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REITs, Utilities, Clean Tech, Transportation, Autos & Sustainability

Buildings & Parking Lots: Ready for a Recharge?

The Real Estate and Freight industries could enjoy material revenue accretion & ESG benefits from onsite solar power generation by leveraging existing assets in new ways. Our collaborative work across REITs/Utilities/Clean Tech/Transportation/Autos quantifies a \$500 billion TAM.

Sustainability  alphawise 



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Buildings & Parking Lots: Ready for a Recharge?

We see a confluence of favorable dynamics that can drive a rapid acceleration in distributed/onsite clean energy generation within the Real Estate and Transportation industries in the US: Attractive renewables economics, growing customer demand for clean energy solutions, a surge in demand for fleet vehicle electrification, and a greater appreciation in the renewables and EV charging segments that the US real estate industry possesses multiple assets that are of great value: footprint, interconnection, captive demand, and growing customer preference for clean energy — to name a few. Working across the REITs/Utilities/Clean Tech/Transportation/Autos research teams, we have quantified the potential TAM (\$ capex), solar capacity potential (megawatts), onsite power generation opportunity (megawatt-hours), and revenue accretion (\$) for 50 of the largest REITs.

Key Takeaways: **(1)** We believe there is very significant potential for the real estate industry to enjoy material revenue accretion and ESG benefits from onsite solar power generation and potentially EV charging driven by leveraging existing assets in new ways. **(2)** We have quantified a \$500 billion capex TAM across US real estate (rooftops) and commercial trucking (parking lots) properties. **(3)** Unlike capital outlays that many other industries might incur to address climate, we believe this spend could result in value creation for REITs and Freight. For REITs, some stocks offer a revenue accretion opportunity in the double digits, while on average, across the MS coverage,

we estimate 3% accretion. We have developed a proprietary interactive mapping tool (*REITs Solar Rooftop Opportunity*) that visualizes a number of metrics for 50 of the largest REITs by geographic location. **(4)** We have assessed which stocks are best positioned across industries to tap into this opportunity. *Exhibit 1* shows industry and stock positioning. **(5)** In this report, we provide a "tutorial" for key considerations and potential ways to monetize onsite solar power generation and potential bottlenecks (such as long interconnection queues).

WHAT'S CHANGED		
Prologis, Inc. (PLD.N)	From	To
Price Target	\$175.00	\$180.00

Monetization could be in the form of cost savings (by producing power at a cheaper cost than the local utility) and/or by creating a new revenue stream when the power is sold to others (including tenants, the local utility, and potentially wholesale power markets). Given the potential margin of error in estimating company-level savings, our conservative analysis focuses on the revenue opportunity when the onsite power generation is sold at our estimated state-level solar levelized cost of electricity (LCOE) — the cost of producing solar electricity onsite that embeds a 10% equity IRR. This represents the minimum price at which the solar system owner would sell the power, although we would note there are multiple ways to monetize a higher price.

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Exhibit 1: Sector and Stock Positioning

Sector Exposure	Equity Exposure to Rooftop Solar			
	Sector	MS Analyst(s)	Sector Positioning	Most Exposed Stocks
↑	REITs	Richard Hill, Ronald Kamdem	While broadly constructive for the sector, industrial REITs should benefit most from rooftop solar. Within our coverage, we see PLD as most levered to this opportunity.	PLD (OW)
	Clean Tech	Stephen Byrd, David Arcaro, Laura Sanchez	Clean Tech stocks are natural beneficiaries of C&I distributed solar penetration: (1) equipment manufacturers; (2) developers/installers of distributed solar systems; (3) battery storage.	SEDG (EW), MAXN (EW), SHLS (EW), HASI (EW), FLNC (EW), STEM (EW), AMPS (EW), NEE (EW), AES (OW)
	Freight	Ravi Shanker	Solar opportunity allows for quicker penetration of EVs across fleets and cost savings. Large carriers are better positioned than small carriers.	ARCB (OW), ODFL (EW), XPO (EW), KNX (OW)
	Autos	Adam Jonas	Pairing rooftop solar with charging stations enables EV penetration. This supports our EV penetration bull case, which involves faster deployment of charging infrastructure.	TSLA (OW), FREY (OW), RIVN (OW)
	Utilities	Stephen Byrd, David Arcaro, Laura Sanchez	Positioning (negative): Distributed energy coupled with battery storage poses a significant long-term risk to the traditional utility business model. We see this 'customer defection' risk most pronounced in the west and northeast regions.	PCG (EW), EIX (EW), SRE (EW), ED (UW), ES (EW), PEG (OW)

Source: Morgan Stanley Research

Sizing the Opportunity: We estimate ~40b sq. ft. in roof/parking space available in the US in real estate and commercial trucking properties that could be used to generate solar power. The associated capex need translates into a \$500+ billion aggregate TAM, \$492 billion related to the real estate industry and \$10 billion to commercial trucking. Within real estate, we quantify a \$28 billion TAM for a select group of REITs, of which we estimate 90% will be "in the money" by 2025. There is a 328 GWdc solar capacity opportunity in aggregate, or ~3.5x the solar capacity installed in the US as of 2020. This capacity could generate 352 TWh of electricity per year, over 25% of the total electricity consumed by commercial properties in the US — implying a similar level of carbon abatement — and ~10% of total electricity sales in the US (representing the potential load loss for electric utilities).

What does this mean for REIT stocks? Through distributed solar systems, selected REITs could generate onsite an average of ~45% of their electricity consumption needs. This varies widely by REIT type, with some properties, such as Industrial and self-Storage, being able to generate onsite over 100% of their electricity demand. For the largest 50 REITs across a select number of segments, and focusing on "in-the-money" states, selling the onsite power generation at our estimated solar levelized cost of energy (LCOE) could drive an annual revenue potential of \$1.7 billion, at a minimum. We quantify an average revenue accretion opportunity of 3% for our REITs coverage (**Exhibit 12**), with DRE, EXR, EGP, NSA, and PLD seeing the highest accretion at above 9%. **Based on this analysis, we are raising our base and bull case valuations for Prologis by +3%**

(to \$180) and +10% (to \$225), respectively.

What does this mean for trucking stocks? Most large truck carriers in the US operate a fleet of terminals and service centers across the country — which for LTL carriers form the lifeblood of their networks. Similar to REITs, we believe there could be an opportunity to install solar on the rooftops of these buildings and on their parking lots. Also similar to REITs, trucking fleets create captive demand for onsite solar generation. Until a utility-powered EV charging network is built across the country, carriers could use site-generated solar power for low-cost, reliable, captive power generation — solving a key chicken-and-egg problem for charging infrastructure. Based on EV truck penetration rates, we estimate that 10-15 years of initial penetration of Class 8 EVs could be powered by captive solar generation alone. Specifically, we estimate 25-30% of the current truck fleet of the 10 largest trucking carriers in the US (4 TL, 6 LTL) could be effectively recharged on an ongoing basis by onsite solar power generation alone, this represents a ~\$10 billion TAM and a solar capacity opportunity of ~7 GWdc.

In collaboration with Morgan Stanley's AlphaWise team, we developed a proprietary mapping tool to illustrate the potential for solar installations at 50 large REITs. Our tool visualizes a number of metrics associated with solar installations, categorized by REIT and geographic location. We also map solar irradiance across the US — a measure of the energy intensity of solar and proxy for solar generation economics.

Executive Summary

Decarbonization, a cost or opportunity? In this report, we focus on two industries that must rapidly decarbonize to align with the goals outlined in the Paris Agreement (i.e., halt climate change) — real estate and freight. While disparate industries, they share a commonality that could advance their carbon reduction efforts: access to expansive surface area that could potentially accommodate solar panel installations at scale. **In aggregate, the solar opportunity represents capex of ~\$500 billion across these industries.** However, unlike capital outlays that many other industries might incur to address climate, we believe this spend could result in value creation for both industries.

Key Takeaways

- Our TAM includes ~\$490 billion related to capex within the real estate industry and ~\$10 billion related to commercial trucking. Within real estate, we identify ~\$30 billion for the 50 of the largest REITs, representing ~\$800 billion of market cap.
- In aggregate, we estimate 328 GWdc of theoretical solar installation capacity, ~3.5x the level of installed capacity in 2020. Annual electricity generation from this capacity represents 352 TWh, which amounts to >25% of total electricity consumption from commercial properties in the US and ~10% of total electricity sales in the US.
- Relative to commercial utility rates, we estimate 9% lower electricity costs by 2025 on average across the US for power generated onsite... in addition to carbon abatement of ~135 MMtCO₂ per year.

- Among the REITs we assessed in our report (top 50% of market cap), our rooftop solar TAM represents ~45% of their electricity consumption, implying the same level of carbon abatement from purchased electricity. For industrial and self-storage properties, the onsite generation potential represents ~110% of their needs on average.
- Within Freight, we estimate 10-15 years of initial penetration of Class 8 EVs could be powered by captive solar generation alone — solving a key chicken-and-egg problem of charging infrastructure.

We illustrate the opportunity through our proprietary AlphaWise mapping tool. Our tool visualizes a number of metrics associated with solar installations, categorized by REIT and geographic location. To develop the tool, we collaborated with AlphaWise, comprised of a large global team of data scientists, quants, data analysts, and market research experts. Building on over a decade of experience, AlphaWise continues to pursue two primary goals: (1) generating direct alpha for clients and (2) enhancing the Morgan Stanley research product with a more systematic, data-driven approach.

How to position? Industrial REITs have outsized exposure to the rooftop solar opportunity — and **we are most incrementally constructive on Overweight-rated Prologis (PLD).** Higher conviction and visibility into monetizing the solar, storage and EV charging opportunity leads us to raise our base case PT by +3% to \$180 and our bull case PT by +10% to \$225.

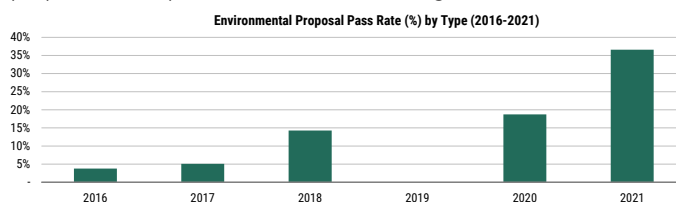
Pressure on the Private Sector to Decarbonize ...

Corporate decarbonization on a path to becoming "table stakes."

Asset owners and investors have intensified calls for companies to align operations with the Paris Agreement. For example, members of the Glasgow Financial Alliance for Net Zero (GFANZ), a global coalition of financial institutions and investors to facilitate decarbonization, represents >\$130 trillion of assets under management. Last year, engagement efforts reflected this shift, with shareholders passing ~35% of environmental proposals in the US, ~5x the average of the prior five years. Moreover, the SEC has progressed efforts to require climate-related disclosures from corporates — providing

transparency into emissions performance, carbon reduction targets, and related risks and opportunities.

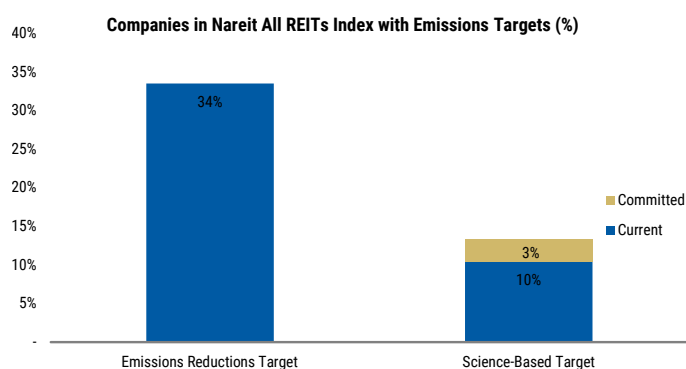
Exhibit 2: Similarly, the percentage of Environmental and Social proposals that passed reached record highs in 2021.



Source: ProxyInsight, Morgan Stanley Research

Corporates have begun to respond to these pressures. According to data from Refinitiv, 70% of companies in the S&P 500 have targets to reduce emissions, representing ~85% of market cap in the index. Within the REITs industry, a key focus of our report, >35% of companies, representing ~70% of market cap in the Nareit All REITs index, have targets to reduce emissions. Over time, however, we expect a shift toward "science-based targets" — which are third-party verified to align with the Paris Agreement and imply an ambitious rate of decarbonization. Currently, ~30% of companies in the S&P 500 have set or committed to set a science-based target — which compares to 13% of REITs. Separately, freight companies are also positioned for aggressive rates of decarbonization. Trucking carriers have published aggressive ESG targets by 2035 and 2050. We expect 27% of the global fleet to be electrified by 2030 and 55% by 2035 including ~38% for N. American Classes 5-7 and ~19% for N. American Class 8.

Exhibit 3: We expect REITs will continue to embrace targets to reduce emissions.



Source: Science-Based Targets initiative; Refinitiv Eikon; Morgan Stanley Research

For both real estate and freight, electrification will have a key role in decarbonization.

... Meets a Unique Opportunity for Value Creation

Value Unlock Through Existing Assets

For the US real estate and freight industries, multiple assets not only could advance decarbonization, but also value creation.

While unrelated in many respects, these industries share a unique commonality — access to expansive surface area that could accommodate solar installations at scale. Solar development could, in many instances, could offer a step-change in carbon reduction while savings costs (and potentially creating monetization opportunities).

For REITs, these assets include (1) a footprint that is in many cases well suited for solar project development (e.g., ease of installing solar trackers, racking and power electronics); **(2)** existing electrical interconnection infrastructure (many renewables developers are struggling with interconnecting new renewable development sites — this process is expensive and time consuming); **(3)** "captive demand," which provides a much greater profit potential than appreciated because of the ability essentially to arbitrage the entire utility cost structure (which is under multiple inflationary pressures) with clean energy solutions (which will, in our view, remain deflationary for many years); and **(4)** growing customer preferences for clean energy solutions at a time when those solutions are more deeply "in the money" relative to legacy solutions.

For Freight, truck terminals, which sit on large footprints of land, could service captive power demand.

Most large truck carriers in the US operate a fleet of terminals and service centers across the country — which for LTL carriers form the lifeblood of their networks. Our coverage of the largest five truck carriers in the US has >500 locations across the country that on average contain 11 acres that could theoretically be equipped with solar canopies. In addition, terminals usually have at least one building. As with REITs, we believe there could be an opportunity to install solar on the rooftops of these buildings and on their parking lots. Also similar to REITs, trucking fleets create captive demand for onsite solar generation. Until a utility-powered EV charging network is built across the country, carriers could use site-generated solar power for low-cost, reliable, captive power generation — solving a key chicken-and-egg problem for charging infrastructure.

Carrier Location Map



Source: Morgan Stanley Research, Company Data

Sizing the Opportunity

REITs

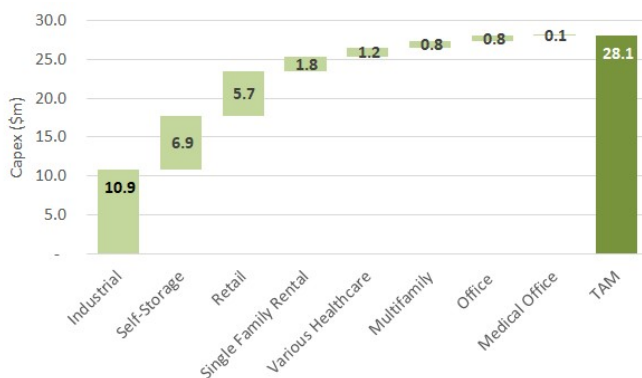
In aggregate, we estimate solar installations represent a ~\$490 billion capex TAM across real estate assets. This includes 38.5 billion sq. ft. of rooftop that could supply ~320 GWdc of solar generation at ~\$1.5/watt in capex. This TAM represents ~345 TWh of electricity generation per year, ~25% of the 1,360 TWy consumed in the US by commercial customers in 2019, according to the US Energy Information Administration (EIA).

Within this TAM, we estimate capex of \$28 billion for the largest 50 REITs across a select number of segments — with 90% "in-the-money" by 2025. Our assumed rooftop area of 2.2 billion sq. ft. implies 18 GWdc of solar generation capacity — and we apply capex per watt of \$1.50. We expect the majority of this capacity will be economic by 2025. To quantify "in-the-money" capacity, we compare our

estimated state-level solar C&I leveled cost of electricity (LCOE) with the average utility commercial rate within each state. On average, for REITs in "in-the-money" states, we estimate the LCOE is >3 cents/kWh below the commercial utility rate, or ~25% savings.

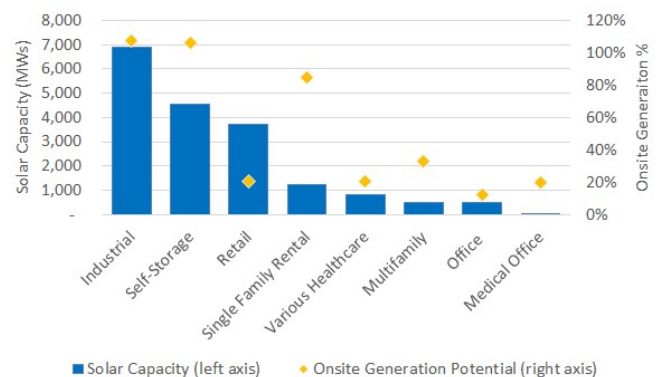
Methodology: We base our analysis on inventory square footage data, segmented by category — industrial, self-storage, retail, single-family rental, healthcare, multifamily, office, and medical office — and geographically by state. We then estimate associated rooftop area through assumed floor levels by REIT category. We then translate rooftop area to an addressable market and revenue opportunity through a series of assumptions (120 sq. ft. / 1 MW), a solar capital cost of ~\$1.5/watt), solar capacity factors of ~15% on average, and our estimate solar C&I solar LCOE).

Exhibit 4: TAM: Capex Opportunity by REIT Type



Source: Morgan Stanley Research estimates

Exhibit 5: Solar Capacity (MW) & Onsite Generation (%) Potential by REIT



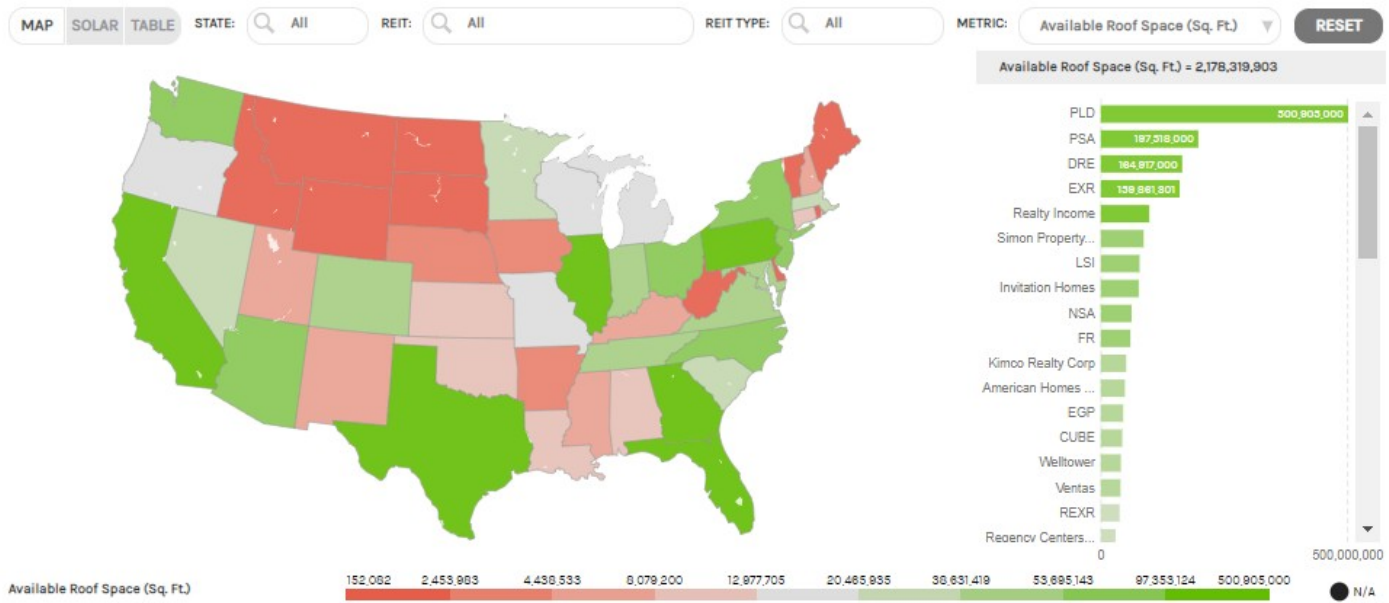
Source: Morgan Stanley Research estimates

Our proprietary AlphaWise mapping tool visualizes this TAM. In collaboration with Morgan Stanley's AlphaWise team — we developed a proprietary mapping tool to illustrate the potential for solar installations at REITs covered by Morgan Stanley. Our tool visualizes a number of metrics associated with solar installations, categorized by REIT and geographic location. We also map solar irradiance across the US — a measure of the energy intensity of solar and proxy for solar generation economics.

Exhibit 6: Our proprietary mapping tool visualizes the solar installation opportunity for REITs across the United States.

REITs Rooftop Solar Opportunity

US map and chart showing Available Roof Space (Sq. Ft.) for **All states**, **All REITs** and **All REIT types**. Click on the map or chart to explore the data. Hover over the map and chart for more details.



Note: Cost of Onsite Solar Power Generation and Revenue Opportunity Potential are not available for Multifamily REIT type

Source: AlphaWise; Morgan Stanley Research estimates

Industrial and storage REITs are best positioned for upside monetization opportunities. Warehouses and storage facilities benefit from large rooftop space and less energy intensity per square foot vs. other real estate verticals — which could result in less energy consumption relative to generation potential. We believe industrial REITs could potentially monetize surplus solar power generation through net metering, wholesale markets, or to customer unable to construct on-site solar projects. Some challenges exist, including potential changes in state net metering policies and interconnection delays. EV charging represents another potential source of value, whether through onsite generated or purchased electricity. Lastly, system owners could sell renewable energy certificates, though value and availability vary by market.

Exhibit 7: Industrial & Storage REITs in 'In-the-Money' States

REIT	Available Roof Space (Sq. Ft.)	Solar Capacity Potential (MW-dc)	Capex Need (\$mn)	Electricity Generation Potential (MWh/yr.)	Estimated Electricity Consumption (MWh/yr)	Onsite Generation Potential (%)
INDUSTRIAL REITS						
EastGroup Properties Inc.	44,817,000	373	540	460,015	403,353	114%
First Industrial Realty Trust, Inc.	52,855,000	440	684	516,699	475,695	109%
Prologis, Inc.	403,061,000	3,359	5,319	4,002,822	3,627,549	110%
Duke Realty Corp.	154,886,000	1,291	1,990	1,471,414	1,393,974	106%
Rexford Industrial Realty, Inc.	38,133,166	318	558	410,877	343,198	120%
Terreno Realty Corp.	12,311,707	103	170	119,749	110,805	108%
SELF-STORAGE REITS						
Extra Space Storage Inc.	149,750,054	1,248	1,912	1,435,837	1,347,750	107%
Life Storage, Inc.	74,993,172	625	932	714,730	674,939	106%
National Storage Affiliates Trust	55,821,772	465	698	545,255	502,396	109%
Public Storage	182,722,000	1,523	2,310	1,772,694	1,644,498	108%
CubeSmart	41,003,614	342	527	390,756	369,033	106%
Total	1,210,354,485	10,086	15,639	11,840,848	10,893,190	109%

Source: Morgan Stanley Research. PLD includes US only estimates.

Freight

Among 10 of the largest trucking carriers in the US, we estimate \$10 billion of potential capex associated with power generation at terminals. On average, we estimate 25-30% of trucking fleets could be recharged on an ongoing basis by onsite power generation alone. This includes a range of 14% (some TLs) up to 75% (some LTLs), with the wide variation driven by their geographical footprint indeed. Also, LTLs have more terminals and a larger physical footprint per truck than TLs.

Exhibit 8: Carrier Summary Table

Company	Category	Solar Capacity Potential (MW-dc)	Capex Need (\$mn)	Electricity Generation Potential (MWh/yr.)	Estimated Electricity Consumption (MWh/yr)	Onsite Generation Potential (%)
ARCB	LTL	569	865	618,486	827,200	75%
KNX LTL	LTL	314	423	342,990	568,600	60%
XPO	LTL	1,651	2,520	1,818,864	3,100,000	59%
SAIA	LTL	493	744	552,759	1,140,000	48%
ODFL	LTL	712	1,082	790,364	1,857,600	43%
KNX TL	TL	750	1,083	842,277	3,805,000	22%
HTLD	TL	103	157	114,943	526,000	22%
WERN	TL	242	362	275,708	1,572,200	18%
FDX	LTL	1,068	1,622	1,163,292	7,319,600	16%
TFII	LTL	633	963	690,545	4,920,800	14%
SNDR	TL	228	346	252,168	1,800,000	14%
Total		6,763	10,167	7,462,394	27,437,000	27%

Source: Company data, Transport Topics, Morgan Stanley Research Estimates

Given that we expect 25-30% industry Class 8 EV penetration between 2037 and 2040, this analysis concludes that roughly 10-15 years of initial penetration of Class 8 EVs could be powered by captive solar generation alone. This would give the industry a headstart on building out broader charging infrastructure. Further developments in solar panel yields, broader 3P installation of solar panels and selling back to the grid could buy the industry even more time and/or reduce costs. However, we believe this benefit may be largely restricted to the larger carriers who have larger and more developed terminal networks as well as the balance sheets, margins and management teams with the foresight and flexibility to make the needed investments.

Enabling electrification is key to driving cost savings for the industry. We expect electrification will cumulative cost savings from EV trucks over the next decade is roughly equal to ~100% of 2020

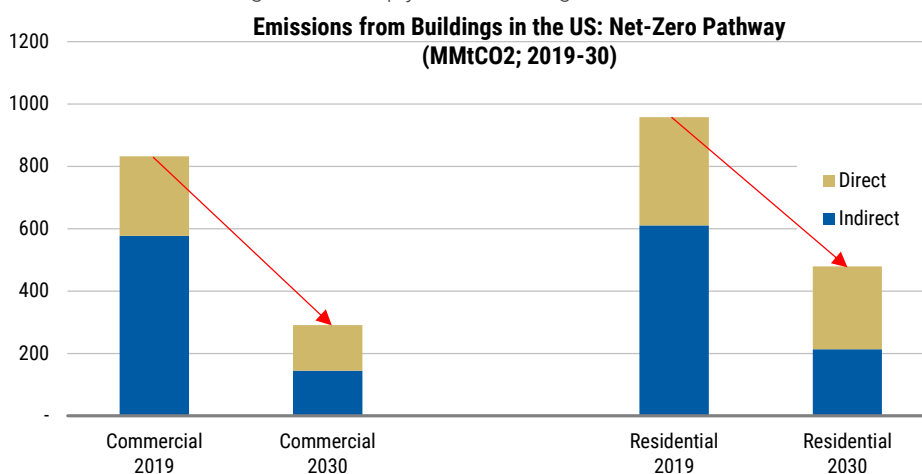
EBIT and could be an EBIT boost of MSD-LDD% for the carriers, depending on subsidies.

Methodology: Building square footage across the nearly 500 truck terminals in our data set average ~2,500 locations in our data set. These are typically similar to single level warehouses, so we use square footage as a proxy for suitable roof area installations – and we make similar assumptions as our approach for REITs. In addition, our analysis includes total paved acreage at each site, including parking facilities. We assume the paved area can be equipped with solar canopies. Similar to our rooftop assumptions, we assign a 20% "haircut" for conservatism and to reflect areas that may be "drive only." We then quantify potential solar generation capacity and associated cost using geolocation data, assuming the average EV Class 8 truck uses a 1MW battery and effectively drives 100,000 miles per year.

What Is the Decarbonization Impact for REITs?

The building stock in the US is a major contributor to GHG emissions. According to data from the EIA, commercial and residential buildings contributed to ~35% of total energy-related CO₂ emissions in 2019; ~70% of these emissions were from purchased electricity. To align with a net-zero pathway, non-residential and residential buildings must reduce emissions from purchase electricity by ~75% and ~65%, respectively, according to our analysis of data from the IEA's net-zero trajectory for buildings.

Exhibit 9: If the US follows the global net-zero trajectory laid out by the IEA, emissions associated with buildings must steeply decline through the end of this decade.



Source: U.S. Energy Information Administration (EIA), <https://www.eia.gov/environment/emissions/carbon/>; International Energy Agency (IEA), <https://www.iea.org/reports/tracking-buildings-2021>; Morgan Stanley Research

Rooftop solar installations could meaningfully advance progress toward net-zero targets. In aggregate across REITs in our analysis, we estimate rooftop solar has the potential to reduce emissions from purchased electricity by ~45% (assuming current electricity generation is from fossil fuels). The opportunity is most significant for industrial and self-storage buildings — which we estimate have the potential to generate more electricity from rooftop solar than power consumption. Within multifamily and retail, we see ~30% and ~20% of potential emissions reductions associated with electricity. For office, the relatively lower rooftop area to power consumption results in more modest potential emissions reductions.

Exhibit 10: We estimate rooftop solar could reduce emissions across our assessed REIT subset (\$800 B market cap) by ~45%. Industrial and self-storage REITs have outsized opportunities for carbon abatement.

REIT Type	Estimated Electricity Consumption (MWh/yr.)	Estimated Annual Emissions (MMtCO ₂)	Electricity Generation Potential (MWh/yr.)	Net Purchased Electricity (MWh/yr.)	Potential Annual Emissions (MMtCO ₂)	Annual Emissions Reduction (MMtCO ₂)	Annual Emissions Reduction (%)
Industrial	7,422,203	3	7,962,656	(540,453)	0	3	(107%)
Self-Storage	4,895,390	2	5,207,611	(312,221)	0	2	(106%)
Retail	20,419,581	8	4,158,888	16,260,693	6	2	(20%)
Single Family Rental	1,742,516	1	1,481,508	261,008	0	1	(85%)
Various Healthcare	4,314,626	2	896,402	3,418,224	1	0	(21%)
Multifamily	1,766,303	1	583,461	1,182,842	0	0	(33%)
Office	4,257,225	2	520,527	3,736,698	1	0	(12%)
Medical Office	230,360	0	46,444	183,916	0	0	(20%)
Total	45,048,204	17	20,857,495	24,190,709	9	8	(46%)

Source: Morgan Stanley Research

Industry & Equity Implications

Within our North American coverage, the REITs, freight, and clean tech are positioned to benefit from the rooftop solar opportunity — while utilities could face headwinds. At the stock level, Overweight-rated Prologis (PLD) offers the most direct exposure to this theme. As a result of higher conviction in solar, storage, and EV charging, we increase our bull case PT for PLD by +10%, to \$225 (Exhibit 52).

Exhibit 11: Across our coverage, we view Prologis (PLD) as best positioned to capture the opportunity from rooftop solar, storage, and EV charging.

Equity Exposure to Rooftop Solar				
Sector Exposure	Sector	MS Analyst(s)	Sector Positioning	Most Exposed Stocks
↑	REITs	Richard Hill, Ronald Kamdem	While broadly constructive for the sector, industrial REITs should benefit most from rooftop solar. Within our coverage, we see PLD as most levered to this opportunity.	PLD (OW)
	Clean Tech	Stephen Byrd, David Arcaro, Laura Sanchez	Clean Tech stocks are natural beneficiaries of C&I distributed solar penetration: (1) equipment manufacturers; (2) developers/installers of distributed solar systems; (3) battery storage.	SEDG (EW), MAXN (EW), SHLS (EW), HASI (EW), FLNC (EW), STEM (EW), AMPS (EW), NEE (EW), AES (OW)
	Freight	Ravi Shanker	Solar opportunity allows for quicker penetration of EVs across fleets and cost savings. Large carriers are better positioned than small carriers.	ARCB (OW), ODFL (EW), XPO (EW), KNX (OW)
	Autos	Adam Jonas	Pairing rooftop solar with charging stations enables EV penetration. This supports our EV penetration bull case, which involves faster deployment of charging infrastructure.	TSLA (OW), FREY (OW), RIVN (OW)
	Utilities	Stephen Byrd, David Arcaro, Laura Sanchez	Positioning (negative): Distributed energy coupled with battery storage poses a significant long-term risk to the traditional utility business model. We see this 'customer defection' risk most pronounced in the west and northeast regions.	PCG (EW), EIX (EW), SRE (EW), ED (UW), ES (EW), PEG (OW)

Source: Morgan Stanley Research

REITs

We see PLD as the company within our coverage that has the highest likelihood of monetizing the solar, storage and EV charging opportunity set within our coverage. PLD is currently the 3rd largest solar provider in the US — and this is despite only 4% of available company-controlled roofs having solar panels, suggesting there exists a large addressable market that is untapped. The company would like to grow solar panel penetration by 10x (from ~4% of roofs to ~40% of roofs). Indeed, we have conviction there exists a

sizable long-term potential earnings contribution from PLD's planned efforts given both market exposure and management's communication with investors.

We raise our base case PT by +3% to \$180 and our bull case PT by +10% to \$225. Higher conviction and visibility into monetizing the solar, storage and EV charging opportunity leads us to raise our base case PT by +3% to \$180 and our bull case PT by +10% to \$225 as we ascribe an additional value to the energy business supported by our DCF analysis.

Exhibit 12: Summary Table, Including Potential Revenue Accretion, by REIT (Morgan Stanley-covered REITs) – *the onsite generation potential variation is a representation of roof space available relative to energy needs (the more floors a building has the less likely it is that onsite generation alone can supply electricity needs)*

REIT	Ticker	Available Roof Space (Sq. Ft.)	Solar Capacity Potential (MW-dc)	Capex Need (\$mn)	Electricity Generation Potential (MWh/yr.)	Estimated Electricity Consumption (MWh/yr)	Onsite Generation Potential (%)	Revenue Opportunity Potential (\$m/yr.)	MS 2022 Revenue Estimate (\$mn)	Revenue Accretion (%)
Duke Realty Corp.	DRE.N	164,917,000	1,374	2,125	1,552,188	1,484,253	105%	163	1,158 e	14.1%
Extra Space Storage Inc.	EXR.N	160,884,324	1,341	2,061	1,533,628	1,447,959	106%	156	1,509 e	10.4%
EastGroup Properties Inc.	EGP.N	45,571,000	380	550	467,809	410,139	114%	43	464 e	9.2%
National Storage Affiliates Trust	NSA.N	62,504,225	521	786	603,183	562,538	107%	61	664 e	9.2%
Prologis, Inc.	PLD.N	500,905,000	4,174	6,646	4,814,999	4,508,145	107%	510	5,580 e	9.1%
Site Centers Corp	SITC.N	21,212,986	177	265	198,919	975,797	20%	20	369 e	5.5%
Public Storage	PSA.N	198,319,000	1,653	2,515	1,906,907	1,784,871	107%	193	3,716 e	5.2%
Macerich Co	MAC.N	25,959,635	216	351	253,263	1,194,143	21%	27	540 e	5.0%
Kimco Realty Corp.	KIM.N	51,574,558	430	667	498,977	2,372,430	21%	51	1,239 e	4.1%
Broadstone Net Lease, Inc.	BNL.N	15,978,500	133	202	144,599	735,011	20%	16	393 e	4.0%
Spirit Realty Capital	SRC.N	24,553,500	205	308	226,371	1,129,461	20%	24	687 e	3.4%
Phillips Edison & Company, Inc	PECO.O	19,302,699	161	244	180,699	887,924	20%	19	549 e	3.4%
Regency Centers Corp	REG.O	29,984,572	250	385	287,638	1,379,290	21%	30	921 e	3.2%
Urban Edge Properties	UE.N	8,257,073	69	112	70,001	379,825	18%	9	281 e	3.0%
STORE Capital Corp	STOR.N	27,840,310	232	351	266,427	1,280,654	21%	27	887 e	3.0%
Realty Income Corp	O.N	98,548,950	821	1,241	914,584	4,533,252	20%	95	3,342 e	2.9%
Agree Realty Corp.	ADC.N	9,370,200	78	120	84,937	431,029	20%	9	420 e	2.2%
Simon Property Group Inc	SPG.N	87,218,411	727	1,122	807,408	4,012,047	20%	86	4,885 e	1.8%
National Retail Properties Inc	NNN.N	9,875,030	82	120	95,219	454,251	21%	9	749 e	1.2%
Physicians Realty Trust	DOC.N	5,119,113	43	64	46,444	230,360	20%	5	414 e	1.2%
Ventas Inc	VTR.N	40,114,874	334	517	371,826	1,805,169	21%	40	4,409 e	0.9%
Office Properties Income Trust	OPI.O	4,660,000	39	60	43,302	349,500	12%	5	569 e	0.8%
Healthpeak Properties Inc	PEAK.N	14,977,610	125	191	147,001	673,992	22%	15	1,924 e	0.8%
Welltower Inc.	WELL.N	40,788,096	340	525	377,575	1,835,464	21%	40	5,330 e	0.8%
Highwoods Properties	HIW.N	5,421,800	45	63	50,474	406,635	12%	5	801 e	0.6%
Vornado Realty Trust	VNO.N	7,278,200	61	98	60,255	545,865	11%	8	1,561 e	0.5%
SL Green Realty Corporation	SLG.N	5,543,374	46	75	44,190	415,753	11%	6	1,488 e	0.4%
Paramount Group Inc.	PGRE.N	2,578,336	21	35	20,553	193,375	11%	3	713 e	0.4%
Boston Properties, Inc.	BXP.N	9,876,941	82	131	87,038	740,771	12%	10	3,185 e	0.3%
Hudson Pacific Properties	HPP.N	2,649,298	22	38	26,889	198,697	14%	3	1,014 e	0.3%
American Homes 4 Rent	AMH.N	49,014,184	408	588	475,802	568,761	84%	-	1,413 e	0.0%
AvalonBay Communities Inc.	AVB.N	19,571,425	163	266	180,860	567,767	32%	-	2,523 e	0.0%
Equity Residential	EQR.N	16,491,448	137	225	157,534	478,417	33%	-	2,692 e	0.0%
Essex Property Trust, Inc.	ESS.N	11,656,299	97	167	119,560	338,149	35%	-	1,551 e	0.0%
Invitation Homes Inc	INVH.N	77,026,235	642	963	766,958	893,812	86%	-	2,169 e	0.0%
Tricon Residential Inc	TCN.N	24,124,684	201	288	238,748	279,943	85%	-	386 e	0.0%
UDR, Inc.	UDR.N	13,166,846	110	170	125,507	381,970	33%	-	1,455 e	0.0%

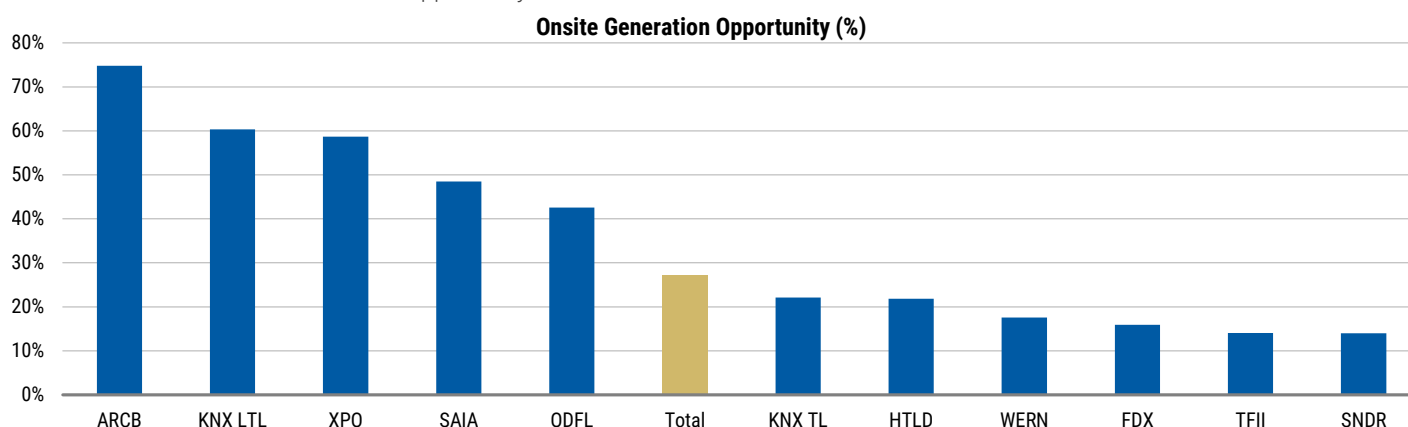
Source: Morgan Stanley Research estimates

Freight

Distributed solar generation would allow for potential quicker penetration of EVs across their fleet, the cost savings realized should also be improved. In our initial EV Insight [here](#), we concluded that all-in EBIT for trucking carriers could be boosted by ~10% from electrification, a number that could be much higher with captive solar power generated at a much lower cost than electricity purchased off the grid in most states. We emphasize that all large carriers stand to win from an operating cost and market share perspective relative to small mom-and-pop carriers.

The LTLs are better placed for captive onsite solar power generation benefits because they have a more extensive network of truck terminals and a larger footprint overall. However, we believe TLs can strike deals with customers at drop-and-hook facilities to build solar infrastructure that can charge trucks during load/unload time. We see LTLs with the highest footprint concentrated in solar-friendly states as the biggest potential winners here, including **ARCB** (OW), **KNX** (OW), **XPO** (EW), **SAIA** (UW), and **ODFL** (EW). On the other hand, TLs with more of a North/East footprint come in at the lower half of this analysis, including **SNDR** (OW), **TFII** (OW), **WERN** (OW), **HTLD** (EW), and **FDX** LTL (EW).

Exhibit 13: Carrier Onsite Generation Opportunity



Source: Company data, Transport Topics, Morgan Stanley Research

Clean Tech

Clean Tech stocks are the natural beneficiaries of increased penetration of distributed C&I solar resources and EV charging networks. We see 4 types of companies that should benefit: 1) Equipment manufacturers given increased demand for distributed solar panels (**MAXN**), inverters (**SEDG**), and other solar balance of system wiring equipment (**SHLS**); 2) developers/installers of C&I distributed solar systems and/or EV charging systems (**AMPS**, **NEE**, **AES**, **SHLS**); 3) battery storage players (**FLNC** and **STEM**); and 4) financiers of such projects (**HASI**). Residential installers (**RUN** and **SPWR**) are also exposed to distributed solar, but primarily to the residential market.

Utilities

Distributed energy coupled with battery storage poses a significant long-term risk to the traditional utility business model. As utility customers (residential and C&I) opt for rooftop solar combined with energy storage, utility bills for the remaining utility customers rise further due to the need for utilities to spread their fixed costs over a smaller remaining customer base, which in turn provides an even greater incentive for the remaining utility customers to switch to solar + storage. If net metering policies in the US are significantly altered and customers receive a much lower rate on the power they sell back to the grid than what is received today, we would expect incremental demand for behind-the-meter (BTM) storage, which would allow the customer to self-consume more of the energy generated from their solar panels. The electric utilities with the greatest risk of customer loss, in our view, are **PCG**, **EIX**, **SRE**, **ED**, **ES**, and **PEG**.

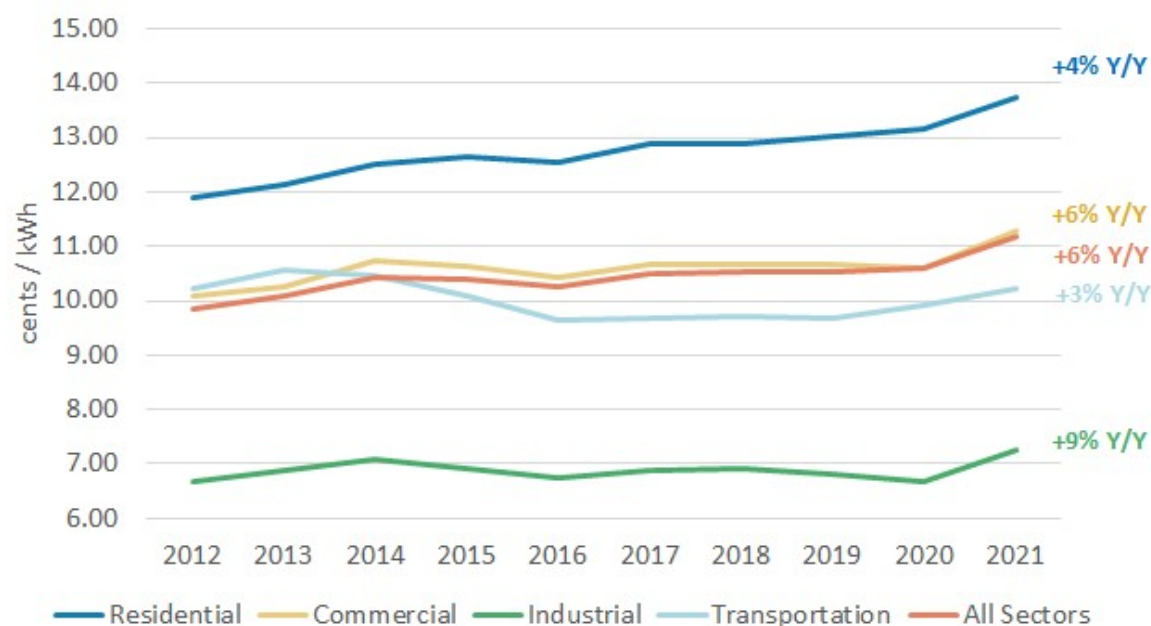
Distributed Solar Market Landscape

New installations of distributed solar resources (solar systems that are installed at the customer site and owned by the customer as opposed to the local utility) grew at a 10%+ CAGR over the past 5 years, twice the growth seen in total new installations in the US over the same period. These installations occur at residential and commercial and industrial (C&I) properties and are driven by three key dynamics that we expect will persist for an extended period of time: **(1)** an improving "economic wedge" between distributed energy generation and utility rates, **(2)** improving economics of battery storage, and **(3)** a large focus on decarbonization by corporations and governments. We expand on these dynamics below.

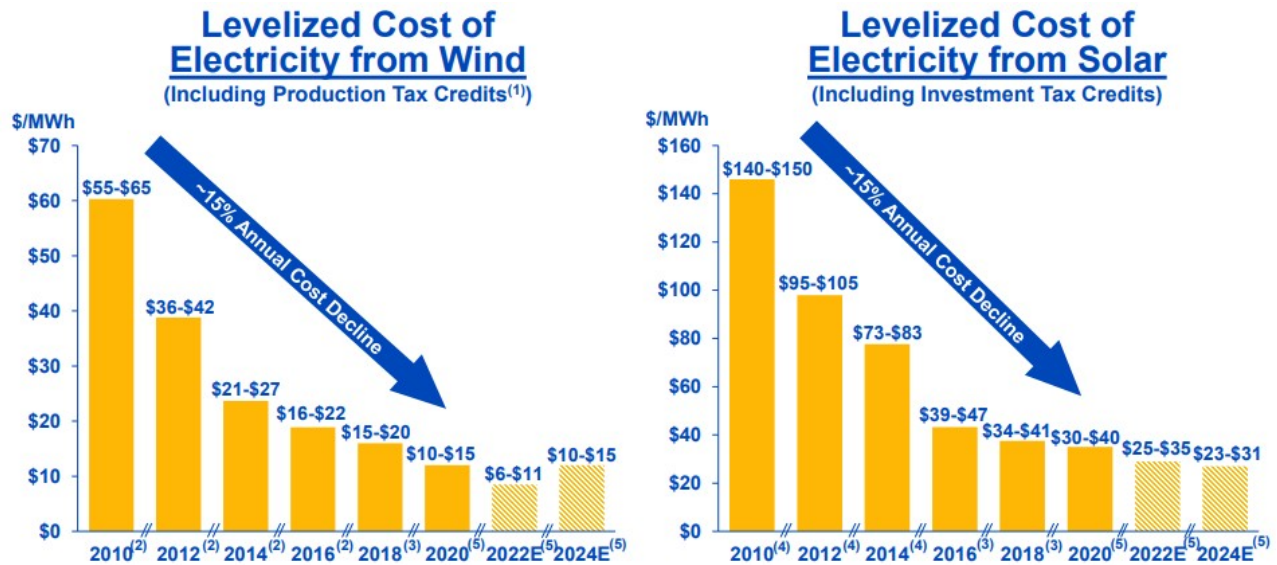
Long-Term Growth Drivers

1) Improving economic wedge between distributed renewable energy and utility rates: The US Energy Information Administration (EIA) reported recently that in 2021, US retail electricity prices rose at the fastest pace in over a decade, with C&I average rates increasing the most, by 6%+ and ~9% Y/Y, respectively — see [Exhibit 14](#). While adjusted for inflation utility rates have remained relatively unchanged over time, the cost of renewable energy contracts has declined by 15% annually over the past decade — see [Exhibit 15](#). There are near-term factors impacting both utility rates and renewable energy contracts, but we expect that once supply chains normalize we will continue to see utility rates rise (or be flat net of inflation in the best cases) and the cost of renewable energy contracts drop driven by scale and extended policy support. We also expect adoption of distributed resources to increase as battery storage becomes economically scalable.

Exhibit 14: Average Price of Electricity to Ultimate Customers



Source: EIA, Morgan Stanley Research

Exhibit 15: Wind & Solar Technologies Have Seen 15% Annual Cost Declines

Source: NextEra Energy presentation

2) Improving economics of battery storage: We believe the storage market is in the very early stages of adoption and is at the outset of a 10-year or longer period of rapid growth. We estimate a ~30% CAGR in storage deployments through 2030 with even higher near-term growth driven by a number of key growth factors: cost reductions, an improving economic value proposition for customers, growing comfort with the technology, a continued increase in renewables penetration, and rising grid costs and reliability issues. By pairing solar systems with battery storage customers can smooth their onsite energy production with their energy consumption (charge the batteries during the sunny hours and use the electricity in other times of the day) and reduce their peak loads, thus reducing their reliance on the utility grid and the magnitude of fixed/demand charges — more on this in [Sizing the Opportunity](#).

We expect the cost of storage to continue to decline in the medium to long term. The levelized cost of storage (LCOS) for standalone energy storage has declined by 41% since 2018, according to a Lazard

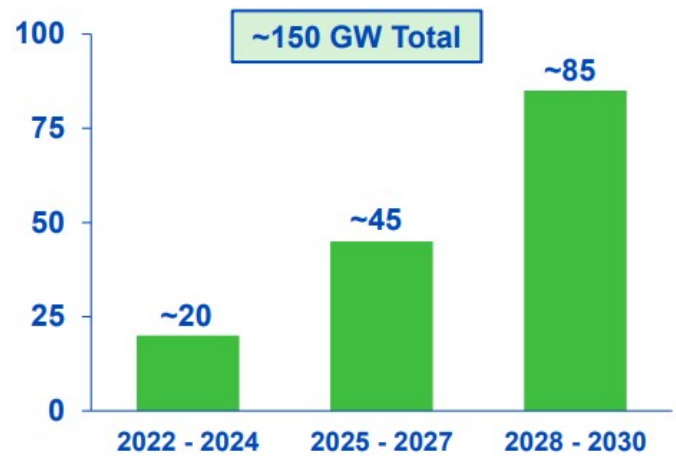
levelized cost of energy (LCOE) analysis. We see increased adoption as the technology becomes more competitive, which in turn drives scale and causes costs to drop further. We see the cost to developers dropping even more if a standalone investment tax credit (ITC) for storage is passed, as well as extensions of tax credits for wind and solar.

For a detailed overview of the storage market, see our recent report [here](#).

3) A focus on decarbonization: There has been a material increase in decarbonization efforts by corporations and state and local governments over the past several years. Whether it is driven by economic reasons (distributed solar generation can offer savings relative to utility rates in many states), a preference for environmentally friendly solutions, or regulatory actions, we believe this dynamic will only increase going forward.

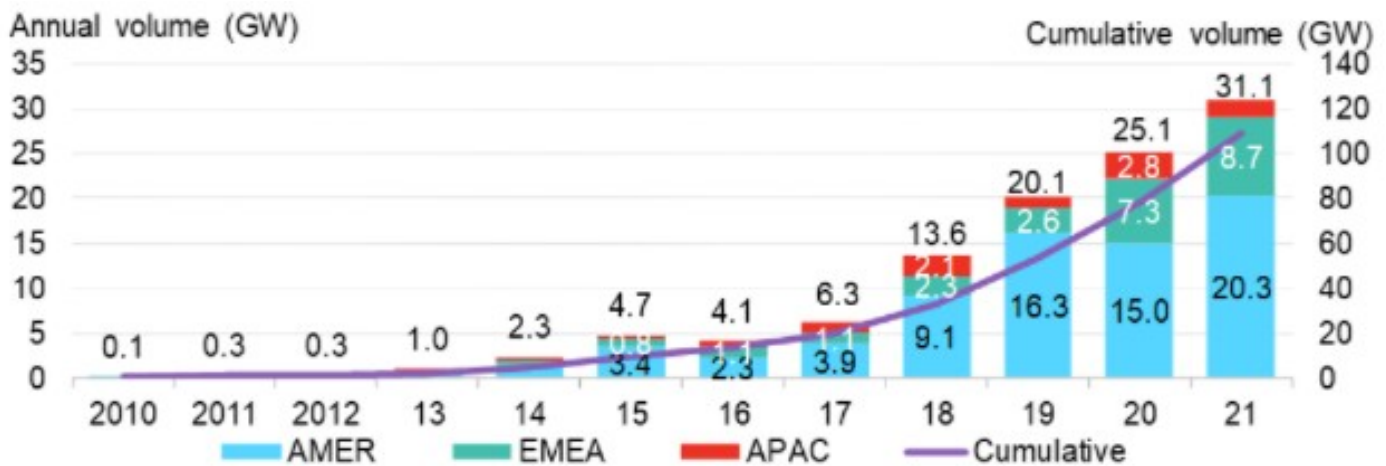
Despite some near-term challenges related to supply chain disruption, we see a market that is up for grabs by renewable energy developers and building owners — see Exhibit 16. Fully 92% of S&P 500 companies have released ESG reports according to the Government Accountability Institute, 60% of Fortune 500 companies have set climate and energy goals, and even more — 350+ companies — have pledged to use 100% renewable energy by 2050. This has driven a large increase in corporate renewables power purchase agreements (PPAs), through which corporations buy power directly from renewable energy developers instead of buying power from the utility — see Exhibit 17. More recently, we have seen real estate companies not only signing contracts with renewable energy developers but owning and operating distributed solar systems on their roofs — see [What Are the REITs Saying?](#)

Exhibit 16: US C&I Renewable Energy Demand (GWs)



Source: NetxEra Energy presentation

Exhibit 17: Global Corporate PPA Volumes

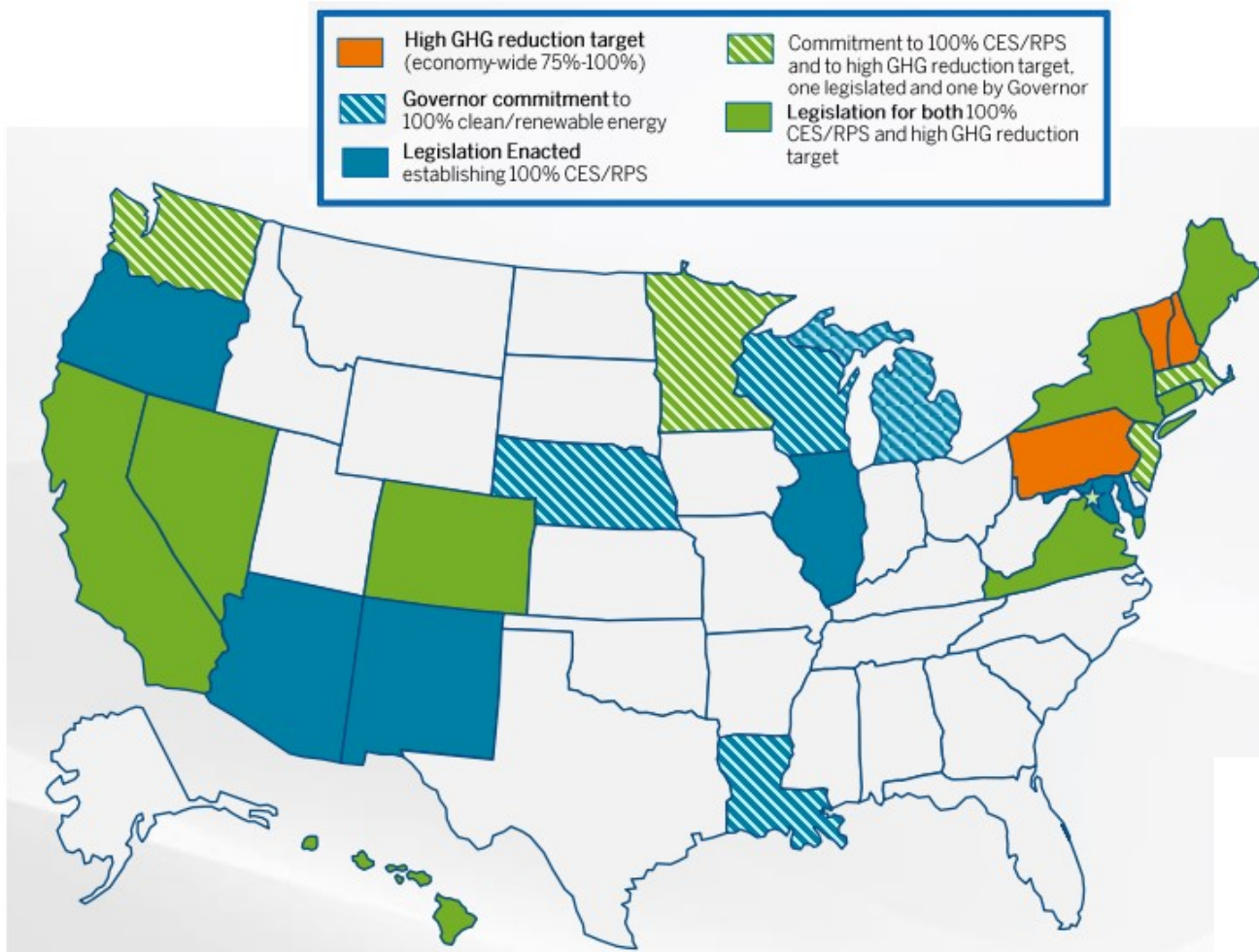


Source: Onsite PPAs excluded. APAC volume is an estimate, Pre-reform PPAs in Mexico and sleeved PPAs in Australia are excluded, Capacity is in MW DC. Source: BNEF

Governments, both state and federal, have also ramped up their focus on decarbonization. Today, 25 states and the District of Columbia (which together represent 54% of US electricity customers) have 100% clean electricity targets, deep GHG targets, or both — see Exhibit 18. To meet these targets, states incentivize investment in clean energy development through rebates, tax credits, subsidies, and low-interest loans for renewable energy projects. This third-party tool allows for easy tracking of solar incentives by state. The federal government has also subsidized solar invest-

ment for many years through the solar ITC. Currently, the ITC is worth 26% of the up-front capital costs for projects starting construction in 2022, 22% in 2023, and 10% for commercial projects starting construction in 2024 (0% for residential projects unless leased from a business like RUN). The latest version of the Build Back Better legislation includes an extension of the solar ITC through 2031 and other incentives such as direct pay of tax credits that could drive a 21% increase in C&I installations in 2022-26, according to the Solar Energy Industries Association (SEIA).

Exhibit 18: States with Strong Decarbonization Targets



Source: Exelon Presentation

The decarbonization of the transportation industry also drives exciting opportunities for the power sector (utility-scale and distributed). While penetration of electric vehicles (EVs) today and over the near term is not material relative to the total electricity consumed in the US, we see EV adoption as a key disruptor over the medium to long terms. Edison International noted in a recent White Paper (*Mind the Gap: Policies for California's Countdown to 2030*) that in California alone there is a funding gap of \$10 billion related to 900,000 EV chargers needed to support 7.9 million zero emission vehicles (ZEVs) required to reach state EV targets by 2030. McKinsey estimates that by 2030, some ~14 million commercial vehicles will be on the road. *Why is this relevant for the real estate market?* Because property owners can help filling in the EV charging gap by offering EV charging infrastructure in their properties. For a C&I building owner

this could represent another revenue stream, while for solar developers this represents larger solar+battery systems and higher average revenue per installation (ARPI). In this report, we expand on the potential of electrification in the commercial trucking space, including medium- and heavy-duty Class 8 trucks — see *Sunshine & Parking Lots*.

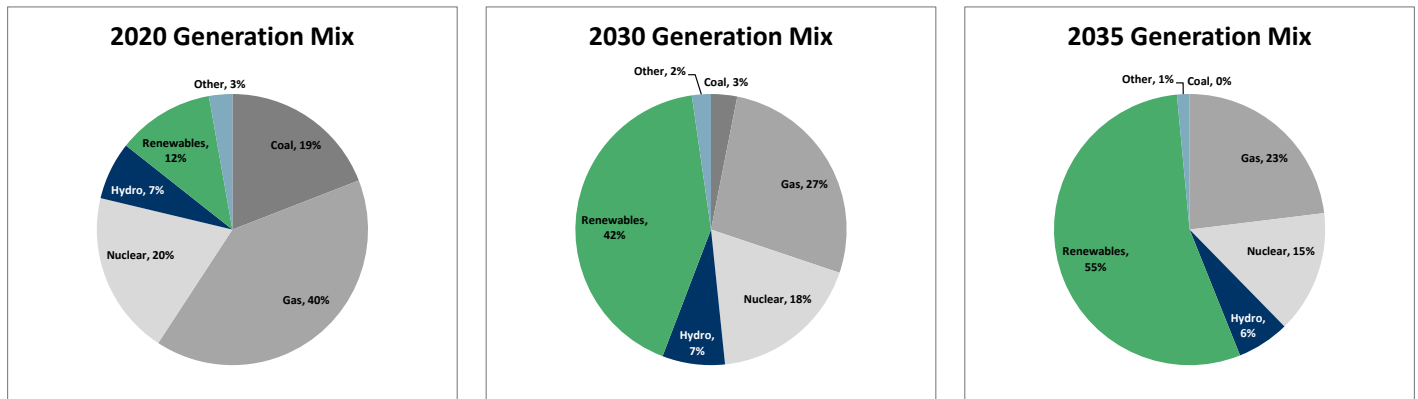
Overall, we estimate the share of renewables generation in the US power supply mix will increase from 12% in 2020 to 40%+ in 2030 and 55% in 2035, with solar playing a key role. We estimate 535 GWac of solar capacity to be installed in 2021-35, of which ~190 GWac represents distributed generation (or behind-the-meter, BTM) installations. This implies 12.5 GWac/yr of distributed solar installations on average, or a 12% CAGR from 2020 levels of ~4 GWac.

Looking at the C&I market within the solar distributed space, the SEIA expected some spillover effects in 2022 after 2021 saw flat installations on the back of supply chain constraints and interconnection delays. This, coupled with demand pull-in from the current ITC schedule and numerous state-level policy programs, was expected to drive double-digit growth in C&I installations in 2022-23, according to the SEIA. However, the industry group now estimates the recent decision by the Department of Commerce (DoC) to investigate anti-circumvention of solar panels imports from Cambodia, Malaysia, Thailand, and Vietnam — which represent 80% of the US panel imports — could impact 2022-23 solar installations by 46%, 318 projects or 51 GW of solar capacity potentially being canceled or delayed.

A preliminary determination is due around August 25, 2022, and the final determination around January 22, 2023. We ultimately expect the DoC to dismiss this investigation but in the meantime, until there is clarity, we see the largest impacts for large-scale solar projects. See our previous notes on this [here](#) and [here](#).

On the positive side, with passage of pending federal clean energy incentives, the SEIA estimates the potential for an additional 21% increase in C&I installations in 2022-26. Although timing of passage is to be determined, we see a high likelihood that existing renewables tax credits, including the solar ITC, will be extended.

Exhibit 19: Morgan Stanley Projections of the US Power Generation Mix by Fuel Type (solar share increases from ~5% in 2020 to ~15% in 2030 and ~20% in 2035)



Source: EIA, S&P Global Market Intelligence, Morgan Stanley Research estimates

Our Proprietary Mapping Tool for REITs

In collaboration with Morgan Stanley's AlphaWise team, we developed a proprietary mapping tool to illustrate the potential for solar installations at 50 of the largest REITs. Our tool visualizes a number of metrics associated with solar installations, categorized by REIT and geographic location. We also map solar irradiance across the US — a measure of the energy intensity of solar and proxy for solar generation economics.

What Is AlphaWise?

AlphaWise includes a large global team of data scientists, quants, data analysts, and market research experts. Our experts collaborate closely with one another and work with fundamental analysts, strategists, and economists to identify investment debates that data can clarify. Building on over a decade of experience, AlphaWise continues to pursue two primary goals: (1) generating direct alpha for clients and (2) enhancing the Morgan Stanley research product with a more systematic, data-driven approach.

Methodology

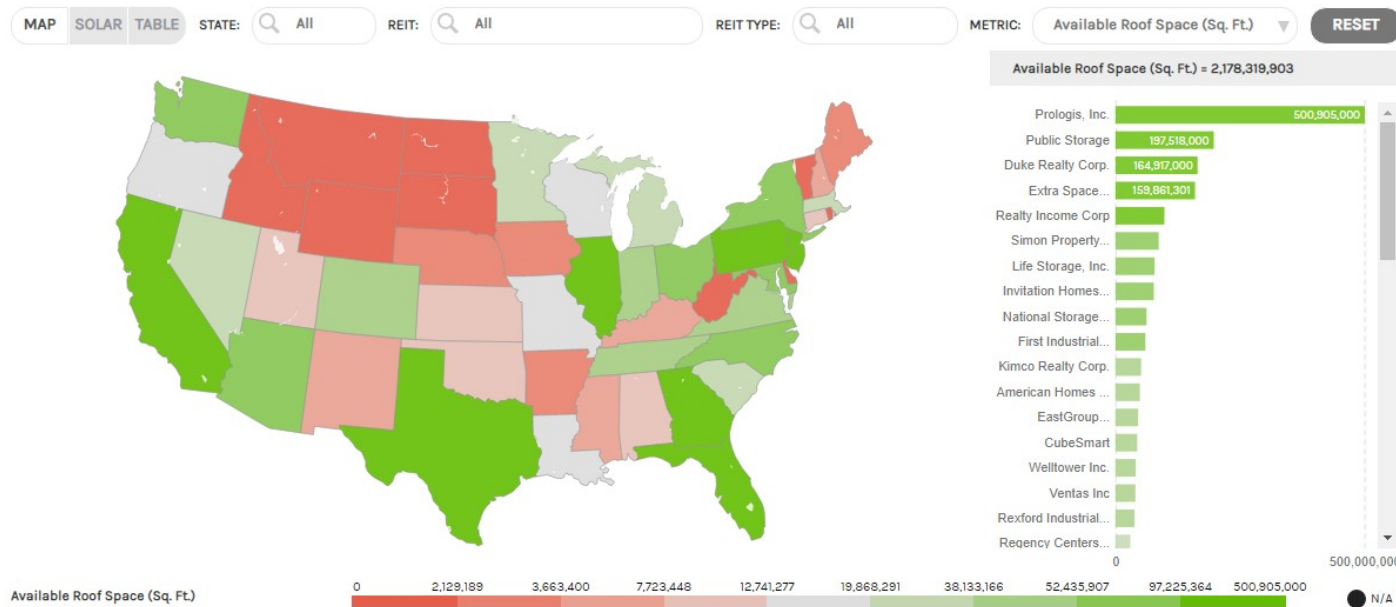
We first size rooftop area by category and geographic footprint across 50 large REITs. We base our analysis on inventory square footage data, segmented by category — industrial, self-storage, retail, single-family rental, healthcare, multifamily, office, and medical office — and geographically by state. We then estimate associated rooftop area through assumed floor levels by REIT category.

We then translate rooftop area to revenue opportunity from onsite solar generation through a series of assumptions:

- *Solar capacity potential:* Each 100,000 sq. ft. area has capacity for 1 MW of solar power capacity; we apply a 20% buffer to this to account for vents and equipment, along with not being able to site solar equipment on the edges of rooftops, which leads to 120k sq. ft. / 1 MW.
- *Capex need / TAM:* We estimate capital costs of ~\$1.5/watt by 2025 (excluding battery storage but includes soft costs such as permits and interconnection fees).
- *Electricity generation potential:* Calculated using our estimated solar C&I capacity factors (CFs) for fixed tilt systems of between 13% and 19%, with the average CF across the US at ~15%.
- *Savings vs. Utility Rate:* We compare our proprietary state-level solar C&I levelized cost of energy (LCOE) model to utility commercial rates across the US. We estimate an average savings rate of 18%, with several states offering >35% savings, although we acknowledge there are various complexities not captured in this simplistic approach, which we expand on in [Sizing the Opportunity](#).
- *Revenue opportunity potential:* Calculated focusing on "in-the-money" states, where we assume all the solar electricity produced onsite (the electricity generation potential from above) is sold at our estimated solar C&I LCOE.

REITs Rooftop Solar Interactive

US map and chart showing Available Roof Space (Sq. Ft.) for **All states**, **All REITs** and **All REIT types**. Click on the map or chart to explore the data. Hover over the map and chart for more details.



Note: Cost of Onsite Solar Power Generation and Revenue Opportunity Potential are not available for Multifamily REIT type
 Source: Morgan Stanley Research, NREL

How to use the Mapping Interactive

[Click here for Interactive Map](#)

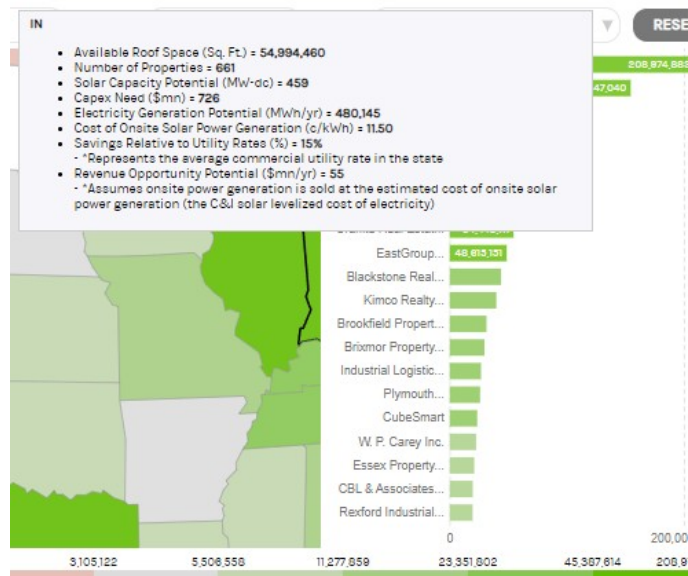
The mapping tool has three tabs: **Map**, **Solar**, and **Table**. These can be toggled in the top left region of the interactive. The interactive also has a "RESET" button in the top right to undo all selections.

The "Map" tab visualizes solar characteristics by state, REIT, and REIT type. Metrics displayed include:

- Available roof space
- Number of properties
- Solar capacity potential (MW-dc)
- Capex need (\$mn)
- Electricity generation potential (MWh/yr)
- Cost of onsite solar power generation (c/kWh)
- Savings relative to the associated utility rate (%)
- Revenue opportunity potential (\$ mn/yr.)

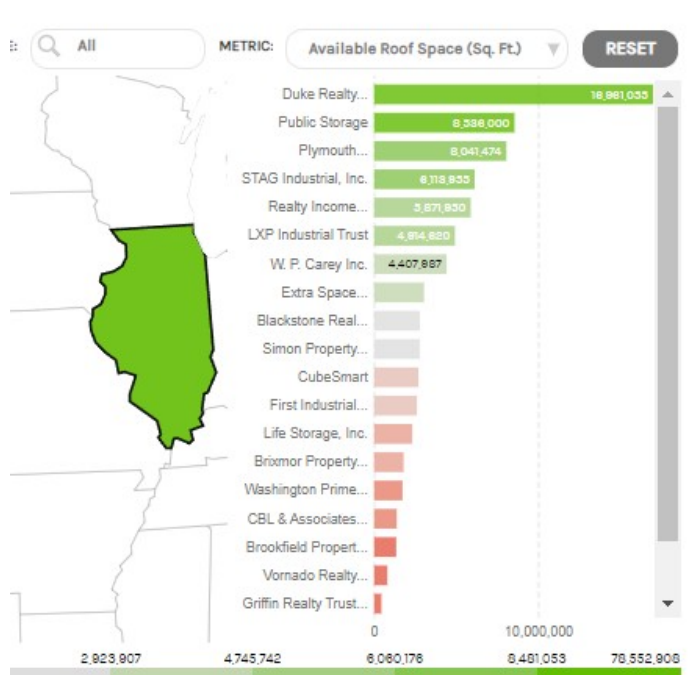
To visualize these metrics geographically, hover the cursor over a state. The display will show aggregated metrics for REITs in that state. Clicking the state (or choosing from the state drop-down) will display a list of REITs along the right side of the interactive and associated metrics chosen in the top-right drop-down. Data can be filtered further by selecting a specific REIT or REIT type.

Exhibit 20: Hovering over a state will display metrics in aggregate among REITs in that location



Source: AlphaWise; Morgan Stanley Research estimates

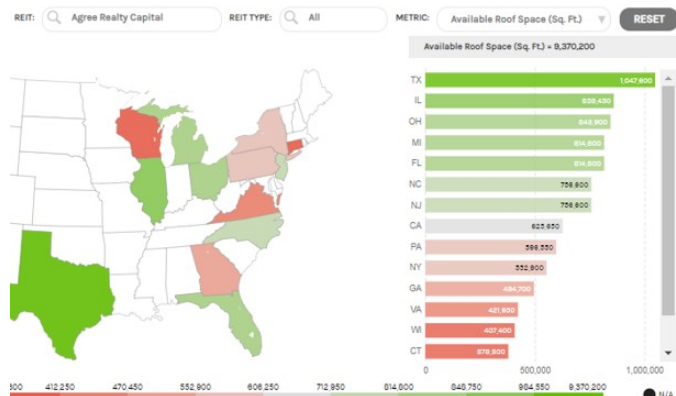
Exhibit 21: Clicking a state will display a list of REITs along with a distribution of a chosen metric



Source: AlphaWise; Morgan Stanley Research estimates

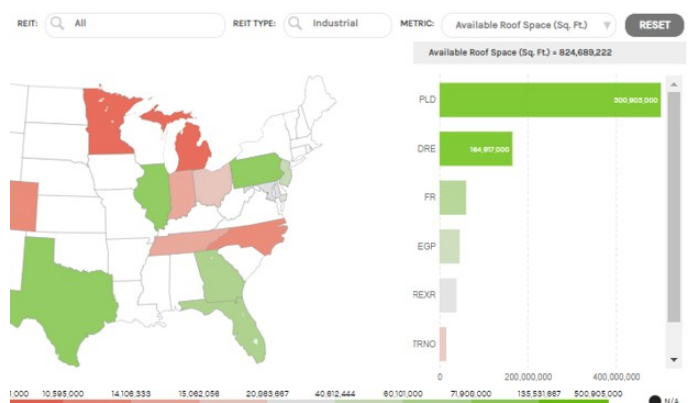
To visualize the metrics by REIT, first choose a REIT name from the drop-down at the top, along with a specified metric. The interactive will display the distribution of that metric across states where the REIT has a presence. To visualize by REIT type, follow the same instructions — but instead of a specific REIT, choose from the "REIT TYPE" drop-down. Hovering over a state will cause the interactive to display metrics for a REIT or REIT type in that state.

Exhibit 22: Choosing a REIT from the drop-down will display a distribution of metrics across states



Source: AlphaWise; Morgan Stanley Research

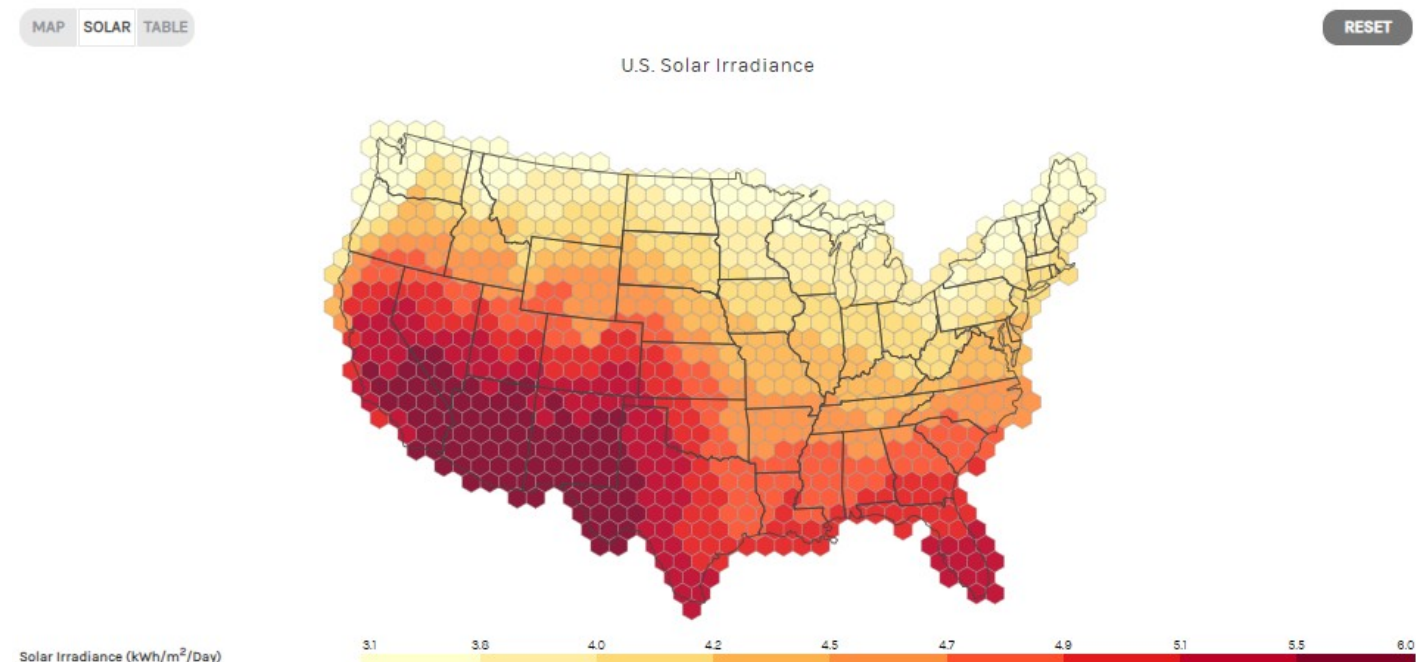
Exhibit 23: To visualize by REIT type, follow the same instructions — but instead of a specific REIT, choose from the "REIT TYPE" drop-down



Source: AlphaWise; Morgan Stanley Research

The "Solar" tab displays solar irradiance across the US. The National Renewable Energy Lab defines solar irradiance as "The amount of solar energy that arrives at a specific area of a surface during a specific interval" (see [here](#)). We display solar irradiance as kWh/m²/day. Solar irradiance directionally reflects unit economics for solar power generation.

Exhibit 24: Solar irradiance directionally reflects unit economics for solar power generation



Source: AlphaWise; Morgan Stanley Research

The "Table" tab displays the full list of REITs and associated metrics. Each metric is sortable. Drop-downs across the top can filter by state, REIT, or REIT type. Ask us for an Excel version of this database.

Exhibit 25: Our interactive also displays full data in a table format.

Company	Available Roof Space (Sq. Ft.)	Number of Properties	Solar Capacity Potential (MW-dc)	Capex Need (\$mn)	Electricity Generation Potential (MWh/yr)	Cost of Onsite Solar Power Generation (c/kWh)	Savings Relative to Utility Rates (%)	Revenue Opportunity Potential (\$mn/yr)
PLD	500,905,000	2,696	4,174	6,648	4,815,000	10.51	21%	511
PSA	197,518,000	2,776	1,646	2,503	1,898,464	10.99	20%	195
DRE	164,917,000	553	1,374	2,125	1,552,190	10.90	21%	162
EXR	159,861,301	2,080	1,334	2,049	1,522,844	11.04	20%	155
Realty Income	98,375,200	10,929	820	1,237	913,220	11.11	18%	95
Simon Property Group Inc	86,889,948	0	722	1,117	804,644	10.99	19%	84
LSI	78,629,987	1,076	654	978	748,460	10.99	21%	75
Invitation Homes	77,026,236	0	642	963	766,958	-	-	0
NSA	62,504,225	975	518	784	603,182	10.94	20%	61
FR	60,101,000	0	502	785	574,544	10.97	20%	60
Kimco Realty Corp	51,574,563	0	431	667	498,978	11.01	21%	50
American Homes 4 Rent	49,014,185	0	409	589	475,803	-	-	0
EGP	45,571,000	0	379	550	467,810	9.42	26%	42

Source: AlphaWise; Morgan Stanley Research

Sizing the Opportunity

Key Figures:

- There are ~40 billion sq. ft. in roof/parking space available in the US in real estate and commercial trucking properties that could be used to generate solar power.
- The associated capex need translates into a \$500+ billion aggregate TAM, \$492 billion related to the real estate industry and \$10 billion to commercial trucking. Within real estate, we quantify a \$28 billion TAM for a selected group of REITs, of which we estimate 90% will be "in the money" by 2025.
- There is a 328 GWdc solar capacity opportunity in aggregate, ~3.5x the solar capacity installed in the US as of 2020. This capacity could generate 352 TWh of electricity a year, over 25% of the total electricity consumed by commercial properties in the US and ~10% of total electricity sales in the US.
- Our estimated 2025 average cost to produce onsite solar electricity by C&I customers (the solar C&I LCOE) of 11.13 cents per kWh compares to average utility rates for commercial customers of 12.26 cents per kWh (also by 2025), implying 9% savings potential.
- Through distributed solar systems, selected REITs could generate onsite an average of ~45% of their electricity consumption needs. This varies widely by REIT type, with some properties, such as Industrial and self-Storage, being able to generate onsite over 100% of their electricity demand.
- For the largest 50 REITs across a selected number of sub-sectors, and focusing on "in-the-money" states, selling the onsite power generation at our estimated solar C&I LCOE drives an annual revenue potential of \$1.7 billion. We quantify an average revenue accretion opportunity of 3% for our REITs coverage sector, with DRE, EXR, EGP, NSA, and PLD seeing the highest accretion at above 9%.
- 25-30% of the current truck fleet of the 10 largest trucking carriers in the US (4 TL, 6 LTL) could be effectively recharged on an ongoing basis by onsite solar power generation alone.
- Based on EV truck penetration rates, roughly 10-15 years of initial penetration of Class 8 EVs could be powered by captive solar generation alone, giving the industry a long head start to build out a broader charging infrastructure.

Exhibit 26: Total Opportunity by 2025 Across Real Estate and Commercial Trucking Properties

Sector	Available Sq. Ft.	TAM / Capex Need (\$mn)	Solar Capacity Potential (MW-dc)	Potential Electricity Generation (MWh)
Real Estate	38,500,814,419	492,122	320,840	344,503,047
Selected REITs	2,181,339,166	28,156	18,178	20,857,495
Commercial Trucking	824,521,018	10,167	6,763	7,462,394
Total Opportunity	39,325,335,436	502,289	327,603	351,965,441

Source: Morgan Stanley Research estimates

We chose 2025 as our base year for this analysis because the US solar market is currently constrained by solar panel availability, high commodity and transportation costs, and long interconnection queues, making 2025 a more feasible year for this market to fully ramp up.

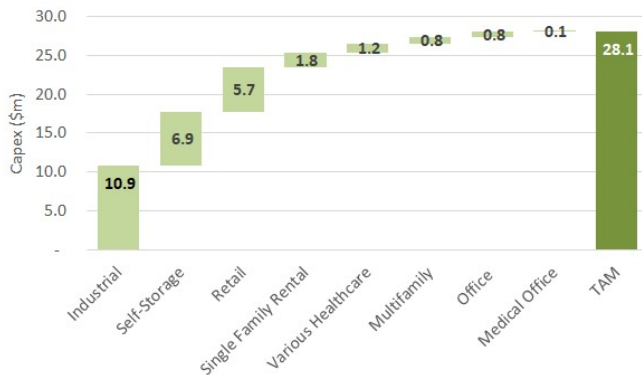
Sunshine & Rooftops

In aggregate, we estimate a solar TAM of \$492 billion across the commercial real estate market in the US, representing ~320 GWdc of solar generation capacity. This represents the solar opportunity (in \$ and GWs) related to our estimated available roof space in such properties of ~38.5 billion sq. ft., where we assume 1 MW of solar capacity for every 120,000 sq. ft. (net of a 20% buffer) and a capital cost of ~\$1.5/watt for a solar system — we look at the implications of adding battery storage to the solar systems later in this section. Assuming an average solar capacity factor of 15%, this TAM drives ~345 TWh of electricity generation per year, ~25% of the 1,360 TWh consumed in the US by commercial customers in 2019 according to the EIA — we use 2019 as the base year given that 2020 was impacted by Covid-19 while 2021 data is not yet available — and 9% of total electric sales in the US (representing the potential load loss for electric utilities). We would note that there are significant differences across property types (e.g., industrial and storage properties

can generate more electricity than they consume given the size of the properties and their electricity consumption profile, while buildings that have multiple floors tend to generate much less electricity than what they actually consume). At the national level, we estimate an average cost to produce onsite solar electricity by C&I customers (the solar C&I LCOE) of 11.13 cents per kWh by 2025, which compares to average utility rate for commercial customers of 12.26 cents per kWh (also by 2025), implying 9% savings potential. There are various nuances to consider, which we explain below.

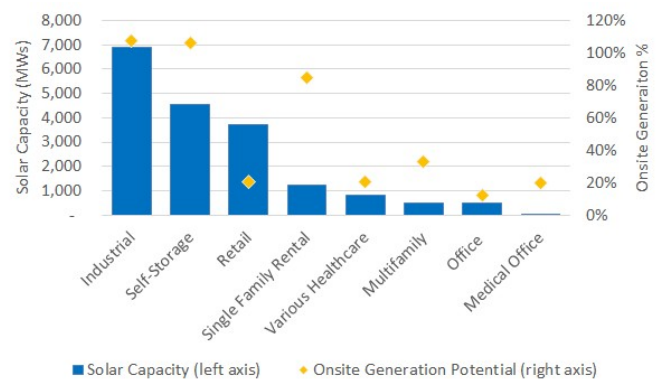
Quantifying the opportunity for the largest 50 REITs across a select number of segments (industrial, self-storage, retail, single-family rental, healthcare, multifamily, office, and medical office): Narrowing the analysis to 50 large REITs that represent \$800 billion of market cap (or 50%) of the REIT group at \$1.6 trillion, and focusing on their US footprint and key states, we estimate a solar TAM of \$28 billion across 2.2 billion sq. ft. of available roof space. This represents a solar capacity opportunity of ~18 GWdc (~15 GWac) and over 20 TWh of electricity generation potential. Relative to our estimated current electricity consumption for this set of properties of 45 TWh, we estimate that ~45% of electricity could be potentially generated onsite. As highlighted above, there are material differences across property types.

Exhibit 27: TAM: Capex Opportunity by REIT Type



Source: Morgan Stanley Research estimates

Exhibit 28: Solar Capacity (MW) & Onsite Generation (%) Potential by REIT



Source: Morgan Stanley Research estimates

Exhibit 29: Summary Table: Opportunity by REIT Type

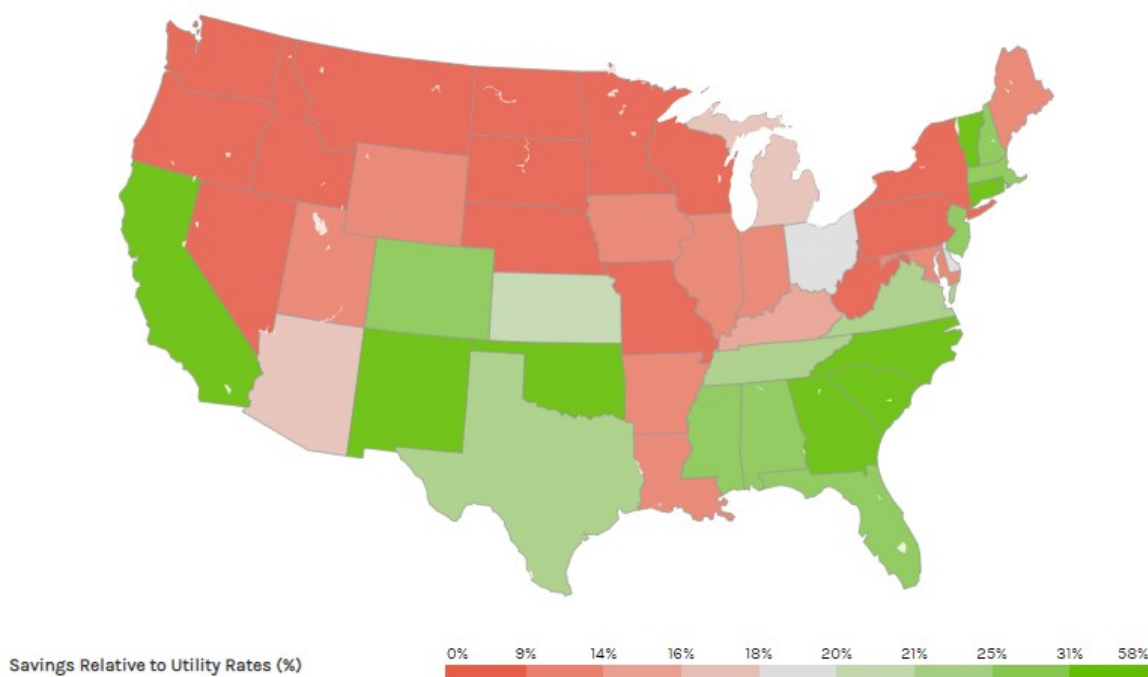
REIT Type	Available Roof Space (Sq. Ft.)	Solar Capacity Potential (MW-dc)	Capex Need (\$mn)	Electricity Generation Potential (MWh/yr.)	Estimated Electricity Consumption (MWh/yr)	Onsite Generation Potential (%)
Industrial	824,689,222	6,872	10,868	7,962,656	7,422,203	107%
Self-Storage	543,932,201	4,533	6,904	5,207,611	4,895,390	106%
Retail	443,903,928	3,699	5,666	4,158,888	20,419,581	20%
Single Family Rental	150,165,103	1,251	1,838	1,481,508	1,742,516	85%
Various Healthcare	95,880,580	799	1,232	896,402	4,314,626	21%
Multifamily	60,886,018	507	828	583,461	1,766,303	33%
Office	56,763,002	473	756	520,527	4,257,225	12%
Medical Office	5,119,113	43	64	46,444	230,360	20%
Total	2,181,339,166	18,178	28,156	20,857,495	45,048,204	46%

Source: Morgan Stanley Research estimates

We estimate 90% of the REIT-focused TAM will be "in the money" by 2025. While the transition to onsite power generation is not purely driven by economics but also by a preference for becoming more ESG-friendly and having control over their own power generation in places where there is grid instability, we also quantified the "in-the-money" opportunity by comparing our estimated state-level solar C&I LCOE — *which represents the cost of producing solar electricity onsite and embeds a 10% equity IRR* — with the average utility commercial rate in the same state. **We estimate an "in-the-money"**

TAM of \$25 billion and a solar capacity potential of 16.4 GWdc based on 2b sq. ft. of available roof space, an average solar C&I LCOE of 10.81 cents/kWh and an average utility commercial rate of 14.23 cents/kWh. States that offer the largest savings (of over 35%) include RI, CA, NM, CT, and SC. In certain cases (CA, NM, and SC), this is driven by the low cost of generating onsite solar power in the state given strong solar resources; in others (RI and CT), the favorable economics of distributed solar are driven by very high utility rates in the state.

Exhibit 30: Savings: Solar C&I LCOEs vs. Average Utility Commercial Electric Rates



Source: Alphawise, Morgan Stanley Research estimates

See *Appendix A: Solar C&I LCOEs vs. Utility Commercial Rates* for the backup data of *Exhibit 30*.

Is this a revenue generator model or a cost saving opportunity? It could be both but there are various complexities to consider:

a) If the onsite power generation is used primarily to supply onsite electricity needs (although this is generally not the model pursued) the cost savings must be calculated relative to what the utility charges to that customer per kWh of electricity consumed. For C&I utility customers this rate varies widely depending on the customer electricity load profile, the utility, and the state. Given the potential margin of error in estimating company-level savings, we focused on the aggregate cost saving opportunity in "in-the-money" states by using the average utility commercial rates in each state as a point of reference. In this case, we estimate ~\$740 million in cost savings per year across the 50 large REIT — *we exclude multifamily and single-family rental properties from this estimate given these are individually metered and pay residential utility rates rather than commercial rates.*

However, not all the utility rate is considered "avoidable" when a customer decides to generate power onsite. For C&I utility customers in particular, demand charges (which are fixed charges) can be material — *20-75% of the total electricity rate based on conversations with industry experts.* These charges are incurred because even after customers switch to distributed solar they need to remain connected to the utility electric grid for backup purposes (for example, to supply their energy needs when the sun isn't shining and there isn't a battery storage). Demand charges are calculated based on the customer peak demand (the time in the day when the customer electricity demand is the highest) and vary by utility and by state. For sensitivity purposes, if we were to assume 20% of the commercial utility rate is fixed, the aggregate cost savings decline from \$740 million to ~\$280 million. Potential ways to minimize utility customers' peak load, and therefore demand charges, include: adding battery storage to the buildings (either with or without a solar system) and via energy management solutions. Adding battery storage to the solar systems has the following implications:

- The aggregate estimated TAM for the commercial real estate market in the US increases from ~\$500 billion to ~\$875 billion as the capital cost rises from ~\$1.5/watt for a solar system to ~\$2.7/watt for a solar+battery system — *projected values by 2025 (the current capital cost of a solar system alone is ~\$2/watt while we estimate the cost of a battery system is at ~\$1.3/watt, with the cost for the lithium-ion battery alone at ~\$200/kWh-dc)*
- Focusing on the largest 50 REITs across a selected number of sub-sectors the estimated TAM increases from ~\$28 billion to \$50 billion, but only 28% of this TAM would be "in the money" (vs. 90% without storage) driven by an average solar+battery LCOE of ~17 cents/kWh (vs. 11 cents/kWh without storage). That said, as we noted previously: 1) The transition to generating solar electricity onsite is partly driven by an interest in "greening" buildings (ESG component) and in having control over their own power generation (particularly relevant in states like CA, where grid reliability is low and utility rates are high). 2) We could be underestimating the "in-the-money" opportunity given the presence of demand charges. If demand charges are high for a given building, the savings with solar alone might be compromised, while by adding storage the battery would charge at peak production times (sunny hours) and discharge at peak load times, bringing demand charges down and overall increasing the savings opportunity. Ultimately, adding storage increases the investment need but allows for peak load shaving and potentially for other monetization opportunities discussed in the following section: *Upside Opportunities for Monetization*

b) Absent storage and if demand charges are prohibitively high, or if there is a surplus of solar electricity, the onsite power generation could be sold to others, including the local electric utility, customers who want clean electricity but are unable to construct on-site solar projects via community solar projects, and wholesale markets. Each approach would offer different revenue opportunities — *see the next section for details* — but at a minimum, and focusing on the "in-the-money" states, if all the solar electricity were to be sold at our estimated C&I LCOE (without a battery), we estimate a revenue opportunity potential of \$1.7 billion per year across 50 large REITs.

Under this simplified revenue approach, and assuming that REITs are the owners and operators of the solar systems, we an average revenue accretion opportunity of 3% for our REITs coverage sector, with DRE, EXR, EGP, NSA, and PLD seeing the highest accretion at above 9%.

Exhibit 31: Summary Table, Including Potential Revenue Accretion, by REIT (*Morgan Stanley-covered REITs*)

REIT	Ticker	Available Roof Space (Sq. Ft.)	Solar Capacity Potential (MW- dc)	Capex Need (\$mn)	Electricity Generation Potential (MWh/yr.)	Estimated Electricity Consumption (MWh/yr)	Onsite Generation Potential (%)	Revenue Opportunity Potential (\$m/yr.)	MS 2022 Revenue Estimate (\$mn)	Revenue Accretion (%)
Duke Realty Corp.	DRE.N	164,917,000	1,374	2,125	1,552,188	1,484,253	105%	163	1,158 e	14.1%
Extra Space Storage Inc.	EXR.N	160,884,324	1,341	2,061	1,533,628	1,447,959	106%	156	1,509 e	10.4%
EastGroup Properties Inc.	EGP.N	45,571,000	380	550	467,809	410,139	114%	43	464 e	9.2%
National Storage Affiliates Trust	NSA.N	62,504,225	521	786	603,183	562,538	107%	61	664 e	9.2%
Prologis, Inc.	PLD.N	500,905,000	4,174	6,646	4,814,999	4,508,145	107%	510	5,580 e	9.1%
Site Centers Corp	SITC.N	21,212,986	177	265	198,919	975,797	20%	20	369 e	5.5%
Public Storage	PSA.N	198,319,000	1,653	2,515	1,906,907	1,784,871	107%	193	3,716 e	5.2%
Macerich Co	MAC.N	25,959,635	216	351	253,263	1,194,143	21%	27	540 e	5.0%
Kimco Realty Corp.	KIM.N	51,574,558	430	667	498,977	2,372,430	21%	51	1,239 e	4.1%
Broadstone Net Lease, Inc.	BNL.N	15,978,500	133	202	144,599	735,011	20%	16	393 e	4.0%
Spirit Realty Capital	SRC.N	24,553,500	205	308	226,371	1,129,461	20%	24	687 e	3.4%
Phillips Edison & Company, Inc	PECO.O	19,302,699	161	244	180,699	887,924	20%	19	549 e	3.4%
Regency Centers Corp	REG.O	29,984,572	250	385	287,638	1,379,290	21%	30	921 e	3.2%
Urban Edge Properties	UE.N	8,257,073	69	112	70,001	379,825	18%	9	281 e	3.0%
STORE Capital Corp	STOR.N	27,840,310	232	351	266,427	1,280,654	21%	27	887 e	3.0%
Realty Income Corp	O.N	98,548,950	821	1,241	914,584	4,533,252	20%	95	3,342 e	2.9%
Agree Realty Corp.	ADC.N	9,370,200	78	120	84,937	431,029	20%	9	420 e	2.2%
Simon Property Group Inc	SPG.N	87,218,411	727	1,122	807,408	4,012,047	20%	86	4,885 e	1.8%
National Retail Properties Inc	NNN.N	9,875,030	82	120	95,219	454,251	21%	9	749 e	1.2%
Physicians Realty Trust	DOC.N	5,119,113	43	64	46,444	230,360	20%	5	414 e	1.2%
Ventas Inc	VTR.N	40,114,874	334	517	371,826	1,805,169	21%	40	4,409 e	0.9%
Office Properties Income Trust	OPI.O	4,660,000	39	60	43,302	349,500	12%	5	569 e	0.8%
Healthpeak Properties Inc	PEAK.N	14,977,610	125	191	147,001	673,992	22%	15	1,924 e	0.8%
Welltower Inc.	WELL.N	40,788,096	340	525	377,575	1,835,464	21%	40	5,330 e	0.8%
Highwoods Properties	HIW.N	5,421,800	45	63	50,474	406,635	12%	5	801 e	0.6%
Vornado Realty Trust	VNO.N	7,278,200	61	98	60,255	545,865	11%	8	1,561 e	0.5%
SL Green Realty Corporation	SLG.N	5,543,374	46	75	44,190	415,753	11%	6	1,488 e	0.4%
Paramount Group Inc.	PGRE.N	2,578,336	21	35	20,553	193,375	11%	3	713 e	0.4%
Boston Properties, Inc.	BXP.N	9,876,941	82	131	87,038	740,771	12%	10	3,185 e	0.3%
Hudson Pacific Properties	HPP.N	2,649,298	22	38	26,889	198,697	14%	3	1,014 e	0.3%
American Homes 4 Rent	AMH.N	49,014,184	408	588	475,802	568,761	84%	-	1,413 e	0.0%
AvalonBay Communities Inc.	AVB.N	19,571,425	163	266	180,860	567,767	32%	-	2,523 e	0.0%
Equity Residential	EQR.N	16,491,448	137	225	157,534	478,417	33%	-	2,692 e	0.0%
Essex Property Trust, Inc.	ESS.N	11,656,299	97	167	119,560	338,149	35%	-	1,551 e	0.0%
Invitation Homes Inc	INVH.N	77,026,235	642	963	766,958	893,812	86%	-	2,169 e	0.0%
Tricon Residential Inc	TCN.N	24,124,684	201	288	238,748	279,943	85%	-	386 e	0.0%
UDR, Inc.	UDR.N	13,166,846	110	170	125,507	381,970	33%	-	1,455 e	0.0%

Source: Morgan Stanley Research estimates

Sunshine & Parking Lots

We are very bullish about the potential of electrification in the commercial trucking space, including in with medium- and heavy-duty Class 8 trucks. Please see our 2021 Insight on the EV truck opportunity [here](#) and the 2022 update [here](#). **We expect 27% of the global fleet to be electrified by 2030 and 55% by 2035 including ~38% for N. American Class 5-7 and ~19% for N. American Class 8.** We are very encouraged by the fact that many large Class 8 TL and LTL Trucking carriers have published aggressive ESG targets by 2035 and 2040 (see [here](#)), several are already running pilot commercial operations on EV-only routes for select customers (see [here](#)) and mgmt. teams of these fleet operators are ready to commit to truck electrification even at worse unit economics than diesel, due to the diesel benefits as outlined in our 2021 note (on the other hand, we expect the cumulative cost savings from EV trucks over the next decade will be roughly equal to ~100% of 2020 EBIT and could be an EBIT boost of MSD-LDD% for the carriers, depending on subsidies). Based on these penetration estimates and our analysis in this note **we believe roughly 10-15 years of initial penetration of Class 8 EVs could be powered by captive solar generation alone, giving the industry a long head start to build out a broader charging infrastructure.**

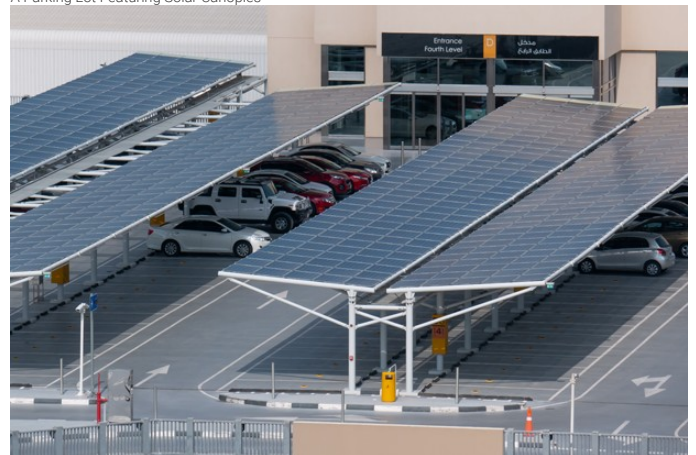
One of the obstacles to penetration of electrification across trucks fleets that we commonly run into is the chicken-and-egg problem of charging infrastructure. Even fully-electric Class 8 trucks that carry no up-front cost or payload penalty even go on sale — just as we saw with passenger cars — **the most common push-back we get is how to build an electric charging infrastructure for these trucks.** With little room for downtime and most of these trucks operating on highway routes away from population centers across America, **the industry is trying to figure out how to build a highway truck charging infrastructure, can the electric grid support it, how much will it cost/who will pay for it and how long will it take.** These are broader questions for the utility/electrification space, some of which we have addressed [here](#) and [here](#) for the auto EV space, with the broad conclusions applying to the trucks space as well.

However, here is also where solar on-line power generation steps in. Until a utility-powered EV charging network is built across the country, **carriers could use site-generated solar power for low-cost, reliable, captive power generation.** This could be supplemented by third-party solar generation (i.e., third-party truck stops and private shipper manufacturing and warehousing facilities — which is not covered in this report) and excess solar power generated

and resold by commercial REIT solar installations (as covered in this report).

Most large truck carriers in the US operate a fleet of terminals and service centers across the country. For TL carriers, these terminals are a relatively limited network used for parking and service but for the LTL carriers, their extensive terminal network forms the lifeblood of their network where loading/unloading of freight between the linehaul and local pickup-and-delivery service takes place. We tried to estimate what % of the current truck fleet of some of the largest truck carriers in the country could be solar powered by installing solar panels on their existing terminal site. Truck terminals can vary greatly in size — within our own coverage universe, the smallest terminals were only a few acres in size and the largest over 100 acres — the average truck terminal size across over 500 locations in our coverage of 5 of the largest truck carriers in the US was 11 acres. The average truck terminal usually has at least one building (in several cases 2-3 buildings) and on average, the nearly 500 locations we compiled data on had building square footage of ~30,500. Since these are truck terminals, they usually are similar to single level warehouses and we use square footage as a proxy for roof area where solar panels can be easily installed (similar to the rest of the analysis in this report, we use 80% of the available rooftop square footage for potential solar panel installation and assume 1MW generation from 120k sqft of solar panels/year). In addition to building rooftops however, we also look at the total paved acreage of the site including the parking facilities and assume that the paved area can also be equipped with solar with the installation of solar canopies (like the one below). We also assume the 20% "haircut" here to be conservative and account for areas that may be "drive only." We then calculate the amount of solar power generated and cost of generation using geolocation data, assuming the average EV Class 8 truck uses a 1MW battery and effectively drives 100,000 miles per year.

A Parking Lot Featuring Solar Canopies



Shutterstock

We analyzed the terminal network of 10 of the largest trucking carriers in the US (4 TL, 6 LTL) and concluded that on average roughly 25-30% of their current truck fleet could be effectively recharged on an ongoing basis by onsite solar power generation alone. This includes a range of 14% for some TLs (that have a more limited terminal network) up to 75% for some LTLs. Given that we expect 25-30% industry Class 8 EV penetration between 2037 and 2040, this analysis concludes that roughly 10-15 years of initial penetration of Class 8 EVs could be powered by captive solar generation alone, giving the industry a long headstart to build out a broader charging infrastructure. Further developments in solar panel yields, broader 3P installation of solar panels and selling back to the grid could buy the industry even more time and/or reduce costs. However, we believe this benefit may be largely restricted to the larger carriers who have larger and more developed ter-

minal networks as well as the balance sheets, margins and management teams with the foresight and flexibility to make the needed investments, compared to smaller mom-and-pop trucking companies who make up 90%+ of the industry but on average operate 10 year old trucks today on razor-thin margins. Together with broader electrification and autonomous trucking penetration, this is another reason to expect significant consolidation of the sector in the next decade and the super economics, operating flexibility and ESG footprint of intelligent trucks (EV + autonomous) pushes the market toward large carriers.

We estimate a TAM of ~\$10 billion associated with building the captive solar generation systems and a solar capacity opportunity of ~7 GWdc.

Exhibit 32: Carrier Summary Table

Company	Category	Potential Solar Capacity (MW-dc)	Potential Capex (\$mn)	Potential Electricity Generation (MWh)	Estimated Electricity Consumption (MWh/yr)	Onsite Generation Opportunity %
ARCB	LTL	569	865	618,486	827,200	75%
KNX LTL	LTL	314	423	342,990	568,600	60%
XPO	LTL	1,651	2,520	1,818,864	3,100,000	59%
SAIA	LTL	493	744	552,759	1,140,000	48%
ODFL	LTL	712	1,082	790,364	1,857,600	43%
KNX TL	TL	750	1,083	842,277	3,805,000	22%
HTLD	TL	103	157	114,943	526,000	22%
WERN	TL	242	362	275,708	1,572,200	18%
FDX	LTL	1,068	1,622	1,163,292	7,319,600	16%
TFII	LTL	633	963	690,545	4,920,800	14%
SNDR	TL	228	346	252,168	1,800,000	14%
Total		6,763	10,167	7,462,394	27,437,000	27%

Source: Company data, Transport Topics, Morgan Stanley Research Estimates

Carrier Location Map



Source: Morgan Stanley Research, Company Data

Upside Opportunities for Monetization

Summary: There are numerous ways in which distributed solar resources can be monetized. System owners could sell the power to: 1) local utilities via a mechanism called net metering; 2) wholesale markets at more attractive rates, although this is currently "in the works" by RTOs; 3) customers who want clean electricity but are unable to construct on-site solar projects via community solar programs; and/or 4) electric vehicle owners via the installation of EV charging stations in the properties. System owners can also monetize renewable energy credits (RECs) when available.

Electricity Sales to the Grid

Excess power generation represents potential upside; this opportunity could be most pronounced for industrial and storage REITs.

Warehouses and storage facilities benefit from large rooftop space and less energy intensity per square foot vs. other real estate verticals — which could result in less energy consumption relative to generation potential. In our analysis, we identified 11 industrial and/or storage REITs with properties in "in-the-money" states. Among these REITs, we estimate 1.2 billion sq. ft. of available rooftop space, a solar capacity opportunity of 10 GWdc, and an annual electricity generation potential of 12 TWh, which compares to an annual estimated electricity demand of 11TWh (based on 9kWh/sq. ft. electricity demand for these type of buildings). Our analysis implies ~950 GWh of excess power that system owners could hypothetically sell to the grid or others.

Exhibit 33: Industrial & Storage REITs in 'In-the-Money' States

REIT	Available Roof Space (Sq. Ft.)	Solar Capacity Potential (MW-dc)	Capex Need (\$mn)	Electricity Generation Potential (MWh/yr.)	Estimated Electricity Consumption (MWh/yr)	Onsite Generation Potential (%)
INDUSTRIAL REITS						
EastGroup Properties Inc.	44,817,000	373	540	460,015	403,353	114%
First Industrial Realty Trust, Inc.	52,855,000	440	684	516,699	475,695	109%
Prologis, Inc.	403,061,000	3,359	5,319	4,002,822	3,627,549	110%
Duke Realty Corp.	154,886,000	1,291	1,990	1,471,414	1,393,974	106%
Rexford Industrial Realty, Inc.	38,133,166	318	558	410,877	343,198	120%
Terreno Realty Corp.	12,311,707	103	170	119,749	110,805	108%
SELF-STORAGE REITS						
Extra Space Storage Inc.	149,750,054	1,248	1,912	1,435,837	1,347,750	107%
Life Storage, Inc.	74,993,172	625	932	714,730	674,939	106%
National Storage Affiliates Trust	55,821,772	465	698	545,255	502,396	109%
Public Storage	182,722,000	1,523	2,310	1,772,694	1,644,498	108%
CubeSmart	41,003,614	342	527	390,756	369,033	106%
Total	1,210,354,485	10,086	15,639	11,840,848	10,893,190	109%

Source: Morgan Stanley Research. PLD only includes US estimates.

We view Prologis as especially well positioned to capture upside from electricity sales. According to PLD, the company is the third largest solar private solar provider in the US. The company plans to increase installed solar capacity globally from the current level of 286+ MW to 400 MW by 2025. In support of this goal, the board recently elevated and provided quantification of ESG efforts in management compensation. For instance, in the 2022 bonus scorecard, management has a target of 350 MW of installed solar capacity in 2022.

There are a number of ways in which excess distributed solar resources can be monetized:

1) Selling the surplus electricity to the local utility: Assuming the 11 REITs mentioned above sell the power at the retail rate (the average utility commercial rate), we estimate a revenue opportunity of \$140m. These sales are done via a mechanism called net metering, a billing mechanism that credits solar energy system owners for the electricity they add to the utility grid. Credits tend to be at the full retail rate, which is a very attractive rate given that distributed generation incurs only a portion of the costs incurred by a utility. These policies vary by state, in some cases require legislative changes, and are currently being challenged in CA.

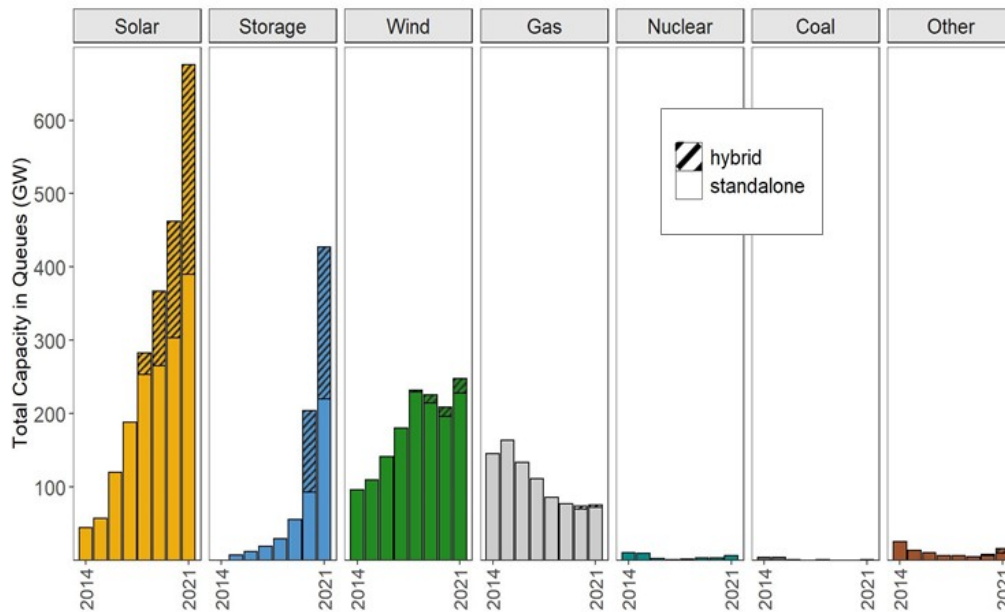
Growing solar penetration and improving economics could eventually erode policy that supported early scalability of the technology. In California, for instance, the NEM 3.0 Proposed Decision (PD) would significantly reduce the net metering rate and decrease the value proposition for certain commercial customers in the state. This proposal has received significant pushback and is still being evaluated by the California Public Utility commission (CPUC). Similarly, a bill in Florida was passed by the legislature (although it was recently vetoed by the governor) that would have decreased the net metering credit from the retail price to the full avoided cost, lowering the returns/savings for owners of distributed solar systems. Broadly, if changes in net metering policies materially reduce economics in the US, we would expect incremental demand for behind-the-meter (BTM) storage — allowing customers to self-consume more of the energy generated from solar panels. For example, in Germany, after similar policy changes, the size of solar systems and battery attach rates increased as customers added more energy management services to their homes/buildings such as water heaters, EV chargers, HVAC systems, etc. Nonetheless, changes in policies create near term disruption in the market.

2) Selling the surplus electricity to wholesale markets: The Federal Energy Regulatory Commission (FERC) issued Order No. 2222 in September 2020 enabling aggregations of distributed energy resources to participate on a level playing field in the wholesale markets. These include small, flexible resources such as customer-sited batteries, electric vehicles, rooftop solar, and smart thermostats. Implementation of this order would allow for these resources to get compensated at the wholesale electricity rate, which can be well above the retail rate that utilities currently pay. Currently, though, regional transmission operators (RTOs) are working with stakeholders to create compliance plans. We would note that integration with storage could optimize these sales via energy arbitrage, where the battery could charge when solar power is abundant and discharge (and sell it to the wholesale market) when prices are high.

3) Selling the surplus electricity to customers who want clean electricity but are unable to construct on-site solar projects: This can be done via community solar programs. In this case, the owner/operator of the solar system would inject the power into the utility electric grid who would then bill its customer for power as usual but credit the amount related to the MWh of solar generation since the utility didn't generate this electricity itself. Subsequently, the utility customer buying the solar power would receive a bill from the owner/operator of the solar system at the rate agreed upon. Under this scenario, and focusing on the "in-the-money" states, if the solar electricity generated by the 50 large REITs analyzed were to be sold at our estimated LCOE we estimate a revenue opportunity potential of \$1.7 billion per year.

Interconnection delays could be a headwind. In order to develop distributed solar projects, developers have to work with local utilities and in some cases federal agencies to interconnect the projects to the electric grid as projects need to undergo a series of impact studies before they can be built. Driven by covid-related slowdowns and overall a large queue of projects, developers are seeing material delays in the approval of new projects. According to data gathered by the Lawrence Berkeley National Laboratory (LBNL), there are currently over 1,400 GW of generation and storage capacity in the queue awaiting interconnection with wholesale/merchant electric transmission system operators (see [Exhibit 34](#)) as of the end of 2021, with the vast majority being solar capacity. Also according to LBNL, "the typical duration from connection request to commercial operation increased from ~2.1 years for projects built in 2000-2010 to ~3.7 years for those built in 2011-2021." Further, in some cases the local utility might not allow for new interconnection of distributed solar systems because of intermittency issues caused to the overall utility system.

Exhibit 34: Energy Capacity in the Interconnection Queue



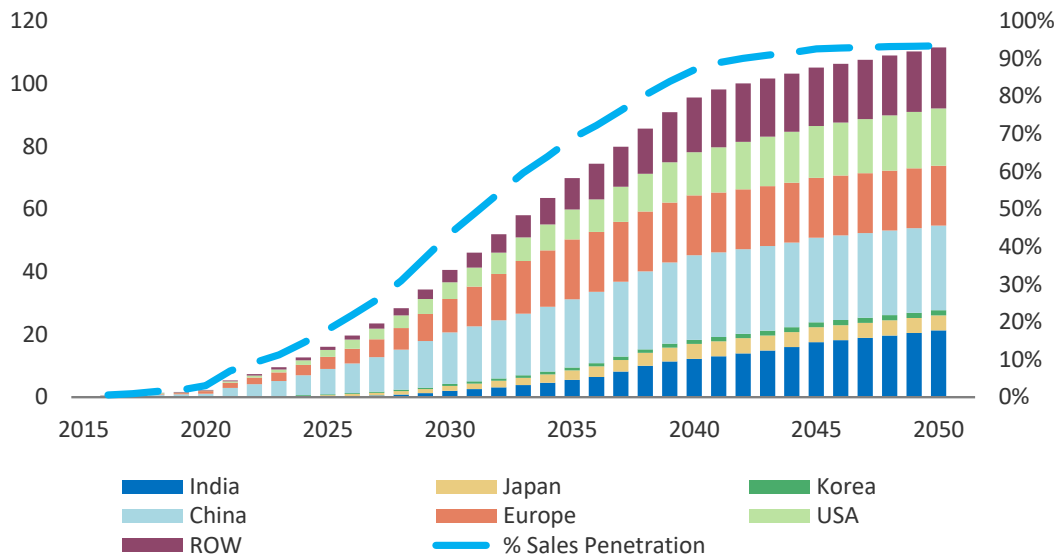
Source: Lawrence Berkeley National Laboratory (LBNL)

EV Charging

Passenger EVs

Battery electric vehicle (BEV) penetration is set to inflect. Our global autos team expects BEV sales penetration will grow from ~7% in 2021 to ~43% by 2030 and ~87% by 2040. The decline in ICE sales and rise in BEV sales will reach equilibrium in the early 2030s with global BEV sales surpassing 50% sales penetration for the first time on an annualized basis in 2032. While global EV penetration will take until 2032 to become the majority of sales, certain regions are progressing quicker in terms of EV adoption and will pass the 50% threshold sooner based on most recent Morgan Stanley estimates. Specifically, China is expected to cross the threshold in 2029, Europe in 2030, both Japan and S. Korea in 2034, and the US in 2035.

Exhibit 35: Global BEV Sales Estimate



Source: Morgan Stanley Research Estimate

Support for this fleet will require a once-in-a-generation investment in infrastructure. In a report led by our autos team (see *Autos & Shared Mobility: EV Infrastructure: Tesla's Footprint Maps a \$2.7T Industry Problem*), we previously sized potential infrastructure spend using the footprint of Tesla, the OEM that is making the most substantial investments in its own proprietary EV infrastructure network. Specifically, we overlaid Tesla's physical footprint of charging stations, service centers, stores and galleries, assembly and gigafactory capacity with our assumptions of global EV sales, EV fleet and EV miles through 2040. Globally, we had estimated ~\$385 billion of potential investment by 2040 needed to build the underlying utility grid infrastructure to support EV charging stations: comprised of \$205 billion for supercharger stations, \$125 billion for destination chargers, and ~\$55 billion for the enhancement of the distribution grid in response to increasing local residential loads. In the US, we estimated a need in 2040 for ~70 million home charges, ~2.5 million destination chargers, and ~1 million superchargers — together requiring capex of ~\$90 billion.

Passenger EV charging could represent an incremental opportunity, especially retail and residential. While we note several challenges (such as higher power load and whether EV charging is qualified income), charging infrastructure could service parked passenger vehicles at REIT properties. In general, these types of properties do not have capacity to generate excess solar power relative to consumption. As a result, they would need to source electricity from the grid to service the additional load. Within our coverage, a number of REITs have begun to install or plan to install EV chargers. Among retail REITs, examples include Kimco, Phillips Edison, Macerich, Simon Property Group, Site Centers, Urban Edge, and Regency Centers. Examples among residential REITs include AvalonBay, Equity Residential, UDR, and Essex Property Trust.

Exhibit 36: Support for a rapidly growing EV fleet will require a once-in-generation investment in infrastructure.

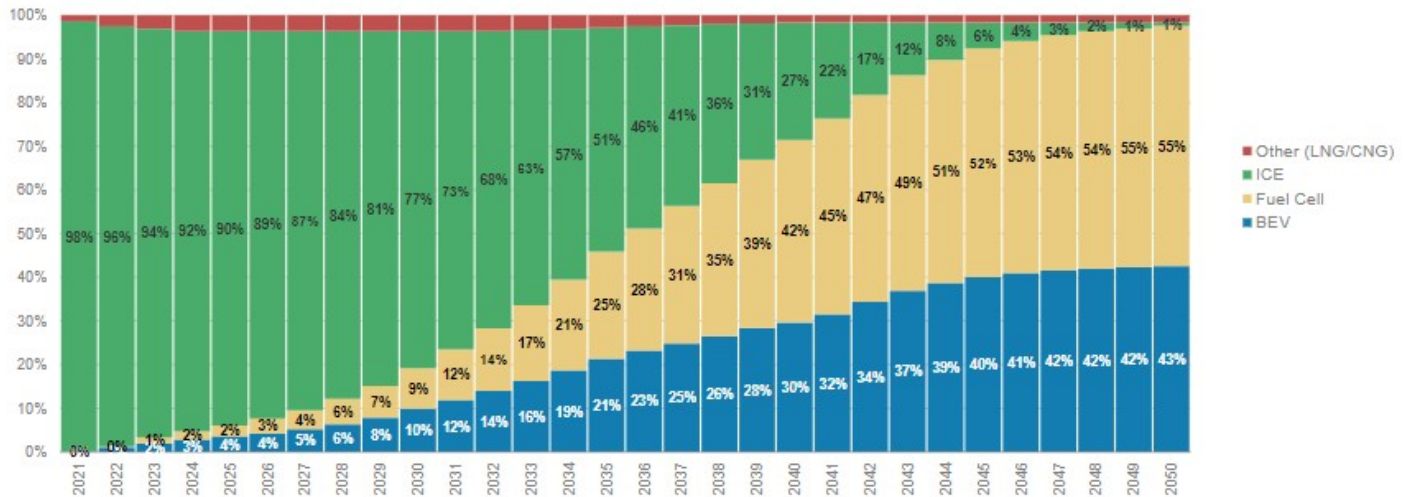
Required infrastructure			
Quantity	2025	2030	2040
Home chargers	4,466,143	14,380,300	66,725,945
Superchargers	93,517	292,263	984,419
Destination chargers	201,917	620,022	2,540,619
Stores & galleries & Service Centers	3,926	9,822	37,609
Vehicle plants	1.8	3.8	13.9
Gigafactories	1.8	3.8	13.9
Infrastructure Investment (\$mn)	2025	2030	2040
Home chargers	2,442	8,265	42,362
Superchargers	3,423	10,969	38,836
Destination chargers	442	1,425	6,452
Stores & galleries & Service Centers	3,064	8,514	38,838
Vehicle plants	3,735	8,193	31,285
Gigafactories	9,338	20,482	78,212

Source: Morgan Stanley Research

Commercial Vehicles

Bullish on penetration of the electrification of commercial trucking. Regulation, technology advancements, and improving total cost of ownership are set to catalyze rapid adoption of zero emissions vehicles within the commercial vehicles market. As noted, we expect 27% of the global fleet to be electrified by 2030 and 55% by 2035 including ~38% for N. American Classes 5-7 and ~19% for N. American Class 8. Charging infrastructure will be required to solve the chicken-and-egg problem for ensuring reliable charging access.

Exhibit 37: We forecast 25-30% industry Class 8 EV penetration in 2037-40.



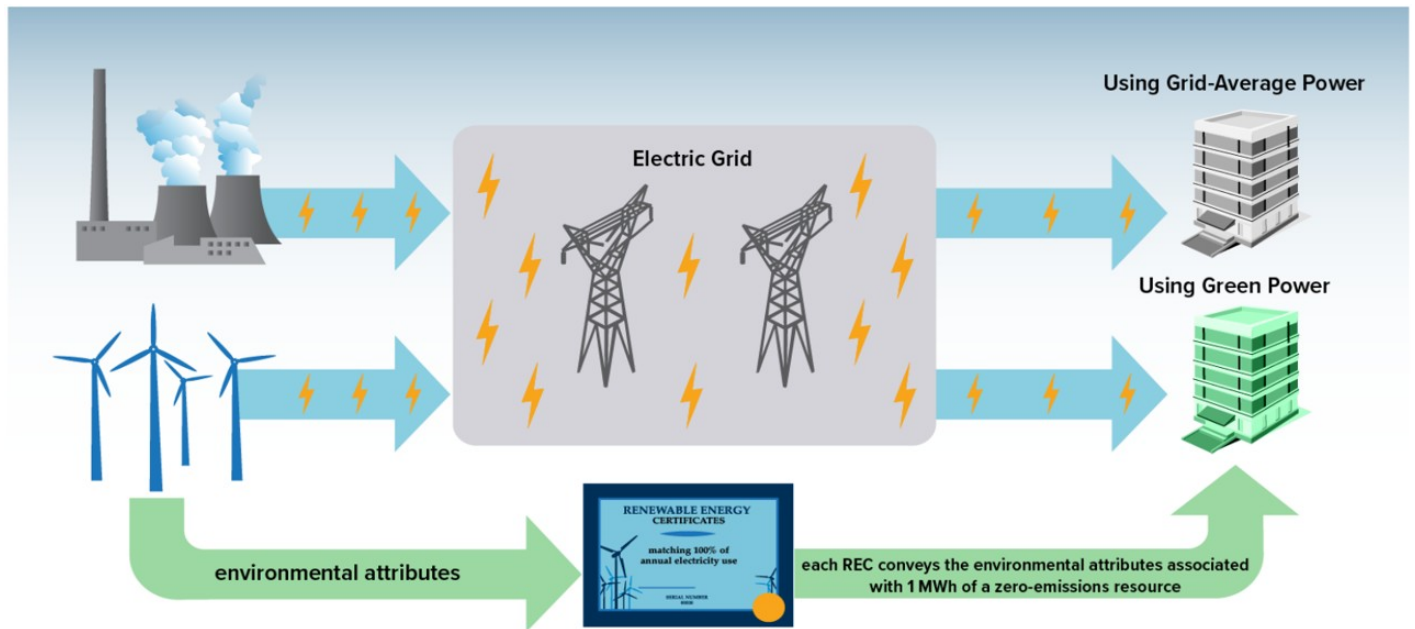
Source: ACT, ACEA, EV-Volumes, Morgan Stanley Research

Beyond the opportunity for trucking terminals (see the section *Sizing the Opportunity*), commercial EV charging may represent an opportunity for industrial REITs. Prologis has led embracement of the charging opportunity - similar to the company's approach to solar. Prologis outlines four dynamics that underpins the charging opportunity: (1) charging vehicles either at or near logistics facilities will minimize route deviation; (2) investment strategy provides buildings with optimal grid agencies, (3) synergies with development and construction that result in below market installation costs for chargers; (4) ability to capture the retail energy margin through either wholesale procurement or onsite generation.

Renewable Energy Certificates

Solar production generates renewable energy certificates with potential for monetization. Renewable energy certificates (RECs) represent rights to the carbon reduction impact of each MWh of electricity generated from renewable energy such as solar. Owners of solar generation can trade these rights — allowing the buyer to claim credit for "green" electricity without directly purchasing power from a renewable energy source (seller forfeits this right). For instance, an industrial plant that purchases power from the grid — which may have commingled electricity from both fossil fuel and renewable generation — could claim 100% clean power by acquiring RECs that match electricity usage. Beyond the voluntary market, some states have Renewable Portfolio Standards (RPS) that require renewables to comprise a certain percentage of power generation within the state. In these markets, fossil fuel weighted utilities with deficits may purchase RECs for regulatory compliance.

Exhibit 38: Renewable energy certificates represent the low carbon attributes of renewable energy such as solar and wind.

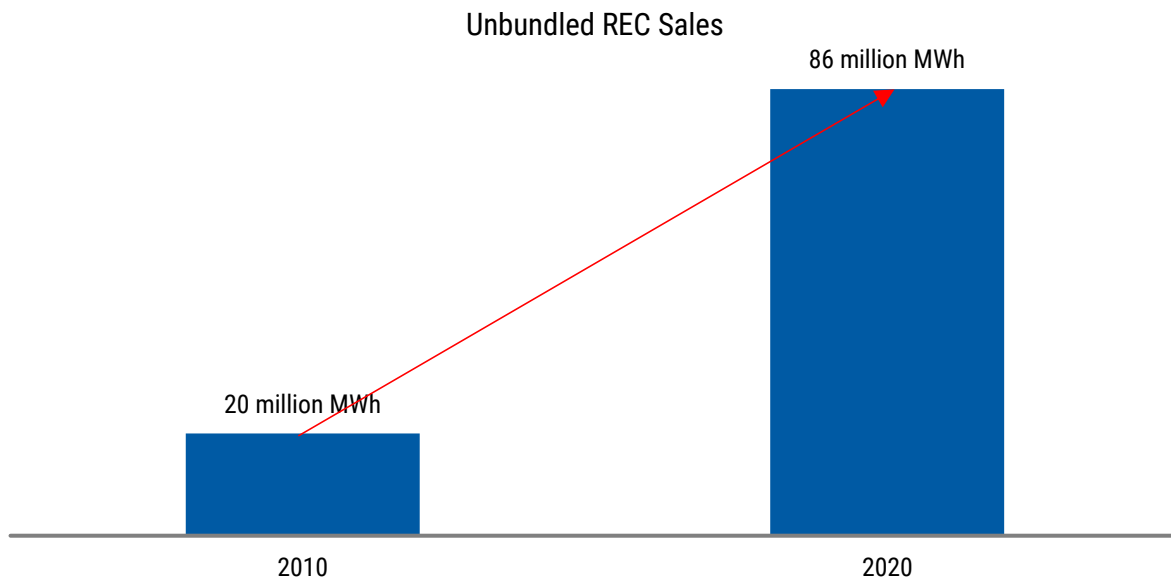


Source: Offsets and RECs: What's the Difference? EPA Green Power Partnership, February 2018, https://www.epa.gov/sites/default/files/2018-03/documents/gpp_guide_recs_offsets.pdf

REC values have risen in the voluntary market. According to the National Renewable Energy Laboratory (NREL), the market for unbundled RECs (those that have been separated from underlying electricity) in the voluntary market during 2020 was comprised of 221,000 customers and 86 million MWh of electricity (see *Status*

and Trends in the Voluntary Market). This represented >4x the level in 2010. NREL also notes that REC prices rose from \$1.20/MWh in December 2020 to \$6.60/MWh in August 2021.

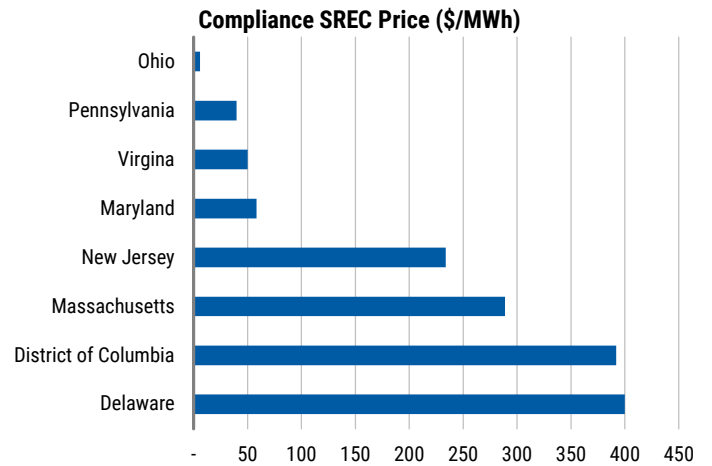
Exhibit 39: The voluntary market for unbundled RECs rose from 20 million MWh in 2010 to 86 million MWh in 2020.



Source: O'Shaughnessy, Eric. Burd, Rebecca. *Status and Trends in the Voluntary Market (2020 Data)*, National Renewable Energy Laboratory (NREL), <https://www.nrel.gov/docs/fy22osti/81141.pdf>; Morgan Stanley Research

REC prices in compliance markets vary meaningfully by state. In some states, Renewable Portfolio Standards explicitly mandate a proportion of solar in the overall mix. In these instances, utilities can purchase solar renewable energy certificates (SRECs), specifically tied to solar generation, to meet deficits in solar production. Selling into these markets could provide cash flow for solar producers (though as noted, forfeiting claims to the "green" impacts of the associated electricity). Prices of SRECs vary across states — dictated by the supply and demand and policy dynamics of complying with respective Renewable Portfolio Standards.

Exhibit 40: SREC prices in compliance markets vary meaningfully by state.



Source: SRECTrade (<https://www.sretrade.com/>); Flett Exchange (<https://www.flettexchange.com/>); Morgan Stanley Research

Decarbonization Impact for REITs

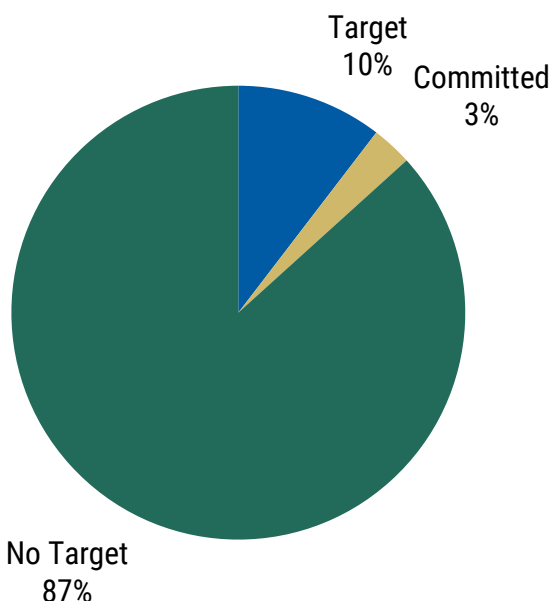
Science-Based Target Trajectory

Stakeholders — including asset owners & investors, proxy advisers, and regulators — are intensifying pressure on the private sector to reduce emissions. Asset owners and investors are pushing companies to align operations with the Paris Agreement. Members of the Glasgow Financial Alliance for Net Zero (GFANZ), a global coalition of financial institutions and investors to facilitate decarbonization, now represents >\$130 trillion of assets under management. Proxy advisers have also begun to scrutinize decarbonization plans — and we believe will more frequently recommend votes against companies in "Say on Climate" proposals if emissions targets do not align with the Paris Agreement. Lastly, the SEC is set to release upcoming rulemaking related to climate disclosure. We believe rules could require the reporting of both Scope 1 and 2 emissions, and potentially, bring scrutiny to unsubstantiated emissions targets. The SEC also recently released guidance that we view as more accommodative toward shareholder resolutions requesting more stringent emissions targets.

REITs have begun to embrace Paris-aligned decarbonization pathways — but much progress remains. Earlier this year, we assessed climate efforts across 173 public REITs (the NAREIT ALL REITs Index) (see *How REITs Stack Up on Emissions Reductions*). Among these REITs, ~35% have disclosed emissions reduction goals — representing ~70% of aggregate market cap. However, Paris-alignment is more mixed — just 13% of companies having set or committed to set a science-based target (SBT) - reflecting third party verification of alignment with the Paris agreement (i.e., the level required to halt climate change. Within the Nareit All REITs Index, these companies comprise 40% of market cap.

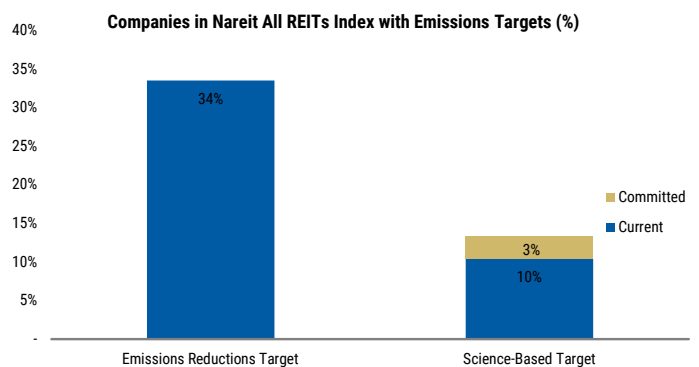
Exhibit 42: While just 13% of companies in the Nareit All REITs index have set or committed to set a science-based target. . .

Nareit All REITs Index: Companies with Science-Based Targets



Source: Science Based Targets initiative; Refinitiv Eikon; Morgan Stanley Research

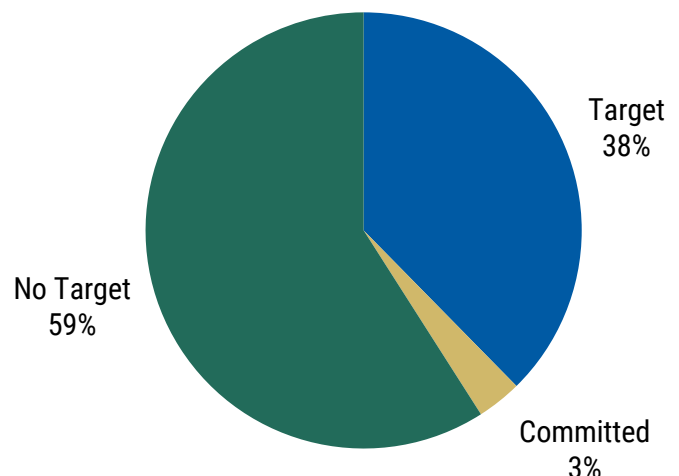
Exhibit 41: Within the Nareit All REITs index, 13% of companies have set or committed to set a science-based target.



Source: Science Based Targets initiative; Refinitiv Eikon; Morgan Stanley Research

Exhibit 43: . . . these companies represent ~40% of market cap in the index.

Nareit All REITs Index: Market Cap with Science-Based Targets



Source: Science Based Targets initiative; Refinitiv Eikon; Morgan Stanley Research

What Are "Science-Based Targets"?

Paris-aligned corporate emissions scenario. In 2015, a partnership among CDP, the United Nations Global Compact, World Resources Institute (WRI), and the World Wide Fund for Nature (WWF) established the Science-Based Targets initiative (SBTi). The organization provides a framework for corporate-level emissions reductions targets that align with warming thresholds defined in the Paris Agreement. As a result, targets must minimally support a pathway to maintain warming below 2°C (vs. pre-Industrial levels), though SBTi encourages a maximum of 1.5°C. Beginning in June 2022, however, the SBTi will accept only 1.5°C scenarios.

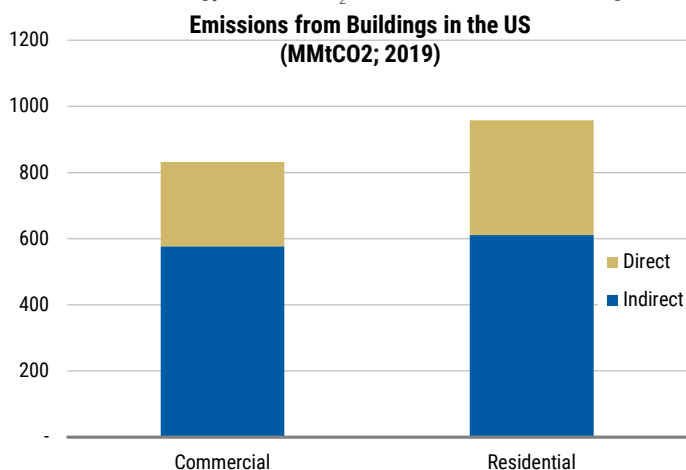
Criteria for science-based targets (non-exhaustive):

- Base year representative of typical GHG profile, recommended to be most recent applicable year or average of consecutive years (whichever more accurately reflects emissions profile).
- Target year that, from the date of submission, covers at least 5 years and at most 10 years. SBTi recommends long-term targets with interim milestones staged every 5 years.
- Targets must include Scope 1 and 2 emissions, with Scope 3 optional in most instances. However, Scope 3 emissions must be included in a target if Scope 3 comprises 40% or greater of aggregate emissions.
- Offsets cannot be applied toward emissions targets though may be used for incremental reductions. Similarly, avoided emissions may not be included in a target.
- Target setting methods for Scopes 1 and 2 emissions broadly include two approaches: absolute contraction and sectoral decarbonization approach (SDA). Within absolute contraction, the rate of emissions reductions is consistent across companies. Within the SDA, emissions intensity converges to a specific metric.

Approach toward net-zero targets. In late October, SBTi launched the "Net-Zero Standard" — which allows companies to combine shorter-term SBTs with long-term net-zero targets. This framework would require most companies with net-zero targets to achieve minimum emissions reductions of 90-95% by 2050.

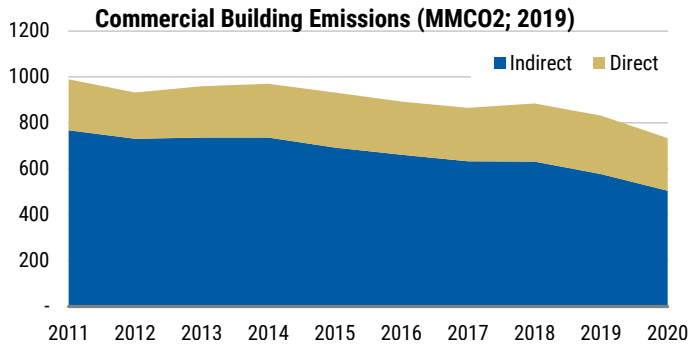
The building stock in the US is a major contributor to GHG emissions. According to data from the EIA, commercial and residential buildings contributed to ~35% of total energy-related CO₂ emissions during 2019. Emissions from commercial buildings totaled ~830 MMtCO₂, 70% of which was from purchased electricity. Similarly, emissions from residential buildings totaled ~960 MMtCO₂, ~65% of which was from purchased electricity.

Exhibit 44: Commercial and residential buildings contributed to ~35% of total energy-related CO₂ emissions in the US during 2019.



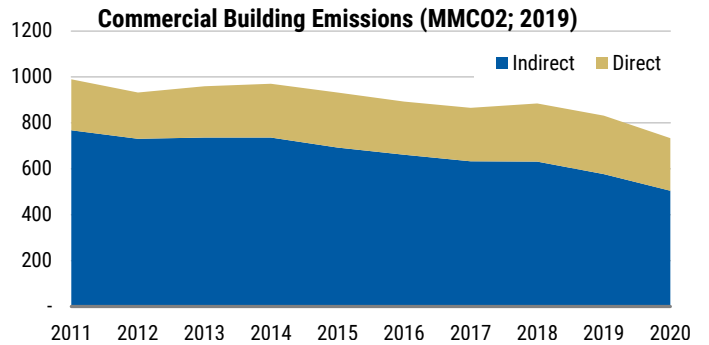
Source: U.S. Energy Information Administration (EIA), <https://www.eia.gov/environment/emissions/carbon/>; Morgan Stanley Research

Exhibit 45: Emissions from commercial buildings in 2019 totaled ~830 MMtCO₂, 70% of which was from purchased electricity.



Source: U.S. Energy Information Administration (EIA), <https://www.eia.gov/environment/emissions/carbon/>; Morgan Stanley Research

Exhibit 46: Emissions from residential buildings in 2019 totaled ~960 MMtCO₂, ~65% of which was from purchased electricity.



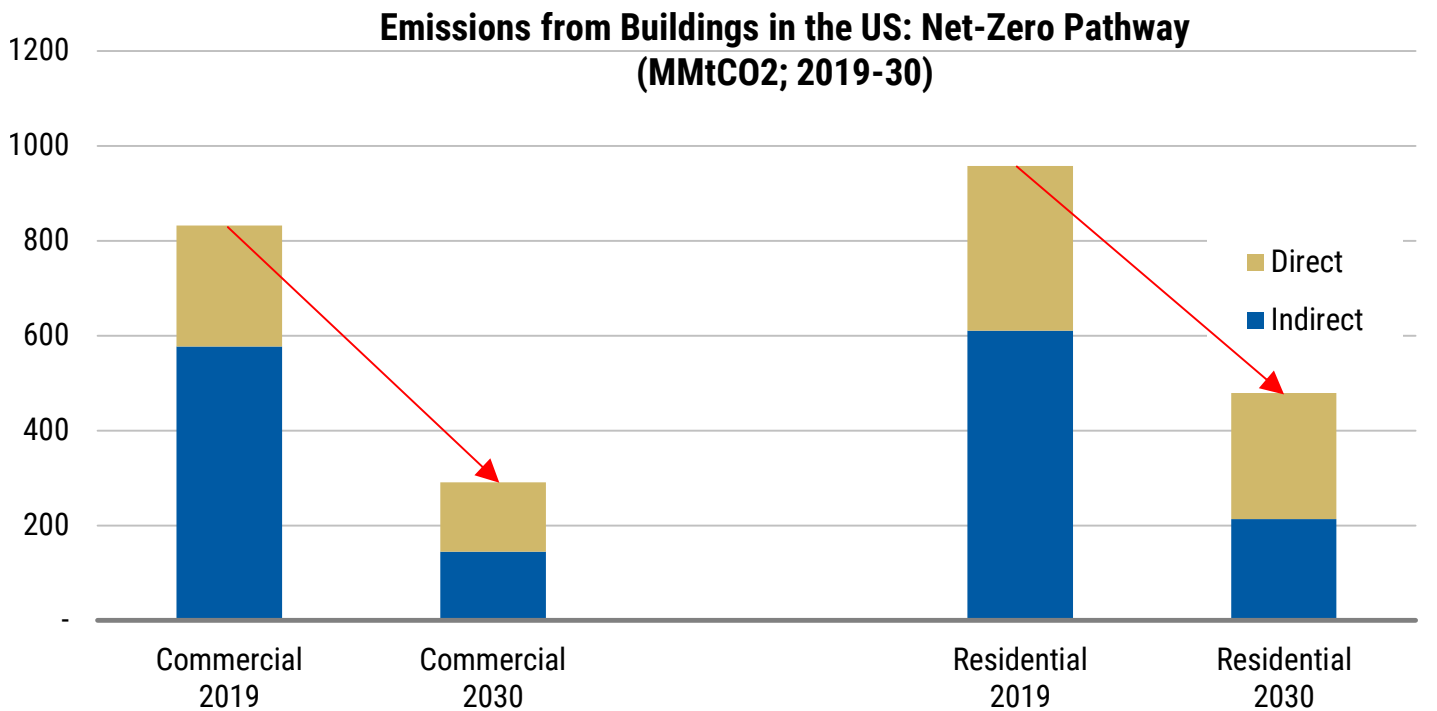
Source: U.S. Energy Information Administration (EIA), <https://www.eia.gov/environment/emissions/carbon/>; Morgan Stanley Research

Net-zero pathway requires a steep reduction in emissions.

According to our analysis of data from the IEA's net-zero trajectory for buildings (see *IEA: Tracking Buildings 2021*), non-residential buildings must reduce emissions by ~65% globally from 2019 to 2030 — including a ~75% reduction in emissions from purchased electricity. Similarly, residential buildings must reduce emissions by ~50% over this period, including a ~65% reduction in emissions from

purchased electricity. Assuming the US follows this trajectory, emissions from commercial buildings would decline from ~830 MMtCO₂ to ~300 MMtCO₂ (emissions from purchased electricity down from ~580 MMtCO₂ to ~140 MMtCO₂). Similarly, emissions from residential buildings would decline from ~960 MMtCO₂ to ~480 MMtCO₂ (emissions from purchased electricity down from ~610 MMtCO₂ to ~210 MMtCO₂).

Exhibit 47: If the US follows the global net-zero trajectory laid about the IEA, emissions associated with buildings must steeply decline through the end of this decade.



Source: U.S. Energy Information Administration (EIA), <https://www.eia.gov/environment/emissions/carbon/>; International Energy Agency (IEA), <https://www.iea.org/reports/tracking-buildings-2021>; Morgan Stanley Research

Sizing the Carbon Reduction Potential

Rooftop solar installations could meaningfully advance progress towards net-zero targets. In aggregate across the real estate assets in our analysis, we estimate rooftop solar has the potential to reduce emissions consumed by commercial customers by ~25%.

In absolute terms this represents potential for ~135 MMtCO₂ per year of carbon abatement. According to the EIA, the power sector emits 0.85 pounds of CO₂ per kWh of electricity generation (1.55 billion metric tons in aggregate). This translates to 1MMtCO₂ for every 2.6 million MWh (or 2.6 TWh). We apply this factor to potential rooftop solar generation.

Among the subset of REITs assessed in this report (\$800 B market cap), we estimate potential for rooftop solar to reduce emissions from purchased electricity by ~45%. This assumes current electricity generation is from fossil fuels. In absolute terms, associated carbon abatement is ~10 MMtCO₂ per year. The opportunity is most significant for industrial and self-storage buildings — which we estimate have the potential to generate more electricity from rooftop solar than power consumption. Within multifamily and retail, we see ~30% and ~20% of potential emissions reductions associated with electricity. For office, the relatively lower rooftop area to power consumption results in more modest potential emissions reductions.

Exhibit 48: We estimate rooftop solar could reduce emissions across our assessed REIT subset (\$800 B market cap) by ~45%. Industrial and self-storage REITs have outsized opportunities for carbon abatement.

REIT Type	Estimated Electricity Consumption (MWh/yr.)	Estimated Annual Emissions (MMtCO ₂)	Electricity Generation Potential (MWh/yr.)	Net Purchased Electricity (MWh/yr.)	Potential Annual Emissions (MMtCO ₂)	Annual Emissions Reduction (MMtCO ₂)	Annual Emissions Reduction (%)
Industrial	7,422,203	3	7,962,656	(540,453)	0	3	(107%)
Self-Storage	4,895,390	2	5,207,611	(312,221)	0	2	(106%)
Retail	20,419,581	8	4,158,888	16,260,693	6	2	(20%)
Single Family Rental	1,742,516	1	1,481,508	261,008	0	1	(85%)
Various Healthcare	4,314,626	2	896,402	3,418,224	1	0	(21%)
Multifamily	1,766,303	1	583,461	1,182,842	0	0	(33%)
Office	4,257,225	2	520,527	3,736,698	1	0	(12%)
Medical Office	230,360	0	46,444	183,916	0	0	(20%)
Total	45,048,204	17	20,857,495	24,190,709	9	8	(46%)

Source: Morgan Stanley Research

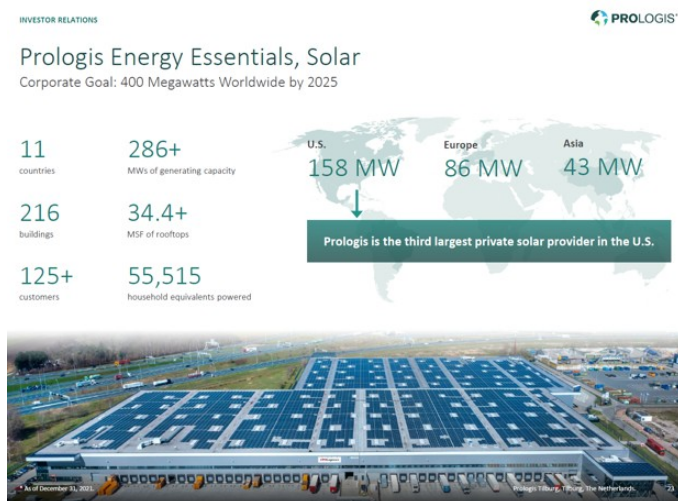
Sector & Stock Implications

REITs

Covered by Richard Hill & Ronald Kamdem

We see PLD as the company within our coverage that has the highest likelihood of monetizing the solar, storage and EV charging opportunity set within our coverage. PLD is currently the third largest solar provider in the US despite only 4% of available company controlled roofs having solar panels on them suggesting there exists a large addressable market that been untapped as the company would like to grow solar panel penetration by 10x (from ~4% of roofs to ~40% of roofs). Indeed, we have conviction there exists a sizable long-term potential earnings contribution from PLD's planned efforts given both market exposure and management's communication with investors. As an example, PLD's California exposure accounts for ~25% of NOI wherein battery electric vehicle registrations are ~7x higher than the next state, while the company believes the continued ramp-up in EV demand in California will serve as a tailwind to demand. In addition, we note relative to other companies within our coverage, PLD has provided investors with the most comprehensive earnings framework for how to frame the potential earnings impact from the energy business.

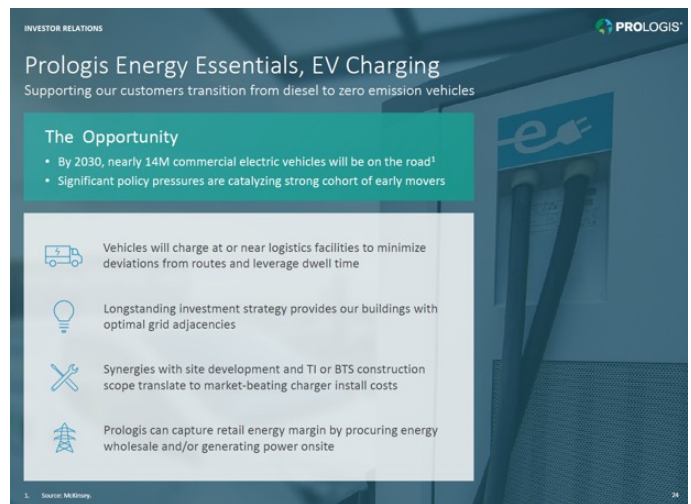
Exhibit 49: PLD Solar Opportunity



Source: Company data, Morgan Stanley Research

For context, PLD's Essentials platform, which the company believes will account for \$75 million in revenue in 2022 relative to a core FFO base of ~\$3.2 billion encompasses operational services (such as providing forklifts for tenants), a workforce platform, transportation platform, a digital platform (providing data and insights to customers) and an energy business. PLD believes the energy platform will account for ~50% of the Essentials business revenue over time and, the Essential business may produce ~\$75 million of revenue in 2022, double to ~\$150 million in 2023, double again to ~\$300 million by 2025, and eventually reach \$1 billion. The FFO growth contribution in 2022 is expected to be 75-100bps vs. a 50bp contribution to growth from the Essentials platform targeted in 2019 at the Investor Day. We believe the Essentials/energy arm of

Exhibit 50: EV Charging to be a large component in the energy business



Source: Company data, Morgan Stanley Research

PLD's business can serve as upside to earnings estimates on a longer-term basis, and we could see management providing additional financial disclosures and guidance in the next 2-3 years.

Raising our base case PT by +3%, to \$180, and bull case value by +10%, to \$225. Higher conviction and visibility into monetizing the solar, storage and EV charging opportunity leads us to raise our base case PT by +3%, to \$180, and our bull case value by +10%, to \$225. We keep our valuation multiples unchanged on PLD's core business in both our base case (31x) and our bull case (35x), but we ascribe an additional \$5/\$20 per share value in our base/bull case values. Our methodology in arriving to this additional per share value is through a DCF analysis with the following assumptions:

Base case (Exhibit 51):

- Capital investment: We assume PLD invests \$200 million per year through 2036 in the energy business.
- Unlevered return on capital: We assume PLD will earn a 15% unlevered return on capital on energy investments with 3 years between initial investment and stabilization. This is in line with the IRR management currently expects on an unlevered basis with the energy business.
- Sources of capital: We assume 60% leverage on capital investments, with a cost of debt of 2.75% and while we do not expect the company to issue new equity as it can fund through free cash flow and dispositions, for calculation purposes we use an average equity issuance price of \$160.
- DCF Framework: Utilizing a 6% cost of equity and a 2% terminal growth rate after 2036 implies a per share value of ~\$5. Our terminal value in our DCF implies a 23x operating income multiple.

Bull case (Exhibit 52):

- Capital investment: We assume PLD invests an average of \$470 million per year through 2036 in the energy business with investment ramping to \$500 million per year in 2024.
- Unlevered return on capital: We assume PLD will earn a 20% unlevered return on capital on energy investments with 3 years between initial investment and stabilization.
- Sources of capital: We assume 60% leverage on capital investments, with a cost of debt of 2.75% and while we do not expect the company to issue new equity as they can fund through free cash flow and dispositions, for calculation purposes we use an average equity issuance price of \$160.
- DCF Framework: Utilizing a 6% cost of equity and a 3% terminal growth rate after 2036 implies a per share value of ~\$20. Our terminal value in our DCF implies a 32x operating income multiple.

Exhibit 51: Key Assumptions in PLD Energy Base Case

Year:	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Operating Income	\$24,000	\$51,000	\$81,000	\$111,000	\$141,000	\$171,000	\$201,000	\$231,000	\$261,000	\$291,000	\$321,000	\$351,000	\$381,000	\$411,000	\$441,000
Interest Expense	\$3,300	\$6,600	\$9,900	\$13,200	\$16,500	\$19,800	\$23,100	\$26,400	\$29,700	\$33,000	\$36,300	\$39,600	\$42,900	\$46,200	\$49,500
Capex	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000
Free Cash Flow	(\$179,300)	(\$155,600)	(\$128,900)	(\$102,200)	(\$75,500)	(\$48,800)	(\$22,100)	\$4,600	\$31,300	\$58,000	\$84,700	\$111,400	\$138,100	\$164,800	\$191,500
Growth:									58.0%	85.3%	46.0%	31.5%	24.0%	19.3%	16.2%
Net Income:	\$20,700	\$44,400	\$71,100	\$97,800	\$124,500	\$151,200	\$177,900	\$204,600	\$231,300	\$258,000	\$284,700	\$311,400	\$338,100	\$364,800	\$391,500
Levered Return:		29.6%	33.4%	33.4%	33.4%	33.4%	33.4%	33.4%	33.4%	33.4%	33.4%	33.4%	33.4%	33.4%	33.4%

Source: Morgan Stanley Research

Exhibit 52: Key Assumptions in PLD Energy Bull Case

Year:	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Operating Income	\$27,200	\$78,200	\$155,550	\$238,000	\$323,000	\$408,000	\$493,000	\$578,000	\$663,000	\$748,000	\$833,000	\$918,000	\$1,003,000	\$1,088,000	\$1,173,000
Interest Expense	\$3,300	\$9,075	\$17,325	\$25,575	\$33,825	\$42,075	\$50,325	\$58,575	\$66,825	\$75,075	\$83,325	\$91,575	\$99,825	\$108,075	\$116,325
Capex	\$200,000	\$350,000	\$500,000	\$500,000	\$500,000	\$500,000	\$500,000	\$500,000	\$500,000	\$500,000	\$500,000	\$500,000	\$500,000	\$500,000	\$500,000
Free Cash Flow	(\$176,100)	(\$280,875)	(\$361,775)	(\$287,575)	(\$210,825)	(\$134,075)	(\$57,325)	\$19,425	\$96,175	\$172,925	\$249,675	\$326,425	\$403,175	\$479,925	\$556,675
Growth:									395.1%	79.8%	44.4%	30.7%	23.5%	19.0%	16.0%
Net Income:	\$23,900	\$69,125	\$138,225	\$212,425	\$289,175	\$365,925	\$442,675	\$519,425	\$596,175	\$672,925	\$749,675	\$826,425	\$903,175	\$979,925	\$1,056,675
Levered Return:		32.3%	34.6%	37.1%	38.4%	38.4%	38.4%	38.4%	38.4%	38.4%	38.4%	38.4%	38.4%	38.4%	38.4%

Source: Morgan Stanley Research

Freight

Covered by Ravi Shanker

Much like in our past EV (see [here](#)) and autonomous (see [here](#) and [here](#)) analysis where we have concluded that Intelligent trucking (EV + autonomous) will be a significant tailwind for the industry — especially large, well-funded established companies over small, mom-and-pop players, **this solar analysis also concludes that there are significant benefits for large carriers over small ones. Not only will this allow for potential quicker penetration of EVs across their fleet, the cost savings realized should also be improved.** In our initial EV Insight [here](#), we concluded that all-in EBIT for trucking carriers could be boosted by ~10% from electrification, a number that could be much higher with captive solar power generated at a much lower cost than electricity purchased off the grid in most states.

Who wins within Trucking?

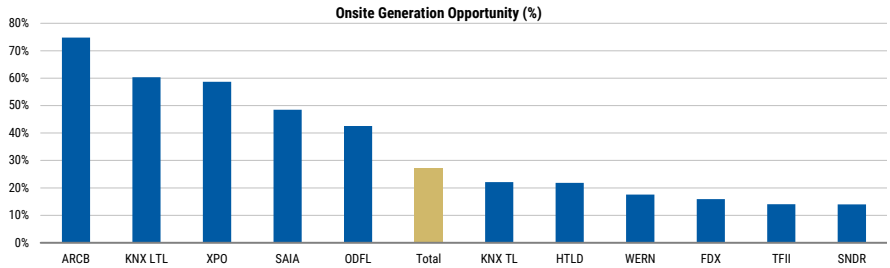
The LTLs are better placed for captive onsite solar power generation benefits because they have a more extensive network of truck terminals and a larger footprint overall. However, we believe TLs can strike deals with customers at drop-and-hook facilities to build solar infrastructure that can charge trucks during load/unload time (which can take several hours for each trip, potentially) to help supplement their existing footprint of solar capacity. We see LTLs with the highest footprint concentrated in solar-friendly states as the biggest potential winners here, including ARCB (OW), KNX (OW), XPO (EW), SAIA (UW), and ODFL (EW). On the other hand, TLs with more of a North/East footprint come in at the lower half of this analysis, including SNDR (OW), TFII (OW), WERN (OW), HTLD (EW), and FDX LTL (EW). However, we again emphasize that all large carriers stand to win from an operating cost and market share perspective relative to small mom-and-pop carriers. This analysis was conducted on large carriers with available terminal and facility size data — we intend to expand this analysis to more carriers (as data becomes available), leasing companies like Ryder and truck terminals, over time.

Clean Tech

Covered by Stephen Byrd, David Arcaro, & Laura Sanchez

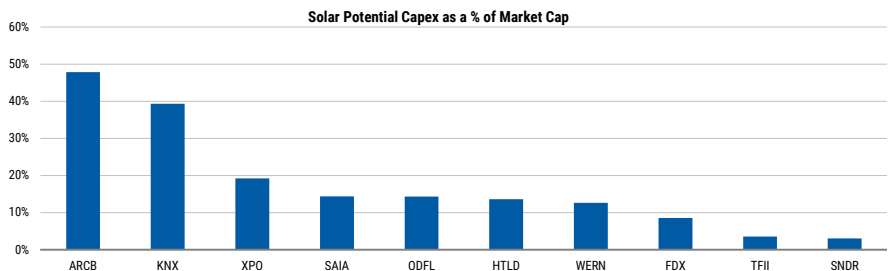
Clean Tech stocks are the natural beneficiaries of increased penetration of distributed C&I solar resources and EV charging networks. We see 4 types of companies that should benefit: 1) Equipment manufacturers given increased demand for distributed solar panels (**MAXN**), inverters (**SEDG**), and other solar balance of system wiring equipment (**SHLS**); 2) developers/installers of C&I distributed solar systems and/or EV charging systems (**AMPS**, **NEE**, **AES**, **SHLS**); 3) battery storage players (**FLNC** and **STEM**); and 4) financiers of such projects (**HASI**). Residential installers (**RUN** and **SPWR**) are also exposed to distributed solar but primarily to the Residential market.

Exhibit 53: Carrier Onsite Generation Opportunity



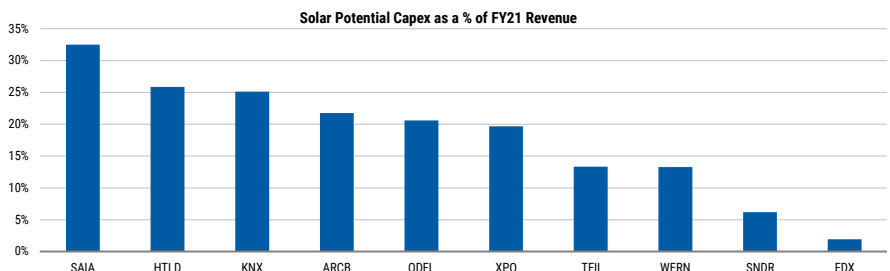
Source: Company data, Transport Topics, Morgan Stanley Research

Exhibit 54: Carrier Capex as a % of Market Cap



Source: Morgan Stanley Research, Refinitiv

Exhibit 55: Carrier Capex as a % of FY21 Revenue



Source: Morgan Stanley Research, Refinitiv

Maxeon Solar (MAXN - EW): Maxeon is a solar panel manufacturer offering the highest efficiency premium-priced solar panels based on unique patented technology, along with more standardized panels (with a modest efficiency advantage) manufactured in China through a joint venture with a large Chinese producer. The company was spun out of SunPower (SPWR) in August 2020. In 2022, MAXN has been building panel manufacturing capacity for use in the US market, aimed at utility-scale power plants and large-scale commercial and industrial systems. Outside of its exclusive supply agreement to rooftop solar provider SPWR in the US and Canada until 2024, MAXN sells its patented, high efficiency IBC panels and its lower priced shingled cell panels into commercial markets globally. The Maxeon Air is an ultrathin, ultralight, and flexible panel technology

that eliminates the use of glass and aluminum framing as well as racking, ballasts or anchors used in a traditional solar array. The company is introducing this product to target low-load commercial rooftops that cannot handle the weight of traditional panels, which it estimates to address 4GW of roof space in Europe alone. Maxeon Air systems are 50% lighter than conventional ones and use a "peel-and-stick" method for ease of installation and lower installation time. We would note that MAXN customer **SPWR (EW)**, post the sale of its commercial solar business to Total Energies, will still maintain a small portion of light commercial solar as a part of its residential business that could see incremental upside given the tailwinds listed in this note. In 2021, light commercial accounted for 20% of SPWR's installations excluding the legacy commercial business.

SolarEdge Technologies (SEDG - EW): For SEDG (a smart energy technology company with a leading presence in the global solar photovoltaic inverter market and a developing presence in storage, EV space, and energy management), the US represented ~40% of its total revenue and ~35% of its total delivered capacity in 2021. While its primary exposure in the US is to the residential market, the company does have a strong product offering in the C&I market. Overall, we would expect a stronger C&I market in the US to drive incremental opportunities for SEDG, although would note the margin profile for C&I is much lower than that of resi. For reference, the company has mentioned that ASPs for resi could be ~24 cents/watt, while for Commercial these could be ~11c/watt.

Shoals Technologies (SHLS - EW): Shoals is a provider of electrical balance of system solutions for large-scale solar (+battery) projects, and recently launched a comprehensive EV charging product for commercial applications, which positions them to benefit from increased penetration of C&I solar and EV charging. Its flagship Big Lead Assembly (BLA) product combines multiple components into a prefabricated solution that lowers electrical installation costs by ~40%, eliminates for several components (reducing electrical material costs by ~20%), and reduces the number of potential failure points in the system. While this product is primarily used in large utility-scale projects, it also provides plug-n-play connectors and inline fuses for commercial and rooftop solar applications. Additionally, SHLS has developed a fully-integrated commercial EV charging product including, a Fuel Power Center, Raceways (above-ground cabling), EV-BLA (customized wiring that reduces the required wiring), and Quick Connect Bases, which reduce installation costs versus conventional solutions by 20-30%.

Hannon Armstrong (HASI - EW): Hannon provides capital to behind-the-meter and grid scale assets developed by companies in energy efficiency, renewable energy, and other sustainable infrastructure

markets. The company directly funds onsite power, and in some cases storage, for C&I customers via PPAs and expects to see growth in other distributed energy components such as EV charging infrastructure as the energy transition continues to evolve. Of their \$3.7 billion portfolio, ~8% is in C&I assets, and the company has noted further opportunities in the C&I space within their >\$4b pipeline, which is heavily weighted towards behind-the-meter assets (including distributed solar). Some of the sponsors that HASI has worked with in the C&I space include Engie and SunPower.

Altus Power (AMPS - EW): Altus is the largest developer, owner, and operator of large-scale roof, ground mount, and carport solar and energy storage systems for C&I and community solar customers in the US - the exact market that we are tackling in this collaborative note. We believe some property owners (REITs or Freight companies) will look to own and operate the solar systems. For example, the world's largest owner, manager, and developer of logistics real estate, is the third largest private solar provider in the US, with 158 MW of solar capacity in the country (285 MW+ globally). Federal Realty (not covered) and AvalonBay Communities are also pursuing this solar strategy. However, many other property owners might not have the capabilities or interest in becoming an electricity provider and running the operations of the solar systems. These type of companies will hire a developer, such as AMPS. Given the company's focus on the C&I market and their relatively long history in the space (since 2009), we would see it as a natural developer/owner/operator of C&I solar systems.

NextEra Energy (NEE - EW): NEE is the largest developer of renewable projects in the US and is primarily focused on utility-scale projects. That said, the company has been recently highlighting the opportunity in the C&I space. While this might be via large-scale, front-of-the-meter projects (as opposed to behind-the-meter, or distributed generation), where NEE would sell the electricity via long-term power purchase agreements to the C&I customers, we would flag them as potential beneficiaries in the event that property owners look to outsource the development and management of the solar systems, similar to AMPS case. Currently, NEE has 235 MW of distributed solar generation in its 2022-24 development pipeline, or 3% of their total solar development pipeline during the same period. NEE has particularly highlighted the opportunity in the C&I market for "energy management" services, which as mentioned previously in this note, is another way to bring demand charges down and make distributed solar generation more attractive (by lowering the fix charge that particularly large commercial customers pay in their utility bills).

AES Corp.: (AES - OW): AES is global developer of renewable assets and similar to NEE it focuses on large scale, front-of-the-meter projects. The company has signed large contracts with corporations such as Google and Microsoft in which AES provides clean energy electricity via large scale projects, and has an energy management software that it sells to C&I customers through utilities (called Uplight). Similar to NEE, today AEE's portfolio of distributed solar and/or battery projects is fairly small relative to its total portfolio and pipeline.

Stem (STEM - EW): Stem provides battery storage systems with multiyear software subscriptions. The company is focused on providing smart energy storage via Athena, Stem's AI-powered software platform that optimizes a range of energy assets to minimize customer bills and maximize revenue for large-scale battery systems. Stem is one of the largest C&I storage companies globally based on deployed GWh of storage. Though the company is growing rapidly in the FTM market which is larger scale and lower hardware margin (though longer contract duration on software), we believe Stem will continue to maintain strong market share in the C&I market given its software has been proven to provide customers 30% savings when switching from competitors. Stem recently expanded the functionality of its software to offer EV route and charge schedule optimization for its BTM customers. Stem management estimates a \$4 billion TAM for this EV offering and can double the software revenue capture opportunity at customers that are deploying Stem's storage products. The company partnered with ENGIE earlier this year to integrate Stem's software with Engie's EV charging infrastructure and will co-market a turnkey eMobility solution.

Fluence Energy (FLNC - EW): Fluence Energy is a provider of large-scale energy storage systems. The company delivers storage hardware, operational services, and software subscriptions to optimize storage assets. Its offerings help utilities, developers, and commercial & industrial (C&I) customers manage the electric grid, dispatch electricity in wholesale markets, manage the intermittency of renewables, and save money on electricity bills. Just under 30% of Fluence's total contracts are focused on C&I customers and aims to offer a similar value proposition to Stem with these customers: using AI software to save on customer bills. For exposure to C&I storage, we prefer STEM to Fluence due to a more established software business (with 4x longer contract duration in FTM and 20x software runtime hours), faster revenue growth, less dependence on hardware margin expansion, and a less construction focused business model, given that Fluence is a storage system integrator while Stem purchases finished storage systems from system integrators.

Other companies that should be beneficiaries but are not covered by Morgan Stanley include Enphase (ENPH), Sunnova (NOVA), Generac (GNRC).

Autos

Covered by Adam Jonas

To facilitate the transition to green/renewable energy generation, as well as to support EV charging, we need to transition to the battery economy, or as we view it, The New Oil. The global investment level for batteries is easily in the trillions of dollars over the next decade. The technology is proven and getting better with each generation and greater competition, and governments have never been more supportive. These factors may drive higher BEV penetration, which will drive economies of scale, and ultimately push battery costs lower which in turn will support faster development of charging infrastructure. We expect a chicken-and-egg relationship whereby higher EV penetration will improve economics of charging infrastructure, while greater penetration/density of fast charging infrastructure will help foster greater EV penetration. This is particularly true of our bull case for EV penetration. We assume 87% BEV penetration of global light vehicle sales by 2040, producing 95.6 million units annually. We also assume a global average battery size of ~75 kWh/unit and pricing of ~\$75/kWh by 2040.

We estimate that the order of magnitude of battery capacity required to move 100% of the global light vehicle fleet to electric + grid-level/distributed stationary storage may be in the 20-40 TWh range, and could cost between \$1.5-3.0 trillion range. Just for the battery factories. (See: [Autos & Shared Mobility: 13 Ways to Play the Battery Capex Cycle \(8 Apr 2022\)](#)). Once the upstream mining/refining, downstream grid upgrades, renewable energy supply, charging infrastructure and related automobile manufacturing plants, recycling, service and support is factored in, we estimate that number may be in the magnitude of \$10-20 trillion or more over a 20-year period.

Under our US Autos coverage, we see 3 names in which investors can leverage the storage narrative: FREY (OW, \$18PT), TSLA (OW, \$1,300 PT), and RIVN (OW, \$85PT).

- **FREY** — We view FREY as a "land grab" type of play that highlights the trend toward national champions due to its favorable relationship with the Norwegian government. FREY is well positioned to leverage its unique manufacturing processes (licensed from 24M), advantages offered from Nordic energy production and battery supply chain, and low carbon and cost efficient battery cell manufacturing to be a serious player in the battery economy of the coming decades — see [Autos & Shared Mobility: 'Battery Biotech' Mindset: Initiate on FREY at Overweight, MVST at Underweight \(3 Aug 2021\)](#).

- **TSLA** — TSLA is a car company and a tech company, but almost more important, it is an energy company. Over the course of this year, we expect to see TSLA emerge as a renewable energy onshore infrastructure company. While battery production is important, where materials come from, where they are processed, and where they end up is equally as important. Events of recent weeks/months suggest that the current battery supply chain is arguably much less stable/secure than the O&G supply chain. We believe TSLA possesses the scale and know-how to construct the EV supply chain (upstream) and EV infrastructure (downstream) needed for a green economy — see [Tesla Inc: Tesla, Batteries and US National Security \(30 Mar 2022\)](#).
- **RIVN** — Rivian is a well-capitalized pure EV startup OEM that can leverage its strategic relationship with Amazon to derive scale and build software and services competencies for its consumer business. While it may not be apparent to investors today, we believe RIVN will emerge as a vertically integrated battery name. This will arise via RIVN executing on co-investments in dedicated capacity in offtake, JV, and/or prepayment arrangements to secure greater supply of cells and enabling materials. This vision was articulated by RIVN CEO RJ Scaringe, who recently stated, "...need to secure supply of raw materials... and any smart player in the space is spending a lot of time understanding the intricacies of the dynamics around lithium, nickel... building relationships and assets across the spectrum of different industries to make sure we have secure supply." — see [Rivian Automotive, Inc.: Battery Shortage + National Security = Electric Metal Onshoring \(19 Apr 2022\)](#).

Utilities

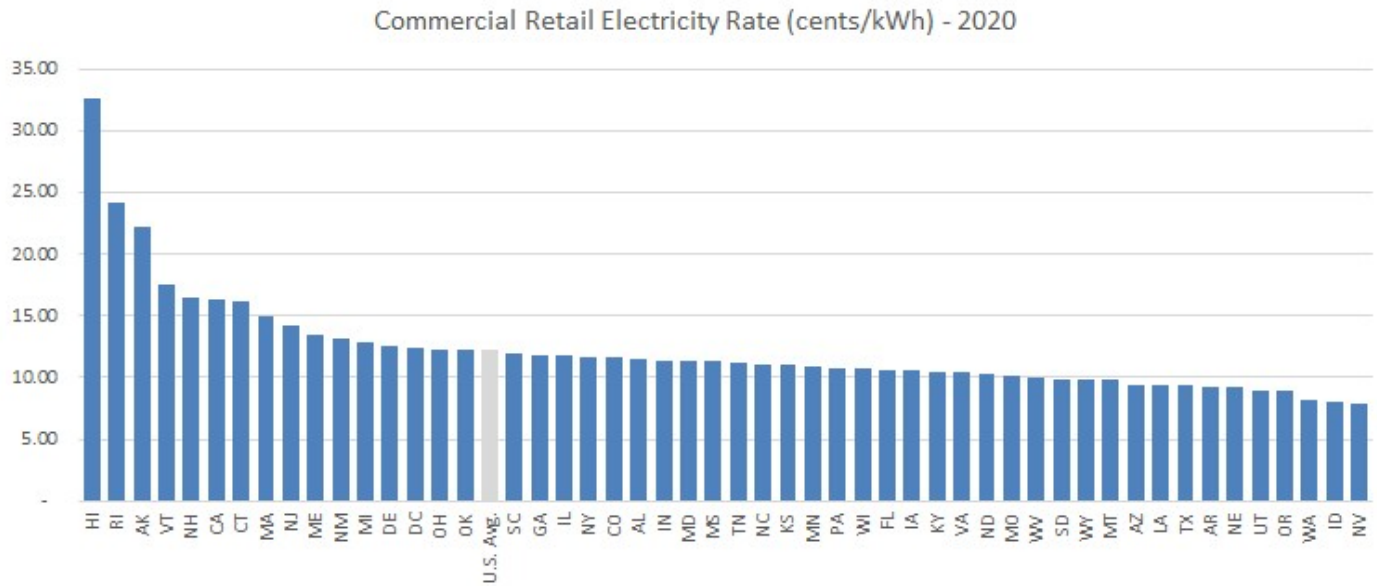
Covered by Stephen Byrd & David Arcaro

As we wrote in our 2022 outlook note (here) we believe there is, in certain regions of the US, a greater long-term risk that customers may choose to self-supply their power requirements, starting with distributed energy solutions (solar and fuel cells), but ultimately leading to complete defection (fuel cells coupled with storage, solar coupled with storage, and/or local generation such as the integrated "cord cutter" product developed by Generac).

Distributed energy coupled with battery storage poses a significant long-term risk to the traditional utility business model. As utility customers (residential and C&I) opt for rooftop solar combined with energy storage, utility bills for the remaining utility customers rise further due to the need for utilities to spread their fixed costs over a smaller remaining customer base, which in turn provides an even greater incentive for the remaining utility customers to switch to solar + storage. If net metering policies in the US are significantly altered and customers receive a much lower rate on the power they sell back to the grid than what is received today, we would expect incremental demand for behind-the-meter (BTM) storage, which would allow the customer to self-consume more of the energy generated from their solar panels. For example, in Germany, after similar policy changes, the size of solar systems and battery attach rates increased as customers added more energy management services to their homes/buildings such as water heaters, EV chargers, HVAC systems, etc.

Broadly speaking, the onsite power generation opportunity identified in this analysis of 345 TWh (for the broad Real Estate sector) represents 9% of total electric sales in the US – this is potential loss of load that utilities could face. In terms of where the risk of "customer defection" is greatest, a good starting point is to look at the comparison of commercial electric rates by state, shown in [Exhibit 56](#). We find especially interesting that the regions with the highest customer bills also have (1) above-average risk of climate change damage, (2) higher commodity prices, and (3) above-average risk of grid instability. **The electric utilities with the greatest risk of customer loss, in our view, are PCG, EIX, SRE, ED, ES, and PEG.**

Exhibit 56: High Commercial rates in the northeast and the west coast result in potentially attractive locations for distributed solar



Source: EIA, Morgan Stanley Research

What Are the REITs Saying?

Bottom line, we think the rooftops of commercial real estate provides a largely untapped opportunity to create low-cost renewable energy. Indeed, not only will the installation of solar panels reduce reliance on traditional energy to power the specific property, but, in some cases, there may be the creation of excess energy that can be sold back to the grid.

A Key Question: Is Solar REIT-Eligible Income?

Current law prescribes that REIT eligible income must be passive in nature. At least 75% of a REIT's annual gross income must be from real estate-related income such as rents from real property and interest on obligations secured by mortgages on real property. An additional 20% of a REIT's gross income must be from the above-listed sources or other forms of income such as dividends and interest from non-real estate sources (like bank deposit interest). No more than 5% of a REIT's income can be from non-qualifying sources, such as service fees or a non-real estate business.

The law also requires REITs assets that produce related income to consist of real property or other inherently permanent structures (OIPs) affixed to real property. Regulations in 2016 rejected that solar panels are OIPs as they serve an active function of producing electricity (for sale). Therefore, a REIT cannot directly monetize solar income unless such assets are placed in a taxable REIT subsidiary (TRS), which would be subject to full corporate level taxation. Therefore, in order to indirectly monetize solar income, REITs can lease property (rooftops, parking lots, etc.) to solar operators and capture the economics in the rent base.

Electric vehicle charging: Some service income may qualify as rents from real property if the services are customarily provided to tenants of other properties of similar class and location. Services must also be furnished primarily for the benefit of the REIT's tenants, guests, customers, or subtenants in connection with the rental of real property. The question is are EV charging stations are customary? There is no definitive answer today, but EV charging services will likely be considered customary in the near future as the economy transitions to a greater share EVs.

Industrial REITs may be further along in this initiative, and have the most potential upside. However, our review of the corporate responsibilities reports for various other REIT subsectors suggests that opportunity is not limited to industrial. Below we provide key highlights for apartments, open-air shopping centers & malls, and single-family rentals to illustrate the growing importance of solar panels, but note its use is not limited to the segments.

Industrial REITs

- **Prologis (PLD)** is the largest REIT in the US by market cap (\$125 billion), has a total enterprise value of \$150 billion and 2022e EBITDA of \$4.7 billion. **Despite a core real estate business that is experiencing record growth, the company has been vocal about aspirations of becoming the largest power provider in the US.** In its **2020 Sustainability report**, the company noted it installed 40 MW of additional capacity for a total of 252 MW globally, enough to power ~42k average homes (see [Exhibit 55](#)). The company is now the third largest private solar provider in the US, with 286 MWs of generating capacity as of 2021, and it has a goal of 400 MWs of generation capacity worldwide by 2025 (see [Exhibit 65](#)). With 125+

customers already, the company is well past the proof of concept stage and is now focusing on scaling this business. What is most compelling about PLD's opportunity to scale is that of the 1 billion SF of space in the portfolio, the company is currently utilizing less than 4% for solar.

- **Prologis Energy storage and EV charging could be an even greater opportunity.** The company is also making significant investment in energy storage and EV charging. By 2030, nearly 14 million commercial electric vehicles will be on the road, according to a McKinsey study. Vehicles are likely to charge at or near logistics facilities to minimize deviations from routes as well as

leverage downtime. Indeed, trucks at industrial facilities are idle while packages are loaded and unloaded, and they could potentially be charging at the same time. Combining solar, energy storage, and EV charging can serve as upside to earnings estimates on a longer-term basis, and we could see management providing additional financial disclosures and guidance in the next 2-3 years. Our meetings with management suggest these business could generate mid-teens unlevered IRRs and could be \$400-500 million of additional revenues in a 5- to 8-year time frame on a revenue base of \$5.6 billion in FY22e.

- **Prologis has made progress reducing greenhouse gas emissions**, both across its own operations (Scope 1 & 2) and within its value chain (Scope 3). While it is important to note that the pandemic caused major shifts across the global economy that have impacted PLD's footprint, efforts to drive energy efficiency and increase the use of renewable energy are also contributing to the company's results.
 - **In 2020, PLD achieved a 21% reduction in Scope 1 & 2 footprint compared to 2019**, although this represents a 40% increase compared to PLD's 2016 baseline due to the growth of the business in the intervening years (see Exhibit 65). The reduction was largely driven by a decline in emissions from PLD's vehicle fleet. As the largest driver of PLD's operational footprint, the company continues to explore opportunities to further drive down mobile combustion emissions.
 - **PLD's Scope 3 emissions reduced by 28% from 2019 to 2020**, driven by a 38% reduction in downstream leased assets, despite a simultaneous 10% increase in total warehouse square footage (see Exhibit 58). This brings PLD's total Scope 3 reduction to 37% against the company's science-based target (SBT) baseline year, far exceeding the company's reduction target. In the coming years, the company will look to fortify and further grow its reductions through the continued rollout of LED lighting, cool roofs, sustainable building standards and other approaches.
- **Duke Realty (DRE)** stated in its **2020 Corporate Responsibility Report** that "we realize the impact we have on the communities we serve and the world in which we live. Duke Realty is committed to thoughtful, sustainable practices. Our sustainable development, energy and resource usage policies help to create a cleaner, healthier environment for those we serve. In fact, we are working toward implementing green energy sources at facilities across the country."
 - In 2020, Duke Realty partnered with Solar Landscape on a community solar project — the installation of solar panels on the rooftops of several Duke Realty buildings in New Jersey. Community solar projects enable the capture of solar energy for the neighboring community. The panels are installed on rooftops of large commercial buildings/warehouses and the captured energy flows into the power grid and benefits the community as a whole. This was the first community solar project in the state of New Jersey. For this project, more than 18,000 solar panels were installed across the rooftops of four Duke Realty buildings. The energy generated is enough to power more than 1,200 homes annually — 50 percent of those homes are low- to moderate-income households.
 - This community solar project, covering one million square feet of rooftop, generates 11.1 megawatts annually of clean electricity for the surrounding community. **Through this project and similar ones across the nation, Duke Realty has helped generate a total of 28.2 megawatts of clean electric power annually.**
- **EastGroup Properties (EGP)** stated in its **2021 Environment, Social and Governance Report** that "[i]n 2019, we worked with one of our tenants to provide an allowance of up to \$500,000 for the installation of solar panels on one of our Phoenix properties and a second solar installation is planned for our development property in San Diego."
- **STAG Industrial, Inc. (STAG) announced in December 2021** the completion of the nation's largest rooftop community solar project hosted on its facility in Hampstead, MD. The 9.2 MW system is one of three hosted on STAG properties across the state and are part of Maryland's community solar program that provides low-cost renewable energy to local homes and businesses. Co-developed by Summit Ridge Energy and Black Bear Energy, the systems have an aggregate capacity of 11.6 MW and will generate over 15 million kWh of electricity annually — the equivalent of powering nearly 1,500 homes. With the addition of these sites, STAG now hosts over 25.5 MW of solar nationally.

- Rexford Industrial Realty (REXR, not covered)** stated in its **2021 Environmental, Social and Governance Report** that "[w]e continuing to unlock the value of our rooftops for renewable energy. We are in the process of evaluating an expansion of our solar program to include direct investment and development, providing power directly to tenants, and other renewable investments. They continue that "we set a goal that by the end of 2022, we will have over 9 megawatts of solar installed on our buildings. This will reduce our consumption of non-renewable energy while supporting our response to climate change."

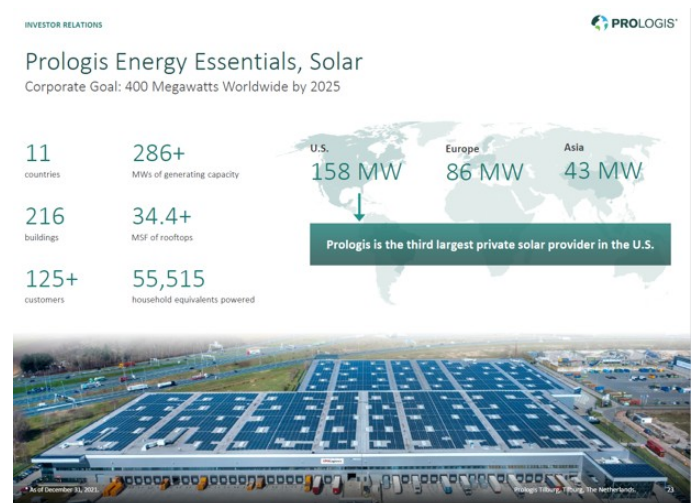
- Terreno Realty (TRNO, not covered)** announced in **April 2022** that it had entered agreements to host rooftop solar projects in Washington, D.C., with an aggregate power generating capacity of 8.4 MW — equivalent capacity to power over 700 homes. The company expects the projects to be operational in 2023 as part of Terreno Realty Corporation’s sustainability goal of rooftop solar on at least 5% of total rooftop area by year-end 2024.

Exhibit 57: PLD Solar Capacity



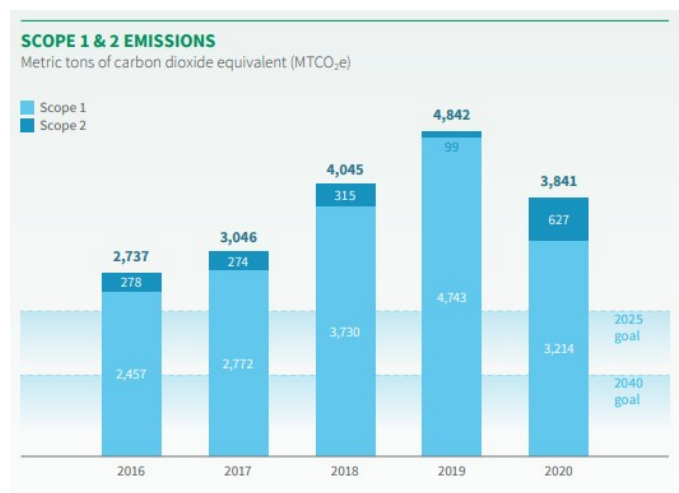
Source: Company Data, Morgan Stanley Research

Exhibit 58: PLD Solar Goal



Source: Company Data, Morgan Stanley Research

Exhibit 59: PLD Scope 1 & 2 Emissions



Source: Company Data, Morgan Stanley Research

Exhibit 60: PLD Scope 3 Emissions

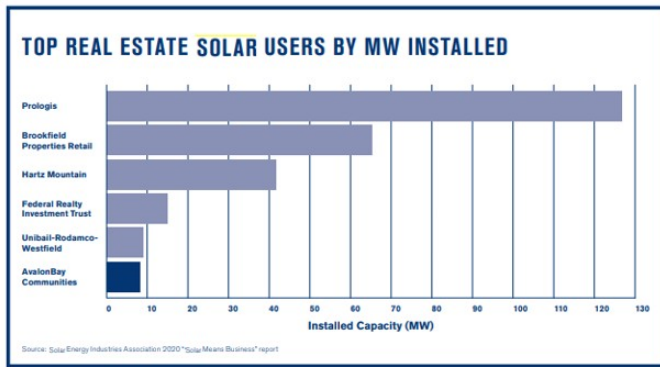


Source: Company Data, Morgan Stanley Research

Apartment REITs

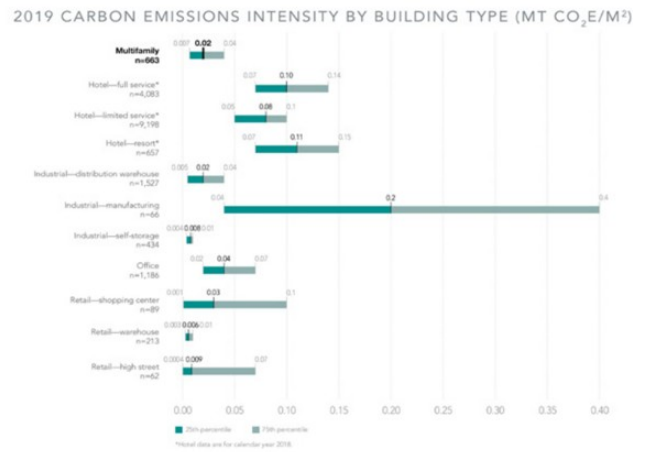
- AvalonBay (AVB)** stated in its **2020 Corporate Responsibility Report** that "we installed solar panels at seven communities, adding 560 KW watts of renewable power to our portfolio. This is in addition to the existing nine communities already generating over 1 megawatts of solar power. In 2021, we are working to complete onsite solar projects at 34 more communities. These will contribute an additional 5.9 megawatts of renewable power. And we continue to look for additional opportunities to implement further solar adoption, with 46 more communities currently undergoing preliminary feasibility analysis." The company continued that "[b]y the end of 2022 AvalonBay will have 55 solar sites operating with a total of 8.6 megawatts of solar generating 12,400 MWhrs of electricity per year. And in 2020 we moved 56 percent of our procurable common area electric load to renewable wind energy, with the result that by the end of 2021 we will have 85 percent of our procurable load from renewable sources." Based on the latest data available from 2019, the total of 55 solar sites and 8.6 MW of installed solar will place AvalonBay just below the top five of all real estate users of solar based on MW installed.
- Essex Property Trust** stated in its **2021 Corporate Social Responsibility Report** that "throughout 2021, the department's priorities have included solar energy systems, EV charging stations, efficient heat pumps/HVAC, battery storage, water conservation and drought tolerant landscaping." The company continued that "[i]n 2021, we invested more than \$10 million in solar energy systems that contributed to the generation of 8,494 MWh of clean energy to our properties. We also made additional investments in 3 solar pool systems and heat pumps, creating more sustainable living conditions for our residents." Bottom line: The company 1) has 93 solar energy systems, with solar energy generated by its communities increasing by 26% in 2021; 2) has 6.6MW of installed capacity of photovoltaic (PV) energy systems in the past 5-years, which have generated more than \$24,391 MWh of renewable energy for its communities, making them less dependent on the grid; and 3) has invested \$30.8 million of renewable energy project, \$28.7 million in energy efficient projects and \$3.7 million in water efficiency projects.
- Equity Residential** stated in its **2021 Environment, Social and Governance Report** that it has 109 properties that are powered by on-site clean or renewable energy. Through 2020, approximately a third of its properties feature some source of on-site clean or renewable energy, including solar PV, solar thermal, or cogeneration.
- UDR** stated in its **2021 Environment, Social and Governance (ESG) Report** that "[n]ew rooftop solar investments added over 841,000 kilowatt hours (kWh) of clean renewable electric capacity in 2020, bringing our annual solar production capacity to 1.7 million kWh." It provided further detail, stating that "[i]n 2020, UDR installed rooftop solar on five communities. Ten of our communities now have solar generation with annual capacity totaling 1.7 million kWh. These investments are economically sound and environmentally responsible as they lower our electric consumption and, therefore, GHG emissions. In 2021 and beyond, we will continue to underwrite opportunities to deploy solar where building or parking lot configurations allow. Battery storage is also high on our list of potential opportunities as it would reduce our reliance on the grid during peak pricing times while also providing short-term emergency power." The multifamily sector averages 0.02 MT CO₂e per meter squared compared to other real estate sectors that range from less than 0.01 metric tons to 0.4 metric tons. "We believe our building type lowers our physical and regulatory risks compared to other real estate sectors. Despite this, we believe future ESG-based regulatory risk remains elevated for the multifamily sector and we will continue to monitor and incorporate into the company's overall ESG Governance Process."

Exhibit 61: AVB Solar Capacity



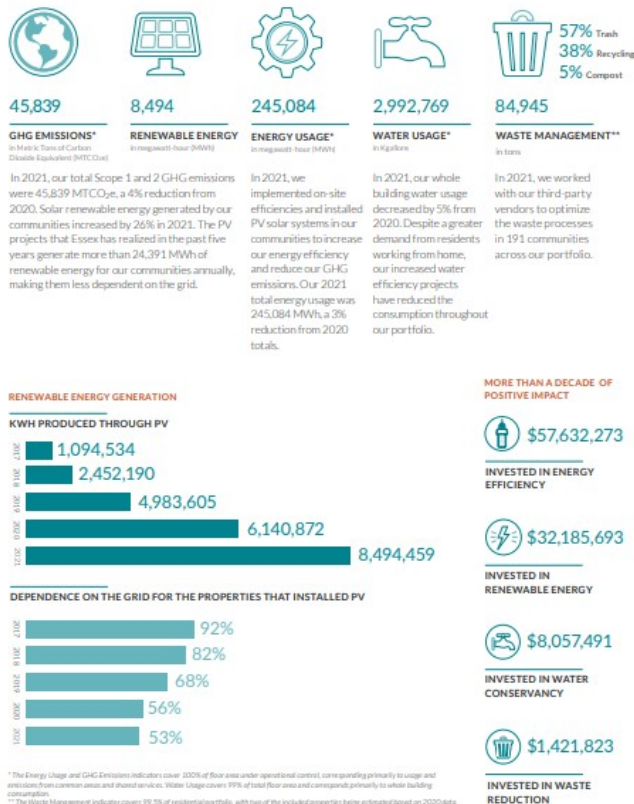
Source: Company filings Morgan Stanley Research

Exhibit 62: UDR Carbon Emission



Source: Company filings Morgan Stanley Research

Exhibit 63: ESS ESG



Source: Company filings Morgan Stanley Research

Exhibit 64: ESS Solar



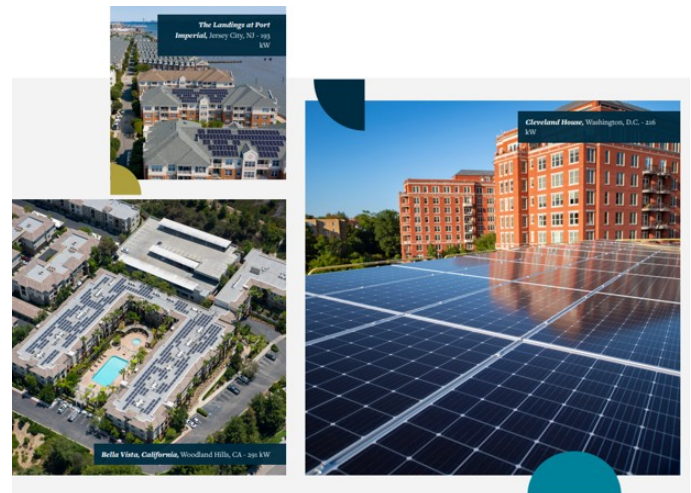
Source: Company filings Morgan Stanley Research

Exhibit 65: EQR Solar



Source: Company filings Morgan Stanley Research

Exhibit 66: EQR Solar



Source: Company filings Morgan Stanley Research

Open Air Shopping Centers

- Kimco Realty Corp** stated in its **2020 Corporate Responsibility Report** that "[o]ur solar energy program has proven to be a pioneering effort among property owners. In 2009, Kimco was the first among its peers to form a solar development subsidiary focused on building and operating rooftop solar arrays on our properties and supplying clean energy to our retail tenants. With the help of additional solar operators this initiative has expanded to include 6.7 megawatts of installed solar production capacity, with another 3.7 megawatts under construction. By displacing a portion of the existing supply of electricity for retailers, Kimco can provide lower cost electricity while helping offset a portion of the tenant's emissions footprint. Our most recent solar projects are in the New York metropolitan area, at our new headquarters in Jericho, New York, and at three Staten Island retail properties: Greenridge Plaza, Forest Avenue Shopping Center, and Richmond Shopping Center. We are also installing solar at Festival at Hyannis Shopping Center, one of our properties in Massachusetts."
- Site Centers** stated in its **2020 Corporate Responsibility & Sustainability Report** that "[t]he production of renewable energy is also a key energy management strategy for SITE Centers. We are currently producing 3,286mWh of solar energy each year. 1,686mWh are utilized by common areas of our properties to operate parking lot and building lighting. This program allows SITE Centers to provide clean energy to operate our properties, provide clean energy to our surrounding energy grids and help to achieve our goal of mini-

mizing emissions and greenhouse gases from sourcing energy that is generated from fossil fuels."

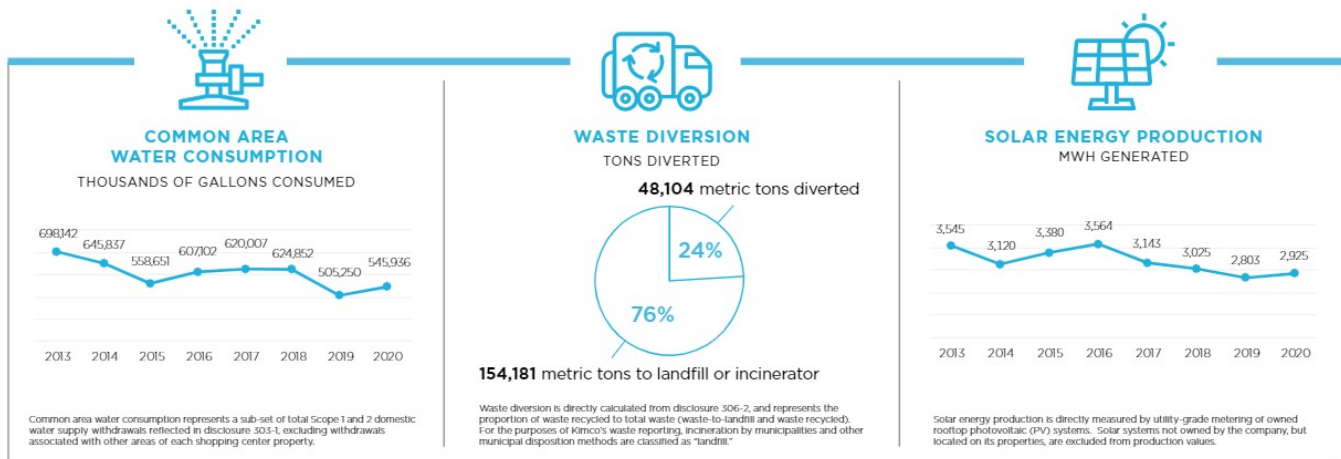
- Urban Edge** noted in its **2020 Environment, Social and Governance Report** that "[w]e have installed a one-megawatt photovoltaic (solar cell) system at our largest property, The Outlets at Bergen Town Center in Paramus, New Jersey, reducing the mall's energy consumption by approximately 900,000 kilowatt-hours annually. We are currently reviewing additional solar energy options in the hope of reducing the overall energy consumption across the portfolio."
- Regency Centers** stated in its **2020 Corporate Responsibility Report** that "[w]e have long acknowledged the benefits of renewable energy including contributing to a low-carbon environment, lowering operating costs, addressing certain air pollution, diversifying energy supply, and reducing dependence on fossil fuels. Where possible, we work with tenants to provide affordable renewable energy at our properties and have recently become a signatory to the Renewable Energy Buyers Alliance's Commercial Real Estate Principles. The Principles codify many of the initiatives we have had in place for some time. This includes collaborating with tenants to provide access to renewable energy options and engaging in public disclosure and benchmarking of our properties' energy use and environmental footprint." It continued that "Regency commenced installing renewable energy systems at our properties in 2011, and in 2020 had 16 solar energy arrays at 11 of our centers producing approximately 4,000 megawatt hours of clean power. Almost dou-

bling production from the approximate 2,400 megawatt hours our solar systems produced in 2019. In addition, in 2020, we again purchased renewable energy credits to partially offset emissions generated by the common areas at our properties."

- **Phillips Edison & Company** stated in its **2020 Corporate Responsibility Report** that "three shopping centers had solar

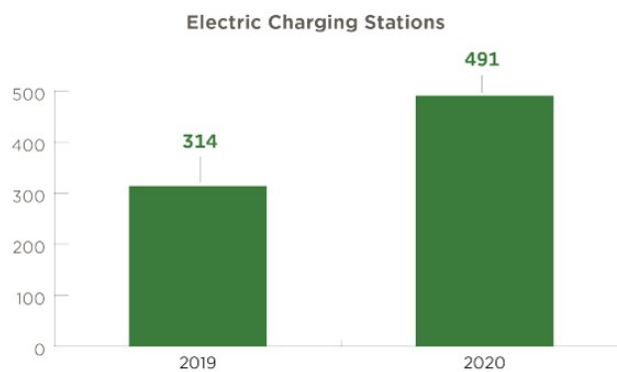
roofs installed in 2020 for a total of 111,012 square feet of new roofs replaced with GAF TPO roof membrane and installed solar panels throughout the area. The roofs will be maintained for 20 years with no cost to PECO or our Neighbors. In return the power generated from the solar panels is sold back to the grid. A total of 256 kW of solar was installed and total portfolio output is 4.5 MW." In total, PECO has existing solar 14 properties across 5 states.

Exhibit 67: KIM ESG



Source: Company filings Morgan Stanley Research

Exhibit 68: REG Electric Charging



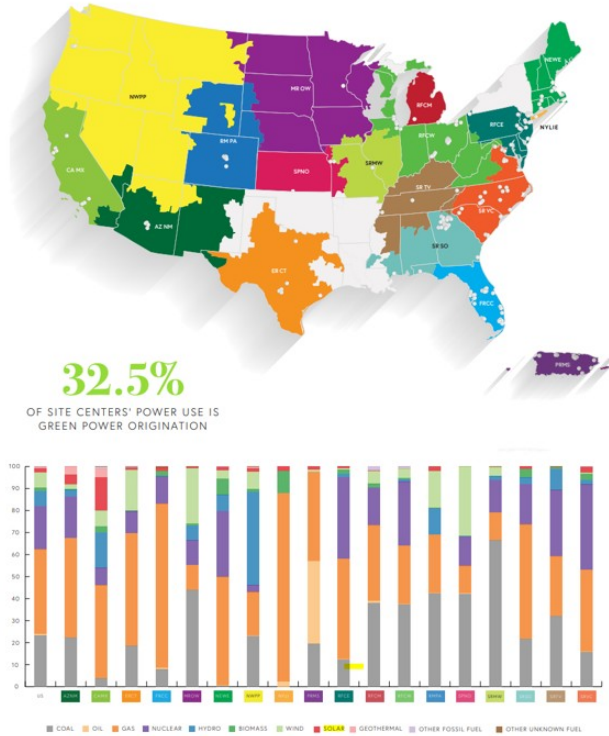
Source: Company filings Morgan Stanley Research

Exhibit 69: PECO Solar Arrays



Source: Company filings Morgan Stanley Research

Exhibit 70: SITC ESG



Source: Company filings Morgan Stanley Research

Malls

- **Macerich** stated in its **2020 Corporate Responsibility Report** that "[we] have an objective of 15% of energy gener-

ated from on-site renewable and clean energy sources by 2030, currently 10% of energy generated by solar and fuel cell systems. [Our] portfolio includes solar energy systems at 14 properties generating more than 16 million kilowatt-hours of electricity annually."

- **Simon Property Group** stated in its **2020-2021 Sustainability Report** that it will work to meet or exceed reducing carbon emissions associated with its energy consumption by 68% (baseline 2019), and by 20.9% for emissions associated with tenant energy consumption by 2035 (baseline 2018). With regard to sustainable local energy, the company stated that "by 2030, Simon aims to increase the share of renewable energy in our global energy mix substantially and double our global rate of improvement in energy efficiency. We continue to optimize our energy efficiency and procure electricity from cleaner energy sources. Simon is forward thinking and wants to power its assets with sustainable energy. Working through Direct Energy, we are enjoying affordable clean energy that provides over 150,000 MWh's of green power to our properties in Texas. Furthermore, "In September 2019, we completed the installation of three on-site renewable energy projects on the rooftops of Clinton Premium Outlets, Jackson Premium Outlets and Jersey Shore Premium Outlets. In total, these projects generated 730 MWh annually, which is used to power the common areas of these centers and reduces the carbon footprint of our properties even further. To ensure Simon adds new sustainable

Exhibit 71: MAC ESG

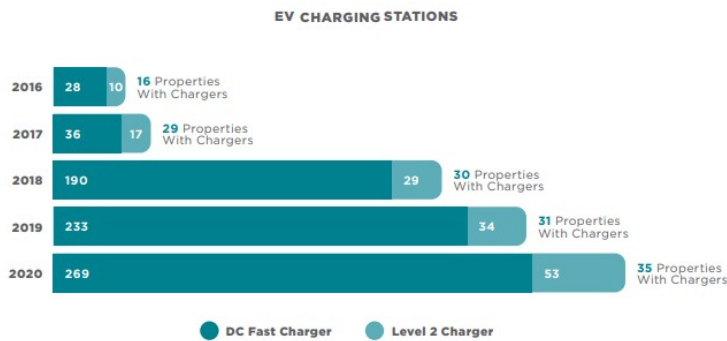


Source: Company filings Morgan Stanley Research

properties to its portfolio, "we have updated our sustainable development guidelines to incorporate energy efficiency, water conservation, sustainable sourcing and the socio-economic impact into the design of every major redevelopment of the property." The company provided a case study where "to optimize energy efficiency, all buildings at Denver Premium Outlets were designed with a high solar reflective index (SRI) roof system. High solar reflectance minimizes the solar energy absorbed, and as a result, the infrared radiation

emitted from the building. Infrared radiation emissions are the primary contributor to the heat trapped by greenhouse gases and as a result, global warming. High SRI roofs also reduce the amount of cooling needed, resulting in less GHG emissions, and lower operating costs. All throughout the center they incorporated voltage energy efficient LED lighting. LED lights use 75% less energy and last 25 times longer than incandescent lighting. The property also includes solar PV panels on the roof which produce 107,000 kWh."

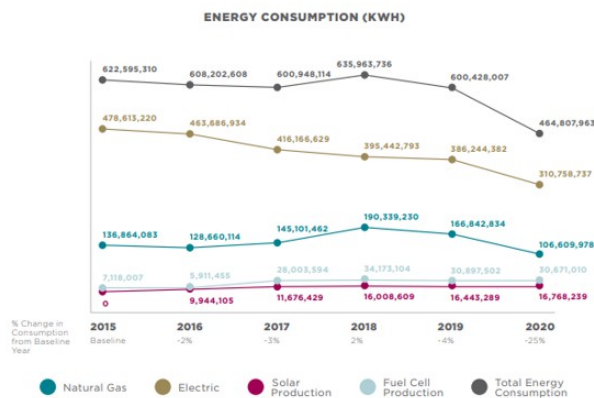
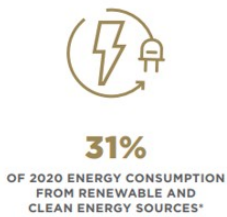
Exhibit 72: MAC EV Charging



Source: Company filings Morgan Stanley Research

Exhibit 73: MAC ESG

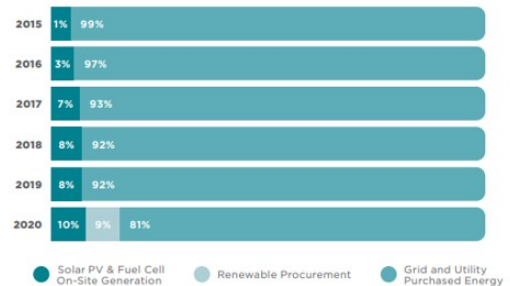
ENERGY PERFORMANCE



*Renewable and clean energy sources include on-site energy generation from solar photovoltaic systems and fuel cells, renewable energy procurement, and renewable energy credits (RECs).

Source: Company filings Morgan Stanley Research

ENERGY SOURCES %



RENEWABLE AND CLEAN ENERGY PRODUCED ON-SITE (KWH)

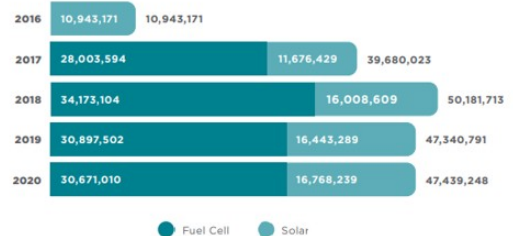
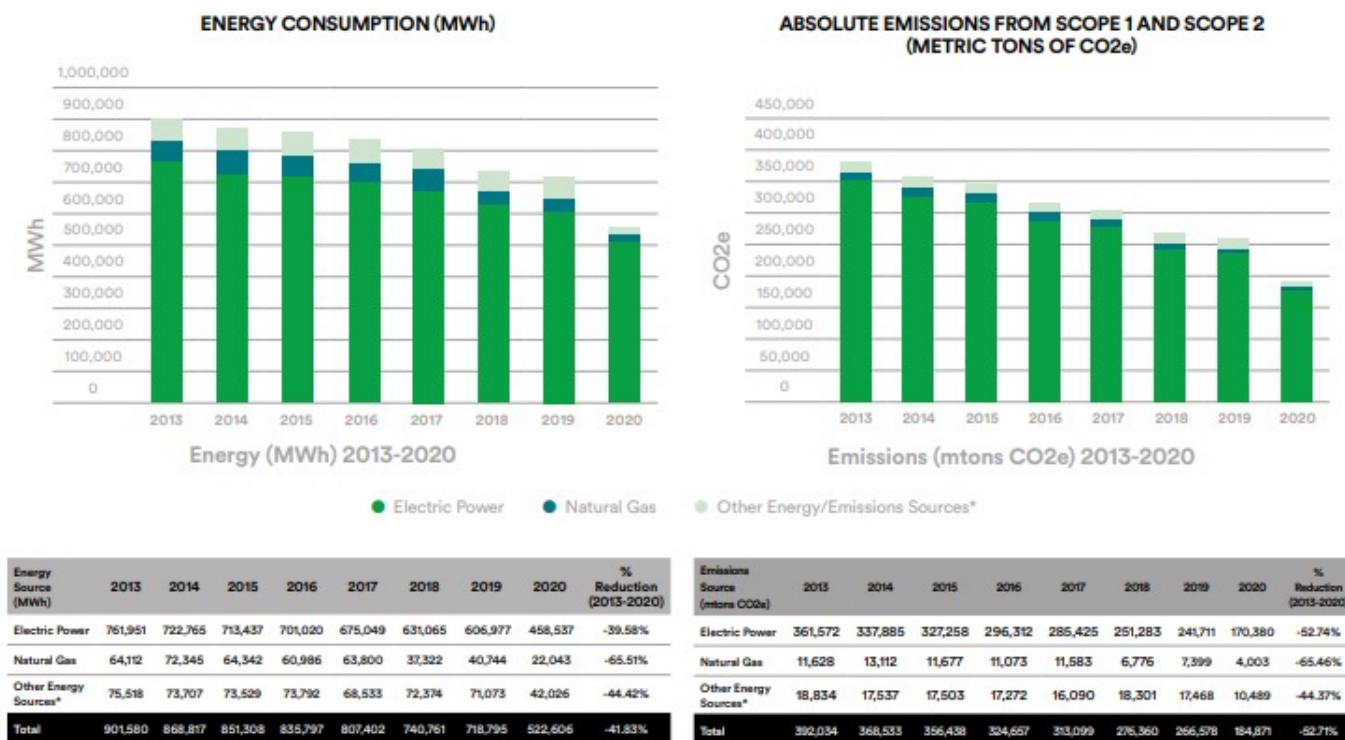


Exhibit 74: In the period 2013-20, SPG reduced their direct energy consumption by 41% and carbon footprint by 52%. Simon has committed to reduce absolute Scope 1 and 2 GHG emissions by 68% by 2035, from a 2019 base year.



* Other energy/emission sources include chilled water, diesel, ethanol blends, gasoline petrol, propane, and refrigerants.

Source: Company filings Morgan Stanley Research

Single Family Rentals

- **American Homes 4 Rent** stated in its 2021 Sustainability Report that "in 2021 [they] initiated two pilot projects to install solar panels at our facilities, one at select community amenity centers and one at select homes in our existing portfolio." More important, it is launching a renewable energy pilot. Specifically, the company stated that "we partnered with award-winning energy solutions company Elevation last year to explore new ways and technologies to generate cleaner energy and lower our annual carbon footprint. In 2021, we began implementing a pilot renewable energy program at select amenity centers in our portfolio. At The Ponds at Walden Woods and Creekside Ranch communities, we installed premium solar panels, whose high-grade quality ensures reliable production in varying weather conditions

and reduces the likelihood of failure or underperformance. We also began preparations to launch a second pilot phase on ten of our existing homes, an initiative that will include: Custom-designing and installing solar panels on homes' roofs, Upgrading homes' insulation and sealing leaks in ducts and vents, Adding a Curb energy monitor that connects to the homes' electric system and provides real-time updates on energy usage and production — data that will be made accessible to the resident(s) as well."

Appendix A: Solar C&I LCOEs vs. Utility Commercial Rates

Exhibit 75: 2025e C&I Solar LCOEs vs. Avg. Utility Commercial Rates by State

State	Avg. Utility Comm. Rate (c/kWh)	C&I Solar LCOE (c/kWh)	Savings
Average	14.35	11.13	-18%
RI	28.78	12.05	-58%
CA	19.41	10.32	-47%
NM	15.70	9.06	-42%
CT	19.21	12.05	-37%
SC	14.24	9.11	-36%
VT	20.89	13.86	-34%
GA	14.07	9.37	-33%
OK	14.58	10.10	-31%
NC	13.18	9.16	-31%
AL	13.73	9.57	-30%
CO	13.80	9.72	-30%
NH	19.63	13.86	-29%
NJ	16.90	12.01	-29%
MS	13.42	9.57	-29%
MA	17.85	13.05	-27%
FL	12.66	9.40	-26%
VA	12.38	9.42	-24%
TN	13.32	10.17	-24%
TX	11.08	8.58	-23%
KS	13.11	10.40	-21%
OH	14.64	11.74	-20%
DE	14.95	12.01	-20%
AZ	11.21	9.06	-19%
MI	15.21	12.38	-19%
DC	14.71	12.01	-18%
KY	12.48	10.39	-17%
IN	13.55	11.50	-15%
IA	12.52	10.71	-14%
IL	13.96	12.01	-14%
ME	16.07	13.86	-14%
AR	11.05	9.57	-13%
LA	11.10	9.87	-11%
MD	13.46	12.01	-11%
UT	10.67	9.72	-9%
WY	11.65	10.80	-7%
SD	11.74	11.00	-6%
MN	12.94	12.16	-6%
NY	13.81	13.02	-6%
NE	10.94	10.48	-4%
WI	12.71	12.27	-3%
MO	12.05	11.70	-3%
ND	12.28	12.16	-1%
WV	11.85	11.74	-1%
NV	9.44	9.74	0%
PA	12.78	13.27	0%
MT	11.62	12.60	0%
OR	10.67	12.06	0%
ID	9.58	12.12	0%
WA	9.64	12.37	0%

Source: EIA, Morgan Stanley Research estimates

Appendix B: From Theoretical to the Actual with PLD

Prologis SolarSmart is a way for Prologis' customers to take control of their energy expenses and realize the benefits of onsite power for their warehouse operations. Customers agree to buy power generated on-site at or below local utility rates, and only during their lease term. There is no upfront expense for customers, and no lengthy power agreements that extend past lease expiration. Prologis, provides an opportunity for energy savings and a turnkey solution for customers:

1. California and New Jersey are live! If you are an industrial customer in California or New Jersey with PLD today you can pick up the phone and call PLD and say I'm interested in Solar Energy!
2. **What happens next?** PLD will ask the customer to share their energy usage (interval data) which you can get from your utility. Once PLD get the data they process it in 7-10 business days and will make a recommendation on 1) system sizing, 2) solar cost per KWh and 3) overall economics of the opportunity. PLD then presents the customer with a proposal that reviews the design, economics and process.
3. **Zero up front cost for the customer.** If feasible and customer accepts then your lease contract is amended with the Prologis SolarSmart Agreement. It is a couple paragraph lease amendment with the customer that is made to commence with the project. PLD will build, operate and maintain the facility. The entire process is managed by Prologis. Most solar work takes place on the roof, in electrical rooms and outside of your operating space. Finally, a brief power outage will be required to connect the system and start delivering power savings to the building.
4. **What does the customer pay?** Customers pay for the power generated through the Prologis SolarSmart program, in addition to the power they continue to consume from the local utility. Importantly the customer only pays for energy used while occupying and/or legally possession of the space. It is co-terminus with the lease.
5. **How does this impact the customers current utility bill?** Rooftop solar installations are typically connected to the local utility grid; PLD is not taking buildings "off grid." The solar system will operate during the day, offsetting power from the grid. Your current utility connection will remain for reliability, evenings and consumption above the solar output. Customers' existing utility accounts will remain in-tact. The solar power is an add-on to the existing utility connection. Therefore, customers will receive a standard electricity bill and a secondary solar bill posted to their Prologis account ledger.
6. **Can the customer get renewal credits?** In some locations yes, in others no. Solar approvals and financing can be complex. Where possible, namely California, Renewable Energy Certificates (RECs) can be provided to Prologis SolarSmart customers, if requested, while in New Jersey, the RECs are retained by the local utility based on the regulatory framework. Participating customers will be using onsite energy for a portion of their consumption instead of grid power.

Morgan Stanley is currently acting as financial advisor to XPO Logistics, Inc. ("XPO") with respect to its proposed plan to separate the company's brokered freight transportation operations from its less-than-truckload (LTL) business in North America, as announced on March 8, 2022. The proposed separation is subject to various conditions, including the effectiveness of a Form 10 registration statement, receipt of a tax opinion from counsel, the refinancing of XPO's debt on terms satisfactory to the XPO board of directors, and final approval by the XPO board of directors. XPO has agreed to pay fees to Morgan Stanley for its services, including transaction fees that are contingent upon the consummation of the proposed transaction. Please refer to the notes at the end of the report.

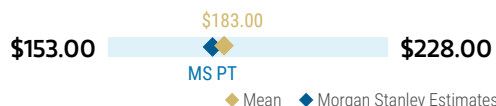
Risk Reward – Prologis, Inc. (PLD.N)

Best in Class Growth and Balance Sheet

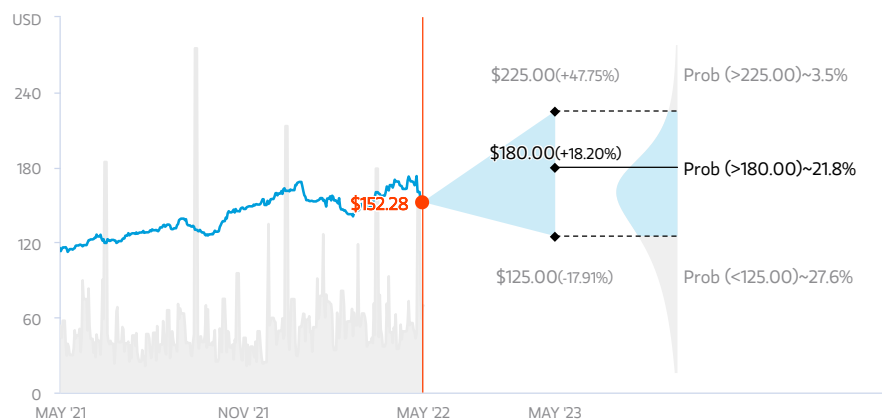
PRICE TARGET \$180.00

Our PT for PLD of \$180 is based on our estimated 23e FFO/share of \$5.60 to come up with an expected '23 FFO multiple of 31.3x. PLD's exposure to last-mile urban warehouses, high barrier markets with strong rent growth, and investment grade balance sheet warrant a growing premium valuation. We add in \$5 per share value for the energy business supported by our DCF.

Consensus Price Target Distribution



RISK REWARD CHART AND OPTIONS IMPLIED PROBABILITIES (12M)



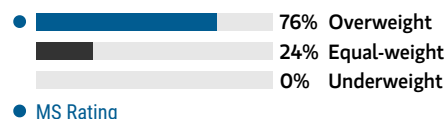
Key: — Historical Stock Performance ● Current Stock Price ◆ Price Target

Source: Refinitiv, Morgan Stanley Research, Morgan Stanley Institutional Equities Division. The probabilities of our Bull, Base, and Bear case scenarios playing out were estimated with implied volatility data from the options market as of 04 May, 2022. All figures are approximate risk-neutral probabilities of the stock reaching beyond the scenario price in either three-months' or one-years' time. View explanation of Options Probabilities methodology [here](#)

OVERWEIGHT THESIS

Prologis is a high quality play on the attractive industrial sector that is benefitting from secular eCommerce trends. Exposure to infill sub-markets with high supply barriers position the company to achieve superior rent growth versus peers across its US markets. This view is supported by our deep-dive supply analysis by sub-market. We believe value creation will be both organic and non-organic through execution of accretive acquisitions, development deliveries, and the promote opportunities from PLD's strategic capital business.

Consensus Rating Distribution



Source: Refinitiv, Morgan Stanley Research

Risk Reward Themes

Secular Growth: *Positive*

View descriptions of Risk Rewards Themes [here](#)

BULL CASE

\$225.00

35x '23e FFO + \$20 DCF value of energy business

Rent growth re-accelerates and global industrial activity improves in 2022. US markets experience a re-acceleration in demand for warehouse space as retailers play catch up to AMZN. PLD's MTM grows into the 40s and same-store NOI growth in the high single digits continues. Our price target of \$204 uses our estimated 23e FFO/share of \$5.79 to come up with an expected '23 FFO multiple of 35x. We add in \$20 per share value for the energy business based on DCF analysis.

BASE CASE

\$180.00

31x '23e FFO + \$5 DCF value of energy business

PLD outperforms peers through superior same store growth with contribution from development land bank and ancillary businesses. E-commerce penetration continues and inventories rebuild as. Our price target of \$175 uses our estimated 23e FFO/share of \$5.60 to come up with an expected '23 FFO multiple of 31.3x. We also look at a DCF model using a cost of equity of 5.7% and a terminal growth rate of 3%. We add in \$5 per share value for the energy business based on DCF analysis.

BEAR CASE

\$125.00

23x '23e FFO; No value for Energy Business

Global growth/US Economy slows and rent growth decelerates. The leasing momentum slows and rent growth in the US and Europe levels out and same-store growth peaks. Our price target of \$125 uses our estimated 23e FFO/share of \$5.36 to come up with an expected '23 FFO multiple of 23.3x. We also look at a DCF model using a cost of equity of 6.1% and a terminal growth rate of 1.5%.

Risk Reward – Prologis, Inc. (PLD.N)

KEY EARNINGS INPUTS

Drivers	2021	2022e	2023e	2024e
KEI - FFO Growth (Row 144) (%)	14.6	11.2	10.9	11.2
KEI - Dividend Payout Ratio (Row 151) (%)	57.9	65.4	68.5	70.1
KEI - SS-NOI Growth (Row 36) (%)	6.1	7.8	7.8	7.3

INVESTMENT DRIVERS

- PLD rent spreads continue to accelerate as the mark to market opportunity widens
- Further utilization of the \$28bn land bank with additional growth from Essentials platform
- Inventory rebuilding story continues

MS ALPHA MODELS

3/5 BEST	24 Month Horizon	3/5 MOST	3 Month Horizon
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Source: Refinitiv, FactSet, Morgan Stanley Research; 1 is the highest favored Quintile and 5 is the least favored Quintile

SUSTAINABILITY & ESG

Indicator of Change	0.00	+1.0	-1.0
Disclosure Rate	45%		

RISKS TO PT/RATING

RISKS TO UPSIDE

- Continued widening of PLD's mark to market opportunity leading to faster same store NOI growth beyond '23
- More external growth through higher acquisition/development activity than currently modelled
- Energy business becomes a material earnings driver

RISKS TO DOWNSIDE

- Negative impacts to global supply chains from COVID-19
- A retail or broader economic slump would weigh on warehouse space demand
- Rising interest rates

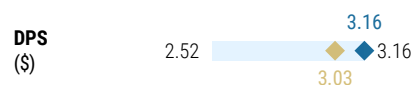
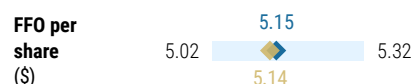
OWNERSHIP POSITIONING

Inst. Owners, % Active	57.2%	
HF Sector Long/Short Ratio	1.2x	
HF Sector Net Exposure	1.1%	

Refinitiv; MSPB Content. Includes certain hedge fund exposures held with MSPB. Information may be inconsistent with or may not reflect broader market trends. Long/Short Ratio = Long Exposure / Short exposure. Sector % of Total Net Exposure = (For a particular sector: Long Exposure - Short Exposure) / (Across all sectors: Long Exposure - Short Exposure).

MS ESTIMATES VS. CONSENSUS

FY Dec 2022e



◆ Mean ◆ Morgan Stanley Estimates

Source: Refinitiv, Morgan Stanley Research

Disclosure Section

Mortgage Backed Securities (MBS) and Collateralized Mortgage Obligations (CMO)

Principal is returned on a monthly basis over the life of the security. Principal prepayment can significantly affect the monthly income stream and the maturity of any type of MBS, including standard MBS, CMOs and Lottery Bonds. Yields and average lives are estimated based on prepayment assumptions and are subject to change based on actual prepayment of the mortgages in the underlying pools. The level of predictability of an MBS/CMO's average life, and its market price, depends on the type of MBS/CMO class purchased and interest rate movements. In general, as interest rates fall, prepayment speeds are likely to increase, thus shortening the MBS/CMO's average life and likely causing its market price to rise. Conversely, as interest rates rise, prepayment speeds are likely to decrease, thus lengthening average life and likely causing the MBS/CMO's market price to fall. Some MBS/CMOs may have "original issue discount" (OID). OID occurs if the MBS/CMO's original issue price is below its stated redemption price at maturity, and results in "imputed interest" that must be reported annually for tax purposes, resulting in a tax liability even though interest was not received. Investors are urged to consult their tax advisors for more information. Government agency backing applies only to the face value of the CMO and not to any premium paid.

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For valuation methodology and risks associated with any recommendation, rating or price target referenced in this research report, please contact the Client Support Team as follows: US/Canada +1 800 303-2495; Hong Kong +852 2848-5999; Latin America +1 718 754-5444 (U.S.); London +44 (0)20-7425-8169; Singapore +65 6834-6860; Sydney +61 (0)2-9770-1505; Tokyo +81 (0)3-6836-9000. Alternatively you may contact your investment representative or Morgan Stanley Research at 1585 Broadway, (Attention: Research Management), New York, NY 10036 USA.

Analyst Certification

The following analysts hereby certify that their views about the companies and their securities discussed in this report are accurately expressed and that they have not received and will not receive direct or indirect compensation in exchange for expressing specific recommendations or views in this report: David Arcaro, CFA; Stephen C Byrd; Mark Carlucci, CFA; Todd Castagno, CFA, CPA; Richard Hill; Adam Jonas, CFA; Ronald Kamdem, CFA; Laura Sanchez; Ravi Shanker; Emmett Simmons.

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(as of April 30, 2022)

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Stock Rating Category	Coverage Universe		Investment Banking Clients (IBC)			Other Material Investment Services Clients (MISC)	
	Count	% of Total	Count	% of Total IBC	% of Rating Category	Count	% of Total Other MISC
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Equal-weight/Hold	1564	44%	373	44%	24%	705	45%
Not-Rated/Hold	0	0%	0	0%	0%	0	0%
Underweight/Sell	564	16%	95	11%	17%	219	14%
Total	3,552		842			1550	

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INDUSTRY COVERAGE: Clean Tech

COMPANY (TICKER)	RATING (AS OF)	PRICE* (05/04/2022)
David Arcaro, CFA		
Maxeon Solar Technologies Ltd. (MAXN.O)	E (08/09/2021)	\$13.77
Laura Sanchez		
TPI Composites Inc. (TPIC.O)	E (02/25/2022)	\$13.15
Stephen C Byrd		
Altus Power Inc (AMPS.N)	E (04/07/2022)	\$6.06
Array Technologies Inc (ARRY.O)	E (03/29/2021)	\$9.25
Bloom Energy Corp. (BE.N)	E (01/12/2021)	\$20.30
First Solar Inc (FSLR.O)	U (11/04/2020)	\$78.70
Fluence Energy Inc (FLNC.O)	E (11/22/2021)	\$10.86
Hannon Armstrong (HASI.N)	E (02/03/2016)	\$42.87
Plug Power Inc. (PLUG.O)	O (10/13/2021)	\$23.40
Shoals Technologies Group (SHLS.O)	E (02/22/2021)	\$14.11
Solaredge Technologies Inc (SEDG.O)	E (11/30/2021)	\$284.60
Stem Inc (STEM.N)	E (03/23/2022)	\$8.25
SunPower Corp (SPWR.O)	E (01/13/2022)	\$19.06
Sunrun Inc (RUN.O)	O (03/10/2021)	\$24.34

Stock Ratings are subject to change. Please see latest research for each company.

* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Regulated Utilities

COMPANY (TICKER)	RATING (AS OF)	PRICE* (05/04/2022)
David Arcaro, CFA		
AVANGRID, Inc (AGR.N)	++	\$44.75
Consolidated Edison Inc (ED.N)	U (07/02/2020)	\$93.50
Eversource Energy (ES.N)	E (10/19/2021)	\$88.57
Stephen C Byrd		
Algonquin Power & Utilities Corp (AQN.N)	++	\$14.06
Ameren Corp (AEE.N)	E (04/14/2020)	\$93.86
Atmos Energy Corp. (ATO.N)	O (12/15/2020)	\$115.31
CenterPoint Energy Inc (CNP.N)	O (02/17/2022)	\$31.34
CMS Energy Corp (CMS.N)	E (07/31/2017)	\$68.84
Dominion Energy Inc (D.N)	E (08/31/2021)	\$82.51
DTE Energy Co. (DTE.N)	O (01/06/2022)	\$130.76
Duke Energy Corp (DUK.N)	E (08/25/2014)	\$110.51
Edison International (EIX.N)	E (01/12/2015)	\$70.36
Entergy Corp (ETR.N)	U (01/06/2022)	\$118.66
Exelon Corp (EXC.O)	O (08/27/2019)	\$47.92
FirstEnergy Corp (FE.N)	O (03/23/2020)	\$43.65
ONE Gas Inc (OGS.N)	E (01/06/2022)	\$85.82
PG&E Corp (PCG.N)	E (11/15/2018)	\$13.03
Pinnacle West Capital Corp (PNW.N)	E (03/23/2020)	\$74.22
PPL Corp (PPL.N)	E (07/16/2013)	\$28.89
Sempra Energy (SRE.N)	E (08/10/2018)	\$164.51
Southern Company (SO.N)	U (08/13/2014)	\$74.57
South Jersey Industries Inc (SJI.N)	E (05/28/2021)	\$34.44
Spire Inc (SR.N)	E (09/01/2020)	\$74.35
Xcel Energy Inc (XEL.O)	E (10/19/2021)	\$73.40

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INDUSTRY COVERAGE: Real Estate Investment Trusts

COMPANY (TICKER)	RATING (AS OF)	PRICE* (05/04/2022)
Richard Hill		
American Assets Trust Inc. (AAT.N)	E (05/18/2020)	\$36.01
American Homes 4 Rent (AMH.N)	E (11/15/2018)	\$38.30
AvalonBay Communities Inc. (AVB.N)	O (11/08/2021)	\$222.48
Equity Residential (EQR.N)	E (12/12/2016)	\$80.23
Essex Property Trust, Inc. (ESS.N)	E (04/01/2020)	\$323.37
Healthpeak Properties Inc (PEAK.N)	E (03/20/2017)	\$32.28
Invitation Homes Inc (INVH.N)	O (08/11/2020)	\$38.75
Kimco Realty Corp. (KIM.N)	E (03/30/2022)	\$25.31
Macerich Co (MAC.N)	U (09/14/2020)	\$14.01
Phillips Edison & Company, Inc (PECO.O)	E (03/09/2022)	\$34.90
Physicians Realty Trust (DOC.N)	E (09/13/2021)	\$17.54
Regency Centers Corp (REG.O)	E (12/17/2019)	\$72.96
Safehold Inc (SAFE.N)	O (02/09/2022)	\$46.31
Simon Property Group Inc (SPG.N)	O (02/11/2021)	\$124.58
Site Centers Corp (SITC.N)	E (04/27/2020)	\$16.20
Tricon Residential Inc (TCN.N)	E (11/01/2021)	\$13.93
UDR, Inc. (UDR.N)	E (11/08/2021)	\$52.06
Urban Edge Properties (UE.N)	U (12/17/2019)	\$19.31
Ventas Inc (VTR.N)	E (10/04/2021)	\$57.75
Welltower Inc. (WELL.N)	O (03/20/2017)	\$90.22
Ronald Kamdem, CFA		
Agree Realty Corp. (ADC.N)	O (04/01/2022)	\$69.04
Boston Properties, Inc. (BXP.N)	E (09/10/2019)	\$122.93
Broadstone Net Lease, Inc. (BNL.N)	E (04/15/2021)	\$20.60
Duke Realty Corp. (DRE.N)	E (10/07/2019)	\$53.01
EastGroup Properties Inc. (EGPN)	E (04/12/2017)	\$179.07
Extra Space Storage Inc. (EXR.N)	U (09/16/2019)	\$195.57
Highwoods Properties (HIW.N)	O (06/24/2020)	\$41.19
Hudson Pacific Properties (HPP.N)	U (04/15/2021)	\$23.37
National Retail Properties Inc (NNN.N)	O (04/15/2021)	\$45.11
National Storage Affiliates Trust (NSA.N)	E (08/07/2018)	\$57.18
Office Properties Income Trust (OPI.O)	U (12/13/2019)	\$21.73
Paramount Group Inc. (PGRE.N)	O (10/10/2019)	\$9.71
Prologis, Inc. (PLD.N)	O (02/12/2020)	\$152.28
Public Storage (PSA.N)	E (01/22/2021)	\$355.17
Realty Income Corp (O.N)	O (05/04/2020)	\$68.58
SL Green Realty Corporation (SLG.N)	E (05/28/2020)	\$71.09
Spirit Realty Capital (SRC.N)	E (05/04/2020)	\$43.53
STORE Capital Corp (STOR.N)	E (05/04/2020)	\$28.26
Vornado Realty Trust (VNO.N)	U (05/28/2020)	\$38.12

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INDUSTRY COVERAGE: Freight Transportation

COMPANY (TICKER)	RATING (AS OF)	PRICE* (05/04/2022)
Ravi Shanker		
ArcBest Corp (ARCB.O)	O (12/10/2020)	\$81.29
C.H. Robinson Worldwide Inc. (CHRW.O)	U (06/09/2013)	\$110.55
Canadian National Railway Co. (CNR.TO)	E (12/02/2021)	C\$151.86
Canadian Pacific Railway Ltd. (CPTO)	++	C\$93.48
CSX Corporation (CSX.O)	U (12/10/2020)	\$35.50
Expeditors International of Washington I (EXPD.O)	U (12/02/2021)	\$110.81
FedEx Corporation (FDX.N)	E (06/20/2013)	\$209.49
GXO Logistics, Inc (GXO.N)	E (08/12/2021)	\$61.70
Heartland Express Inc. (HTLD.O)	E (03/15/2022)	\$14.21
Hub Group Inc (HUBG.O)	E (02/13/2018)	\$78.36
J.B. Hunt Transport Services Inc. (JBHT.O)	E (05/06/2011)	\$178.43
Knight-Swift Transportation Holdings Inc (KNX.N)	O (12/13/2017)	\$50.65
Landstar System Inc (LSTR.O)	U (02/23/2016)	\$159.89
Norfolk Southern Corp. (NSC.N)	U (06/03/2016)	\$264.67
Old Dominion Freight Line Inc (ODFL.O)	E (11/09/2021)	\$291.02
Saia, Inc. (SAIA.O)	U (02/23/2016)	\$225.89
Schneider National Inc. (SNDR.N)	O (05/01/2017)	\$24.49
TFI International Inc (TFII.N)	O (06/10/2020)	\$86.26
TuSimple Holdings Inc (TSPO)	O (05/10/2021)	\$11.22
Union Pacific Corp. (UNP.N)	E (03/23/2020)	\$237.09
United Parcel Service (UPS.N)	U (02/23/2016)	\$183.80
US Xpress Enterprises Inc (USX.N)	E (12/02/2021)	\$3.68
Werner Enterprises (WERN.O)	O (02/23/2016)	\$42.46
XPO Logistics, Inc. (XPO.N)	E (02/19/2019)	\$57.20

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INDUSTRY COVERAGE: Autos & Shared Mobility

COMPANY (TICKER)	RATING (AS OF)	PRICE* (05/04/2022)
Adam Jonas, CFA		
Adient PLC (ADNT.N)	U (03/17/2021)	\$36.67
American Axle & Manufacturing Holdings Inc (AXL.N)	O (02/28/2022)	\$7.17
Aptiv Plc (APT.V.N)	O (03/30/2020)	\$110.42
Asbury Automotive Group Inc (ABG.N)	E (07/26/2021)	\$200.72
AutoNation Inc. (AN.N)	E (09/28/2021)	\$126.14
Avis Budget Group Inc (CAR.O)	U (10/13/2021)	\$291.21
BorgWarner Inc. (BWA.N)	U (11/09/2020)	\$38.98
Carmax Inc (KMX.N)	O (07/10/2018)	\$100.18
Carvana Co (CVNA.N)	E (05/04/2022)	\$59.65
Ferrari NV (RACE.N)	O (05/09/2019)	\$211.75

Fisker Inc (FSR.N)	O (08/09/2021)	\$10.54
Ford Motor Company (F.N)	U (01/29/2021)	\$14.98
FREYR Battery SA (FREY.N)	O (08/03/2021)	\$9.74
General Motors Company (GM.N)	E (02/08/2022)	\$41.17
Group 1 Automotive, Inc (GPI.N)	E (07/26/2021)	\$189.01
Harley-Davidson Inc (HOG.N)	E (02/01/2022)	\$41.06
Hertz Global Holdings Inc (HTZ.O)	E (12/06/2021)	\$20.72
Lear Corporation (LEA.N)	E (02/28/2022)	\$137.34
Li-Cycle Holdings Corp. (LICY.N)	E (02/10/2022)	\$7.19
Lithia Motors Inc. (LAD.N)	U (02/09/2021)	\$309.33
Lucid Group Inc (LCID.O)	U (09/13/2021)	\$20.26
Magna International Inc. (MGA.N)	O (10/14/2021)	\$62.82
Microvast Holdings Inc. (MVST.O)	U (08/03/2021)	\$5.31
Penske Automotive Group, Inc (PAG.N)	U (11/17/2021)	\$114.53
Polaris Inc. (PII.N)	O (01/19/2021)	\$111.24
Quantumscape Corp (QS.N)	E (11/15/2021)	\$16.50
REE Automotive Ltd (REE.O)	U (09/13/2021)	\$1.92
Rivian Automotive, Inc. (RIVN.O)	O (12/05/2021)	\$33.92
Sonic Automotive Inc (SAH.N)	U (11/17/2021)	\$49.05
Tenneco Inc. (TEN.N)	E (02/23/2022)	\$16.40
Tesla Inc (TSLA.O)	O (11/18/2020)	\$952.62
Visteon Corporation (VC.O)	U (03/22/2018)	\$110.88

Victoria A Greer

Goodyear Tire & Rubber Company (GT.O)	E (04/16/2021)	\$14.31
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INDUSTRY COVERAGE: Diversified Utilities / IPPs

COMPANY (TICKER)	RATING (AS OF)	PRICE* (05/04/2022)
David Arcaro, CFA		
Public Service Enterprise Group Inc (PEG.N)	O (07/02/2020)	\$69.27
Stephen C Byrd		
AES Corp. (AES.N)	O (03/23/2020)	\$21.92
American Electric Power Co (AEP.O)	O (03/10/2020)	\$100.72
Constellation Energy Corporation (CEG.O)	O (03/16/2022)	\$61.81
MGE Energy, Inc. (MGEE.O)	U (11/17/2021)	\$80.22
NextEra Energy Inc (NEE.N)	E (04/14/2020)	\$73.06
NRG Energy Inc (NRG.N)	O (09/06/2019)	\$38.25
Vistra Corp (VST.N)	O (03/25/2019)	\$25.92

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