Accelerating energy transitions

what technologies *ought* to be in the mix

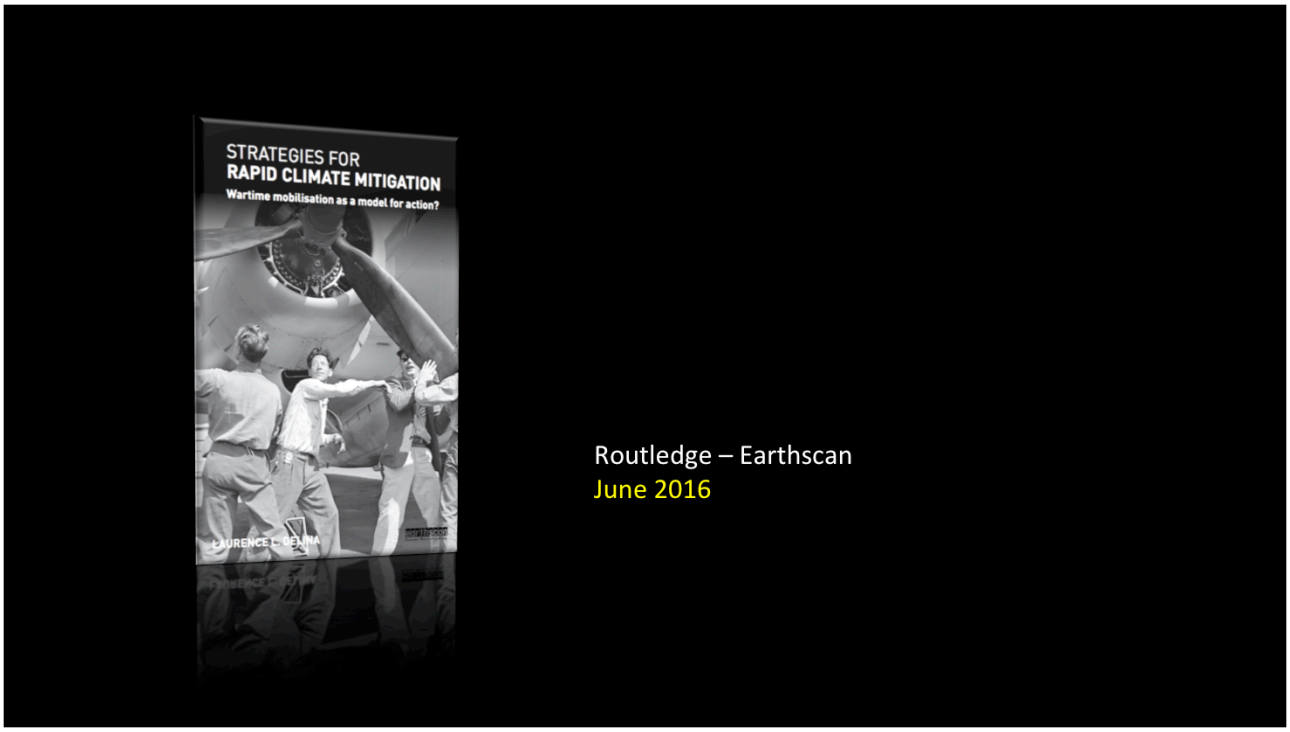
BOSTON UNIVERSITY
Laurence Delina
25 October 2016 | Harvard Energy Journal Club

Spring 2013
HKS

Energy Journal Club
Sir David King

Little bit of a background
Filipino
Twice a fellow at the Kennedy School
Now with BU investigating energy transitions in developing countries

PhD from UNSW Australia on strategies for rapid climate mitigation



PhD resulted into this book
Completed before the signing of the Paris Agreement in December 2015

Where world governments agreed to limit global average temperature
rise to well below 2°C, and to strive to limit it to 1.5°C.

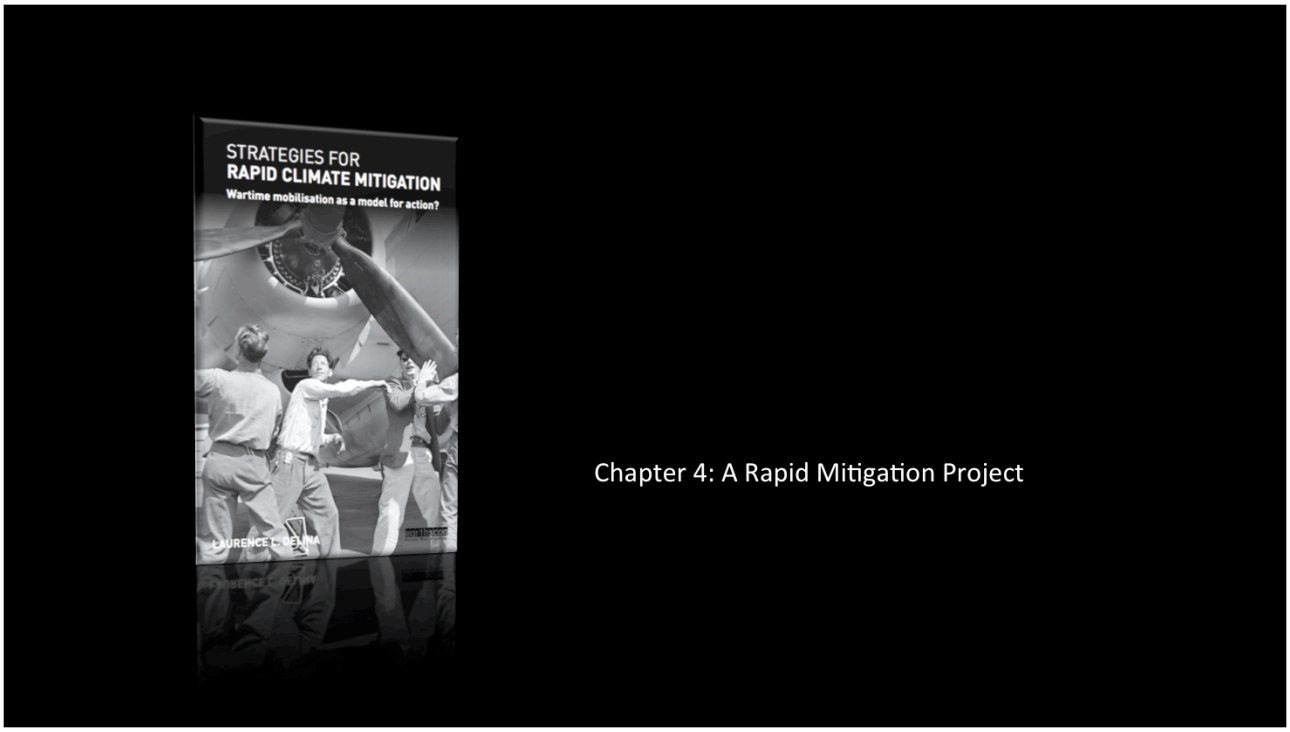
The book is premised on the fact that we are already experiencing climate change at a rapid pace. Therefore, action to curtail further impact needs to be done speedily as well.

We will skip the discussion on what sort of impacts are these.
I am assuming we have heard enough of these already.

In this book, I focus on how we could accelerate climate mitigation in the energy sector – meaning how to rapidly replace fossil fuel powerplants and fossil fuel use with sustainable energies.

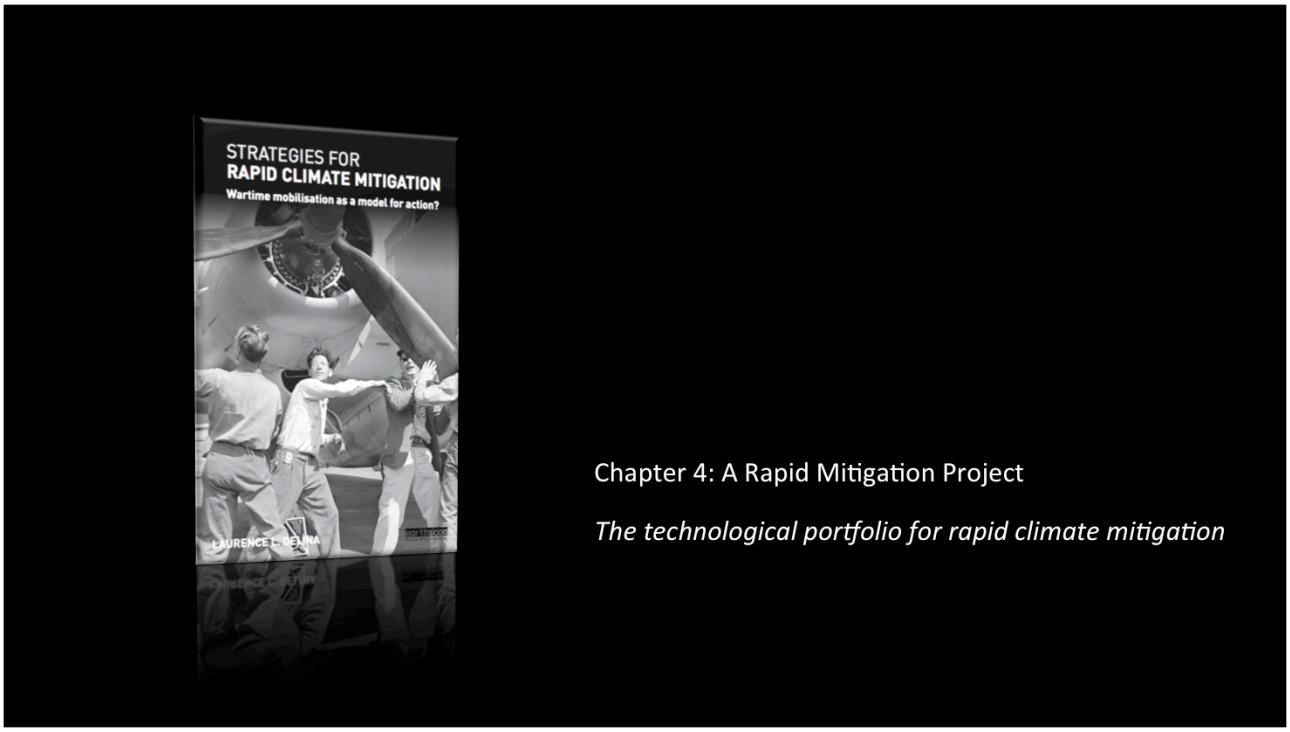
I do this by looking at the rapid sociotechnical changes that occurred during World War 2 and see what possible, replicable strategies can be employed for rapid climate action.

We will not be discussing the policy strategies, the financing strategies, and labor mobilisation strategies today.



My talk today will revolve around Chapter 4 of this book.

The chapter deals with the technologies of rapid mitigation, viewed through the lenses of accelerated energy transitions.



In particular, I focus today's discussion on one section of this chapter.

This section deals with the technological portfolio.

What I want to gain from our conversation later is your views regarding these sets of technologies.

Take note that this book was written between 2011 and 2015, and polished for book publication beginning in September last year.
The manuscript was finished in end-November, a week before the Paris climate talks.

So, the book doesn't talk about the normative ambition of the Paris Agreement, rather it speaks of a thought experiment on what countries can do to accelerate action on climate by rapidly changing our energy architecture.

In addition to this section of the book, let us also navigate today's talk using some recent materials published post-Paris.

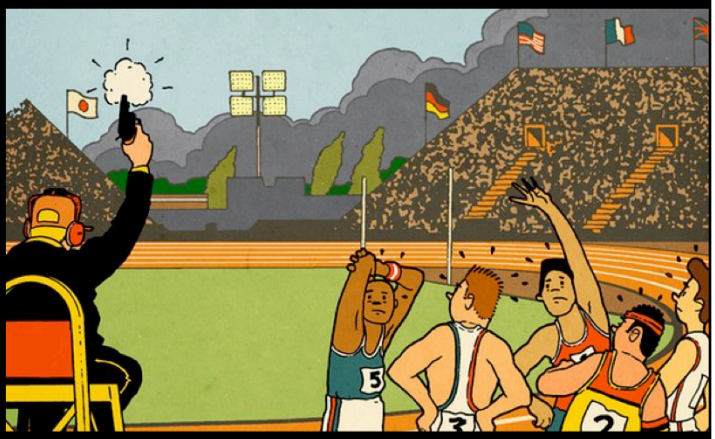
Again Paris is about limiting warming to 2C while striving for 1.5C.

theguardian

Climate deal: the pistol has fired, so why aren't we running?
Bill McKibben

There can be no complacency after the Paris talks. Hitting even the 1.5C target will need drastic, rapid action

Sunday 13 December 2015



Despite that,

Bill McKibben, of 350.org, who happened to be among those few people who read the book manuscript before its June publication, wrote in The Guardian, a day after the signing of the Agreement in December 13, this opinion piece.

The pistol has fires, so why aren't we running.

In this piece McKibben wrote:

Hitting those targets (and he meant the 2C target) is absolutely necessary: even the one-degree rise that we've already seen is wreaking havoc on everything from ice caps to ocean chemistry. But meeting it won't be easy, given that we're currently on track for between 4C and 5C. Our only hope is to decisively pick up the pace. In fact, pace is now the key word for climate. Not where we're going, but how fast we're going there. Pace – velocity, speed, rate, momentum, tempo. That's what matters from here on in. We know where we're going now; no one can doubt that the fossil fuel age has finally begun to wane, and that the sun is now shining on, well, solar. But the question, the only important question, is: how fast.

Indeed, the urgency of climate action is one that is least discussed in the policy sphere. And, I personally think, this is a new kind of climate denialism.

The discussion on accelerating climate action, nevertheless, has started to gain attention – at least in few pockets of progressive reporting.

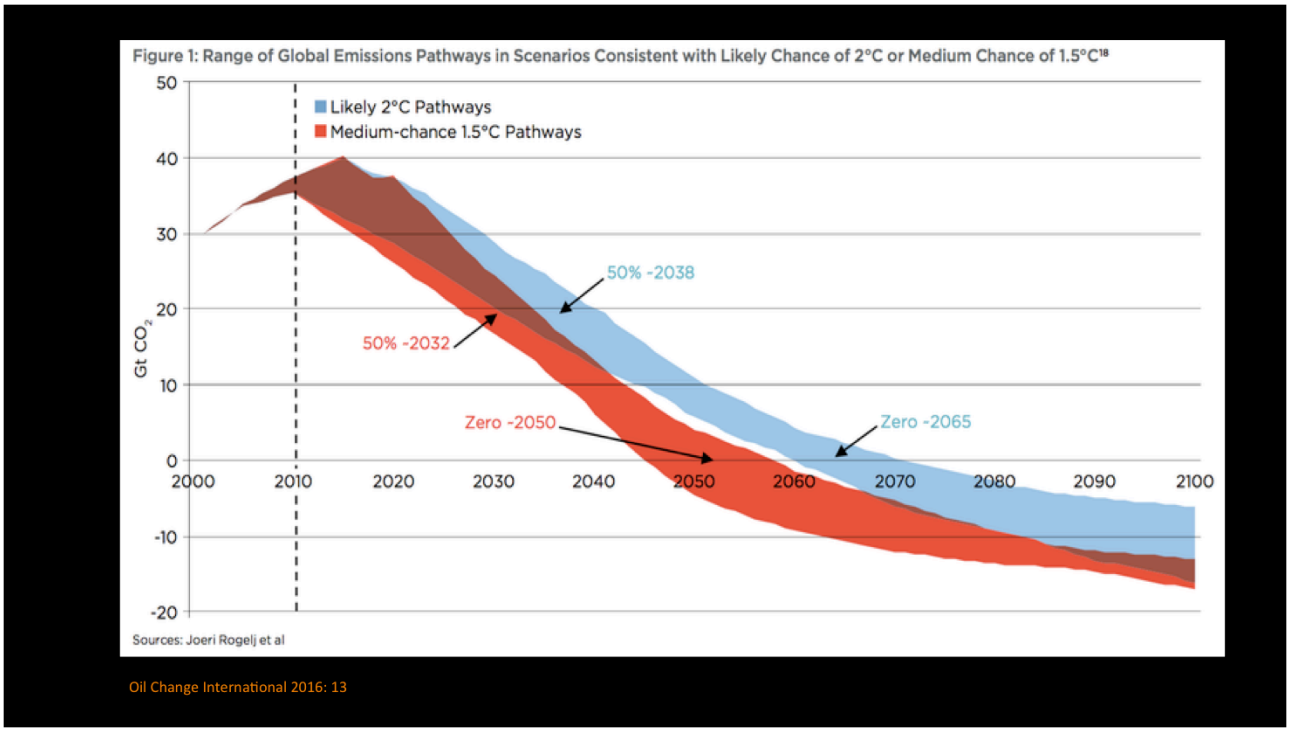
Such as this month's report from Oil Change International.

I think this ahs been mentioned in one of your meetings.

The report highlights that our current global fossil fuel reserves are more than enough to exceed the 2C limit.

Therefore, we should limit further emissions through a managed decline of the fossil fuel industry.

Or using the report's own words, when you're in a hole, stop digging.



Oil Change modeled two scenarios.

One gives us a 66% chance of stopping short of 2C.

The other gives us a 50% chance of stopping short of 1.5C.

Here's what the scenarios look like.

As you can see, in either scenario, global emissions must peak and begin declining immediately.

For a medium chance to avoid 1.5C, the world has to zero out net carbon emissions by 2050 or so — for a good chance of avoiding 2 degrees, by around 2065.

After that, emissions have to go negative. Humanity has to start burying a lot more carbon than it throws up into the atmosphere.

Staying beneath 2C means ceasing all new fossil fuel development. And doing it as quickly as we could.

This requires, in simple graspable words, accelerated transitions, or rapid mitigation.

In the book, I argued that this can be done quickly in the energy sector.

Global: Teske, Muth and Sawyer 2012 WWF, Ecofys, and Office for Metropolitan Architecture 2011 Mathiesen, Lund and Karlsson 2011 Krajacić et al. 2011 Glasnovic and Margeta 2011 Delucchi and Jacobson 2011 Jacobson and Delucchi 2010 Greenpeace International and European Energy Council 2010 Sørensen and Meibom 2000 **Australia:** Australian Energy Market Operator 2013 Elliston, Diesendorf and MacGill 2012 WWF-Australia and Climate Risk 2012 Wright and Hearps 2010 **USA:** Mai, Mulcahy, Hand and Baldwin 2014 Arent, et al. 2014 Bazilian, et al. 2014 Hand et al. 2012 Makhijani 2007 **China:** Liu, Lund, Mathiesen and Zhang 2011 **Germany:** German Advisory Council on Global Change 2011 German Advisory Council on the Environment 2011 **Denmark:** Lund and Mathiesen 2009 Richardson et al. 2011 **Netherlands:** Kern and Smith 2008 **Ireland:** Connolly & Mathiesen 2014 Connolly, Lund, Mathiesen and Leahy 2011 **UK:** Center for Alternative Technology 2010 **New Zealand:** Mason, Page and Williamson 2013, 2010 Sovacool and Watts 2009 **Japan:** Lehmann 2003 **Portugal:** Kraja, Dui and da Graa Carvalho 2011

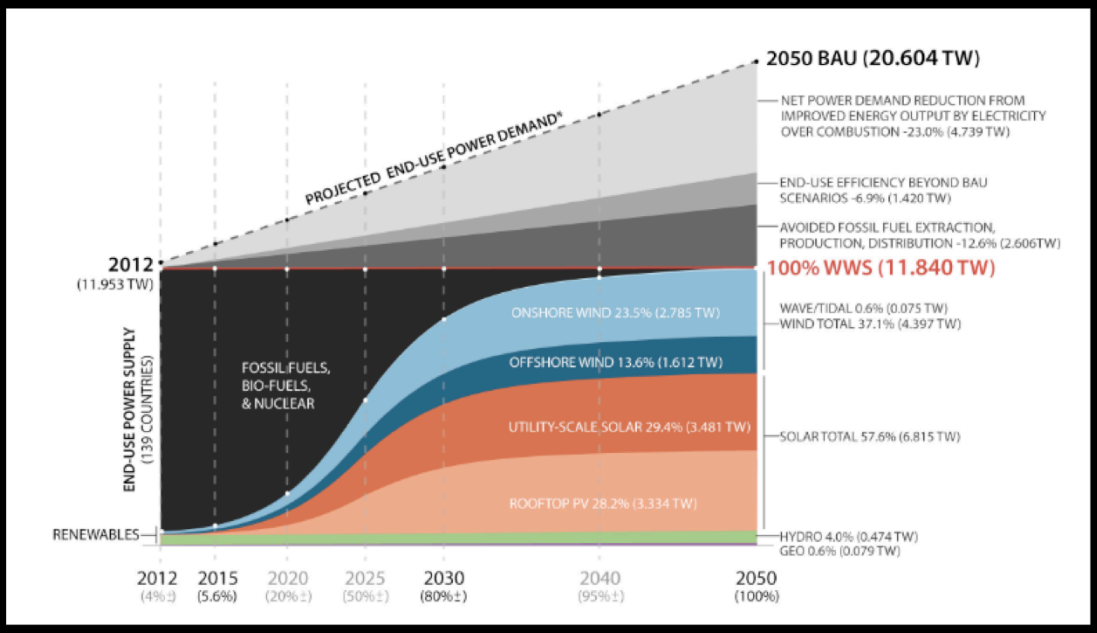
In the last 15 years or so, there has been a preponderance of scenarios and studies about transitioning to 100% renewables.

Some of these are shown in this slide.

Neither of these scenarios specify a transition path nor they share common methodology in their analysis.

However, they remain very valuable in showing earlier that the plausibility of bold, aggressive, large-scale reduction in fossil fuel use is possible.

Of course, we have to take note of the constraints such as source availability, technological readiness, and economic costs, which are varying across geographical spaces and scales.



Jacobson et al. '100% clean and renewable WWS for 139 countries,' 24 October 2016: 10

Perhaps one of the most known of these scenarios is this.

I reckon you've shown or have seen this figure a number of times already.

This figure has been constantly updated, the latest update was just made available yesterday, 24 October

This is a roadmap develop by Mark Jacobson and his team at Stanford showing the technical possibility of transforming all-purpose energy infrastructures of 139 countries to exclusively WWS.

The roadmap envisions 80% conversion by 2030, and 100% by 2050.

At any rate, the roadmap, shown vividly in this figure, highlights a big task ahead: accelerated transitions.

But is accelerating the way we produce, distribute, and consume energy possible?

The traditional view of energy transition is that it is a long-term exercise.

For instance, Vaclav Smil, in an email in 2012, wrote to me, and this is in the book:

"There can be no rapid transition either to new sources of primary energy or to new materials: inertia of existing complex systems, their expensive capitalization, scale of the needed replacements and many inherent problems with alternative conversions and materials make any rapid shifts (that is changes that could be accomplished in less than several decades, or on the order of two generations) impossible."

Overview of rapid energy transitions

Country	Technology/fuel	Market or sector	Period of transition	Number of years from 1 to 25% market share	Approximate size (population affected in millions of people)
Sweden	Energy-efficient ballasts	Commercial buildings	1991–2000	7	2.3
China	Improved cookstoves	Rural households	1983–1998	8	592
Indonesia	Liquefied petroleum gas stoves	Urban and rural households	2007–2010	3	216
Brazil	Flex-fuel vehicles	New automobile sales	2004–2009	1	2
United States	Air conditioning	Urban and rural households	1947–1970	16	52.8
Kuwait	Crude oil and electricity	National energy supply	1946–1955	2	0.28
Netherlands	Natural gas	National energy supply	1959–1971	10	11.5
France	Nuclear electricity	Electricity	1974–1982	11	72.8
Denmark	Combined heat and power	Electricity and heating	1976–1981	3	5.1
Canada (Ontario)[a]	Coal	Electricity	2003–2014	11	13

[a] The Ontario case study is the inverse, showing how quickly a province went from 25% coal supply to zero.

Sovacool, BK 2016, *Energy Research & Social Science,* 13: 208

Contrary to the legitimate reasons and arguments presented in favor of the longevity of energy transitions, some empirical data, however, suggests that under certain conditions, they can occur rather speedily.

Benjamin Sovacool explores no less than ten “quick” energy transitions

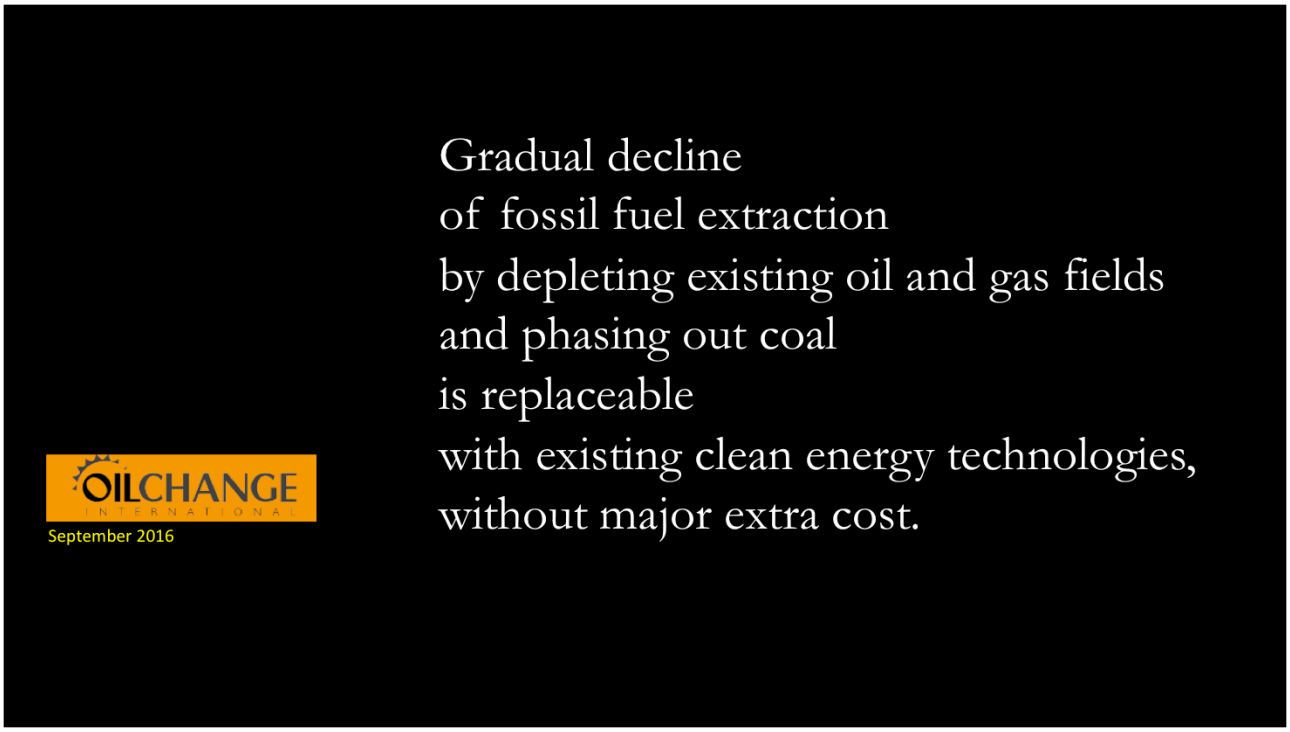
That collectively impacted more than 967 million people.

Countries can, in fact, alter their energy balance in a significant way – stressing low carbon energy sources – in much less time than many decision-makers might imagine.

Critical substitution shifts within [Brazil, France, and Denmark] were accomplished often in less than 15 years.

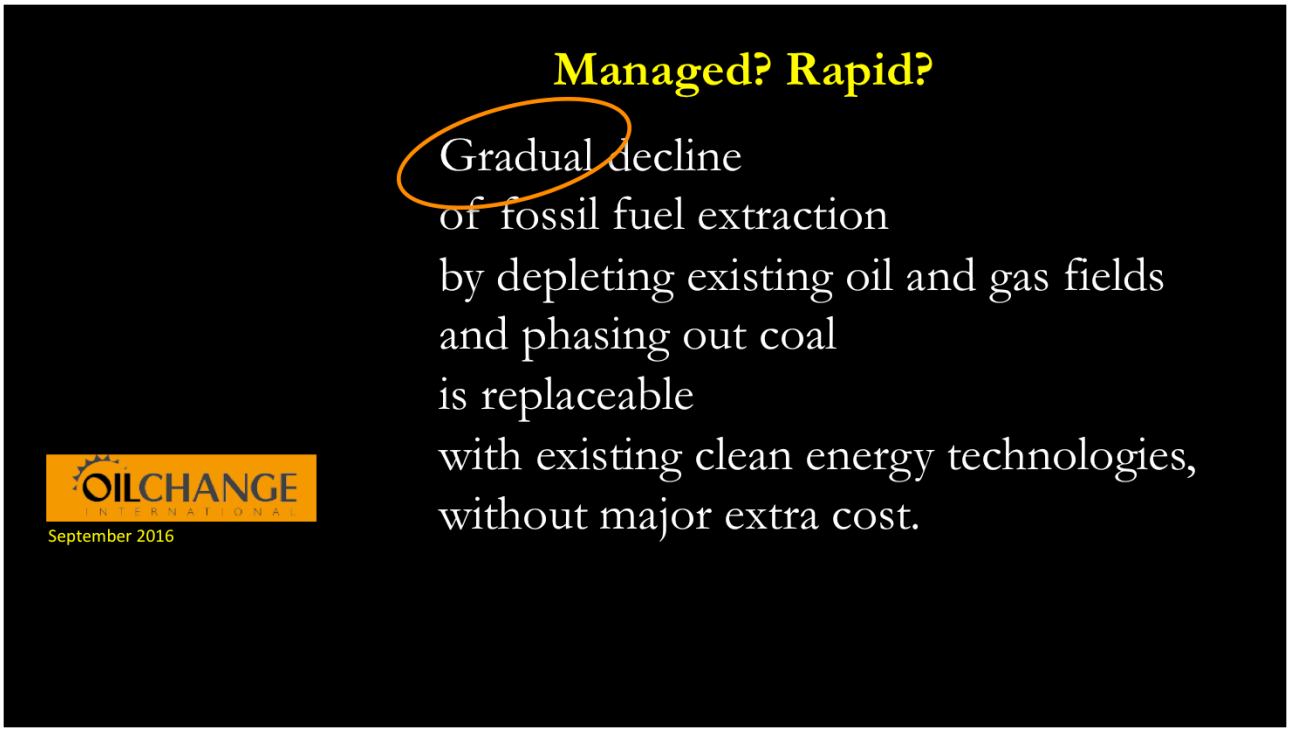
Moreover, these transitions were effectuated even amidst circumstances at times involving highly complex energy technologies.

At any rate, these prior transitions may have been accidental or circumstantial, compare that to future energy transitions, which could become more planned and coordinated – as I have argued in the book -- or backed by aggressive social movement -- as I will be arguing and expanding in my next one.



Going back to the report from Oil Change International.

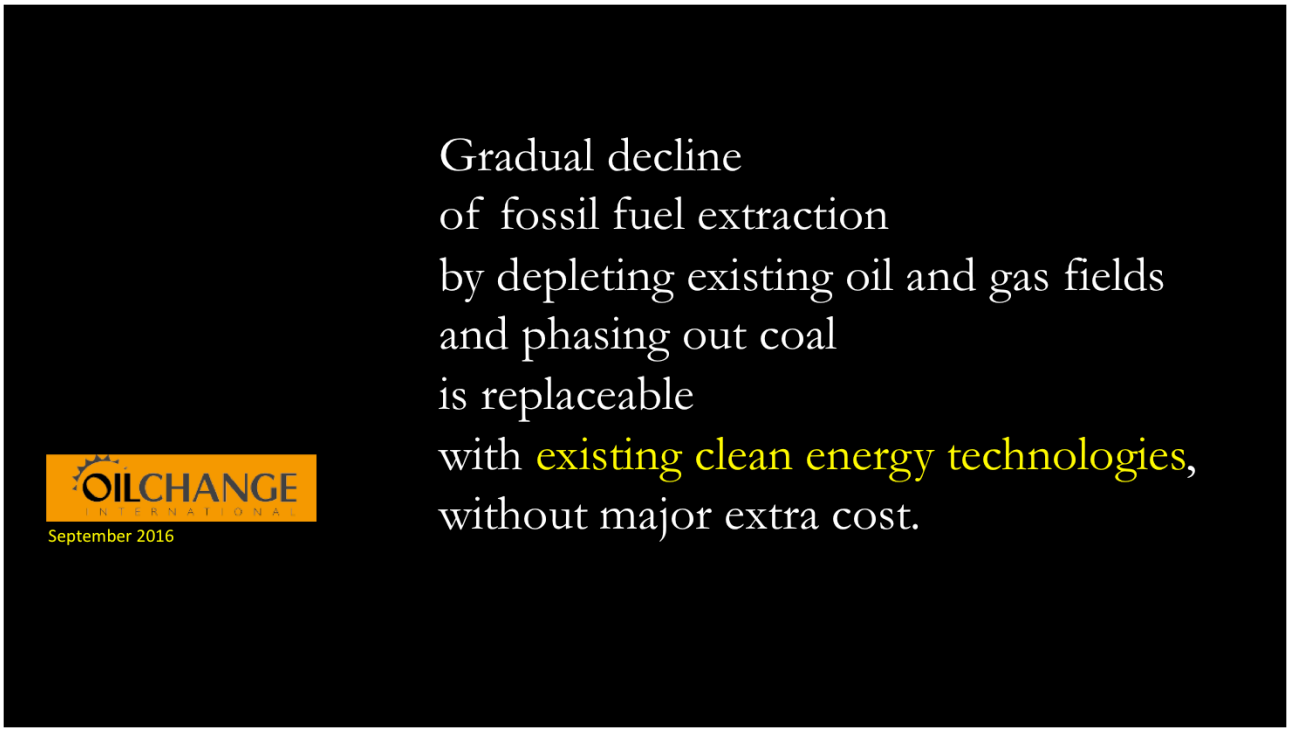
Here is their general conclusion. The gradual…



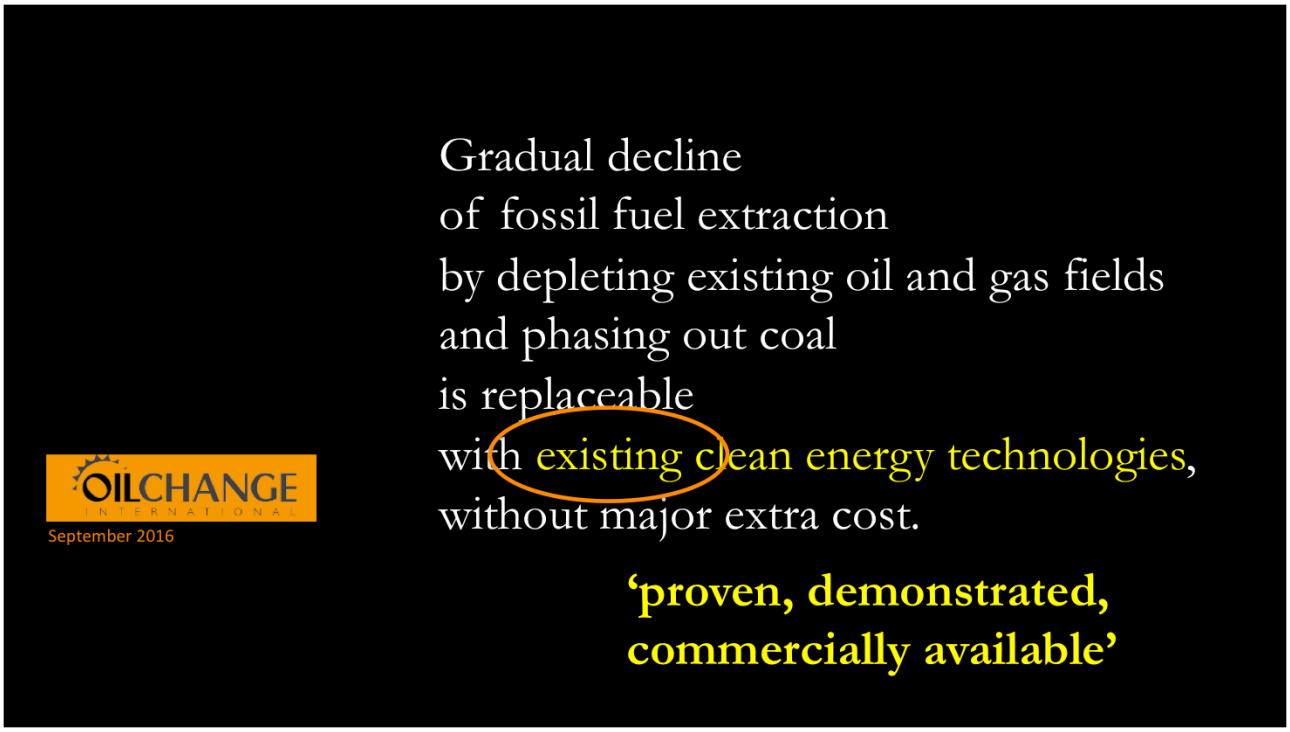
I would like to read the word 'gradual' differently here.

Because reading the report in its entirety, and using the evidence they mentioned, what they actually refer to is 'managed' decline, if not 'rapid' decline.

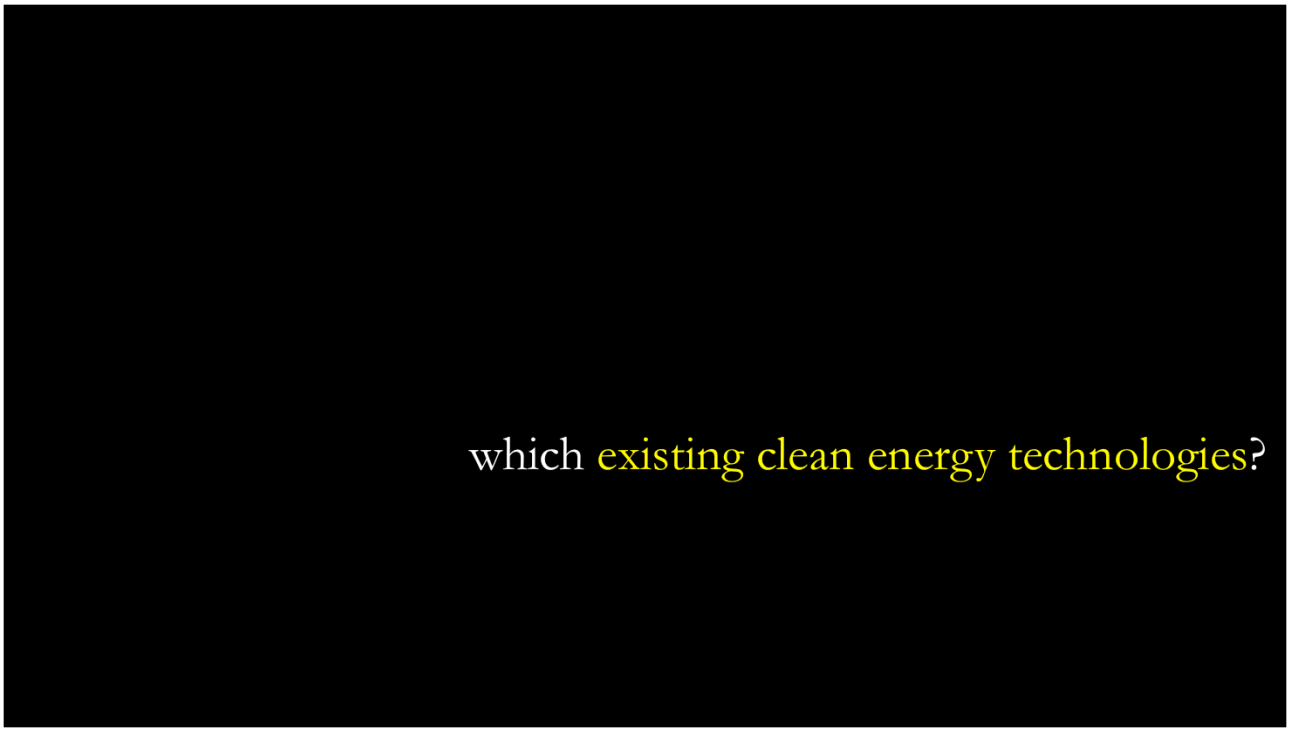
Take note also of the focus on the replacement technologies: clean energy.



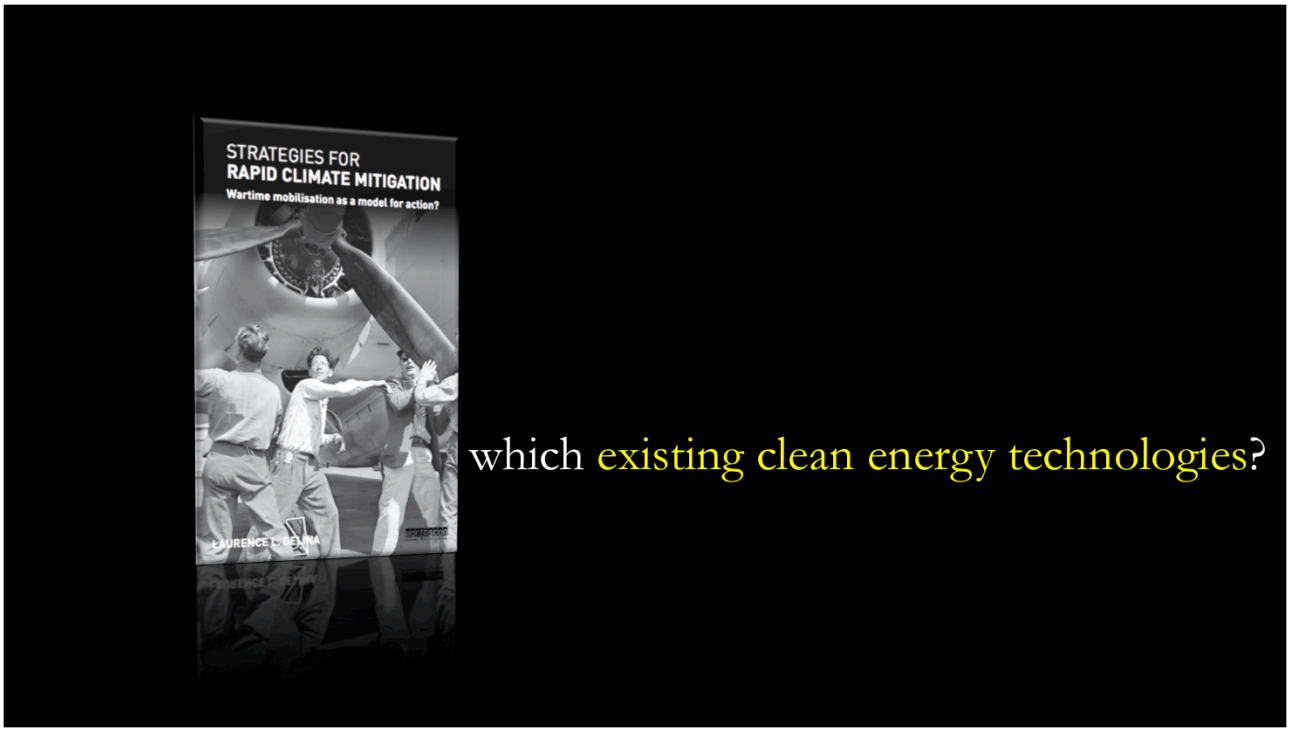
Take note also of the focus on the replacement technologies: clean energy.



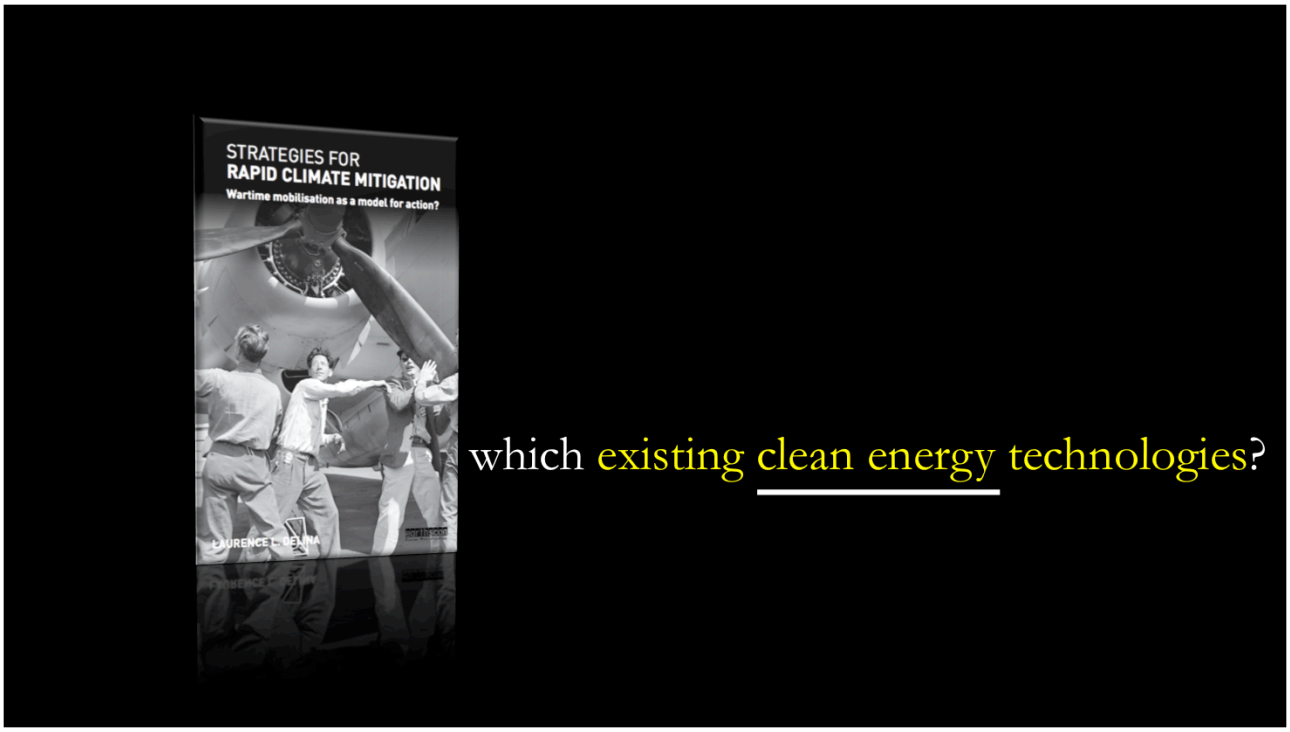
In my book, I use the phrase 'proven and demonstrated' in addition to commercially available



The question I would like us to discuss and focus on today is this.



In the book, I have attempted to respond to this question

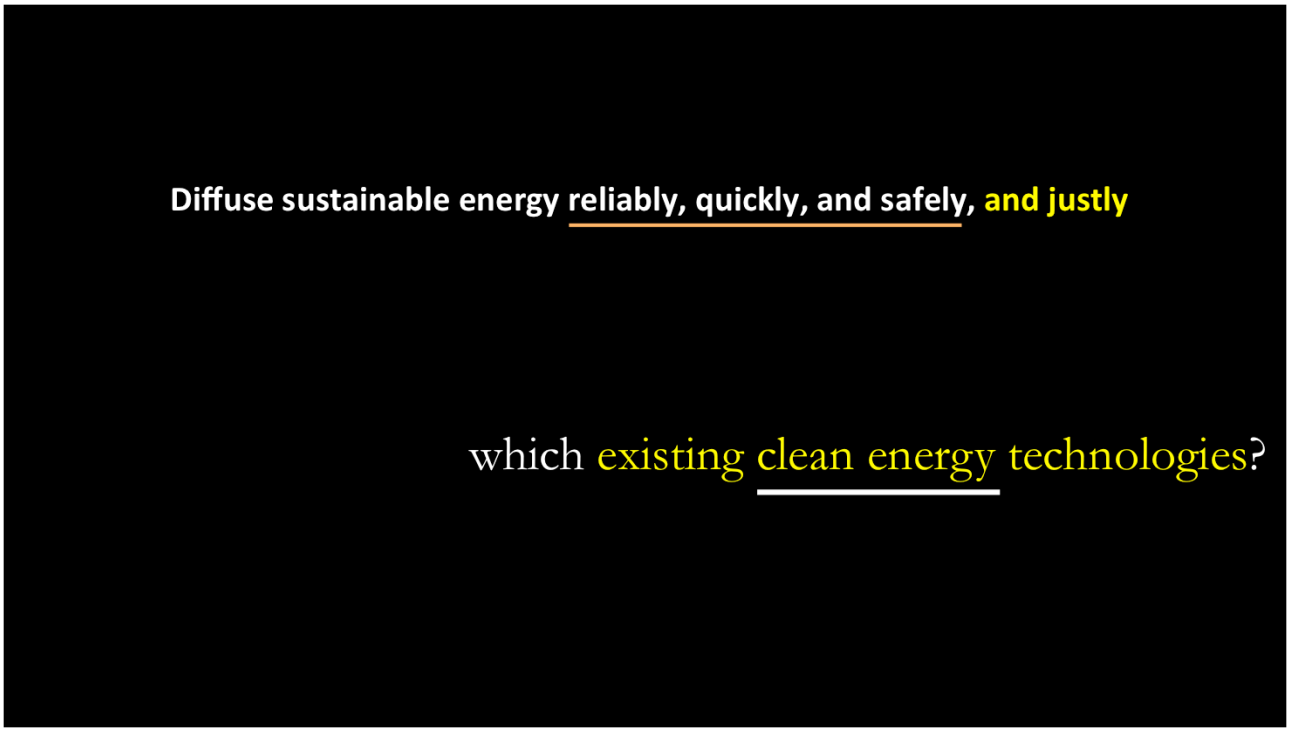


But have to acknowledge the tensions surrounding the meaning of ‘clean energy’ itself.

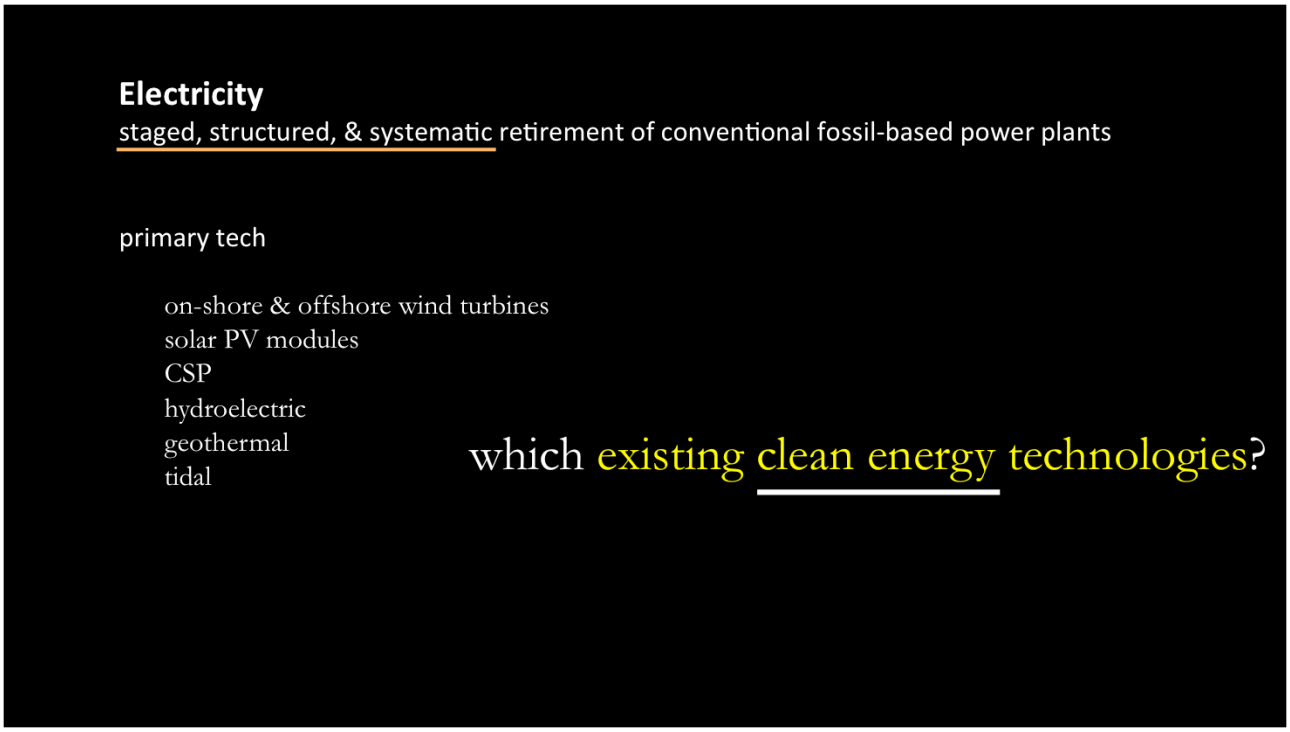
sustainable energy
the form of energy obtained from non-exhaustible resources emitting the lowest GHGs in its life cycle

which existing clean energy technologies?

In the book, I preferred using ‘sustainable energy’ over ‘clean energy’ and defining the term as ‘the form of…



Again, we have to take note of the speed requirement, and to add the concept of justice, which is explicitly mentioned in the Oil Change International report, and in a number of emerging literature on energy transitions.



There are various forms of energy end use. Electricity, transport, heat and cooling, agriculture, etc.

Electricity, however, is key.

You can electrify transport, heating and cooling, and practically almost every other use of energy.

Highlighting the speed requirement, primary technologies for meeting this change include the following.

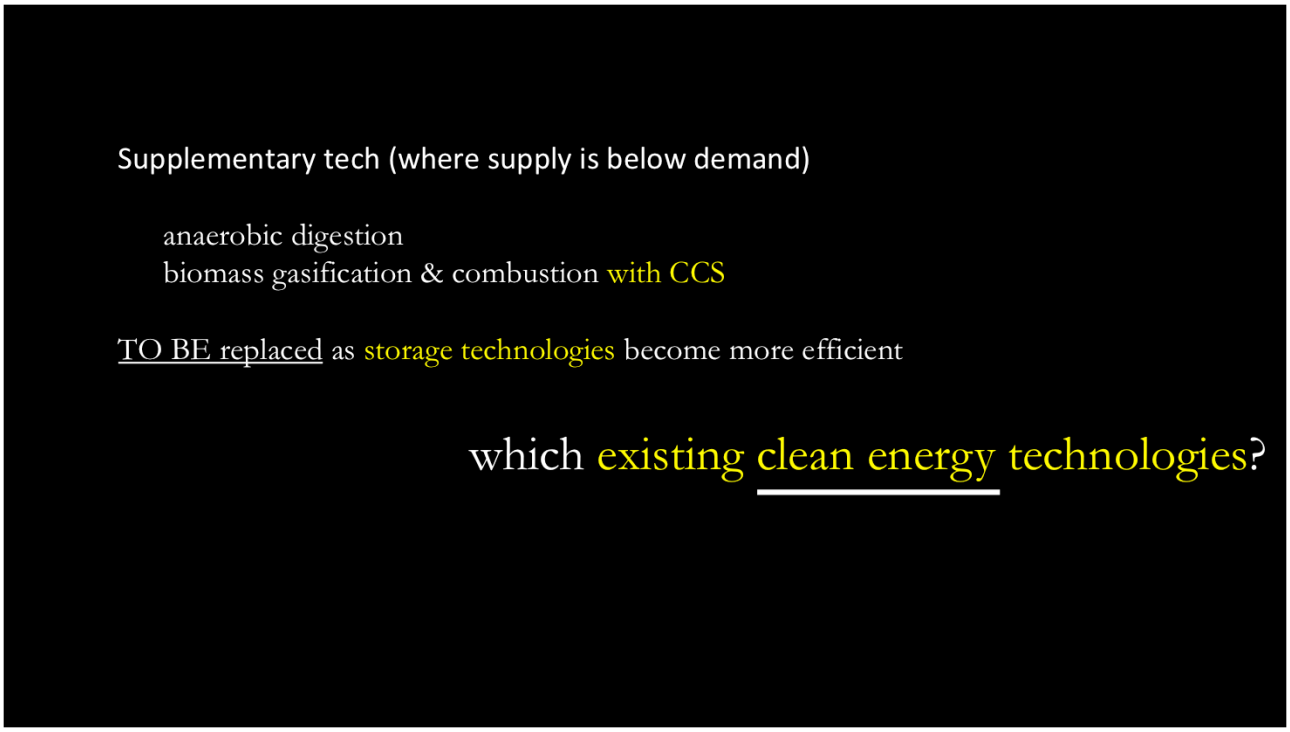
I don't need to describe each of these technologies in detail here.

I am sure you have been discussing part or all of these descriptions already.

What I have to stress is the speed element of deploying these technologies.

Utility-scale wind, solar, and geothermal installations can be accomplished within 2-5 years according to computations by Mark Jacobson.

Tidal, arguably, is a contentious inclusion here.



Following on.

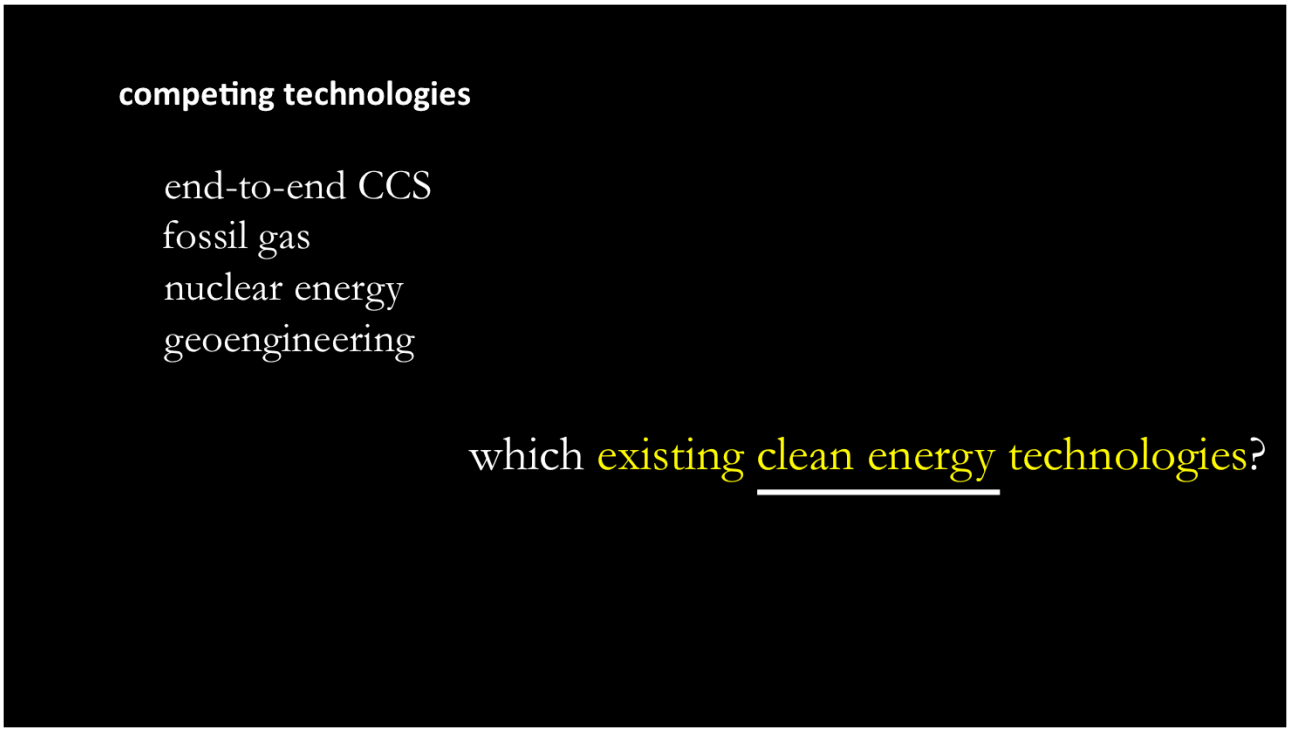
We need to meet gaps in demand. Those that cant be met by primary technologies I have listed in the previous slide.

This can be possibly met by biofuels from anaerobic digestion, and by biomass combustion, ideally with CCS.

This one is contentious. For instance, Jacobson's roadmap excluded this technology. That might be possible; however, in some areas, small-scale biofuel might be needed.

But, and this is an important qualification here, they have to be replaced as storage tech become more efficient and can be widely deployed at commercial scale.

Storage, indeed, especially for large-scale applications, seems to be the key missing item.



Our sustainable energy folks however have serious competitions.

Jacobson: exclude the use of nuclear power, carbon capture, liquid and solid biofuels, and natural gas primarily because they all increase air pollution and climate-warming emissions more than do WWS technologies.

In addition to that, I have argued in the book for the time element.

If energy transition/climate action has to be quick, the deployment of replacement technologies have to be quick as well.

Again using that description: proven and demonstrated, and if you add, commercially available, too.

CCS is not a mature technology

Fossil gas is definitely a nonsustainable resource

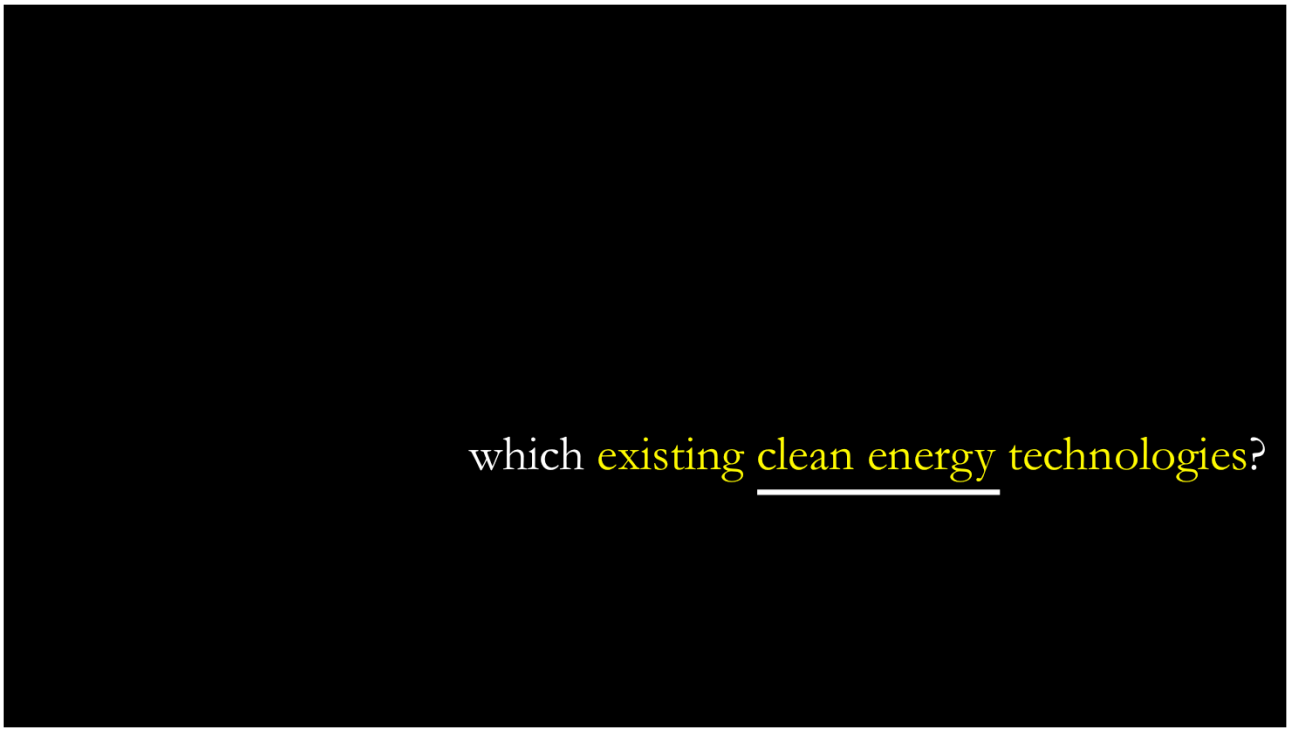
Nuclear energy is the most contentious here. For sure, a lot of discussions had already ensued on the arguments for or against nuclear in this group.

But I would like to highlight here the speed requirement.

Nuclear power has long construction and deployment times – a median of 9 years plus the time required for planning and siting.

Jacobson showed that the time between planning and operation of a nuclear power plant ranges between 10 and 19 years.

Some facilities have even been constructed for 30+ years.



So which technologies?

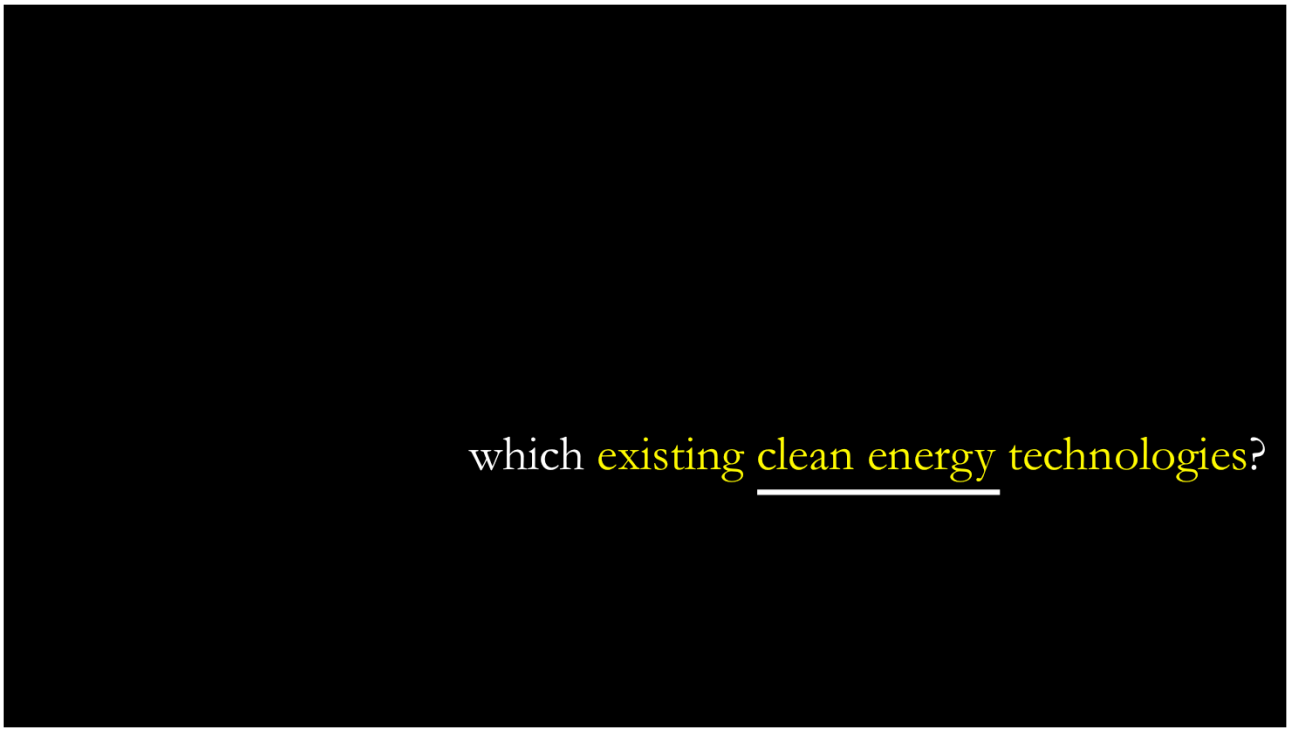
That ends the presentation.

Again thank you for having me. It is a great honor to have this conversation with you today.

I would like to take this opportunity to advertise a special issue I am editing for Energy Research & Social Science.

Abstracts of 500 words are due on New Year's Day 2017.

If you have questions do let me know. That's my email there.



Hopefully, we can focus our discussion on this particular question, and its associated elements and aspects, together.

Because at the moment the world has no real plan to do any things to actually meet the 2C ambition, least the 1.5C goal.

And, sadly, no country on earth is actually taking the 2C target seriously.

Again, the objective we have is to reduce emissions as quickly as possible until we reach a global emissions of zero – hopefully before midcentury.

That's about 34 years from now. In one generation, our generation.