

Meeting California's Carbon Neutrality Goals: Approaches for the Industrial Sector

FEBRUARY 20, 2020



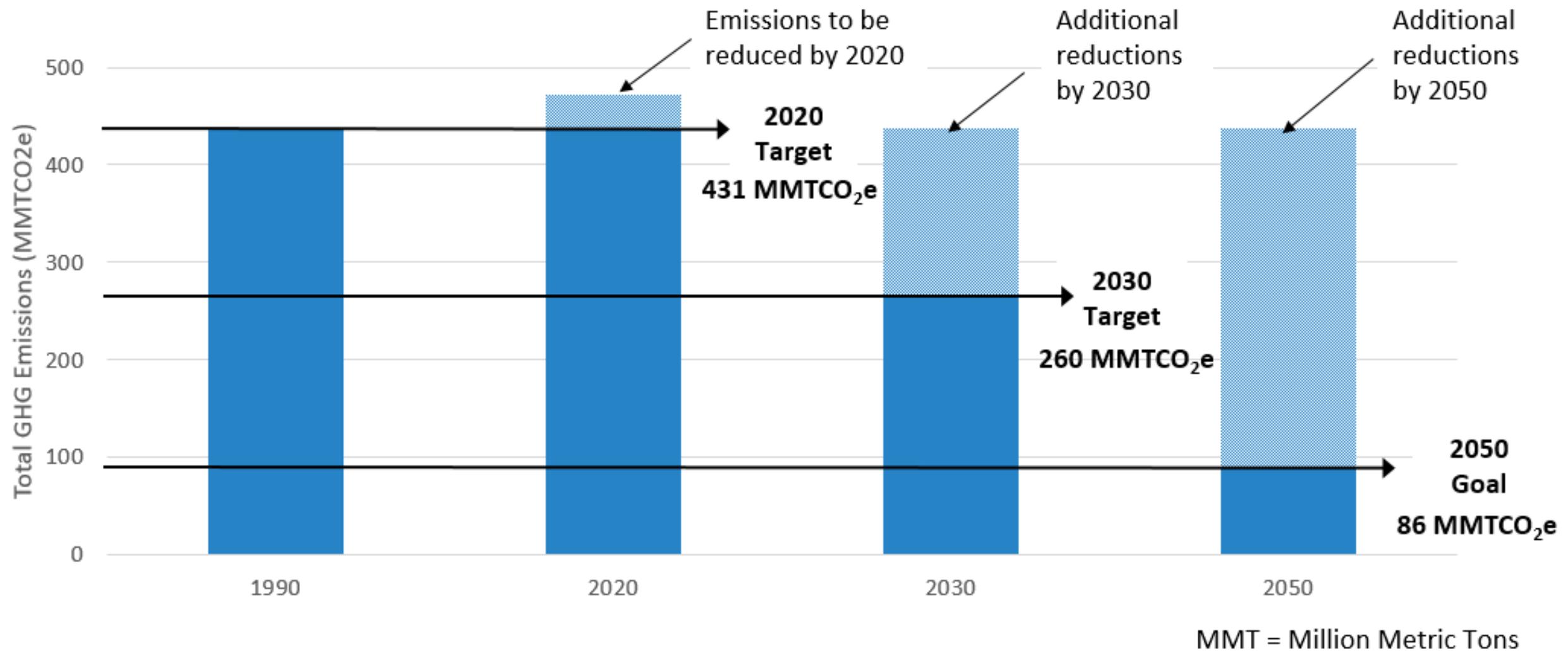
Thank you for joining this California Air Resources Board webinar today titled Meeting California's Carbon Neutrality Goals: Approaches for the Industrial Sector. Today's webinar will be a continuation of our series of public meetings on carbon neutrality, and our second presentation on the industrial sector's contribution to California's carbon neutrality goals.

Webinar Logistics

- Presentation and link to submit and view informal comments:
 - <https://ww3.arb.ca.gov/cc/scopingplan/meetings/meetings.htm>
 - Comment period from Thursday, February 20 to Friday, March 6
- Webcast at <https://video.calepa.ca.gov/>
- Video will be uploaded to the Scoping Plan meetings web page

This webinar is presented live on Cal EPA's video website: video.calepa.ca.gov. A video recording will be available on CARB's Scoping Plan meeting page. I will not be taking live questions today, but we encourage you to submit written comments on our web page by Friday March 6.

California's GHG Emissions Reduction Targets



Source: CARB, 2018

This slide shows California's long-term climate goals. We have some key statutes and executive orders that guide the State's climate targets.

In 2006, AB 32 set our initial 2020 target: to return to 1990 greenhouse gas emission levels.

Then, SB 32 called for 40% below 1990 levels by 2030. CARB's 2017 Scoping Plan lays out a cost-effective and achievable path for this target.

This 2030 target is on the path to achieving the goal of reducing GHG emissions 80% below 1990 levels by 2050.

Both last year's Executive Order calling for carbon neutrality by 2045 and the climate science require us to find ways to reduce GHGs from fossil fuels at all opportunities. This also emphasizes our need to focus on our natural and working lands and other sequestration opportunities. Carbon neutrality will require mitigating greenhouse gas emissions at their source, increasing carbon sinks, and moving toward non-combustion scenarios in the future.

Framing the Path Forward

IPCC Report – Carbon neutrality by 2045 may hold global warming to 1.5°C



Some regions are net emitters; others are sinks



Carbon Neutrality by 2045



Reduce fossil energy and NWL emissions; evaluate potential sinks

Our thinking about how to approach the climate challenge is evolving and carbon neutrality is gaining importance. This concept is that to address climate change, the carbon dioxide and other GHG emissions generated by sources such as vehicles, power plants, and industrial processes must be less than or equal to the amount of carbon dioxide that is stored.

The magnitude of climate change impacts will depend on when carbon neutrality is achieved. The latest science tells us that we need to reach global carbon neutrality by mid-century and indicates that on a global scale, some regions may remain net emitters, while others are better suited to be net sinks.

In California, we have an executive order that calls for carbon neutrality by 2045, consistent with the IPCC report. This executive order introduces the concept of balancing carbon emissions and carbon sequestration within the state. Part of moving toward this balance is reducing fuel use at sources throughout the economy to the maximum extent feasible. In the industrial sector, fuel consumption is tied to a wide range of applications, and eliminating fuel combustion won't always be practical. CARB is evaluating approaches to deep decarbonization while recognizing the importance of the industrial sector to local jobs and the statewide economy.

California Carbon Neutrality (CO₂e)

Today



AB 32 GHG Inventory



Conversion

Natural & Working
Lands Inventory

Minimize emissions

Increase sequestration

Mid-century



Both categories emit GHGs

No net GHG emissions

The path to carbon neutrality requires action on both sources and sinks. As we approach carbon neutrality, we must begin thinking about moving past combustion in all possible areas. Any fuel combustion leads to local air quality impacts, and CARB continues activities to reduce air pollution and improve public health. In the long-term, we recognize that moving beyond combustion won't be feasible everywhere, but where it is possible, it will support both our climate goals and air quality goals.

Today, we track statewide GHG emissions from transportation, electricity, commercial, residential, industrial, agricultural, and waste management sectors, including high-global warming potential gases.

We also track emissions and sequestration in our Natural and Working Lands. Currently these lands are a source of GHG emissions, releasing more carbon than they are sequestering. Some emissions from this sector are part of the natural cycle and are necessary for healthy systems—including emissions from periodic fires.

To achieve carbon neutrality by mid-century:

we must minimize emissions from our fossil energy and industrial sources and transition our natural and working lands from a source to a sink.

As we start to consider the concept of carbon neutrality, our starting point is CARB's existing accounting framework, which includes all major greenhouse gas emissions and not just carbon dioxide.

Carbon Neutrality Meeting Series

- January 2019 – Carbon Neutrality in the California Context
- July 2019 – Public Workshop to Discuss the Role of the Industrial Sector in Meeting California's Carbon Neutrality Goals
- August 2019 – Public Workshop to Discuss Carbon Neutrality: Scenarios for Deep Decarbonization
- August 2019 – Public Workshop to Discuss Carbon Neutrality: Social Cost of Carbon and Affordability
- December 2019 – Public Workshop to Discuss the Role of Carbon Capture, Sequestration, and Options for Utilization
- Carbon Neutrality Meetings at <https://ww3.arb.ca.gov/cc/scopingplan/meetings/meetings.htm>

Over the past year, CARB has held a series of meetings on carbon neutrality listed on this slide: carbon neutrality in the California context, the role of the industrial sector, scenarios for deep decarbonization, social cost of carbon and affordability, and most recently, carbon capture, sequestration, and options for utilization. More information on these meetings can be found on CARB's Scoping Plan meetings web page.

Carbon Neutrality – Role of Industrial Sector

- July 8, 2019 Workshop
- Two sets of panelists presented on:
 - Economic Considerations of Industrial Emission Reductions
 - Development and Implementation of Technologies to Decarbonize Industry
- Key Takeaways for California
 - Current technologies may not result in sufficient emission reductions
 - Prices of renewable fuels and electricity need to decrease
 - Must take an all-of-the-above approach to target GHG-reducing opportunities
 - Strong policies needed to drive deep decarbonization in industry
 - Policies must minimize leakage and recognize the importance of industry to jobs and the economy

CARB held a workshop on the role of the industrial sector in carbon neutrality in July 2019, and this webinar is a follow-up to that discussion.

The workshop last July consisted of two panels: one on the economic considerations of emissions reductions and one on the technologies to decarbonize industry.

I have included some of the key takeaways in this slide.

Current technologies may not result in sufficient emissions reductions needed to decarbonize industry.

Current prices of renewable fuels and electricity need to decrease to warrant large-scale switching to these technologies.

Since we don't know what actions might unlock future low carbon pathways, we need to take an all-of-the-above approach to target GHG-reducing opportunities.

California needs strong policies in place to drive deep decarbonization in industry and any of these policies need to minimize leakage and recognize the importance of industry to jobs and the economy.

Today's Workshop

- Review technology and policy options considered by researchers, industrial groups, and others on industrial decarbonization
- Discuss the current industrial sector regulatory context in California
- Overview of policies and incentives being implemented in other jurisdictions to drive GHG reductions in the industrial sector
- Solicit feedback on potential regulatory and policy approaches

- Please submit written comments by 5:00 p.m. on Friday, March 6 at https://www.arb.ca.gov/lispub/comm2/bcsubform.php?listname=cn-industry-web-ws&comm_period=1

Today's webinar builds on these key concepts. I will review technology and policy options that have been considered by experts
I will provide some context by giving an overview of the current California regulations for the industrial sector.

I will review several policies and incentive mechanisms that other jurisdictions are using to address industrial emissions
I'll finish by teeing up some questions for everyone to consider when submitting comments.

Overview of Technology Options for Decarbonizing Industry

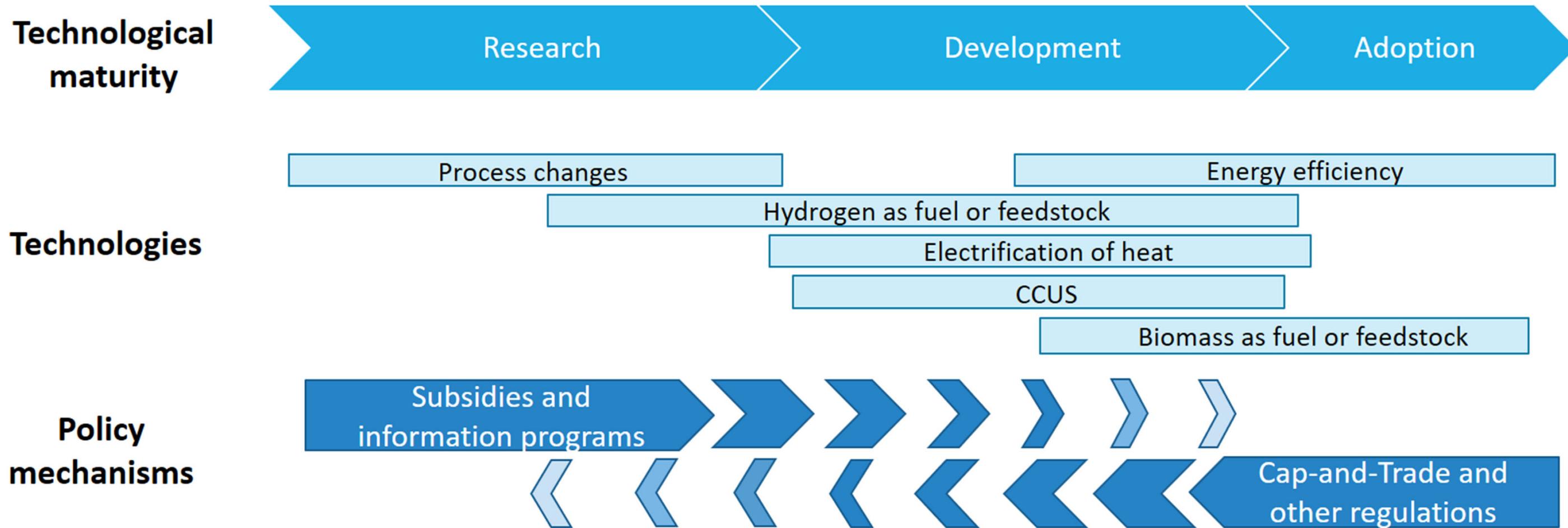
- Process changes and efficiency gains
 - Membrane technology
- New sources of process heat
 - Electric boilers
 - Solar thermal
- Renewable fuels
 - Renewable natural gas
 - Green hydrogen
 - Biomass
- Carbon capture, sequestration, and options for utilization
 - See CARB workshop held December 11, 2019

The technology panelists from the July workshop identified this potential suite of options to work toward industrial deep decarbonization:

- (1) Process changes, such as membrane technologies or other novel approaches.
- (2) New sources of process heat, such as electric boilers and solar thermal heating.
- (3) Renewable fuels, such as renewable natural gas, green hydrogen, and biomass.
- (4) Carbon capture, sequestration, and utilization was also identified as a viable option for industry, and CARB held a workshop exploring potential applications of CCUS last December.

Next I want to go over some policy and incentive mechanisms that may be available to help spur faster transition to these technologies.

Innovation to Ensure a Range of Decarbonization Options



McKinsey & Company (2018). Decarbonization of industrial sector: the next frontier

This is a high level info-graphic from McKinsey and Company showing how different policy mechanisms may be appropriate for incentivizing uptake of different decarbonization technologies depending on the level of technological maturity.

The top describes the technology readiness along the range from research to development to widespread adoption.

The middle shows where industrial technologies fall within the technology readiness levels.

The bottom shows the general policy approaches likely to be appropriate based on the technology's maturity.

This is highlighting that different policies may be more effective at certain levels of technology readiness. For example, grant programs and subsidies may be best to push technology innovation during the research phase, while regulations may be most effective for promoting adoption of mature technologies.

Tools for Decarbonizing Industry

1. Funded research and development
2. Government procurement
 - Buy Clean California
3. Fiscal subsidies
 - Tax incentives, grants, loans
4. Infrastructure development
 - Renewable gas infrastructure, electricity transmission
5. Carbon pricing
6. Carbon tariffs
 - Border carbon adjustment
7. Mandates
 - Direct regulations
8. Voluntary industrial association
 - ISO 50001
9. Clean energy ministerial (Global forums and information sharing)

Innovation for a Cool Earth Forum, 2019. Industrial Heat Decarbonization Roadmap

This is a fairly comprehensive suite of tools to decarbonize industry, and this list is adapted from the cited ICEF report at the bottom. The numbering corresponds to the presentation in that report and does not indicate any preference or priority.

Options include government funded research and development, such as through U.S, Department of Energy national labs. Government procurement such as the Buy Clean California bill. Fiscal subsidies such as grants and loans. Infrastructure development such as accelerated permitting for renewable electricity transmission. Carbon pricing, such as through the Cap-and-Trade Program. Carbon tariffs such as border carbon adjustments. Mandates such as direct regulations for emissions reductions. Voluntary associations such as implementation ISO 50001 standards. And participation in clean energy forums and other information sharing programs.

California's comprehensive suite of policies for reducing greenhouse gas emissions already includes many of these tools. But CARB's Board Resolution 17-46 is directing us to continue to evaluate and explore opportunities to achieve significant cuts in GHG emissions from ALL sectors and sources. So more options for decarbonizing industry may be needed, and we want to explore which options may work moving forward in the California context.

CARB Industrial Sector Regulations

- **Cap-and-Trade Regulation**
 - Economy-wide carbon pricing
 - Incentivizes covered entities to reduce emissions through a steadily increasing price signal
- **Low Carbon Fuel Standard Regulation**
 - Reduce carbon intensity of transportation fuel pool
 - Incentivizes efficiency in the production of traditional fuels
- **Oil and Gas Regulation**
 - Reduces methane emissions from oil and gas production, processing, storage, and transmission
 - Requires regulated entities to limit intentional (vented) and unintentional (leaked or fugitive) emissions
- **Regulation for Energy Efficiency and Co-Benefits Assessment of Large Industrial Facilities**

Over the past decade, CARB has adopted and implemented a suite of measures that work to reduce industrial sector greenhouse gas emissions.

The Cap-and-Trade Regulation, LCFS Regulation, Oil and Gas Regulation, and the Regulation for Energy Efficiency and Co-Benefits Assessment of Large Industrial Sources are measures that cover the industrial sector.

And while we continue to seek further GHG reductions, it is important to recognize the State's long history of addressing health-based air pollutants. California's air quality programs are responsible for significant public health improvements through statewide and regional air quality planning requirements, advancement of technology-based solutions, and risk reduction efforts near industrial facilities.

However, certain communities continue to experience environmental and health inequities from air pollution. CARB is in the process of implementing AB 617 through the Community Air Protection Program, which is providing a community-focused action framework to reduce air pollution and improve public health in communities most impacted.

California Incentive Mechanisms

- Cap-and-Trade Program industrial allowance allocation incentivizes more efficient production
- California Climate Investments (CCI)
 - Food Processor Investment Program
- Utility programs to reduce industrial GHG emissions
- Refinery Investment Credit Program within Low Carbon Fuel Standard (LCFS)
 - Provides LCFS credits for GHG reductions at refineries that lower carbon intensities of CARBOB and diesel

There are also incentive mechanisms in place to encourage industrial GHG reductions.

The Cap-and-Trade Program is designed for compliance flexibility to minimize costs, and there is also free allowance allocation for industrial facilities to minimize leakage. Relocation of industrial production that shift emissions outside of the State without the benefit of reducing overall emissions does not have a global greenhouse gas benefit.

The Cap-and-Trade Program allowance auctions raise proceeds that are re-invested in programs that further the goals of AB 32 through California Climate Investments. An example program is the Food Processor Investment Program, which provides a total of \$120M to food processors. This was first established in the Budget Act of 2017 and had continued funding in 2018. It provides grants to two different tiers of projects: Tier 1 drop-in technologies, like upgrades to boilers and refrigeration systems, and Tier 2 emerging energy technologies, such as solar thermal steam generation and micro-grids.

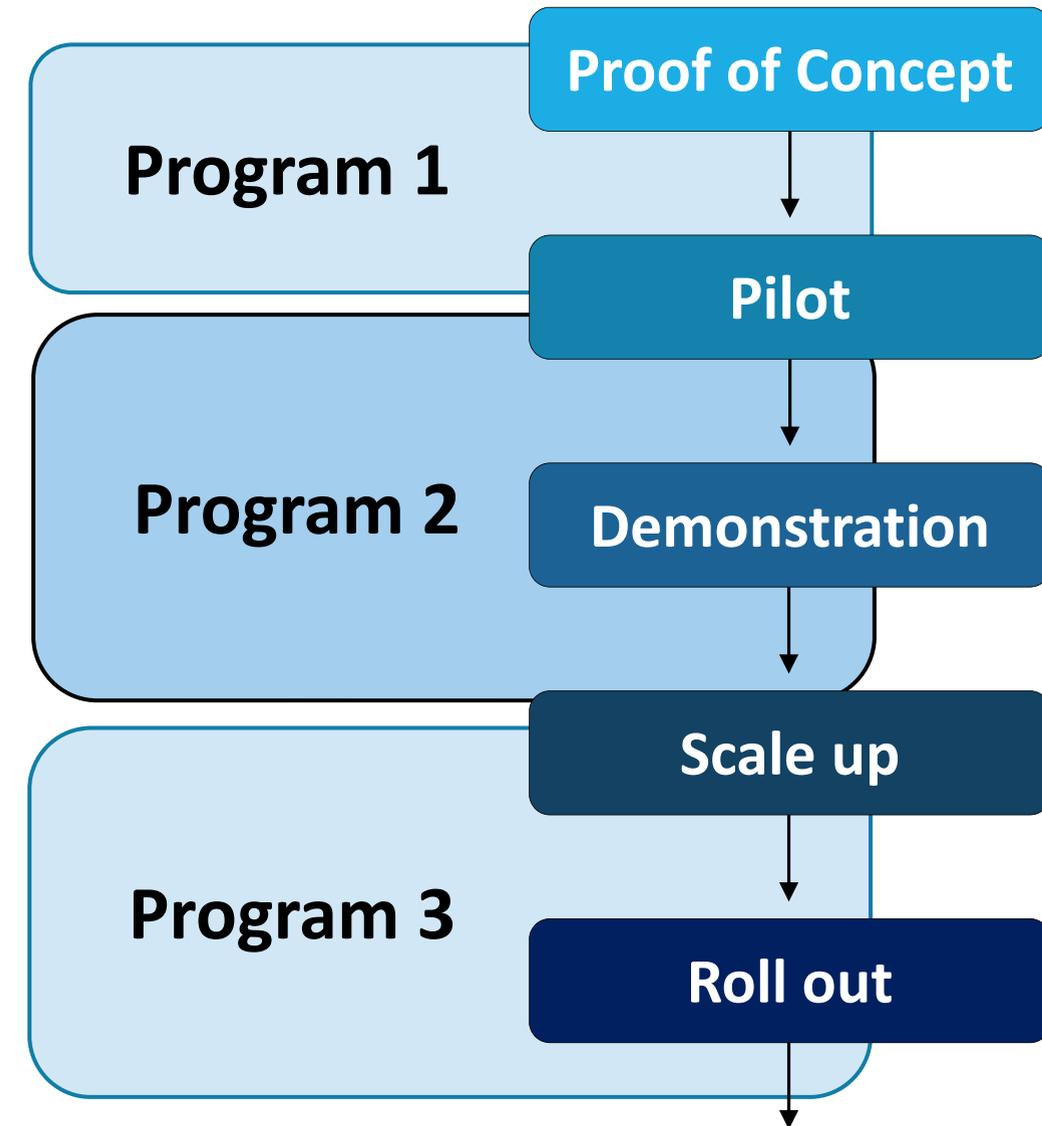
There are also utility incentive programs, such as PIER and EPIC, aimed at reducing industrial GHG emissions through financing for equipment upgrades, energy efficiency programs, and custom rebates.

The refinery investment credit program within LCFS provides credits to projects that reduce GHG emissions at refineries. This is an incentive program that operates within the LCFS regulation, where refineries may receive LCFS credits through an application and approval process. CARB has started receiving applications for this credit, including one to electrify a gas-turbine compressor, and the other for process improvements to a catalytic cracking unit.

CARB could potentially explore other mechanisms to incentivize industrial actions that operate within existing programs, using this LCFS refinery investment credit mechanism as a general model.

Other Programs Incentivizing Industrial Sector GHG Reduction

- European Union
- Canada
- New Zealand
- Australia
- Tokyo



We expect that decarbonizing the industrial sector will be challenging, but California isn't alone in looking to decarbonize industry. Other jurisdictions around the world are working to do the same thing, and they are taking a variety of approaches to dealing with the hurdles and constraints that everyone is facing. Some challenges will be specific to certain jurisdictions, and others will be more universal.

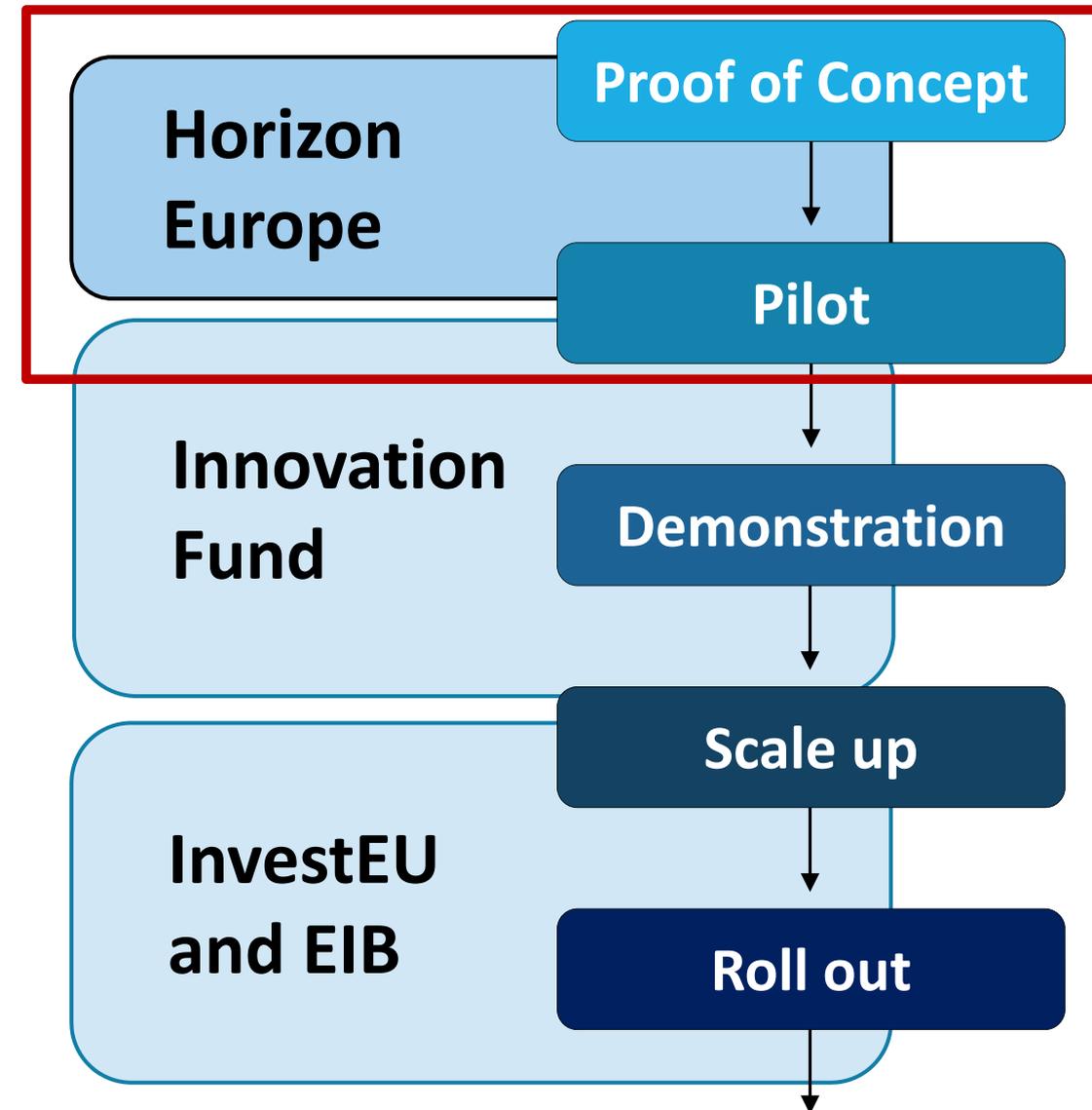
I want to now spend time discussing incentive mechanisms and tools being implemented in other jurisdictions in order to better understand how others are thinking about this challenge and have dealt them. The mechanisms I'll discuss are already up and running, and therefore represent viable approaches for at least some jurisdictions. I'll step through some measures in the EU, Canada, New Zealand, Australia, and Tokyo, and as I do, I encourage you to consider how programs, or elements of programs, may translate to the context of the California industrial sector.

For many of the slides, I'll use this technology readiness chart on the right to identify what types of projects are eligible. The right side of the graphic lists the level of project maturity from laboratory proof of concept to pilot to demonstration, scale-up, and roll out.

On the left side of the graphic, the programs are identified as they relate to certain technology readiness levels.

European Union (1 of 3)

- Horizon2020 (2014-2020) budget of €77 billion
 - €17 billion for advancing industry
 - Faster funding compared with prior programs
 - Interim evaluation
- Horizon Europe (2021-2027) program targets
 - Research and development
 - Proof of concept projects
- Funded Heidelberg Cement plant
 - Oxyfueled kiln with flue gas recirculation
 - €12 million from Horizon Europe
 - Created public/private working group for future low carbon cement initiatives



In the next three slides, I'll discuss three European programs:

- (1) Horizon Europe for R&D and pilot projects;
- (2) the Innovation Fund for pilot, demonstration, and scale up projects;
- (3) And the EU Investment Bank's and InvestEU's financial support for project scale-up and adoption.

This slide covers the Horizon Europe program, which has the objective of advancing early-stage research and innovation. The first phase of Horizon Europe, Horizon 2020, had a budget of 77 billion Euros, started in 2014 and will end this year: 17 billion was specifically earmarked towards advancing industry.

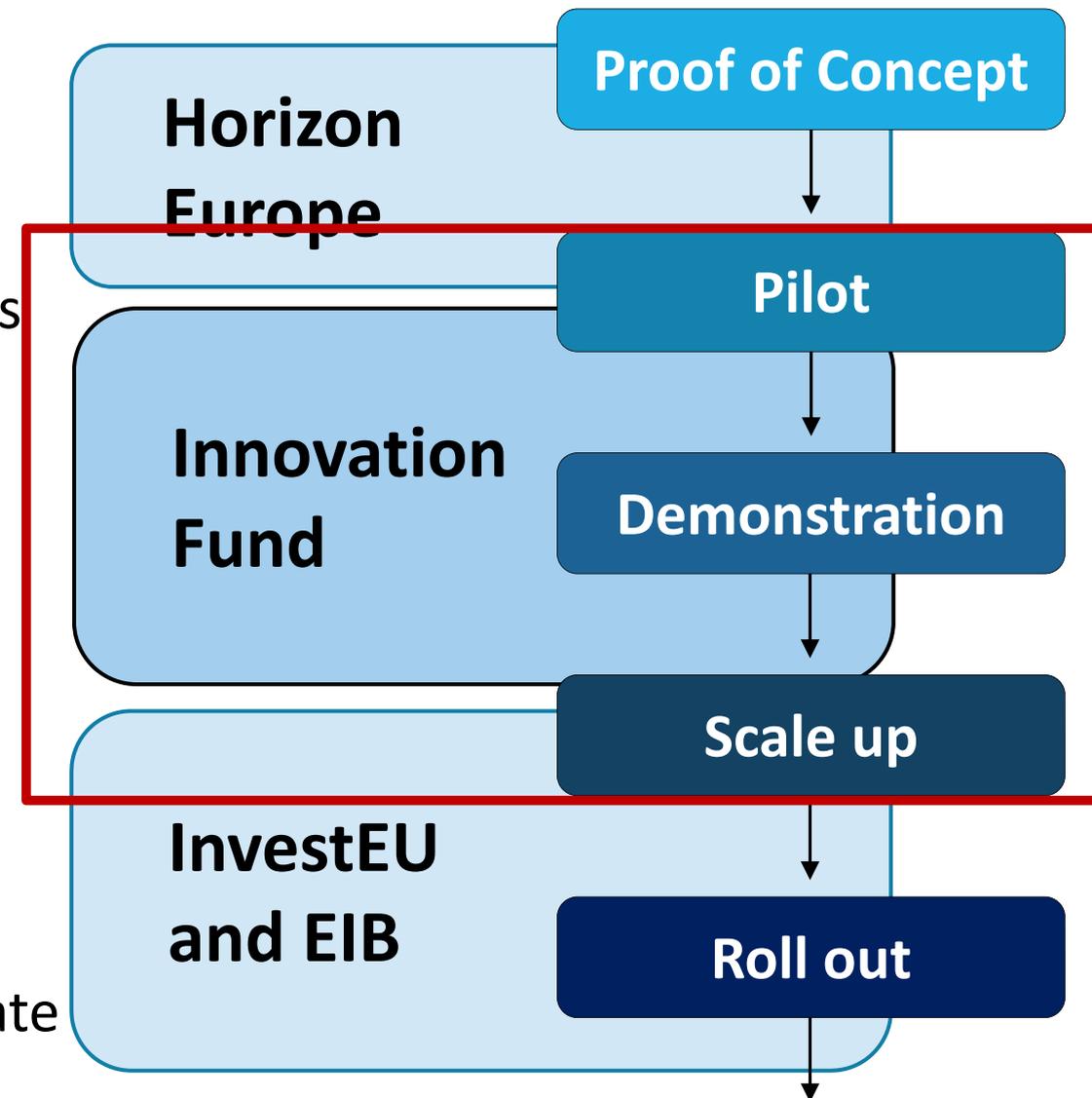
The EU completed an interim evaluation of Horizon 2020 in 2017. The evaluation identified challenges with Horizon 2020's coordinating with other funding sources. The EU also noted that the Horizon 2020 budget had funding for only one out of every four proposals that were evaluated as "high-quality". As of the 2017 interim evaluation, the EU would have needed an additional 66 billion euros to fund all of these "high-quality" projects.

The EU has proposed that Horizon Europe run from 2021 to 2027 with a funding level at 94 billion euros coming directly out of the EU budget.

An example industrial project was at a cement plant in Belgium that received \$12M to install a carbon capture technology to mitigate process emissions. Importantly, this funding built relationships between a broad consortium of cement companies, academics, and non-profits for future low-carbon cement projects. Members of the consortium are now working on an oxy-fired cement kiln to improve fuel combustion efficiency.

European Union (2 of 3)

- **NER300 (2013 to 2020)**
 - €2.1B from 2010-2012 auction of 300 million EU ETS allowances
 - EITE projects limited to biofuel and CCS in certain sectors
 - No EU payment until project operational
- **Funded Vercelli cellulosic ethanol plant**
 - First-of-kind cellulosic ethanol production (€28M)
- **Stakeholder feedback on post-2020 design**
- **Innovation Fund (2021 to 2030)**
 - Auction ~425 million EU ETS allowances (~ €10B)
 - All EITE low-carbon technologies allowable, earlier payment based on milestones, higher EU contribution rate



This slide covers the Innovation Fund that will run from 2021 to 2030, and its predecessor, the New Entrant Reserve 300, that started in 2013 and will conclude this year. These programs target innovative technologies that are proving initial commercial viability and can reduce emissions in the EU Emissions Trading System's covered sectors.

The EU funded the NER300 by auctioning 300 million allowances. The program was limited to specific project types including, renewable energy, bio-refineries, and electricity generation with CCS.

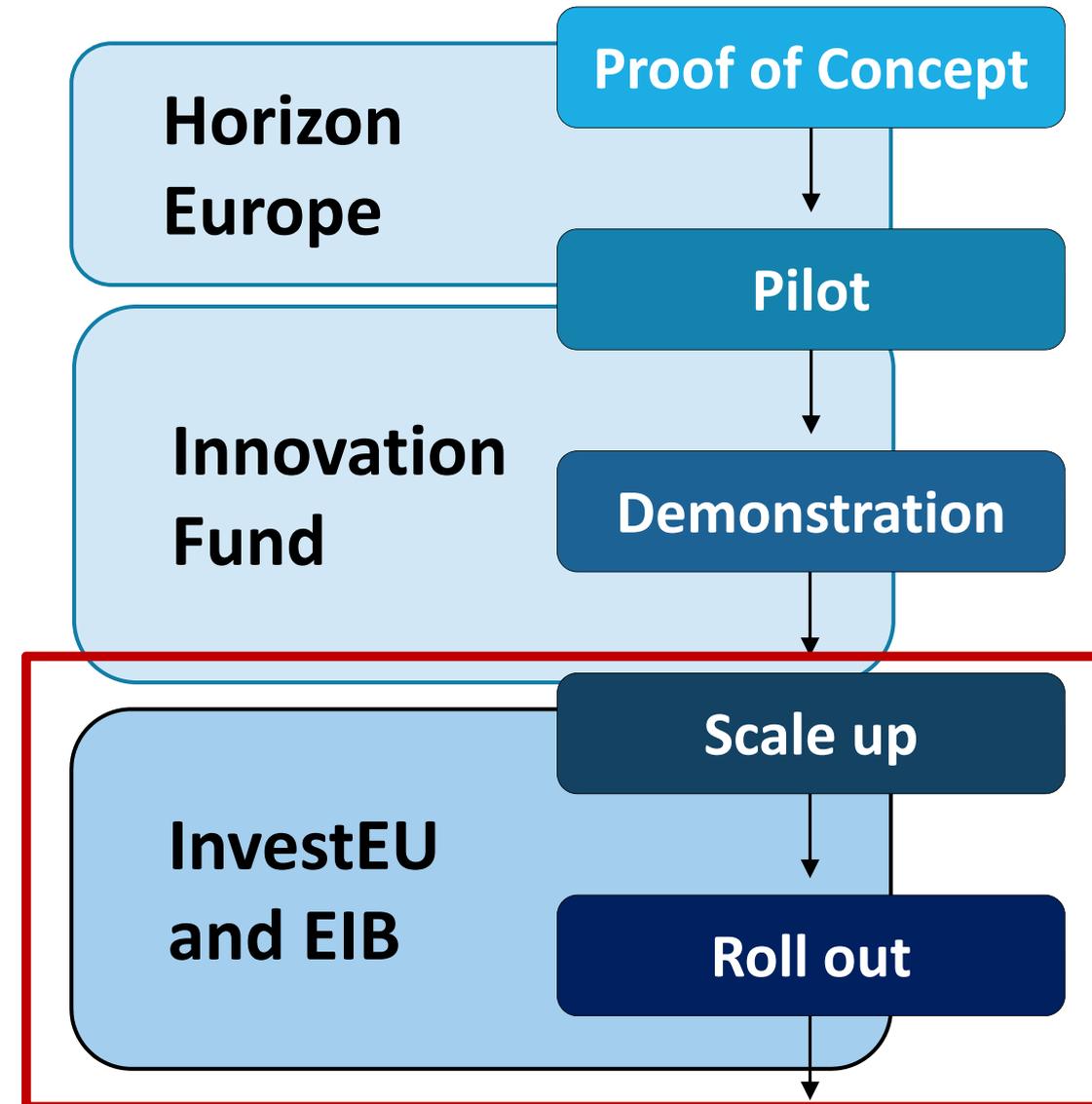
Project applicants only received NER300 payments after project completion and verified emission reductions. This delayed the availability of funds, made capital-intensive projects difficult to develop. In the end, no CCS projects, and only two bio-refineries were funded. One example was the Verchelli cellulosic ethanol plant, which was a first-of-its-kind plant that received 28.4 million euros in NER300 funding and additional funds from the Italian government.

Recognizing that the NER300 program had limited uptake beyond renewable electricity, the EU conducted an internal audit, and solicited stakeholder feedback on opportunities to improve the post-2020 program: the Innovation Fund.

Stakeholder feedback on the NER300 led to several changes for the Innovation Fund. Grants will provide 60 percent of the total project cost, rather than 50 percent, and the fund will disburse over half of the awarded money before project completion based on pre-defined milestones. All innovative project types at covered industrial facilities are eligible and are ranked based on the estimated cost per ton of emissions reduced. The total size of the Innovation fund will be approximately 10 billion euros.

European Union (3 of 3)

- InvestEU
 - Loan guarantee to high risk projects for low carbon technologies
 - Stimulates private capital at lower interest rate
- European Investment Bank (EIB) Financing
 - Any mature technology
 - Subsidized loan rates
- Programs funded Äänekoski bio-product mill
 - Converts wood to chemicals; electricity producer
 - €1.2 billion cost
 - €275 million EIB loan; €75 InvestEU loan guarantee



This slide discusses two EU financing programs that incentivize scale-up and commercialization of projects.

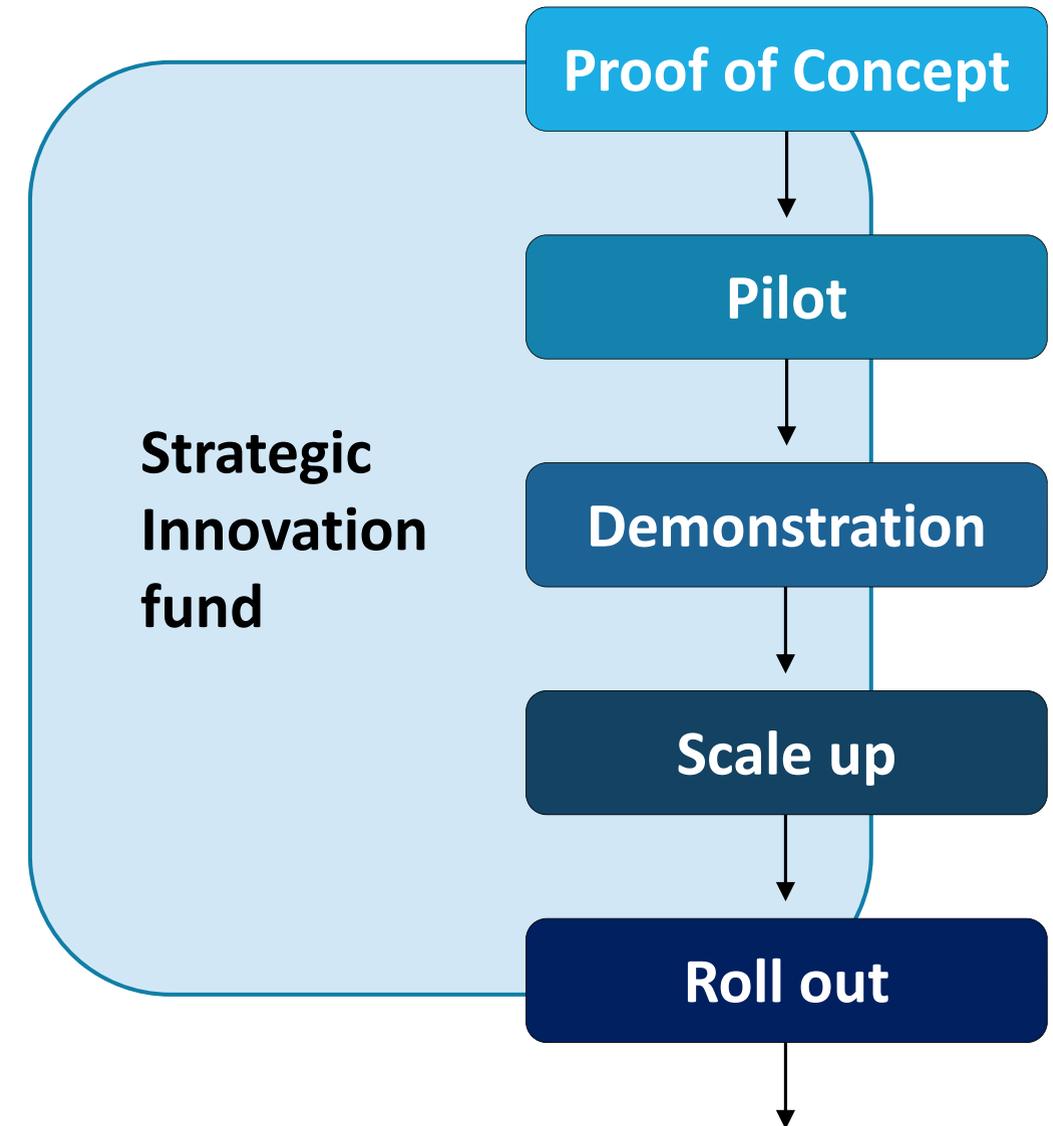
Banks can be hesitant to loan to projects that they view as too risky. To remedy this and get more projects approved for lending, InvestEU provide loan guarantees for low carbon technologies. This stimulates private capital and lowers interest rates. This program is partially funded by the EU budget, and partially funded by the European Investment Bank or EIB.

The EIB loans money to private companies for many types of large projects, including low carbon technology projects. These EIB loans can have a subsidized interest rate for low carbon projects, but have high standards for the creditworthiness of each borrower and the financial viability of each project.

An example project receiving these loans is a Finland bio-product mill, which is the largest wood processing plant in the northern hemisphere. This facility produces 1.3 million metric tons of pulp each year powered entirely by biomass. The facility also produces bio-products, such as oil and gas, and it exports electricity. The total facility cost was 1.2 billion euros, with 275 million from an EIB loan and 75 million in loan guarantees from InvestEU.

Canada (1 of 3)

- **Strategic Innovation Fund (2017 – Current)**
 - Five streams of funding for large projects (\$10-50M (CAD) requested contribution)
 - Contribution is determined by review committee: non-repayable grant, government loan, or both
 - \$250M for the steel and aluminum sector for growth and expansion
 - Since 2017, 64 projects announced; \$2B in funding; \$43B total investment leveraged; 67k jobs created



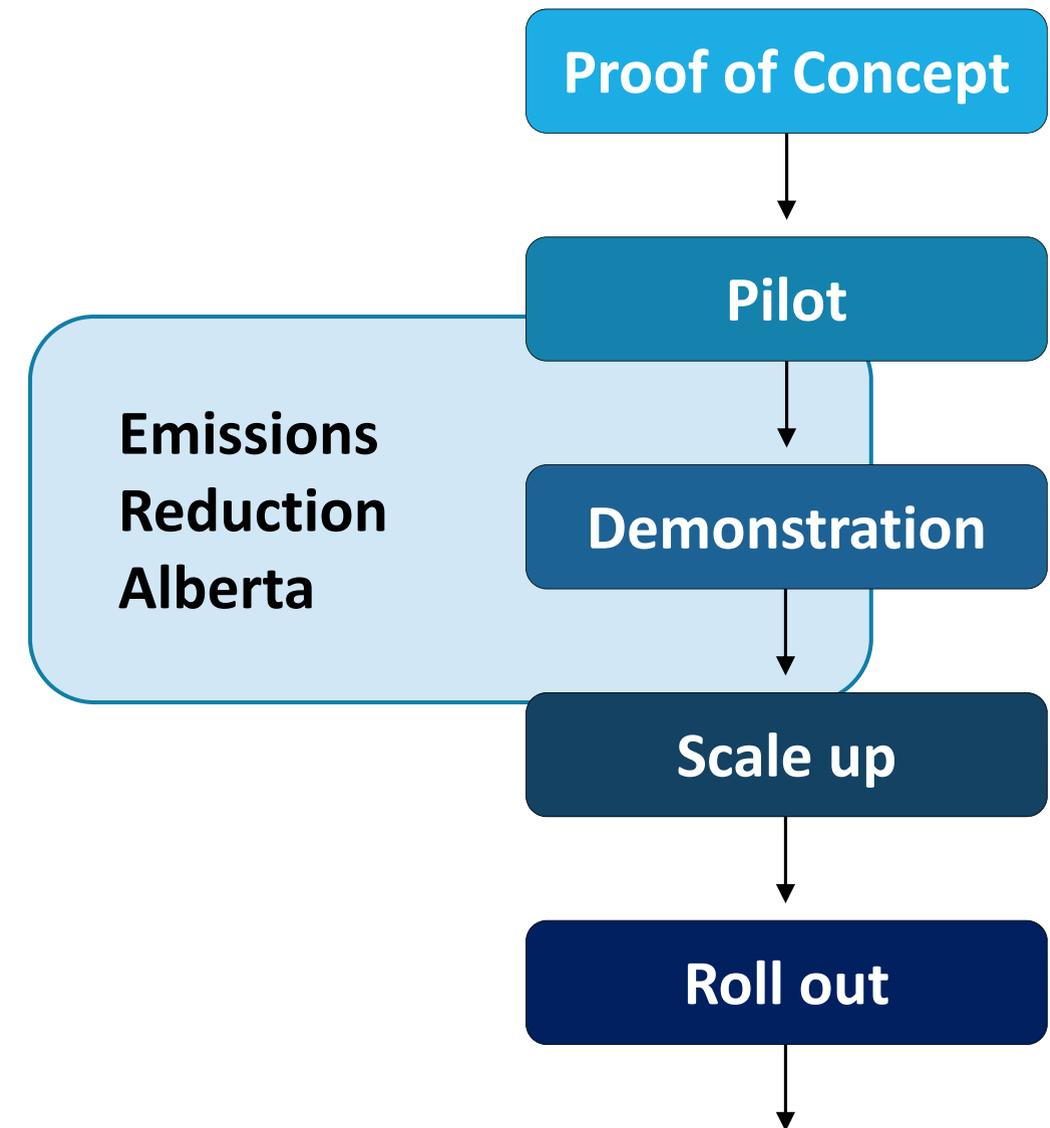
The Strategic Innovation Fund is a Canadian program providing \$10-\$50 million Canadian dollars to five different funding streams: research and development, business growth and expansion, attract and retain large scale investment, advanced industrial technologies, and national innovation ecosystems (which are partnerships between corporations and Canadian universities).

Most of the streams accept applications on a continuing basis with no deadlines, while the industrial technology stream is a competitive grant program. Contribution is determined by review committee: grant, government loan, or both. One interesting aspect of this program is that there was a large amount of funding earmarked for the steel and aluminum sectors to modernize facilities and better integrate the supply chain for these sectors.

The program as a whole funded over Two billion Canadian dollars which leveraged over 43 billion in total investment and created an estimated 67,000 jobs.

Canada (2 of 3)

- Emissions Reduction Alberta program (2009 – Current)
 - Call-for proposal based on targeted themes (Methane Challenge (2017) and Industry Efficiency Challenge (2019))
 - Funds and terms depend on opportunity
 - Two part application process: Expression of Interest and Full Project Proposal
 - To date: \$565M (CAD) funding 165 projects
- CleanBC Industry Fund (2020)
 - Reinvests a portion of carbon tax revenues to reduce emissions of covered industrial emissions.



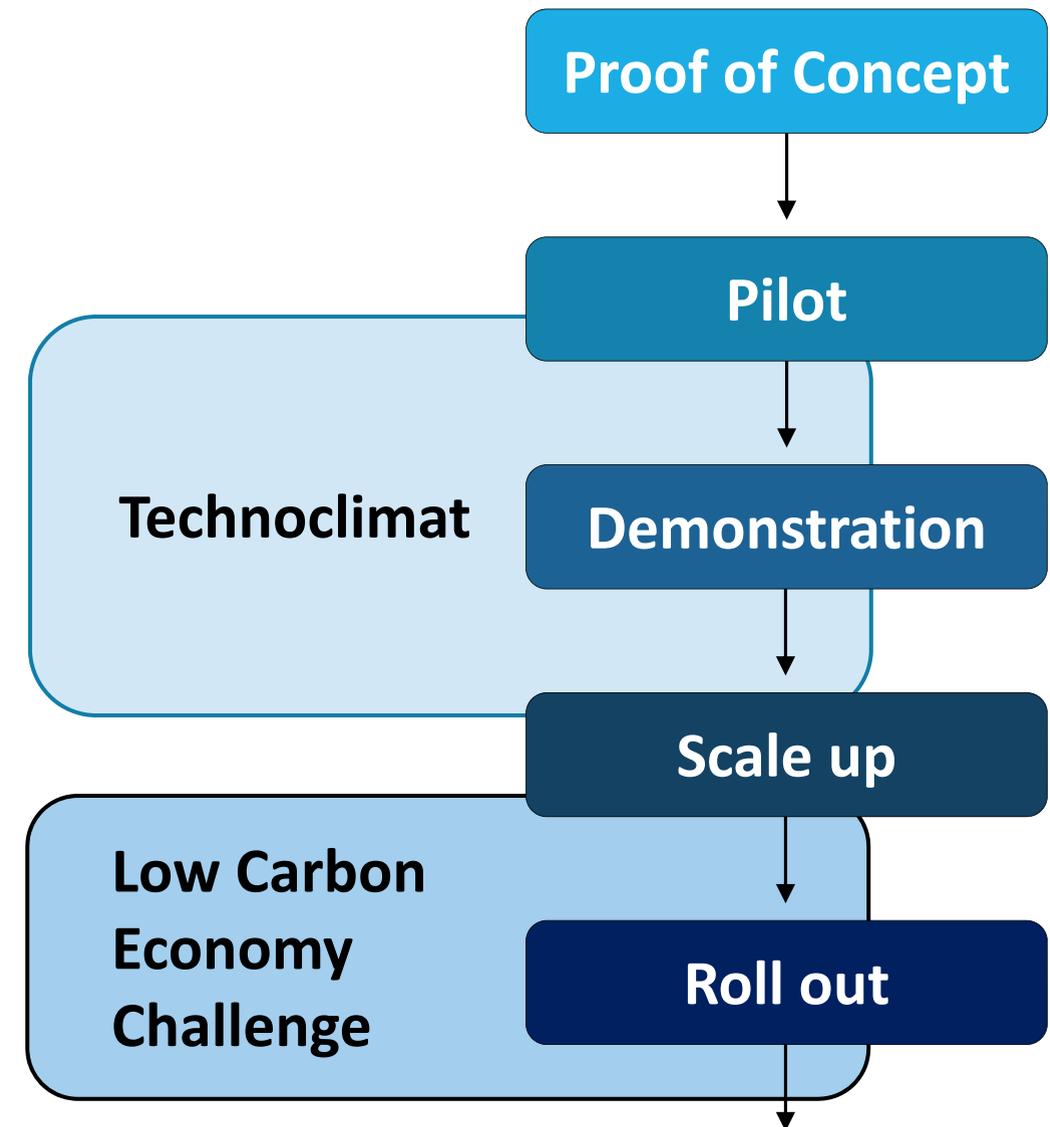
Emissions Reduction Alberta is a grant program that started in 2009 to accelerate development of innovative technologies and transition Alberta to a lower carbon future with a diversified economy. Emissions Reduction Alberta uses a Call for Proposals process to target specific needs. For example: the 2018 methane challenge and 2019 Industry Efficiency Challenge. This type of framework is similar to some California Energy Commission grant funding opportunities, but is usually more generic. For each challenge, the total amount of funding varies, as do the specific terms and cost-sharing requirements. This application process is divided into two stages, the Expression of Interest (EOI) stage and the Full Project Proposal (FPP) stage. Successful applicants then enter into a contractual agreement that outlines details such as the project scope, work plan, deliverables and terms of funding. Each of the projects must regularly submit reports on progress.

As of today, Alberta has provided 565 million Canadian dollars to 165 projects with GHG reductions projected to be 41 million metric tons of CO₂e through 2030. Within the industrial sector, there are several distinct funding opportunities for industrial efficiency, and \$70 million Canadian dollars have been awarded to 11 projects. An example is a \$6 million dollar grant for flue gas energy recovery at a pulp mill.

The CleanBC Industry Fund is a British Columbia Program that will be opening its request for proposals this year. Its aim is to invest a portion of carbon tax revenues into innovative projects to reduce industrial emissions. More than \$12 million has been committed to the program in its first year and these funds are available to industrial facilities covered in their climate program.

Canada (3 of 3)

- Technoclimat (2019)
 - Eligible only to industry covered by Cap-and-Trade
 - Grants up to \$3M, maximum 50% eligible expenses
- Low Carbon Economy Challenge (2019)
 - Wide range of sectors eligible
 - Proposals evaluated on risk and feasibility, cumulative GHG reduced per federal dollar invested; other co-benefits
 - \$20,000 – \$250,000, up to 25% of the total eligible expenses



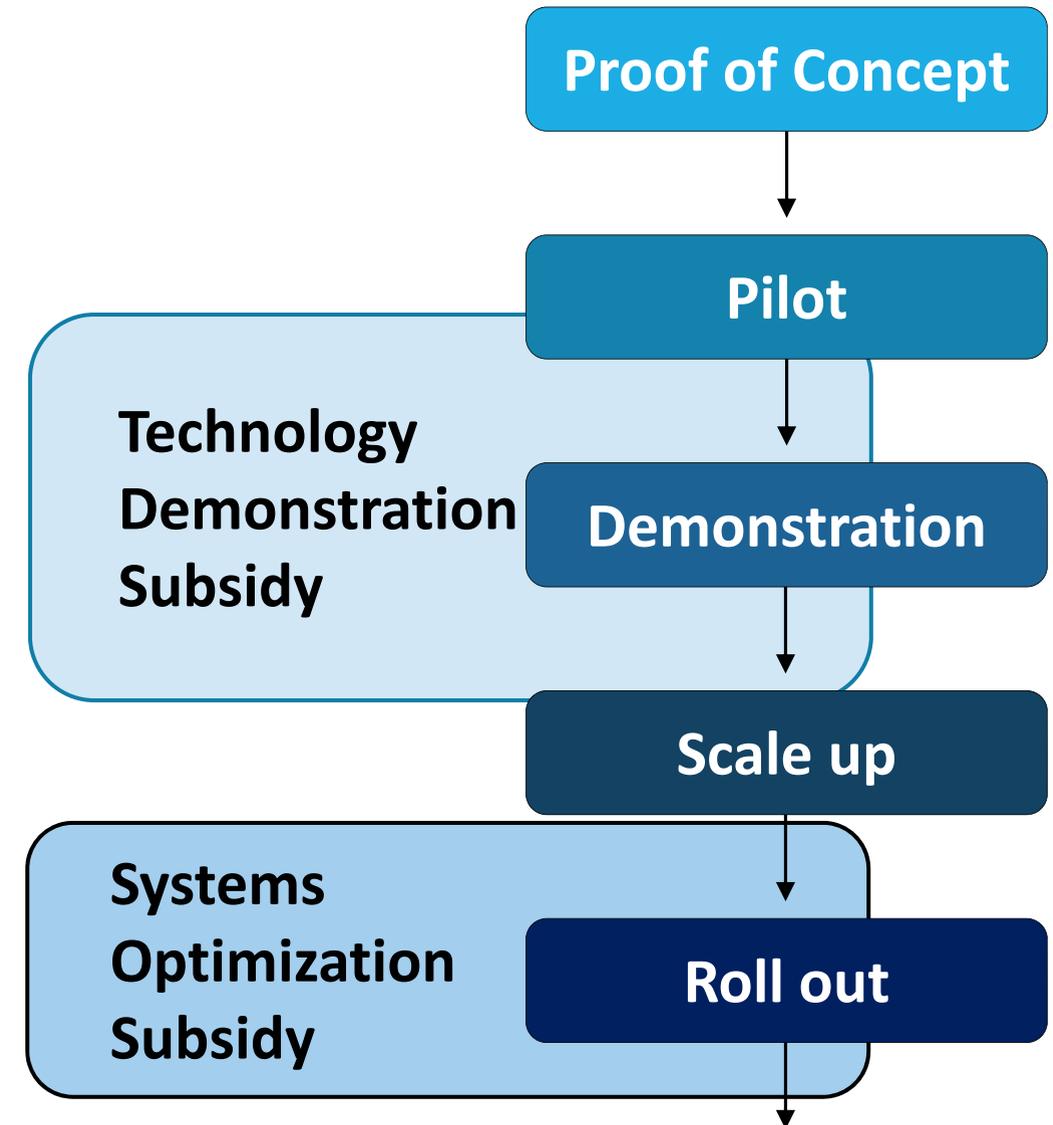
Techoclimat is a grant program to support innovation in energy efficiency and reduce GHG emissions that is administered by Quebec using cap-and-trade auction proceeds. The program is scheduled for one round of grant funding, and applications were due November 2019. Grants are limited only to industrial facilities subject to the Quebec cap-and-trade system. Funds are available for advanced technologies or pre-commercial technologies not currently used in the industrial sector. Grants are available up to \$3 million Canadian dollars, with the requirement that this funding may cover up to a maximum of 50 percent of eligible expenses.

The Low Carbon Economy Challenge is a program by the Canadian federal government that is scheduled for two rounds of grant funding. This program is geared for small and medium sized projects, with requested contributions in the range of 20 thousand to 250 thousand Canadian dollars for commercial ready applications. Grant are available to cover up to 25 percent of total eligible project costs. A total of \$40 million Canadian dollars is available for applications that were due March 2019, and a total of \$10 million Canadian dollars is available for applications that were due November 2019.

Eligibility includes a broad range of sectors: building, industry, forestry, agriculture, waste, transportation, electricity generation, etc. Instead of being sector specific, the main specification is that the technology implemented must be proven technology. Projects are evaluated by a cross-disciplinary review committee comprised of federal officials and expert reviewers who judge applications based on a combination of risk, feasibility, annual GHG emission reductions achieved in the year 2030 per federal dollar invested, and cumulative GHG emission reductions over the project lifetime per federal dollar invested. The program has a total funding pool of \$50M.

New Zealand

- Energy Efficiency and Conservation Authority (EECA): Technology Demonstration Subsidy
 - Supports implementing underutilized technologies and process improvements
 - Funds up to 40% of total project costs up to a maximum of \$250,000 (NZ)
 - Ex: An installed milk snap chilling system led to 30% savings and widespread adoption after demonstration
- EECA Systems Optimization Subsidy
 - Provides for certified independent consultants to optimize systems, including process heat, motors, plant heat, compressed air, refrigeration, and HVAC systems
 - Funds up to 40% of costs up to a maximum of \$100,000



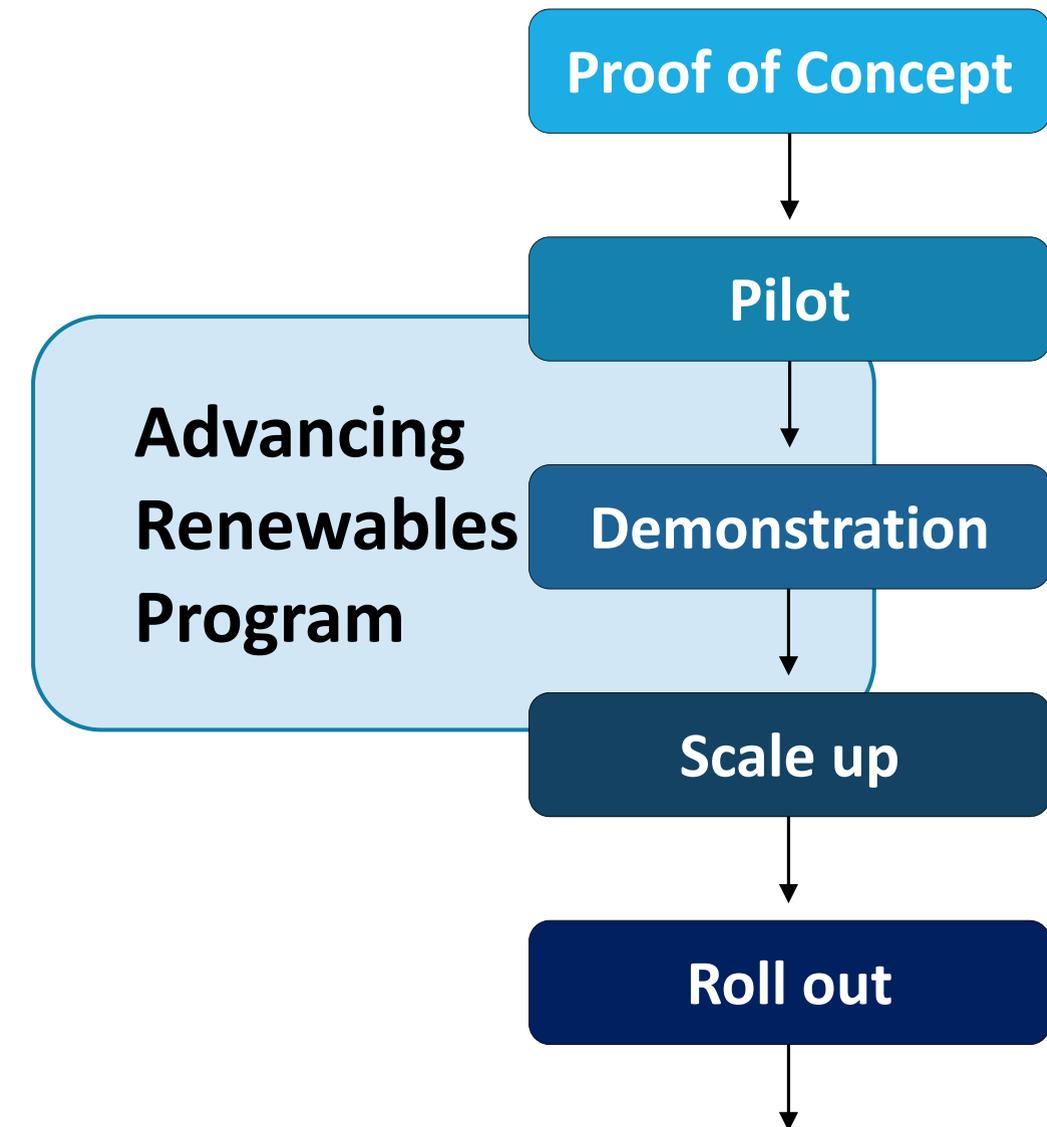
The Energy Efficiency and Conservation Authority (EECA) in New Zealand implements programs supporting reductions in energy use and GHG emissions for large energy users.

The Technology Demonstration Subsidy supports investment in proven but under-used technologies and process improvements. This program subsidizes up to 40 percent of the project cost up to \$250,000 New Zealand dollars. Companies apply by submitting a demonstration project plan. To qualify for funding, projects must reduce energy intensity or GHG emissions, be applicable to multiple businesses in a sector, and must be financially viable. Recipients must also commit to having the project independently monitored.

New Zealand also subsidizes system optimization of existing processes. The System Optimization Subsidy is available to commercial and industrial sites that spend at least \$200,000 dollars annually on energy costs. To qualify, a project must deliver a guaranteed level of energy savings. Generally, projects with a payback period of less than 2 years are not funded.

Australia

- Australian Renewable Energy Agency (ARENA): Advancing Renewables Program
 - Supports a broad range of development, demonstration, and pre-commercial projects for renewable energy
 - Grants will be between \$100,000 and \$50 million (AUD), with applicants expected to at least match the funding
 - Information-sharing requirement
 - Ex: A fuel-switching project at a canola oil plant replaced LPG boilers with a 5 MW biomass boiler that combusts locally sourced timber residue and led to ~80,000 MTCO₂e in emission reductions over the project life. This \$5.4M project was funded with \$2M from ARENA



In Australia, the Australian Renewable Energy Agency (ARENA) implements the Advancing Renewables Program, which is a grant program to support a broad range of development, demonstration, and pre-commercial deployment projects that can deliver affordable and reliable renewable energy. For the industrial sector, ARENA focuses on alternatives to fossil-fueled process heating that have the potential to be applied across multiple sectors. The focus is on key technologies, such as solar thermal, renewable energy, and energy storage.

Grants are expected to be between 100,000 and 50 million Australian dollars, and applicants are expected to at least match the grant funding.

The program prioritizes information-sharing, and any grant recipient must agree to a negotiated knowledge-sharing plan covering project development, implementation, and outcomes findings. The extent to which the data will be made publicly available or provided confidentially to ARENA must be detailed in the sharing plan.

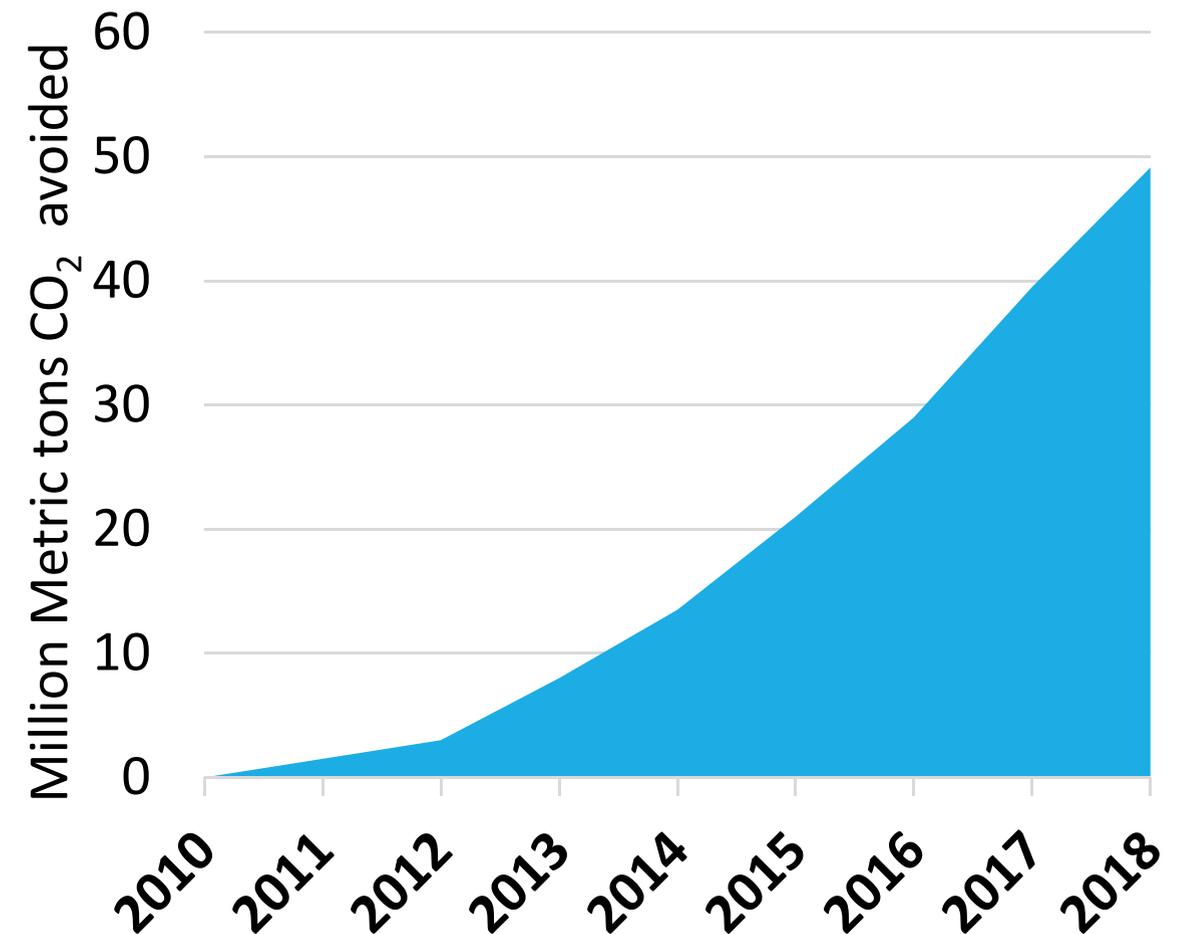
An example project is a fuel switching project at a canola oil plant that replaced its gas boilers with biomass. This project will reduce approximately 80,000 metric tons of CO₂ over the life of the project. This project cost \$5.4 million with approximately half of that from the ARENA grant.

U.S. Loan Programs

- U.S. Department of Energy (DOE) Loans and Loan Guarantee Program
 - Provide debt and loan guarantees to support purchasing advanced vehicles and low-carbon energy
 - Payments exceeded losses by 3 to 1 (as of 2018)
 - Estimated 50 million MT CO₂ avoided (to 2018)

“The [U.S. DOE] loan guarantee program has been successful in bringing to market good projects with good credit support that absolutely would not have been built.”

- **NRG Energy, Inc.**



In 2009, the U.S. Department of Energy started providing financing for low-carbon energy and auto manufacturing. The DOE provides two types of financing.

First, DOE provides loans to companies deploying new technologies that are not attracting commercial loans.

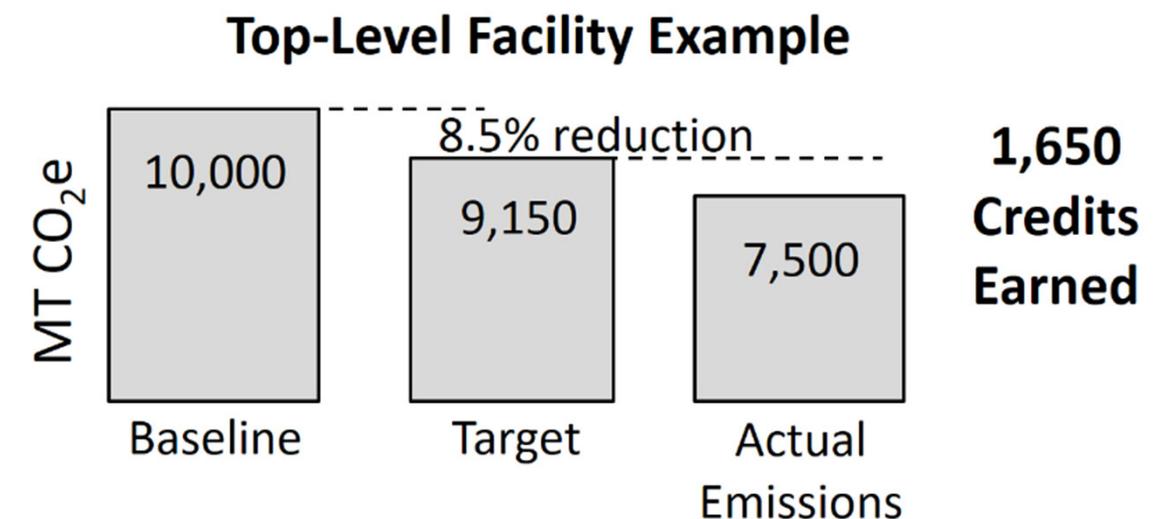
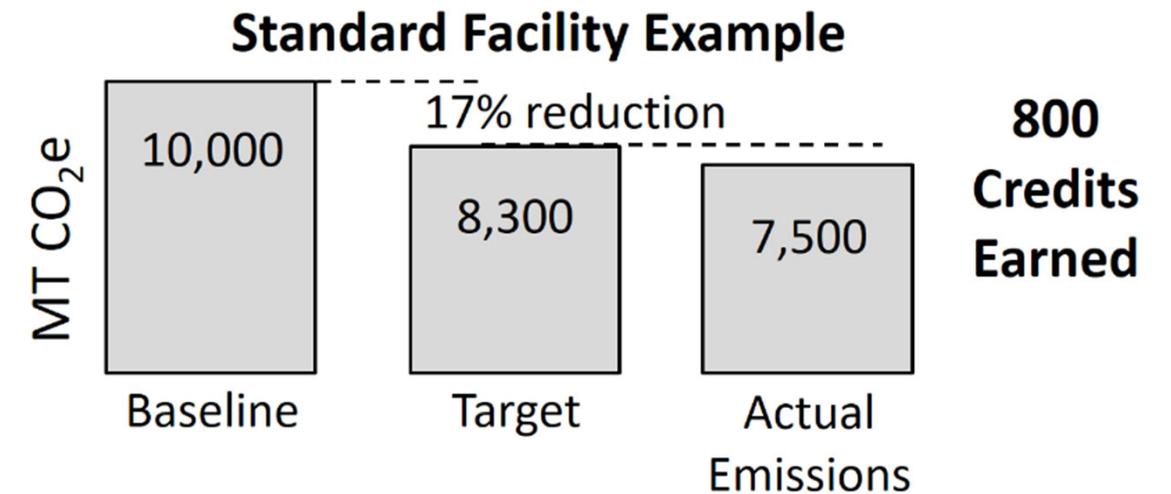
Second, DOE provides loan guarantees to encourage commercial lending to innovative projects. If a project fails, DOE pays some or all of the remaining loan back to the commercial bank.

As of 2018, the overall project portfolio has paid DOE three dollars in loan interest for every dollar DOE has lost on unsuccessful projects. The portfolio has also resulted in estimated cumulative emissions reduction of 50 million metric tons of CO₂ through 2018, and spurred additional commercial lending.

An example of commercial lending following this program is the role it played in spurring growth of U.S. utility-scale photovoltaic solar facilities. Prior to the program, there were no solar PV facilities larger than 100 megawatts. The DOE provided loan guarantees for the first five utility-scale solar projects to exceed 100 megawatts. Within five years, commercial lenders financed an additional 17 projects without DOE support.

Tokyo

- **Top-Level Facility Certification**
 - Decreases stringency of facility's emissions target
 - Requires implementation of several hundred energy saving measures
 - Stringency is reduced by 50% for top-level facilities and 25% for near-top-level facilities
 - For the same level of actual emission reductions, more credits are earned with a lower stringency emission target
 - 66 facilities were top-level certified as of 2017



The next two slides discuss energy management standards. The Tokyo cap-and-trade program incentivizes implementation of energy management practices at industrial sources by providing additional reduction credits to top-level facilities.

The Tokyo program includes facility-specific emission reduction targets, a design that is very different from the California Cap-and-Trade Program. Facilities may get certified as top-level facilities by implementing a long list of energy management practices and achieving outstanding emissions reductions. Top-level certification then lowers a facility's emission reduction target by half, for example from 17 percent to 8.5 percent for the 2015 to 2019 compliance period. This allows top-level certified facilities to earn more emission reduction credits, which can be sold or banked. Certified facilities must annually report on compliance with the top-level standards to maintain top-level status.

The graphic on the right shows how this works. On top, a standard facility has established baseline emissions and a target emissions reduction of 17 percent. If the standard facility reduces its emissions beyond this amount, it earns credits which it can sell or bank them for future compliance.

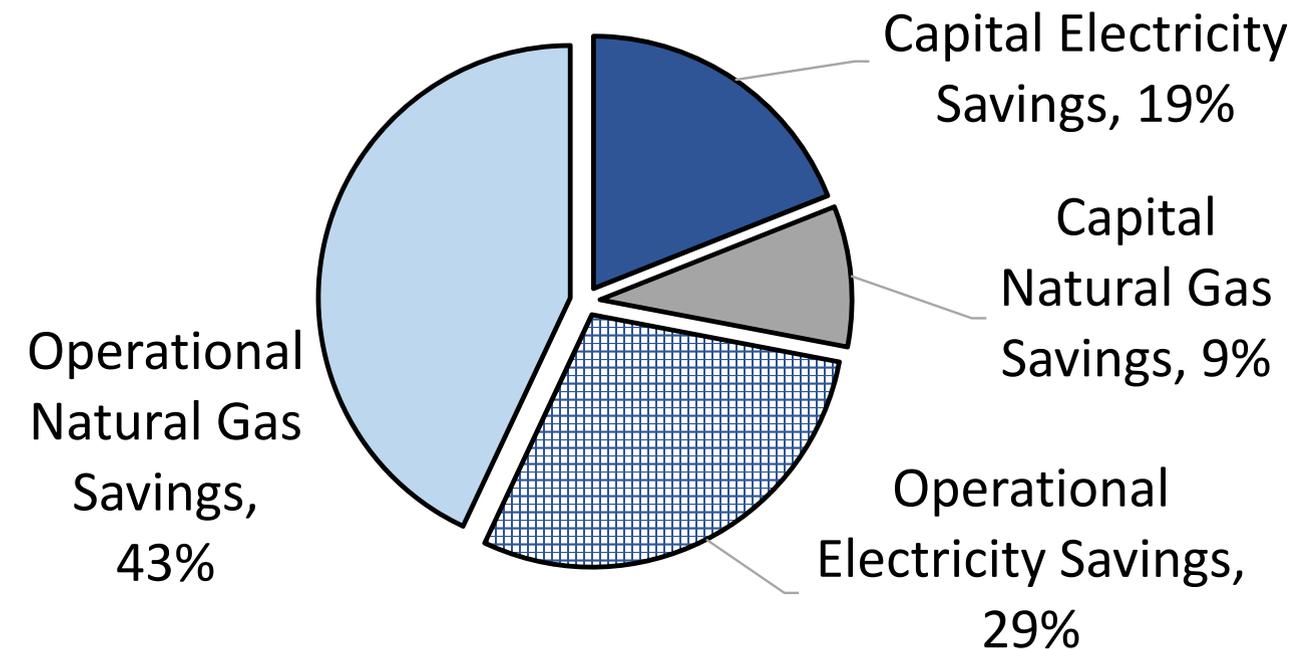
If a facility receives top-level certification, then the emissions reduction stringency is halved, and the credits earned is increased.

As of 2017, 66 facilities were certified.

Energy Management Standard

- International Energy Management Standard (ISO 50001) Adoption
 - Framework for energy performance improvement, but does not prescribe improvement goals
 - Over 40,000 sites worldwide are ISO 50001 certified, with over 80% in Europe
 - Several jurisdictions provide financial incentives
 - U.S. DOE recognizes ISO 50001 standards under its Superior Energy Performance (SEP) program, but provides no financial incentives
 - Example: 13 certified 3M sites collectively improved energy performance 4.2% from 2016 to 2018, reducing emissions by more than 165,600 MT CO₂e over that period.

3M savings breakdown from implementing ISO 50001 at 5 facilities



The International Energy Management Standard, ISO 50001, establishes energy management standards that can be incorporated into national certification programs.

ISO 50001 provides a framework to help companies continually improve energy performance and reduce emissions, but it does not specify reduction targets. ISO 50001 provides energy management standards for both operational processes and management practices. These international standard are implemented at over 40,000 sites worldwide, with over 80 percent of certified sites in Europe. A number of countries, such as Korea, France, and Germany, provide, or have provided, financial incentives to assist facilities in implementing ISO 50001.

As of 2018, the U.S. had 59 certificates at 201 sites. Currently, the DOE certifies and recognizes facilities meeting ISO 50001 standards under its Superior Energy Performance (SEP) program. While a variety of tools, training, and guidelines for implementing this standard are made available by DOE, no financial assistance is provided.

The standards under the SEP program has proven successful, with most facilities reporting 3 to 20 percent improvement in energy performance. For example, over a two year period 3M achieved a 4.2 percent improvement in energy performance collectively for 13 U.S. sites. This translates to a reduction of more than 165,000 metric tons CO₂.

Summary of Programs Incentivizing Industrial Sector GHG Reductions

- Growth in carbon-pricing systems worldwide
- Grants, loans, loan guarantees, energy management standards
 - Technology improvements
 - Fuel-switching
 - Energy efficiency
- Incentive provisions within carbon-pricing programs
 - Credit generation within Tokyo cap-and-trade system
 - Crediting mechanisms within California's Low Carbon Fuel Standard
- Wide range of programs in terms of scope, size, process, and requirements

Again, the latest International Panel on Climate Change science shows that carbon neutrality by mid-century is key to keep global warming below 1.5°C, and meeting this goal requires progress in all sectors, including industry.

We're seeing some technical advancements that can help decarbonize industry, but substantial hurdles remain, including costs.

Each year, more jurisdictions are considering and implementing carbon-pricing systems to address the climate challenge. As indicated in this presentation, jurisdictions are also looking beyond carbon-pricing to other incentive mechanisms to spur innovation and reduce industrial emissions in industry. These incentives include grants, loans, loan guarantees, energy management standards, and compliance credit generation, and we touched on many example programs and example projects.

Many programs share common approaches with regard to eligibility of sectors and technologies and application and approval requirements. But we also identified some novel approaches related to things like information-sharing requirements and other aspects. In California, we have a suite of programs addressing GHG emissions. Our Cap-and-Trade Program, which incentivizes GHG reductions in the industrial sector, also addresses business competitiveness concerns through free allowance allocation within the Program. We need to continue to evaluate and explore opportunities to achieve significant cuts in GHG emissions from ALL sectors and sources, including industry.

So we've been considering actions in other jurisdictions, and looking at which elements and approaches might be useful in California.

Potential Additional Tools for California's Industrial Sector

- Use Cap-and-Trade Program allowance value to further incentivize industrial emissions reductions
 - Set aside a pool of allowances that would be available to industrial facilities for technology upgrades based on applications to CARB, reported emissions data, or some other approach. Example concept: March 2009 - Recognizing and Crediting Early Action in a California Cap-and-Trade Market available online at:
<https://ww3.arb.ca.gov/cc/capandtrade/meetings/031009/presentation.pdf>
 - Set aside a pool of allowances for natural gas suppliers to make renewable fuel use more cost-effective at industrial facilities and to promote decarbonizing the natural gas supply. Example concept: Comments to CARB after April 2018 workshop available online at:
<https://www.arb.ca.gov/lispub/comm2/bccommlog.php?listname=ct-4-26-18-wkshp-ws>

CARB staff has begun considering what potential additional tools we could implement to promote further GHG reductions in the industrial sector. We've looked at reports generated by academics, industry groups, and others. We've assessed regulations and incentives from other jurisdictions, and we've considered models from within our own suite of programs. We're evaluating how these options might fit in our current context.

The Cap-and-Trade Program already provides a carbon-price incentive, but there may be opportunities to further incentivize industrial emissions reductions.

One potential application of this concept would be to set aside a pool of allowances that would be available to industrial facilities for technology upgrades based on applications to CARB, reported emissions data, or some other approach. CARB has considered the concept of allowance set-aside pools within the Cap-and-Trade Program in the past. And, as we consider the much deeper decarbonization needs for achieving carbon neutrality, all options are on the table. For example in March 2009 there were discussions around creating a set-aside pool of allowances for early-action emissions reductions in industry. This CARB presentation teed up a number of discussion questions about how such a set-aside pool could work related to eligibility, timing, and other factors. The crediting mechanism under CARB's Low Carbon Fuel Standard, such as the refinery investment credit and the innovate crude production credit, offer the elements of a potential project application model that could be a model for such a mechanism.

Another potential option is to create a set-aside pool of allowances available to natural gas suppliers to make renewable fuel use more cost-effective at industrial facilities and to promote decarbonizing the natural gas supply. Panelists at our July 2019 workshop identified renewable fuels as one of the options in an "all-of-the-above" approach to decarbonizing industry, but economics were pointed out as a limiting factor. This approach of creating a set aside pool could be a mechanism to bringing certain renewable fuels to market and decarbonizing industries that are especially challenging. Variations on the concept have been publicly discussed and commented on in response to prior CARB workshops, such as in our April 2018 workshop.

This slide is a starting point. These are a couple initial concepts, and not a complete list of potential options. We're interested in hearing feedback on these concepts or variants of these concepts. We're also interested in hearing your feedback on the other programs that we discussed in this presentation, other ideas, and how elements of those programs may be adapted to the California context.

Questions for Stakeholders

- What are your thoughts about the programs in other jurisdiction that were surveyed in this presentation? What elements of these programs might be worth considering for California?
- What other programs administered by CARB could be leveraged or adjusted to support further reductions in the industrial sector?
- What hurdles does California face for decarbonizing the industrial sector? How can CARB help overcome these hurdles?
- Please submit comments by 5:00 p.m. on Friday, March 6 at https://www.arb.ca.gov/lispub/comm2/bcsubform.php?listname=cn-industry-web-ws&comm_period=1

So we've covered quite a bit of material, and we're seeking your feedback. As you prepare comments, we encourage you to consider these questions:

What are your thoughts about the programs in other jurisdiction that were surveyed?

What elements of these programs might be worth considering for California?

What other programs administered by CARB could be leveraged or adjusted to support further emissions reductions in the industrial sector?

What hurdles does California face for decarbonizing the industrial sector? How can CARB help overcome these hurdles?

The comment site is active and will be accepting comments until 5 pm on Friday, March 6.

Your comments are valuable to the process of crafting a robust approach forward, and we appreciate your time and effort in preparing feedback.

Resources

- CARB, 2017. California's 2017 Climate Change Scoping Plan: https://ww3.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf
- IPCC, 2018. Global Warming of 1.5°C: <https://www.ipcc.ch/sr15/>
- USGCRP, 2018. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: <https://nca2018.globalchange.gov/>
- McKinsey & Company, 2018. Decarbonization of industrial sector: the next frontier: <https://www.mckinsey.com/business-functions/sustainability/our-insights/how-industry-can-move-toward-a-low-carbon-future>
- Innovation for a Cool Earth Forum, 2019. Industrial Heat Decarbonization Roadmap: https://www.icef-forum.org/pdf2019/roadmap/ICEF_Roadmap_201912.pdf

For convenience, this slide contains links to some background materials and reports cited in the presentation.

Links to Programs in Other Jurisdictions

- Horizon2020: <https://ec.europa.eu/programmes/horizon2020/en> (Slide 16)
- Innovation Fund: https://ec.europa.eu/clima/policies/innovation-fund_en (Slide 17)
- InvestEU: https://europa.eu/investeu/home_en (Slide 18)
- Strategic Innovation Fund: <https://www.ic.gc.ca/eic/site/125.nsf/eng/home> (Slide 19)
- Emissions Reduction Alberta: <https://www.eralberta.ca/> (Slide 20)
- Technoclimat: <https://transitionenergetique.gouv.qc.ca/en/innovation/program/technoclimat> (Slide 21)
- Low Carbon Economy Challenge: <https://www.canada.ca/en/environment-climate-change/services/climate-change/low-carbon-economy-fund/challenge.html> (Slide 21)
- Technology Demonstration Subsidy: <https://www.eecabusiness.govt.nz/funding-and-support/technology-demonstration-projects/> (Slide 22)
- Systems Optimization Subsidy: <https://www.eecabusiness.govt.nz/funding-and-support/systems-optimisation/> (Slide 22)
- Advancing Renewables Program: <https://arena.gov.au/funding/advancing-renewables-program/> (Slide 23)
- Loans and Loan Guarantee Program: <https://www.energy.gov/lpo/loan-programs-office> (Slide 24)
- Top-Level Facility Certification: https://www.kankyo.metro.tokyo.lg.jp/en/climate/cap_and_trade/ (Slide 25)
- ISO 50001: <https://www.iso.org/iso-50001-energy-management.html> (Slide 26)

Thank You

- Climate Change Scoping Plan
 - <https://ww3.arb.ca.gov/cc/scopingplan/scopingplan.htm>
- Carbon Neutrality Workshops
 - <https://ww3.arb.ca.gov/cc/scopingplan/meetings/meetings.htm>

And this concludes the webinar. Thank you for your time and attention.