater-cadiz-plans-make-billions-selling-mojave-desert-water

[6] http://cadizinc.com/solar-energy/

Transmission infrastructure-

RETI 2.0 TAFAs/ (Hypothetical Study Ranges of renewable energy potential):

- Riverside East (~5,000 MW)
- Imperial Valley (~5,000 MW)
- Import – Palo Verde/Delaney (~3,000 MW)

Recent and proposed transmission projects of note in Area C:

- Coachella Valley is served by the Imperial Irrigation District (IID), with Path 42 connecting to SCE's transmission network at the north end of the valley. Path 42 is in the process of being upgraded in collaboration with SCE. The corridor has been identified as transmission constraint by the California ISO, due to the large amount of renewable energy being developed in the Imperial Valley.

- Existing 500 kV Devers-Palo Verde (SCE), part of Path 46, carries a large amount of solar energy from Eastern Riverside County.

- Proposed 500 kV Red Bluff-Mira Loma, to carry a large amount of solar energy from Eastern Riverside County to the LA Basin (SCE).

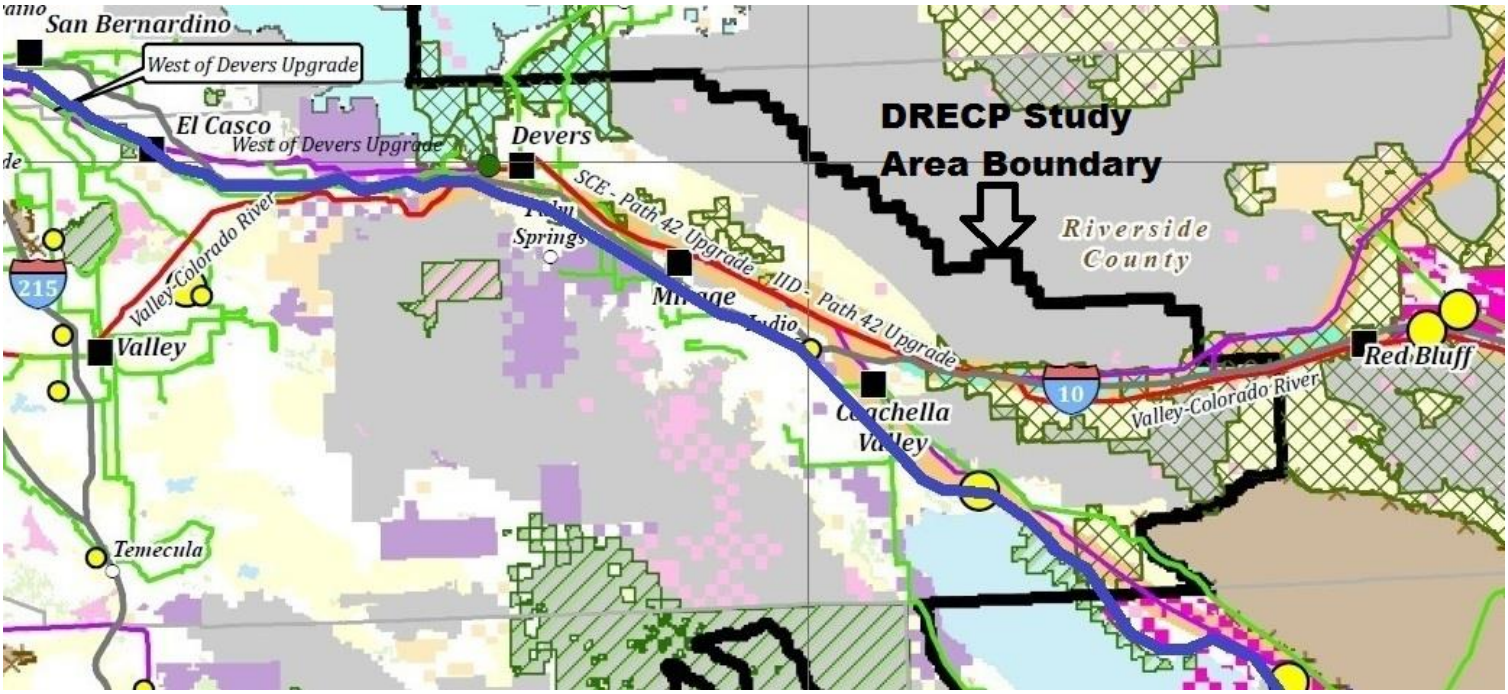

Fig. 11. Selected freight railroad corridors (dark blue) in Area C, overlaid on transmission line and renewable energy project developments. (Background map: California Energy Commission- Renewable Energy Projects in Development 12/17/2015)
Background map of public land designations, transmission line corridors, designated renewable energy development areas, and renewable energy projects both existing and under development- yellow circles for solar PV, red circles for solar thermal, green circles for wind, and brown circles for geothermal. The reddish-purple areas are BLM-preferred focus areas for future renewable energy development, as identified in the Desert Renewable Energy Conservation Plan (DRECP)

Area D (Imperial/Mexicali Valley):

The bi-national region of the Imperial Valley (U.S.) and the Mexicali Valley (Mexico), has a tremendous amount of renewable energy capacity installed and under development.

Railroads-

- UP- Yuma Subdivision (part of the Sunset Route).
- UP Calexico Subdivision, connects the Sunset Corridor to Calexico.
- UP El Centro Subdivision, connects El Centro to SD&AE Railway in Plaster City.
- Ferromex Mexicali line, continues south of the border from the UP Calexico Subdivision to connect with the Mexican national rail network in Sonora.

Renewable energy-

As of late 2016, over 3,000 MW of renewable energy capacity has been installed in the Imperial Valley, and 1,300 MW is proposed or under construction. The majority of this capacity is solar, with 265 MW of wind at Octotillo, and about 570 MW of geothermal capacity. The Imperial Valley has several hundred MW more geothermal capacity in various stages of development. The UP Yuma Subdivision passes through the undeveloped Glamis Known Geothermal Resource Area (KRGA). In the Mexican part of the Imperial Valley, south of Mexicali is the 820 MW Cerro Prieto geothermal power plant, the largest in Mexico.

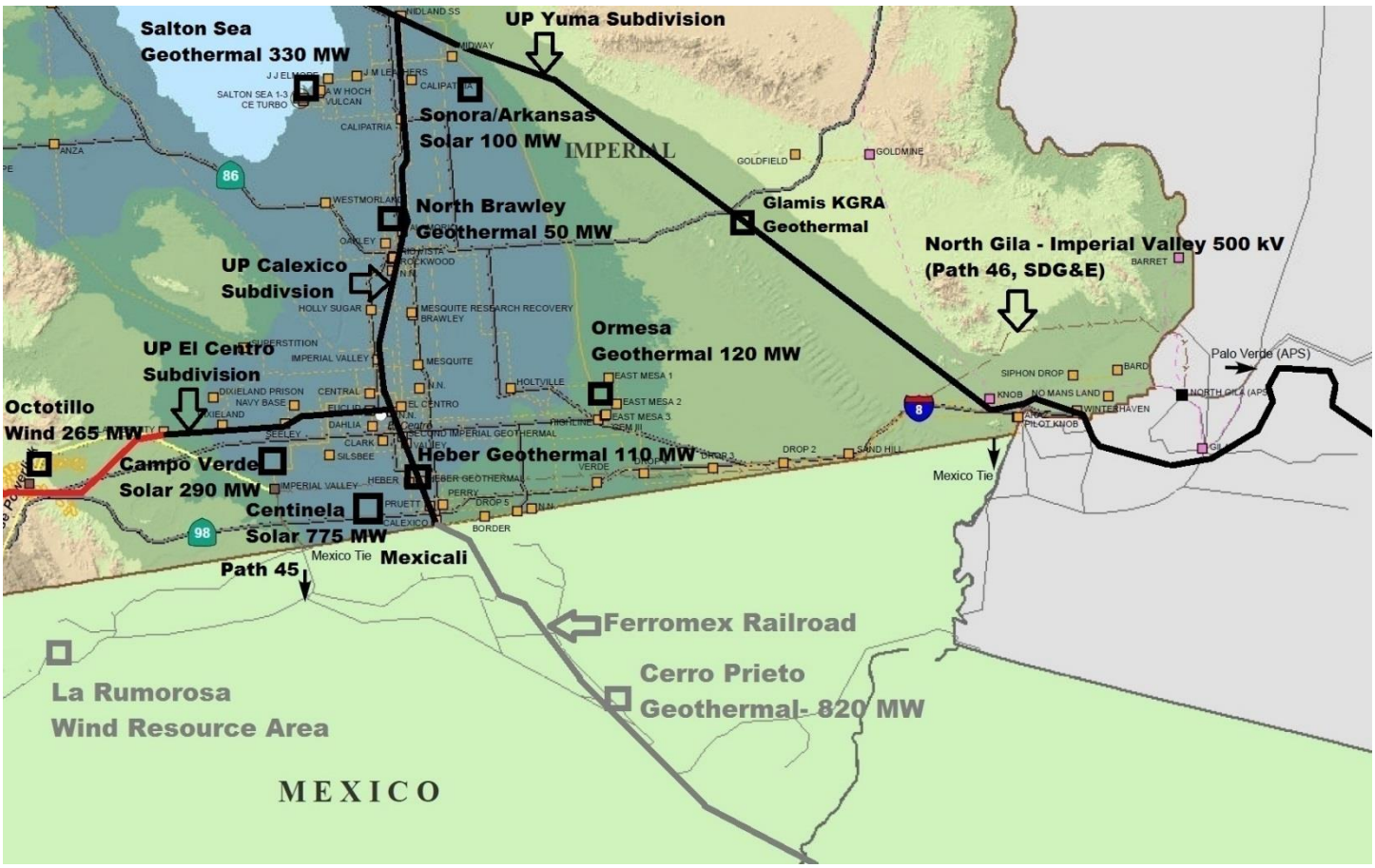

Fig. 12. Freight rail corridors and existing renewable capacity in Area D overlaid on *California Transmission Lines & Substations* (Background map: California Energy Commission)

Transmission infrastructure-

The Imperial Irrigation District (IID) is the publicly-owned utility serving the U.S. side of the valley, while San Diego Gas & Electric (SDG&E) Imperial Valley substation is a major transmission hub located in the western part of the Imperial Valley, just north of the international border. The transmission corridors between the Imperial Valley and the north and west have been identified as major constraint due to the high amount of renewable energy development in the region.

RETI 2.0 TAFAs/ (Hypothetical Study Ranges of renewable energy potential):

- Imperial Valley (~5,000 MW)
- Import – Palo Verde/Delaney (~3,000 MW)

Recent and proposed transmission projects of note in Area D:

- Path 45 consists of two existing 230-kV cross-border transmission links (WECC) between SDG&E transmission system and the Baja California Norte transmission system of Mexican national utility Comisión Federal de Electicidad (CFE). These connect from SDG&E's Otay Mesa to CFE's Tijuana substations, and from SDG&E's Imperial Valley to CFE's La Rosita (near Mexicali) substations. SDG&E's Imperial Valley substation also has additional 230-kV cross-border transmission lines to two merchant natural gas power plants near Mexicali. El Centro Nacional de Control de Energia (CECANCE) and California Independent System Operator (ISO) agreed in October 2016 to explore participation of CFE's Baja California Norte grid in the real time western Energy Imbalance Market[7].

- Proposed North Gila-Miguel conversion to HVDC (SDG&E).

- Proposed Imperial Valley-Valley 500 kV (SDG&E).

- Proposed Midway-Devers 500 kV to North Gila (IID).

- Proposed Hoober-SONGS HVDC (IID).

- Proposed Desert Southwest 500 kV, Section 368 Corridor 30-52 (IID).

- Proposed HVDC transmission link from Baja California Norte grid to the Mexican national grid (CFE).

[7] California ISO press release, October 18, 2016: http://www.caiso.com/Documents/MexicoGridOperatorCENACEtoExploreEIMParticipationForBajaCaliforniaNorte.html

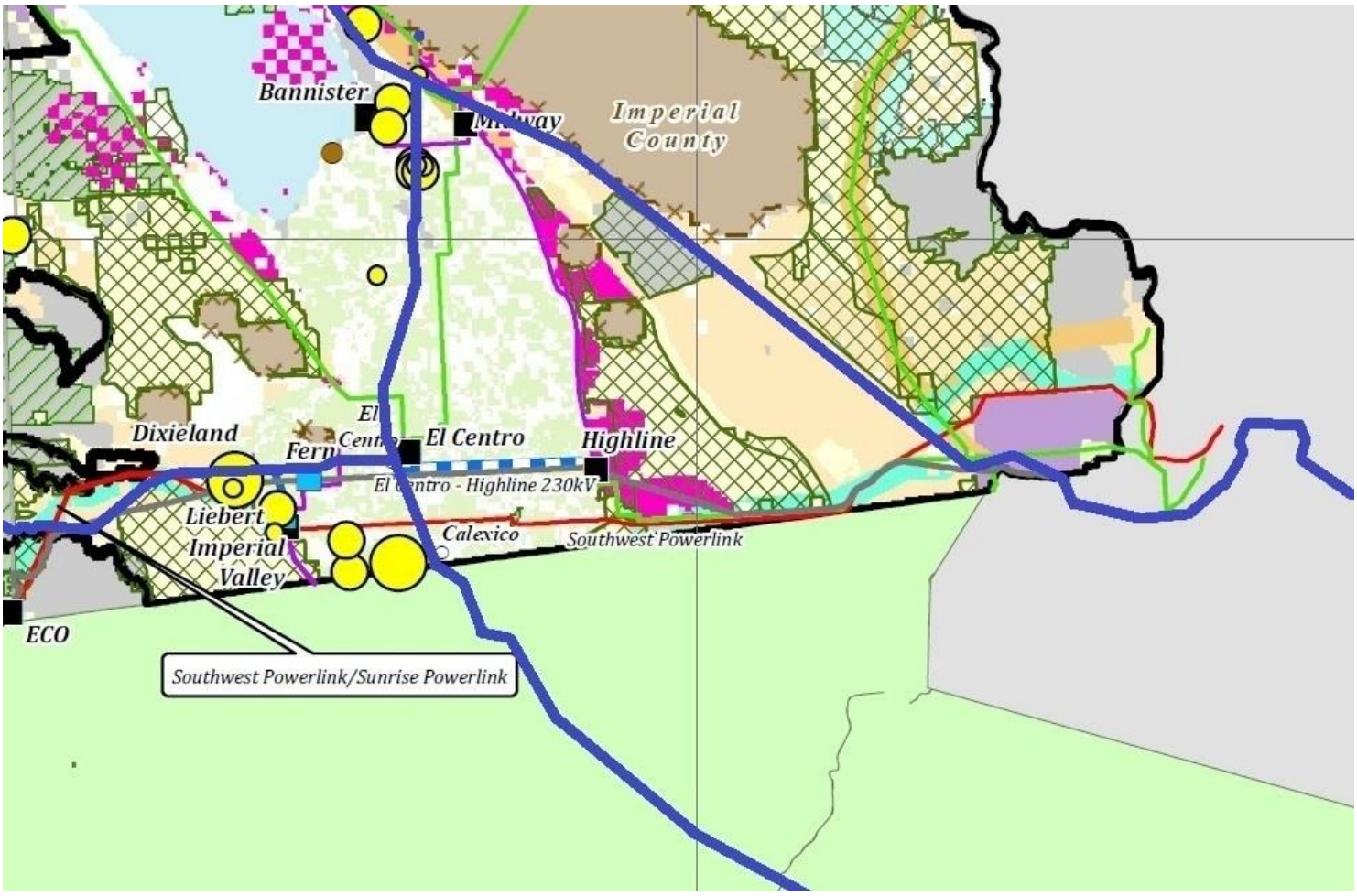

Fig. 13. Selected freight railroad corridors (dark blue) in Area D, overlaid on transmission line and renewable energy project developments. (Background map: California Energy Commission- Renewable Energy Projects in Development 12/17/2015)
Background map of public land designations, transmission line corridors, designated renewable energy development areas, and renewable energy projects both existing and under development- yellow circles for solar PV, red circles for solar thermal, green circles for wind, and brown circles for geothermal. The reddish-purple areas are BLM-preferred focus areas for future renewable energy development, as identified in the Desert Renewable Energy Conservation Plan (DRECP)

Area E (BJRR/SD&AE Corridor):

The BCRR/SD&AE railroad corridor offers an additional transmission route from the renewable energy bounty of the Imperial Valley and Kumeyaay/La Rumorosa wind resource areas to the San Diego/Tijuana metropolitan area.

Railroads-

The San Diego & Arizona Eastern (SD&AE) Railway was originally completed in 1919, connecting San Diego via Mexico to the Imperial Valley. The only rail line connecting the San Diego-Tijuana metropolitan area to the East, the line has been dormant for most of the past three decades. Reopening the line would add much-needed freight rail capacity for the largest bi-national U.S.-Mexico conurbation, which is presently served by only one freight rail line. The Class III San Diego and Imperial Valley (SDIY) Railroad, connects 13 miles north from the international border at San Ysidro to the BNSF yard at the Port of San Diego. Freight rail capacity on the BNSF San Diego Subdivision, which connects the SDIY to the BNSF Southern Transcon in Orange County, is constrained due to sharing of the track with a large number of passenger trains.

In Mexico, the Baja California Railroad (BJRR) runs along the SD&AE route for 44 miles from the San Ysidro Port of Entry in Tijuana to the border near Tecate (Mexico) and Campo (U.S.). The railroad continues in the U.S. as the SD&AE Desert Line for 70 miles to Plaster City. The Desert Line is publicly-owned by the San Diego Metropolitan Transit System (SDMTS). In June 2016, the Tijuana-based BJRR entered into a sublease for most of the Desert Line from the Pacific Imperial Railroad (PIR), a company that has leased the tracks from the SDMTS. Between $60 and $70 million in repairs on 70 miles of track are needed to the Desert Line, including on 57 bridges and 17 tunnels, before any freight can be moved again on the line. The two rail companies will pay for the renovations.[8] Due to BJRR's upgrade and repair efforts, service was recently restored for the entirety of the line's route in Mexico.

San Diego officials estimate that over $6 billion in regional economic activity is lost annually due to trucks delayed crossing the border[9]. Tijuana is Mexico's fifth-largest metropolitan area, and one of North America's major manufacturing centers. Shifting of more freight from truck to rail would ease congestion and reduce air pollution from the region's three Ports of Entry at San Ysidro (the world's busiest land border crossing), Otay Mesa and Tecate. As described by BJRR's website for the Desert Line project[10]:

> The Desert Line rehabilitation will be an opportunity for the maquiladora industry in the region regarding transportation logistics. The reopening of this old route will become a new alternative for freight movement to the East Coast of the United States.
>
> The Desert Line has a length of 70.06 miles from Tecate to Plaster City, consisting of 57 bridges that go from 9 feet to 650 feet tall, and 17 tunnels with a length from 174 feet up to 2,602 feet long, all clearing up a height from 21´7" to 24´11".
>
> In the agreement, BJRR will have the responsibility to operate, maintain, and rehabilitate the existing railroad track from Tecate Mexico/ Tecate Mile Post to Coyote Wells, while PIR will rehabilitate the from Coyote Wells to Plaster City, connecting with one of the main railroad systems in the United States [UP Sunset Corridor].

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[8] "Border rail line to connect U.S., Mexico", *San Diego Union-Tribune*, June 9, 2016: http://www.sandiegouniontribune.com/business/sdut-desert-line-gets-new-operator-repairs-starting-2016jun09-story.html

[9] "MTS cheers deal to rebuild Desert Line railway for Tijuana link", *Times of San Diego*, 9 June 2016: http://timesofsandiego.com/business/2016/06/09/mts-cheers-deal-to-rebuild-desert-line-railway-for-tijuana-link/

[10] http://bajarr.com/eng/news/joint-venture-between-baja-california-rail-road-and-pacific-imperial-railroad-provides-boost-to-regional-growth-2/

This event is the result of a combined effort that demonstrates the importance of strengthening the binational relations between both countries.

The Desert Line will be a new freight route that increases the freight capacities offering more logistical opportunities, reducing truck traffic in Mexico and the Unites States.

Facts to consider:

- Daily there is a trade of $2.1 million between San Diego and Tijuana.
- 135,000 cars and 6,200 truck cross from Mexico to the United State daily at the San Ysidro, Otay Mesa and Tecate Port of Entry, with an estimate of a 2-hour border wait.
- An estimated 6 billion dollars are lost annually due to border delays of trucks carrying freight.

PIR intends to build an intermodal facility near Coyote Wells in Imperial County to load freight and provide space to build the necessary 100-car trains that can be delivered to the Union Pacific main line network. From Plaster City, U.S. Gypsum runs a narrow-gauge railroad 19 miles north to a gypsum mine in the Fish Creek Mountains.

Renewable energy-

The 265 MW Octotillo wind farm, completed in 2012-2013, is located in the western Imperial Valley just north of the international border. The Kumeyaay wind resource area, is also just north of the border and about 40 miles east of San Diego. The existing 50 MW Kumeyaay wind farm, located on the lands of the Campo Kumeyaay Nation (Campo Indian Reservation). Nearby, the proposed Tule wind farm has been proposed (132 MW in phase I, 69 MW phase II by 2019). The wind resources continue south of the border at the La Rumorosa wind resource area, at the northern end of the Sierra de Juárez Mountains. The 155 MW Energia Sierra Juarez wind farm, completed in 2015, was the first project completed in the La Rumorosa wind resource area, the project sells power to SDG&E via the new cross-border transmission link to ECO substation. Up to 1,250 MW of new capacity planned in the La Rumorosa wind resource area. A vast amount of wind energy potential exists along the ridges of Sierra de Juárez Mountains south of La Rumorosa, as shown below in Fig. 16.

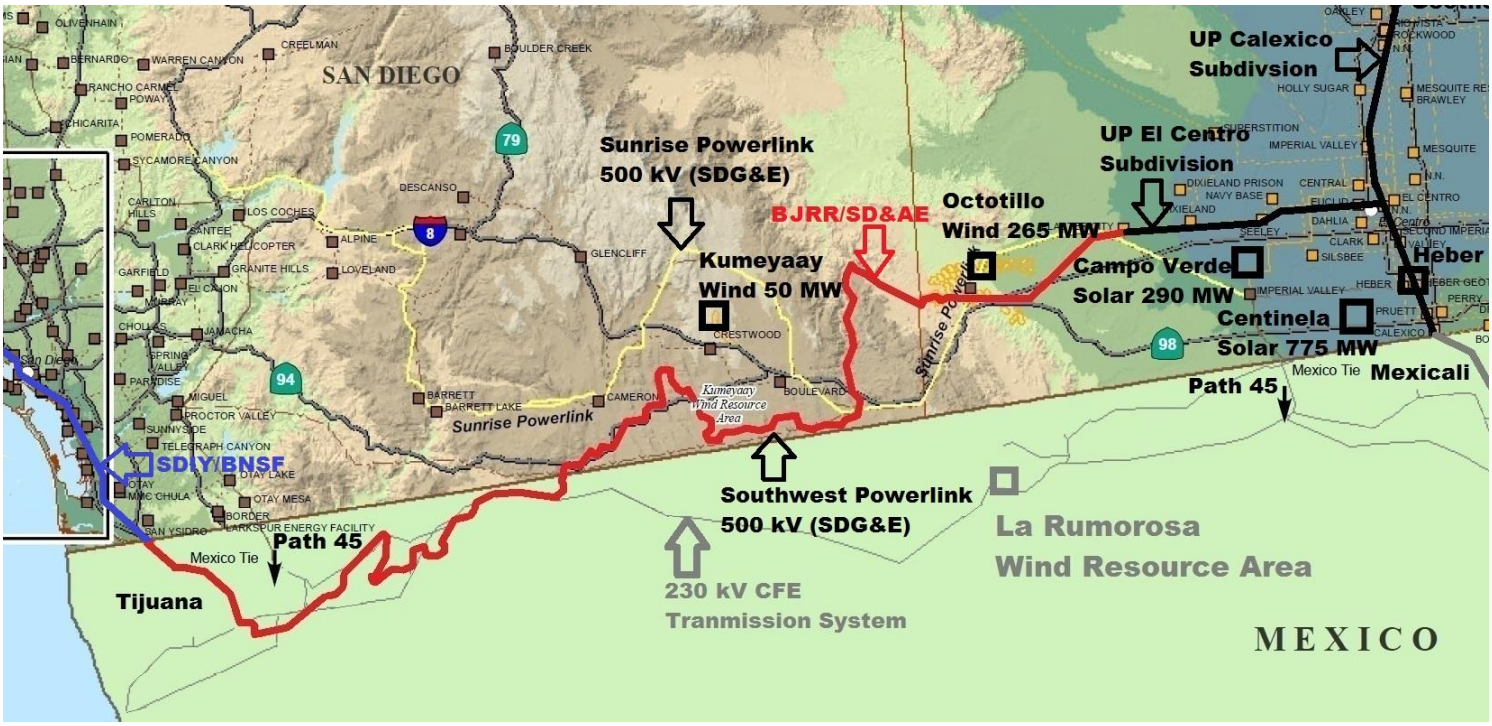

Fig. 14. Freight rail corridors and existing renewable capacity in Area E, overlaid on *California Transmission Lines & Substations* (Background map: California Energy Commission)

Transmission infrastructure-

The "East of Miguel" corridor along the border between the Imperial Valley and the coast has been identified as a major transmission constraint. A new transmission line routed along the BJRR/SD&AE rail line could help ease this constraint.

Recent and proposed transmission projects of note in Area D:

- Southwest Powerlink 500 kV (SDG&E)
- Sunrise Powerline 500 kV, completed in 2013 (SDG&E)
- ECO substation, just north of the border, double-circuit 230 kV cross-border line with total of 1,250 MW capacity connecting to Energia Sierra Juarez wind farm (SDG&E).
- Proposed 300 – 600 MW cross-border connection to CFE through the Fern substation in the Imperial Valley (IID).

Fig. 15. Selected freight railroad corridors (dark blue) in Area E, overlaid on transmission line and renewable energy project developments. (Background map: California Energy Commission- Renewable Energy Projects in Development 12/17/2015)
Background map of public land designations, transmission line corridors, designated renewable energy development areas, and renewable energy projects both existing and under development- yellow circles for solar PV, red circles for solar thermal, green circles for wind, and brown circles for geothermal. The reddish-purple areas are BLM-preferred focus areas for future renewable energy development, identified in the Desert Renewable Energy Conservation Plan (DRECP)

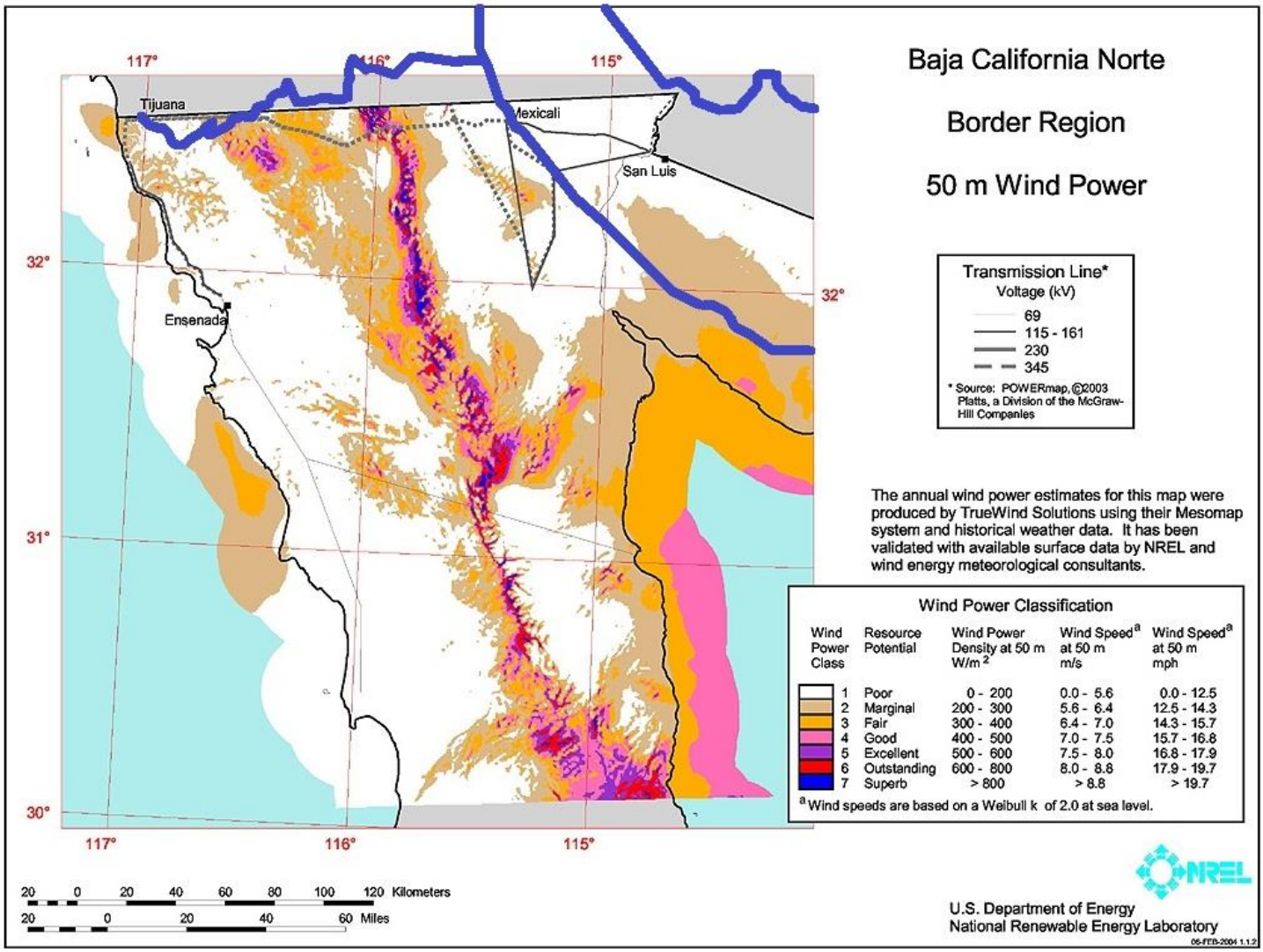

Fig. 16. Railroad corridors overlaid on map of Baja California Norte wind energy potential and major transmission lines
Source: National Renewable Energy Laboratory for the U.S. Department of Energy

Interstate line-haul freight lines originating in Southern California (BNSF Southern Transcon and UP Sunset Route):

Both of the primary Class I railroad interstate corridors terminating in Southern California, the BNSF Southern Transcon and the UP Sunset Route, have excellent opportunities for renewable energy development.

- The Southern Transcon is the main line of the BNSF Railway between Los Angeles and Chicago. Almost entirely double-tracked for its 2,200 miles, the route traverses California, Arizona, New Mexico, Texas, Oklahoma, Kansas, Missouri, Iowa and Illinois.

- UP's Sunset Route runs about 800 miles from Los Angeles to El Paso, Texas across California, Arizona and New Mexico.

Solar energy-

Both the Southern Transcon and the Sunset Route pass through areas in California, Arizona, New Mexico and Texas with some of the best solar energy potential in the United States, as shown on the map in Fig. 17 below.

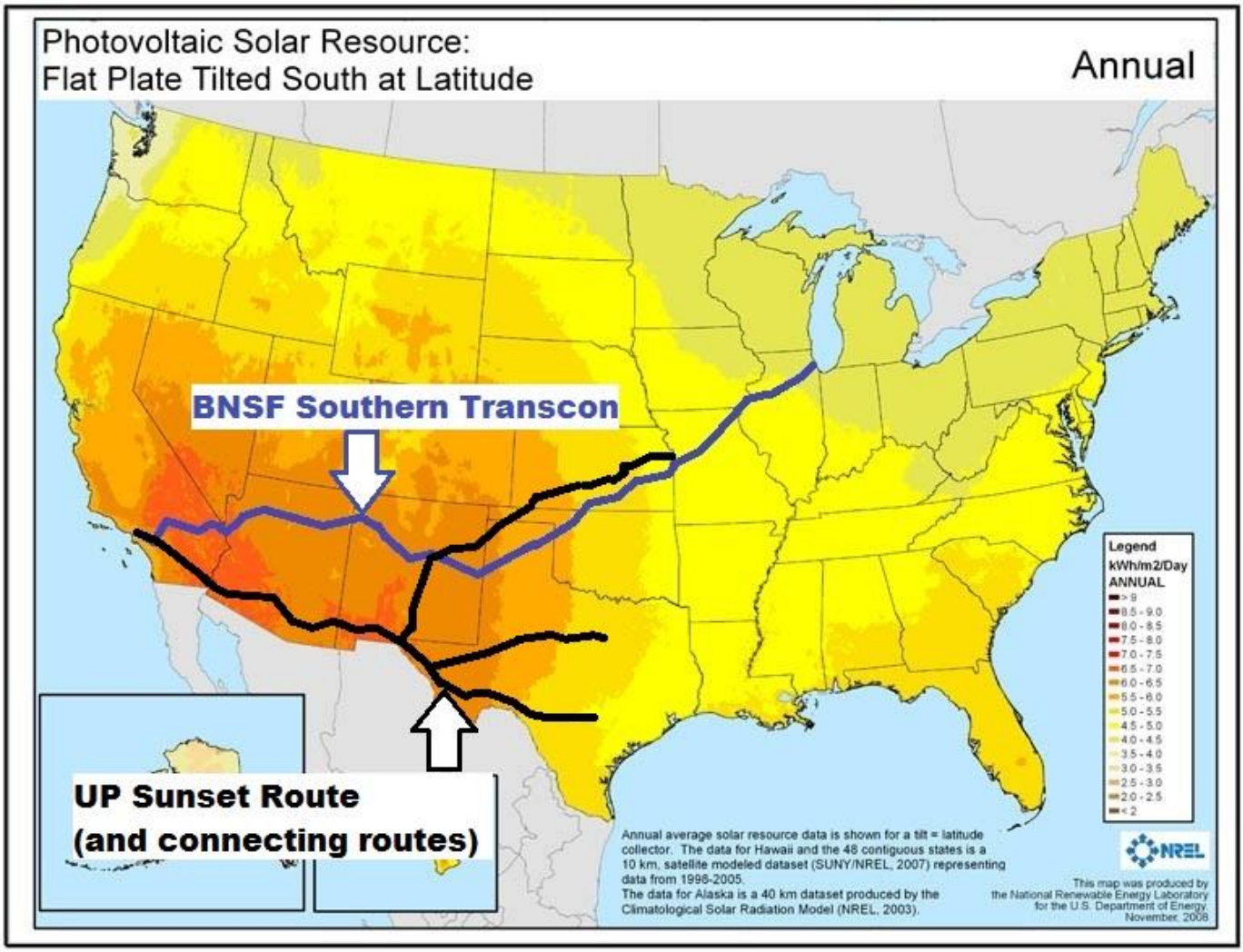

Fig. 17. BNSF Southern Transcon and UP Sunset Route corridors, overlaid on solar photovoltaic energy potential map

Source: National Renewable Energy Laboratory for the U.S. Department of Energy, November 2008

Wind energy-

Both the Southern Transcon and the Sunset Route pass through some of the nation's best wind resources in eastern New Mexico, Texas, Oklahoma and Kansas, as shown on the map in Fig. 18 below.

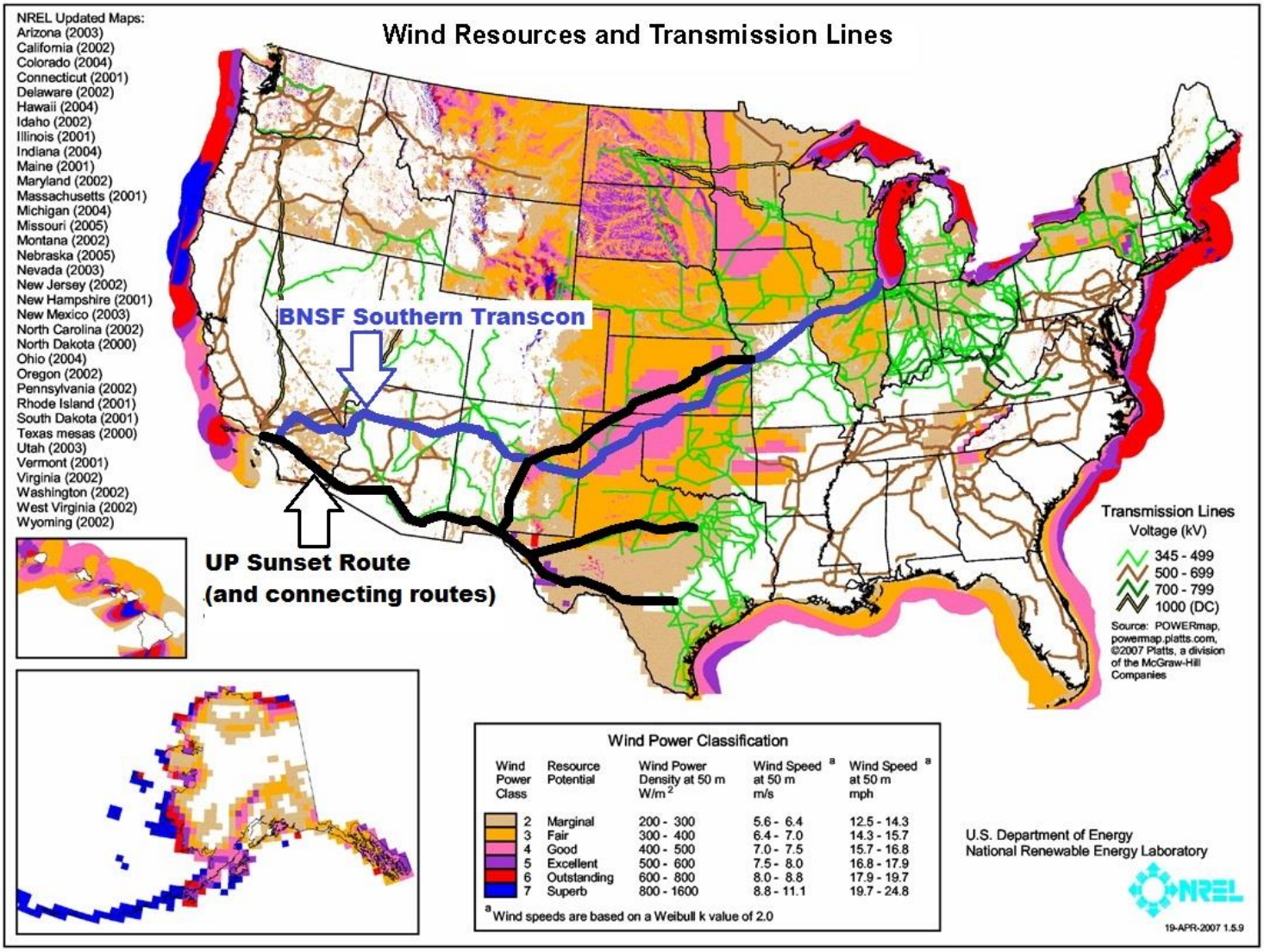

Fig. 18. BNSF Southern Transcon and UP Sunset corridors, overlaid on map of wind energy potential and major transmission lines
Source: National Renewable Energy Laboratory for the U.S. Department of Energy

Electric rail on the Navajo Nation-

The Navajo Nation is located north of the BNSF Southern Transcon corridor, and hosts two of the four existing U.S. all-electric freight railroads. These two short railroads are dedicated and isolated lines to haul coal between a mine and a coal-fired power plant. These short-haul lines use GE E60C all-electric freight locomotives built in the 1970s and 80s, which utilize 25 kV or 50 kV overhead catenary.

The coal-fired 2,040 MW Four Corners Generating Station near Fruitland, New Mexico primarily serves utilities in Arizona and New Mexico. It is served by the all-electric Navajo Mine Railroad (14 mile length, 25 kV, electrification completed in 1984) in New Mexico.

The coal-fired 2,250 MW Navajo Generating Station is owned by a consortium of public and investor-owned utilities including the U.S. Bureau of Reclamation (24.3%), the Salt River Project (21.7%) and the Los Angeles Department of Water and Power (21.2%), Arizona Public Service (14.0%), NV Energy (11.3%), and Tucson Electric Power (7.5%). The mine is served by the Black Mesa & Lake Powell Railroad (78-mile length, 50 kV, completed 1973) in Arizona, powered by electricity provided by the Navajo Tribal Utility Authority.

Perhaps the Najavo Nation's experience with electrified freight rail could be useful for California, especially due to the electric power relationship that already exists with Southern California via the Navajo Generations Station. However, as coal is phased out from California's electricity mix, the Navajo Nation's future solar or wind energy projects could utilize the existing transmission infrastructure to California, or help power an electrified Southern Transcon.

Berkshire Hathway's railroads and power transmission in the 'Southern Transcon' states-

The BNSF Railway is owned by holding company Berkshire Hathway, which also has substantial investments in renewable energy and electric power transmission. Berkshire Hathaway Energy (BHE)'s U.S. Transmission division owns interests in transmission line projects in California, Arizona, Texas and Kansas, all states traversed by the BNSF Southern Transcon.[11] BHE Renewables owns interests in renewable energy projects in the Southern Transcon states of California, Arizona, Texas, Kansas and Illinois. These projects include BHE Solar's 290 MW Agua Caliente project in Arizona, the 550 MW Topaz Solar and 586 MW Solar Star projects in California, as well as BHE Wind's 72 MW Marshall project in Kansas, 81 MW Bishop Hill project in Illinois (about 30 miles north of the Southern Transcon route east of Galesburg), the 290 MW Pinyon Pines I and II in California, and the 300 MW Jumbo Road project in Texas (located close to the Southern Transcon, near the town of Hereford).[12]

It is worth asking if BHE and BNSF could collaborate on siting renewable energy and transmission line projects along railroad corridors. For years, BNSF has expressed interest in electrification along its lines in conjunction with transmission development, but has not moved forward because of the capital costs. As described in this 2009 article in the *Journal of Commerce*:[13]

> Converting the freight rail system to electric trains from today's all-diesel operations might seem like a far-off notion, but BNSF Railway's Matthew K. Rose is starting to explore this new frontier. If his ideas pan out, BNSF's still-early planning efforts could help produce historic change for North American freight railroads.
>
> Rose, BNSF's chairman, president and CEO, told *The Journal of Commerce* his company is in talks with electrical power line builders about stringing or burying transmission lines in some of BNSF's inter-city rail corridors. With those line-easement leases emerging as a possible new revenue source, BNSF officials are also weighing how to electrify the carrier's mainline track system and asking equipment makers about locomotives that could run both under electric or diesel power.
>
> .."We have had conversations with two, if not three, outside organizations," Rose said, "around using railroad right of way for different opportunities of electrification." He does not see such potential power line projects developing quickly on the railroad, but said BNSF is in "serious" talks with two of them.

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[11] http://www.bhetransmission.com/

[12] https://www.bherenewables.com/

[13] "BNSF eyes route to electric trains", *Journal of Commerce*, April 13, 2009: http://www.joc.com/rail-intermodal/bnsf-eyes-route-electric-trains_20090413.html

He said BSNF could opt to draw electricity from those lines for its own use, in lieu of cash payments. With that, it might also offer power along with freight transportation to a new-era industrial park for various types of factories that burn lots of energy.

BNSF has not asked locomotive makers to prepare any plans, Rose said, but has discussed with them what kind of equipment is already available or could be developed if the railroad begins to integrate electric power with its vast diesel territory.

He said the price tag to electrify all BNSF mainline tracks could be $10 billion, including what the carrier would need in dual-mode locomotives. That's too steep a price for BNSF to justify right now, but the initial power line projects could be a way to start.

…Rose thinks the federal government should step in as a matter of public policy, set rail electrification as national goal to cut carbon levels and U.S. dependence on foreign oil, and help fund it across the entire rail network.

"You hear everybody talking about a carbon-constrained world, and a carbon-priced world," he said. "Railroads are so efficient from a carbon standpoint in terms of truck, but we still have an opportunity in terms of electrification. But I just think the capital burdens are so enormous when we're talking about this that its really going to have to be a federal vision, with some federal funding".

Energy Storage and Electric Railroads

Energy storage, and charging systems for locomotives with batteries, will be located at passenger train stations and freight railroads, and would be a new business opportunity for electric utilities. Under utility control, these distributed energy storage systems could be charged at off-peak hours, provide power to the local distribution grid during periods of peak demand, and provide ancillary services such as voltage and frequency support, reactive power, or aid integration of distributed solar energy systems. Southern California is leading the nation in utility-scale energy storage. California's three largest investor-owned utilities (PG&E, SCE, and SDG&E) are required by the CPUC to procure 1,300 MW of energy storage capacity by 2024. SCE's grid storage requirements are procurement of 580 MW total storage capacity by 2020, with an online date no later than 2024.

The substations along an electric freight rail line would be on the order of magnitude of 100 MW in capacity. Energy storage of utility scale magnitudes, say between 20 MW to 100 MW, could be installed at each rail line substation could serve as a backup for electric trains, as well as providing significant benefits to the grid. This scale is similar to energy storage projects in Southern California such as SCE's lithium ion 40 MWh, 8 MW peak BESS facility installed at SCE's Monolith substation in- Tehachapi, adjacent to the largest wind generation area in the state. AES is building 100 MW, 400 MWh ion battery storage facility with SCE, a $1 billion project at AES plants in Long Beach and Huntington Beach, to go online by the end of 2020. A freight rail energy storage system would be a larger version of wayside energy storage systems (WESS) that have been developed for electric rail transit applications. The creation in California of aggregate storage pools provides an interesting opportunity for electrified railroads. The model for aggregated energy storage pools is to offer energy storage packages to utilities by combining fleets of energy storage through diverse locations.

Regenerative braking-

Significant among the benefits of electric locomotives on mountain grades, such as the Cajon Pass north of San Bernardino, is regeneration of power from braking. This recovered power can be used to power other trains nearby on the same line, stored in a WESS, or be fed back to the power grid via bi-directional substations. There are potential benefits to utilities from electric rail regenerative breaking. From a utility perspective, an electric locomotive feeding power back to the grid would basically be serving as distributed generation source. The economic value of power created by regenerative breaking should be studied as part of economic analysis of electric freight rail in Southern California.