Cleaner Trucking Outlook

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Trucks Are Cleaner Today Than Ever Before; But They Can Still Improve

1990s Vintage Truck

2010+ Vintage Truck

Cleaner Engine Options Available Today

Ultra Low NOx Natural Gas; 90% cleaner than current diesel

Cleaner Fuel Options Available Today

1. Renewable Natural Gas: 90% NOx reduction in ULN engine
2. Renewable Diesel Fuel: 30% PM reduction,10% NOx reduction
3. Biodiesel: 50% PM reduction, 10% NOx increase

Source: CARB, U.S. DOE

Renewable diesel—Also called "green" diesel, renewable diesel is a biomass-derived transportation fuel suitable for use in diesel engines. It meets the ASTM D975 specification in the United States and EN 590 in Europe.

Renewable diesel is distinct from biodiesel. While renewable diesel is chemically similar to petroleum diesel, biodiesel is a mono-alkyl ester, which has different physical properties and hence different fuel specifications (ASTM D6751 and EN 14214). The two fuels are also produced through very different processes. While biodiesel is produced via transesterification, renewable diesel is produced through various processes such as hydrotreating (isomerization), gasification, pyrolysis, and other thermochemical and biochemical means. Moreover, biodiesel is produced exclusively from lipids (such as vegetable oils, animal fats, grease, and algae), whereas renewable diesel is produced from lipids and cellulosic biomass (such as crop residues, woody biomass, and dedicated energy crops).

Source: U.S. Department of Energy

In 2019, Electric Is Coming; But Not Widely Available…Yet

Yard Trucks; Demo Stage

Pick Up and Delivery;
Demo Stage

Class 8 Over the Road;
Prototype Stage

ZE Commercial Vehicle introduction timing and pace of deployment will happen in phases or waves

Wave 1
Transit

Wave 2
Delivery

Wave 3
Medium Freight

Wave 4
Heavy Regional Freight

Corridor Longhaul

Freightliner e-Cascadia
Demo Now; Announced 2021

Chanje Class 5 Delivery Van
Available now

E-Fuso Vision One
Announced 2021

Volvo VNR
Demo now; 2019 Europe; 2021 NA?

ZE transit buses
Available now

Fuso ECanter
Available now

Nikola FC tractor
Coming 2022?

Freightliner eM2
Demo now
Announced 2021

Mack e-Refuse
Demo 2020; Coming 2022?

ZE industrial lifts
Available now

Orange EV yard tractor
Available now

Tesla demo
Coming 2021?

Similar drivetrain and component sizing can scale to early near applications

Expanded supply chain capabilities and price reductions enable additional applications

Steadily increasing volumes and infrastructure strengthen business case and performance confidence

2019   **2020**   **2021**   **2022**   **2023**

All New Technology Needs Infrastructure

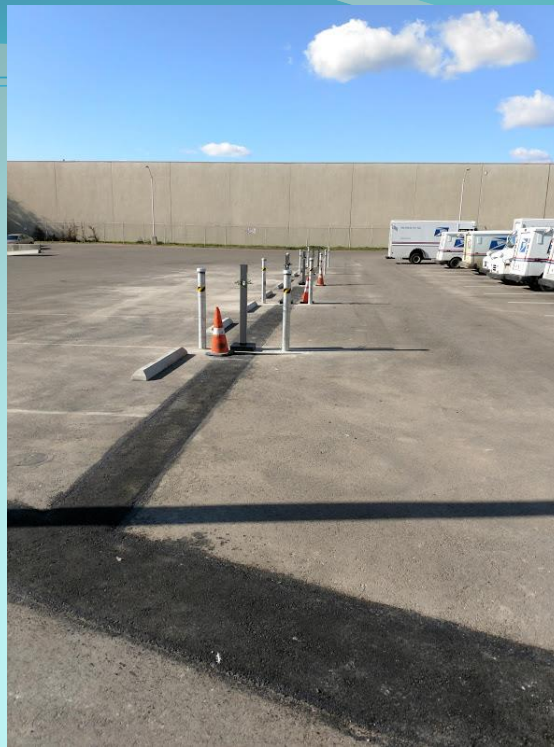**20 + Natural Gas stations in the Valley, but more are needed**

EV charging for cars expanding, but public use truck charging is needed

Example of Challenges

Fresno Main Post Office deploying 10 all-electric parcel delivery vans. Project funded by CARB in partnership with San Joaquin Valley Air Pollution Control District.
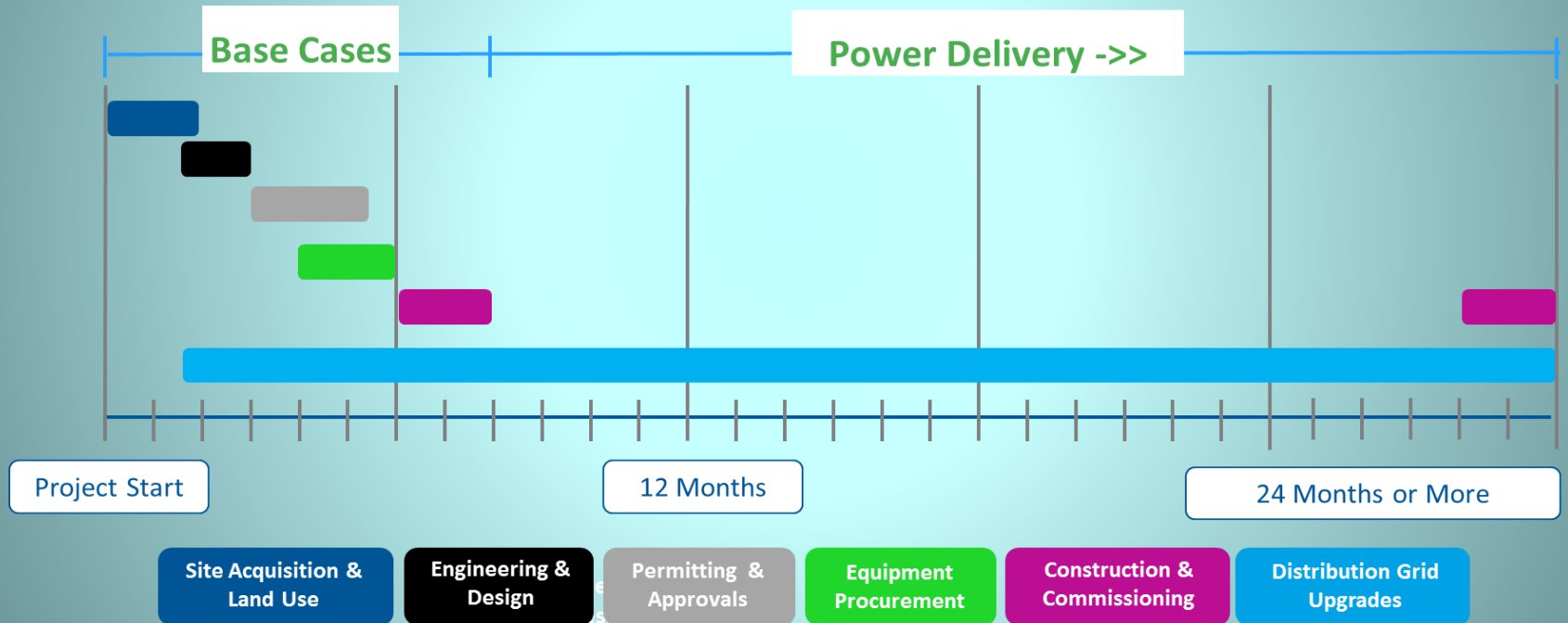
Electric Requires Planning

- Large scale electric will require move to planning holistic integrated community scale deployments of renewable energy, advanced energy storage, and supporting infrastructure.

- These developments should incorporate renovation and efficiency upgrades of existing buildings with new construction while blending onsite energy production with energy-efficient equipment and energy storage.

- Time line for deployment will require up to 4+ years for large scale projects.
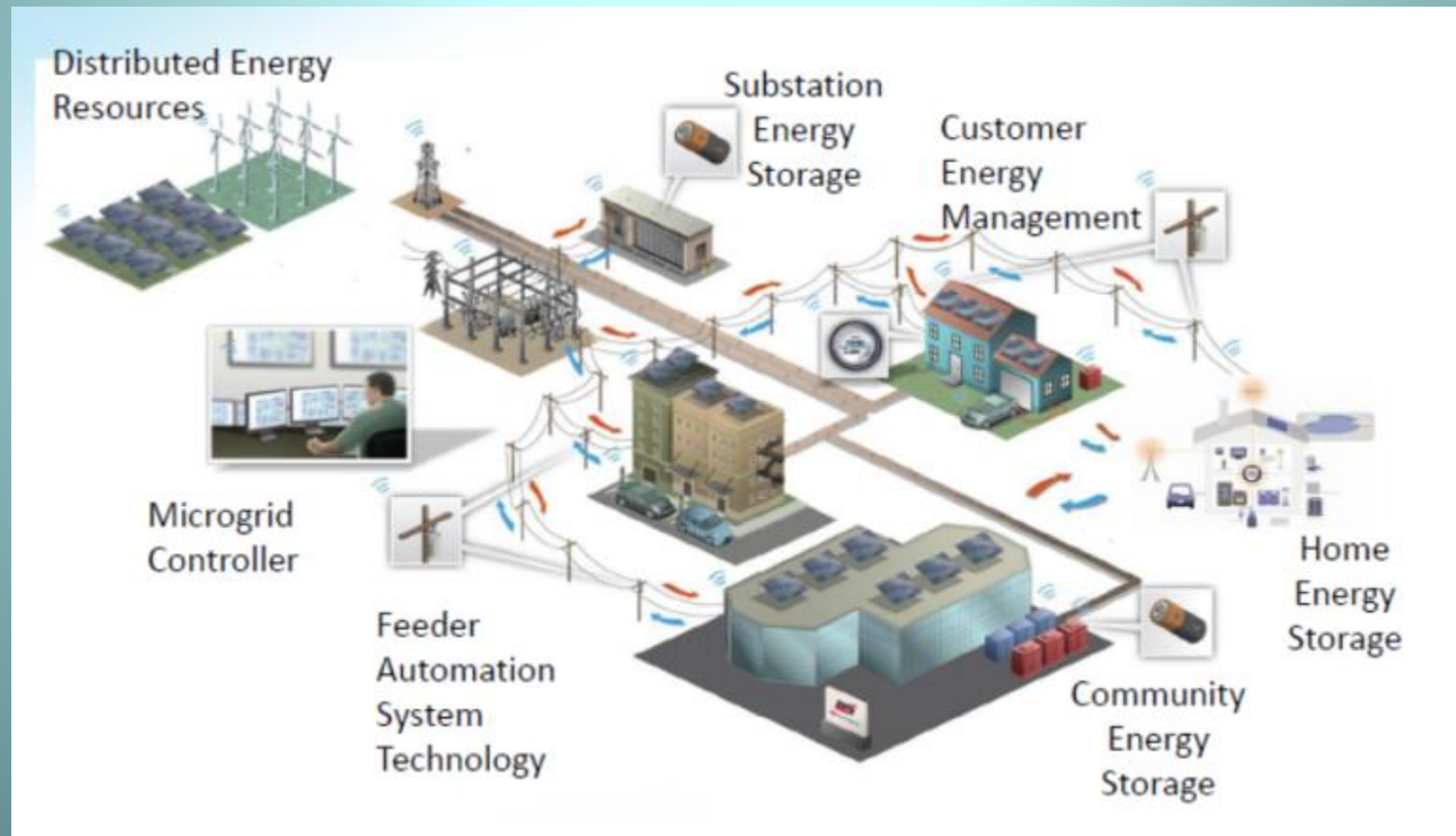
Electric Requires Planning

Distribution Grid Upgrade Schedule Impacts

Base Cases   Power Delivery ->>

Project Start   12 Months   24 Months or More

| Site Acquisition & Land Use | Engineering & Design | Permitting & Approvals | Equipment Procurement | Construction & Commissioning | Distribution Grid Upgrades |

Source: Black and Veatch

What Will These Communities Look Like? It Could Be Something Like This…

Questions?

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