South Coast
Air Quality Management District
21865 Copley Drive, Diamond Bar, CA 91765
(909) 396-2000, www.aqmd.gov

NOTICE OF SPECIAL MEETING OF THE GOVERNING BOARD
Governing Board Retreat

Day One: May 12, 2022
1:00 p.m. to 5:00 p.m.
Day Two: May 13, 2022
9:00 a.m. to 12 p.m.
The Mission Inn Hotel and Spa
The Grand Parisian Ballroom
3649 Mission Inn Avenue, Riverside, CA 92501

Meeting will be a hybrid format
Members of the public may participate either in person or via Zoom or telephone.

Pursuant to Assembly Bill 361, this Special Meeting of the South Coast AQMD's Governing Board will be held at 1:00 p.m. on Thursday, May 12, 2022 and at 9:00 a.m. on Friday, May 13, 2022 through a hybrid format of in-person attendance in the Mission Inn Hotel in the Grand Parisian Ballroom at 3649 Mission Inn Ave., Riverside, California and/or virtual attendance via videoconferencing and by telephone. Please follow the instructions below to join the meeting remotely.

Given health and safety concerns, the meeting format may be changed to full remote via webcast. Please refer to South Coast AQMD's website for information regarding the format of the meeting, updates if the meeting is changed to a full remote via webcast format, and details on how to participate:
http://www.aqmd.gov/home/news-events/meeting-agendas-minutes

Face coverings: State and local public health officials strongly recommend, but do not require the wearing of face coverings while in an indoor public setting.

ELECTRONIC PARTICIPATION INFORMATION
(Instructions provided at bottom of the agenda)
Join Zoom Webinar Meeting - from PC or Laptop
https://scaqmd.zoom.us/j/93128605044
Zoom Webinar ID: 931 2860 5044 (applies to all)
Teleconference Dial In +1 669 900 6833
One tap mobile +16699006833,9414149-2308#
Audience will be allowed to provide public comment in person, through Zoom or telephone.
PUBLIC COMMENT WILL STILL BE TAKEN

AGENDA

It is expected that item 1 will be completed on Day One. However, items may be taken in any order and items may be heard on either day.

DAY ONE (Begins at 1:00 p.m.)	
Welcome (30 minutes)	Chair Ben J. Benoit Vice Chair Vanessa Delgado South Coast AQMD
1a. Overview of Draft 2022 AQMP Control Strategy (1 ½ hours) *Dr. Rees will provide an overview of the Draft 2022 AQMP mobile and stationary source control measures highlighting the technology needs to achieve attainment of the 2015 National Ambient Air Quality Standard for ozone.*	Dr. Sarah Rees Deputy Executive Officer Planning, Rule Development and Implementation
1b. Transforming Mobile and Stationary Sources to Zero Emissions – The Future of Energy (2 hours) *Dr. Brouwer will discuss the types of energy and infrastructure needs that will be needed to deploy mobile and stationary zero emission technologies to support the Draft 2022 AQMP control strategy.*	Dr. Jack Brouwer Professor of Mechanical and Aerospace Engineering and Director of the National Fuel Cell Research Center and Advanced Power and Energy Program at the University of California, Irvine
DAY TWO (Begins at 9:00 a.m.)	
2a. NOx and VOC Ozone Attainment Strategy Background on South Coast AQMD's NOx and VOC Ozone Attainment Strategy (30 minutes) *Dr. Rees will provide background information regarding the 2022 AQMP ozone attainment strategy.*	Dr. Sarah Rees Deputy Executive Officer Planning, Rule Development and Implementation
2b. The Chemistry of Ozone Formation and the Role of NOx and VOC emissions (1 hour) *Dr. Cohen will provide a detailed discussion of the effects of NOx and VOC emission reductions on the formation of ozone for the South Coast Air Basin and the most effective control strategy to achieve attainment of the 2015 National Ambient Air Quality Standard for ozone.*	Dr. Ronald C. Cohen Professor of Chemistry and of Earth and Planetary Sciences University of California, Berkeley
3. Incentives and Rebates for Zero-Emission Technologies for Residential Sources (1 hour) *Dr. Katzenstein will provide an overview of incentives to kick start zero-emission water heaters, space heaters, pool heaters, and stove tops.*	Dr. Aaron Katzenstein Deputy Executive Officer Technology Advancement Office
4. Update on the South Coast AQMD's Diversity, Equity, and Inclusion Programs (30 minutes)	Dr. Anissa (Cessa) Heard-Johnson Deputy Executive Officer Diversity, Equity, and Inclusion Office

No General Public Comment Period at a Special Meeting Members of the public may address this body concerning any agenda item before or during consideration of that item. (Gov't. Code Section 54954.3(a)). If you wish to speak, raise your hand on Zoom or press Star 9 if participating by telephone or if in-person please provide a Request to Address the Board card to the Clerk of the Board if you wish to address the Board on an agenda item. Speakers will be limited to three (3) minutes or less on each agenda item. At a special meeting, no other business may be considered, there is public comment only for items on the agenda, and there is no general public comment period. (Government Code Section 54956(a)). The agenda for this meeting is posted at South Coast AQMD Headquarters, 21865 Copley Drive, Diamond Bar, California and at the Mission Inn Hotel 3649 Mission Inn Ave., Riverside, California at least 24 hours in advance of the meeting.
ADJOURNMENT
Americans with Disabilities Act and Language Accessibility Disability and language-related accommodations can be requested to allow participation in this Special Governing Board meeting. The agenda will be made available, upon request, in appropriate alternative formats to assist persons with a disability (Gov't Code Section 54954.2(a)). In addition, other documents may be requested in alternative formats and languages. Any disability or language related accommodation must be requested as soon as practicable. Requests will be accommodated unless providing the accommodation would result in a fundamental alteration or undue burden to the South Coast AQMD. Please contact Clerk of the Boards at 909-396-2500 from 7:00 a.m. to 5:30 p.m. Tuesday through Friday or send the request to cob@aqmd.gov.

INSTRUCTIONS FOR ELECTRONIC PARTICIPATION

Instructions for Participating in a Virtual Meeting as an Attendee
As an attendee, you will have the opportunity to virtually raise your hand and provide public comment.

Before joining the call, please silence your other communication devices such as your cell or desk phone. This will prevent any feedback or interruptions during the meeting.

Please note: During the meeting, all participants will be placed on Mute by the host. You will not be able to mute or unmute your lines manually.

After each agenda item, the Chairman will announce public comment.

A countdown timer will be displayed on the screen for each public comment.

If interpretation is needed, more time will be allotted.

Once you raise your hand to provide public comment, your name will be added to the speaker list. Your name will be called when it is your turn to comment. The host will then unmute your line.

Directions for Video ZOOM on a DESKTOP/LAPTOP:

- If you would like to make a public comment, please click on the **"Raise Hand"** button on the bottom of the screen.
  This will signal to the host that you would like to provide a public comment and you will be added to the list.

Directions for Video Zoom on a SMARTPHONE:

- If you would like to make a public comment, please click on the **"Raise Hand"** button on the bottom of your screen.
- This will signal to the host that you would like to provide a public comment and you will be added to the list.

Directions for TELEPHONE line only:

- If you would like to make public comment, please **dial *9 to raise your hand** to signal that you would like to comment and **dial *6 to toggle mute and unmute**.

South Coast AQMD

OVERVIEW OF THE 2022 DRAFT AIR QUALITY MANAGEMENT PLAN CONTROL STRATEGY

May 12, 2022

Governing Board Retreat

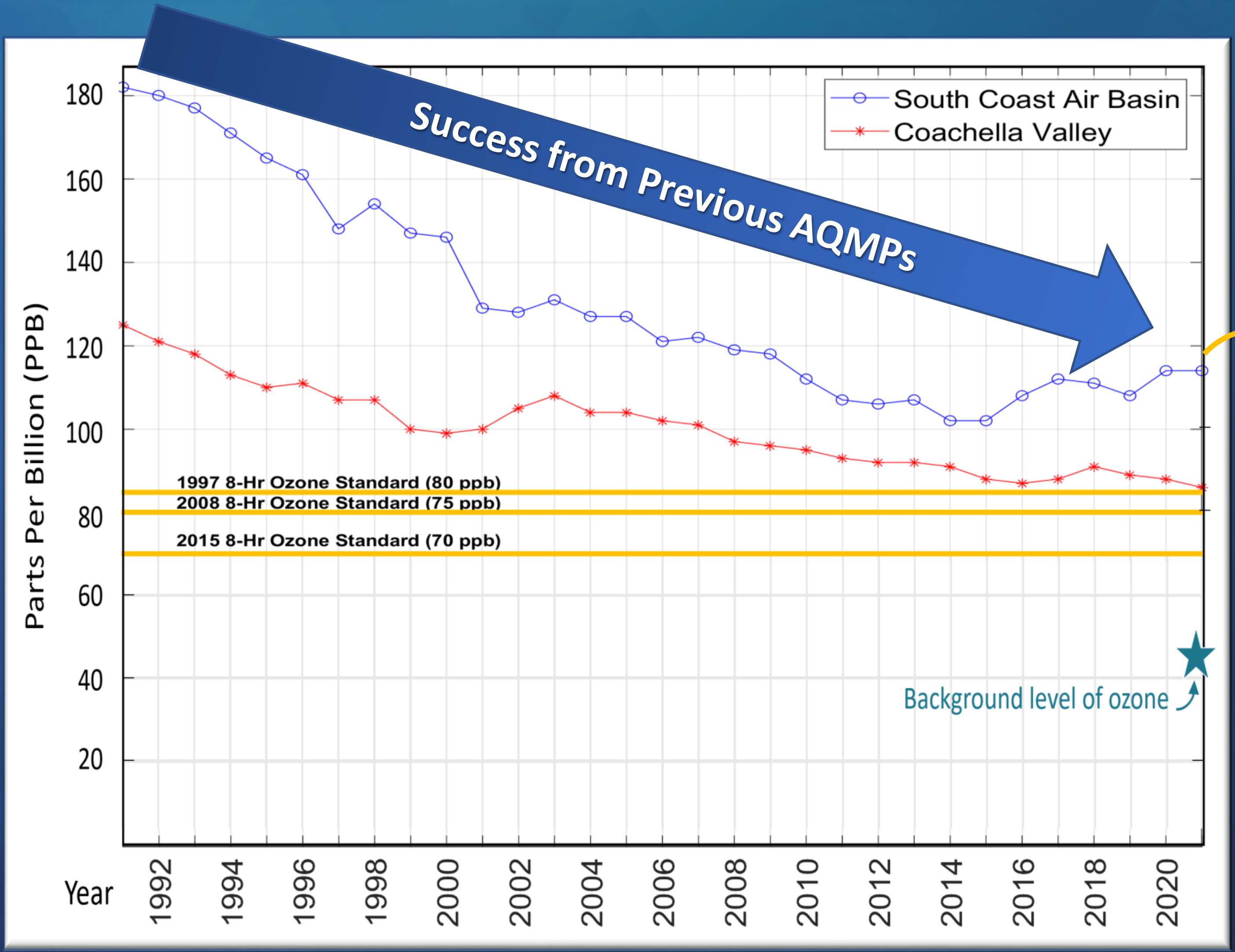
OVERVIEW

- Background on 2022 Draft AQMP
  - Proposed South Coast AQMD Control Measures
    - Stationary/Area Sources and Mobile Sources
  - Proposed CARB State SIP Strategy
  - Additional Considerations
  - Next Steps

Background – Air Quality Management Plans

- ▷2022 Air Quality Management Plan (AQMP) focuses on attaining U.S. EPA's 2015 8-hour ozone standard with attainment year in 2037
- ▷When U.S. EPA revises a National Ambient Air Quality Standard
  - ▷South Coast AQMD is required to prepare an AQMP if the region does not meet the standard
  - ▷Each plan is prepared for a specific standard and does not address all standards at once
- ▷In 2015, U.S. EPA strengthened the ozone NAAQS from 75 to 70 parts per billion (ppb)
  - ▷EPA does not consider costs when setting a health-based standard

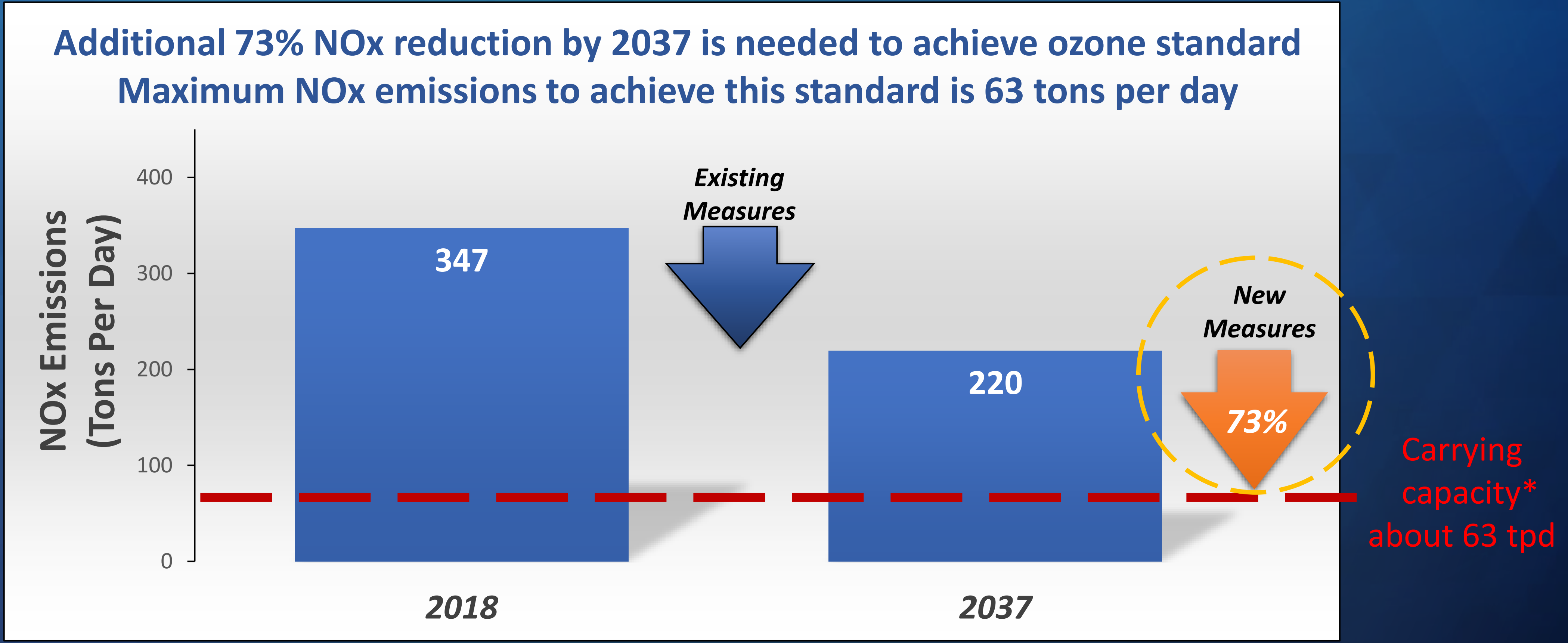
Ozone Trends in the South Coast Air Basin*



Trend in recent years discussed in presentations tomorrow

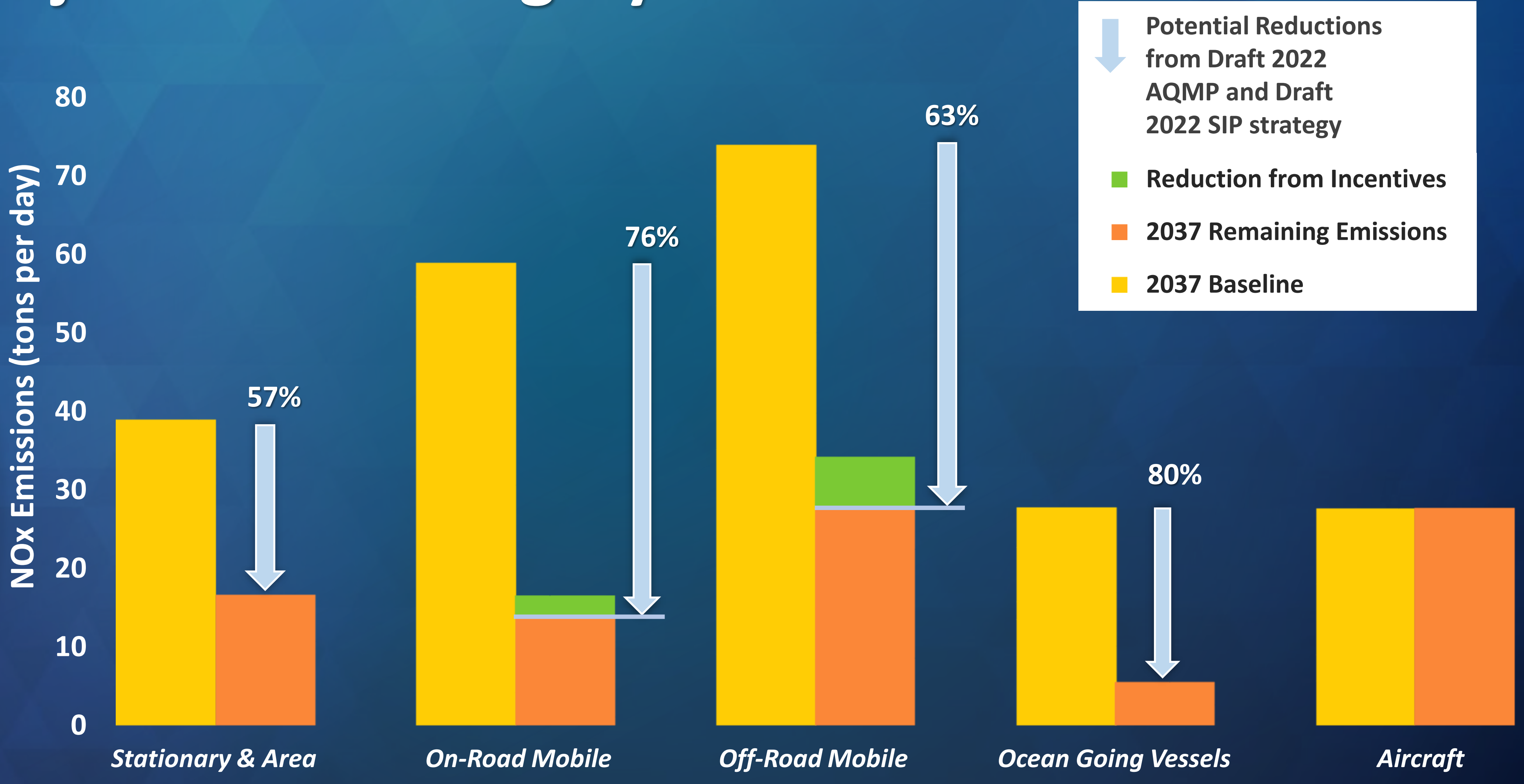
** Design values shown, Preliminary data for 2021*

Maximum NOx Emissions to Achieve Standard



*Carrying Capacity is maximum allowable NOx emissions to attain a standard

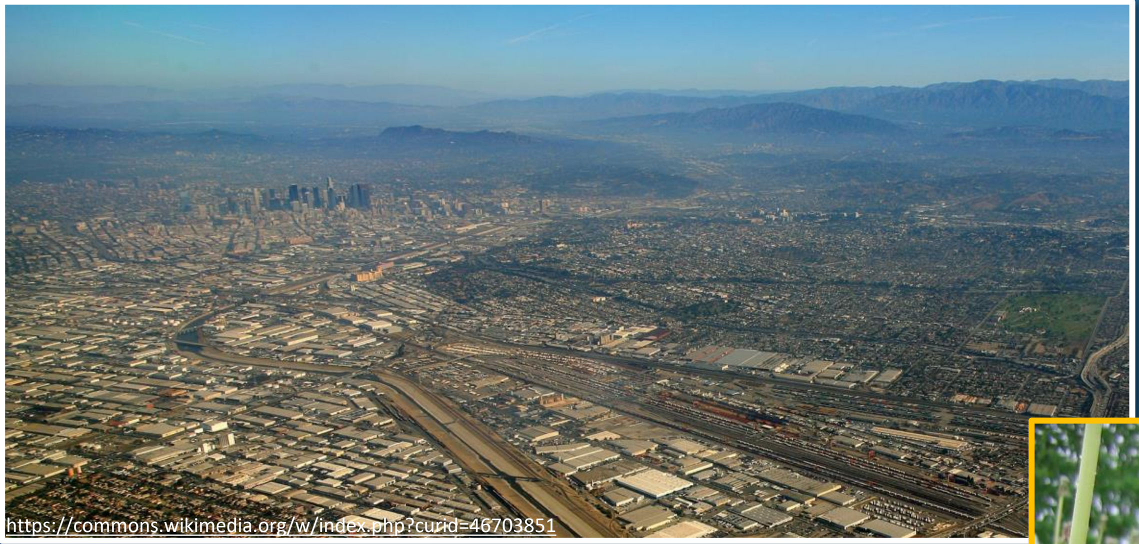
Summary of Draft Approach to Reducing NOx by Major Source Category



Reducing emissions from federal sources is critical

**Some incentives also anticipated for area sources, but not yet defined*

Deeper Dive Into Control Measures



Previous presentations to Board at '50,000-foot' level of detail

- ▷ Overall Need
- ▷ Transition to Zero Emissions

Discussion today dives deeper 'into the weeds'

- ▷ Specific Control Measures
- ▷ Roles for Different Agencies

Agency Roles for Control Measures

- South Coast AQMD focus on stationary and area sources
  - Limited mobile source measures
- CARB focus on mobile sources
  - Limited stationary/area source measures
- EPA cannot be assigned control measures

2022 AQMP Proposed Stationary and Area Sources Control Measures

Overview of Draft South Coast AQMD Stationary and Area Source Control Strategy

- NOx Control Measures
- Co-Benefits from Greenhouse Gas Reductions
- Limited Strategic VOC Measures
- Other Measures

Draft Stationary and Area Sources NOx Control Measures

Residential Combustion

- R-CMB-01: Residential Water Heating
- R-CMB-02: Residential Space Heating
- R-CMB-03: Residential Cooking
- R-CMB-04: Residential Other Combustion Sources

Commercial Combustion

- C-CMB-01: Commercial Water Heating
- C-CMB-02: Commercial Space Heating
- C-CMB-03: Commercial Cooking
- C-CMB-04: Small Internal Combustion Engines (Non-permitted)
- C-CMB-05: Small Commercial Miscellaneous Combustion Equipment (Non-permitted)

Residential and Commercial Building Measures

Large Combustion (e.g., Industrial)

- L-CMB-01: NOx RECLAIM (formerly CMB-05)
- L-CMB-02: Large Boilers and Process Heaters
- L-CMB-03: Large Internal Combustion Engines (Prime Engines)
- L-CMB-04: Large Internal Combustion Engines (Emergency Standby Engines)
- L-CMB-05: Large Turbines
- L-CMB-06: Electric Generating Facilities
- L-CMB-07: Petroleum Refineries
- L-CMB-08: Landfills and POTWs
- L-CMB-09: Incinerators
- L-CMB-10: Miscellaneous Combustion

State and Local Policies for Residential and Commercial Buildings

California Energy Commission (CEC) Title 24 (2022 Code)

- Electric ready measures from 2023 onward for single family, multi-family, and commercial new buildings

California Air Resource Board (CARB) Draft 2022 SIP Strategy

- Proposed Zero-Emission Standard for Space and Water Heaters at the point of sale in 2030

Bay Area AQMD

- Rulemaking for zero NOx emissions standard for space and water heating units with a proposed compliance date of 2027 to 2031

City of Berkeley

- All electric new buildings of all types, effective January 1, 2020
- A plan adopted to electrify existing buildings with a phased approach in 2021 -2045

Over 50 cities/counties in California

- Adopted building codes supporting all-electric new constructions (mostly Northern CA)

South Coast AQMD Approach for Residential and Commercial Building Measures

1. Coordinating with local and state agencies to build upon existing programs
2. Phasing in requirements for zero emission water/space heating and cooking through a regulatory approach
3. Allowing near-zero and other lower NOx technologies as a transitional alternative if installing a zero emission unit is determined to be infeasible
4. Utilizing incentives to accelerate the adoption of zero emission units and address inequities

Residential Building Control Measures

R-CMB-01: Water Heating

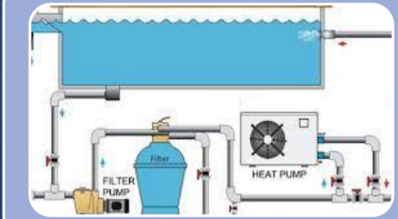
- Includes residential NG-fired water heaters subject to Rule 1121

R-CMB-02: Space Heating

- Includes NG-fired central furnaces subject to Rule 1111

R-CMB-03: Cooking Devices

- Includes stoves, ovens, griddles, broilers, and others



R-CMB-04: Other Combustion Sources

- Primarily comprised of swimming pool heaters and laundry dryers

Commercial Building Control Measures

C-CMB-01: Water Heating

- Large water heaters and small boilers and process heaters subject to Rule 1146.2

C-CMB-02: Space Heating

- Space heating sources (i.e., forced air furnaces) with a rated heat input capacity between 175,000 and 2,000,000 BTU per hour

C-CMB-03: Cooking Devices

- Includes commercial fryers, ovens, stoves, griddles, and broilers subject to Rule 1153.1
- Others commercial cooking devices not currently regulated by South Coast AQMD or any other agency

Large Combustion Control Measures

L-CMB-01 and -10: Miscellaneous Equipment

- Emission reductions completing implementation of 2016 AQMP measure CMB-05

L-CMB-02 through -05: Equipment Specific Measures

- Industrial boilers, engines, and turbines

L-CMB-06 through -09: Industry Specific Measures

- Applies to power plants, refineries and waste handling facilities
- Assessment to evaluate zero-emission technology

Proposed Method of Control

Approach and Implementation

- **Regulatory Approach:**
  - ➢ Require zero NOx emissions; allow lower NOx technology when not be feasible
  - ➢ Amend or develop rules reflecting updated BARCT
- **Incentive Approach:**
  - ➢ Focus on disadvantaged communities
  - ➢ Encourage early deployment of zero emission equipment
- **Implementation:**
  - ➢ 2029 (or earlier) for new construction; later for existing buildings and equipment (would address stranded assets from recently revised BARCT rules)
- **2037 Attainment Year**
  - ➢ About 40-70 percent reduction (zero emission for 10-50 percent of the applicable sources; lower NOx for the rest)
- **Cost for implementing zero emission units:**
  - ➢ No additional lifetime cost for new buildings
  - ➢ Additional cost if needing to upgrade infrastructure (~$2,000-$5,000 for older buildings) but could be done at time of replacement

Draft Stationary Source Measures Reductions

Control Measure	2037		
	NOx Baseline (tpd)	NOx Reduction (tpd)	Remaining NOx (tpd)
Residential Combustion	9.8	6.4	3.4
Commercial Combustion	11.5	7.4	4.1
Large Combustion (e.g., Industrial)	17.9	6.9	11.0
Further Deployment of Cleaner Technologies	N/A	3	N/A
Total South Coast AQMD Stationary and Area Source Measures	**39.3**	**23.8**	**15.5**

Draft Stationary Source GHG, VOC and Other Measures

Co-Benefit from GHG Reductions

- ECC-01 Co-Benefits from Existing and Future GHG Programs, Policies, and Incentives
- ECC-02 Co-Benefits from Existing and Future Residential and Commercial Building Energy Efficiency Measures
- ECC-03 Additional Enhancements in Reducing Existing Residential Building Energy Use

Strategic VOC Measures

- FUG-01 Improved Leak Detection and Repair
- FUG-02 Emission Reductions from Cooling Towers
- CTS-01 Further Emission Reductions from Coatings, Solvents, Adhesives, and Sealants
- FLX-02 Stationary Source VOC Incentives
- BIO-01 Assessing Emissions from Urban Vegetation

Other Measures

- MCS-01 Application of All Feasible Measures
- MCS-02 Wildfire Prevention
- FLX-01 Improved Education and Public Outreach

VOC Controls

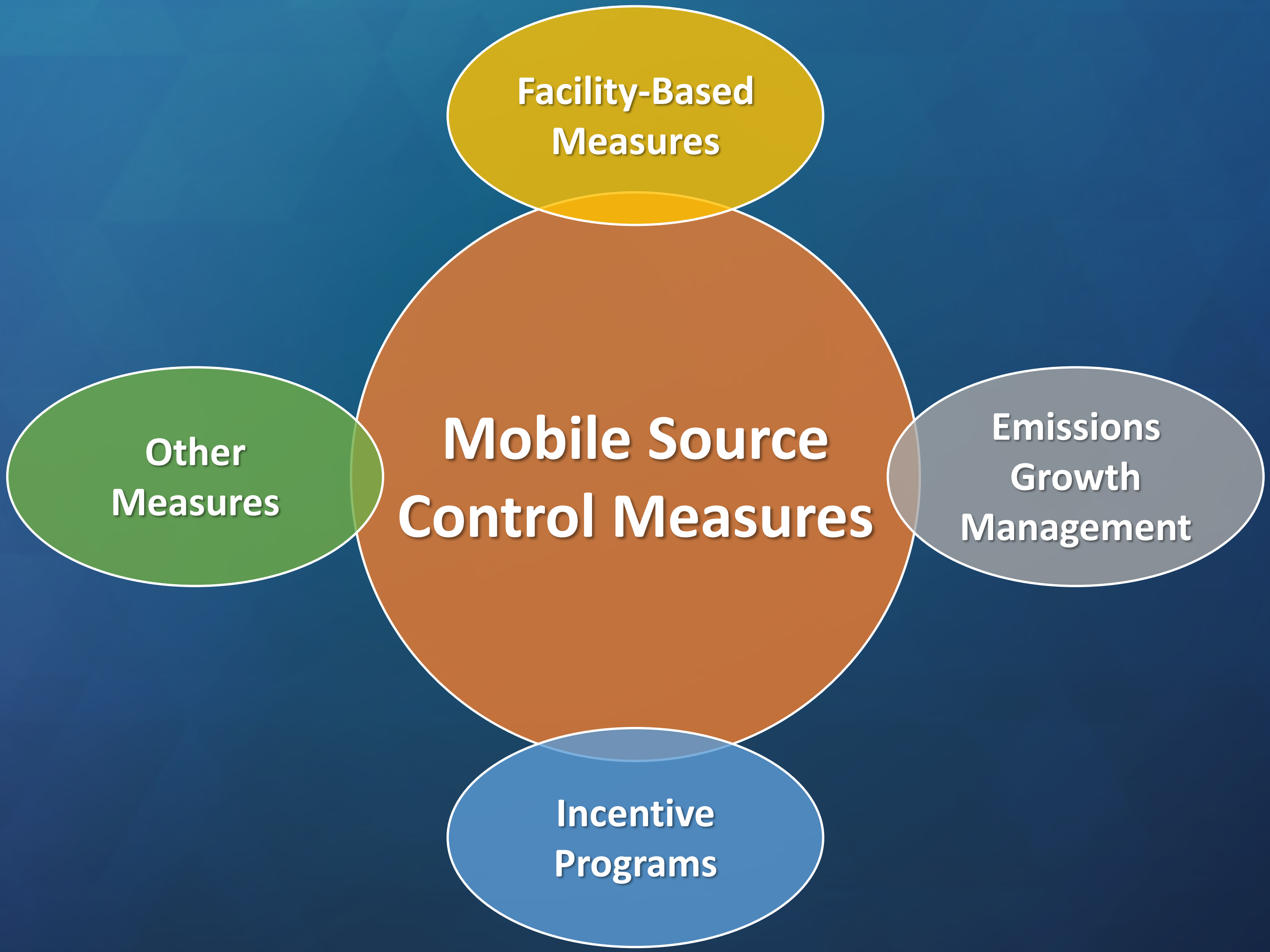
- While NOx is primary pollutant of concern for attainment, some VOC reductions can still improve air quality
  - Early reductions in VOCs can reduce ozone
  - VOC reductions contribute to reduction in fine PM
  - Many VOCs are also toxics

VOC Control Strategy

- ▷CTS-01 Emission Reductions from Coatings, Adhesives, and Sealants
  - ▷Multiple rules will be assessed category by category to determine appropriate VOC limits
  - ▷Some VOC limits expected to be increased while others will need to be reduced
  - ▷Technology assessment will include review of available low-toxicity, zero and near-zero VOC materials
  - ▷Addresses toxic compounds PCBTF and TBAc
- ▷BIO-01 Emissions from Urban Vegetation
  - ▷Biogenic VOCs are becoming dominant part of VOC inventory
  - ▷Measure includes studying biogenic VOCs and promoting low-VOC vegetation

2022 AQMP Proposed Mobile Source Control Measures

Overview of Draft South Coast AQMD Mobile Source Control Strategy



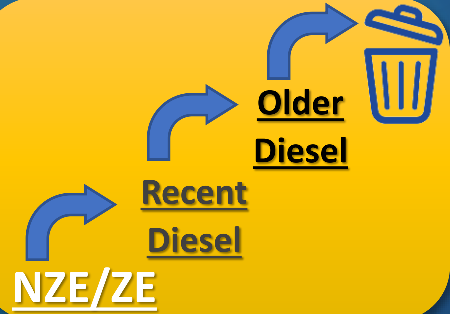
Facility-Based Measures

- ▷Indirect Source Rules
  - ▷**Ports** – New ISR in development
  - ▷**Railyards** – New ISR in development for new railyards, followed immediately by existing railyards
  - ▷**Warehouses** – Enforcement and quantification of existing rule, and periodic re-evaluation to determine if amendments are necessary
- ▷Voluntary Agreements (MOUs)
  - ▷**Airports** – Extension/expansion of existing MOUs with major airports
- ▷Unique consideration for facility-based measures
  - ▷Quantified SIP credit likely not possible at time of AQMP and rule adoption. Credit obtainable as measure is implemented.
  - ▷Potential scope of measures are limited as many sources that visit these facilities are primarily regulated federally or internationally

Emissions Growth Management

- **New and re-development projects**
  - Potential for regulatory (e.g., ISR) or non-regulatory approach
- **General Conformity (federal projects)**
  - Proposing to move away from current ‘set-aside’ / first come-first served approach through future rulemaking
  - Example approach: High Speed Rail (Burbank-LA)
    - Project mitigates own emissions first, then contributes to mitigation fund to address remaining emissions in community
- **Clean Construction Policy**
  - Develop uniform model program that local agencies can use to require cleanest construction equipment available
  - Could include uniform air quality mitigation fund for CEQA projects if all feasible mitigation already implemented

Incentive Programs



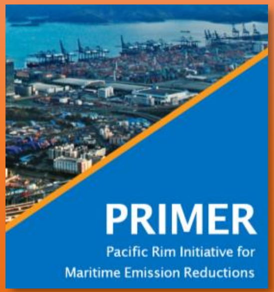
Replace Your Ride

Small Off-Road Equipment Exchange

Truck Trade Up

Passenger Locomotives

***Focus*:**
Take credit for, and seek to expand, existing successful programs



Reg. XVI

Existing Incentive Programs

Pacific Rim Initiative for Maritime Emission Reductions

Mobile Source Emission Reduction Credits

Other Measures

- ▷**Fugitive VOC Reductions from Tanker Vessels**
  - ▷High VOC emission rates (multiple tons/hour) can occur during tank venting episodes
    - ▷Venting needed to avoid overpressurization of tanks
  - ▷Regulatory and non-regulatory approaches being considered
    - ▷Authority is limited, however air quality impact can be high (air quality and odors)

- ▷**Rule 2202 – Employee Commute Reduction Update**
  - ▷Update rideshare programs for large employers
    - ▷Take advantage of increased telework option for many businesses

Other Measures - continued

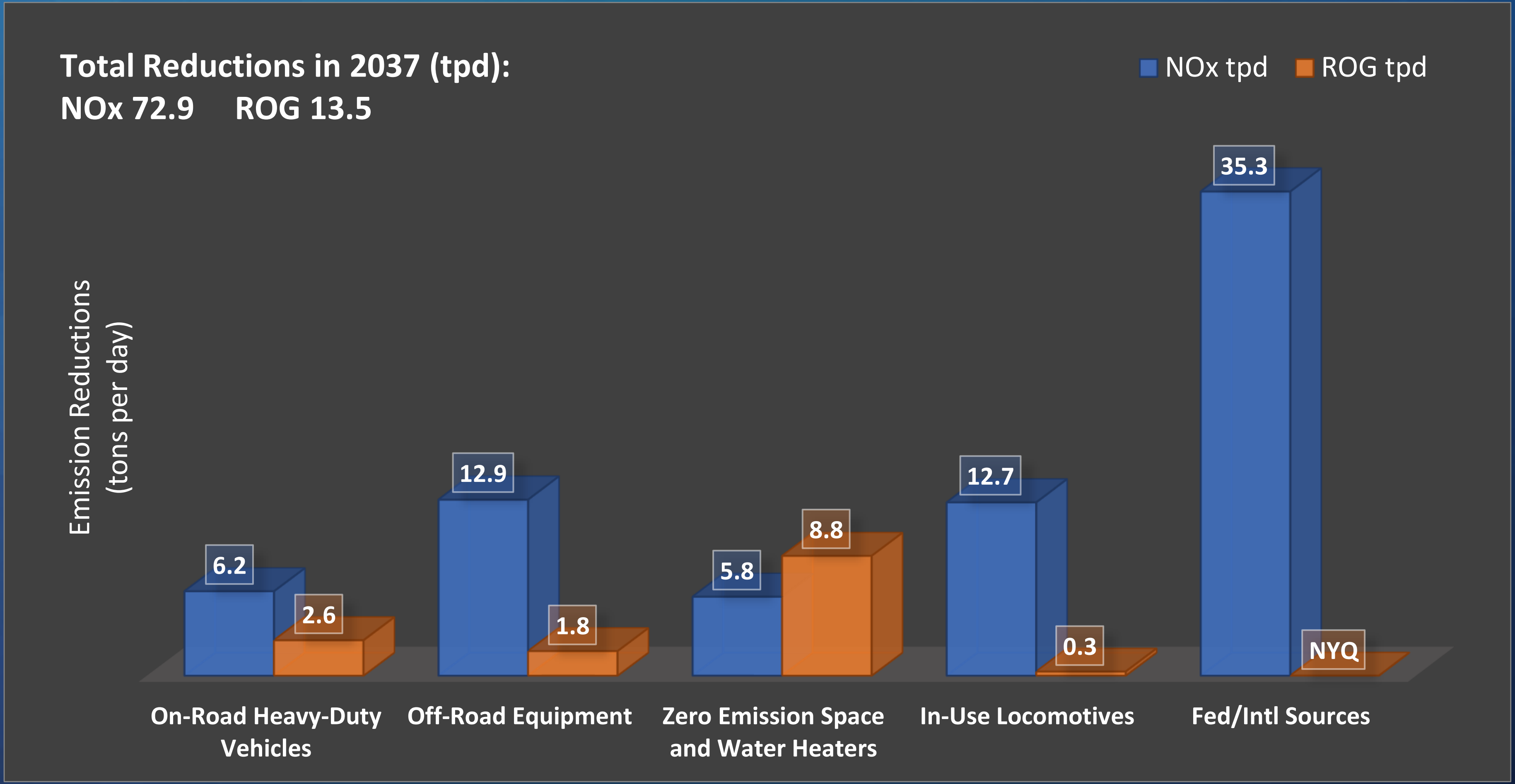
- **Zero Emissions Infrastructure for Mobile Sources**
  - Many AQMP and SIP measures rely on widespread availability of ZE fueling/charging infrastructure
  - Significant policy development needed to support transition
    - Many agencies are actively developing policies
    - South Coast AQMD should not lead the effort, but must actively participate

ZE Fueling/Charging Infrastructure Workplan

Strategies for Zero Emissions Fueling / Charging Infrastructure
• *Assess Zero Emission Infrastructure Needs for the South Coast AQMD*
• *Assist in Developing Cost Projections*
• *Assist in Assessing Funding Needs*
• *Identify Targeted Policies & Strategies to Support ZE Vehicle Adoption*
• *Collaborate with Local Utilities*
• *Identify Policy Needs Across Different Sectors*
• *Pursue Equitable and Affordable Solutions*
• *Align Efforts with Other Local, State, and Federal initiatives*

Summary of CARB's Draft SIP Measures

2022 State SIP Strategy Measures – South Coast Reductions



On-Road Vehicles

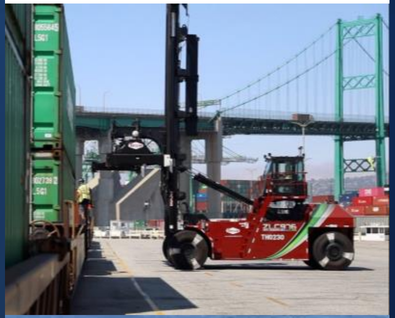
Measure	Description	NOx (tpd)	ROG (tpd)	CARB Board Hearing
Advanced Clean Fleets Regulation	Zero-emission requirements for truck and bus fleets operated in CA, starting in 2024	5.3	0.5	2023
Zero-Emissions Trucks Measure	Transition all remaining trucks to ZEVs by 2045	NYQ	NYQ	2025
Advanced Clean Cars II	Phases in zero emission sales requirement for light duty cars and pickup trucks, starting in 2026, achieving 100% sales by 2035	4.4	3.5	June 2022
Clean Miles Standard	Reduce GHG emissions from ride-hailing services (TNCs)	<0.1	<0.1	May 2021 (adopted)
On-Road Motorcycle New Emissions Standards	New standards to align with more stringent “Euro 5” regulations, starting with MY 2024	0.9	2.1	Fall 2022

Advanced Clean Fleets (ACF) – Draft Requirements

- ▷ **Public Fleets (Cities, Counties, Special Districts, and State Agencies)**
  - ▷ ZEV purchases begin at 50% in 2024 and 100% in 2027
  - ▷ Plug-in hybrids count the same as ZEVs until 2035
- ▷ **Drayage Trucks (Seaports and Railyards)**
  - ▷ Only ZEVs can be added to CARB's Drayage Truck Registry starting in 2024
  - ▷ 100% ZEV drayage fleet by 2035
- ▷ **High Priority and Federal Fleets**
  - ▷ Beginning January 1, 2024, all additions must be ZEVs
  - ▷ Optional ZEV phase-in as a percentage of the total fleet (2025 – 2042)
- ▷ **100% ZEV sales for all medium- and heavy-duty vehicles by 2040**

Off-Road Measures

- ▷Tier 5 Off-Road New Compression-Ignition Engine Standards *
- ▷Amendments to In-Use Off-Road Diesel-Fueled Fleets Regulation
- ▷Transport Refrigeration Unit Regulation *
- ▷Commercial Harbor Craft Amendments *
- ▷Cargo Handling Equipment Amendments
- ▷Off-Road Zero-Emission Targeted Manufacturer Rule
- ▷Clean Off-Road Fleet Recognition Program
- ▷Spark-Ignition Marine Engine Standards



**Expected to achieve the highest level of NOx reductions in South Coast for this category*

Tier 5 Off-Road New Compression-Ignition Engine Standard

- Potential Tier 5 standards:
  - NOx standard ~90% more stringent than current Tier 4
  - PM standard ~75% more stringent than current Tier 4
  - CO_2 standards to reduce GHG emissions from 5 to 10% below current levels
- Additional elements: low-load test cycle, extending useful life and warranty provisions, enhancing in-use compliance procedures, and first-time off-road diesel OBD requirements
- Estimated reductions (2037): 1.8 tpd NOx
- Proposed CARB Board hearing: 2024/2025

Transport Refrigeration Units (TRU)

- Transition diesel-powered TRUs to ZE technologies
- Phase 1 (adopted February 2022):
  - ZE requirements for truck TRUs
  - PM emission standard for new non-truck TRUs
  - New requirements for lower global warming potential refrigerants

- Phase 2 (draft measure in 2022 State SIP Strategy)
  - ZE requirements for trailer TRUs, shipping container TRUs, railcar TRUs, and TRU generator sets
  - CARB currently assessing ZE technologies for these TRUs
- Estimated reductions (2037): 4.6 tpd NOx
- Proposed CARB Board hearing: TBD

Commercial Harbor Craft (CHC)

- ZE requirements for:
  - New excursion vessels in 2025
  - Short run (< 3nm) ferries in 2026
  - Shore power required after 15 minutes at dock
- Other vessels: Tier 3 or 4, plus a diesel particulate filter
- Biennial opacity testing, renewable diesel fuel, annual compliance fees
- Estimated reductions (2037): 2.6 tpd NOx, 0.2 tpd ROG
- Proposed CARB Board hearing: Spring 2022

Other Off-Road Measures

Measure	Proposed Requirements	Potential Reductions (tpd)	CARB Board Hearing
In-Use Off-Road Diesel Fleet Regulation Amendments	• 10-yr phase out of Tiers 0 to 2 • Provision to ban adding Tier 3 & 4 interim vehicles	1.3 NOx 0.1 VOC	2022
CHE Regulation Amendments	• Transition to ZE from 2026, 90% penetration by 2036	1.2 NOx 0.3 VOC	2024
Off-Road ZE Targeted Manufacturer Rule	• Manufacturers to produce ZE equipment and/or powertrains as a percentage of their annual sales volume	1.1 NOx	2025
Clean Off-Road Fleet Recognition Program	• A voluntary program to encourage fleets to adopt ZEVs • Fleet recognition based on standardized criteria/rating system	NYQ	2025
Spark-Ignition Marine Engine Standards	• ZE for <19 kW outboard and personal watercraft • 0.5 or 10 g/kW-hr HC+NOx for 19+ kW depending on engine size and emission control technology	0.3 NOx 1.2 VOC	2026/2027

Other Sources

Measure	Description	NOx (tpd)	ROG (tpd)	CARB Board Hearing
Consumer Products Standards	Consider rulemaking to reduce NOx emissions in non-attainment areas	NYQ	8	2027
Zero-Emission Standard for Space and Water Heaters	Zero-emission requirements for space and water heaters in new and existing residential and commercial buildings, starting in 2030	5.8	0.8	2025
Enhanced Regional Emission Analysis for SIPs	• Change process for developing Motor Vehicle Emission Budgets • Evaluate process for Transportation Control Measures • Update funding guidelines for vehicle registration fee and CMAQ programs	NYQ	NYQ	TBD

Federal/Intl. Sources – CARB Measures

Measure	Description	NOx (tpd)	ROG (tpd)
In-Use Locomotive Regulation	Proposed regulation to accelerate adoption of advanced cleaner technologies, incl. zero-emission, for locomotive operations	12.7	0.3
Heavy Duty Truck Standard	EPA's current proposed rule to lower NOx standards, taking effect in 2027	10.2	NYQ
Future Measures for Aviation Emission Reductions	Advocate for stricter emission regulations, further evaluate authority, comprehensive inventory, incentive programs, etc.	NYQ	NYQ
Future Measures for Ocean-Going Vessel Emissions Reductions	Consider additional incentives or regulatory measures to achieve additional reductions	21.1	NYQ

In-Use Locomotive Regulation – Proposed Concepts

- **Spending Account**
  - Operators required to deposit funds into spending account each year
  - Funds must be used to purchase the cleanest available or ZE technology
- **In-Use Operational Requirements (starting in 2030)**
  - Locomotives that are 23 years old and older are banned
  - New passenger, switch and industrial locomotives must be zero emission
  - New line-haul locomotives must be zero emission by 2035
- **Idling Limit**
  - No idling of main engine after 30 minutes
- **District Level Reporting**
  - Engine information, activity by air district, any idling over 30 minutes

Ocean Going Vessels

State Regulatory Actions and/or Incentives

Cleaner engines/fuels than required by U.S. EPA and IMO	Vessel speed reduction within CA waters	At-anchor emission reductions	Bulkers & general cargo ships potentially subject to At-berth Regulation
Implementation: 2025+		Emission Reductions: TBD	

Advocacy and/or Petition for Federal Actions

IMO Tier IV marine engine standards for NOx	Federal requirements for cleaner marine fuel and vessel visits (Target: all visits by Tier III by 2031)
Implementation: TBD Emission Reductions: TBD	Implementation: TBD Emission Reductions: 21.1 tpd of NOx

Public Measure Suggestions – "New Section" in State SIP

On-Road Mobile Source Strategies	On-Road Heavy-Duty Useful Life Strategy
	Additional Incentive Programs – Zero-Emission Trucks
	Enhanced Transportation Choices
	Enhanced BAR Consumer Assistance Program
Stationary/Area Source Strategies	Suggested Control Measure – Indirect Source Rule
	BACT/BARCT Determinations
	Additional Building and Appliance Emission Standards
	Pesticide Regulation

List of Measures – Federal Action Needed

Federal/ International Sources

- On-Road Heavy-Duty Vehicle Low-NOx Engine Standards
- On-Road Heavy-Duty Vehicle Zero-Emission Requirements
- Off-Road Equipment Tier 5 Standard for Preempted Engines
- Off-Road Equipment Zero-Emission Standards Where Feasible
- More Stringent Aviation Engine Standards
- Cleaner Fuel and Visit Requirements for Aviation
- Zero-Emission On-Ground Operation Requirements at Airports
- More Stringent National Locomotive Emission Standards
- Zero-Emission Standards for Switch Locomotives
- Address Locomotive Remanufacturing Loophole
- More Stringent NOx and PM Standards for Ocean-Going Vessels
- Cleaner Fuel and Vessel Requirements for Ocean-Going Vessels

Additional Considerations

Summary of Emission Reductions

Sources	NOx	VOC
Year 2037 Baseline [a]	220	389
Emission Reductions:		
South Coast AQMD Stationary & Area Sources	21	1
South Coast AQMD Mobile Sources	10	0
CARB SIP Strategy [b]	104	69
Aircraft	19	3
South Coast AQMD Stationary Sources: Further Deployment of Cleaner Technologies	3	
Total Reductions (all measures)	***157***	***73***
Set-Aside Accounts [c]	-0.5	-4
2037 Remaining Emissions [d]	**63**	**321**

[a] Emission assumptions from SCAG's 2020 RTP/SCS are already reflected in the AQMP baseline, including TCMs

[b] Reductions from mobile sources include CARB 2016 and 2022 State Strategy. The emission reductions do not match with the draft 2022 SIP Strategy due to discrepancy in emissions inventory versions and base year used to forecast future emissions from. Final version will reconcile the discrepancy.

[c] SIP reserve for potential technology assessment and phaseout of toxics

[d] Numbers may not add up due to rounding.

Includes about 67 tpd in 'black box' (54 tpd federal sources)

Control Measure Costs

- ▷Cost estimates for the AQMP are still in development
  - ▷Socioeconomic analysis targeted for release in mid June
- ▷Preliminary analysis indicates some measures will have much poorer cost-effectiveness (e.g., higher $/ton reduced) than previously adopted rules
- ▷Staff is seeking the most cost-effective approaches, however the scale of needed emission reductions limits the options

Potential Approach for Cost-Effectiveness

- ▷Previous threshold of $50,000 per ton NOx reduced used in rulemaking to guide Best Available Retrofit Control Technology
  - ▷Exceeding threshold triggered additional analysis and process
- ▷Proposing to update approach:
  - ▷Update thresholds to match inflation
  - ▷Different thresholds for mobile source vs. stationary source controls
    - ▷Using incentive programs as a guide: $200,000 per weighted ton* for mobile sources
  - ▷If proposed BARCT limit has cost-effectiveness that exceeds threshold:
    - ▷Hold public meeting to discuss lower cost-effectiveness options
    - ▷Present options for the Board's consideration at public hearing for rule adoption
- ▷Seeking input on how to approach cost-effectiveness during individual rulemaking

**Using Moyer guidelines: [NOx + ROG + (20 x PM)]*

Next Steps

- ▷Draft AQMP released for 46-day comment period May 6
  - ▷Comments due June 21
- ▷Revised Draft AQMP anticipated release in mid-Summer
- ▷Draft Final AQMP released early September for October Board consideration
- ▷Draft Socioeconomic Analysis anticipated mid June
- ▷Draft CEQA analysis anticipated mid-Summer

Draft AQMP available at:

http://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan

UCI

Agenda Item 1b

NATIONAL FUEL CELL RESEARCH CENTER

Energy Future

for: South Coast Air Quality Management District

from: San Diego Union Tribune

Prof. Jack Brouwer, Ph.D., Director

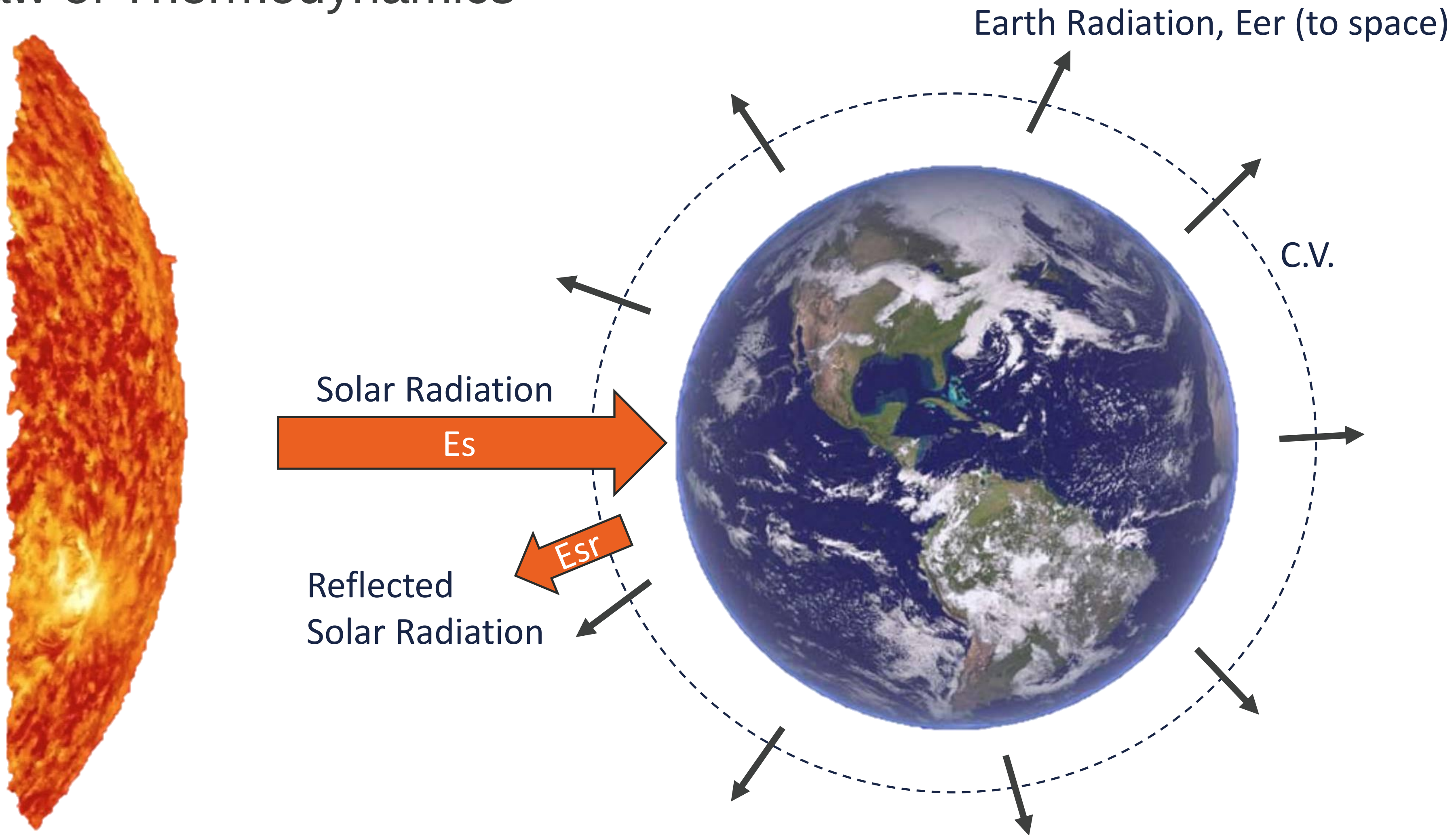
May 12, 2022

Outline

- Fossil Fuels are not sustainable or equitable
  - Resource scarcity and geographic availability
  - Air quality and climate pollutants
- How can we achieve zero emissions economy-wide?
  - Adopt more and more solar and wind power
  - Electrify as much as possible
  - Use electro-fuels & renewable fuels for everything else
- Hydrogen – the most important electro-fuel
- Air quality improvements of hydrogen & fuel cells
  - Fuel cells vs. backup diesel generator AQ impacts
- Challenges & “Potential” Challenges of hydrogen
  - Water use
  - Leakage & climate impact
  - Air quality (with combustion)

Earth Energy Balance

- First Law of Thermodynamics



$$\Delta E_{earth} = Es - Esr - Eer$$

Primary Energy on Earth

All from the Sun!*

Sun Energy

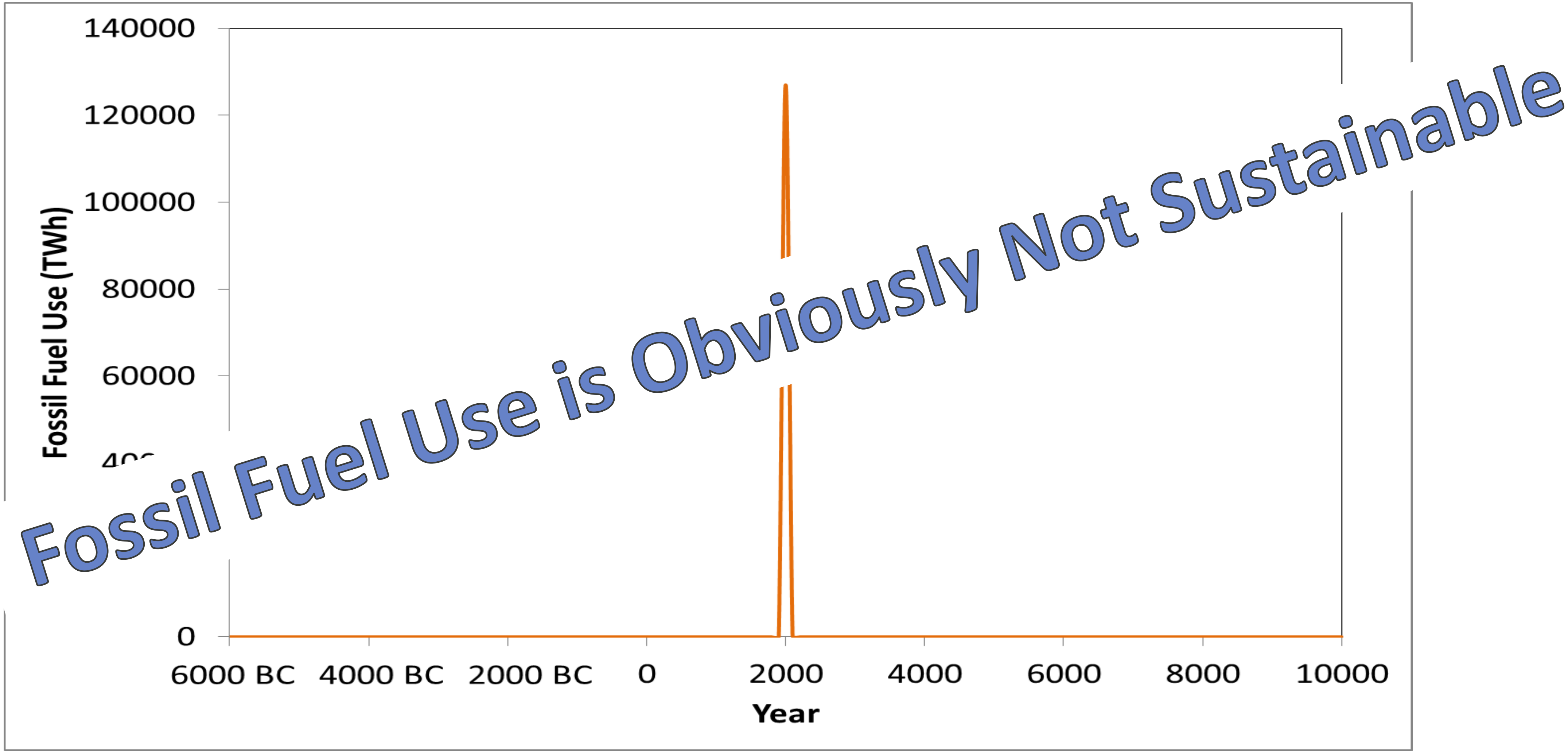
- Dead plant/animal life, heat, pressure (millions 100s of millions of years) – Fossil Fuels
  - coal, oil, natural gas
- Corn/Trees/Grass (months – years)
  - ethanol, biogas, biomass
- Hydro (weeks – months)
  - evaporation, clouds, rain, lakes
- Wind (days – weeks)
  - wind turbine
- Solar (instant)

"Energy sustainability requires conversion of resources at the same rate at which they are naturally replenished on earth without externalities"

* except for nuclear

Energy on Earth

Current Practices are Obviously not Sustainable

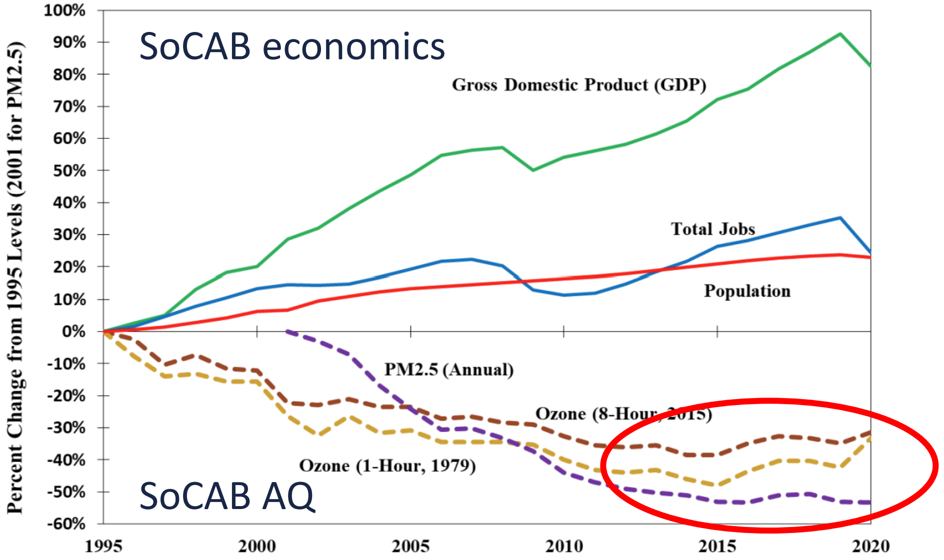


Not Just Renewable – Zero Externalities

Energy Conversion has improved quality of life, but, unfortunately also is the most significant cause of environmental and geopolitical problems (externalities)

- Criteria Pollutant Emissions
  - Acid Rain
  - Particulate Matter
  - Volatile Organic Compounds
  - Nitrogen and Sulfur Oxides
  - Carbon Monoxide
  - …
- Greenhouse Gas Emissions
  - Carbon dioxide, methane, nitrous oxide, …
- Resource recovery damage (e.g., mines)
- Regional resource depletion – geopolitical dependencies
- Overall primary energy resource depletion – not sustainable

Serious Health and Air Quality Consequences



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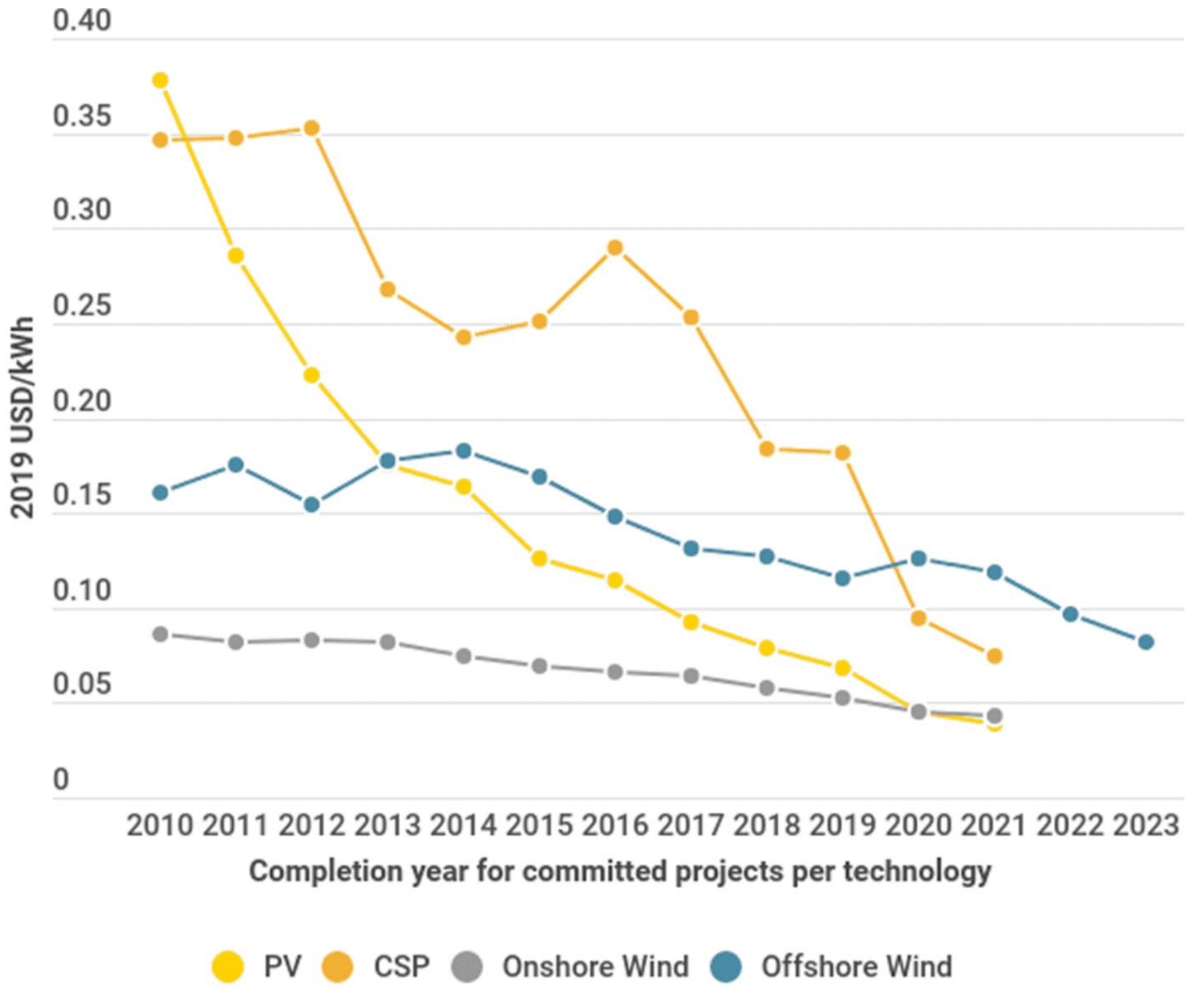
Adopt More Solar & Wind

We must increasingly adopt energy conversion that is sustainable & naturally replenished quickly

Good News!

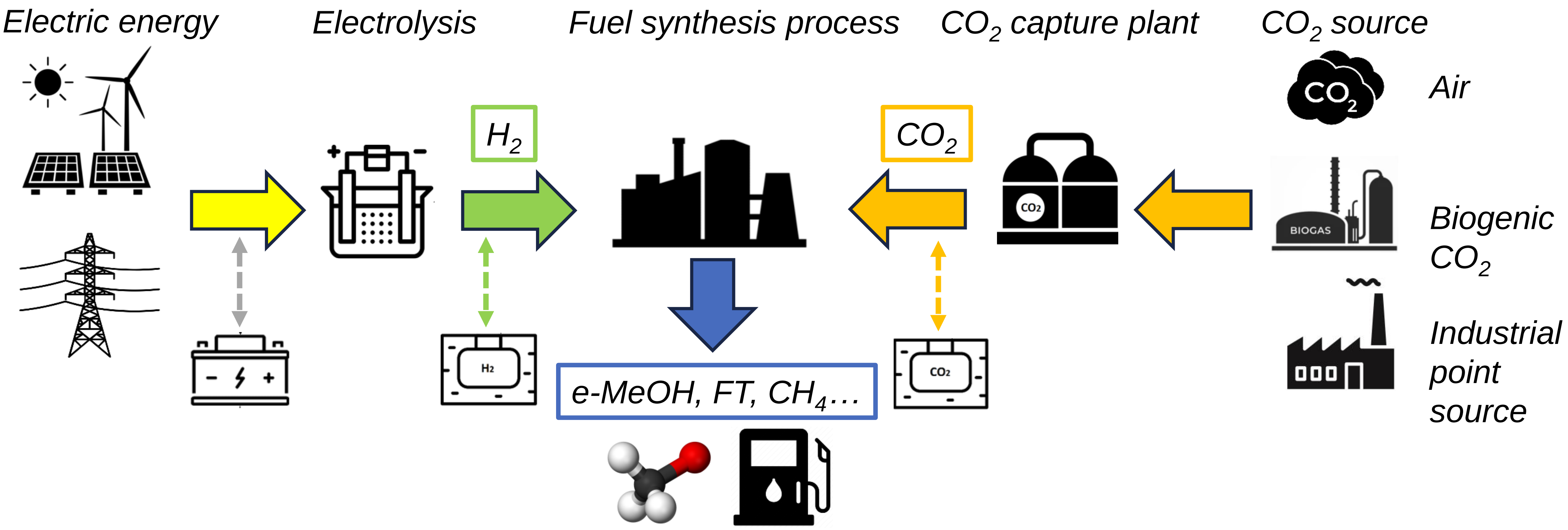
- Widely available around world
- Now typically cheapest form of primary energy



From: IRENA, www.irena.org/newsroom/pressreleases/2020/Jun , 2020

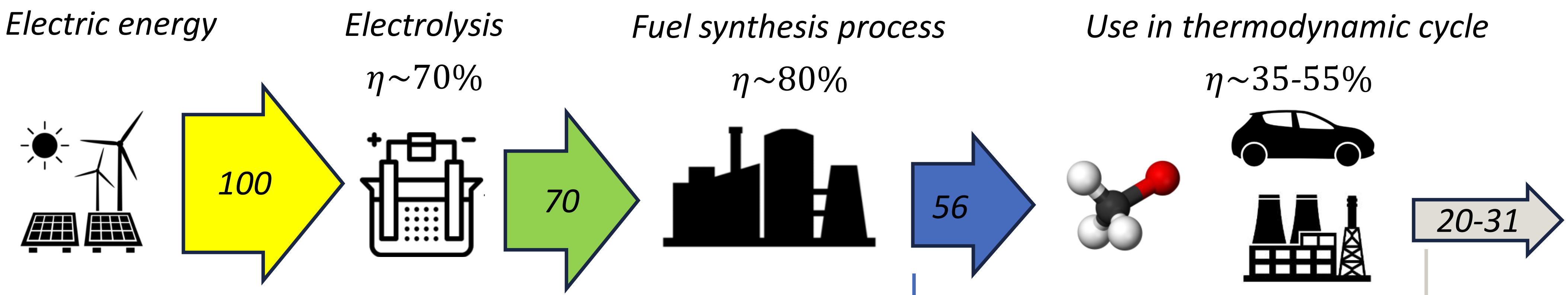
Then Use E-Fuels & Renewable Fuels

- e-fuels: synthetic fuels produced from electricity
- Each process has a certain efficiency (loss of energy)



From: Matteo Romano, Politécnico di Milano, 2022

Energy efficiency



Simplified balance (no transport loss, energy for CO_2 capture not included, etc..)

Power to power efficiency = 20-31% vs. 70-90 % of direct use of electricity

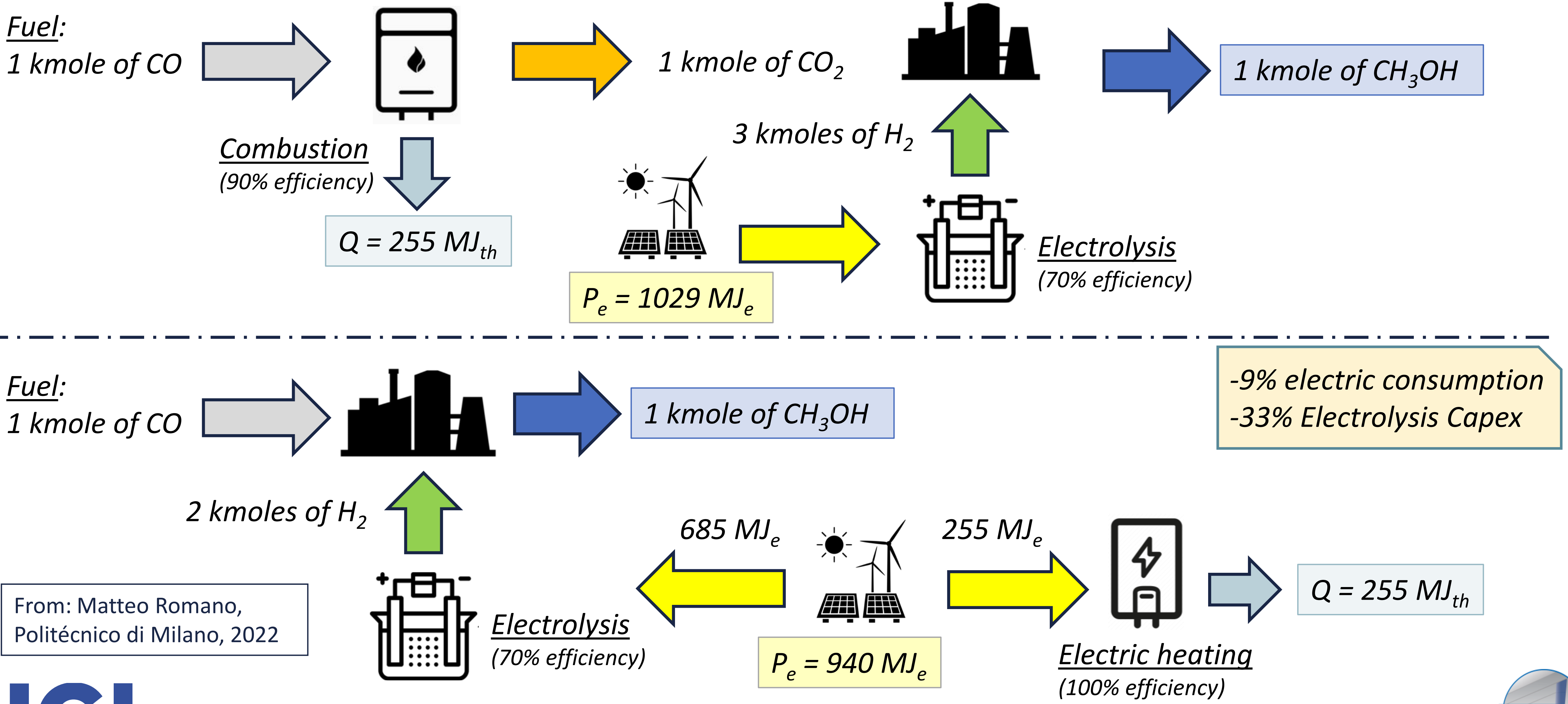
Power to heat efficiency = 50-55% vs. 95-250 % of electrified heating

Direct use of electricity is preferable from energy efficiency perspective

From: Matteo Romano, Politécnico di Milano, 2022

Energy efficiency

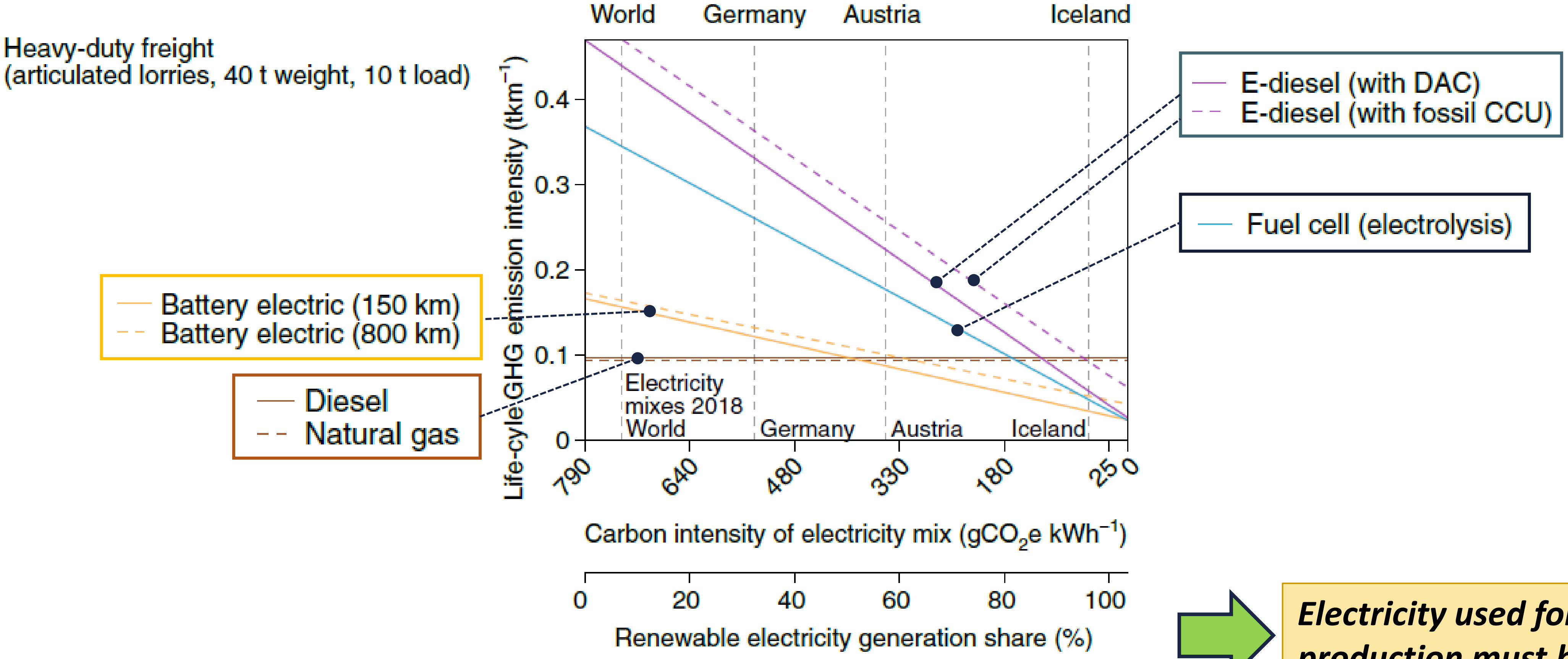
Does it make sense to produce e-fuels from CO_2 originated from combustion of another fuel?



From: Matteo Romano, Politécnico di Milano, 2022

Environmental impact

On the carbon footprint of electricity



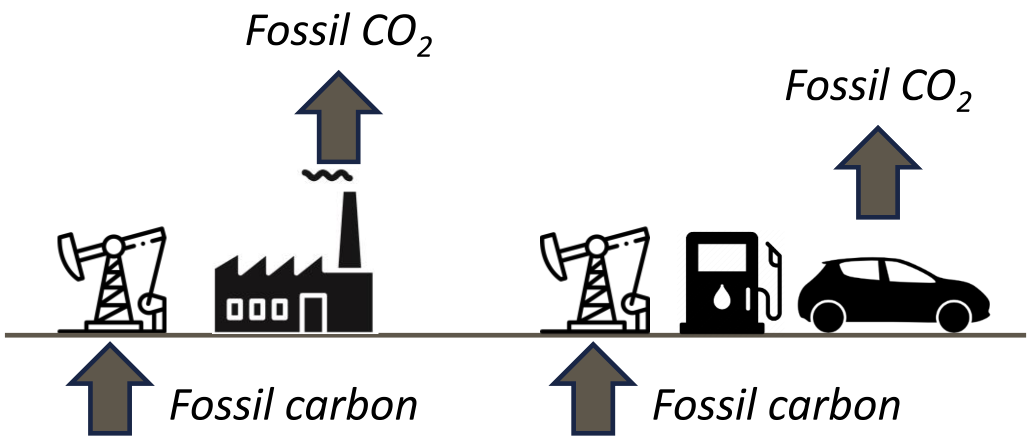
Electricity used for e-fuels production must be low-carbon

Ueckerdt et al., 2021. *Potential and risks of hydrogen-based e-fuels in climate change mitigation*. Nature Climate change.

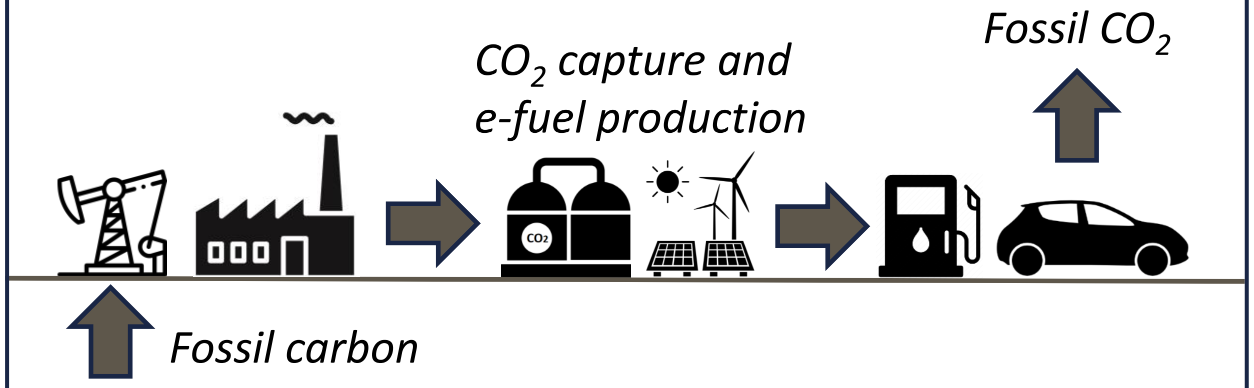
Environmental impact

On the origin of carbon

Current economic model



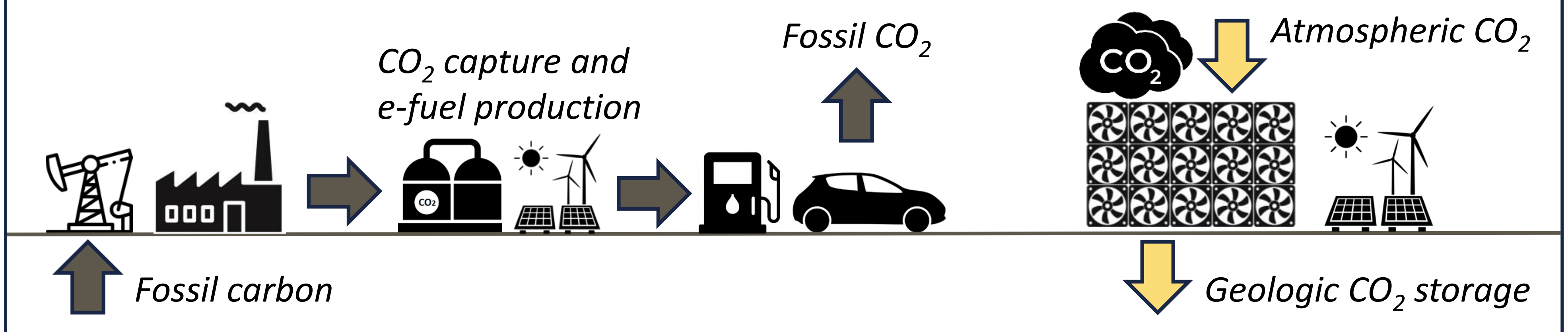
Open C economic model with CCU



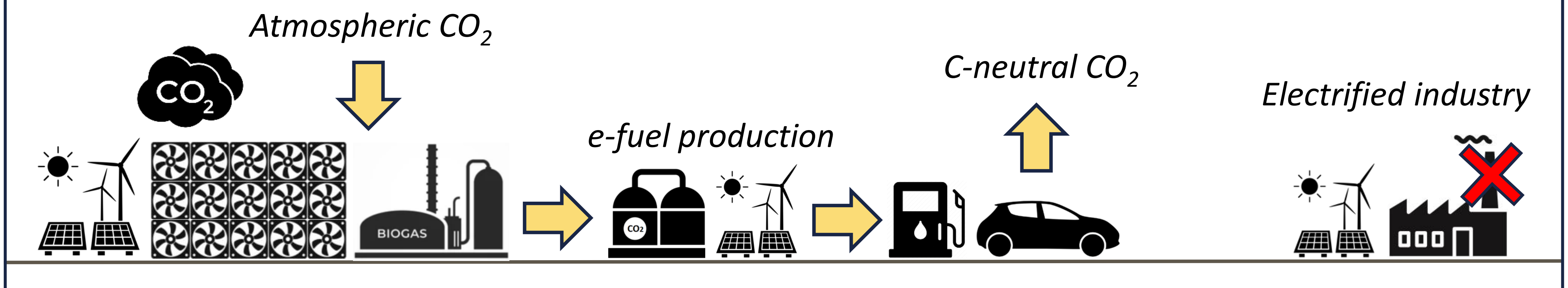
e-fuel system based on fossil carbon allows reducing the system CO_2 emissions by about 50% compared to the current economic model.
This may be acceptable in the transition phase, but is not sufficient in a long-term "net-zero" target.

Environmental impact

Circular economic model with CCU + offset with negative emission technology and CCS



Circular economic model without fossil carbon and CCS



Net-zero e-fuel systems must include atmospheric CO_2 capture

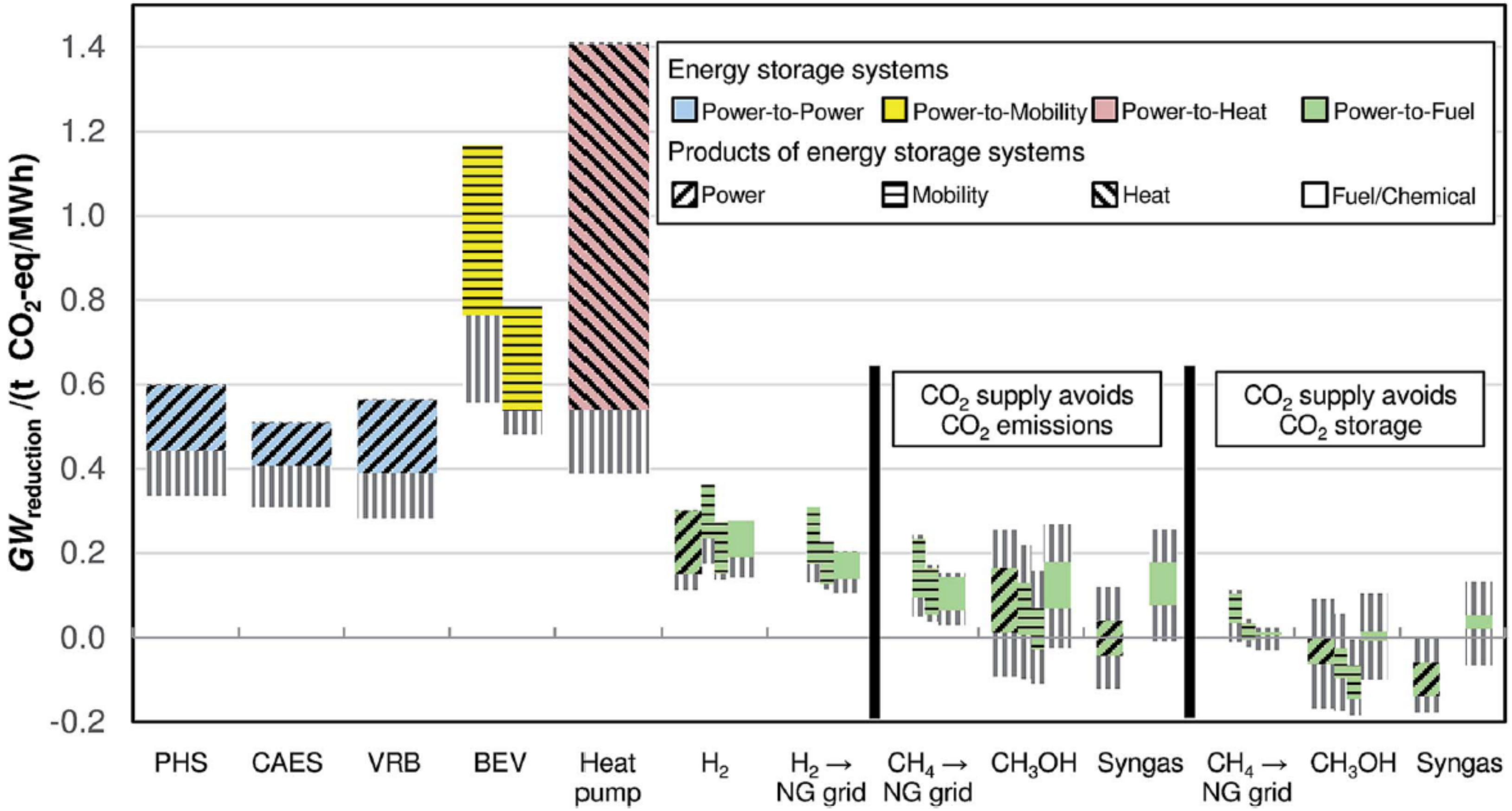
From: Matteo Romano, Politécnico di Milano, 2022

Environmental impact

On the best use of renewable electricity in the transition

Ranking based on LCA environmental benefits:

1./2. Heat pump heating & Power-to-Mobility
3. Power-to-power
4. Power-to-H_2 (chemical/industry)
5. Power-to-e-fuels

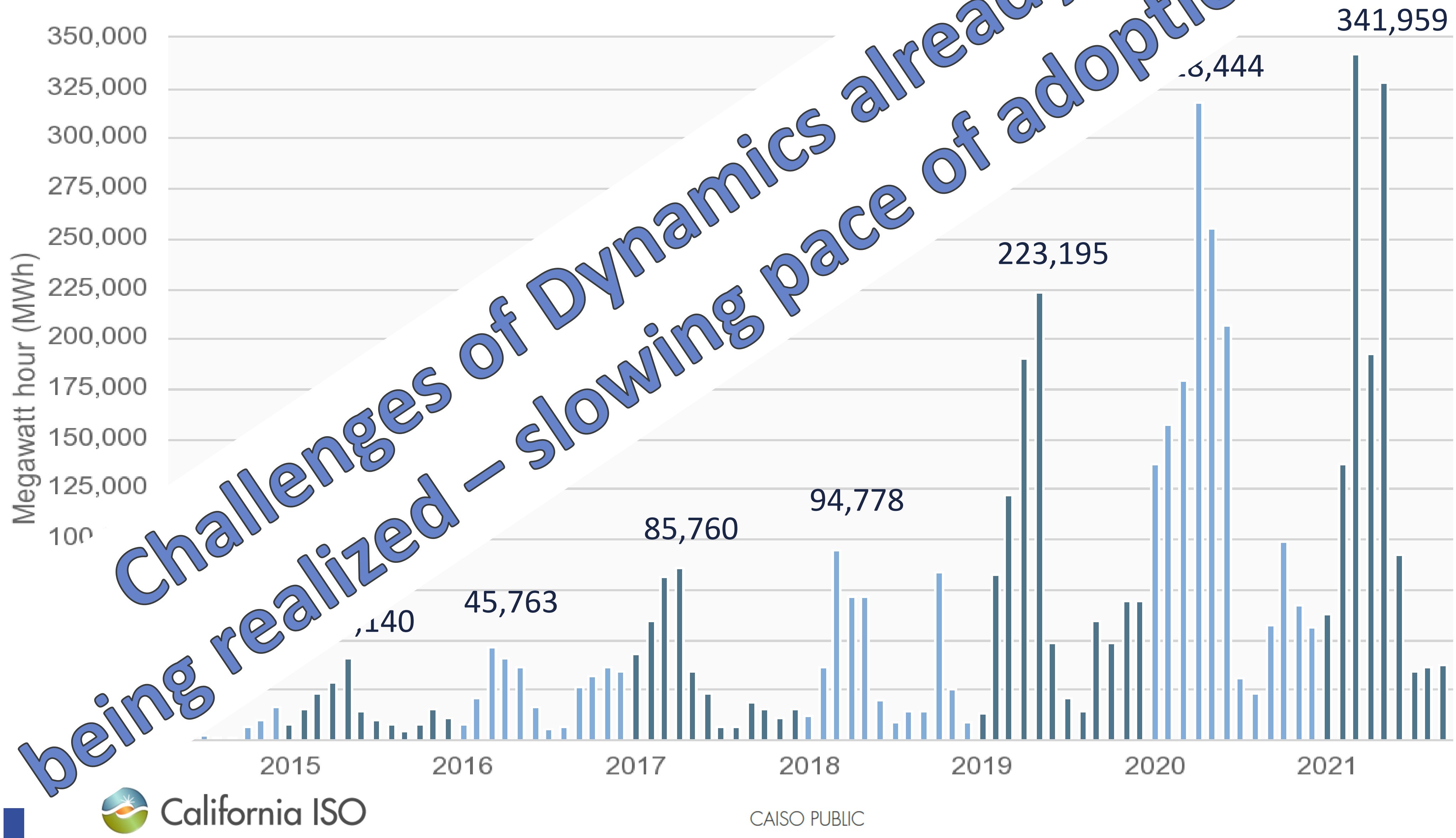


Sternberg, Bardow, 2015. *Power-to-What? – Environmental assessment of energy storage systems*. Energy and Environmental Science, 8, 389-400.

Directly Use More Renewable Electricity

- Electrify buildings, especially residential new construction – but not all built environment demand is amenable and some infrastructure upgrades are too costly
- Always use renewable electricity directly whenever possible (demand management)
- Store in electrochemical battery energy storage systems first (most efficient storage) – but some uses require rapid fueling, long range, heavy payload (fuel cells)
- Battery electric vehicles (BEV) & fuel cell electric vehicles (FCEV) are important

High Renewable Use is Challenging (C… CA)



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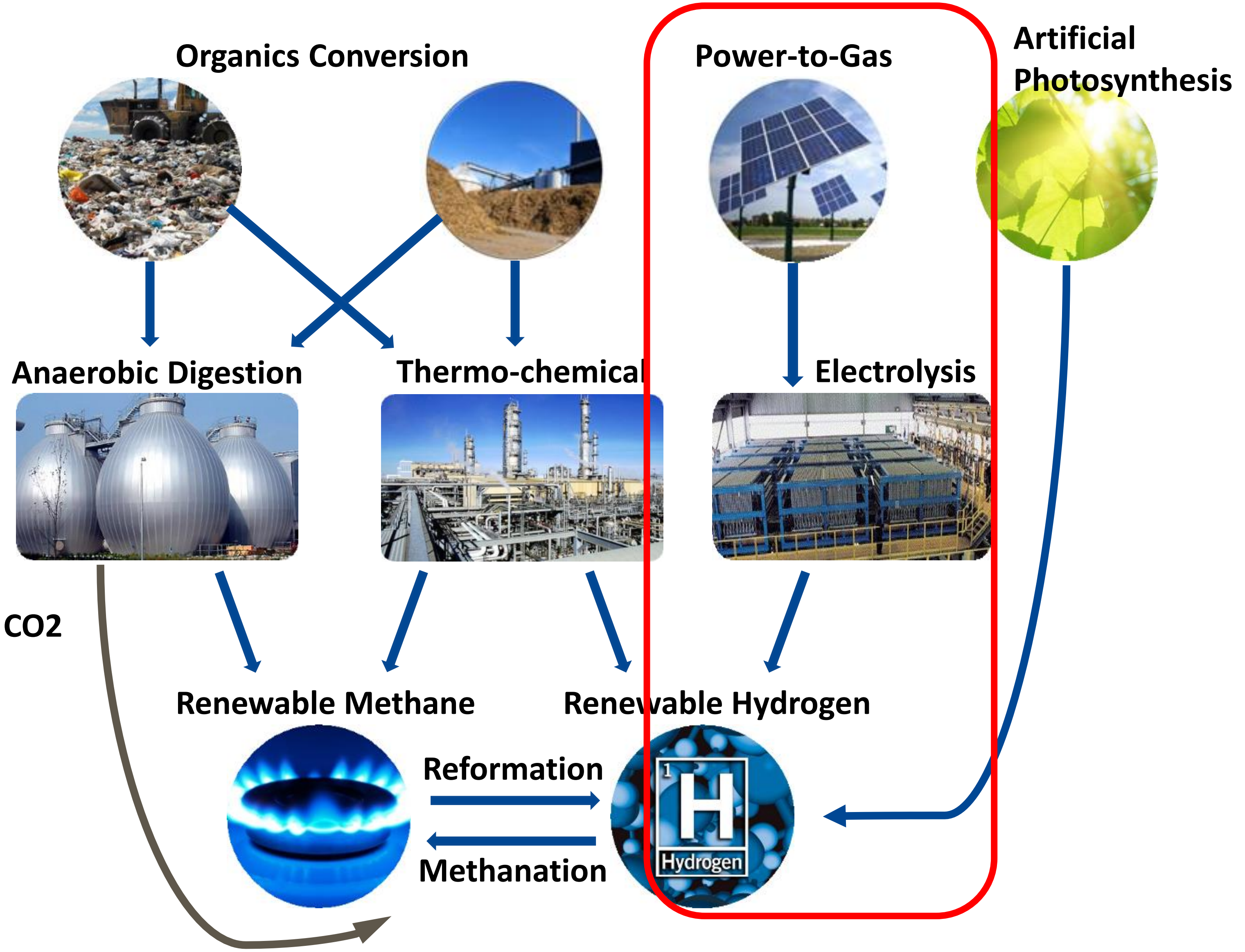
Colors of Hydrogen – Carbon Intensity & Emissions!

- No accepted/agreed-to standard (example below)
- Emissions vary within colors; picking colors stymies market; other negative outcomes
- Should rather use "Carbon Intensity" and "Emissions" metrics for hydrogen

Color	Technology	Feedstock
Gre[illegible]n	Electrolysis	Solar, Wind, Hydro, Geothermal, Tidal
Green	[illegible]am reforming, Gasification, Digestion	Biogas, Biomass, Waste
Pink/Purple	Elect[illegible]	Nuclear
Yellow	Electrolysis	[illegible]ower
Blue	Steam reforming or Gasification [illegible]	[illegible]atural Gas, Coal
Turquoise	Pyrolysis w/ solid ca[illegible]oduct	[illegible]
Grey	Steam[illegible]	Natural Gas
Brown	[illegible]ification	Brown Coal
Blac[illegible]	Gasification	Black Coal

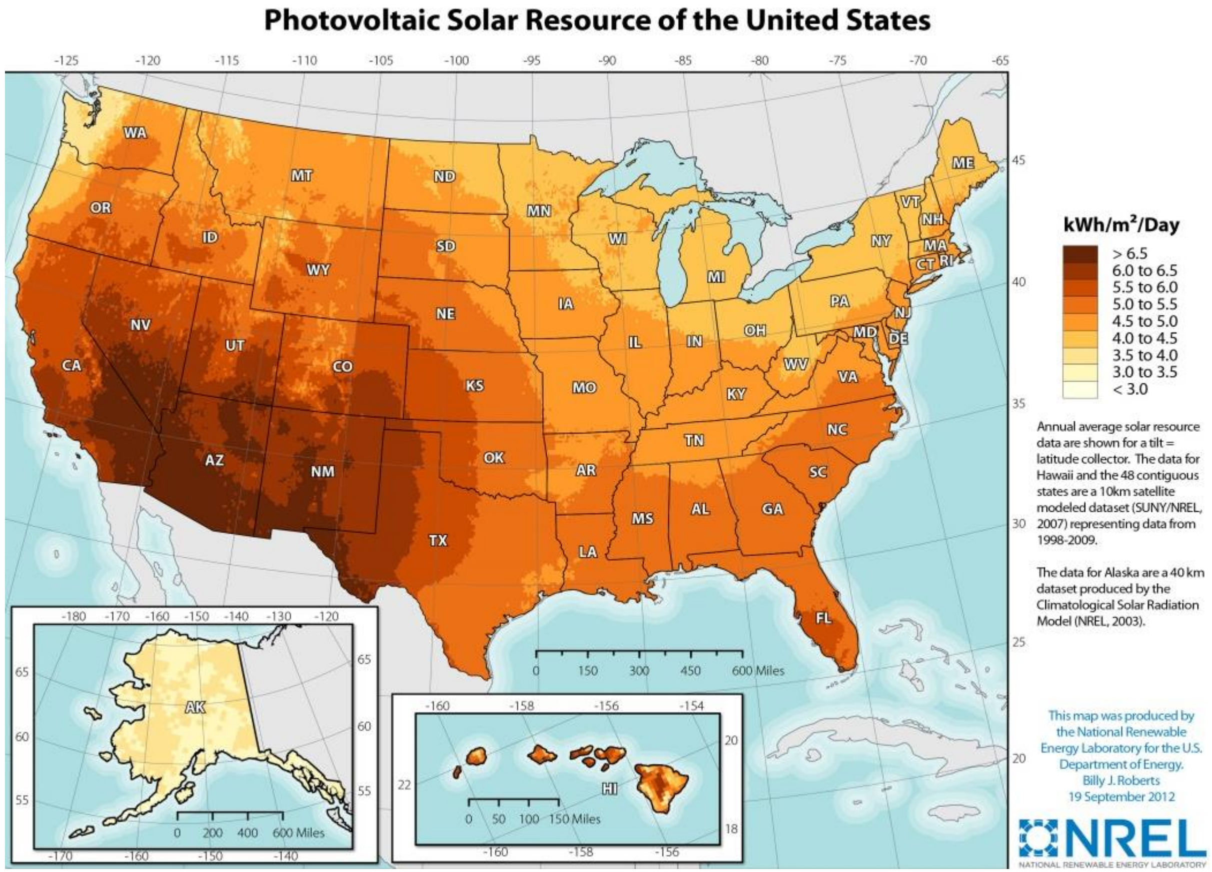
Renewable and Zero-carbon Gaseous Fuel Pathways

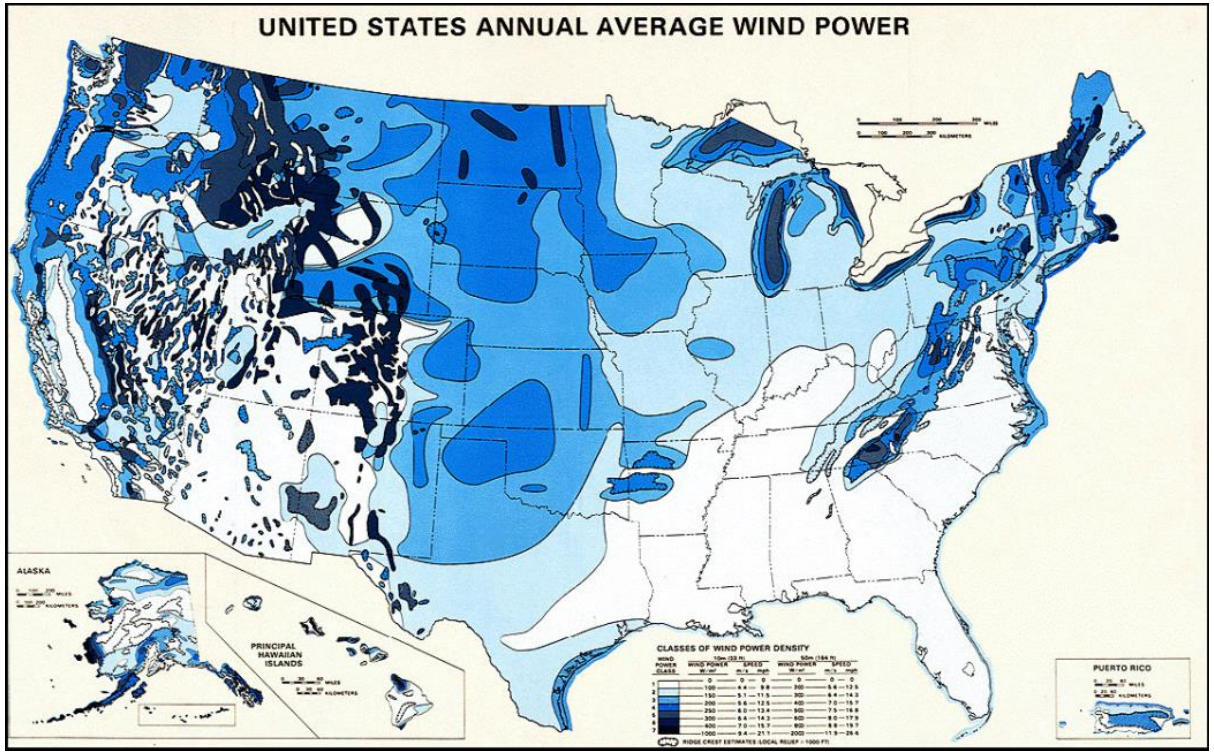
- “Green” in the traditional sense of environmentally sensitive and desirable



Solar & Wind Power – most widely available resources

- Renewable future will be more equitable all around the world

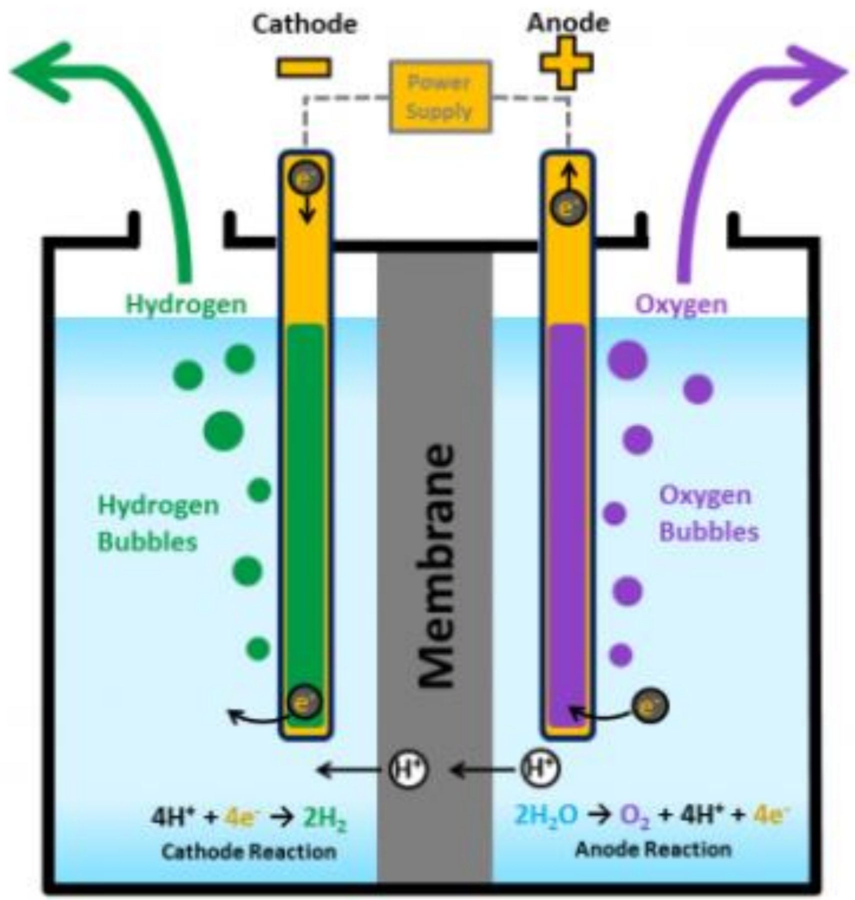




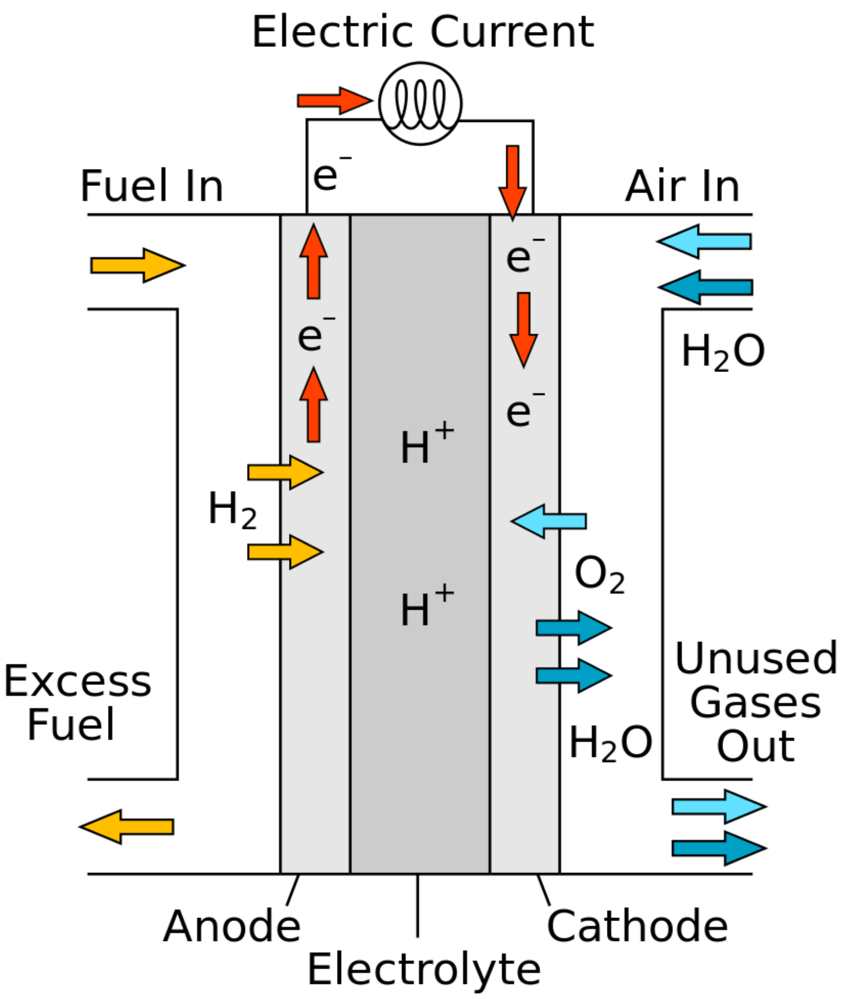
NREL, 2018

Fuel Cells & Electrolyzers

Electrolyzer (make H_2 from power)



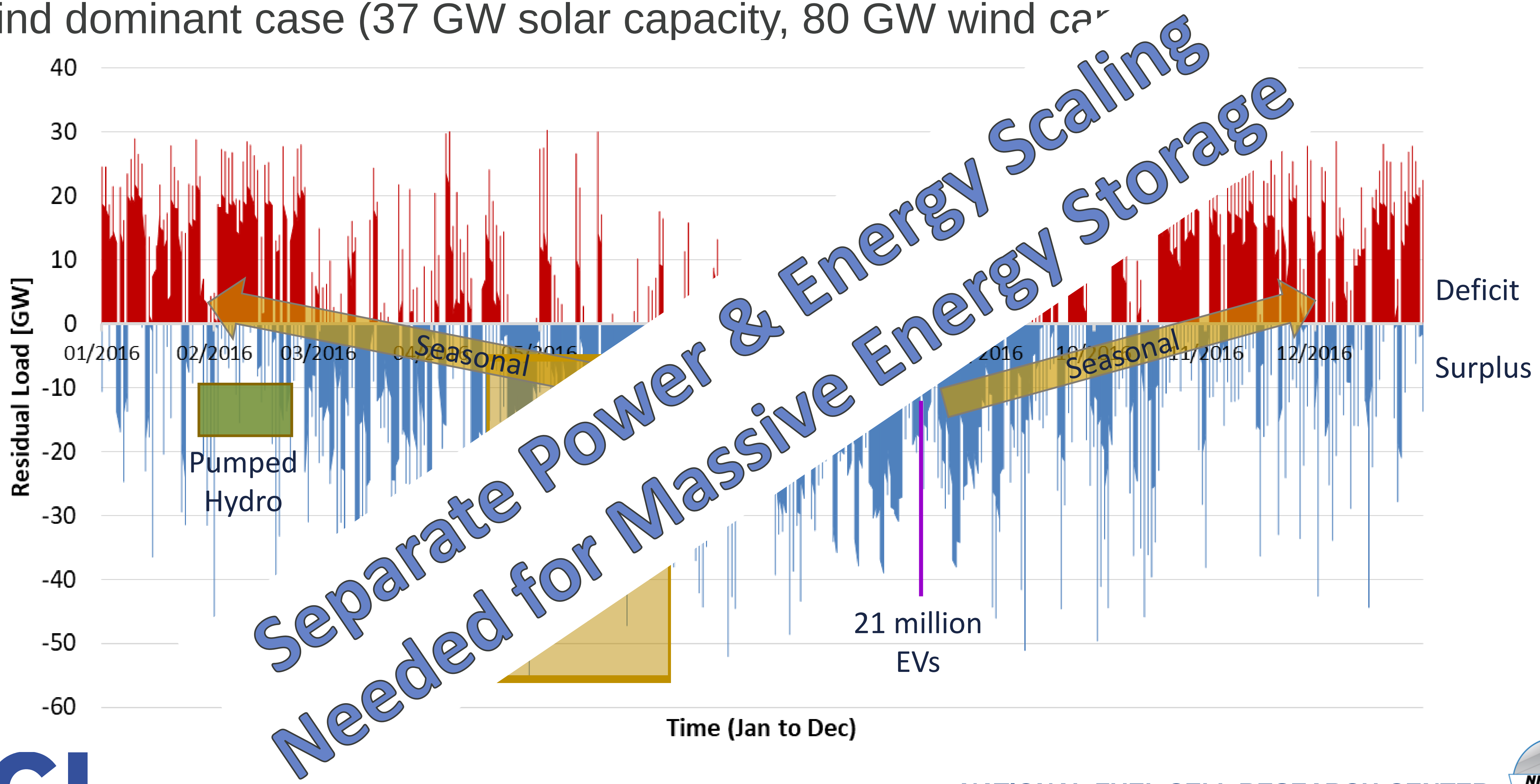
Fuel Cell (make power from H_2)



From: FCHEA (https://www.fchea.org/)

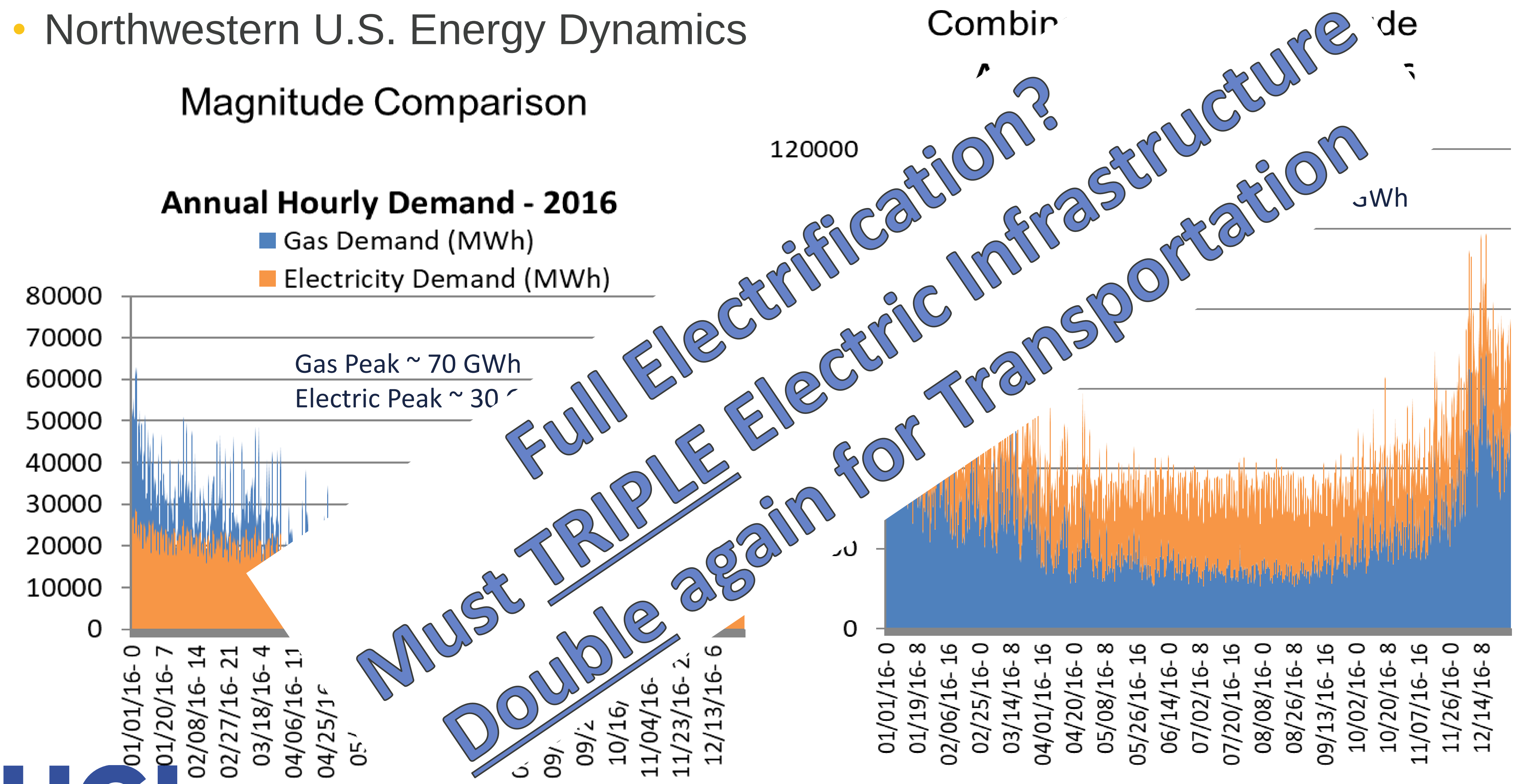
Dynamics of Renewable Future are Challenging

- Wind dominant case (37 GW solar capacity, 80 GW wind cap



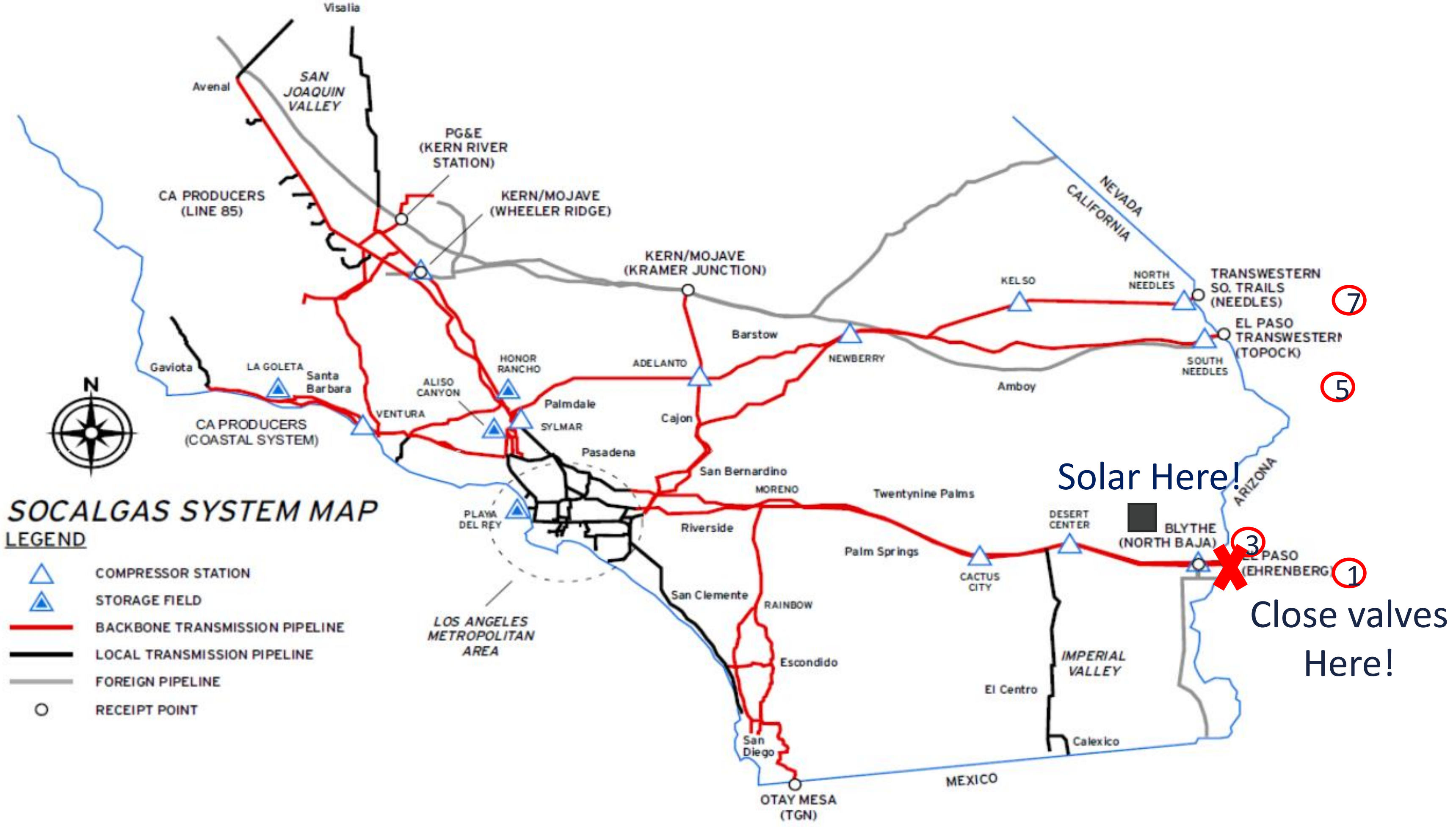
We Must Transform the Gas System

- Northwestern U.S. Energy Dynamics



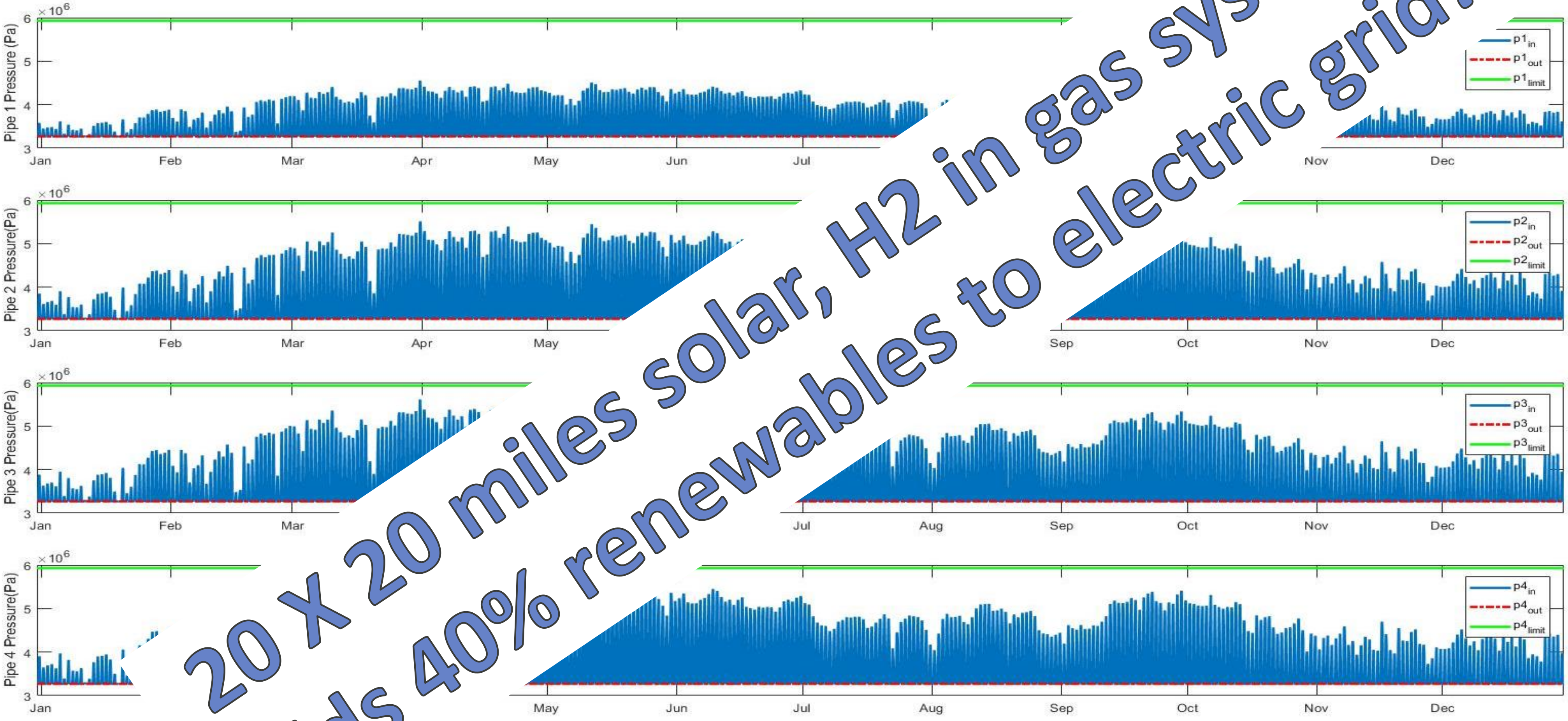
Gas System – Resource for Zero Emissions & Resilience

- First mix X% – HUGE Resource for grid renewables & transportation electrification
- Then piecewise convert to pure hydrogen



Gas System – Resource for Zero Emissions & Resilience

- 40% of all electric demand – 20 sq. miles of solar, only gas sy
  for H_2 storage AND all T&D for resilience

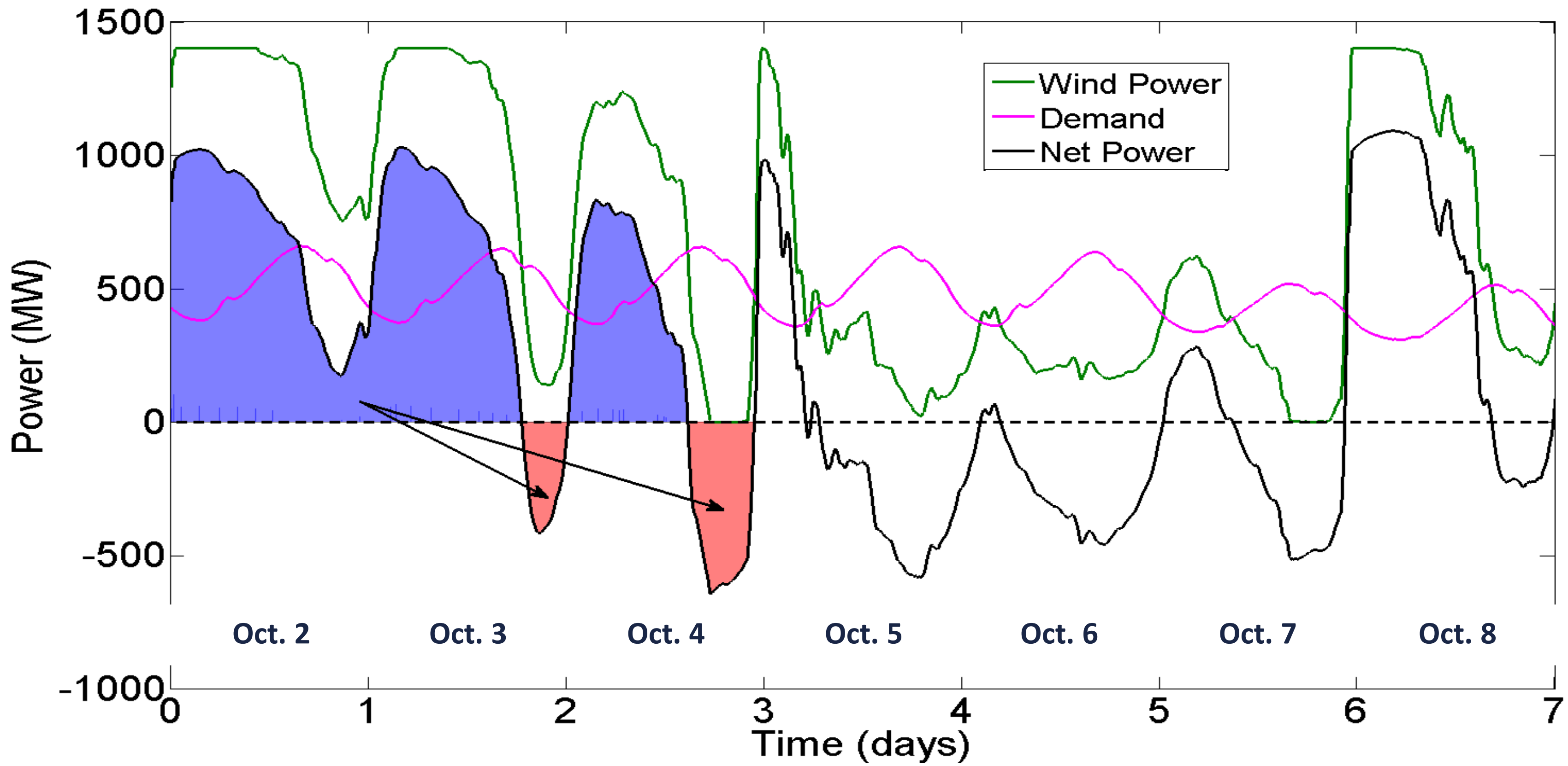


20 X 20 miles solar, H2 in gas system adds 40% renewables to electric grid!

Heydarzadeh, Zahra, PhD Dissertation, UC Irvine, J. Brouwer advisor, 2020.

Hydrogen Energy Storage Dynamics

- Hydrogen Storage complements Texas Wind & Power Dynamics

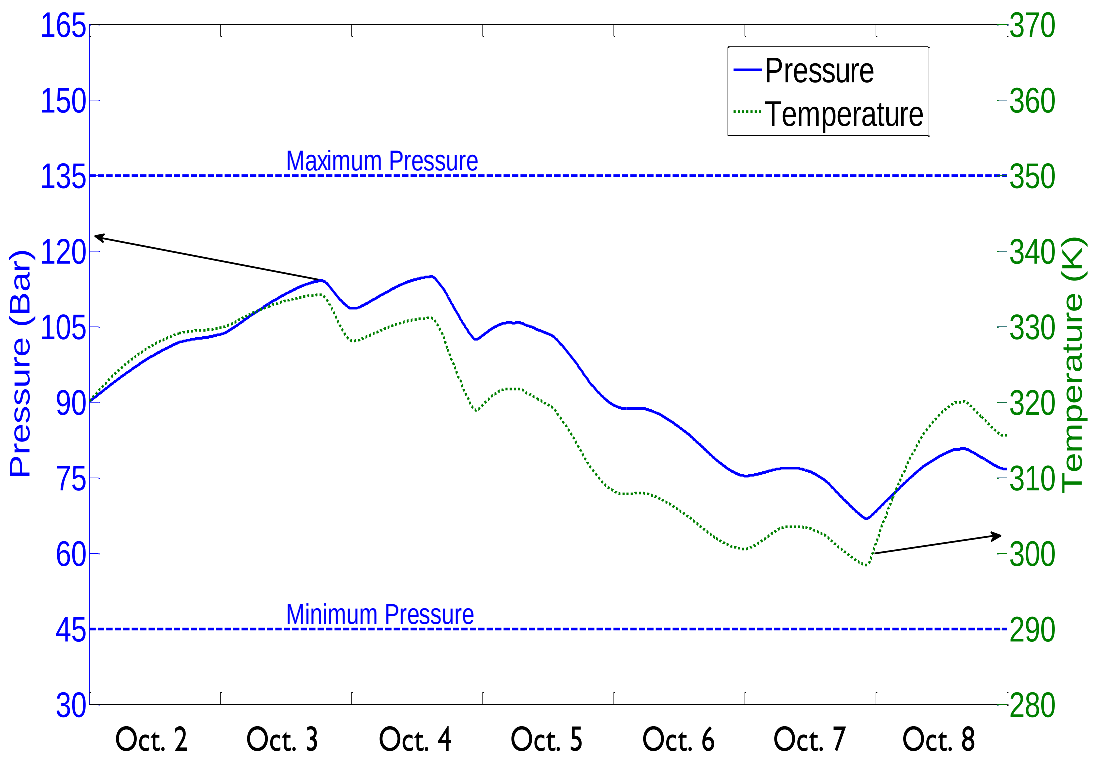


- Load shifting from high wind days to low wind days
- Hydrogen stored in adjacent salt cavern

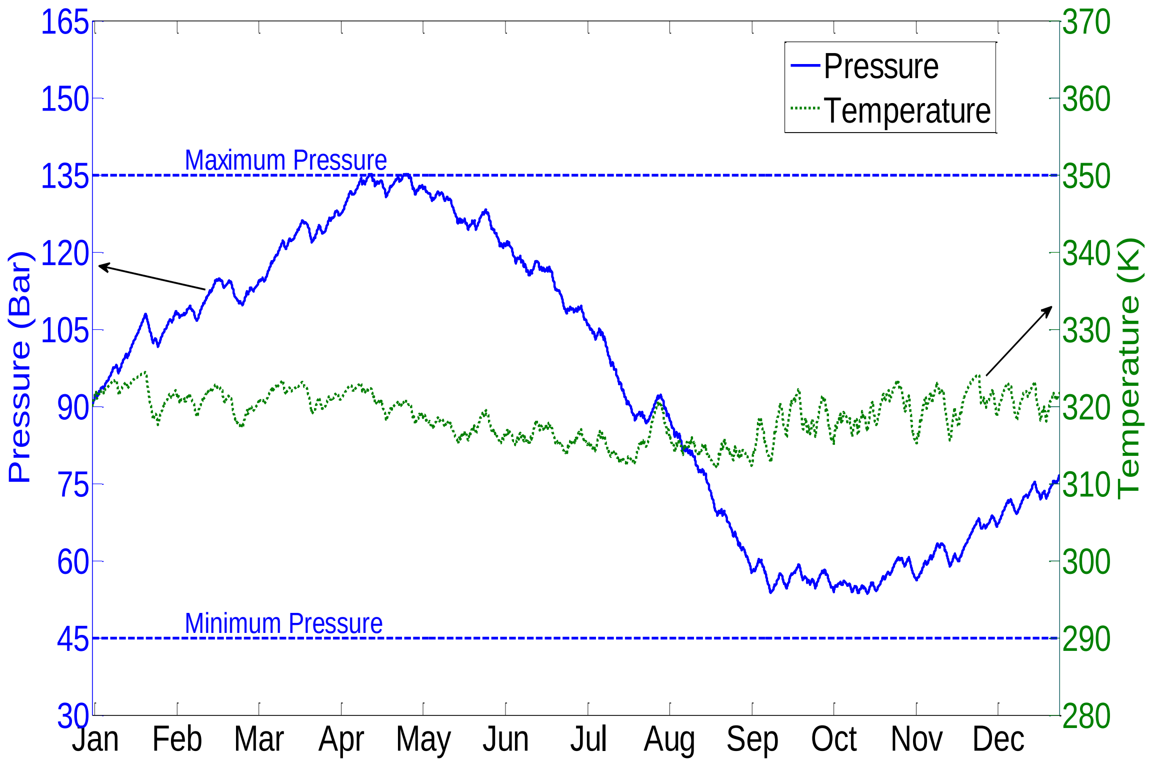
Maton, J.P., Zhao, L., Brouwer, J., Int'l Journal of Hydrogen Energy, Vol. 38, pp. 7867-7880, 2013

Hydrogen Energy Storage Dynamics

- Weekly and seasonal storage w/ H_2, fuel cells, electrolyzers
  - Weekly



Seasonal



But what can we do if we don't have a salt cavern?

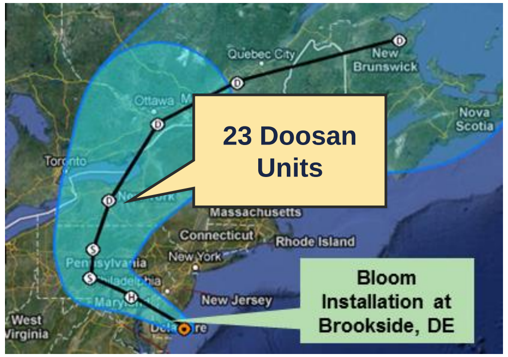
Maton, J.P., Zhao, L., Brouwer, J., Int'l Journal of Hydrogen Energy, Vol. 38, pp. 7867-7880, 2013

Demonstrated Resilience of Fuel Cells and Gas System

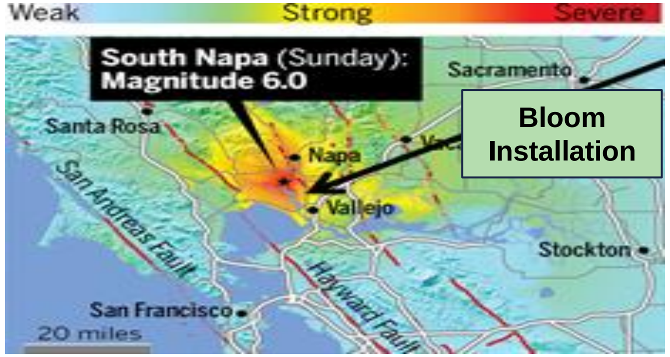
San Diego Blackout, 9/28/11

Winter Storm Alfred, 10/29/11

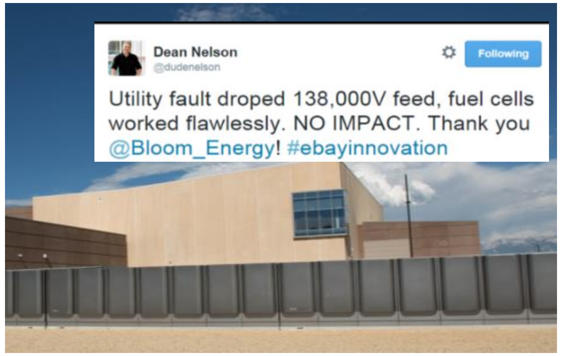
Hurricane Sandy, 10/29/12



CA Earthquake, 8/24/14



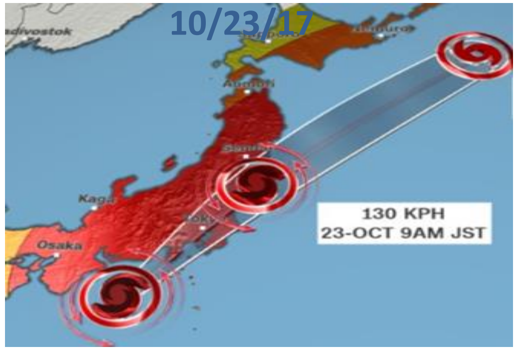
Data Center Utility Outage, 4/16/15



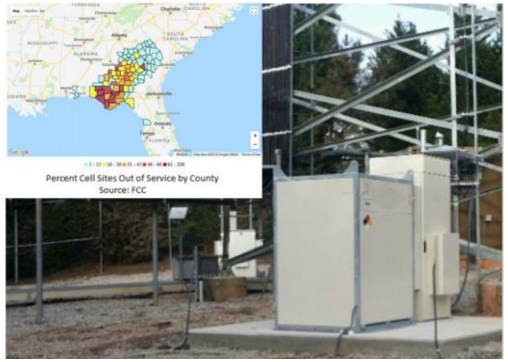
Hurricane Joaquin, 10/15/15

Napa Fire, 10/9/17

Japanese Super-Typhoon, 10/23/17

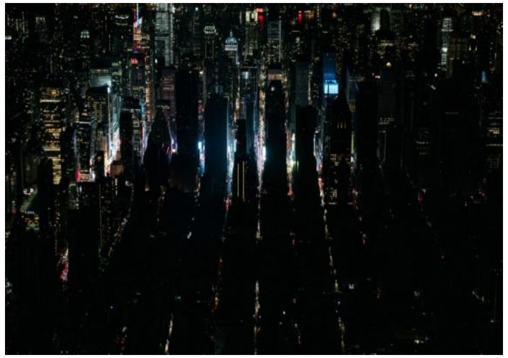


Hurricane Michael, 10/15/18



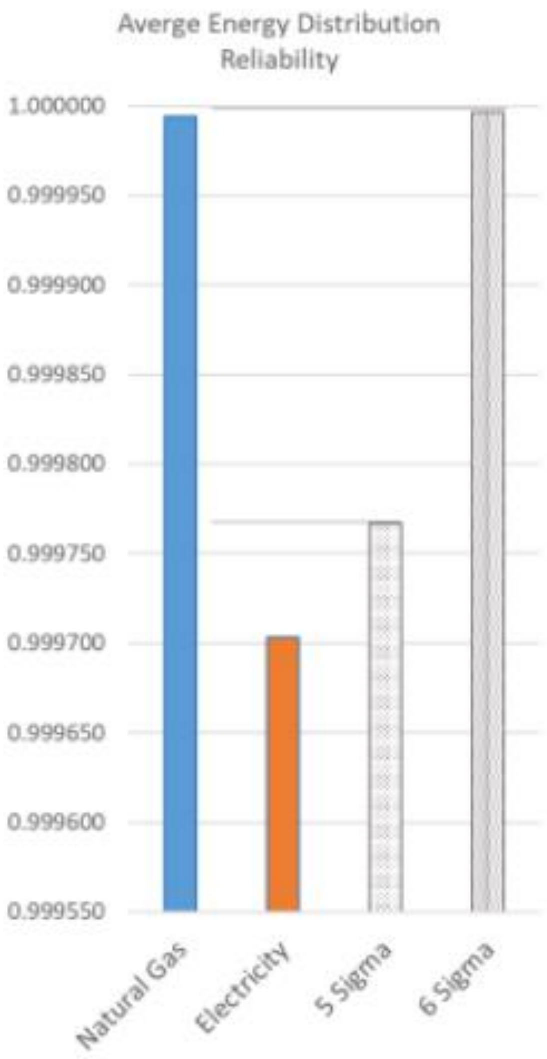
Ridgecrest Earthquakes, 7/4-5/19

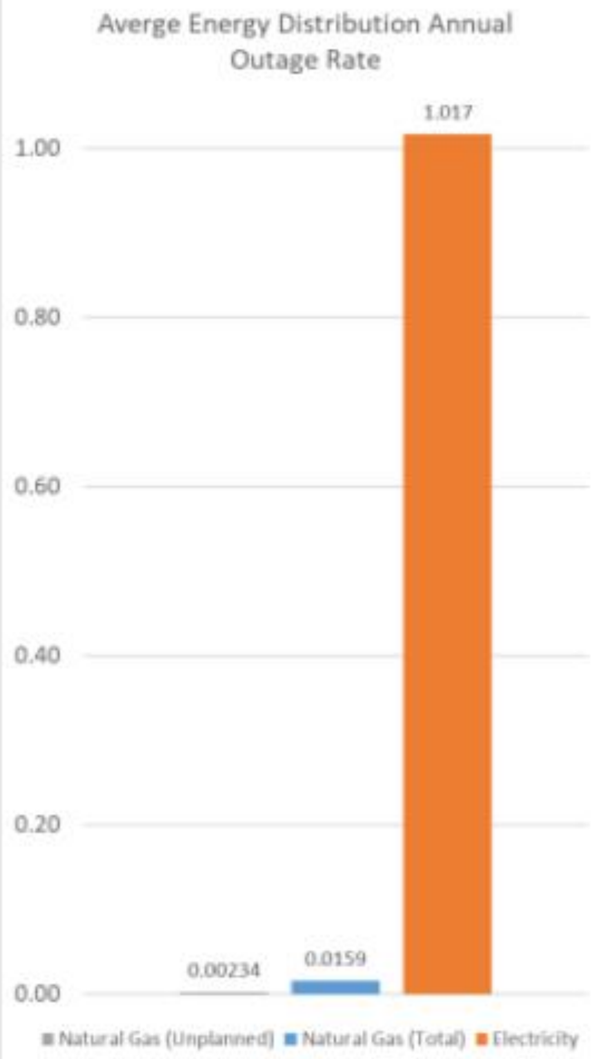
Manhattan Blackout, 7/13/19



Natural Gas and Electric Distribution Service Reliability

- Electricity "is considerably more vulnerable" to being damaged compared to natural gas (pg.17)
- Considering that hydrogen could be distributed in the same way as natural gas, hydrogen infrastructure could be the more reliable power distribution method in times of extreme weather





Liss, W., & Rowley, P. (2018). *Assessment of natural gas and electric distribution service reliability*. Gas Technology Institute.

Why Hydrogen? Zero Emission Fuels Required

- Provide zero emissions fuel to difficult end-uses

Anything that requires (1) rapid fueling, (2) long range, (3) large payload

Why Hydrogen? Industry Requirements for Heat, Feedstock,

- Many examples of applications that cannot be electrified

Steel Manufacturing & Processing

Cement Production

(Photo: ABB Cement)

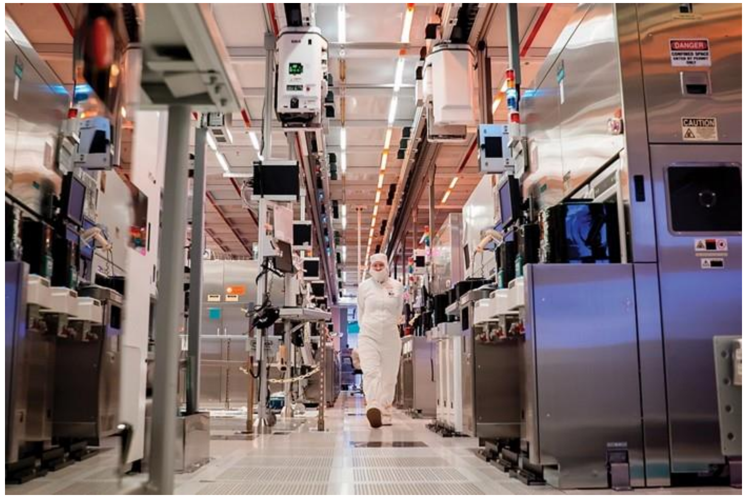
Plastics

(*Photo:* DowDuPont Inc.)

Ammonia & Fertilizer Production

(Photo: Galveston County Economic Development)

Computer Chip Fabrication



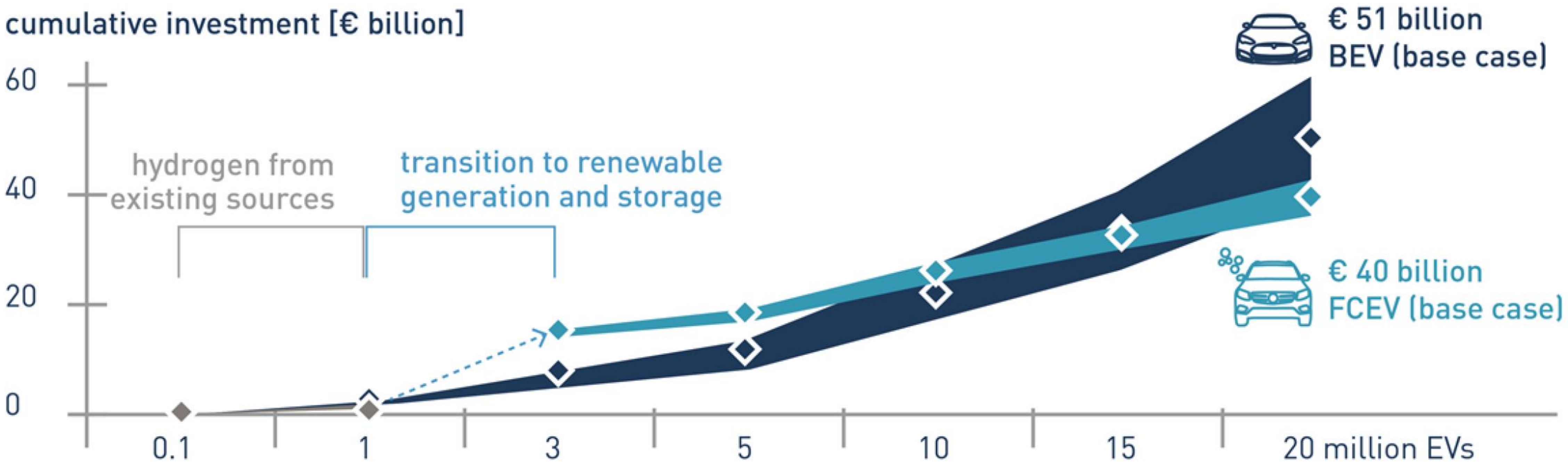
(Photo: American Chemical Society)

Pharmaceuticals

(Photo: Geosyntec Consultants)

Infrastructure Limits Require both FCEV & BEV

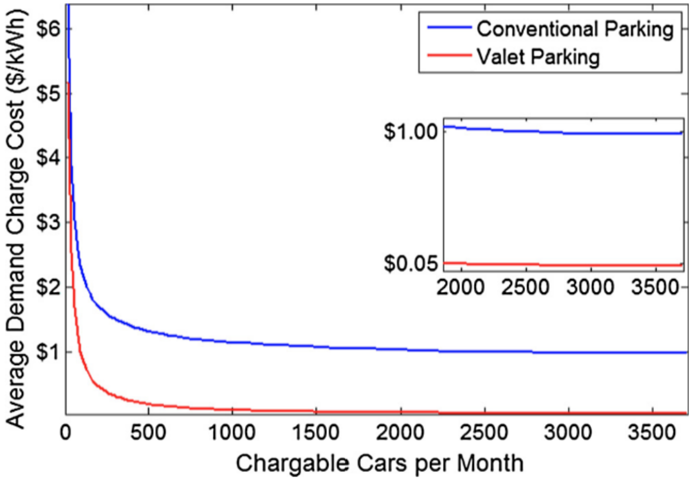
Comparative Analysis of Infrastructures: H2 & FCEV vs. Grid & BEV

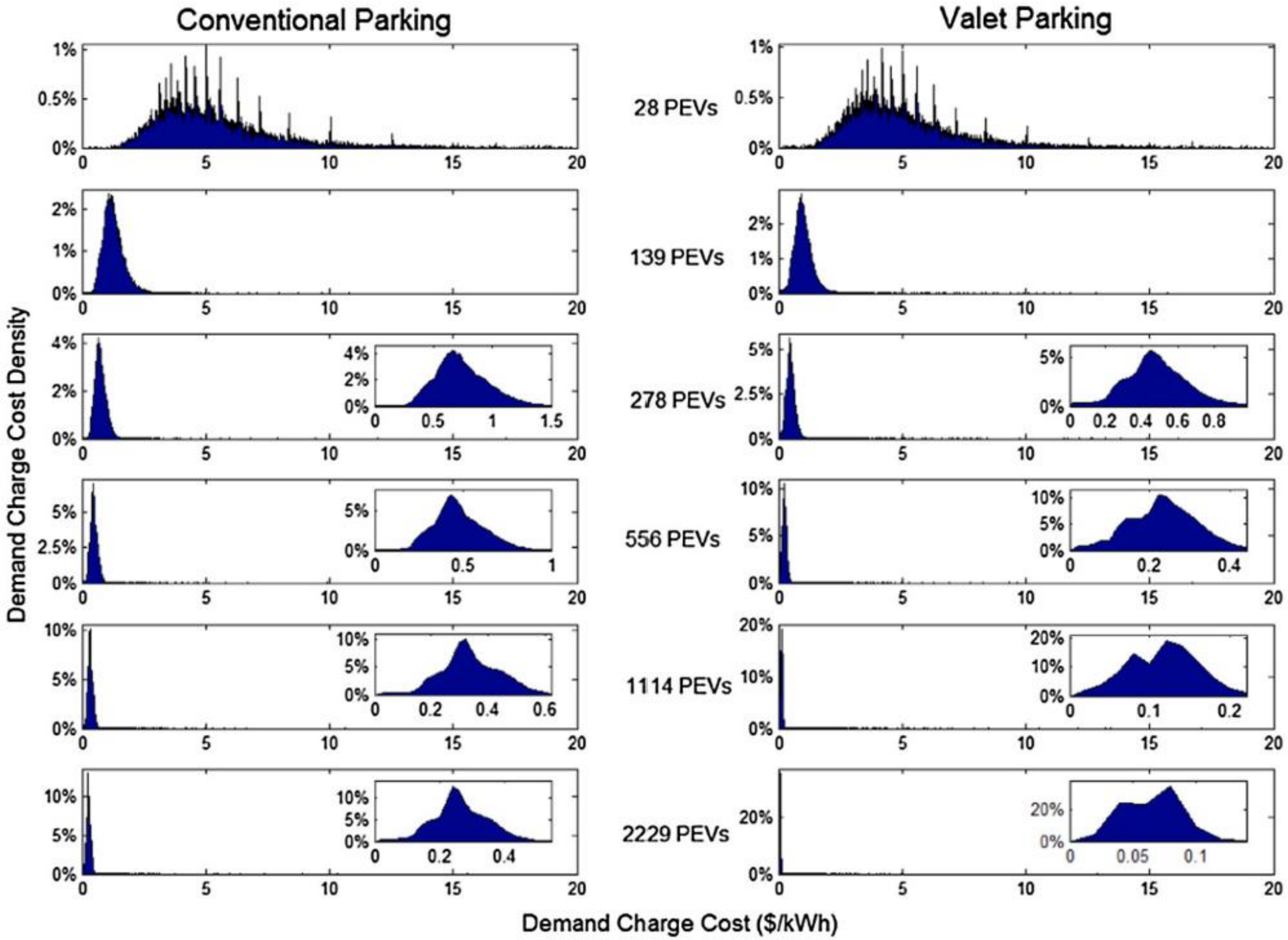


Robinius, Martin, Jochen Franz Linßen, Thomas Grube, Markus Reuß, Peter Stenzel, Konstantinos Syranidis, Patrick Kuckertz, and Detlef Stolten. *Comparative analysis of infrastructures: hydrogen fueling and electric charging of vehicles*. Forschungszentrum Jülich GmbH, Zentralbibliothek, Verlag, 2018.

BEV "Only" Case Will be Too Expensive

- At low levels of PEV use, demand charges are extremely high (>$1.00 per kWh).
- Increasing the number of available EVSE can increase the number of PEVs refueled & lower costs.
- Increasing refueling power increases demand charges in all scenarios. Increasing charger power from 44 kW to 120 kW ~ doubles demand charges

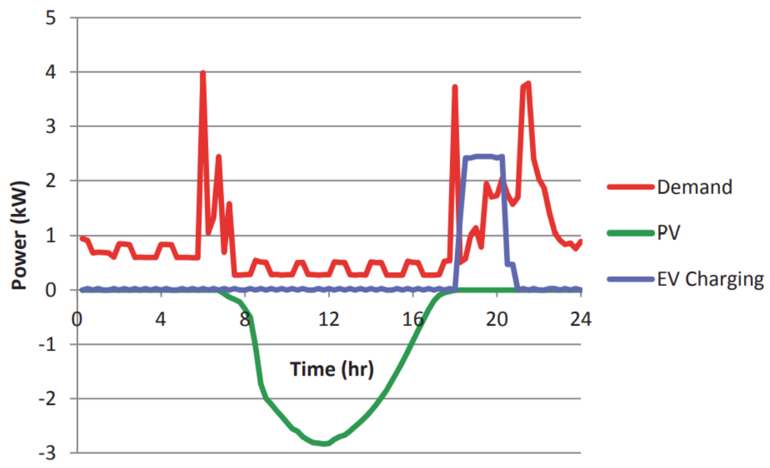


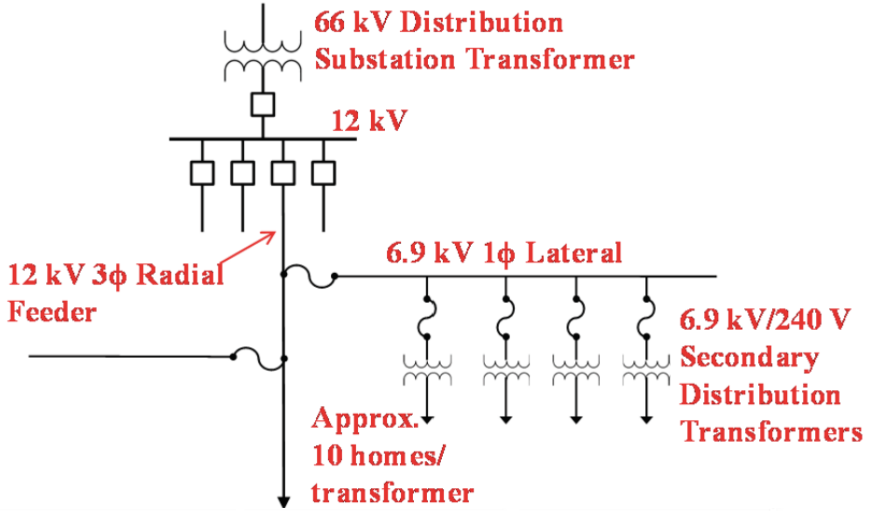


Flores, Robert J., Brendan P. Shaffer, and Jacob Brouwer. "Electricity costs for an electric vehicle fueling station with Level 3 charging." *Applied Energy* 169 (2016): 813-830.

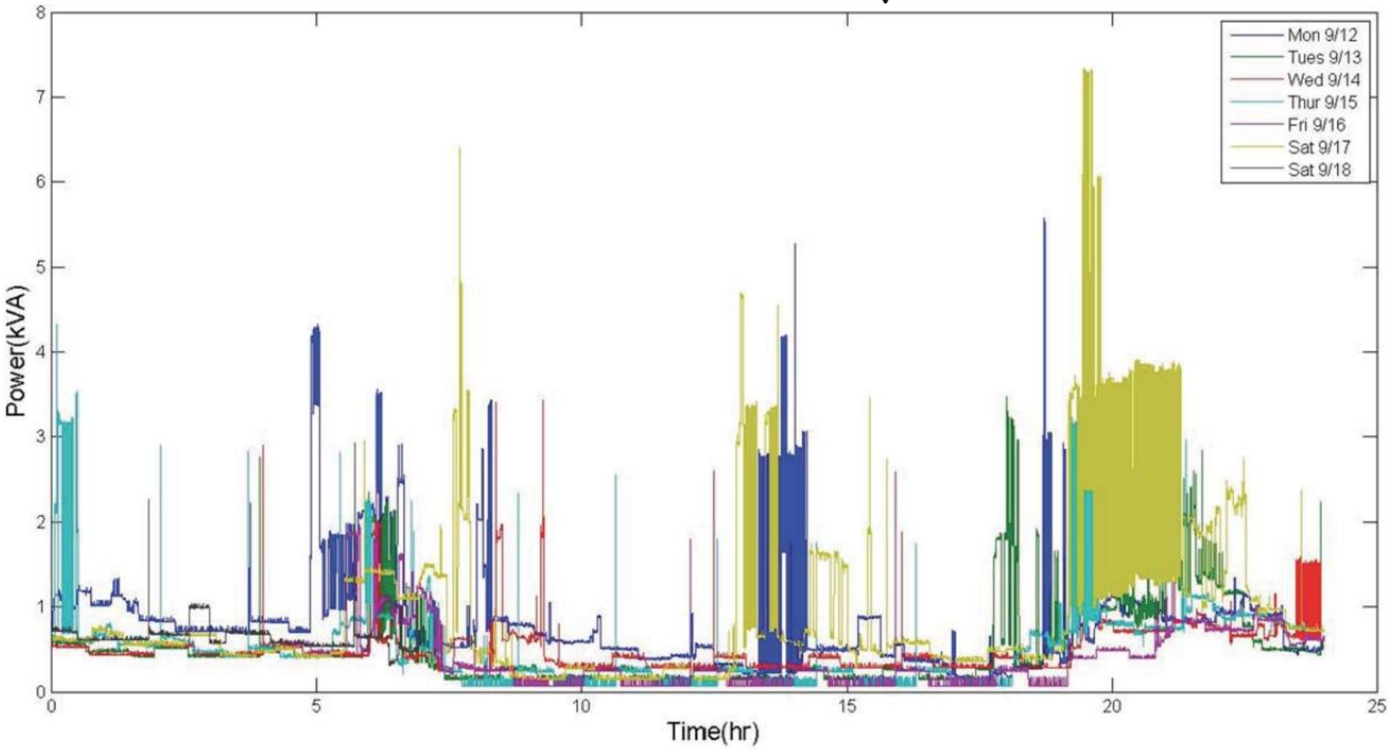
Residential Circuits Cannot Support 100% BEV

- Level 1 charging
  - 20A, 120V, 2.4kW
  - On average only 7/10 homes on the circuit can accommodate level 1 EV charging





- Level 2 charging
  - Up to 80A, 240V, 19.2kW
  - On average only 2/10 homes on the circuit can accommodate level 2 EV charging unless scheduled/controlled



Cinar, R. G. (2014). Applying Smart Grid Technologies to the Secondary Distribution System. University of California, Irvine.

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U.S. DOE “Hydrogen Energy Earthshot”

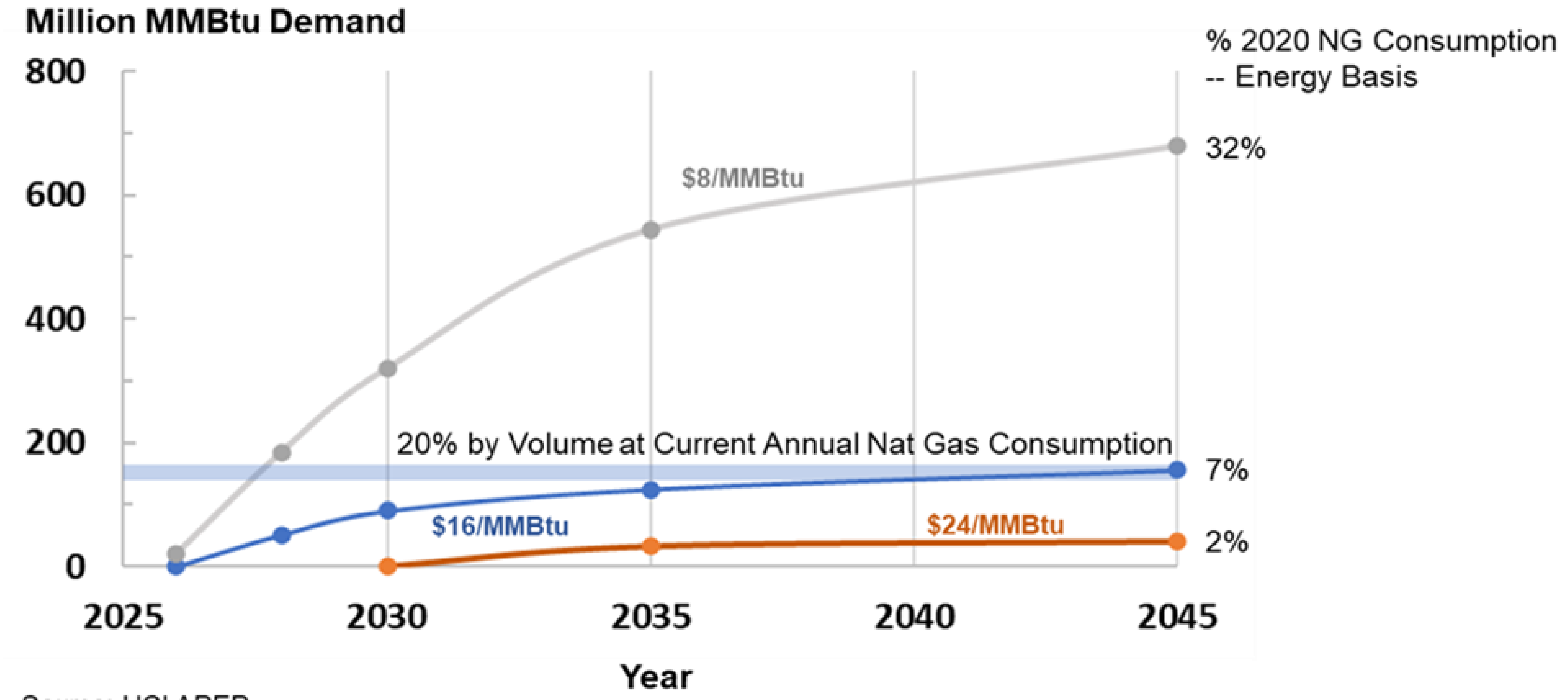
- Accelerate breakthroughs of more abundant, affordable, and reliable clean energy solutions within the decade

Office of Energy Efficiency & Renewable Energy » Hydrogen Shot

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Hydrogen

- Reduce RH_2 cost from ~$5/kg to $1/kg to unlock new markets for hydrogen, including steel manufacturing, ammonia, energy storage, and heavy-duty trucks

Grid Dispatch Modeling

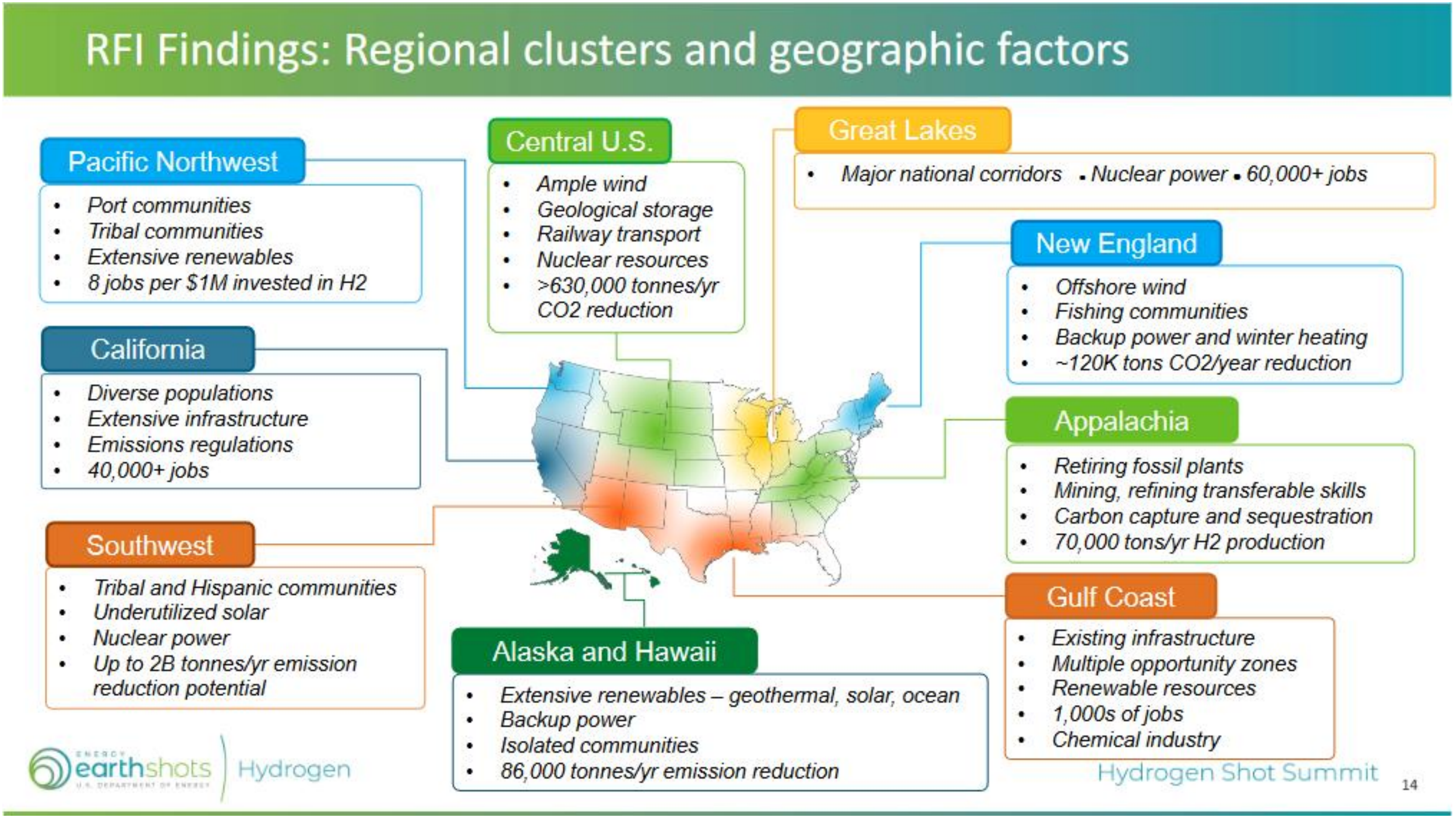


Source: UCI APEP

Grid dispatch modeling using CPUC RESOLVE model shows that use of renewable hydrogen for VER firming becomes cost optimal in some hours beginning at a cost of $24/MMBtu (just over $3/kg).

Federal Opportunity: US $8B for 4-8 Regional Hydrogen Hubs

"Hydrogen Shot, RFI Results, and Summary of Hydrogen Provisions in the Bipartisan Infrastructure Law"



https://www.federalregister.gov/documents/2022/02/16/2022-03324/notice-of-request-for-information-rfi-on-regional-clean-hydrogen-hubs-implementation-strategy

UC: Expertise, Facilities & Innovation

10 Campuses

UNIVERSITY OF CALIFORNIA

3 National Laboratories

Lawrence Berkeley (Est. 1931)

Los Alamos (Est. 1943)

Lawrence Livermore (Est. 1952)

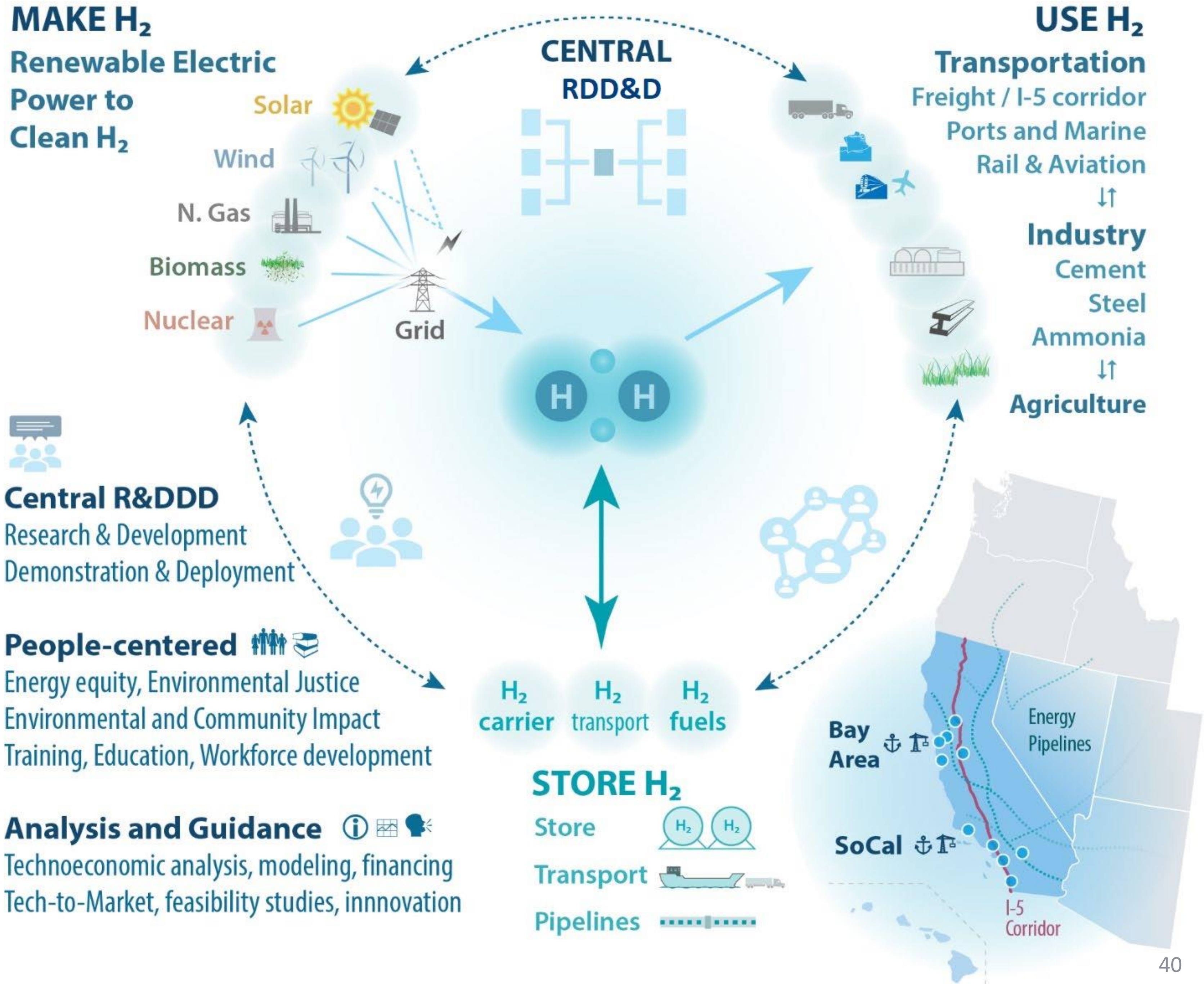
People (Expertise) | Tools (Unique facilities / testbeds) | Big Ideas (Innovative culture)

ARCHES

Alliance for Renewable Clean Hydrogen Energy Systems

A Public/Private Partnership

For a Clean California H_2 Ecosystem

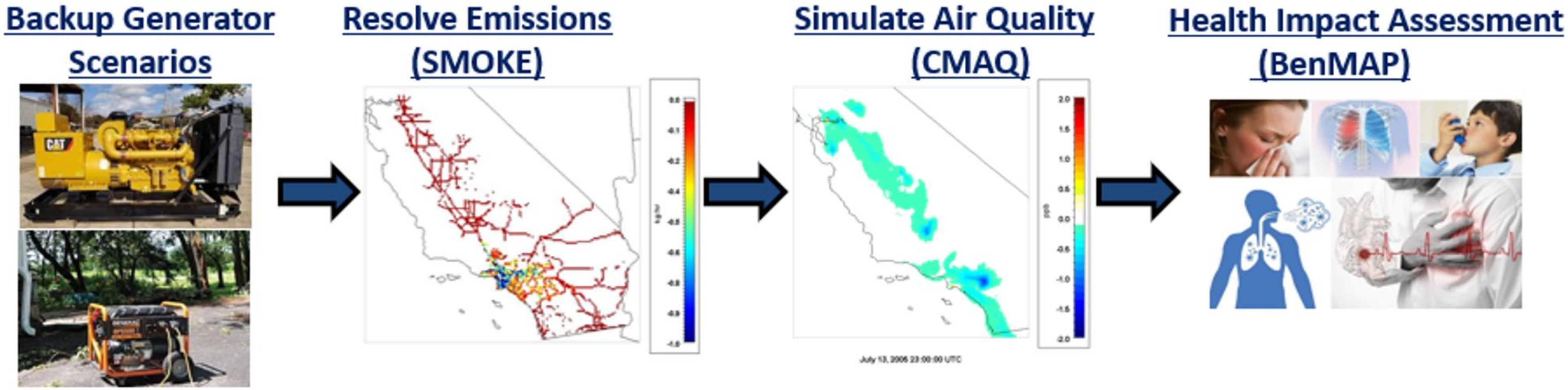


Outline

- Fossil Fuels are not sustainable or equitable
  - Resource scarcity and geographic availability
  - Air quality and climate pollutants
- How can we achieve zero emissions economy-wide?
  - Adopt more and more solar and wind power
  - Electrify as much as possible
  - Use electro-fuels & renewable fuels for everything else
- Hydrogen – the most important electro-fuel
- Air quality improvements of hydrogen & fuel cells
  - Fuel cells vs. backup diesel generator AQ impacts
- Challenges & “Potential” Challenges of hydrogen
  - Water use
  - Leakage & climate impact
  - Air quality (with combustion)

Air Quality Impacts of Diesel Backup Generators

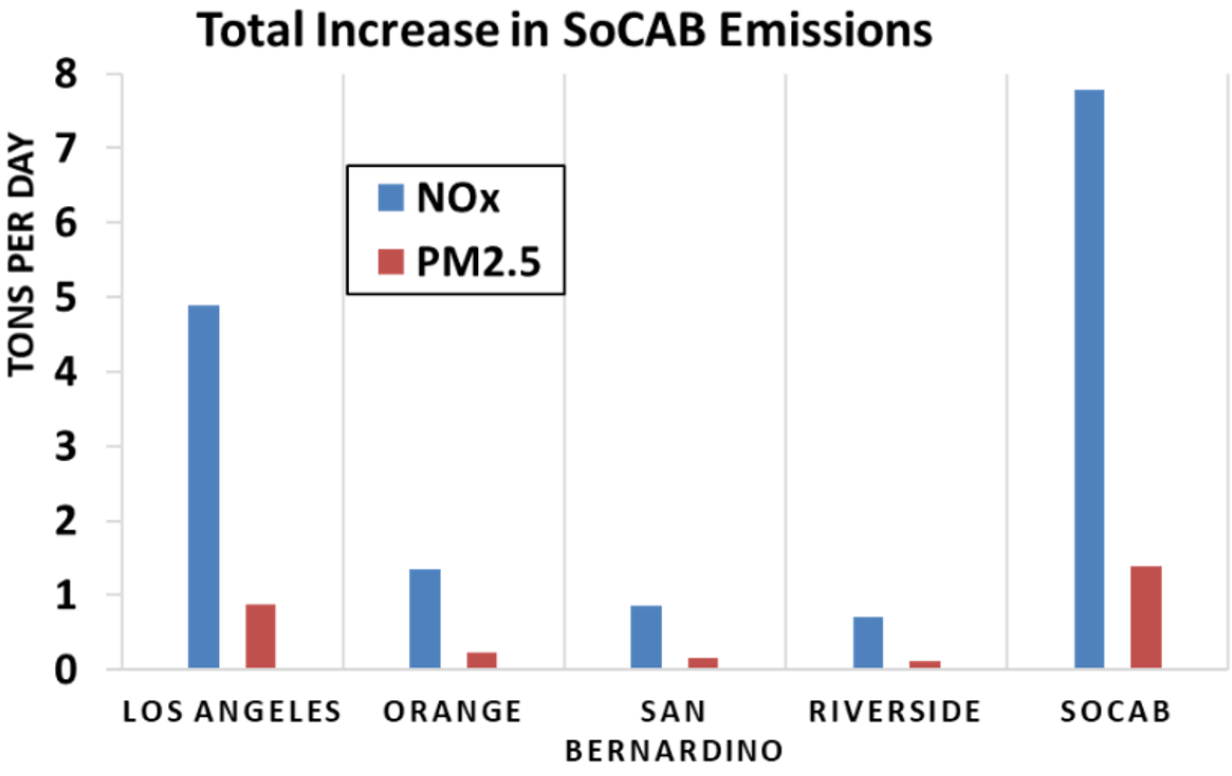
- The <u>only alternative</u> to H2 & Fuel Cells that is currently available and being widely implemented to deal with reliability and resilience (e.g., for wildfires & PSPS events) is *diesel backup generation*
- Recent APEP study

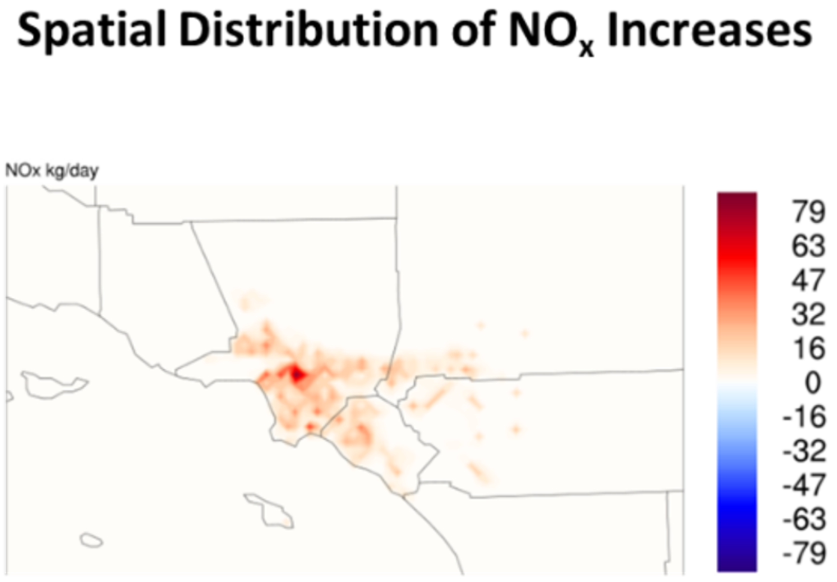


Overview of study methodology

Air Quality Impacts of H_2 & Fuel Cell Alternatives

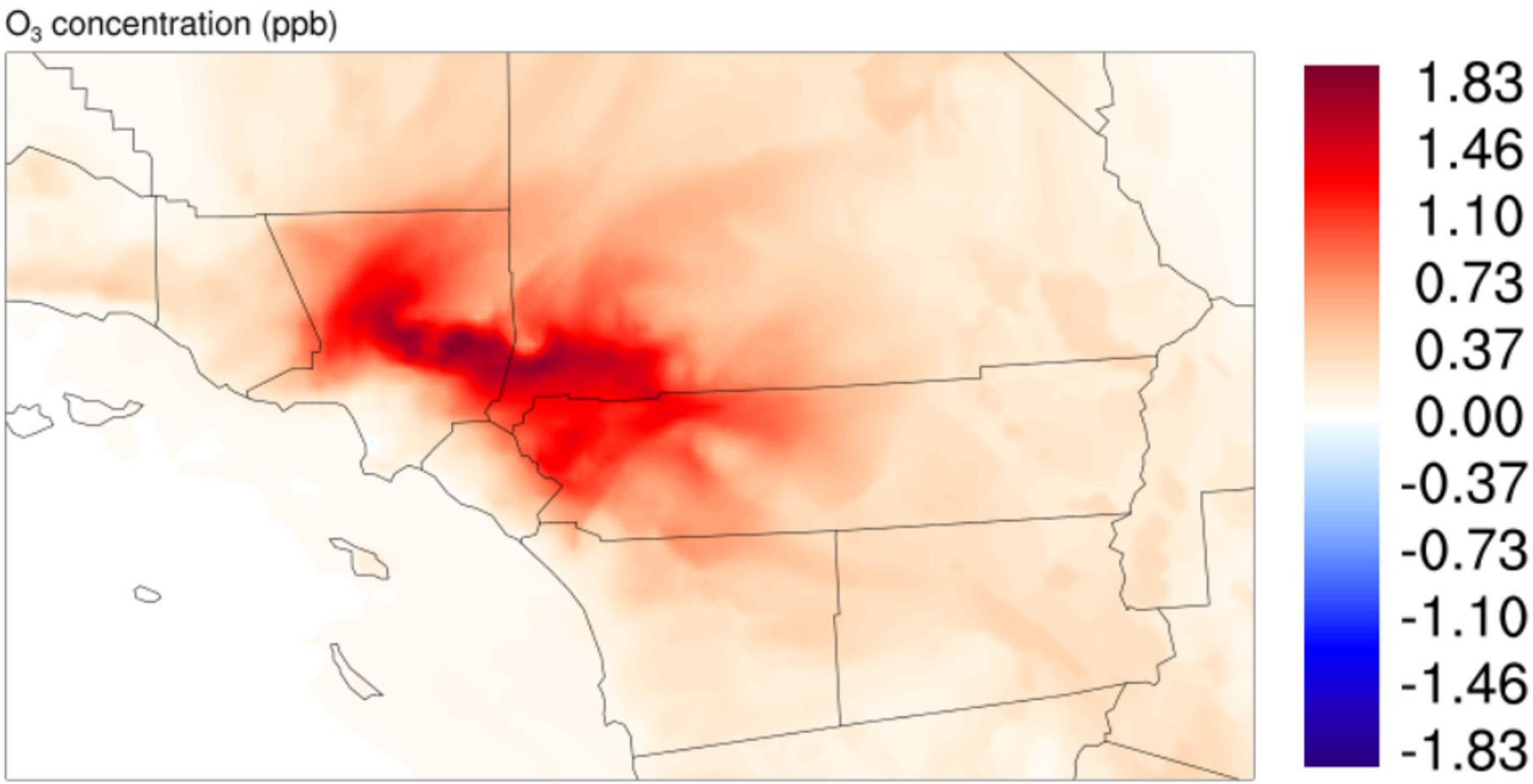
- Total increases of NOx and $PM_{2.5}$ and spatial location of NOx emissions increases of the Grid Disruption Scenario





Air Quality Impacts of Diesel Backup Generators

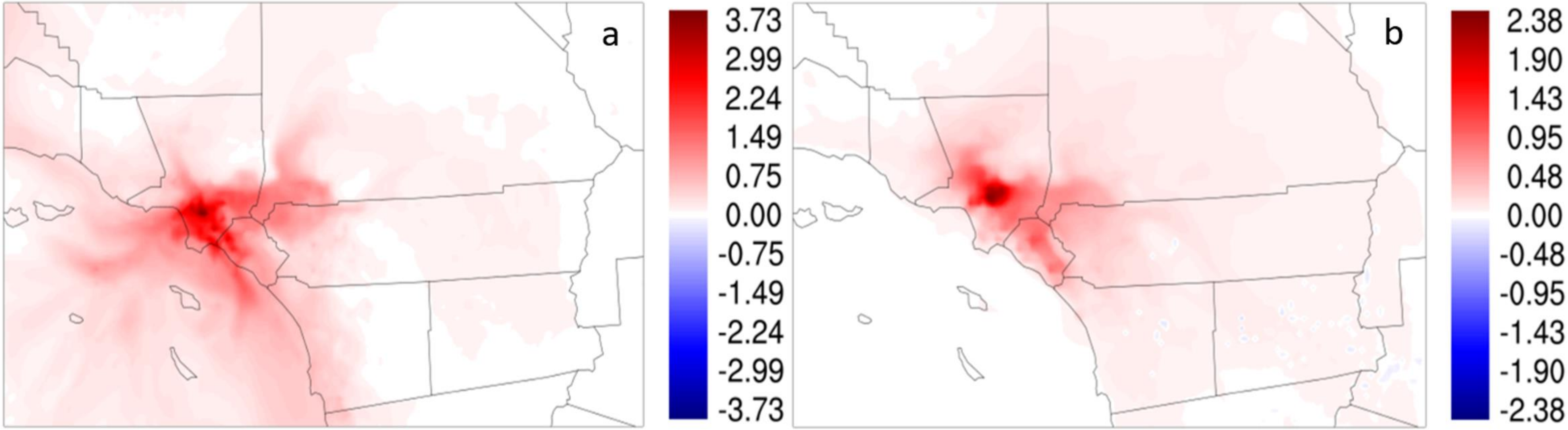
- Changes in ground-level ozone (O_3) due to grid disruption scenario



http://apep.uci.edu/PDF/Potential_Public_Health_Costs_from_Air_Quality_Degradation_During_Grid_Disruption_Events_070921.pdf

Air Quality Impacts of Diesel Backup Generators

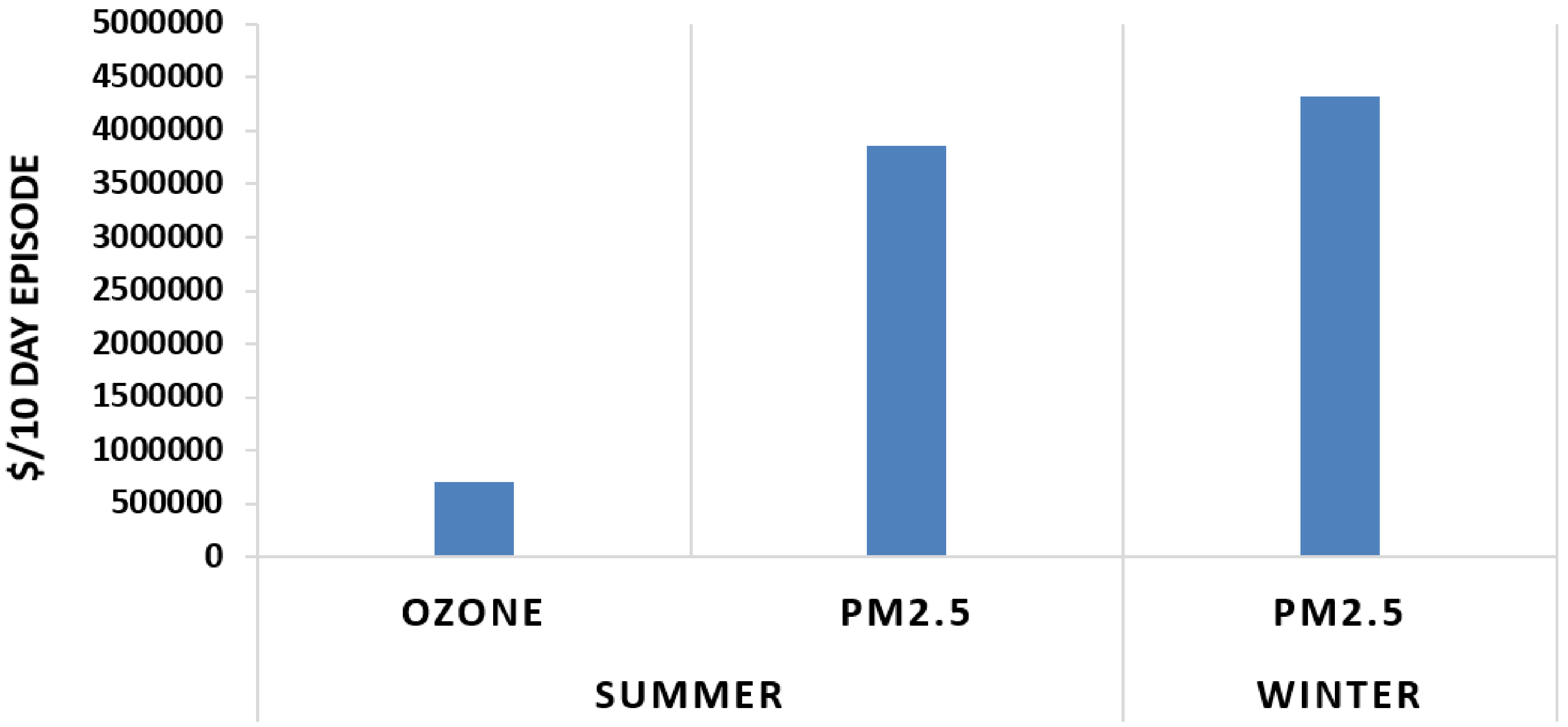
- Increases in ground level MD24H $PM_{2.5}$ from the widespread use of fossil backup generators during a grid disruption for winter (a) and summer (b) with units in $\mu g/m^3$



http://apep.uci.edu/PDF/Potential_Public_Health_Costs_from_Air_Quality_Degradation_During_Grid_Disruption_Events_070921.pdf

Air Quality Impacts of Diesel Backup Generators

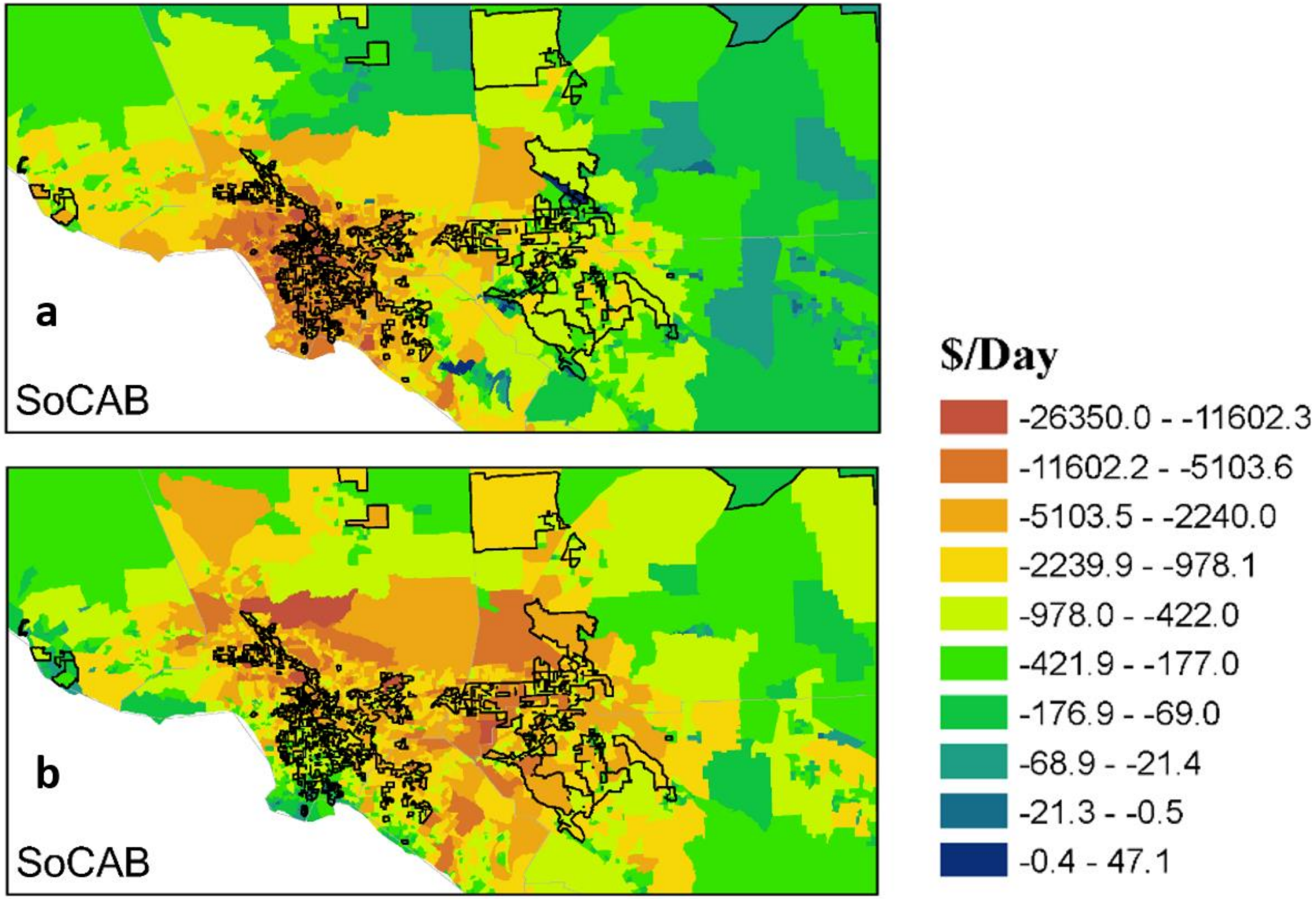
- Public health costs estimated from increased short-term exposure to ozone and $PM_{2.5}$ that results from fossil back-up generators operating during a grid disruption



http://apep.uci.edu/PDF/Potential_Public_Health_Costs_from_Air_Quality_Degradation_During_Grid_Disruption_Events_070921.pdf

Air Quality Impacts of Diesel Backup Generators

- Spatial distribution of public health costs from AQ degradation in (a) winter and (b) summer
- Boundaries for socially disadvantaged communities (DAC) according to CalEnviroScreen 3.0 are outlined
- DACs are disproportionately impacted



http://apep.uci.edu/PDF/Potential_Public_Health_Costs_from_Air_Quality_Degradation_During_Grid_Disruption_Events_070921.pdf

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  - Fuel cells vs. backup diesel generator AQ impacts
- Challenges & "Potential" Challenges of hydrogen
  - Water use
  - Leakage & climate impact
  - Air quality (with combustion)

Water Use for Hydrogen via Electrolysis

- Future “Hydrogen Economy” uses less water than current fossil fuel energy conversion economy
- Anecdotes:
  - All Southern California cars could be powered by less than 1% of CA aqueduct flow
  - Any home could be hydrogen powered with 1 additional toilet flush (1.6 gallons) / day

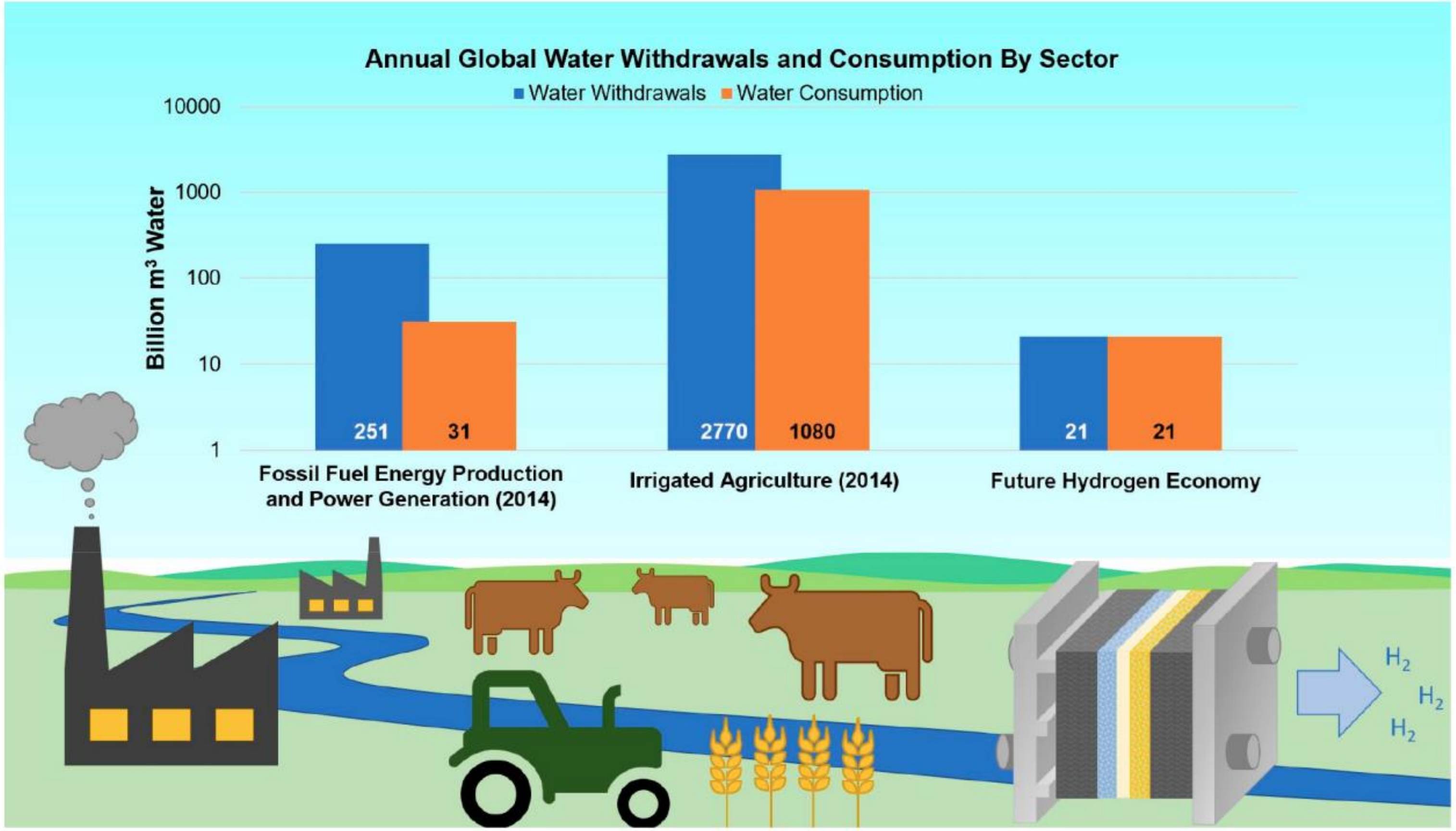


Figure 1. Comparison of the global freshwater withdrawal and consumption of three different sectors: fossil fuel energy production and power generation, agriculture, and the implementation of a global hydrogen economy. Note that the bar chart is on a log scale.[3,5]

Rebecca R. Beswick, Alexandra M. Oliveira, and Yushan Yan, *ACS Energy Letters* **2021** *6* (9), 3167-3169, DOI: 10.1021/acsenergylett.1c01375

Water Use for Hydrogen via Electrolysis

- Amount of water is not a problem

Water Consumption for Green Hydrogen

… “The water consumption of electricity gen ssil electricity compared to solar and wind power … Us lytic hydrogen has an overall water consumption of ~130 l hydrogen production powered by solar or wind has a gH_2 (Shi et al., 2020). With a 30 L/kgH_2 water consumption Mt/yr demand for hydrogen using green H_2 would consu which is three orders of magnitude less than global fresh ion m^3/yr (UNESCO, 2019), making the water footprint of gible from a global perspective.”

resh water to produce hydrogen (Bhardwaj et al. 2021;

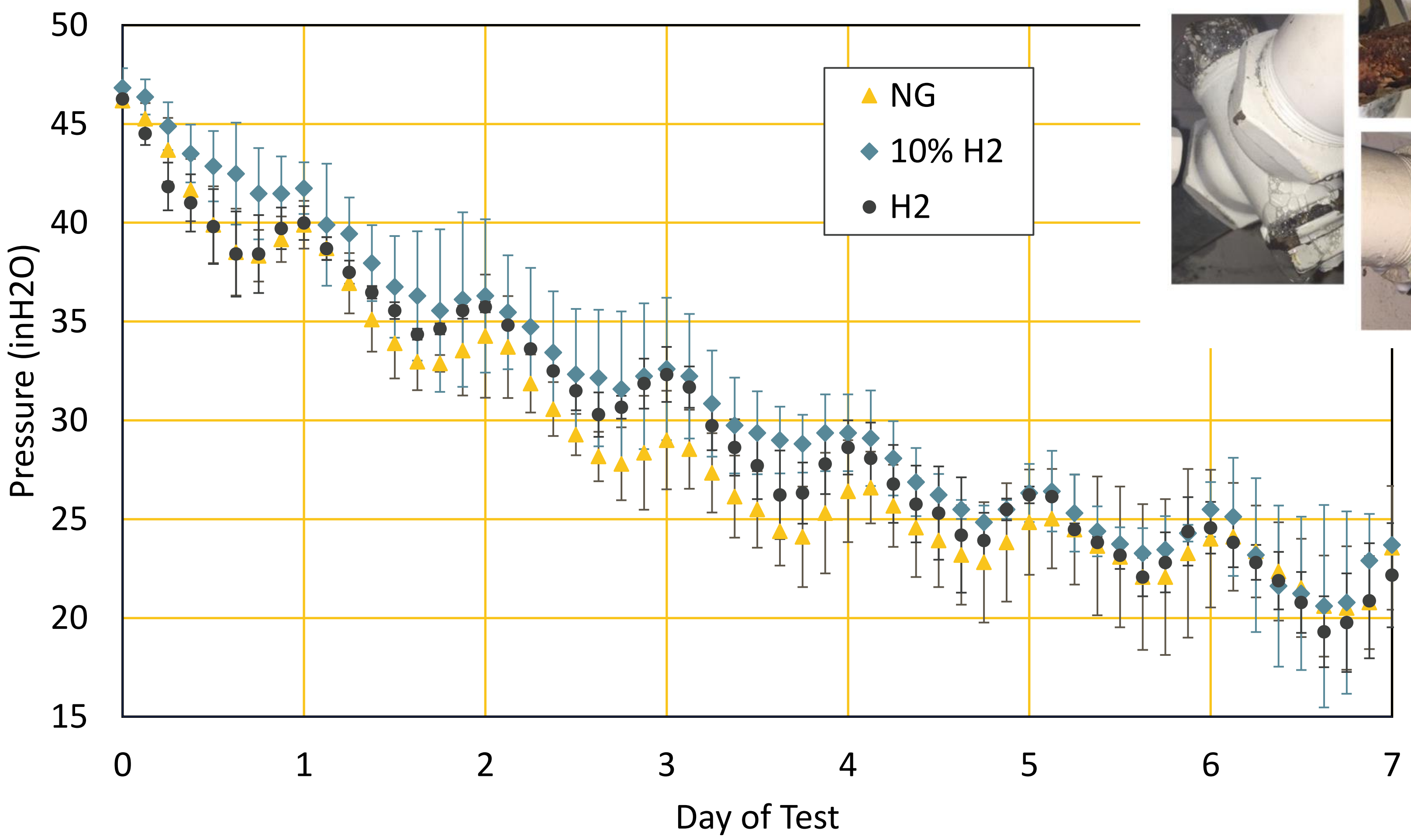
Challenges remain w.r.t. locations of water availability & distributed/desert environments of renewables

, E., Braverman, S., Lou, Y., Smith, G., Bhardwaj,
er, J., McCormick, C. and Friedmann, J., 2021.
hydrogen in a circular carbon economy: Opportunities
nd limits. *Columbia Center for Global Energy Policy*.

H_2 leakage from NG Infrastructure

H2 injection into existing natural gas infrastructure (low pressure)

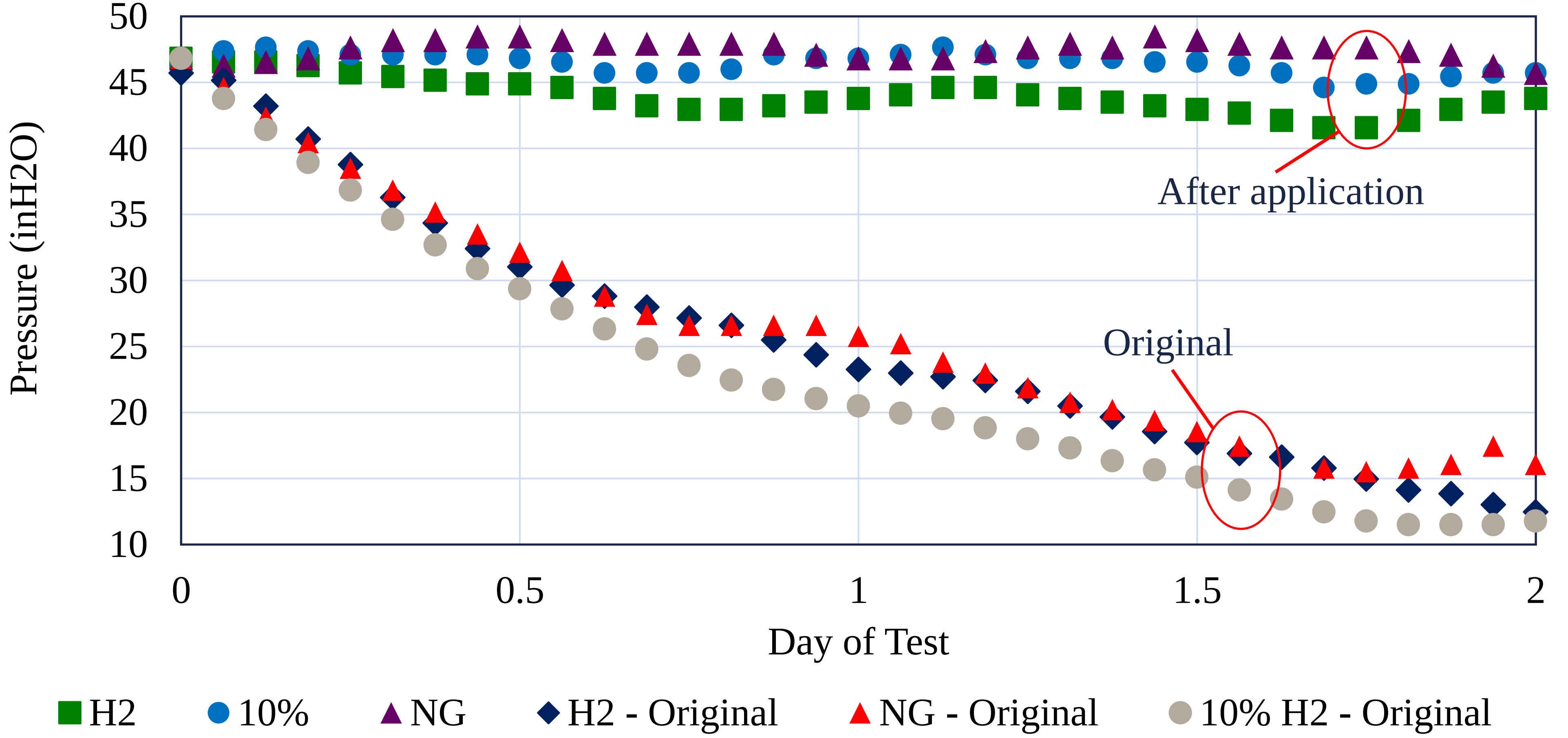
- NG, H_2/NG mixtures, H_2 leak at same rate



H_2 leakage from NG Infrastructure

H2 injection into existing natural gas infrastructure (low pressure)

- Copper epoxy applied (Ace Duraflow®) to mitigate H_2 leaks



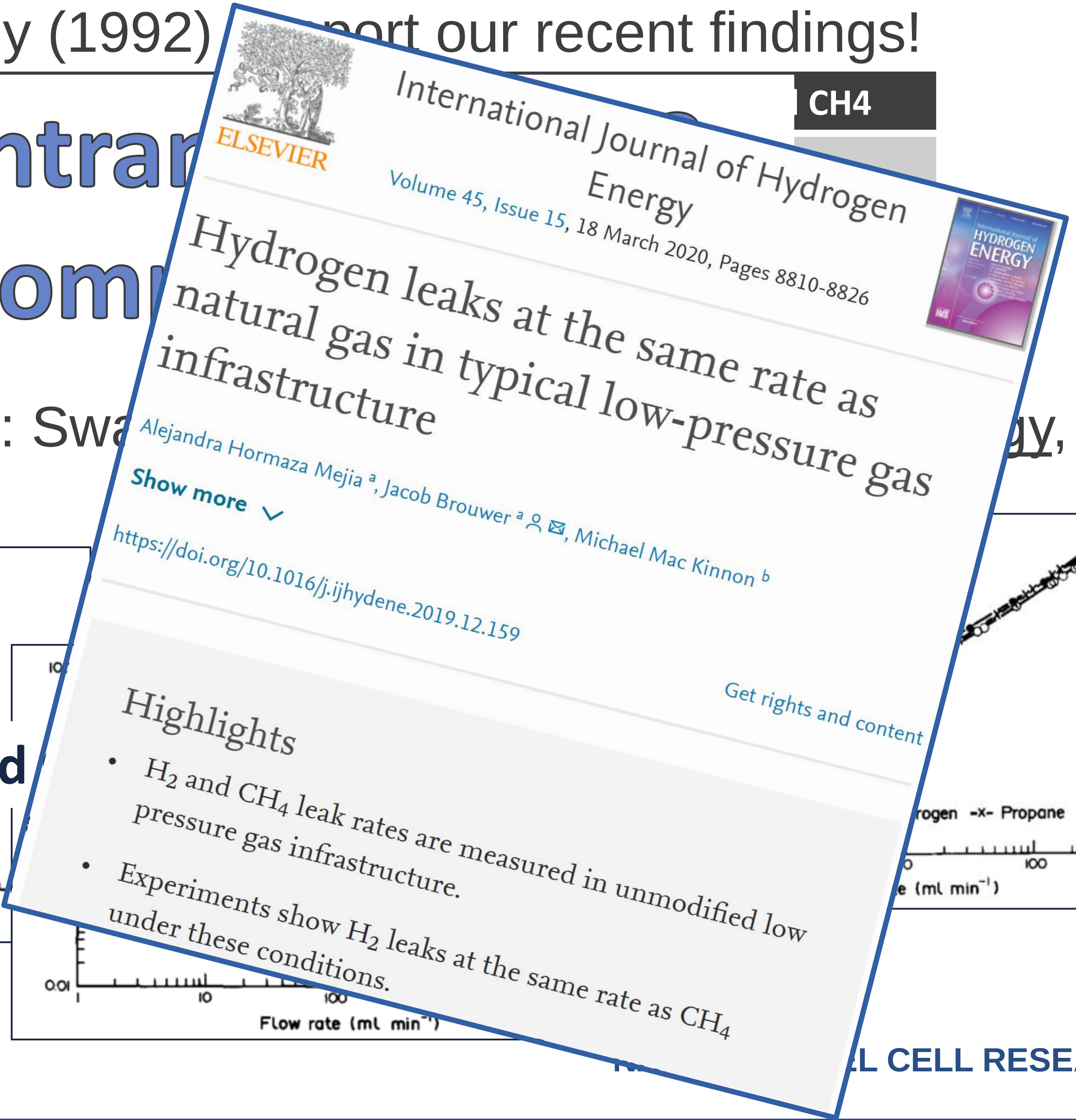
H_2 leakage from NG Infrastructure

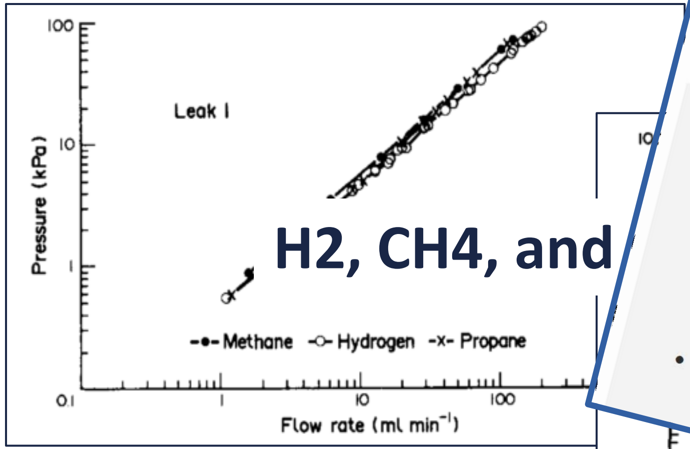
- Results from a previous study (1992) support our recent findings!

Lea	CH4
~~Diffusi~~	
~~La~~	
~~Tu~~	

Entran
Com

- First publication on this topic: Swa... gy, Vol. 17, pp. 807-815, 1992.





H2, CH4, and

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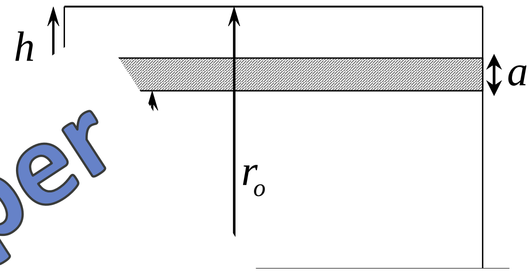
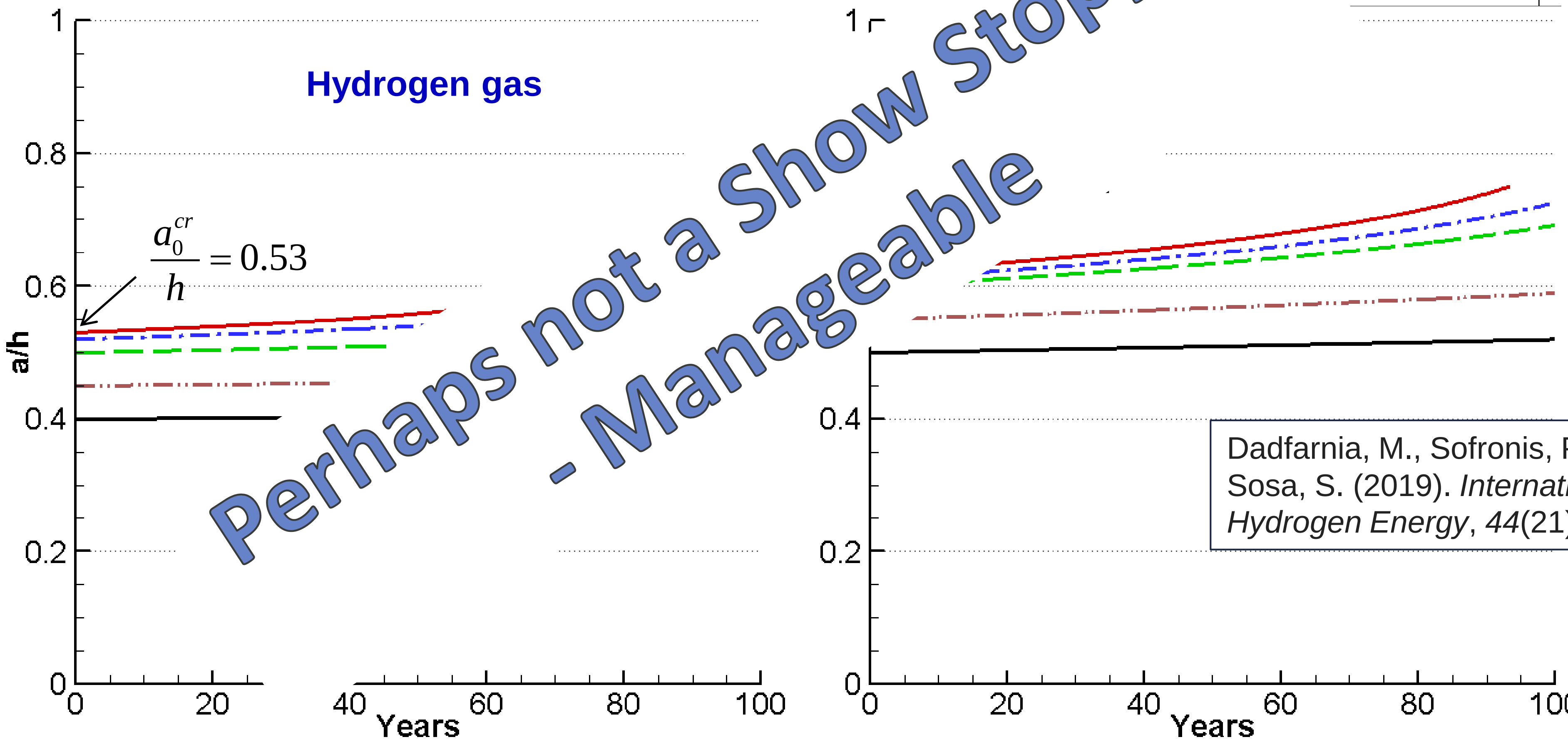
NFCRC

Existing Pipeline Embrittlement – mostly in Transmission

- Simulation of H_2 embrittlement and fatigue crack growth with UIUC
- Fatigue crack growth in 6” SoCalGas pipeline



0.188” wall thickness: $(h = 0.188'' = 4.8\ \text{mm})$

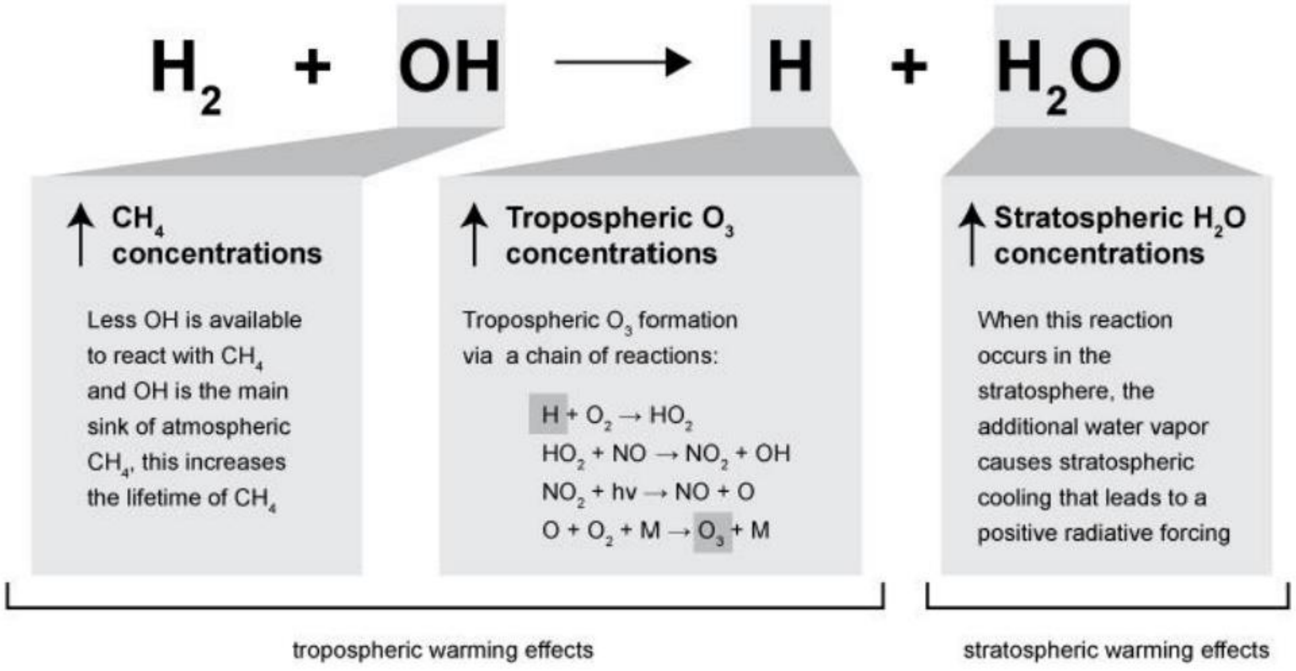


Dadfarnia, M., Sofronis, P., Brouwer, J., & Sosa, S. (2019). *International Journal of Hydrogen Energy*, *44*(21), 10808-10822.

Hydrogen Leakage – Climate Impacts

- Recent EDF study: Hydrogen an indirect climate pollutant
- Reduces OH radical pool, leaving methane in atmosphere longer
- Makes water in stratosphere, which has warming effect

} Good Atmospheric Chemistry



<u>Study Could be Improved</u>:

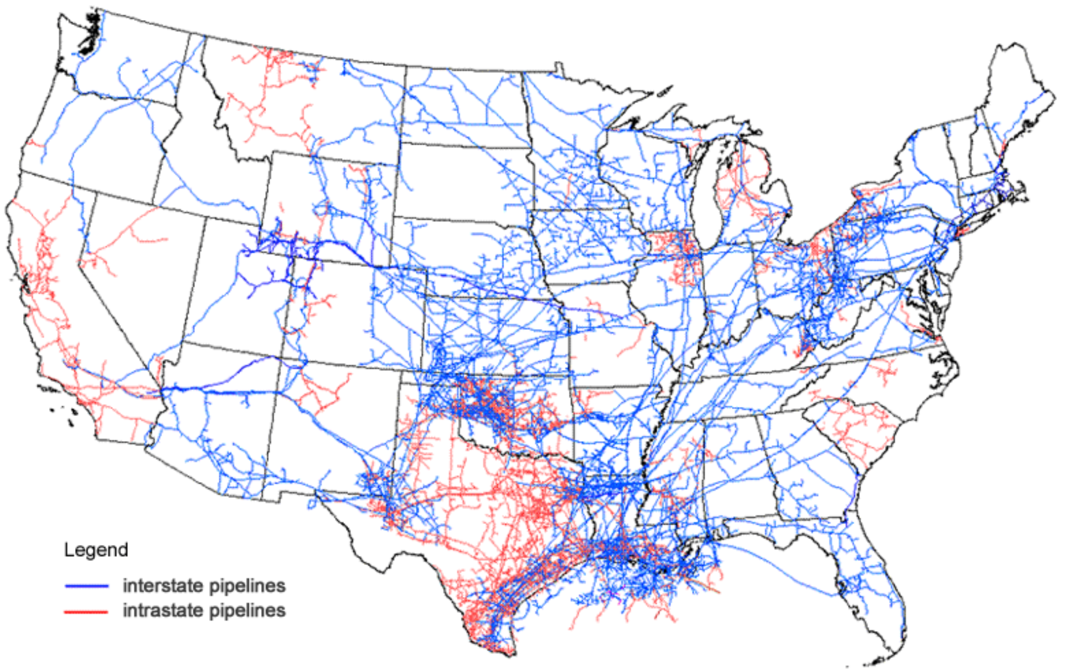
(1) Better analysis/assumptions for H_2 leakage rate

(2) Corresponding reduction in methane (CH_4) emissions

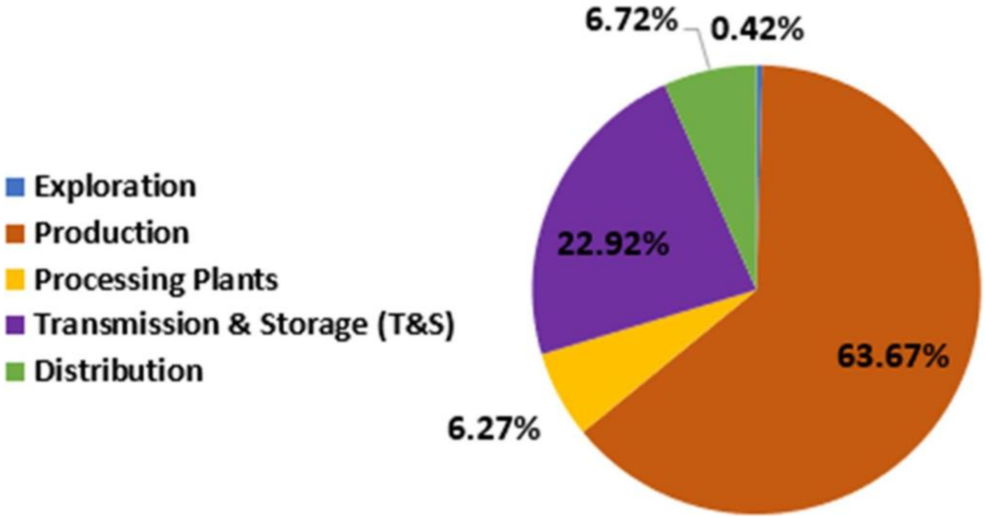
Ocko, I. B. and Hamburg, S. P.: Climate consequences of hydrogen leakage, Atmos. Chem. Phys. Discuss. [preprint], https://doi.org/10.5194/acp-2022-91, in review, 2022.

Fossil Methane – Very Different System vs. Renewable H_2

- Methane emissions: 87% in production, transmission/storage (many super-emitters)
- Distribution systems – mostly plastic pipe with quite low leakage rates
- Hydrogen will be mostly made from local renewable electricity & require distribution
- Fossil natural gas requires production/extraction & interstate transmission



Source: U.S. Energy Information Administration, *About U.S. Natural Gas Pipelines*



Natural gas leaks in Sectors of NG system

Heydarzadeh, Z., Mac Kinnon, M., Thai, C., Reed, J., & Brouwer, J. (2020). Marginal methane emission estimation from the natural gas system. *Applied Energy*, *277*, 115572.

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NATIONAL FUEL CELL RESEARCH CENTER

Proposed New SoCalGas Infrastructure: Angeles Link

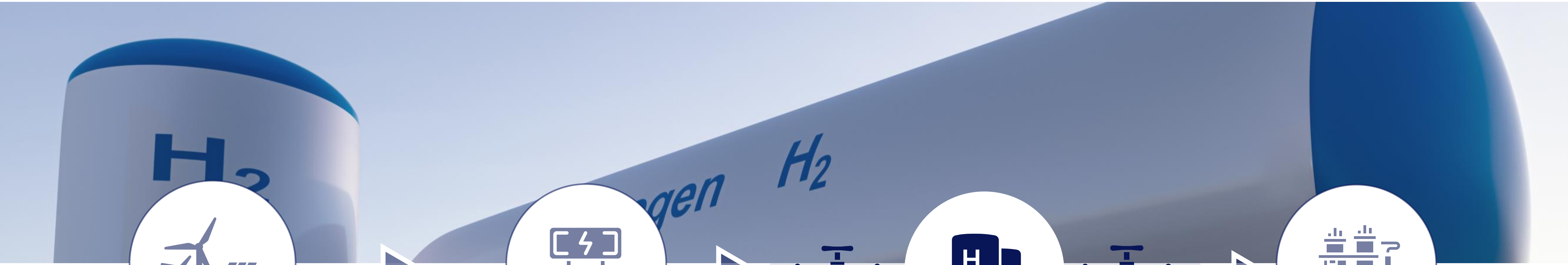
- Proposal to develop what would be the nation's largest green hydrogen energy infrastructure system to deliver clean, reliable energy to the Los Angeles region
- When built, the Angeles Link green hydrogen system could reduce greenhouse gas emissions, improve local air quality, and help SoCalGas serve California's energy needs for generations to come.
- Angeles Link can drive deep decarbonization of heavy-duty transportation, dispatchable electric generation, industrial processes and other hard-to-electrify sectors of the SoCal economy
- **Timing: Memo account application filed with California Public Utilities Commission in February 2022**

ANGELES LINK

Shaping the Future with Green Hydrogen.

From: Yuri Freedman, Southern California Gas Company, 2022.

SoCalGas' Angeles Link: How Could it Work?



25-35 GW Curtailed/New/Solar/Wind
2 GW Batteries

Start with 100% renewable electricity

Utilize renewable electricity that is on the grid or being curtailed to provide power to electrolyzer

10-20 GW Electrolyzers

Convert it into green hydrogen with advanced electrolyzers

Electrolysis splits water into hydrogen and oxygen -- with virtually zero greenhouse gas and criteria pollutant emissions

Hydrogen infrastructure

*Deliver it into LA Basin by pipeline

SoCalGas will use its expertise in pipeline infrastructure and potential rights-of-way to safely deliver hydrogen from outside of LA Basin to industries that need it most

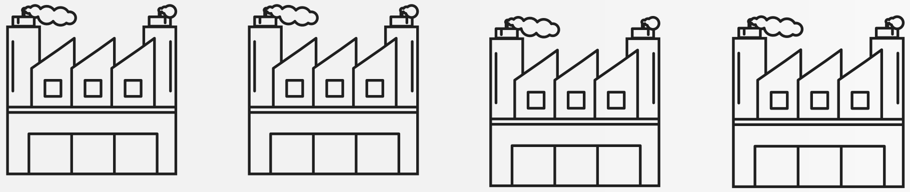
14.3 million tons of CO_2 emissions eliminated

Use it to decarbonize sectors that can't be plugged in

Dispatchable electric generation and hard-to-electrify sectors like manufacturing and heavy-duty transportation are the missing links to solving the most challenging aspect of decarbonization; green hydrogen offers the solution

From: Yuri Freedman, Southern California Gas Company, 2022.

SoCalGas' Angeles Link: Project Benefits



Haynes | Scattergood | Harbor | Valley

Could provide **zero-carbon green hydrogen** to assist LADWP's conversion of its natural gas electric generation facilities

+

Displace **3 million gallons of diesel per day**

reducing NOx **(24,721 tons per year)**, $PM_{2.5}$ and other hazardous air pollutants associated with diesel emissions

=

Could significantly reduce regional natural gas demand to potentially remove **14.3 million metric tons of CO_2**

→

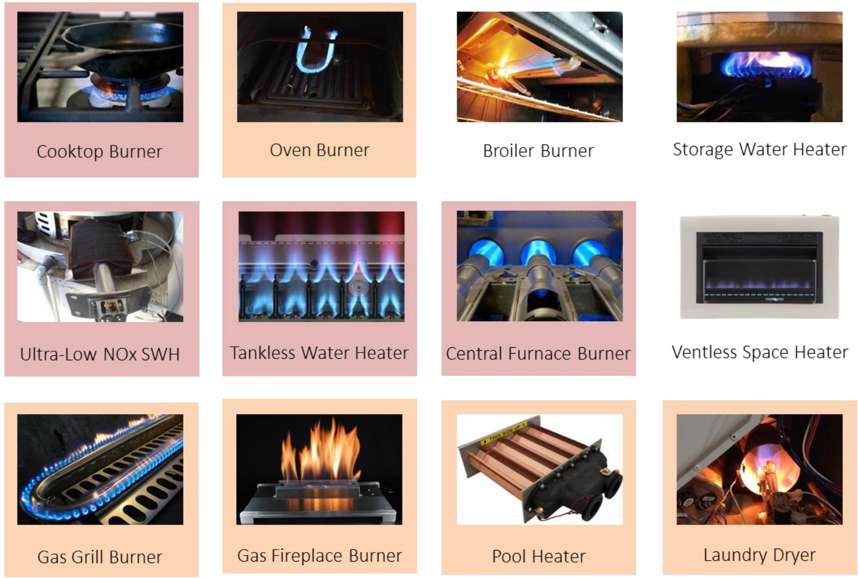
Equivalent to eliminating 57% of LA County's large stationary source CO_2 emissions

From: Yuri Freedman, Southern California Gas Company, 2022.

Combustion Emissions – Appliances

Summary

- Hydrogen addition improves emissions for most un-modified burners
  - Those using ~80% NG / 20% H_2
- Understanding established to propose modifications to accommodate even more hydrogen



CFD
Experiment Test + CFD
} Burner Performance Reports Available for each—Appendices for Final Report

	1. Cooktop			2. Oven			3. Gas Fireplace			4. Low NO_x SWH			5. Tankless WH		
Fuel Mixture	NO_x	CO	Upper Limit	NO_x	CO	Upper Limit	NO_x	CO	Upper Limit	NO_x	CO	Upper Limit	NO_x	CO	Upper Limit
CH_4 - H_2	-23%	-14%	55%	0%	-38%	30%	3966%	-100%	100%	0%	+27%	10%	-20%	-10%	>20%
CH_4 - CO_2	-51%	+58%	35%	-92%	+114%	15%	-76%	- 99.9%	45%	-46%	+334%	15%	-45%	+350%	15%

	6. Space Heater			7. Pool Heater			8. Outdoor Grill			9. Laundry Dryer		
Fuel Mixture	NO_x	CO	Upper Limit	NO_x	CO	Upper Limit	NO_x	CO	Upper Limit	NO_x	CO	Upper Limit
CH_4 - H_2	-4%	-14%	45%	-96%	+762%	NA	+128%	-94%	>40%	-62%	-34%	NA
CH_4 - CO_2	-47%	+898%	30%	-99%	+2400%	20%	-100%	-78%	40%	-81%	+118%	15%

Key (NO_x/CO)
% Increase
% Decrease
No Change

Combustion Emissions – Industrial Burners

Quantified NO_x and CO emissions relative to operation on 100% Natural Gas (CH_4)

- **Variation for burners, pollutants, and fuels**

Fuel Mixture	1. LSB		2. SSB		3. MTC		4. Oxygas		5. HSJ	
	NO_x	CO	NO_x	CO	NO_x	CO	NO_x	CO	NO_x	CO
76% CH_4 - 24% H_2	111%	-40%	-64%	-40%	200%	-50%	16%	-20%	48%	-11%
98% CH_4 - 2% CO_2	-5%	11%	-3%	3%	-17%	1%	-4%	3%	-2%	3%
94% CH_4 - 6% C_2H_6	5%	8%	2%	3%	3%	4%	5%	8%	3%	4%
95% CH_4 - 5% C_3H_8	9%	3%	3%	6%	5%	4%	4%	6%	8%	5%

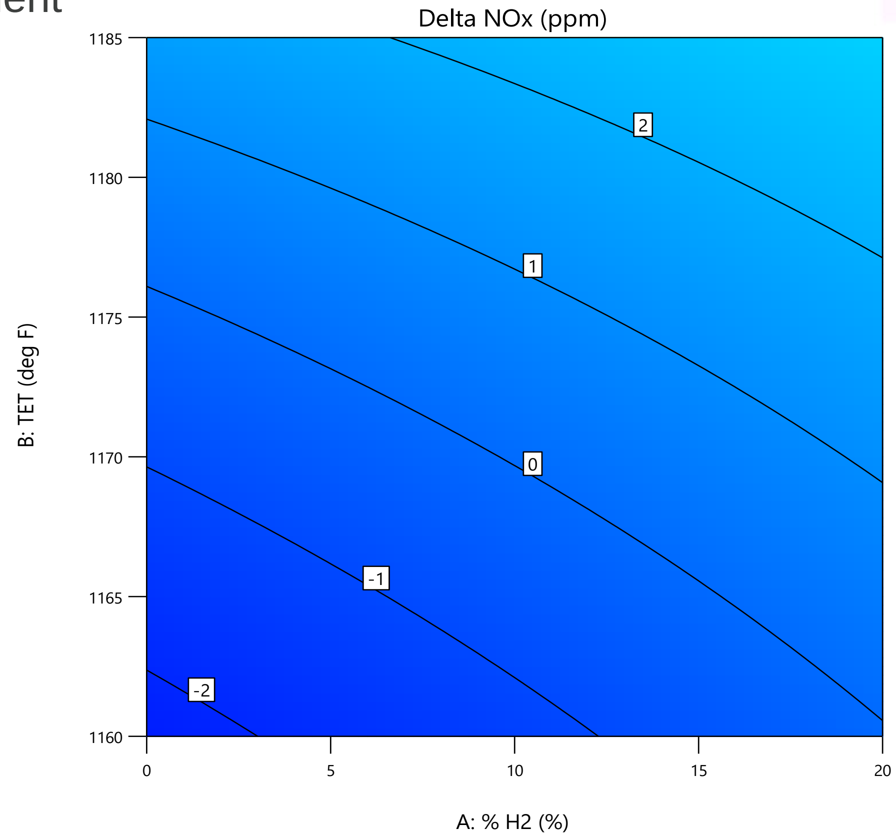
Fuel Mixture	6. GTC		7. RT		8. IRB		9. SB	
	NO_x	CO	NO_x	CO	NO_x	CO	NO_x	CO
76% CH_4 - 24% H_2	-20%	-50%	233%	-35%	-60%	-10%	58%	-13%
98% CH_4 - 2% CO_2	-3%	0%	-2%	2%	-3%	-3%	-2%	5%
94% CH_4 - 6% C_2H_6	3%	3%	0%	4%	2%	-5%	3%	4%
95% CH_4 - 5% C_3H_8	3%	3%	5%	4%	1%	-5%	8%	6%

Key (NO_x/CO)
% Increase
% Decrease
No Change

Colorado, Andres; McDonell, Vincent. 2016. *Effect of Variable Fuel Composition on Emissions and Lean Blowoff Stability Limits.* California Energy Commission. Publication number: 500-13-004

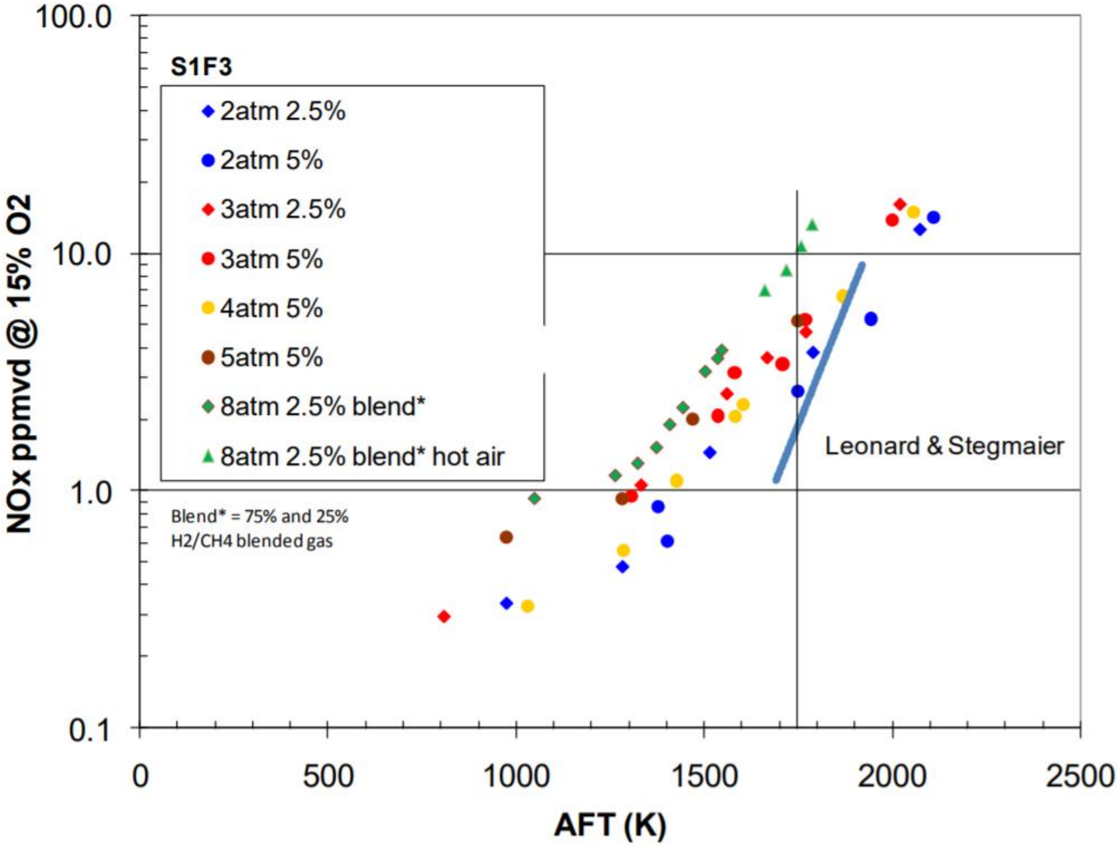
Combustion Emissions – Gas Turbines

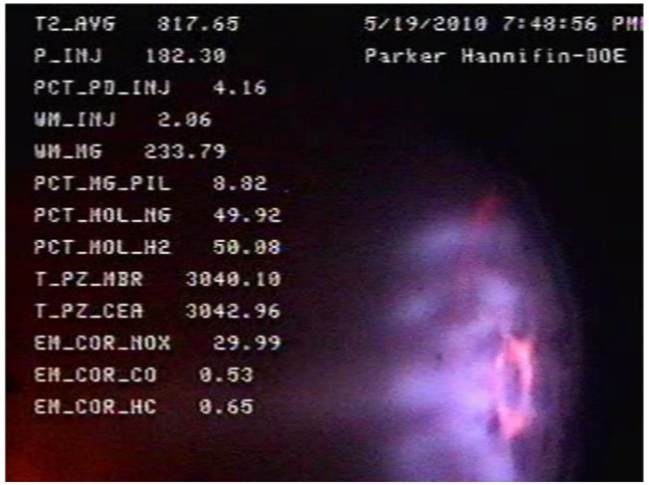
- OEMs are conservative in their developments and targets
  - "Slight increase in NOx may result"
  - This has been the case for decades
    - Original NOx limits were 42 ppm, then 25 ppm, then 9 ppm and now 2.3 ppm
      - ~20x reduction attained through technology development
  - Combustion science guides the development
    - Well established
    - Optimization of local combustion temperatures via flow split adjustments
  - UCI measurements on commercial 60kW engine illustrate that NOx can actually be reduced when adding hydrogen
    - Modification of air distribution within the combustion system can take advantage of the wider flammability limits offered by hydrogen
  - UCI currently testing a 200kW version



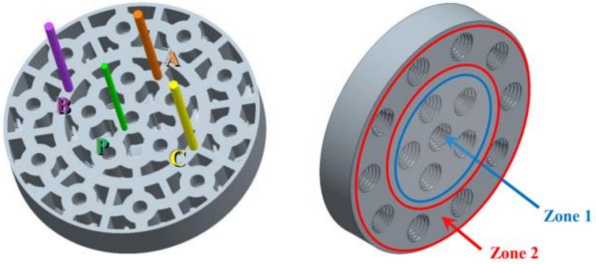
Combustion Emissions – Gas Turbines

- Hydrogen faster flame speed allows <u>more lean</u> operation
- Micro-mixing full-scale GT design





Parker



(a) (b)

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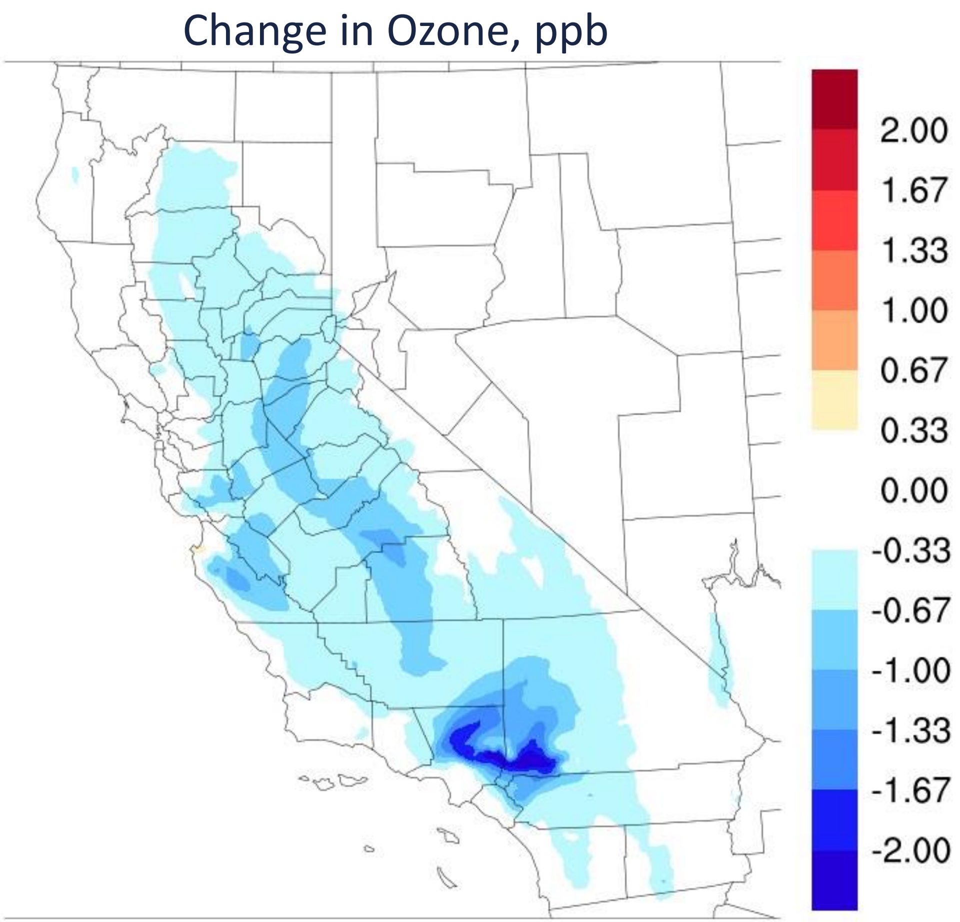
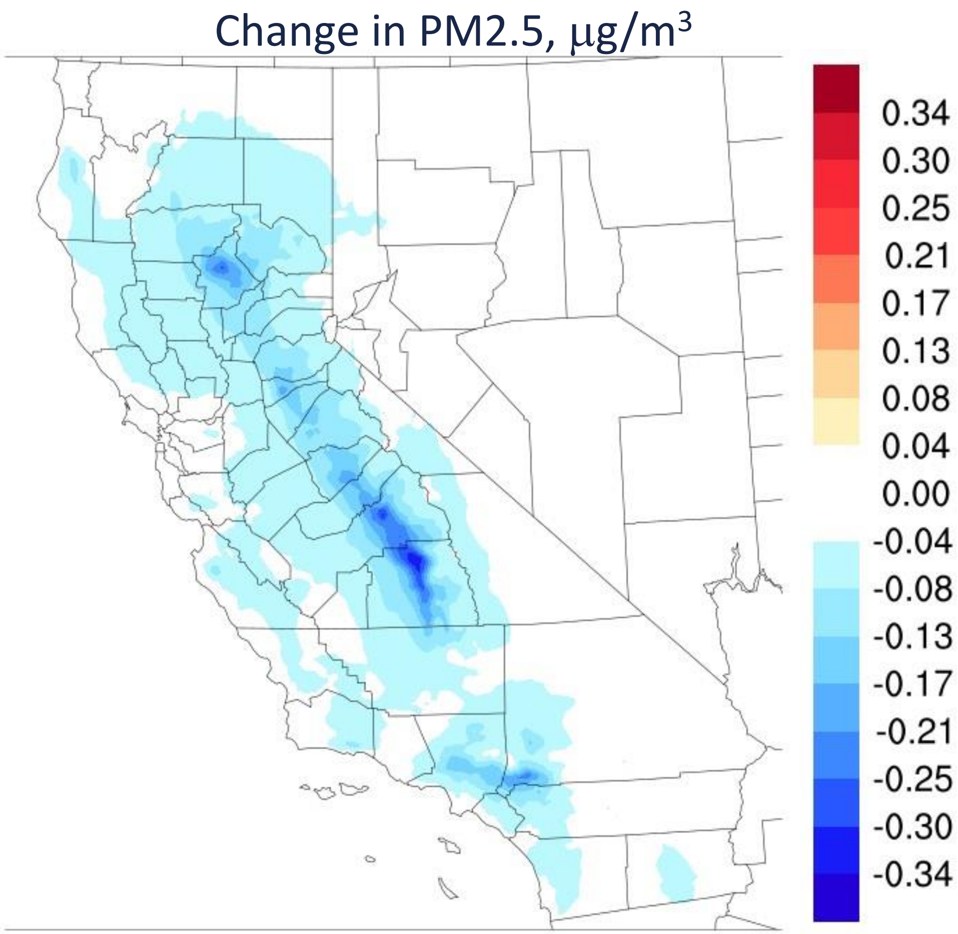
https://www.osti.gov/servlets/purl/1030641

Air Quality Implications

- Example: Adaptation of preferred equipment @ 20% hydrogen addition, summer
  - Using measured/simulated changes in NOx emissions from Appliances, Industrial burners and Gas turbines





Ozone Chemistry In South Coast AQMD

Governing Board Retreat

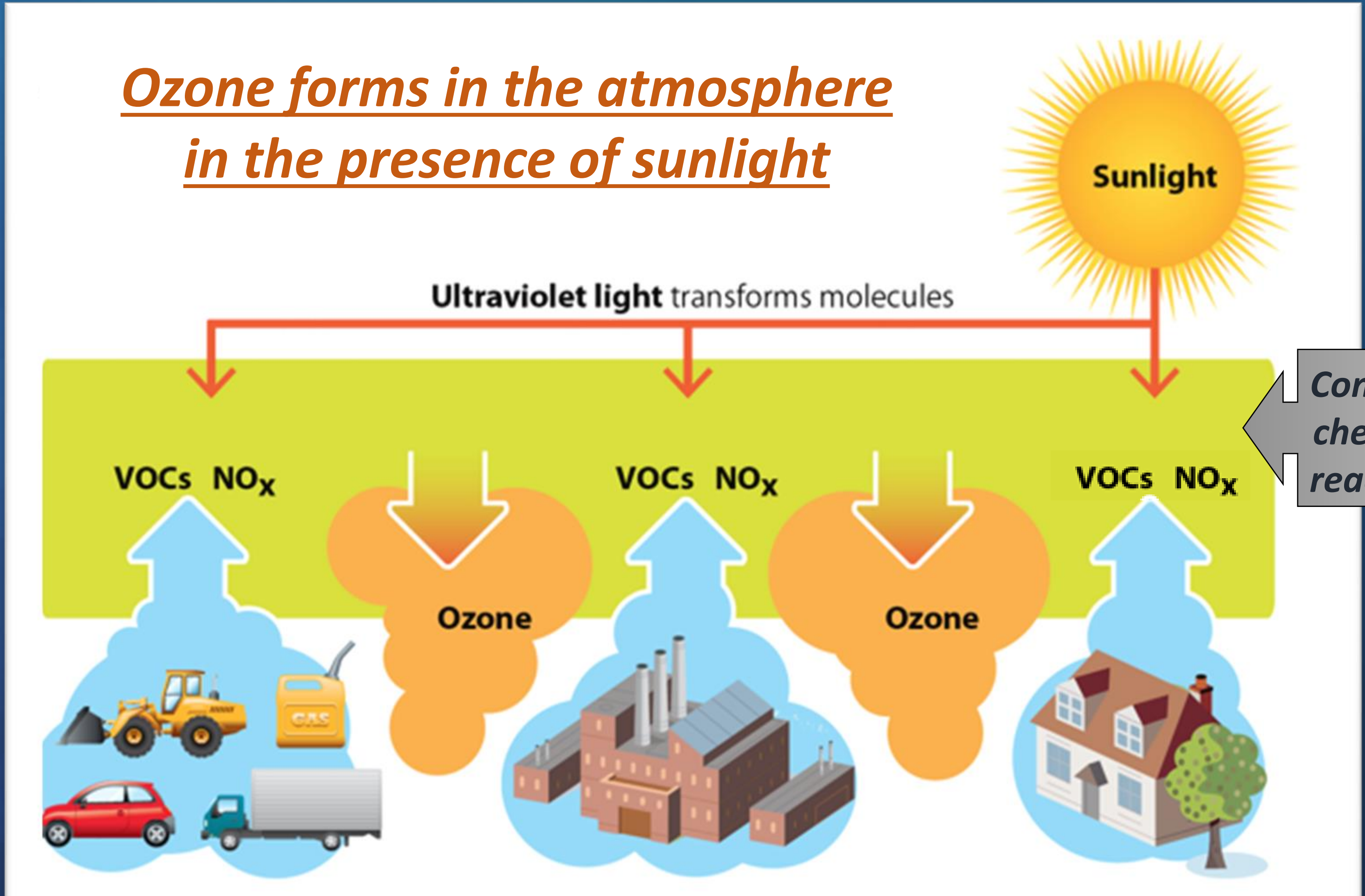
5/13/22

Overview

- ▷Basic pattern of ozone formation in South Coast
- ▷Meteorology and climate impacts on ozone formation

- ▷Guest Speaker: Dr. Ronald Cohen – The Future of LA Air Quality
  - ▷Differences between Nitrogen Oxides (NOx) and Volatile Organic Compounds (VOCs) on ozone formation

Basics 1: Ozone Chemistry



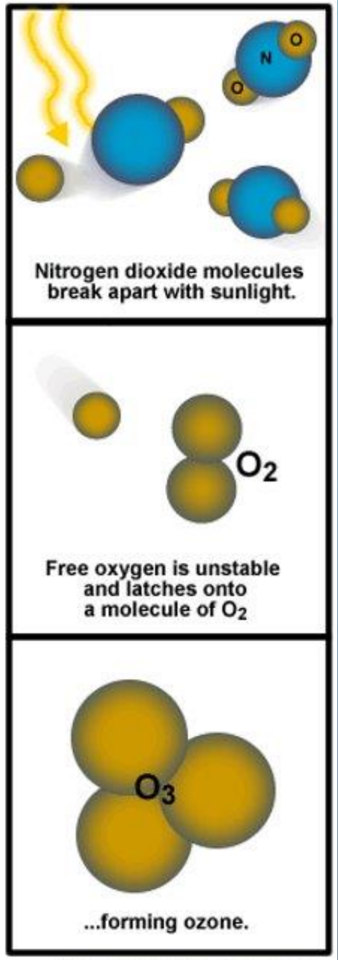
Modified from https://www.pca.state.mn.us/air/ozone

Complex, chemical reactions

***Past*: High Ozone, VOC Dominant**

***Future*: Low Ozone, NOx Dominant**

Ozone Chemistry Detail

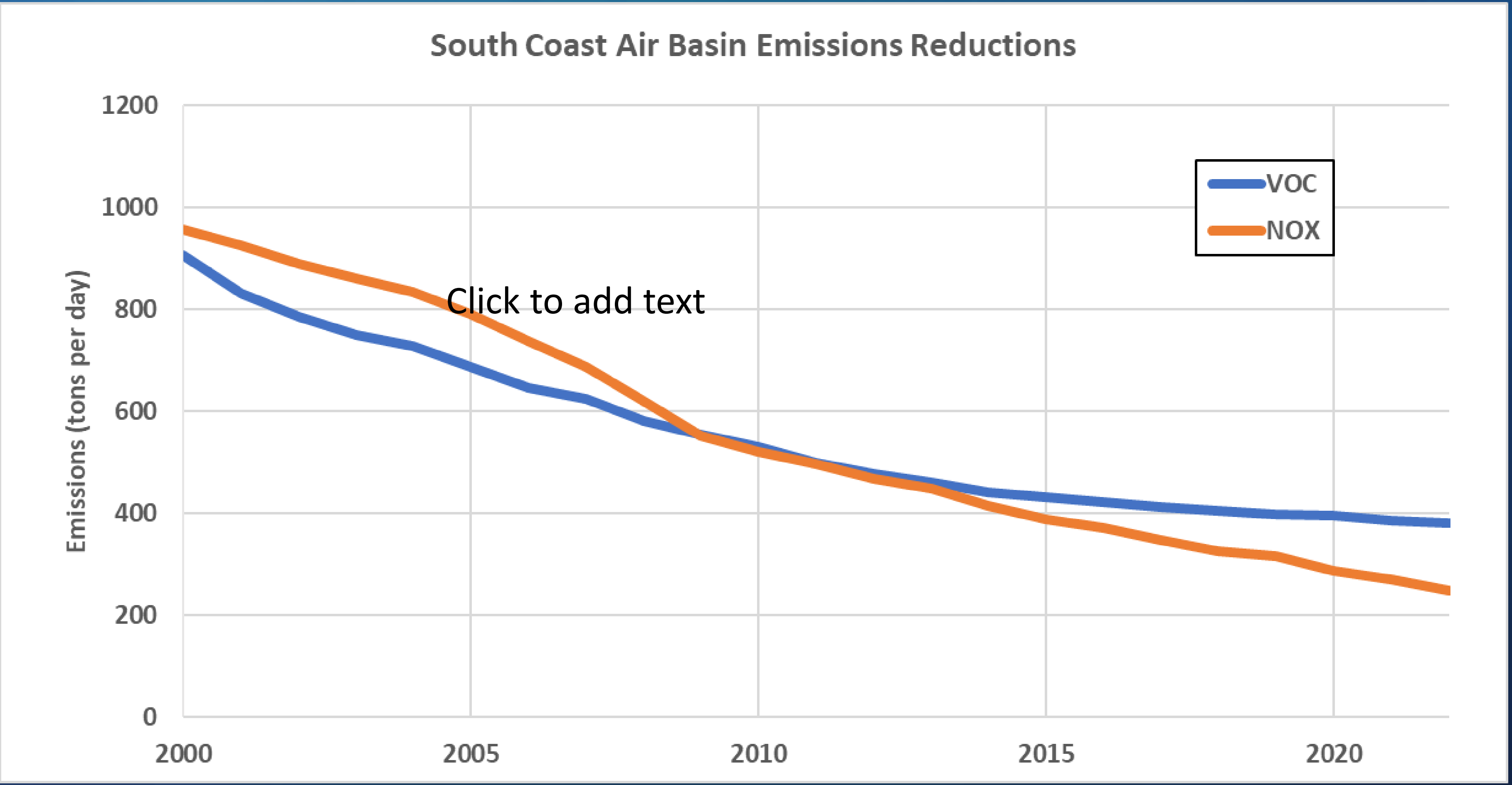


How ground-level ozone is formed.

UCAR ©2003

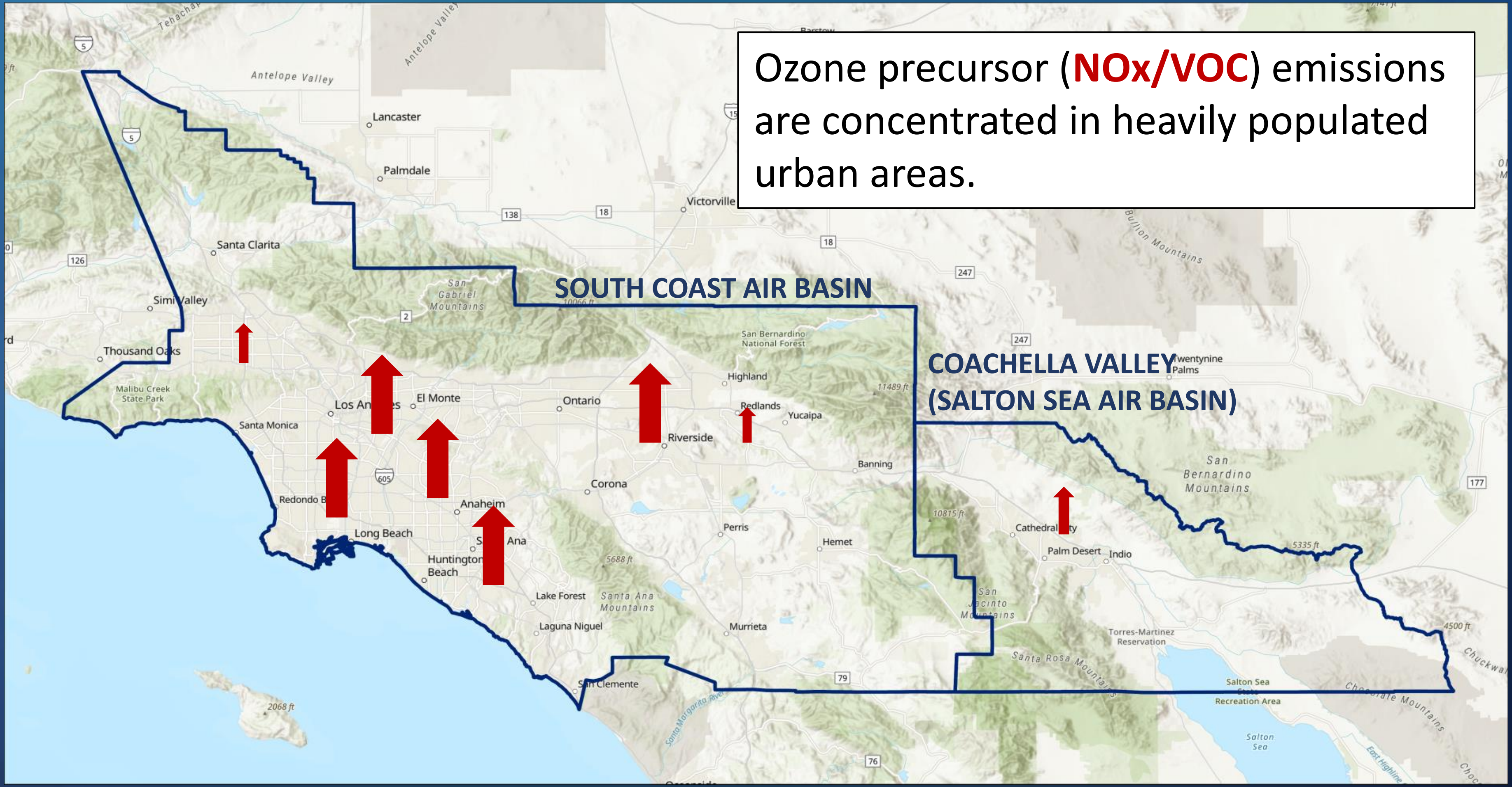
- Central reaction is NO2 to ozone
- Without other building blocks the ozone generated would react with the NOx and form oxygen again
- VOCs act as the fuel, creating key intermediate species that generate more NO2
- The nature of these reactions change depending on the ratio of VOC/NOx
- Transport and aging of emissions also impacts ozone formation

Basics 2: Decades of Emission Reductions

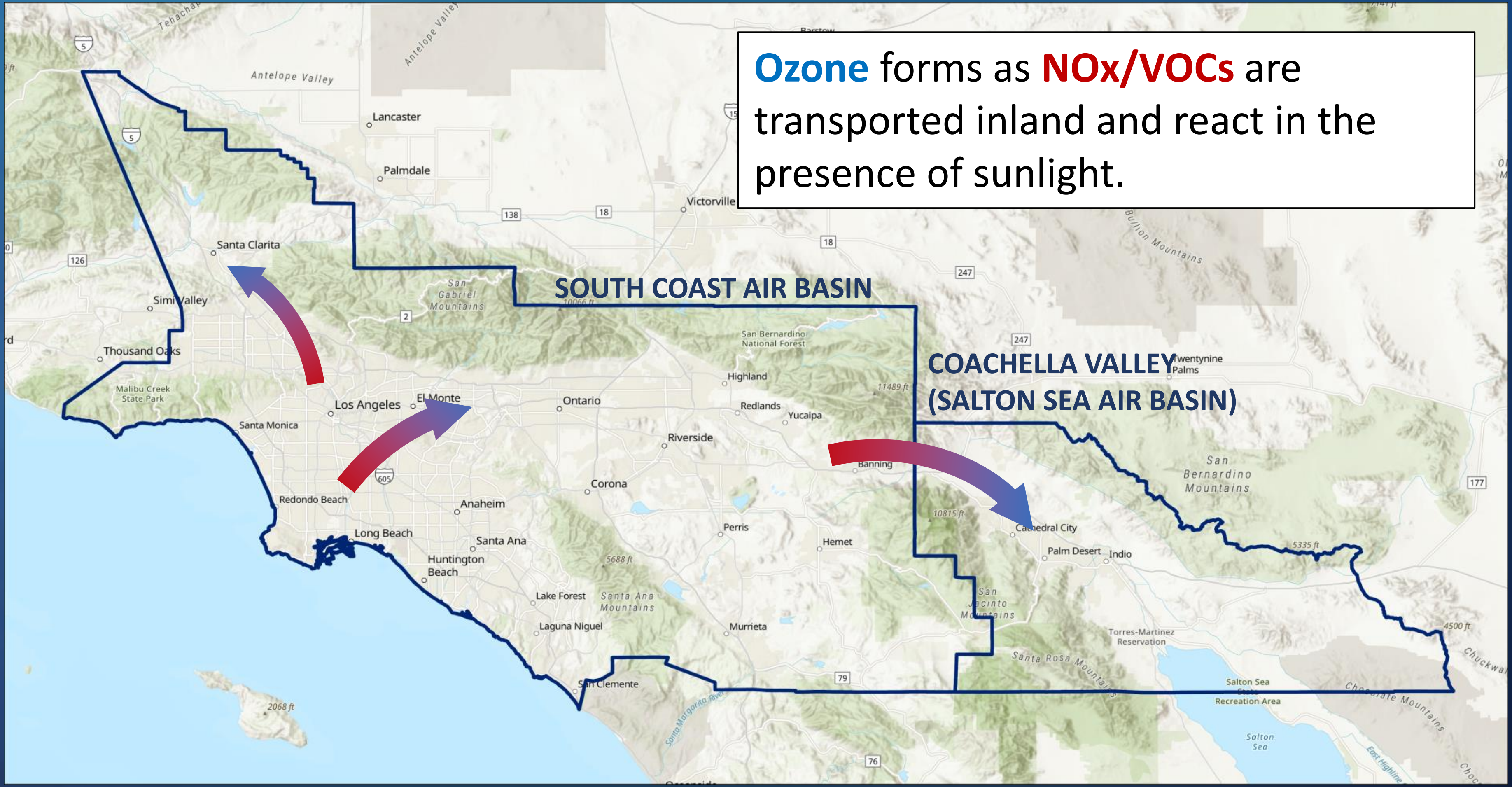


- Summer Planning emissions from CEPAM 2022 v1.01
- Biogenic emissions are not included

Basics 3: Location of NOx & VOC Emissions

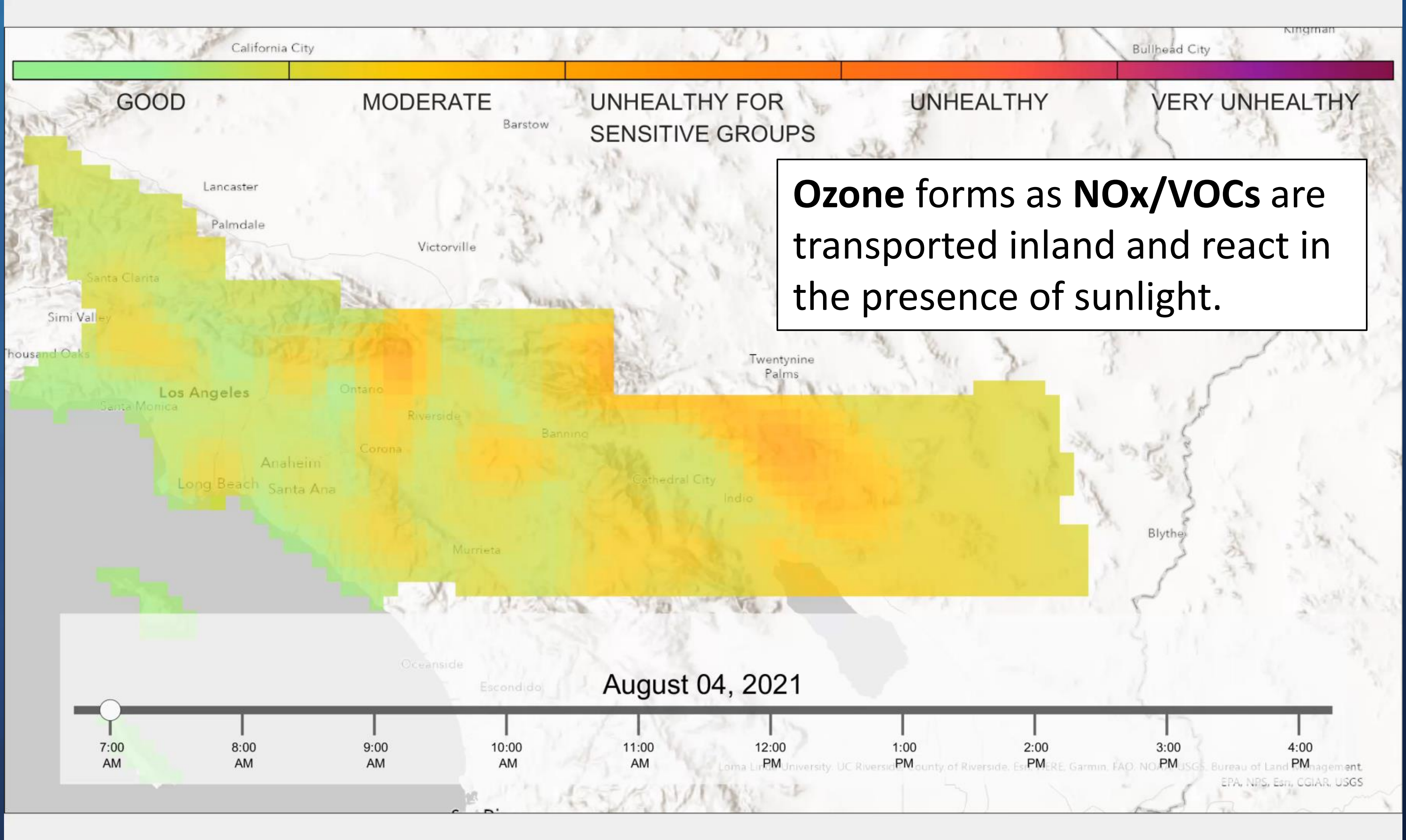


Basics 4: Emissions Transport and Ozone Formation

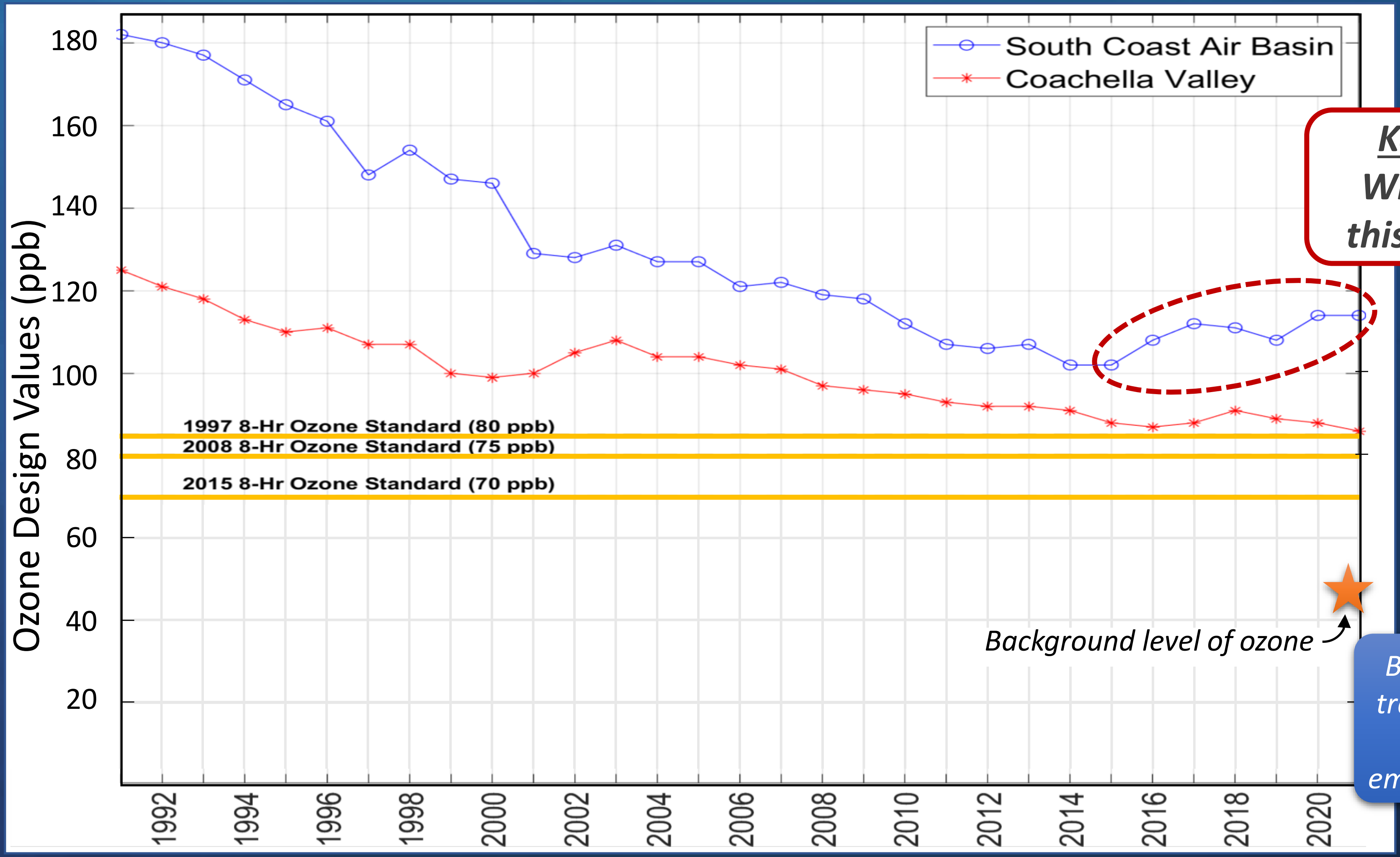


Ozone forms as NOx/VOCs are transported inland and react in the presence of sunlight.

Basics 5: Ozone Formation Throughout the Day



Ozone Trends in the South Coast Air Basin*



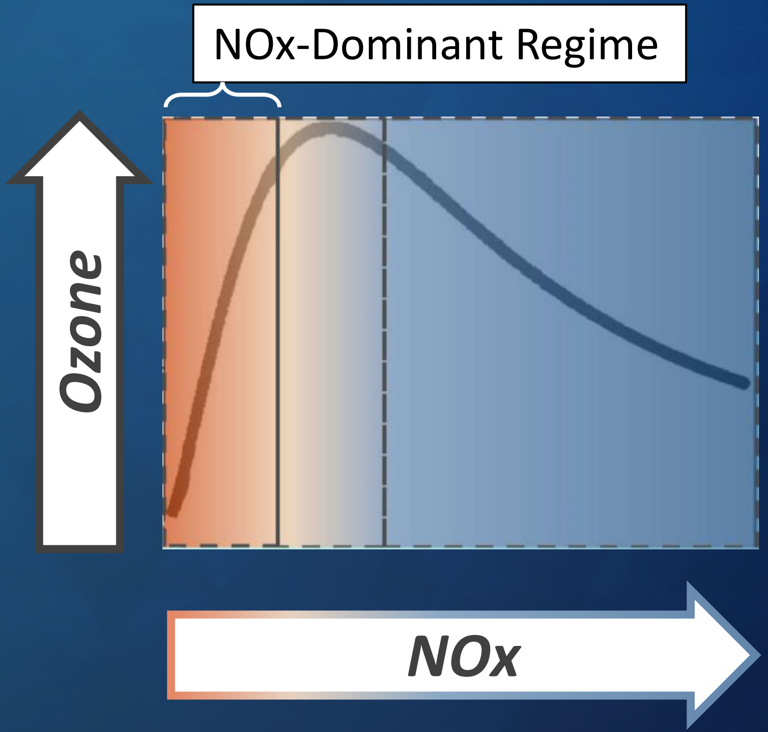
***Key Question*: What is causing this recent trend?**

Background from ozone transported from outside SCAQMD and VOC emissions from vegetation

* *Preliminary data for 2021*

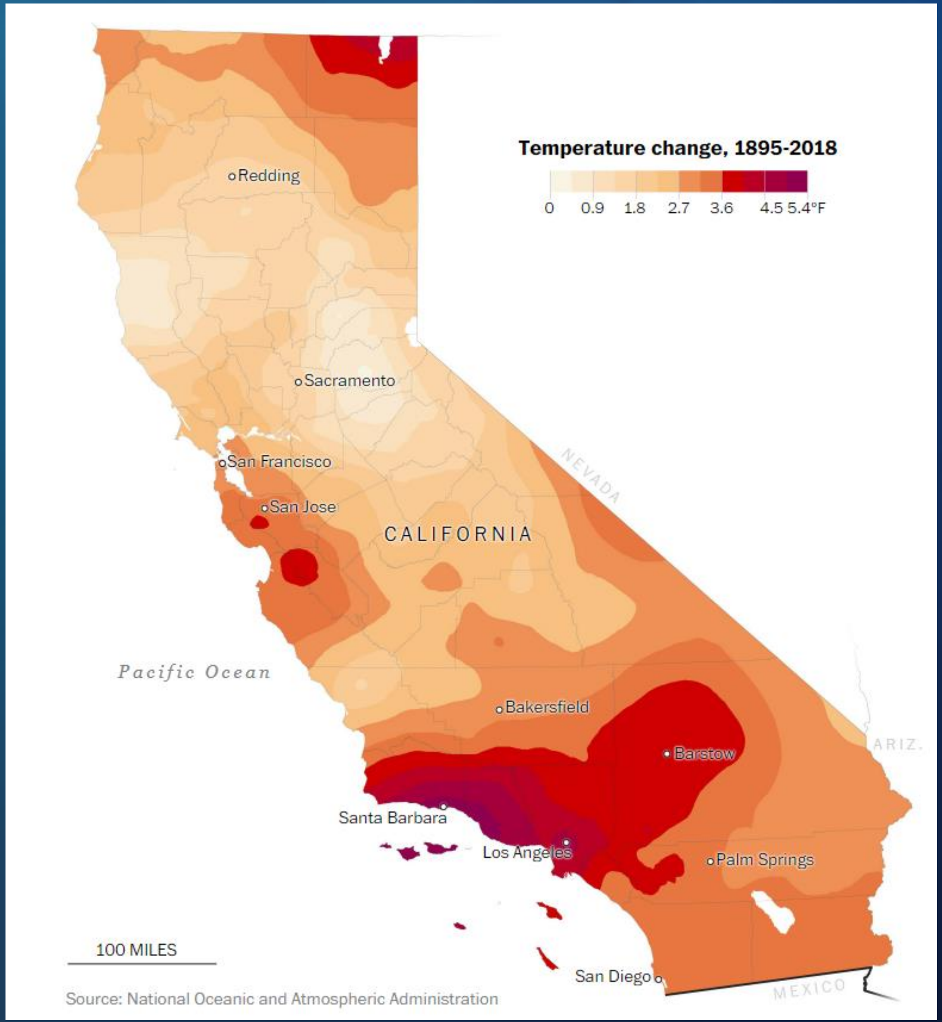
Key Question: Why Has Ozone Increased in Recent Years?

- Are NOx controls working?
  - Temporary increases in ozone are expected as our air basin transitions to a NOx-dominated regime
    - Low ozone levels are only possible in our basin if NOx is dominant
  - Next presentation will explore further
- What about climate change?
  - Next slides



Potential Impact of Climate Change on Ozone Concentrations

- Frequency and intensity of heat waves will continue to increase due to climate change
  - Stagnant days are also projected to become more frequent
- Since ozone is sensitive to temperature and other meteorological factors, future warming may impose a “climate penalty.”

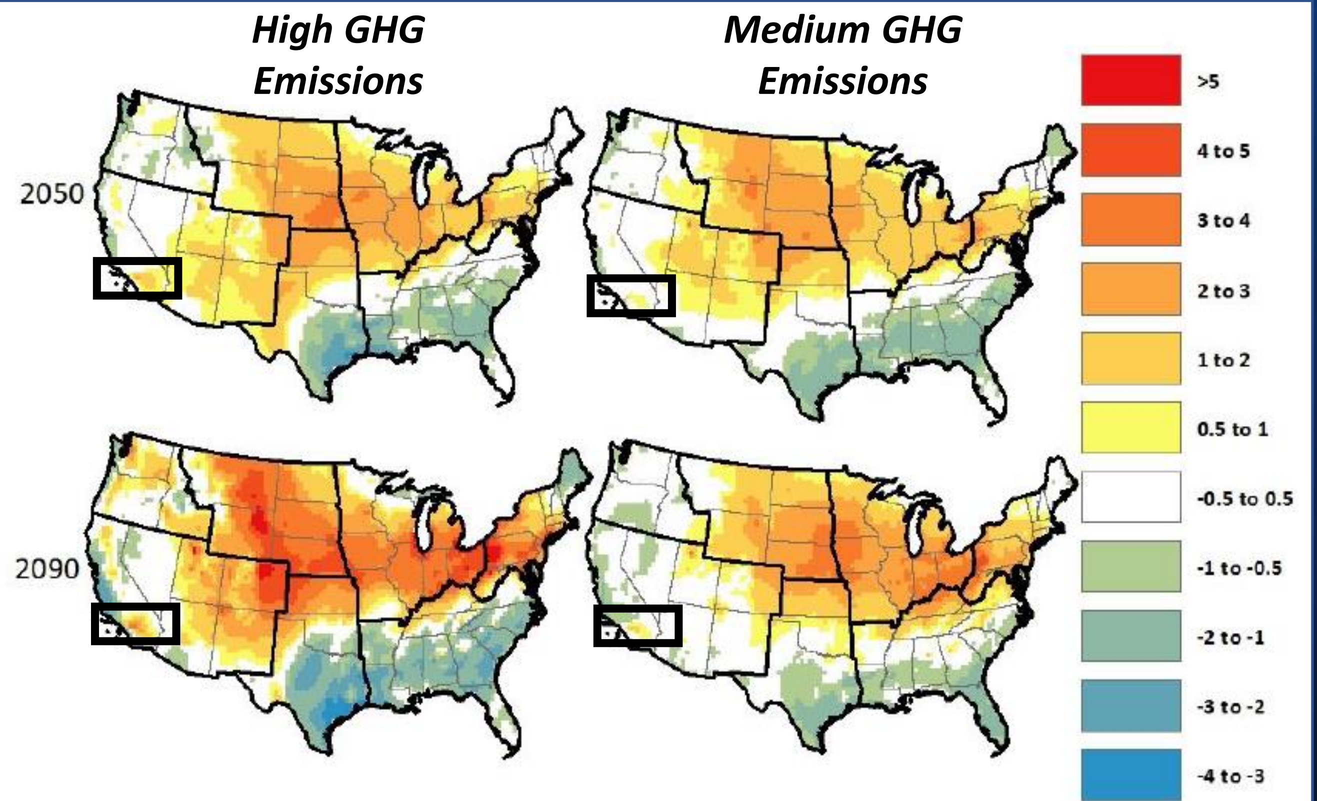


Washington Post, 2019

Potential Impact of Climate Change on Ozone Concentrations

- EPA modeling studies in support of 4th National Climate Assessment projects several ppb increases* in summer ozone in southern California in 2050/2090
- Ozone increases are larger under high GHG emissions scenario compared to medium scenario

Change in Summer-Average Maximum Daily Ozone

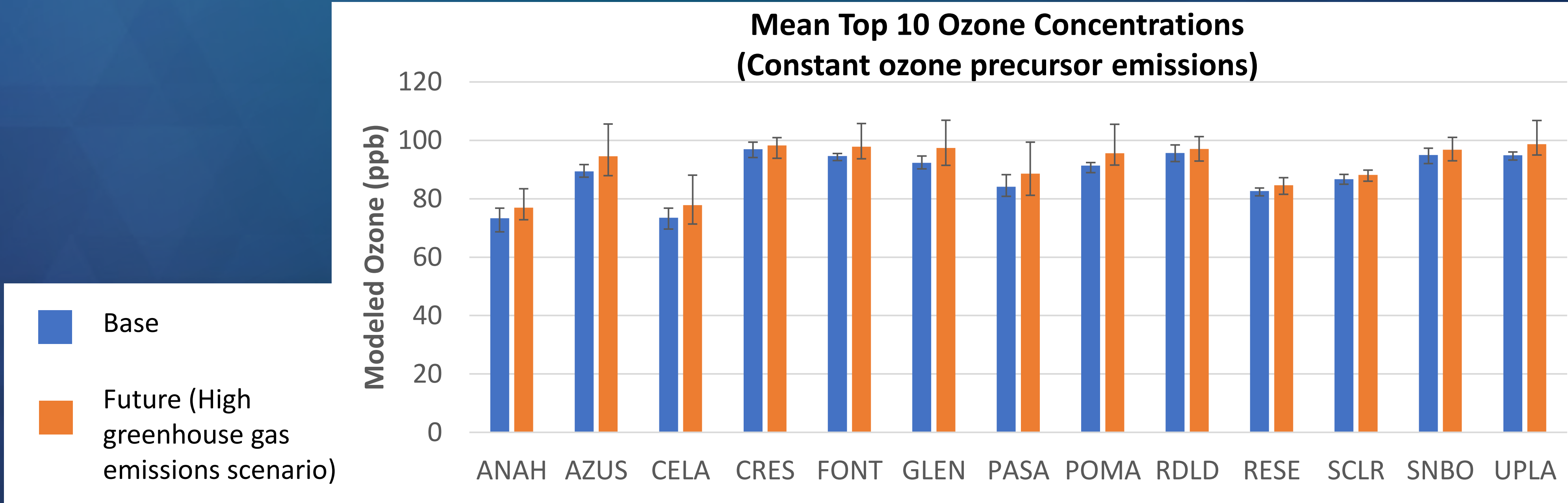


EPA, 2017

** Does not consider emission reductions from our ozone control strategy*

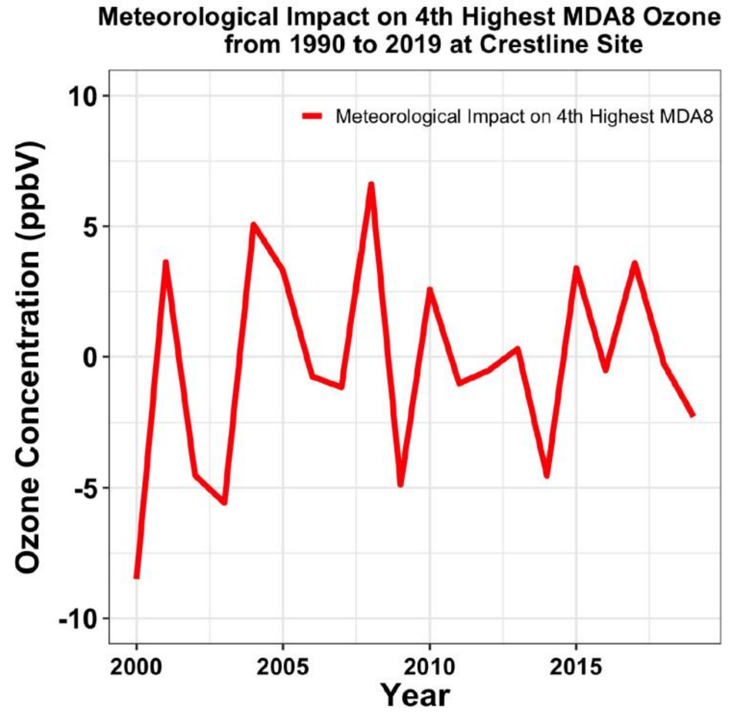
Potential Impact of Climate Change on Ozone Concentrations

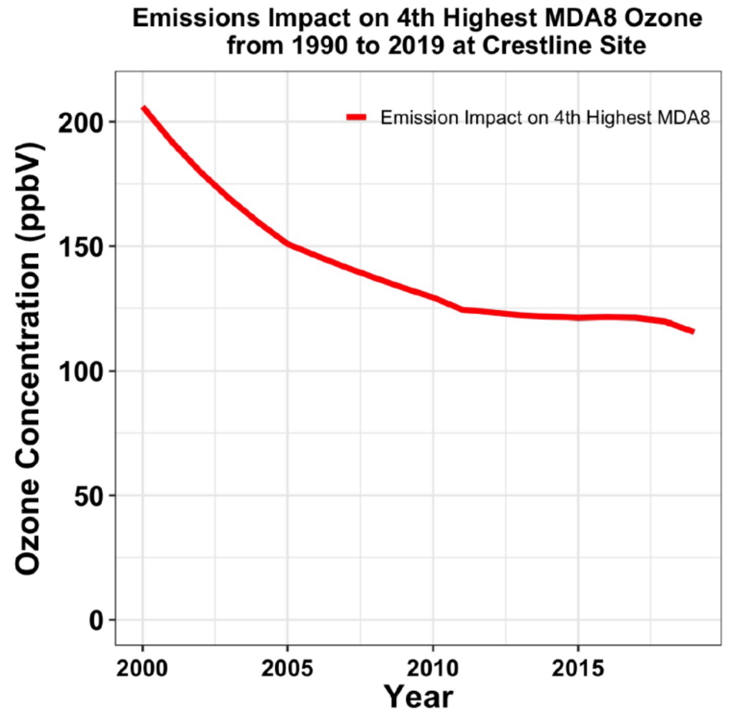
- Modeling studies performed by South Coast AQMD show an average climate impact of +1-2 ppb on top 10 ozone concentrations in the Basin by 2037, with increases up to +6% in some locations.
  - Large uncertainties associated with future GHG emissions, vegetation response, wildfires, land use changes, etc.



Effects of Meteorology on Top Ozone Concentrations

- The highest ozone levels occur on hot, sunny days with stagnant conditions
- Top ozone concentrations can fluctuate by ± 8 ppb from year to year due to meteorology
- Impacts from year-to-year changes in meteorology are larger than effect of decreasing emissions in recent years





Summary

- ▷Ozone is formed in the atmosphere in South Coast and transported into inland regions
  - ▷The reactions forming ozone are very complex
  - ▷NOx reductions are key to reducing ozone in our region
- ▷Ozone formation is influenced by higher temperatures
  - ▷Climate change will cause higher temperatures, which will increase peak ozone levels
  - ▷Year-to-year fluctuation in meteorology has a stronger influence on peak ozone levels than climate change in near to medium term
- ▷Next up: NOx/VOC discussion with Dr. Cohen

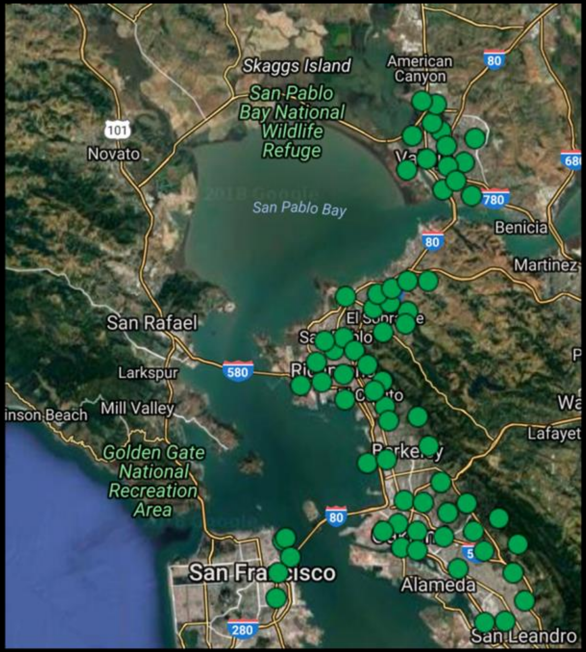
The future of LA air quality (in summer)

Ron C. Cohen,
Distinguished Professor,
Department of Chemistry
Department of Earth and Planetary Science
UC Berkeley

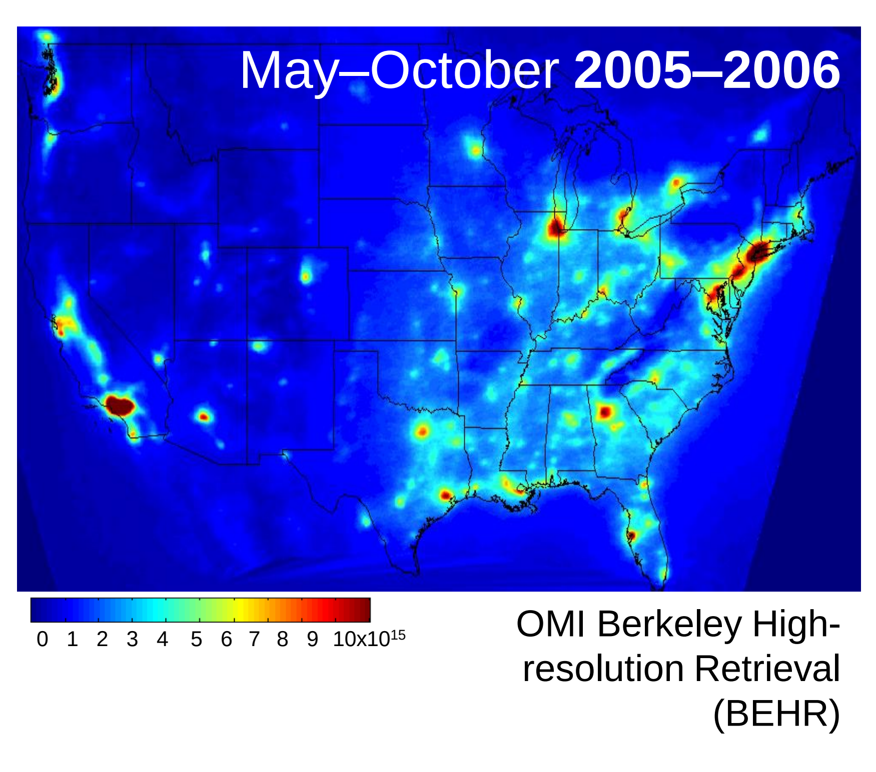
2021-2022
Chair of the UC Berkeley Academic Senate

My Research

Mapping emissions with neighborhood resolution



http://beacon.berkeley.edu

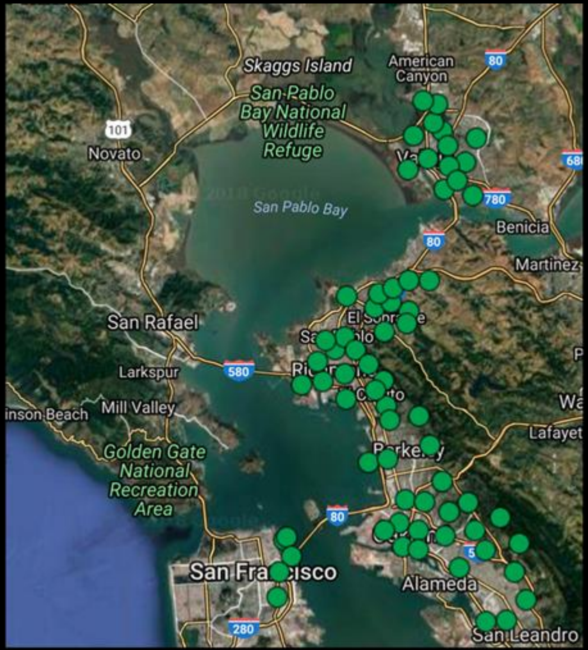


Observing urban chemistry from space

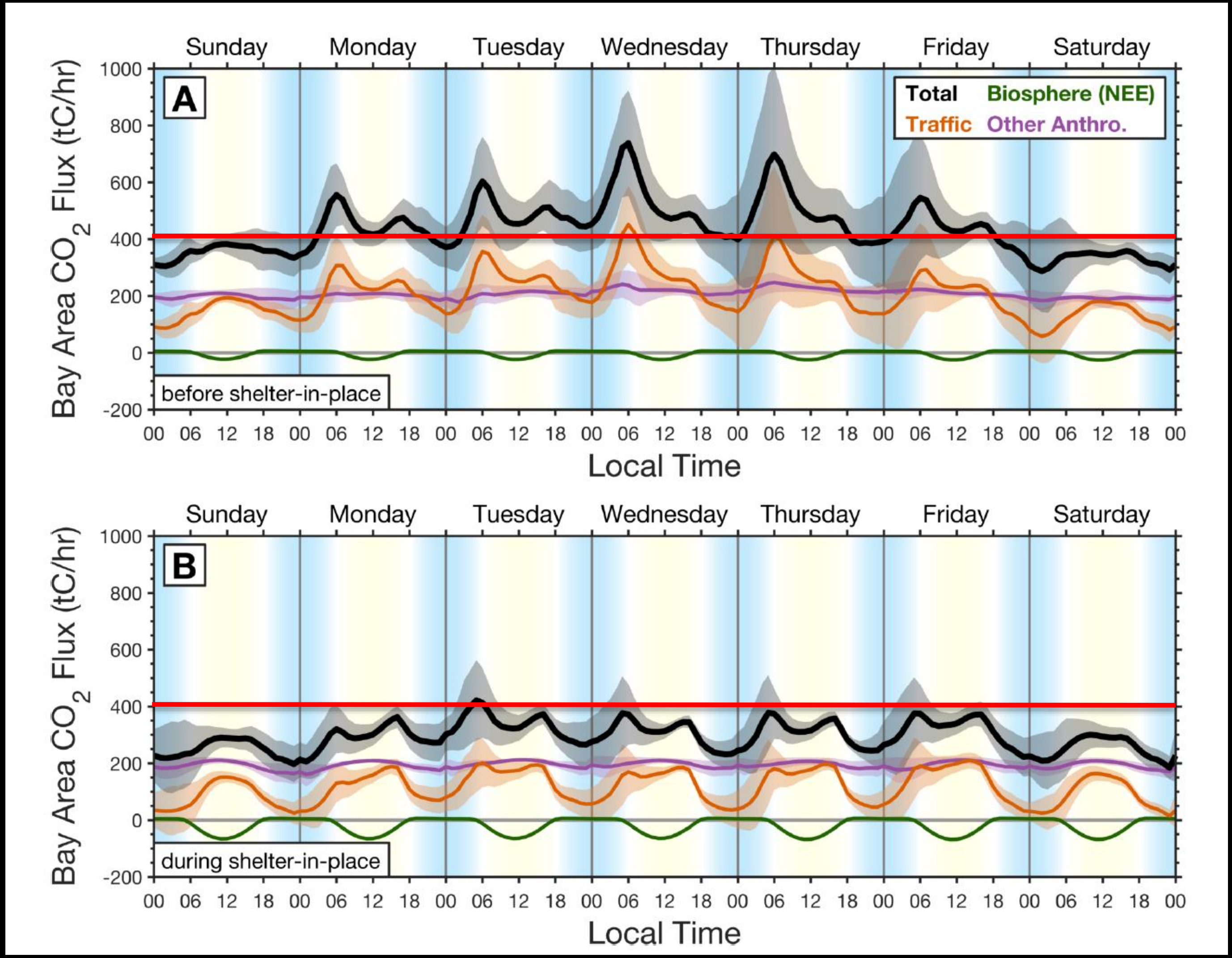
Understanding the role of plants and soils on our air

2020 CO_2 emissions before and after COVID shelter-in-place

25% overall reduction; 45% vehicle reduction



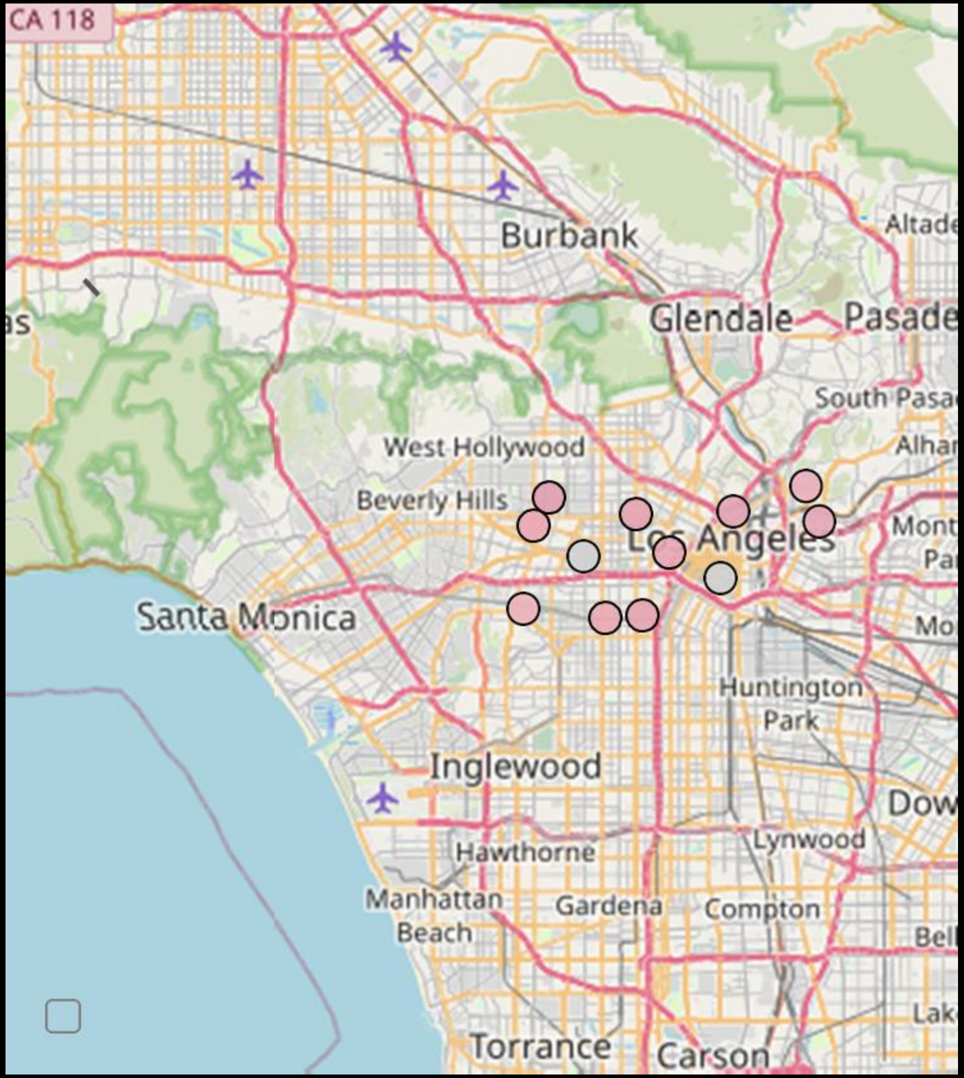
http://beacon.berkeley.edu



Turner, et al., Geophys. Res. Lett. doi.org/10.1029/2020GL09003, 2020

Measures CO_2, CO, NO_2, NO, O_3 and PM2.5 at each location

In collaboration with Will Berelson at USC



https://dornsife.usc.edu/news/stories/3525/sensors-map-greenhouse-gases/

Today:
Temperature, emissions and high ozone events

Peer reviewed literature

C.M. Nussbaumer and R.C. Cohen, *The role of temperature and NO_x in ozone trends in the Los Angeles basin*, Env. Sci. and Tech., https://doi.org/10.1021/acs.est.0c04910, 2020.

C.M. Nussbaumer and R.C. Cohen, *Impact of OA on the Temperature Dependence of PM 2.5 in the Los Angeles Basin*, Env. Sci. and Tech., 10.1021/acs.est.0c07144, 2021.

NOAA Press release
https://cpo.noaa.gov/News/News-Article/ArtMID/6226/ArticleID/2182/Air-Quality-in-the-Los-Angeles-Basin-Increasingly-Dependent-on-Temperature

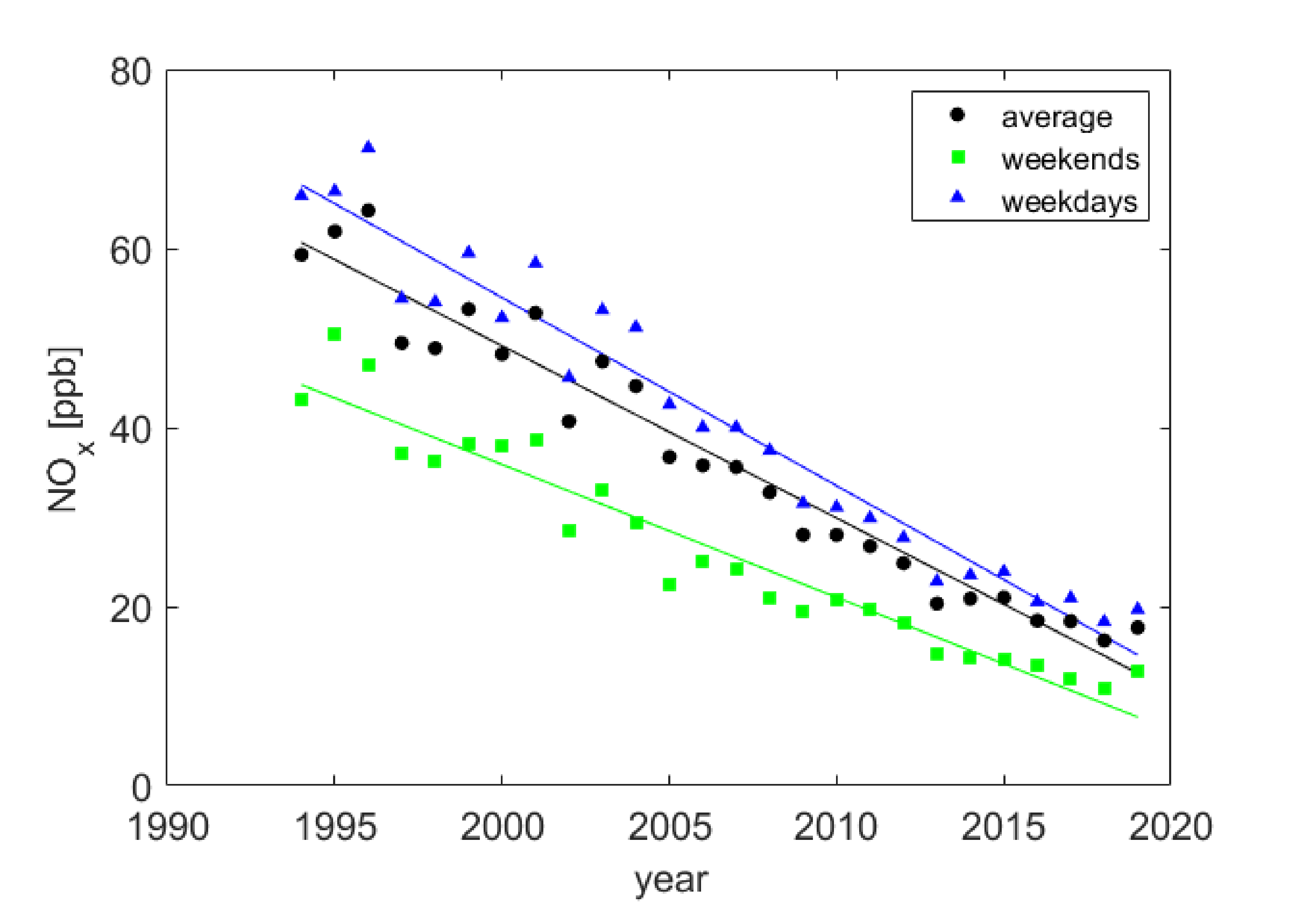
Three Key ideas for today

- **Ingredients for ozone (and they are linked to CO_2):**
  volatile organic chemicals (VOC)
  nitrogen oxides (NO_x)
  sunlight

- **Regulation has been incredibly effective at reducing NO_x and VOC**
  but may be reaching limits for VOC

- **Temperature affects VOC more than NO_x**

NOx reductions in LA

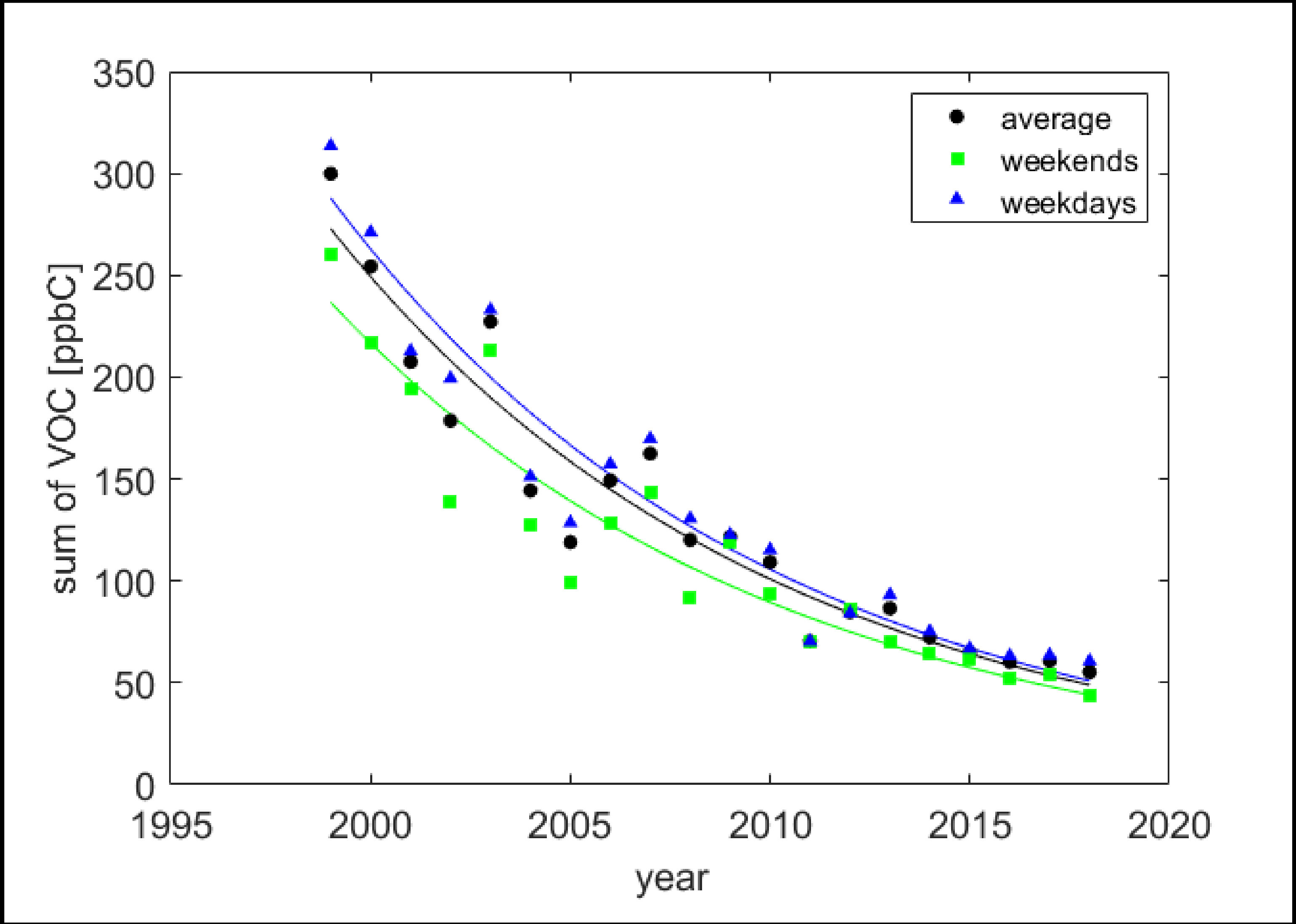


NOx has decreased almost linearly.

~7.5%/year

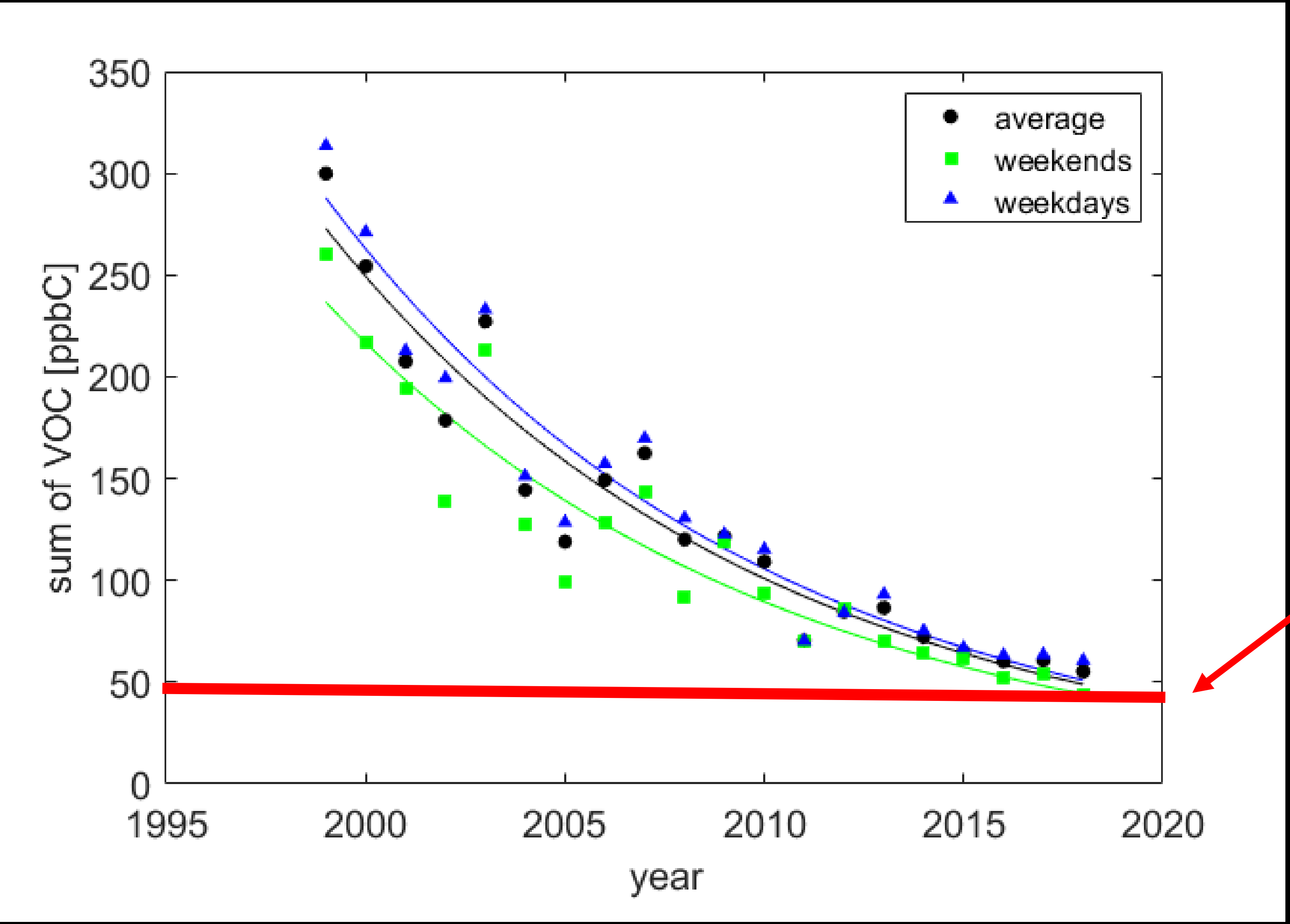
Heavy duty diesel trucks are ~half the NO_x source.

VOC reductions in LA



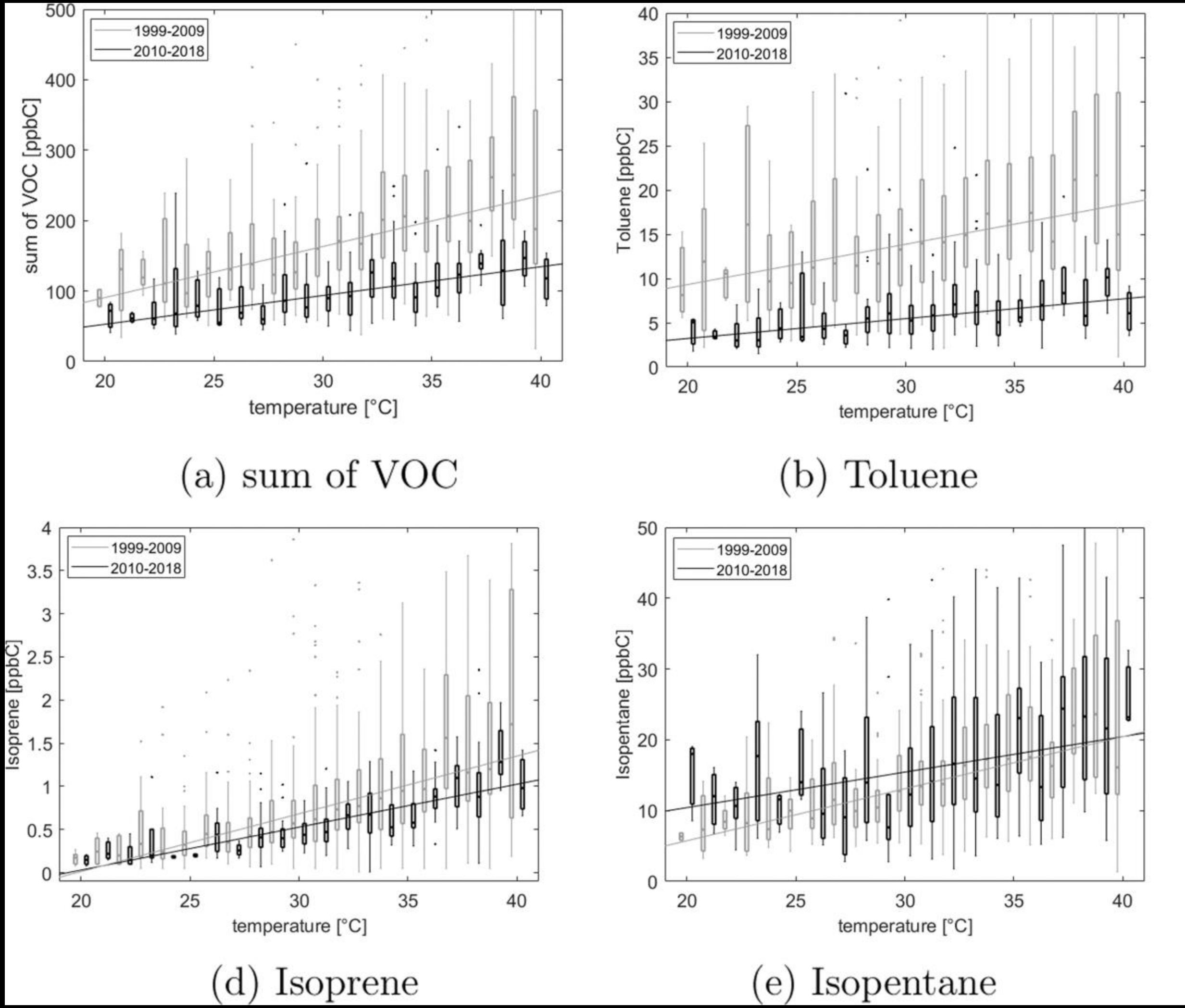
Rapid VOC decreases observed early in this century are slowing.

VOC reductions in LA



Sources of VOC that are not regulated yet or perhaps can't be (e.g. trees)

Some VOC are strongly temperature dependent



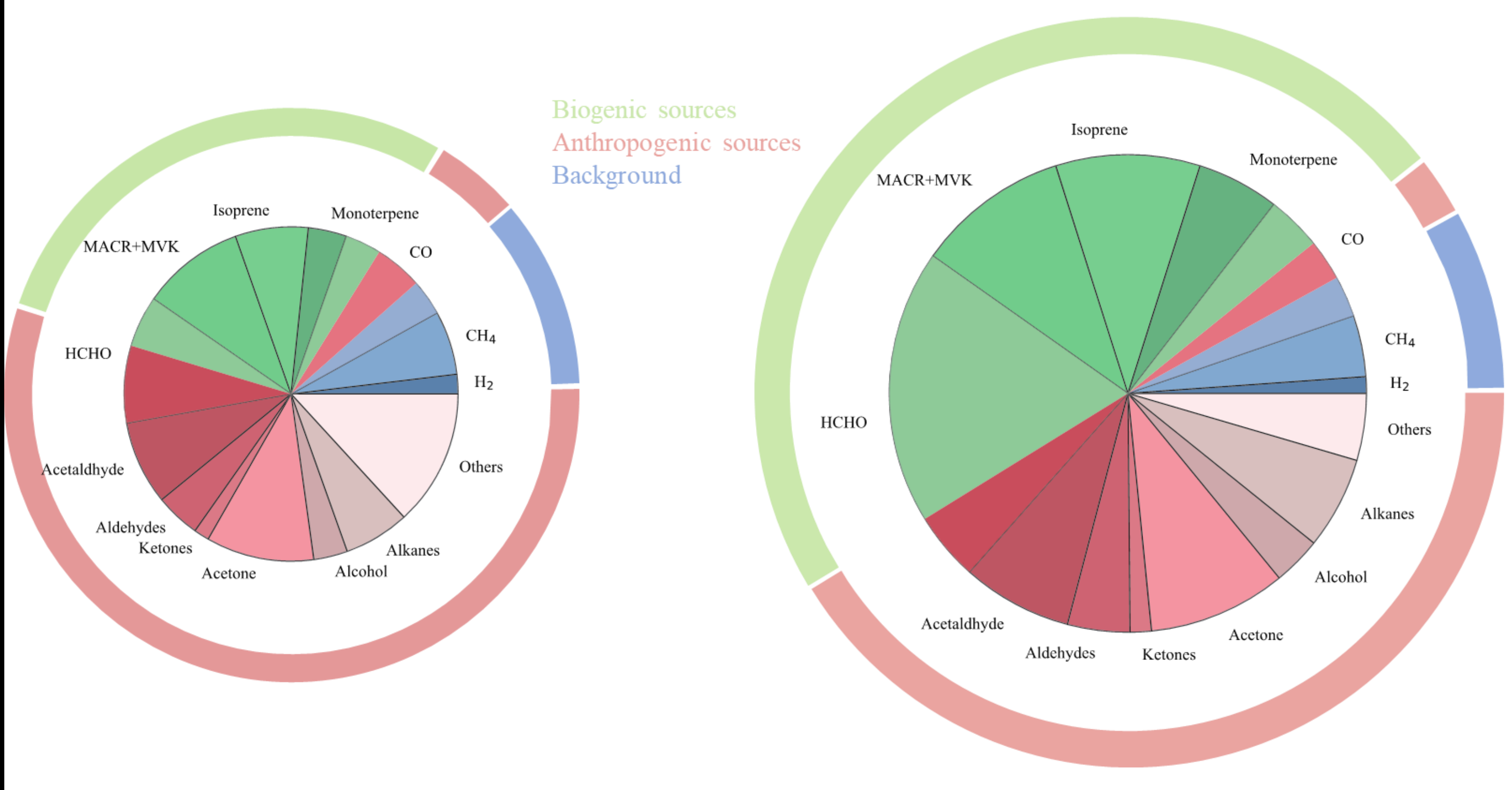
(a) sum of VOC (b) Toluene

(d) Isoprene (e) Isopentane

Some chemicals have changed a lot, others less so.

Some have a stronger dependence on temperature than others

Modeled VOC (weighted by a measure of importance to ozone production) developed as part of SCAQMD and CARB funded aircraft measurements in June 2021



Low temperature weighted = 3.5

High temperature weighted = 6.0

VOC

Today other sources of VOC are almost equal in importance to cars.

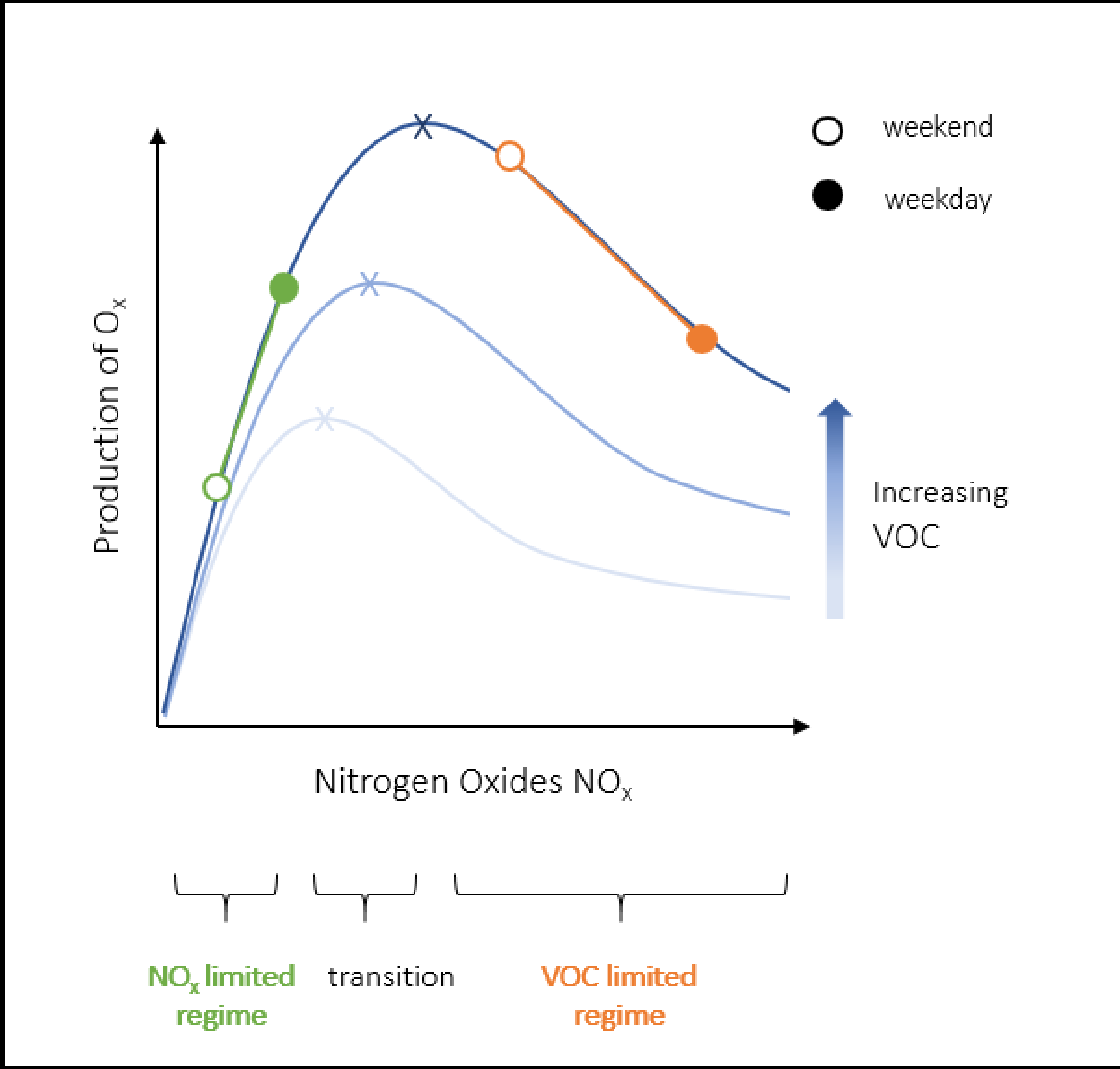
At high temperatures, other sources are more important than cars.

The other sources are emissions from:

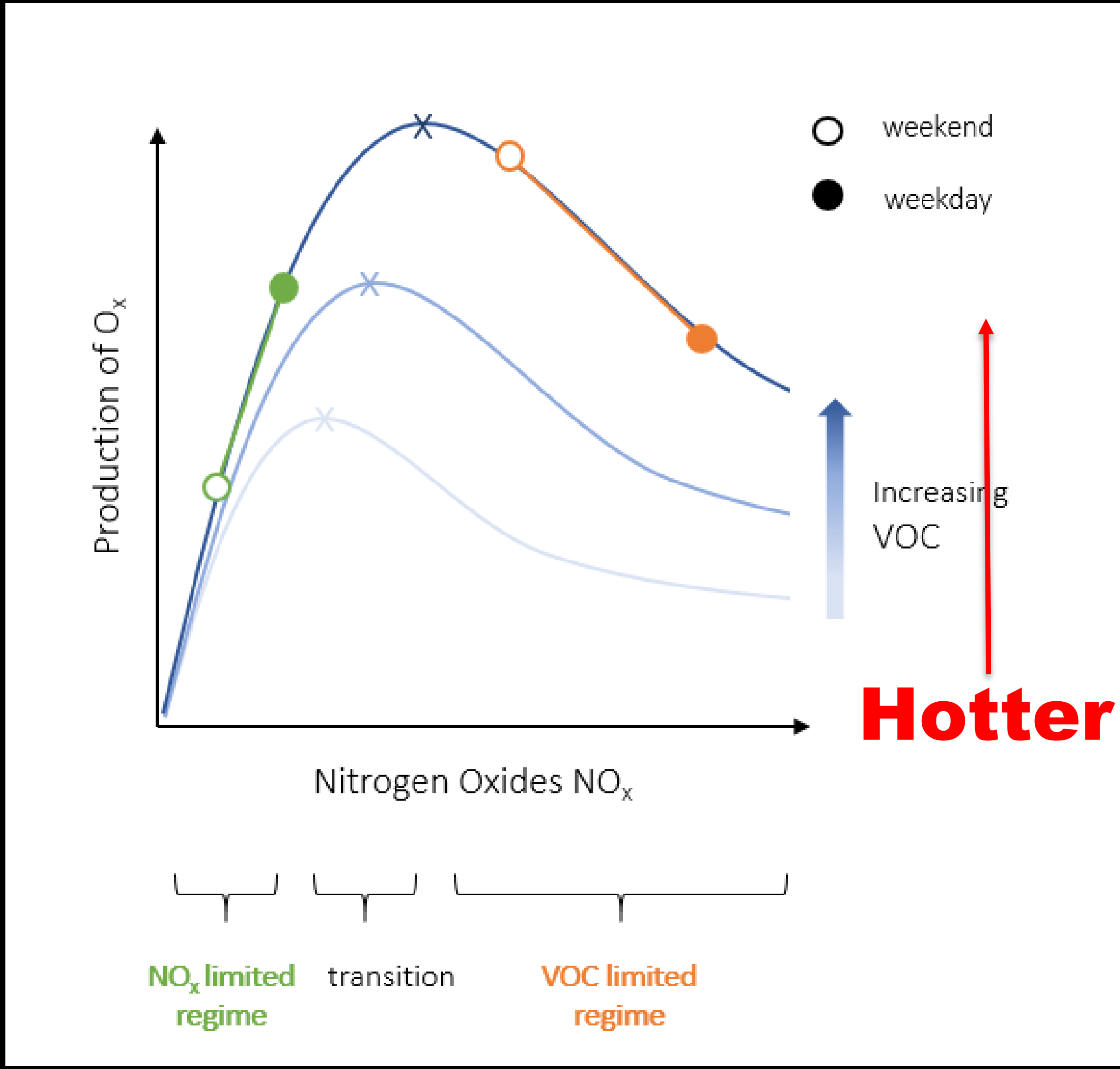
trees (temperature dependent) and

volatile chemical products such as household and business cleaners, personal care products, some industrial chemicals, (probably not temperature dependent)

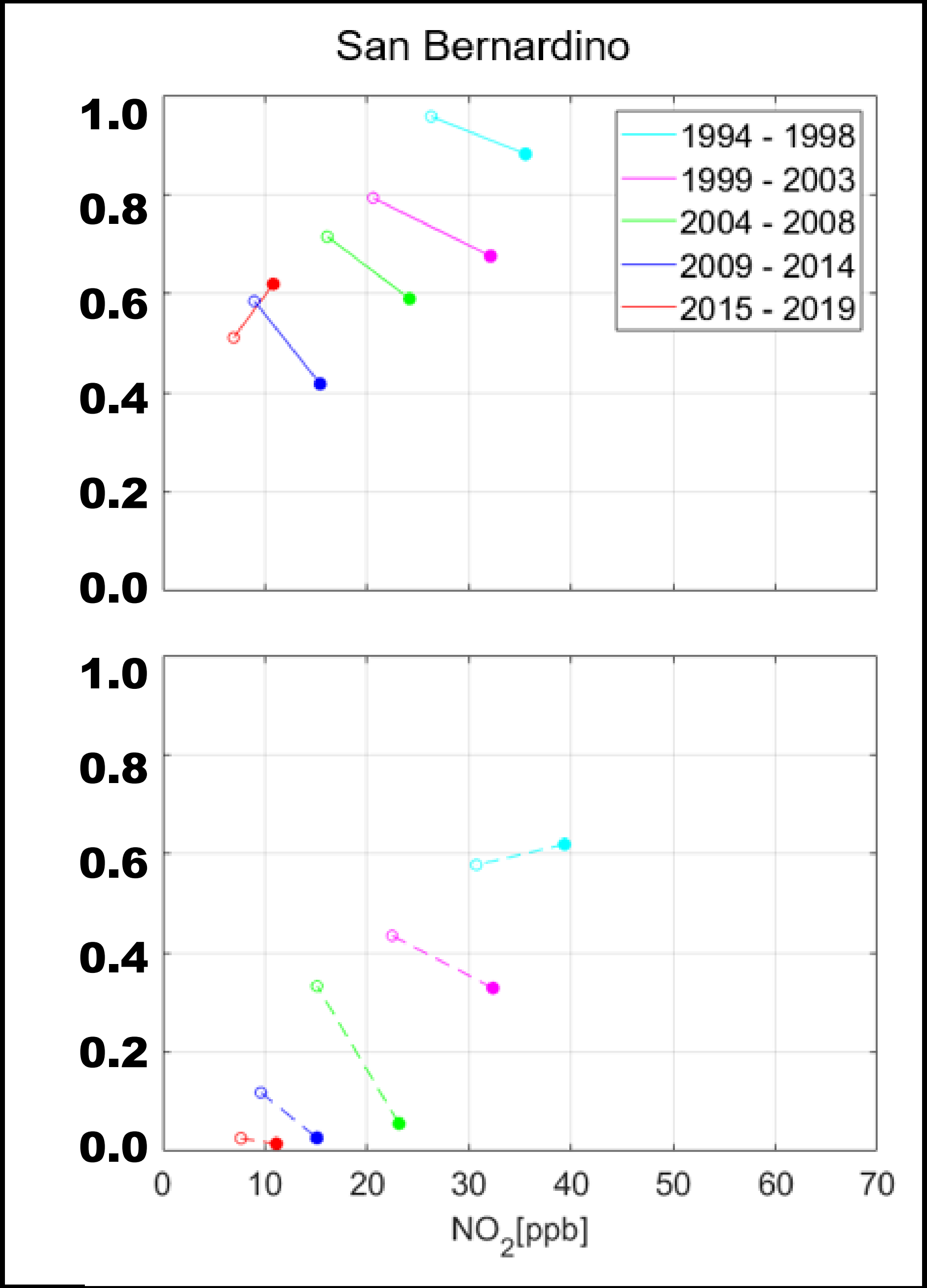
Ozone Chemistry



Ozone Chemistry



Odds of ozone exceeding 100ppb



Hot

(above 86 F)

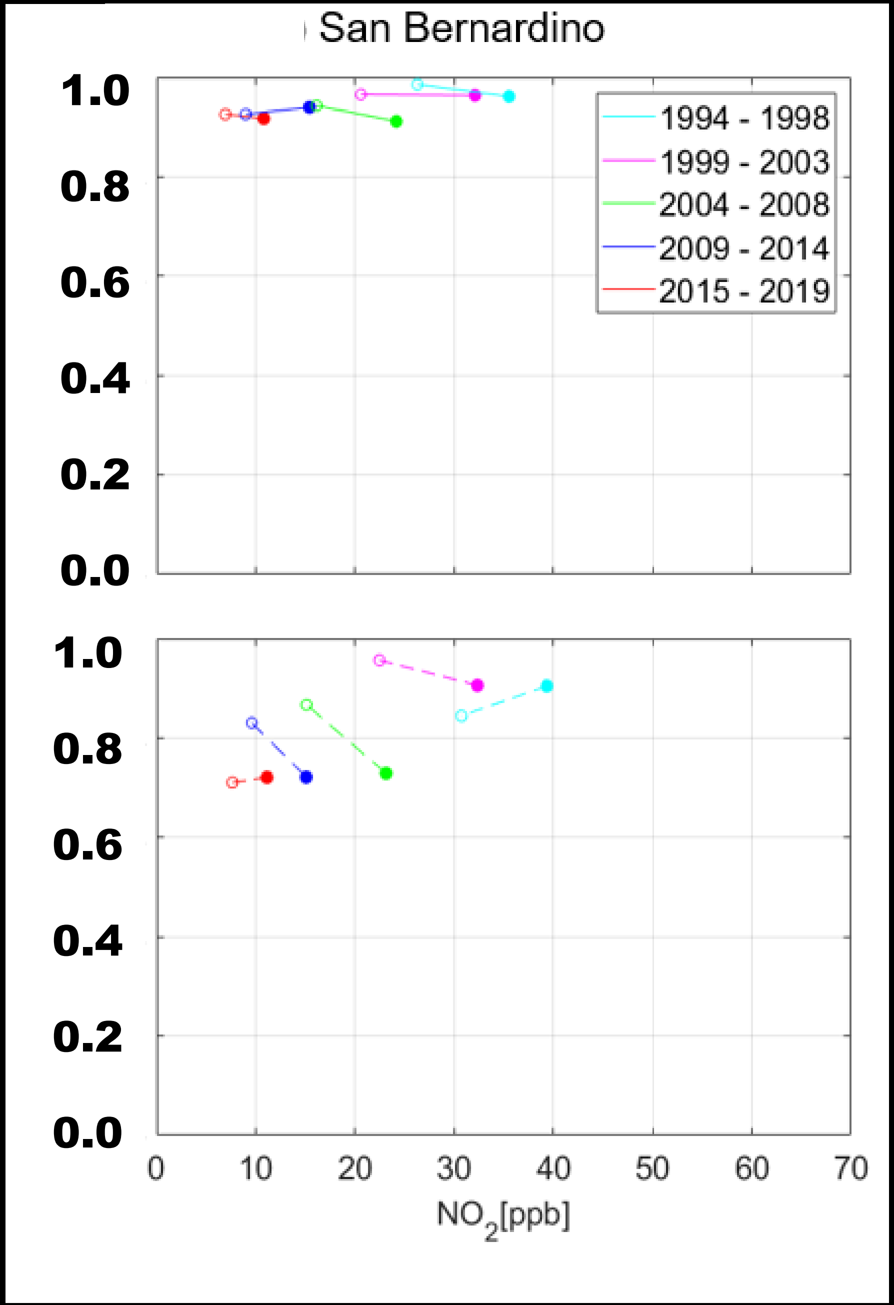
Cooler

(77 - 85 F)

Open circle – weekend

Filled circle – weekday

Odds of ozone exceeding 70ppb



Hot

(above 86 F)

Cooler

(77 - 85 F)

Open circle – weekend

Filled circle – weekday

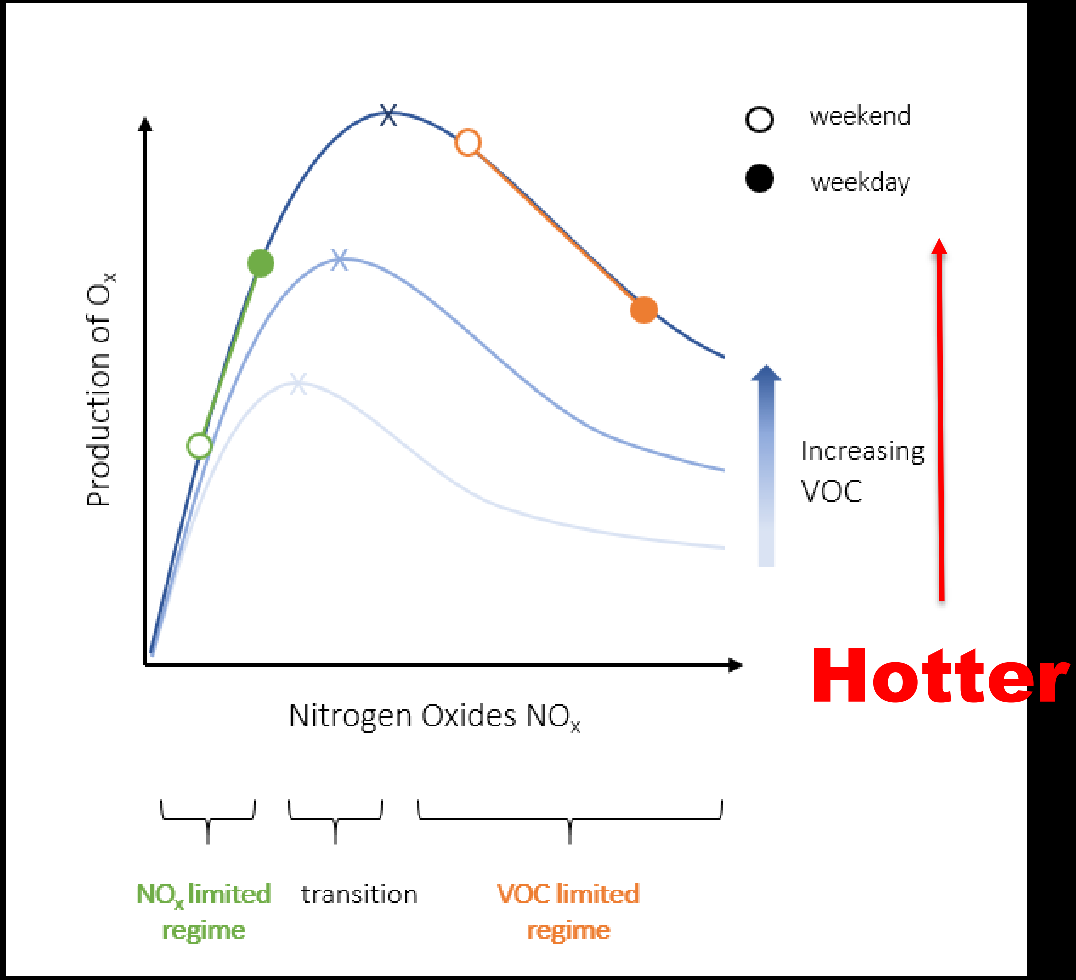
Shelter-in-place and LA ozone air quality

Emissions of NO_x and VOC from cars were reduced, also some NO_x from trucks.

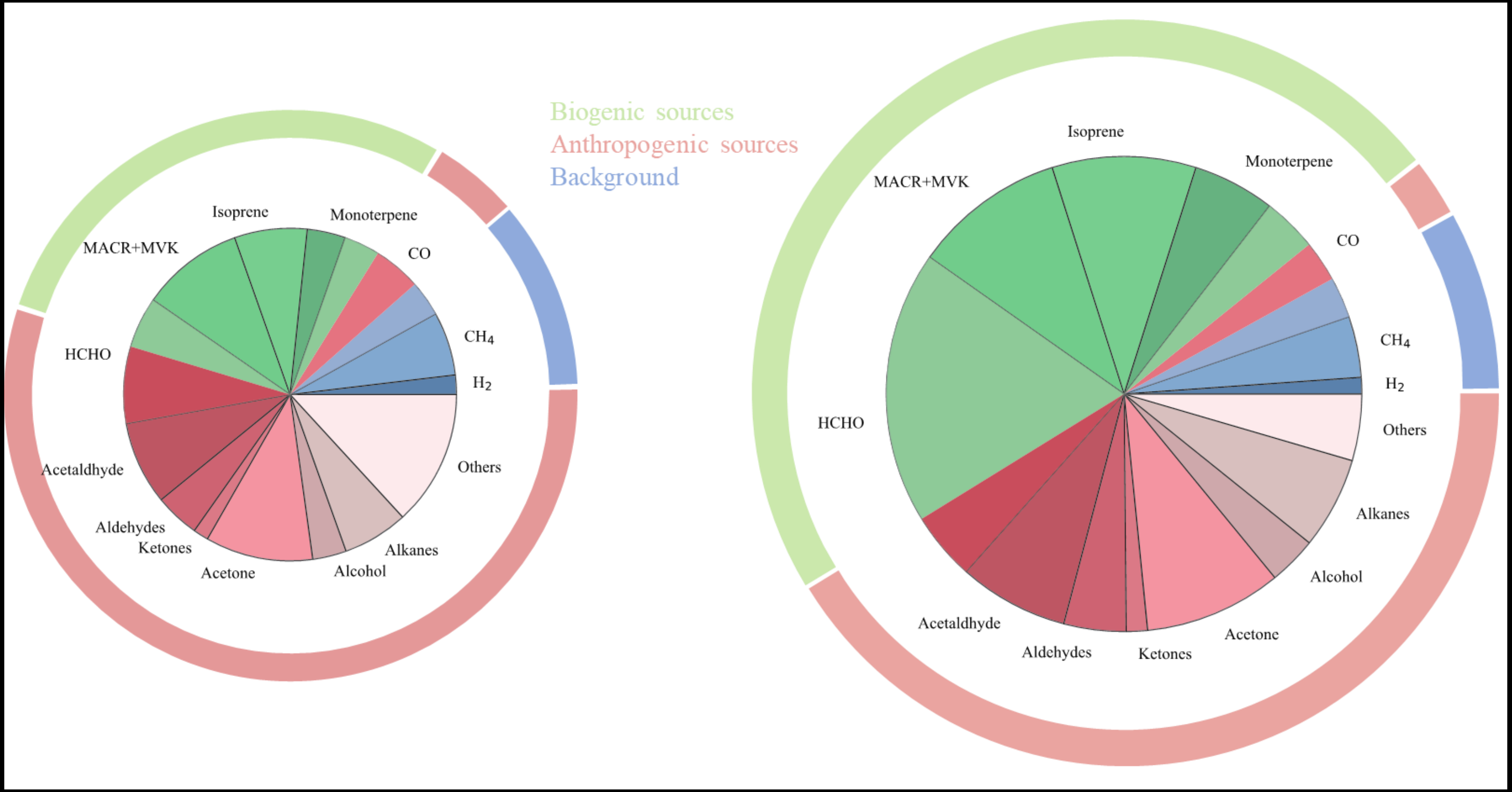
Weather was <u>unusually warm</u> for April.

Result:

Ozone was high on weekdays, similar to higher ozone on weekends in prior years.



Modeled VOC (weighted by a measure of importance to ozone production) developed as part of SCAQMD and CARB funded aircraft measurements in June 2021



Low temperature weighted = 3.5

High temperature weighted = 6.0

Recommendations

Aggressive transition to zero emission technology in all sources including cars and trucks will reduce NOx and the number of days with poor ozone air quality.

There are diminishing returns for reducing anthropogenic VOC because biogenic VOC are an increasing fraction of the remaining molecules, especially when it is hot.

As a result, a NO_x-focused strategy is the only way reduce ozone to the 70 ppb, 2015 8-hour ozone standard.

Planting trees may moderate urban heat and have other social benefits, but could bring negative air quality impact. Care should be taken for tree planting programs to ensure that low VOC species are encouraged.

Your questions

and thank you for listening

Agenda Item 3

Incentives and Rebates for Zero-Emission Technologies for Residential Sources

Governing Board Retreat

South Coast Air Quality Management District

May 13, 2022

Mission Inn, Riverside

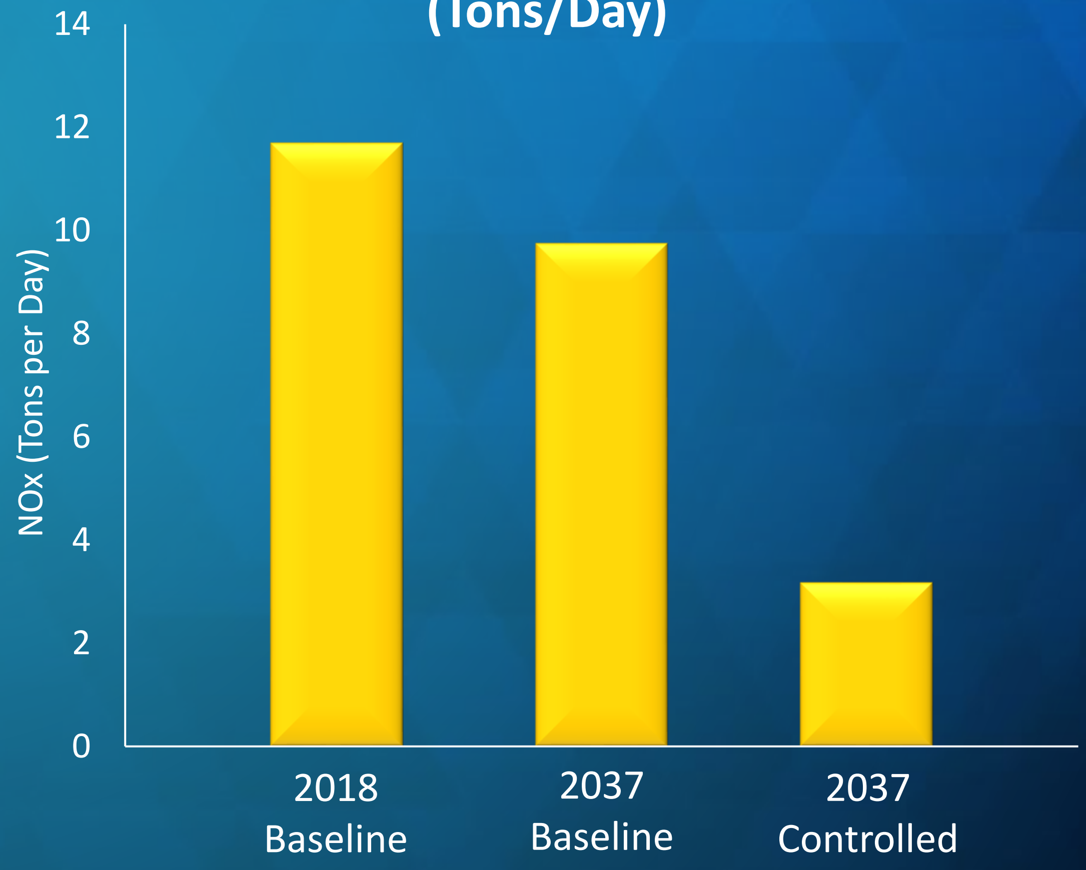
2037 Stationary & Area Source NOx Emissions and Reductions

Control Measure Categories	2037		
	NOx Baseline (tpd)	NOx Reduction (tpd)	Remaining NOx (tpd)
Residential Combustion Sources	9.8	6.4	3.4
Commercial Combustion Equipment	11.5	7.4	4.1
Large Combustion Equipment	17.9	6.9	11.0
Further Deployment of Cleaner Technologies (Stationary Sources)	N/A	3	N/A
Total South Coast AQMD Stationary and Area Source Measures	**39.3**	**23.8**	**15.5**

Overview of Residential and Commercial Combustion Sources Control Strategy

- Residential combustion:
  - A combination of zero-emission and other low-NOx technology approaches
  - 2037 Goal: ~70 percent reduction

Residential Combustion Equipment Baseline and Remaining NOx (Tons/Day)



2022 AQMP Proposed Stationary and Area Source Control Measures

Residential Combustion Sources

- R-CMB-01: Residential Water Heating
- R-CMB-02: Residential Space Heating
- R-CMB-03: Residential Cooking
- R-CMB-04: Residential Other Combustion Sources

Commercial Combustion Equipment

- C-CMB-01: Commercial Water Heating
- C-CMB-02: Commercial Space Heating
- C-CMB-03: Commercial Cooking
- C-CMB-04: Small Internal Combustion Engines (Non-permitted)
- C-CMB-05: Small Commercial Miscellaneous Combustion Equipment (Non-permitted)

Residential and Commercial Building Measures

Large Combustion Equipment

- L-CMB-01: NOx RECLAIM (formerly CMB-05)
- L-CMB-02: Large Boilers and Process Heaters
- L-CMB-03: Large Internal Combustion Engines (Prime Engines)
- L-CMB-04: Large Internal Combustion Engines (Emergency Standby Engines)
- L-CMB-05: Large Turbines
- L-CMB-06: Electric Generating Facilities
- L-CMB-07: Petroleum Refineries
- L-CMB-08: Landfills and POTWs
- L-CMB-09: Incinerators
- L-CMB-10: Miscellaneous Combustion

State and Local Policies for Residential and Commercial Buildings

California Energy Commission (CEC) Title 24 (2022 Code)

- Electric ready measures from 2023 onward for single family, multi-family, and commercial new buildings

California Air Resource Board (CARB) Draft 2022 SIP Strategy

- Proposed Zero-Emission Standard for Space and Water Heaters at the point of sale in 2030

Bay Area AQMD

- Rulemaking for zero NOx emissions standard for space and water heating units with a proposed compliance date of 2027 to 2031

City of Berkeley

- All electric new buildings of all types, effective January 1, 2020
- A plan adopted to electrify existing buildings with a phased approach in 2021 -2045

Over 50 cities/counties in California

- Adopted building codes supporting all-electric new constructions (mostly Northern CA)

Residential Building Control Measures

Appliances

- Water heating, space heating, cooking, others

Regulatory

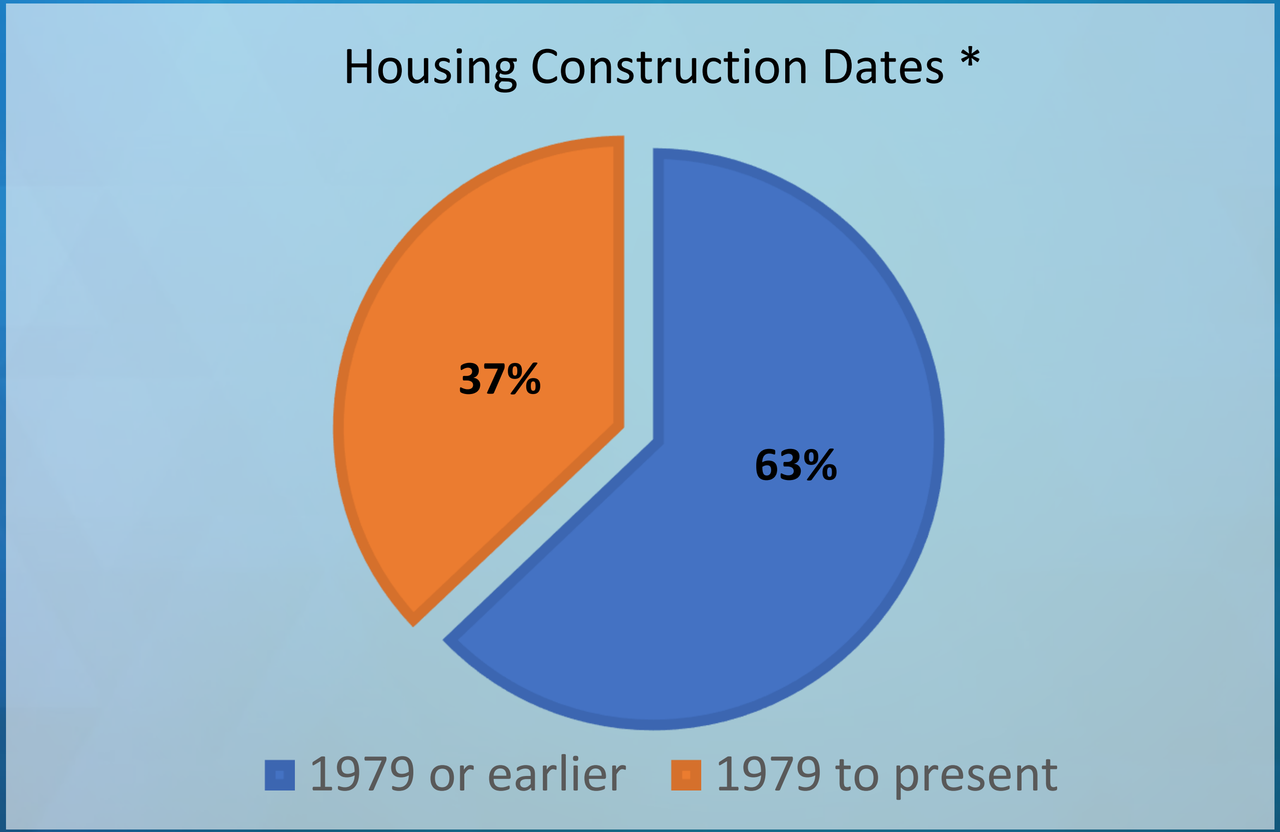
- Require zero emission technology in new buildings; during replacement in existing
- Allow lower NOx technology when zero emission would not be feasible or is cost prohibitive

Incentives

- Focus on older homes and disadvantaged communities
- Additional cost of approximately $2,000 for electrical panel upgrade

Residential Homes - Southern California

- 17 million population, 6 million homes
- Majority are older homes
  - California Title 24 Building Energy Code Adopted in 1978



*SCAG Pre-Certified Local Housing Data, August 2020

Technology – Residential Space Heating

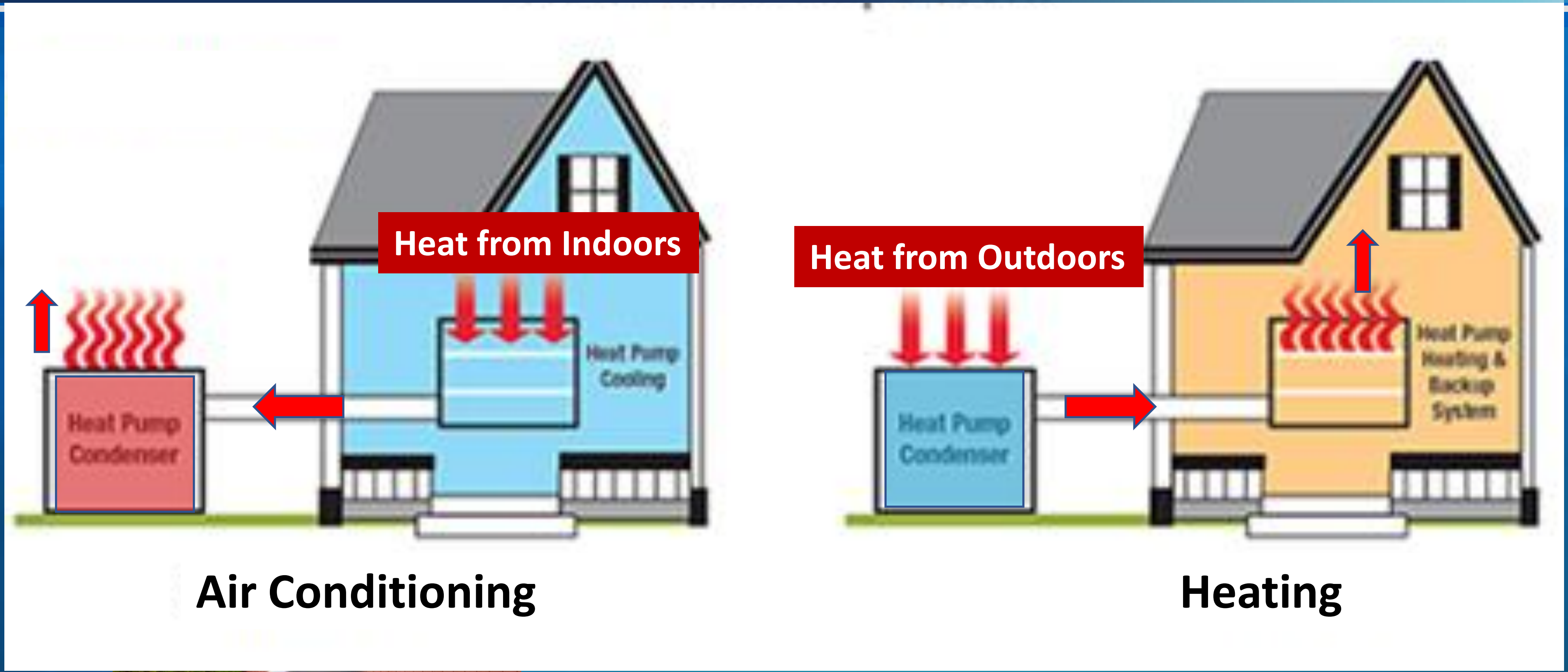
- Traditional gas furnace
  - Subject to Rule 1111 - Reduction of NOx emissions from Natural-Gas-Fired, Fan-Type Central Furnaces
  - 14 ng/J NOx emission limit
  - 95% efficiency for high efficient units

- Heat pump system
  - Zero NOx emissions
  - 300% efficiency

Traditional Gas Furnace

Heat Pump System

How a Heat Pump Works



Technology – Residential Water Heating

- Traditional residential water heaters
  - Subject to Rule 1121- Control of Nitrogen Oxides from Residential Type Natural-Gas-Fired Water Heaters
  - 10 ng/J NOx emission limit
- Heat pump water heaters
  - Zero NOx emission
  - Three to four times more energy efficient
  - 120-volt plug-in design will not require expensive panel upgrades for older homes

Traditional Gas Water Heater

Heat Pump Water Heater

Installation Cost Scenarios

	Combustion	Heat Pump*
Space Heating	Forced Air Central Furnace + AC $12,000-$24,000	Forced Air Ducted Heat Pump $9,000-$17,000
Water Heating	Natural Gas Tank Water Heater: $2,000 - $2,600 Tankless: $3,700 - $5,700	All Electric Heat Pump Water Heater $3,000 - $4,700

*May require electrical panel upgrade $2,000-$4,000

REFERENCE: E3 Report (Residential Building Electrification in California, April 2019):

- Ranges reflect the range of prices across climate zones as a result of labor cost differences
- The costs include labor for system installation

Heat Pump Equipment Cost Comparison

4 Ton AC 14.5 Seer 120K BTU
Natural Gas Furnace
$3.8K

4 Ton 14 Seer Heat Pump
$3.8K

~ 20% more efficient over 14 seer

4 Ton AC 18 Seer
Two Stage
120K BTU Natural
Gas Furnace
$6.6K

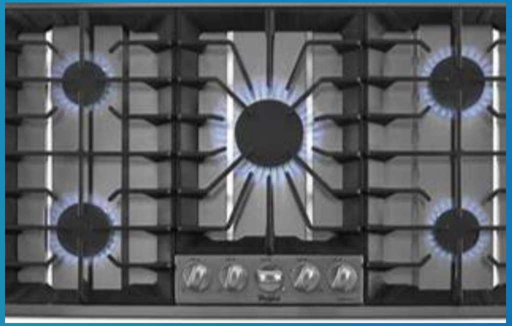
4 Ton 18 Seer Two Stage
Heat Pump
$6.4K

Technology – Pool Heaters

- Pool heaters are regulated under Rule 1146.2 at 55 ppm
- Natural gas pool heaters normally have a capacity ranging from 75,000 to 450,000 BTU per hour
- Estimated at least 200,000 residential pool heaters in the South Coast AQMD
- Zero emission technology for heating pools is the swimming pool electric heat pump
- Potential for low NOx natural gas pool heaters tested at 10-20 ppm

Technology – Residential Cooking

- Traditional cooking tops
  - Gas or electric resistance units with energy efficiencies of approximately 32% and 75-80% respectively
  - Not regulated for NOx (estimating up to 100 ppm for gas units)
- Induction cooking top
  - Zero NOx emission
  - ~ 85% efficiency
  - Rapid heating, precise temp control
  - Induction ready pots and pans



Traditional Gas Cooking Top

Electric Resistance

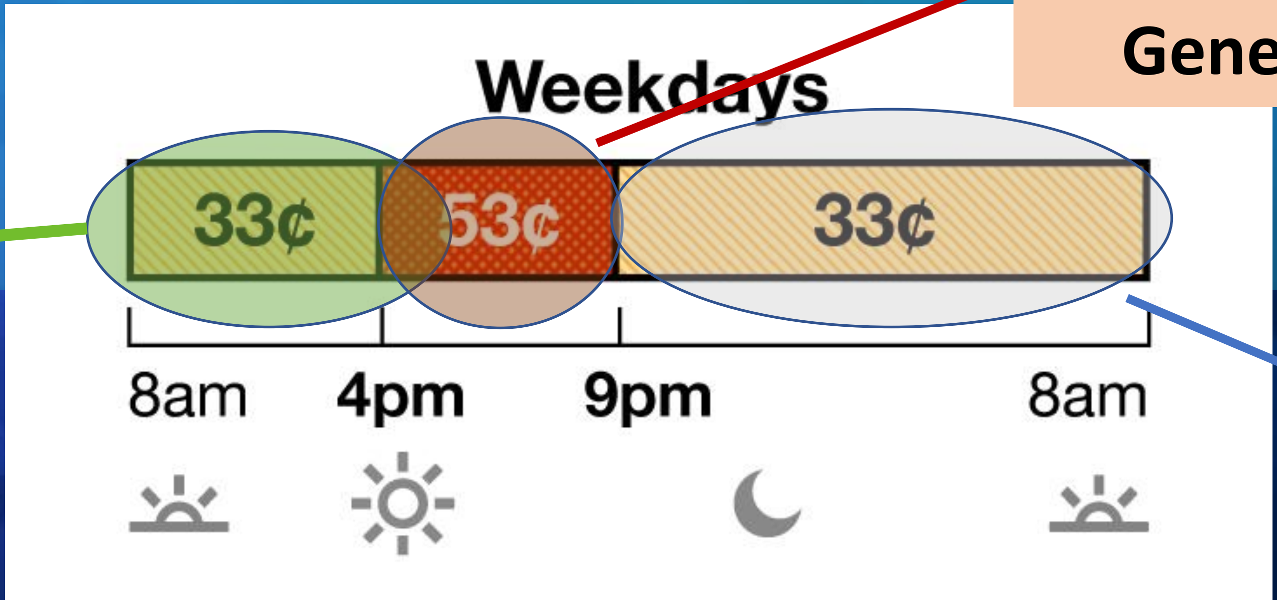
Induction Cooking Top

Solar

- Required under Title 24 for new low rise residential
- May not provide significant relief to electricity bills
- Time-of-Use rates based on demand and availab generation

High Electricity Demand and Low Renewable Generation

Time-of-Use Rate (SCE Summer)

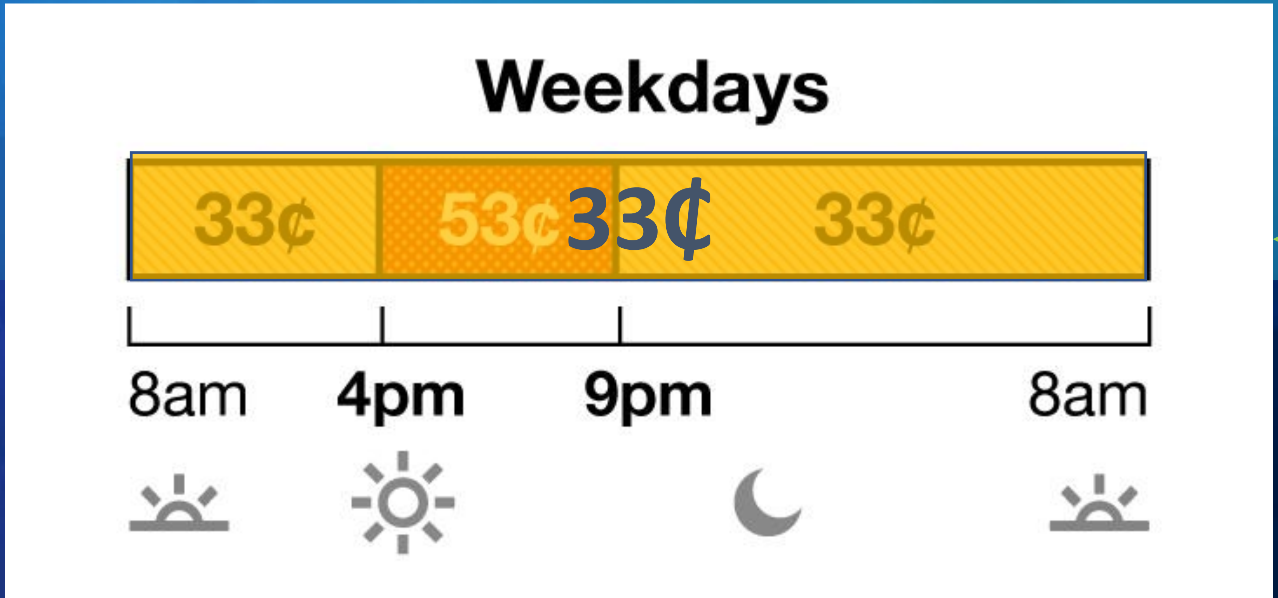


Solar Power Available

Lower Electricity Demand

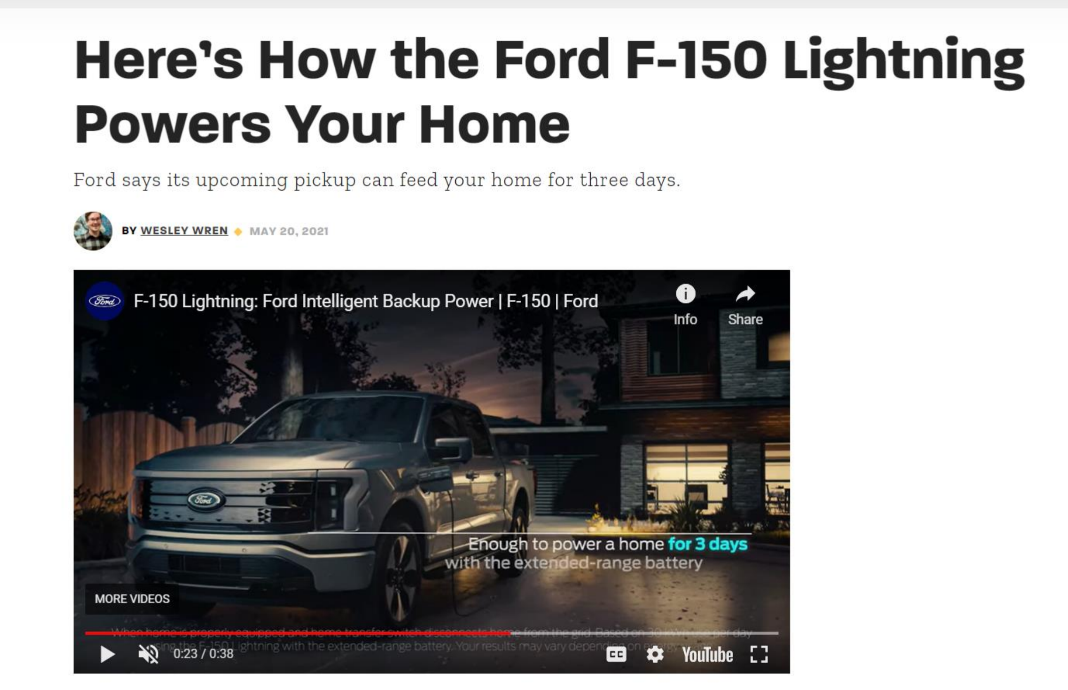
Solar + Storage

- Storage charges when renewable resources available and rates are lowest
- Discharges during highest peak time-of-use rate period



Other Benefits of Storage

- Alternative to backup generators during power outages (public safety power shutoff)
- Demand Response - Reduces need for new generation on grid



Here's How the Ford F-150 Lightning Powers Your Home

Ford says its upcoming pickup can feed your home for three days.

BY WESLEY WREN ◆ MAY 20, 2021

REVIEWED

A record number of people are buying generators—here's why to consider one

Felicity Warner Reviewed
Published 4:41 p.m. ET March 2, 2022

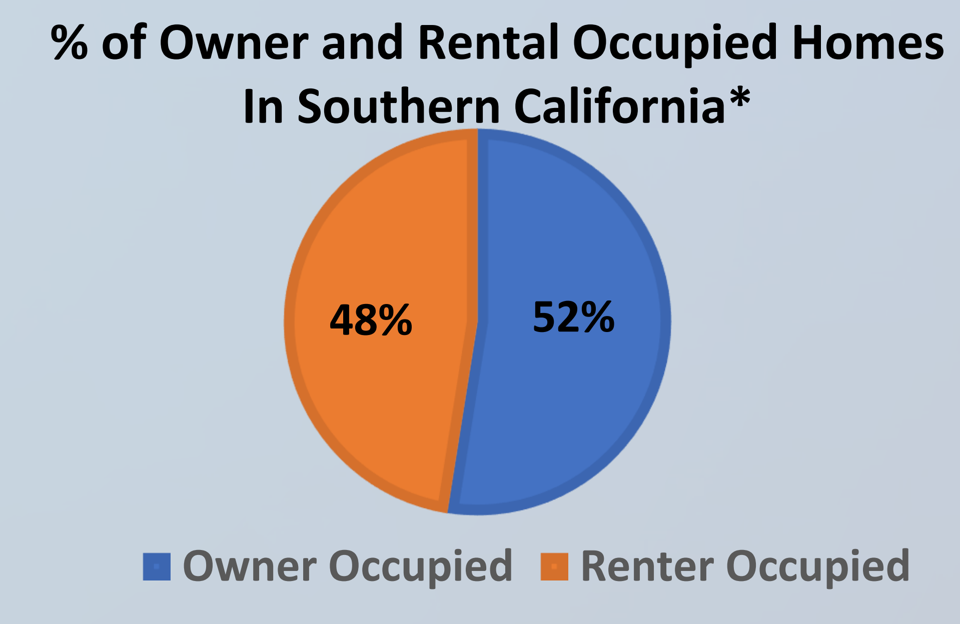
Generator sales are up—here's what to know about buying one. *Reviewed.com*

— Recommendations are independently chosen by Reviewed's editors. Purchases you make through our links may earn us a commission.

USA Today, March 2, 2022

Residential Equipment Replacement – Challenges with Implementation

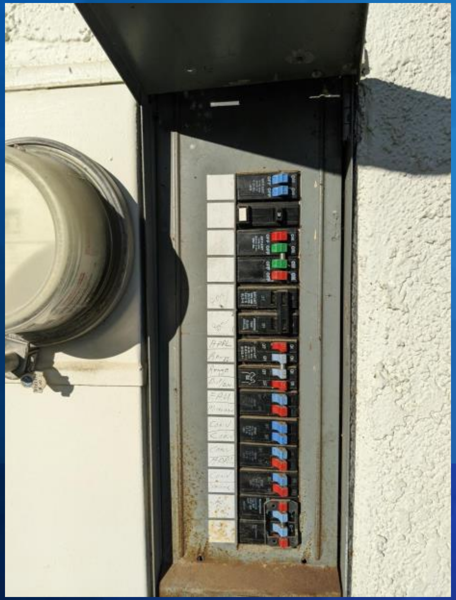
- Small emission benefits with each replacement
- Rental units can be difficult to update
- Uncertainty with trying new technologies
- Electricity rates
- Costs associated with upgrades
  - Appliance replacements
  - Panel replacements, wiring
  - Setting appropriate incentive levels



*SCAG Pre-Certified Local Housing Data, August 2020

Electrical Panels – Issues in older homes

- Most older home panels are 100 amps
- Space constrained to add new circuit breakers for 240V appliances



Older Electrical Panel

Household Retrofit Example:

Pool Heater Heat Pump- 50 amps, 240V

Heat Pump Central Heating – 25 amps, 240V

Heat Pump Water Heater - 15 amps, 240V

Induction Stovetop and Oven - 30 amps, 240V

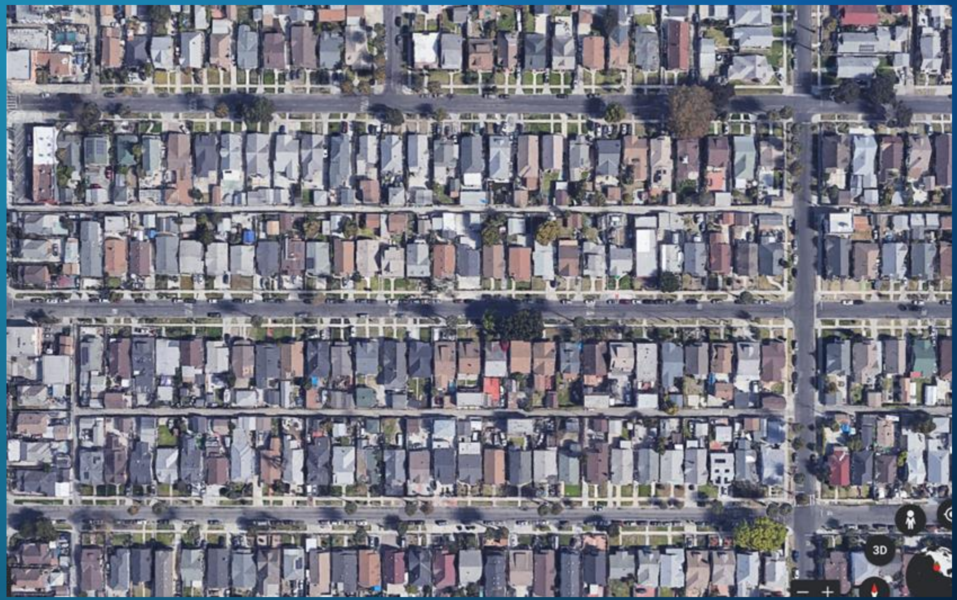
EV charger – 30 amps, 240V

150 amps and need for up to 9 additional circuit breakers

New Electrical Panel

Residential Replacement Incentives -Potential Pathways Forward

- Approach to Implementing Incentives
  - Private public partnerships
  - Whole house approach (multiple appliances, panel upgrades, solar, EV charger..)
- Education
- Targeted Implementation
  - Older Homes
  - Lower income households
  - Modelling to identify best options



Consumer Education Will be Critical

- Consumer education will be an important strategy to communicate
  - Different zero emission technology options
  - Environmental benefits
  - Energy impacts
- Available Incentives
- Owners of rental units
- Private public partnerships
  - Demonstration centers to try out appliances

South Coast AQMD – Clean Air Furnace Rebate Program

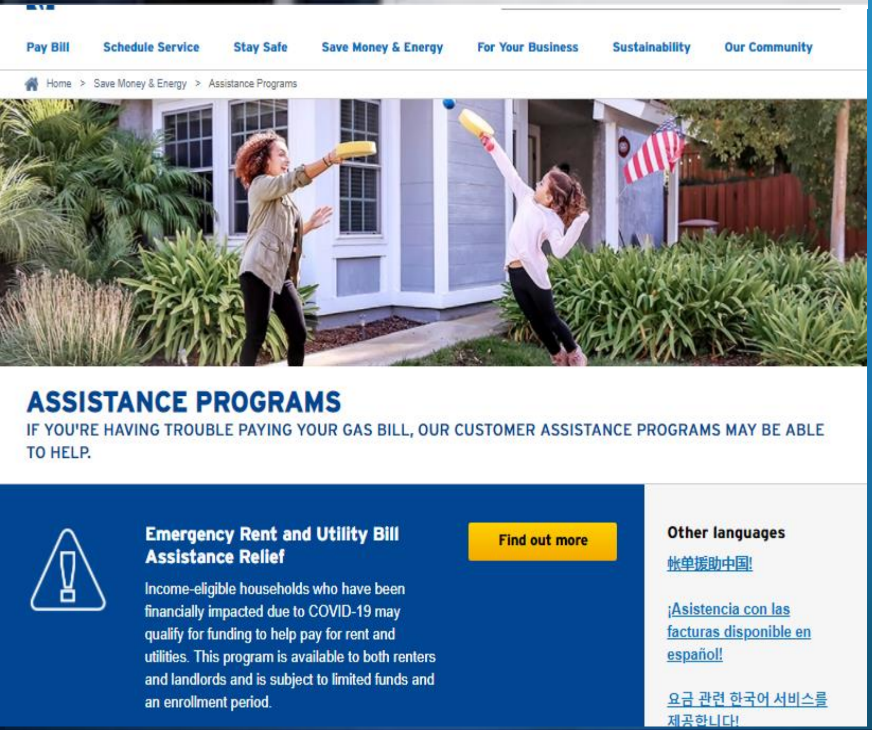
- Established by Governing Board in 2018 to provide rebates for those deploying lower emission furnaces before the compliance date in Rule 1111
  - $3 million helped convert ~5,300 furnaces to ultra-low NOx
- In 2020, the Board approved another $3.5 million was approved for the program including $1,500 rebates for those replacing gas furnaces with an electric heat pump
  - Set aside 25% of funding to dedicate to disadvantage communities
  - Latest funding resulted in over 2,100 units converted to electric

Utility Programs – Southern California Edison (SCE)

SCE administers an Energy Saving Assistance Program –

- Helps income-qualified households conserve energy and reduce electricity costs
- Replaces old, inefficient appliances with new energy efficient appliances
- Free to eligible homeowners and renters
  - Appliance services: lighting upgrades, refrigerator replacement, clothes washer, cooling systems, pool pumps, and installation of smart thermostat
  - Weatherization services: attic insulation, weather stripping and minor repairs intended to keep a home cool in the summer and warm during the winter

Utility Programs – Southern California Gas Company



SoCalGas Energy Saving Assistance Program and appliance replacement rebates –

- Reduce residential natural gas consumption and manage utility bills (e.g., 20% discount on monthly bills for income qualified customers)
- Offers no-cost energy-saving measures and minor home repairs to income qualified homeowners and renters
  - Appliance services: rebates for storage and tankless water heaters, furnaces, ovens, dryers, pool heaters
  - Weatherization services: no cost improvements for attic insulation, door weather stripping, furnace or water heater repair or replacement, water heater blankets, and minor repairs to exterior doors and windows

Utility Programs – Imperial Irrigation District (IID)

Administers the Energy Rewards Program –

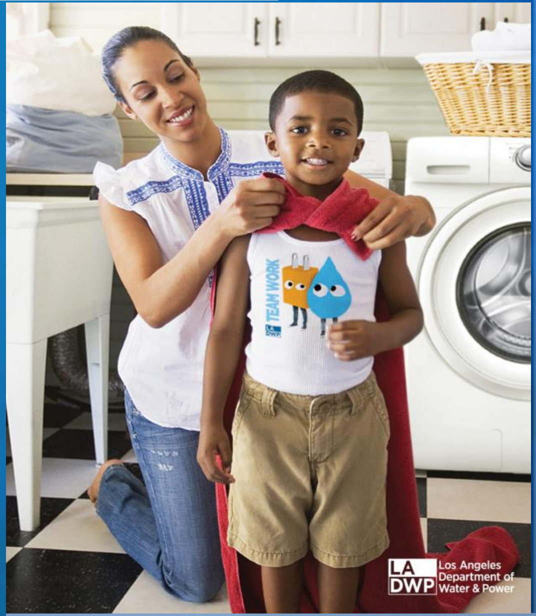
- Offers rebates for residential energy efficiency measures
- HVAC Conversion (gas to electric)
- Residential Weatherization Program – applicants may receive up to $1,500 in services and equipment
  - Appliance services: refrigerator replacement, clothes washer, dish washer, cooling systems, and installation of smart thermostat
  - Weatherization services: Attic insulation, weather stripping, radiant barrier, attic fan installation, duct leak sealing

Utility Programs –
Los Angeles Dept. of Water & Power (LADWP)

LA DWP Los Angeles Department of Water & Power

LADWP rebates and programs –

- Helps households conserve energy and reduce electricity costs
- Replaces old, inefficient appliances with new energy efficient appliances
- Rebate programs provide a portion of the replacement cost
  - Appliance services: refrigerators, clothes washers, televisions, windows, HVAC systems, room AC units, house fans, lighting, programmable thermostats and pool pumps
  - Other services: funding for installation of cool roofs enhanced marketplace website provides instant rebates to applicants



Other Potential Partnerships

- Technology and Equipment for Clean Heating (TECH) Clean California
  - Launched in December 2021
  - $120 million initiative designed to help advance the state's mission to achieve carbon neutrality by 2045
  - 40 percent of the program benefits low-income and disadvantaged communities
- City of Santa Monica
  - Office of Sustainability and the Environment is offering rebates for electrification of existing buildings
  - Replacing gas with electric equipment such as heat pump HVAC, heat pump water heater, heat pump or condensing clothes dryer, service panel upgrade, and cooking devices.

Conclusion

- NOx reductions from existing residential combustion sources will have challenges
  - Emission reductions will accrue over time
  - Will be costly to implement
- Incentives will help accelerate changeovers and incremental costs
- Partnerships will help with costs, education, and implementation
- Regulations and building codes will help with new construction and retrofits

South Coast AQMD

Diversity, Equity, & Inclusion GOVERNING BOARD RETREAT 2021-2022 Update

May 12-13, 2022

FABULOUS FEMALE FRIDAY

Coretta Scott King

April 27, 1927 – January 30, 2006

Civil Right and Human Rights Activist

- Joined the local Ohio chapter of the National Association for the Advancement of Colored People (NAACP)
- Met Martin Luther King Jr. while in his doctorate program in Boston
- Completed her bachelors in music in 1954
    - Performed in freedom concerts (poetry recitation, singing, and lectures)
- Founded the King Center for Nonviolent Social Change
- Continued to write and accept public speaking events on Human Rights
    - Sit-in protests in response to the South African apartheid
    - Active participant in various women's organizations
        - National Organization for Women, Women's International League for Peace and Freedom, and United Church Women.

CLICK PORTRAIT TO WATCH CORETTA SCOTT KING IN "MADE BY HER: MONUMENTAL WOMEN" BY HULU (2021)

Presentation Overview

- Fabulous Female Friday
- DEI Team Introductions
- DEI Goals and Accomplishments
- 2021-2022: Infographics
- 2021-2022: Events
- 2021-2022: J.E.D.I. Think Tanks
- Individual Employee Resource Groups (ERG)
- Joint DEI/ERG Working Groups

2021-2021 DEI GOALS & ACCOMPLISHMENTS

	Contribute Equity related information to Staff	Support Employee Resource Groups	Develop Equity Professional Training
Annual Goals	12	14	4
Year to Date	17	21	9

D.E.I. Infographics

Hispanic Heritage Month

National Coming Out Day

Veterans Day

Winter Holidays

Yalda

Lunar New Year

African American Heritage Month

Women's Herstory Month

Nowruz

Holi

Day of Silence

April Remembrances

Asian Pacific Islander Heritage Month

J.E.D.I. Think Tanks

10/21 Segregated by Design

2/8 Good Trouble

2/15 Japanese American National Museum Virtual Tour

3/15 The History of the Overthrow of Hawaii

4/26 The Tragedy of Air Pollution

D.E.I. Programs

Haft-Seen Display and
Baklava Tutorial

Fabulous Female Fridays

African American Heritage
Month Commemoration

EMPLOYEE RESOURCE GROUPS

ERGS

- Persian
- Allies & Advocates
- Hispanic and LatinX of Success (HALOS)
- Lesbian, Gay, Bisexual, Transgender Queer and Questioning, Intersex, and Asexual+ (LGBTQIA+)
- Black Employee Resources of Change (BEROC)
- Asian Pacific Islander+ (API+)
- Veterans and Active Duty

ERG Working Groups

- COMMUNITY PARTNERSHIP OUTREACH
- EDUCATIONAL EQUITY OUTREACH
- EMPLOYEE PROFESSIONAL DEVELOPMENT
- EMPLOYEE PROMOTION
- EMPLOYEE RECRUITMENT
- EMPLOYEE RETENTION AND ENGAGEMENT
- EQUITY EVENTS PROGRAMMING AND RESOURCES

JOINT DEI/ERG WORKGROUP TIMELINE

July 2021
Workgroups created based on API+, BEROC, HALOS and IDEA panel recommendations

Oct. 2021
1st All ERG joint meeting/initial workgroup discussion

Nov. 2021 - Apr. 2022
4 meetings
90% ERG representation

April 2022
2^{nd} All ERG joint meeting

May 2022
Workgroup recommendations shared with All-ERG members during their meetings

June 2022
Final recommendations will be shared with Executive Council Leadership

Any questions?