Expert's Corner

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How Carbon Management is Becoming a Strategic Requirement on New Large Complex Projects

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While in this century the infrastructure sector will face a range of significant challenges (e.g. economic instabilities, raw construction material shortages), Climate Change will overtake any other major concerns as the most disruptive force. In this context carbon management, the main climate change mitigation measure, will progressively take centre stage on any sizable project and will shift from the current mostly voluntary basis to become increasingly regulated.

Because of their sheer size, Large Complex Projects (LCPs) have a very significant carbon footprint compared to normal projects not just during the project development phase but also during the entire project's lifecycle. Because of this, actions taken by LCP projects to reduce and mitigate carbon emissions can contribute significantly to national and even international climate strategies, a point that has been left aside from current climate policies. LCP's have such an important impact in terms of carbon emissions that it is unlikely that countries' emissions objectives will be achieved without the contribution of LCPs both in terms of emissions reductions but also in leading by example in initiating a snowball effect towards more effective and flexible projects.

This paper looks at Carbon Management from two perspectives: within a LCP and as a LCP. It also explores carbon frameworks to adopt on a LCP (we here introduce our LCP AROTAD approach) and how they can be integrated within overall project management. In the end, Carbon Management is here to stay and such considerations cannot be omitted on any new LCP.

The main findings from this paper are that carbon management is no longer a "good to have" for a LCP to reflect positively towards the stakeholders but a "must-have" for any LCP to remain afloat in a quickly changing world. Despite that the climate crisis is posing serious risks to current LCP frameworks it also offers new opportunities to become part of the solution with new LCPs focused on Carbon Management such as renewables and carbon capture mega projects.

What is a Large Complex Project (LCP)?

While a multitude of construction projects are taking place around the world at any given time, a handful of them is large and complex. Typically, large complex projects would be defined as operating on very significant budgets (not uncommonly in the USD billion-dollar range), large in scale, technologically and logistically challenging. Currently, projects falling under this category may include large bridges, tunnels, energy power plants, petrochemical infrastructures, highways, railways, mining sites, piping installations, roads or, as a matter of fact, any other projects where complexity stems from their very large scale.

Managing carbon on a LCP has shifted significantly from a low priority to the point of becoming the very nature of future LCPs as seen with the rapid rise of renewables or carbon capture megaprojects

What is "Carbon" and how does it relate to LCPs?

Basically, any process which emits carbon-containing Gases (e.g. CO2, CH4, HCFCs…) into the atmosphere contributes to the strengthening of the Greenhouse Effect and thus Global Warming. To date, the most common carbon-containing GHG emitted is still carbon dioxide (CO2) and as a result, Carbon Management is typically centred on carbon dioxide emissions. This is not always the best approach to have with a LCP as the sources can be diverse, complex and very significant compared to a normal project. Indeed, while usually other sources than carbon dioxide are removed from carbon assessments on conventional projects, on a LCP these emissions can be significant and must be included.

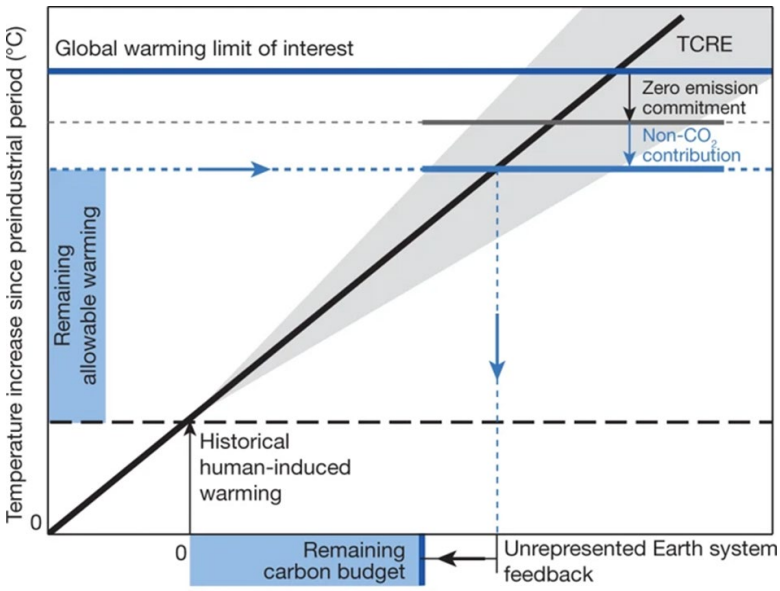
In terms of emissions, it does matter when and where the GHG are emitted and therefore carbon emissions not only comprises direct emissions (e.g. exhaust from manufacturing activities while in operations) but also all other emissions emitted at a different stage of the life cycle of the project incorporating the supply chains (i.e. emissions generated by third parties in relation to the project). In the end, carbon emissions on a LCP reflect any source of carbon-containing GHG emitted to the atmosphere related to the project and because of their sheer size these emissions must be accounted for and mitigated.

It is a fact that stakeholders are increasingly scrutinizing any sizable projects and the companies which finance

them for their overall compliance to regulations but also much beyond in terms of how they benchmark in governance

Why is it important to assess Carbon emissions on a LCP?

A recent research paper published in the journal Nature highlights the importance of estimating and tracking the global "*Remaining Carbon Budget*" for stringent climate targets. The Remaining Carbon Budget can be defined as the amount of CO2 emissions that can still be emitted while keeping the global average temperature increase due to human activities to below a specific temperature limit. This concept can be used to emphasize the urgent need for carbon management on a LCP if we are to meet the objectives set in the Paris agreement. In other words, business as usual from LCPs would rapidly exceed the Remaining Carbon Budget. The below figure highlights the concept of Remaining Carbon Budget and how it relates to the overall emissions landscape:



(source: Nature)

To accurately assess the remaining carbon budget, LCPs must play their part in disclosing their GHG emissions which can only be done through a comprehensive carbon management plan. The Carbon Disclosure Project is one platform a LCP could use but there are other mechanisms in place.

For a long time, carbon footprinting has been seen as a "good to have" to share some data with the stakeholders. However, this situation has already become a "must-have" scenario. As the climate crisis is becoming more and more apparent and the public perception and awareness is slowly changing towards better awareness and realization of a strong need for action, governments will have no choice but to strengthen regulations with regards to carbon emissions which will take place in the form of increased taxation and liability towards project operators. In other words, omitting carbon management from the medium to long term strategies of a LCP is becoming an important risk factor.

Investors are no longer ignorant or passive about the topic. As we have highlighted in another article of this LCP series (How stakeholder management and ESG ratings becomes an essential focus for new Large Complex Projects), the rise of Environmental, Social and Governance (ESG) within the investment world provides the missing link to the need for actions. Furthermore, many large corporations are starting to roll out their plan for carbon neutrality within the first half of the Century. Examples include corporate giants such as Microsoft or Apple and many others aiming to become carbon neutral by as soon as 2030. These are all major companies with projects that will require strong carbon management in the coming years for their LCPs.

Carbon Management within a LCP- the AROTAD approach

The carbon management approach of a LCP is unlike those of normal projects and requires a high degree of dedication and customization. The below framework, which we will refer to as the LCP AROTAD approach (i.e. Assessment, Reduction, Offsetting, Trading, Analysis and Disclosure), can be applied as a backbone to a customized LCP carbon strategy:

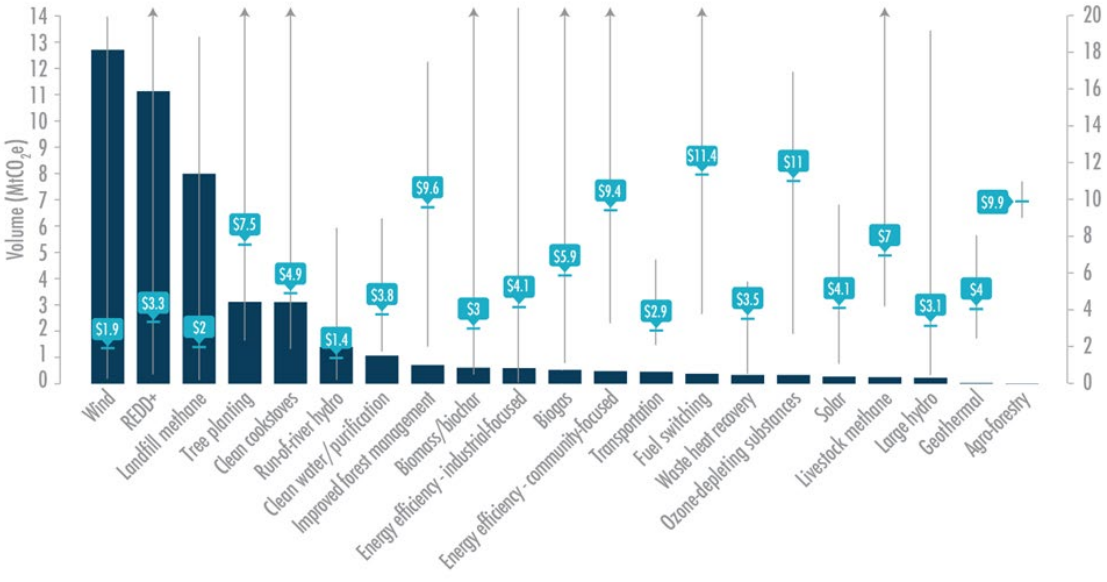
- Accurate assessment of Carbon Emissions: While this process can be straight forward on a normal size project using standard methodologies, it becomes extremely complex to manage on a LCP. For instance, on a normal project, many processes are omitted from the assessment as they are deemed insignificant. However, on a LCP due to the large size every process becomes significant not just in terms of the project itself but often on a regional or even national level (e.g. travels alone would typically involve thousands of people movement by air or land transports) and cannot be omitted despite the fact that some factors have much fewer emissions than other aspects of the project. In other words, a notable difference with LCPs is that every aspect of the project carbon footprint must be accounted for which can be a lengthy and complex process.

  In terms of a LCP it is important to adopt a life cycle approach to the carbon assessment process. Typically, significant carbon emissions will be generated during the development phase but to truly understand the carbon impacts of such a project it is also important to assess the emissions from sourcing, supply chains and the operations phase of the project. A good example is nuclear power plants: while the plants will emit no carbon emissions during operations (or very little compared to fossil fuel-based energy power plants) assessing their carbon footprint on operation alone is a mistake

that often misleads perception of the carbon neutrality of nuclear power because emissions associated with construction and in this particular case decommissioning (which can last decades) is associated with significant emissions. In the end, managing carbon on a LCP requires an integrated approach throughout the project life cycle.

- Carbon reduction action plan through technology and management. Equally complex following the initial assessment will be strategizing solutions to minimize carbon emissions at all levels of the project. This phase is particularly important to the project success because if done well it can reduce the overall project operating cost significantly. It is important to emphasize this point: while on a normal project cost reduction through carbon management is usually insignificant this is far from the case on a LCP. In fact, good carbon management plans will easily translate to multi-million savings on the project operational cost and there are now many specific case studies that support this point. As a general rule the larger the project, the more important the cost-saving potential from carbon management strategies will be.
- Carbon offsetting and carbon trading: While minimizing carbon emissions through good governance and well-selected technologies, this is not enough to manage overall carbon emissions on a LCP. The ultimate goal for a LCP in the 21st century is to achieve carbon neutrality and this can only be achieved through trading. An attribute of carbon emissions is that in the end it doesn't really matter in which part of the world it is generated or offset considering planetary level systems. In other words, emissions generated on the LCP project can be offset through another project anywhere else in the world. There are clear established mechanisms to do this (the Kyoto protocol was one of them and is now being replaced by new Paris Agreement frameworks).

  It is often forgotten that carbon is a tradable commodity and that there are established financial frameworks to do so. If done well, a given LCP project can demonstrate that its processes lead to carbon reduction and can then sell carbon credits on the global market while generating income. Since LCPs emit significant emissions, the income that can be generated by trading carbon can be significant. The figure below gives an idea of the level of carbon trades and average carbon cost occurring per type of projects. Source: Gold Standard



- Carbon analysis is the next important step: Before reporting the data to the stakeholders it is important to take a step back and analyse the large data sets obtained both from the carbon emissions and offsetting measures. The objective at this stage is to gain a clear understanding of the remaining carbon balance budget between what has been generated and what has been cancelled through offsetting and trades. On a LCP this process can be quite tedious and it is important to put into place the right methodologies and systems (e.g. Environmental management systems EMS) to manage large data sets beyond simple Excel spreadsheets
- Carbon disclosure: last but not least it is important that the carbon emissions activities of the LCP be accounted for and transparent. There are several means for a LCP to disclose its carbon emissions, the most common being through sustainability reporting or carbon disclosure reports. Depending on the objectives it is wise to get a third-party player to assess and audit the carbon emissions.

While the LCP AROTAD approach is robust on its own, it is important to highlight the fact that there is no one size fit all approach for LCPs and customization is key to ensure the project success and returns on investments. Customization surrounding this framework is a recommended approach to adopt on any LCP.

Carbon Management as a LCP

Quite interestingly and as we have already elaborated in another paper of this series (How stakeholder management and ESG ratings becomes an essential focus for new Large Complex Projects). It is expected that the next generation of LCPs will progressively shift to become Environmentally related and a large portion of such projects will be aligned with the pursuit of a low carbon-based economy. Large low carbon-related projects will include a range of major infrastructures such as wind and solar photovoltaic farms, nuclear power plants and others.

Renewable Energy Projects

Renewable energies are one of the main tools of the de-carbonification. While they still require significant emissions to manufacture (for instance wind turbines contain large amounts of copper, a process which requires important energy generation for extraction and processing) in their lifetime the amount of carbon emissions produced would only be a fraction of what a fossil fuel-based energy power plant would produce. Thus by progressively replacing fossil fuel-based energy production with renewables we can significantly reduce global carbon emissions and possibly one day completely render the process carbon neutral once the energy required to produce the infrastructures necessary for renewable power plants are also powered by renewable energy (we are still far from this level of projects maturity). A good example of such would be hydrogen production which is currently produced by fossil fuel but could use solar energy.

We are starting to see a significant rise in renewable mega projects throughout the world. While solar photovoltaic and wind (onshore and offshore) are currently topping the list, it is expected that more projects will become significant in the years ahead to include hydropower (not just hydroelectric dams but also tidal energy), concentrated solar and hydrothermal. Renewables definitely have their place in the category of LCPs as they are becoming more and more sizable and complex. The below two case studies highlight the sheer size of latest renewable projects, a major turnaround from just a decade ago when such developments would only comprise relatively small projects.

Photovoltaic Mega Project Case study: The Bhadla Solar Park is the world's largest solar park, with 2,245 MW of solar projects commissioned. Spread across more than 14,000 acres, the park is located at Bhadla village in the Jodhpur district in Rajasthan. The solar park has been developed by multiple entities. Rajasthan Renewable Energy Corporation Limited (RRECL), through its subsidiary, Rajasthan Solar Park Development Company Limited (RSPDCL), has constructed 745 MW of projects. Saurya Urja Company of Rajasthan, a joint venture company of the government of Rajasthan and IL&FS Energy Development Company, has developed infrastructure for 1,000 MW of solar projects.

Wind megaprojects case study: Jiuquan Wind Power Base is the world's biggest wind farm. It will feature 7,000 wind turbines installed across the Jiuquan, Inner Mongolia, Hebei, Xinjiang, Jiangsu and Shandong provinces of Gansu, China. The project is being implemented as part of Renewable Energy Law announced in February 2005, setting out to achieve 200GW of installed wind capacity in the country. A 750kV high-voltage direct current transmission line is also being developed by the State Grid Corporation of China to transmit the electricity generated from the wind and solar projects in the region to the booming central and eastern parts of China.The project is one of six national wind power megaprojects approved by the Chinese government. It is expected to grow to 20,000 megawatts by 2020, at an estimated cost of USD $17.5 billion.

The latest case study in addition to showcasing the large size of modern wind projects also highlights the fact that such projects are usually not limited to the core projects themselves (in this case wind turbines) but often expand much beyond for instance for the installation of electrical grids to cope with the new power demand; Electrical networks are LCPs of their own. However, while renewables are an integral part of the solutions, the new LCP projects will also span other areas and in particular carbon capture.

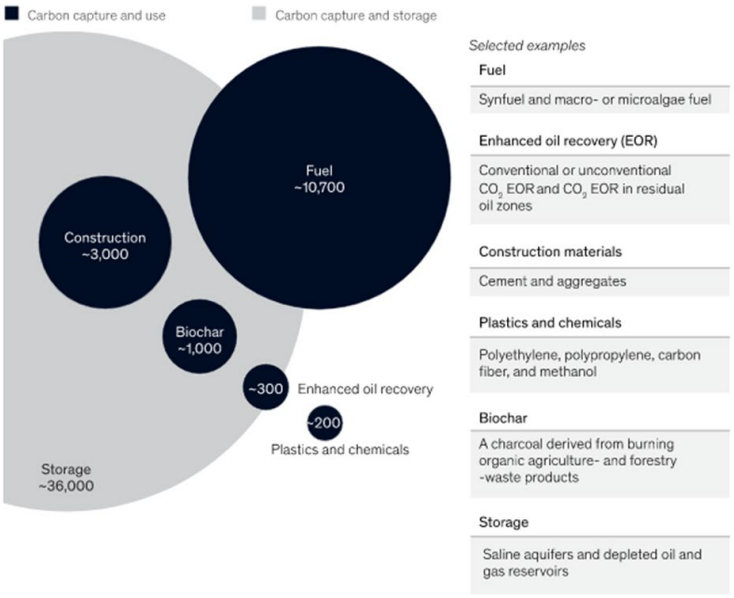
Carbon Capture Projects

Carbon capture can be defined as the process of capturing waste carbon dioxide (CO2) usually from large point sources, for instance from LCPs, transporting it to a storage site, and depositing it where it will not enter the atmosphere, normally an underground geological formation. The aim is to prevent the release of large quantities of CO2 into the atmosphere from heavy industry. The principle behind carbon capture is simple: because carbon was trapped underground in the first place (fossil fuel reserves: petroleum, gas and coal) before being combusted and released to the atmosphere in the form of carbon containing gases, it only makes sense to put it back underground away from the atmosphere.

Beside underground storage, the trapped carbon dioxide can also be used in other industrial applications instead of being buried which closes the loops of some processes. The Circular Economy is another unfolding megatrend as indicated by recent policy release in the EU and Asia including the EU Circular Economy Action Plan 2020 highlighting a clear roadmap for the implementation of a circular economy model and how it is linked to the climate change agenda. Carbon dioxide circularity is of particular interest and many new applications of how it can be used as a raw component for other industrial processes are coming out on an ongoing basis through research and development activities. It is expected that this type of initiative will drive a demand for a new generation of carbon centric LCP projects.

Applications for captured CO_2 cover a wide range of materials.

Technical potential of CCUS in 2030, metric megatons of CO_2 per year[1]



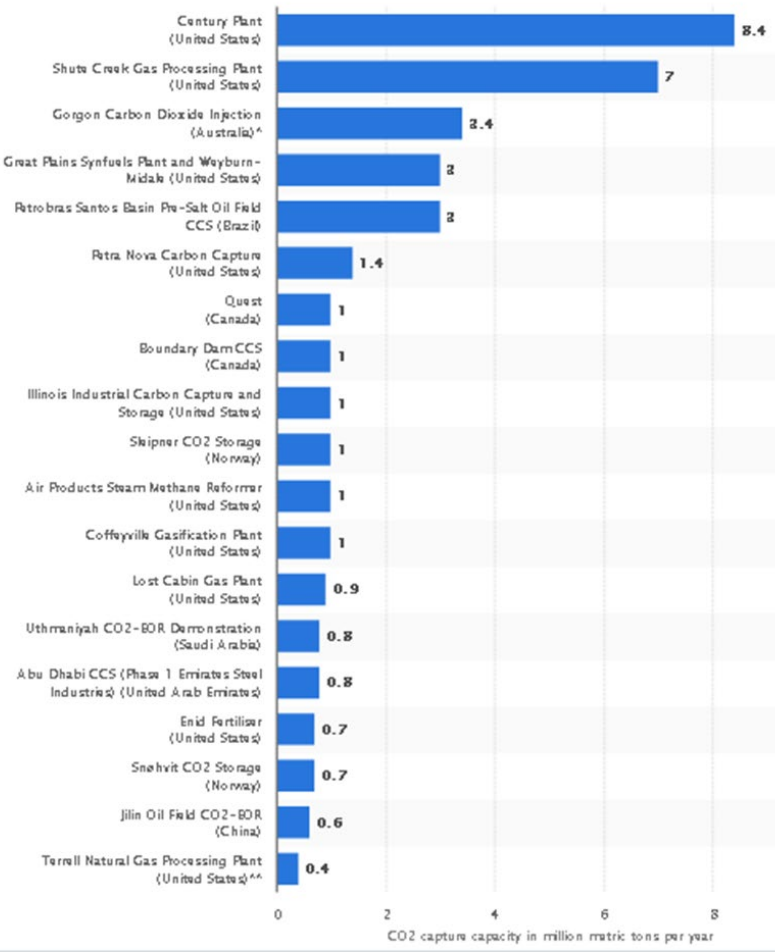
(Source: Mckinsey)

Carbon capture is on its way of becoming one of the LCPs of the future. While the deployment of renewable energy will help to slow down the trend of rising global carbon emissions this will be far from enough and more active carbon removal measures will need to take place. Carbon capture could be used as a transition between a fossil fuel-based economy to a decarbonised one. Two types of carbon capture LCPs can be foreseen, first projects that will produce energy and reinject the carbon emissions directly underground at the source (the location of such projects is key for feasibility). And secondly, infrastructures which will collect trapped carbon emissions from third-party producers and transport them to an underground storage site. While Carbon Capture has great potential for LCPs the challenges faced are currently on two fronts: first of economic nature as Carbon Capture projects are expensive and secondly of legal nature for aspects such as liability and land usage.

LCP Carbon Capture Case study: built by Sandridge Energy, the 1.1 $ billion Century plant is the largest single industrial source CO2 capture facility in the world with a capacity of up to 8.4 Mt/yr. The CO2 is for use in Occidental Petroleum's EOR projects in the Permian Basin of West Texas and southeast New Mexico, one of the largest and most active oil basins in the United States, with the entire basin accounting for approximately 15 percent of total United States oil production. Occidental produces approximately 16% of the basin and the project allows Occidental Petroleum to use at least 3.5 trillion cubic feet of CO2 for the EOR projects and to develop approximately 500 million barrels of reserves from currently owned assets at an attractive cost. While such projects often referred to as "Green oil" are debatable, carbon capture implemented at the source of oil & gas extraction is a temporary solution to reducing emissions from the sector while transitioning to renewables.

While such projects are currently limited, they will serve as case studies and many new carbon capture mega projects are already under construction.

Capacity of operational large-scale carbon capture and storage facilities worldwide as of 2019 (in million metric tons per year). (Source Statistica)



Conclusion

This paper has highlighted the importance that LCPs have to play in national and even international climate policies through carbon management. Managing carbon on a LCP has shifted significantly from a low priority to the point of becoming the very nature of future LCPs as seen with the rapid rise of renewables or carbon capture megaprojects. Whether focused on decarbonisation or other agendas (e.g. civil infrastructure projects), LCPs need to incorporate strong carbon management frameworks to be accountable to their stakeholders. This paper introduces the LCP AROTAD Approach to carbon management which can serve as a backbone to customized assessment solutions. With the strengthening of Climate Change related impacts, it is clear that carbon management and emissions mitigation is becoming a top priority for many governments (but unfortunately not all) and that LCPs need to prepare for increased scrutiny, taxation and barriers related to their emissions. While a significant challenge, carbon management presents an unprecedented opportunity for LCPs in the 21st century.

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