Catalytic actions for transitioning away from fossil fuels

The climate debate is often dominated by ***what*** should be done, as opposed to ***how*** these things can be delivered at scale. The former is well documented and with a few exceptions, attracts a high degree of consensus. It is often the subject of the familiar calls to action issued at international gatherings or in the executive summary of climate reports. The second—**scaling at the required speed**— is much harder, and arguably more important.[1]

Because time is now short and because socio-economic systems are large, this scaling needs to be non-linear. Fortunately, systems science has over the past couple of decades delivered insights on how **catalytic action** can lead to rapid system change.[2] Never straightforward or dead certain, such catalytic measures need to come to the foreground as a separate area of attention. Complementing, not replacing the rest of the arsenal of measures.

The purpose of this paper is to provide a list of examples of such catalytic actions. It cannot be complete, as such actions are deeply determined by the system they intend to change, and with few exceptions resist generalization. The list provided are some generic examples – and there are others. It in no way replaces the things we know that scale linearly, such as solar, wind and notably geothermal, but it is an complmentary set of measures.

The goal is to encourage setting up a process to design and deliver more catalytic solutions. This requires a dedicated **institutional solution**: The UNFCCC Centre for Catalytic solutions (UNF5C?).

Next, we turn to a few selected and illustrative examples of such catalytic solutions:

A continental copper plate - HVDC networks

In the late 19th century inventors Nikola Tesla and Thomas Edison pitched Alternative Current (AC) against Direct Current (DC), in what became known as the battle of the currents. AC prevailed and became the standard for all power transmission. AC has many advantages, but one crucial disadvantage. It loses more than twice the amount of power in transmission over long distances. This has profound consequences for the ability to move power cost effectively and has created the current local monopolies.

Technological advances over the past decades have made DC competitive over long distances. China has become the world leader in deploying High Voltage DC (HVDC) lines to connect remote power generation to demand centers. The South American HVDC network is growing rapidly. New links have been proposed from Australia-Singapore, Morocco-UK and Canada-Europe. The Supergrid institute in France champions network design and technology.

The long-distance connections enabled by HVDC makes possible the transport of renewable power from remote locations such as Chilean or Tibetan plateaus to demand centers. It enables load balancing to match variable demand with variable supply. Southern European solar, Northern European wind and pumped hydro storage in the Alps could form a harmonized resource. The Global Energy Interconnection (GEI) plan envisioned by China is proposing a future global network, much like the current oil or telecommunications infrastructures.

HVDC networks are a critical enabling resource to deliver low carbon power. The technology exists and it is being implemented in many places, but it has nowhere near the policy focus it deserves.

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[1] See Kupers, A Climate Policy Revolution, Harvard University Press, 2020

[2] See Colander and Kupers, Complexity and the Art of Public Policy, Princeton University Press 2014.

Why catalytic: *HVDC dramatically increases the impact and resilience of low carbon power.*

Autonomous vehicles (robotaxi's)

It may be surprising to find autonomous vehicles amongst the catalytic measures to be considered. The common solution to the 10% of global emissions from light vehicles is electrification. However, that largely replaces the stock of fossil cars with electric cars. This delivers a reduced fuel footprint as the power system is decarbonized, along with a slightly increased manufacturing footprint due to higher vehicle weight. This is a significant, but merely incremental change, while autonomous vehicles have the potential to deliver **much deeper reductions**, as well as **enormous co-benefits** in non-climate systems.

There are six broad buckets of benefits from robotaxis:

Far fewer vehicles – Privately owned cars are utilised less than five percent of the time. The consequence of this low asset utilization rate is a high cost of capital, a slow product development cycle, and far too many vehicles. If autonomous vehicles are paid for by usage—as robotaxis—these disadvantages are overcome. A much smaller amount of assets will be used around the clock, maintained efficiently and more quickly replaced. Of course, the common perception is that a private car is cheaper than a taxi. However, a robotaxi will avoid the cost of the driver and have far lower insurance cost from much lower accident rates. Initially in cities, perhaps later outside urban areas, robotaxis would be transformative. After many missed deadlines, the technology is now finally mature. What is still missing is the enterprise model and policy support to deliver this quickly.

Accelerated tech improvement – Cars last on average for almost two decades, sitting idle most of this time. Like taxis or rental cars currently, the assets are replaced much more often as they reach their end of life earlier. In turn this means that technological innovation is accelerated, as new inventions are deployed more quickly. Feedback from their use in turn will accelerate innovation in energy efficiency in a much shorter product cycle.

Much reduced energy use – The weight of current vehicles is determined by the expectation of frequent accidents and resistance to very high-speed crashes. All this extra weight requires energy to move around. Autonomous vehicles will have dramatically fewer accidents, but also rigorously comply with speed limits. As a result, these vehicles can be much lighter, dramatically increasing their fuel efficiency, and in turn requiring smaller batteries. Clearly there is a transition challenge, when light robotaxi's mix with heavy human-driven vehicles. Just as bicycles and pedestrians require dedicated lanes or roads, human controlled vehicles will need to be constrained to their own lanes. The prize is a dramatically smaller energy footprint in motion, as well as in manufacturing.

Transformed cities – As much as a third of urban space is dedicated to storing unused human-driven vehicles. At the price of urban land, this amounts to an enormous transfer of wealth to the car owners in cities, often less than a quarter of the population. Robotaxis would drop off their users, and when necessary, go charge their batteries in an anonymous low-cost location. With the current housing crisis in many cities, as well as the interest in concepts such as the 15min city, the potential benefits represent an enormous opportunity, with co-benefits beyond climate action.

A million fewer fatalities p.a. – Current vehicles are heavy due to the incompetence of human drivers. For example, road fatalities in Brazil alone are equivalent to a plane crash every other day. This would clearly be unacceptable for a new technology introduced today, but society has become numb to this issue. Autonomous vehicles already demonstrate at least a ten-fold improvement in safety, not including the anticipated further rapid progress. The impact of the avoided societal trauma for children, spouses and friends is hard to overestimate.

Consumer norm transformation – Car ownership is an important determinant of social identity. In fact, some of the opposition to EV adoption is associated with fossil brands and styles. Displacing this largest consumer purchase will require overcoming such opposition. However, it will also provide an opportunity for people to replace this symbol of social identity with others. Clearly this can go either way, from guns, through tech to virtue signalling. In any case, the widespread deployment of autonomous vehicles would provide the opportunity to overcome an important path dependency in social norms. And since it is well established that social norms are networked together, it can unlock other changes in consumer behaviour. Already the increased average age for obtaining a driver's license in some countries, leads to an increase in using collective transportation.

***Why catalytic**: Autonomous vehicles enable transformations in adjacent systems, even beyond energy consumption.*

A tweak to the UN 1971 convention

In 1971, the UN adopted a convention defining banned substances. It was preceded in the US by the Controlled Substances Act (CSA), signed into law by President Nixon. Until this day, such substances are listed in a set of four Schedules. The most restrictive, Schedule 1, lists several psychedelic substances such as LSD, psylocibin, MDMA etc.

But how is this relevant for catalytic measures in a transition away from fossil fuels?

Climate action requires caring about nature in the first place. And recent scientific research has confirmed what traditional users knew, namely that these substances strongly increase affinity with nature with minimal risk. For example (Lyons et al 2018) and subsequent studies confirm a large and sustainable effect on user's affinity with nature. This is foundational and deeply catalytic for climate action. The minimal risk is confirmed by studies such as (Nutt et al 2010), as well as by other studies reaching back to the 1950's.

With the possible exception of Western cultures, all peoples have universally used natural psychedelic substances as an integral component of their rituals and relation with nature; iboga in Africa, ayahuasca in South America, pituri in Australia, peyote in North America, local mushrooms in most places. The traditional purposes were for communion with nature, religious experience and social cohesion.

In the 1960's following the discovery of an industrial version of these natural substances by Swiss pharmaceutical companies, LSD was adopted in Western countries as drug holding much practical promise. Alcoholic Anonymous endorsed it for addiction treatment. By the late sixties it had become a symbol of counterculture, explicitly threatening the social order by opposing consumerism, the Vietnam war etc. As a reaction, it was quickly banned by US authorities and subsequently included in the 1971 UN convention.

Whether people actually consume substances like coffee, alcohol or LSD should be their own individual choice. But freeing LSD and other psychedelics from the constraints of the UN 1971 convention would be a powerful catalytic to strengthen affinity with nature. Any transition away from fossil fuel with require bottom-up actions, either by supporting proposed policies, embracing local projects such as geothermal drilling, by consumer choices such as choice of heating and cooling options.

***Why catalytic**: A small change in a UN convention can help enable the social norms that support climate action.*

Demand side temporality

It has become common to refer to renewable power as interruptible. No power source is constant, and the availability factor ranges from a quarter for solar PV to ninety percent for nuclear. However, such considerations miss the point. What is required is to reliably match any variable supply with variable demand. Fortunately, both are relatively easy to predict. Weather, nuclear plant maintenance, consumer habits and industrial demand are knowable patterns.

More surprisingly, power is the only economic good where the expectation is that every demand shall be met. Airline seats or hotel rooms are flexibly priced depending on availability – and when a road is full, traffic backs up. However, it is unchallenged that all new AI data centres must always be powered.

The consequence is that over the past two centuries of the industrial revolution, technologies have largely evolved to ignore supply side constraints and taken unlimited power as a given. Obviously in energy poor regions, work-arounds have been found to adapt to unreliable supply. Either through storage, local generators or flexible processes, but the fundamental model of economic demand comes with the expectation of universal supply.

Demand can be influenced through pricing. In a gentle form of blackmail, some cryptocurrency miners now make more money from interrupting their activities to collect rewards from grid operators, than from mining itself. Industrial cooling facilities adapt their demand by cooling more deeply when power is plentiful. More fundamentally, the engineering challenge of reconfiguring industrial demand to meet supply patterns hasn't even been scratched. Apart from very high temperature processes such as steel manufacturing, the opportunity for human ingenuity appears enormous. Variable pricing will be necessary, but not sufficient. The idea that supply and demand are matched through price is an idea from general equilibrium economics. However, complex economic systems in transformation are actually far from equilibrium and therefore require more than just price signals to evolve and innovate.

Many more subtle tweaks to demand can be imagined. For example, the increase of high-power home appliances such as induction stoves and heat pumps, sends very large induction peaks into the local network. Flattening such peaks with capacitors in the appliances has been shown to be a catalytic measure that frees up a lot of local network capacity at minimal cost.

***Why catalytic**: demand side action is an underdeveloped and arguably enormous resource*

Building Institutional capacity for catalytic action

Catalytic action is often underappreciated as a tool for systemic transformation, as it is not normally part of the standard policy toolset. There is a limited but growing literature describing its potential. However, it is not more study that will accelerate such measures, but an action focused institution. It will leverage the insights from several decades of complex systems science, as well as work in the social sciences.

In addition to providing the foundational quote on the Brazilian flag, Auguste Comte in the early 19th century helped define the top-down quantitative and reductive approach to structuring society through policy. Nearly two centuries later, we have come to understand the complex nature of social systems, and how to leverage catalytic action for desired transformation such as those required for effective climate policy. It is time to add this to the COP toolkit. A new institution would be one way to realise these such catalytic opportunities.

Dr. Roland Kupers is an advisor on Complexity, Resilience and Energy Transition. A widely published author, he has advised corporations, NGO's and the United Nations. He has been affiliated with Oxford, Amsterdam Arizona State and Singapore Management Universities. Roland has been the initiator and lead architect of UNEP's International Methane Emissions Observatory.