W&J | CENTER FOR ENERGY POLICY & MANAGEMENT

Decarbonization: 101

What is Decarbonization?

Decarbonization is a concept that has risen to prominence as a result of the global climate change battle. It is often linked with other terms related to **sustainability**, and though it may be a strategy implemented with others, it is its own standalone practice.

A Brief History of the Concept

The term decarbonization as related to global climate change was first coined by Jesse H Ausubel, Director of the Rockefeller University's Program for the Human Environment, in a **1995** article published in the journal Energy Policy.

Mr. Ausubel's definition of decarbonization at that time was **the reduction of the carbon intensity of a society's primary energy**. **Primary energy**, as defined by the Energy Information Administration (EIA), is "**energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy**" (Energy Information Administration, 2021). An example of primary energy would be a **raw fuel source** such as coal or natural gas. When that fuel is used to create electricity, the electrical energy is known as **tertiary energy** (Ausbel, 1995). Early use on the term discussed the potential for technological development and such development's effect on the future of sustainability. That is, as technology advances and new developments are made, the entire energy grid could decarbonize through lower carbon intensive energy generation.

Today, the best definitions of decarbonization comes from the **Intergovernmental Panel on Climate Change**, who defines decarbonization in two ways: **First**, at the systems-level view: "**The process by which countries or other entities aim to achieve a low-carbon economy, or by which individuals aim to reduce their carbon consumption**"; and then in the carbon reduction level, "**The process by which countries, individuals, or other entities aim to achieve zero fossil fuel zero fossil fuel carbon existence… [which] typically refers to a reduction of the CO2 emissions associated with electricity, industry, and transport**" (Wimbadi & Djalante, 2020).

What is Deep Decarbonization?

While decarbonization as a process has existed for a decades, the conceptual process of deep decarbonization is relatively new. Much like the term decarbonization, **deep decarbonization** has no single definition. Rather, the term refers to a **potential pathway for decarbonization** in general. However, there are semi-official definitions stemming from IPCC reports that are worth noting.

At its simplest, deep decarbonization is a pathway to decarbonization intended to rid carbon emissions from every human-driven process on the planet. Whereas decarbonizing describes the process of **removing carbon from a system**, deep decarbonization describes the **process of removing carbon emissions from all human activities**. The "deep" in deep decarbonization characterizes the extent at which the decarbonization process will happen; that is, decarbonization will occur deep into our existing systems.

Is Decarbonization Possible?

Major advancements in technology will be required for a deeply decarbonized future. Studies show that the industrial sector is ripe with opportunity for decarbonizing (Rissman, et al., 2020). 18 The effects of decarbonizing the industrial sector would exist at a global scale, and presents the best opportunity for widespread change.

It is important to understand the timeframe in which such advancement is anticipated to be made. There are four main studies that are laying the pathways for a deeply decarbonized future: The **Shell Sky Scenario,** which projects developments until the year 2100; **the International Energy Administration's 2-Degree Scenario (2DS)**, which projects developments until the year 2060; the **International Energy Administration's Beyond 2-Degree Scenario (B2DS)**, which also projects to the year 2060; and the **Energy Transitions Commission's Mission Possible Report**, which does not provide a time-series model, but does indicate a net-zero emission system to be achieved by **2050** in developed countries and by **2060** for developing countries (Rissman, et al., 2020). The commonality among these studies are that they have set wide timeframes for development. Deep decarbonization is something that will take as much time as effort to be feasible.

W&J | CENTER FOR ENERGY POLICY & MANAGEMENT

Decarbonization: 101

What can catalyze deep decarbonization?

Integrated Design

Integrated design is the concept of designing with the **whole system** in mind. Rather than designing singular components that will then be fitted into an existing system, integrated design calls for the design of a system in which all components congruently work together to reach an overall greater system efficiency. The positive effects of integrated design are varied. Financially, as systems are designed with overall efficiency over component efficiency as paramount, there is **less waste** and thus **higher returns.** According to a recent study of "diverse industrial projects", projects that redesigned their existing systems to an integrated system "**found to yield 30-60 percent energy savings**" as a result of the retrofit, and "**40-90 percent energy savings in newly built facilities**" (Rissman, et al., 2020). However, there are serious costs of retrofit and of the integrated design process that act as barriers for individual businesses to engage in a retrofit or new construction.
The end goal of any integrated system is to become **more efficient**, **using less energy and materials**, thus c**ontributing to a decrease in carbon emissions** associated with each of those processes.

Private Sector

The private industrial sector will play a crucial role in a deeply decarbonized future. As the "**core of developing low-carbon solutions**" the private industrial sector is where new technologies such as **renewable electricity generation**, **electric vehicles**, and **carbon capture** were researched and developed (Rissman, et al., 2020). Studies call for the implementation of an integrated design philosophy to be adopted by all in the industrial sector.

Public Sector

The public sector can help **facilitate** the deep decarbonization process within all sectors, especially within **industry**. Two areas in which government policies can have a great effect on the decarbonization of industry are in **carbon pricing** and **research and design incentives and investments.**

Carbon Pricing

Carbon pricing is a policy in which **emitters** of carbon dioxide must **pay a fee for their emissions**. Carbon pricing, also referred to as a **carbon tax**, are typically calculated by tonnage of carbon dioxide emitted. There are many existing carbon pricing systems, such as the **Regional Greenhouse Gas Initiative (RGGI)** in the American North Atlantic states. RGGI is a **cap-and-trade system** of carbon pricing. A cap-and-trade is designed so that emitters of carbon dioxide would purchase **credits** that would allow them to emit a certain amount of carbon dioxide. What makes a cap-and-trade system unique is that participating states or businesses can **trade their carbon credits with other participants**. That is, if one entity as a surplus of carbon credits, they can sell them to another participant who has a higher than expected carbon dioxide output. Though the carbon credits are traded, the total amount of carbon dioxide permitted to be emitted **remains the same.**

Research and Development

Though it is the private sector that generally develops major technological advancements, regulators can aid in that development by funding research and development (R&D) programs and initiatives. A study that sets frameworks for the decarbonizing the future notes that such government policies that promote R&D fall into five categories:

1. "Supporting government **laboratories**;
2. Governmental **funding** of academic, public, or private research institutes;
3. Establishing research **partnerships** between government, industry, and sometimes philanthropy;
4. Supporting **entrepreneurial development** of innovative technologies; [and],
5. **Financial incentives** for corporate R&D" (Rissman, et al., 2020).

These types of programs actively work to provide funding to the appropriate and competent organizations or individuals to further technical research. Outcomes of such funding can directly lead to major advancements that could revolutionize global decarbonization efforts.

W&J | CENTER FOR ENERGY POLICY & MANAGEMENT

Decarbonization: 101

Works Cited

Ausbel, J. H. (1995). Technical progress and climatic change. Energy Policy , 23, 411-416.

Energy Information Administration. (2021, 12 14). Glossary. Retrieved from Energy Information Administration: https://www.eia.gov/tools/glossary/index.php?id=p

Rissman, J., Battaille, C., Masanet, E., Aden, N., Morrow III, W. R., Zhou, N., . . . Koch Blank, T. (2020). Technology and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070. Applied Energy.

Wimbadi, R. W., & Djalante, R. (2020). From decarbonization to low carbon development and transition: A systematic literature review of the conceptualization of moving toward net-zero carbon dioxide emissions (1995-2019). Journal of Cleaner Production