

Principal – agent Problems in Programme of Activities CDM (PoA)

The role of the principal can be a public service utility, local authority or company as Managing Entity (ME) and the CPA implementors, and the agent is a household or appliance user. An appliance manufacturer is not a principal. Two types of issues can appear in each context, the misalignment of incentives between principal and agent and/or information asymmetry in that either one cannot be certain what the other does. The characteristics of the principal-agent problem determine whether the outcome of a PoA can be improved by changing the price signals or by improving the information available between the sides. Furthermore and when there is enough behavioural data available, it is possible to quantify tax and fee instruments needed to overcome them.

Managing Entities according to appliances

The most striking feature in the following overview is that all biogas PoAs are governmental even where carbon investors play a role, whereas all stove PoAs are entirely private.

	CFL	SWH	biogas	stoves
Public	Bangladesh, India, Philippines, Senegal	Tunisia, Vietnam	China 4, Nepal, Thailand, Philippines, Vietnam	
Private	Mexico	India 3, South Africa 3	Brazil	Bangladesh, El Salvador Mexico, Guatemala, South Africa

Total of submitted PoA worldwide:	CFL	500 mio
	Biogas	1.8 mio
	Stoves	1.2 mio
	SWH	680,000

In the literature, principle-agent relations are generally distinguished as

	End user choice	No end user choice
End user pays the energy bill	Case 1: no PA problem	Case 2: efficiency problem
End user does not pay energy bill	Case 3: usage and efficiency problem	Case 4: usage problem

Source: OECD 2007

In PoAs these cases do not apply as such because the principle is always the PoA managing entity (ME) relating to a large number of households and because the energy bill changes with the modalities of sharing the carbon income. The principle decides at what prices and when to sell CERs

and what to do with the proceeds, whereas the agent always signs a contract for the CER ownership rights. Thereby the principle-agent relations become more influential.

	Can choose appliance often because of price	Cannot choose appliance HH accept pre-defined model, landlord – tenant type
Direct energy payment users reap reward from efficiency gains but carbon income adds new relation	CFL, SHS, LED only carbon sharing	SWH replacing geysers, refrigerators, biogas replacing coal China stoves replacing coal China
Indirect energy payment users get efficiency gains not from fuel or electricity bills, can be reflected in carbon income or not	on-site built stoves, SWH for new uses of iHOT defined fee	biogas for HHs Nepal, Vietnam stoves Guatemala, El Salvador

A particular principal-agent problem of PoAs appears where CPAs offer equipment and the user decides whether to take the offer based on her/his anticipation of the costs s/he incurs in the future. The better this decision, the lesser the principal-agent phenomenon. The terms of the offer can ignore the user or enable his/her decision.

In the bottom two cases, sharing the carbon revenue increases a non-monetary incentive to the user. In particular in the bottom right case, regulations to determine the use of master meters for a group of biogas users or sub-meters can reduce the problem. The high cost of thermal energy (Btu) meters is a special case. iHOT is in the “can choose” category because SWH always imply installation work and it is possible to reconfigure components even so the user pays only a small part of the appliance’s cost. This is more pronounced when iHOT installations satisfy hot water services that were not addressed before. When the principle’s offer leaves no choice it is on the right.

The right column case households often get an appliance they would not possibly have otherwise and therefore the emission reduction baseline becomes uncertain. New services and additional needs appear and the initial use of the appliance changes because the households do not foresee all impacts. These cases can use particular information and education services and thus there are PoA functions possible for NGOs or third parties with a track record of advising. Ascertaining the baseline increases benefits for the principle and for the agents in a PoA. Very often these PoA have a role for governmental organisations because of their credibility or sovereignty.

Principle-agent problems are the intrinsic reasons for the different PoA designs chosen for appliances. Hence it is easy to mistakenly see them as technological in nature. Independently of principle-agent problems, thus not intrinsic to appliances, are the policy reasons for PoA designs. Economic criteria of appliances are matter of principle-agent problems and similarly matter of policy reasons.

For principle-agent problems PoAs offer an effective solution via the rate setting for households, structuring the monthly electricity bill allows to align split incentives. This is a major area where PoA design will evolve quickly.

Policy concerns are, for example, China pursues regional development with four biogas PoAs and each investor implements the same obligatory programme design, especially that only households below average regional per capita income are eligible. India attempts something similar with CFLs with a tripartite contract between manufacturer, utility and federal government as a precondition, a CPA eligibility criterion. Several Indian utilities have already decided to go their own way and therefore this PoA strategy fails politically. Both the biogas PoA in China and the CFL PoA in India can be substantially improved from operational efficiency grounds, but it is not certain whether this improves the policy objectives possible.

Trends in important PoAs in important countries

Bangladesh

	Entities	Size	Cost	Carbon Income
CFL	Govt/utility	30 mio	1.43 \$/unit	0.028 CERpa/unit
SHS	Govt/NGOs	1.CPA 227k	322 \$/unit	0.15 CERpa/unit
Stoves	Private/NGO	500k pa	3.14 \$ pa/unit	1 – 16.3 CERpa/unit

The stove and the SHS PoAs build on the outreach and logistics of the NGO Grameen Shakti, the energy branch of the well known micro-finance bank. While the SHS PoA uses government funds, the stove PoA is fully foreign and private from JP Morgan. Grameen Shakti’s outreach makes it an unique and ideal partner for JP Morgan and allows it to build the NGO administration into the additionality demonstration and the eligibility criteria for fast expansion of the PoA. The stove PoA is thus an ideal case to study the combination of market competence of JP Morgan with the local banking skills needed. The ability of Grameen to provide outreach for both public and private PoA is exceptional. The importance of the outreach is also that Grameen can judge how much a better stove leads households to make it fit its needs, in other words, Grameen can clarify the baseline for the carbon investor.

In the stove PoA, households pay installation costs and the ME assures the installed stoves’ efficiency. This incentive split depends on households’ collecting cooking firewood in a manner that the ME’s monitoring brings it the carbon income and the ME’s Non-renewable Biomass (NRB) survey reflects the collecting. The information asymmetry is considerable. During the PoA implementation it should be important to re-assess the incentive alignment between NRB accuracy, stove building training and reduction in firewood collection efforts.

China

	Entities	Size	Cost	Carbon Income
4 Biogas	Govt/Renewable energy offices	1.5 mio 1. CPA 765 BMD	4000 RMB/unit 2050 RMB/unit 4800 RMB/unit	3.7 CERpa/unit 2 CERpa/unit
Hydrants	Govt/Ren en off	1. CPA 65 rams	1000 €/unit	8 CERpa/unit
Transformers	Govt			1.7 CERpa/unit

While four biogas PoAs are funded from foreign governments, Finland, Russia and Japan, they copy and extend a Chinese policy that reaches only 15-20% of rural households for lack of funding. Each of the four has regional focused CPA implementors and all technical and organisational details among the four are identical. Foreign carbon investors must use the regional energy offices and so foreign and Chinese funds “mix”. NRDC in effect assigns regions to carbon investors, according to regional economy policies. The first assignment going to Russia, the second to Japan and Finland being third might also express foreign policy concerns. Family income is the sole eligibility criterion for CPAs.

The hydraulic irrigation “Hydrants” have been manufactured in China for a number of years and were slow to be used because of the investment needed. All PoAs in China are therefore controlled and defined fitting other governmental services for rural areas.

One carbon investor submitted a new stove methodology and added a one-off CDM PDD as illustration case to the methodology submission (NM0337), already at full scale like the biogas PoA in China with 200.000 units. Biomass pellets replace “honeycomb” coal and the incentive split depends on the supply and price of pellets by the ME. Households plan coal consumption similar to pellets and both are predictable for the ME. An additional issue is that the stove can be moved and sold.

The division stove – private / biogas – public could remain in China, even so both replace coal and so both add sharing carbon benefits to the relation coal cost to the household. Biogas PoA are a more difficult tool for policy because some services to the households are not monetized such as fertilizer use.

India

	Entities	Size	Cost	Carbon Income
CFL	Govt/utilities and private	400 mio CFLs 15 mio CFLs	92 Rs/unit (bad 40) charge 15 Rs	0.06 CERpa/unit 0.09 CERpa/unit
3 SWH	Private	31.000 units 250.000 units 400.000 iHOT	30.000 Rs/unit charge .05 Rs/ltr	1.2 CERpa/unit 2.8 CERpa/unit
Compost	Govt	20 large cities		3.709 CERpa/unit
Biomass boiler	Private	45 companies		4.500 CERpa/unit
Absorption chiller	Private			764 CERpa/unit
Chillers	Private			362 CERpa/unit
Grid to agricult	Govt	46	15.5 mio\$	14.248 CERpa

The governmental CFL PoA was intended for the whole country, but state level utilities bargain for better terms from carbon funds and often prefer standard one-off CDM projects to avoid the federal government. In both cases, utilities have so far not discriminated among households, irrespective of size and income 2, 3 or 4 bulbs are exchanged. Certainly public utilities need clear political mandates to treat households differently depending on income. Given the strong political push for avoiding any cross-subsidization and full cost recovery, in fact utilities are prevented from distinguishing households and improving the baseline scenarios in CDM. It would take an NGO competent in household economics to establish baselines separately from what utilities do (private investors are bound by the utilities), and for utilities to apply least-cost planning tools and accounting capacity to build the project case on the NGO's baseline.

India offers a capacity building opportunity to bring the microchip based runtime meter developed for LED (Humboldt University) to an Indian NGO interested in improving CDM baselines. Possibly those NGOs active in distributing LED lights for off-grid areas in India will understand how to apply these monitoring means to optimize carbon benefits. On the distribution side of PoA, foreign carbon funds are acquiring the skills appropriate for India and will most likely provide best practice demonstration cases.

Carbon investors RWE and JP Morgan contract the same SWH manufacturer (Nuotech) in India whereas these investors align with different CFL manufacturers (Osram, Philips) against the governmental PoA and each other. This is also the reason why these SWH PoA-DDs have no price information other than what governmental sources publish. This difference between SWH and CFL also reflects the current volume limits of SWH manufacturers. RWE continues to submit one-off CDM for SWH instead of PoAs. The SWH – CFL difference in India reflects also that CFL only reduce the monthly electricity bill whereas especially iHOT offers households other benefits. iHOT changes the well known “energy ladder” in India (wood, kerosene, LPG, electricity) in an unprecedented manner by having a low initial payment of 80 Rs/unit (+ 0.05 Rs/ltr) bypassing the ladder. iHOT has similar features to on-site built stoves where the carbon income is linked to the system efficiency thus SWH maintenance. iHOT opens energy service contracts to households.

In light of the political complexity of CFL PoA, these will not allow to reflect household behaviour or incentives. Off-grid lighting PoA with LED lamps and SWH PoA can evolve faster.

All chiller and boiler PoA are manufacturer (sales) driven and do not change investment decisions. The World Bank runs a chiller programme since 4 years that include CDM but the main focus is the financing approach used by ICICI, the largest Indian bank. The industrial PoA have no significance for the household oriented ones.

Indonesia

	Entities	Size	Cost	Carbon Income
SHP	Foreign co		1.7 mio\$/unit	5.201 CERpa
Compost	NGO / Foreign co	100 /CPA	60 k\$/unit 2 mio\$/unit	239 CERpa/unit 15.324 CERpa/unit

All PoA Managing Entities are foreign and are commercially not sustainable, reflecting the importance of the country for carbon investors but also the unsuitable institutional situation for mitigation efforts.

Vietnam

	Entities	Size	Cost	Carbon Income
SHP	Govt	15 – 25	17.5 mio\$	31.820 CERpa/unit
	Private		5.9 mio\$	144.360 CERpa/unit
Biogas	Govt	140.000	792 \$/unit	2.15 CERpa/unit
SWH	Govt	2.000	400 – 700 \$/unit	1.27 CERpa/unit

The biogas and the SWH PoAs are using foreign government funds and the Vietnamese government extends pre-existing policies with them. That the first private PoA in Vietnam is for SHP reflects more the investor's intent to gain a project in a popular SHP CDM context where 70 SHP CDM are already produced by many large carbon investors. Biogas and SWH PoAs use carbon investors' funds but both are implemented through governmental entities defining what conditions apply to participating households.

The subsidy is paid after the provincial authority inspects a biogas unit, and 80% of the installation cost is paid from a loan to the households. Households have no choice for the biogas installation nor the financial terms. Participation will be limited by the ME defining these parameters so that households will not unduly benefit. The principle has an incentive to keep the subsidy low, the agent to minimise energy cost. The inspectors from the provincial authority bring another set of incentives to the PoA and they get assistance from a Dutch NGO. The loan for the biogas installation is judged in relation to other services by agricultural extension entities such as for marketing, seeds and fertiliser supply. Income from carbon is probably the lesser policy concern and other aspects of the PoA are more important. A private biogas CDM in Vietnam could design and disentangle incentives better so that the bias from the government as ME is revealed.

South Africa

	Entities	Size	Cost	Carbon Income
3 SWH	Private	59.000	15.000 Rand/unit	0.9 CERpa/m2
				1.2 CERpa/m2
stove	Private	1 – 3 mio	Sold for 18\$/unit	0.41 CERpa/unit

The first low-income household oriented CDM project Kuyasa (ref 0079) is blocked since 2005, no replication appears and no CER issuance has been achieved. Perhaps because public services in Townships are politically difficult to address, also because Kuyasa argued that suppressed demand be fully acknowledged. This could also be an influence on SWH with the three competing private PoAs. Two of these are foreign funded (KfW and Standard Bank) and build onto subsidies from ESKOM that are insufficient to create an impact on household decisions.

India is the only other country with competing SWH PoAs besides South Africa, whereas most other countries do not even have a first one. Both India and South Africa have 3 competitors, but in India the carbon investors RWE and JP Morgan are competitive carbon buyers, whereas the South African investors KfW and Standard Bank do not compete at all. This is also illustrated by the carbon

investors RWE and JP Morgan contracting the same SWH manufacturer (Nuetech) in India, whereas these investors align with different CFL manufacturers against each other in that country. The South African SWH PoA are both led by manufacturers and are thus limited in scope.

South Africa is the only country where principle-agent problems seem stronger than policy interests. The SWH PoA from KfW addresses this directly by integrating insurance companies who replace faulty geysers installing SWH instead. Otherwise the omnipresence of ESKOM's supply, pricing and customer relations tradition prevent harnessing carbon finance for end use appliances.

Principle – Agent Relations Comparison

Grameen Shakti allows to design PoA so that the ME performs the crucial role for efficiency gains and therefore the carbon income sharing reflects the principle-agent relation, the principle and the agent incentive remain separate but are closely aligned (CER and firewood collection). Utilities in India and Bangladesh seem unable to design PoAs for CFLs in that manner and instead remain limited by energy policies. Without a Grameen Shakti – type organisation, the Indian context is more prone to a new principle-agent relation in the form of iHOT. There the utilities' electricity bills serve only as proof of residence. Biogas appears to be the preferred way to extend government policy with carbon finance and household conditions in the PoAs do not distinguish according to households' fuel source and costs. One way around this might be to use combinations of methodologies for each energy form in the biogas PoA instead of the generic methodology I.C. The private stove PoA in China also proposes a new methodology. Possibly the South African context does not allow to devise PoAs so that they are not isolated events such as Kuyasa and the SWH PoAs so far. The favourable factors such as the DNA and the high emission factors are not sufficient.

Of course it is not the principle-agent relations that are the cause of these differences but stakeholders, however, comparing the principle-agent relations can explain the diverse PoA outcomes observable, why some design are feasible in a context and others more difficult.

Type of Capacity Development - Increase market dynamic or modify what it does

"PoA Capacity Development demandside factors"

What carbon pays for decides where to intervene and what to offer. Pragmatic choice of support for existing market actors to satisfy stakeholders, outside-in capacity needs, for example:

- Stove - what support can Grameen and Help I. use to improve builder training
- composting - BordaNGOnet signs up villages and PT Compost palm oil plants

"PoA Capacity Development supplyside factors"

Policy objectives determine which users' intentions should appear and which new users are sought. Helping an organisation achieve its goals starts with its self-assessment leading to inside-out capacity needs to increase impacts, for example:

avoid wood collection, hot water available in household

Capacity building can address:

compost	biogas	stoves	SWH	CFL
find new entities in each country to manage composting	private + government known roles, need clear service support	how to connect to <u>existing</u> outreach organisations, technical quality training	select designs and marketing, financial terms for HHs and PoA operation	integrate CFL CDM into utility DSM, in low-income HH programs

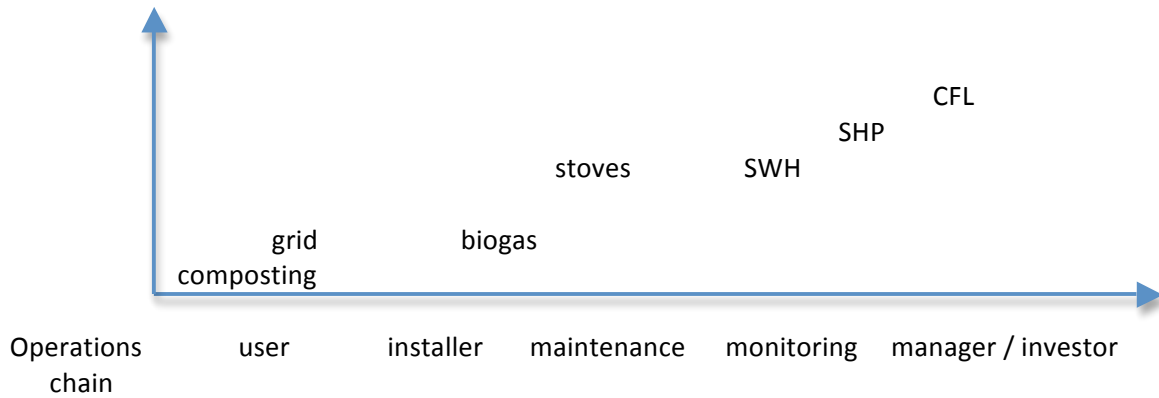
Stoves and biogas have inherent governmental roles that are not provided for in most countries. Biogas PoAs in Thailand, Philippines, Nepal and Vietnam are locally contingent solutions.

The technological characteristics of all PoA are their infrastructure properties. Typically very few producers of appliances supply to mass consumers and the information asymmetry adds to the network properties of grids, fuel, water and electricity. Natural resource endowments and social policy are major factors for the control of these network properties.

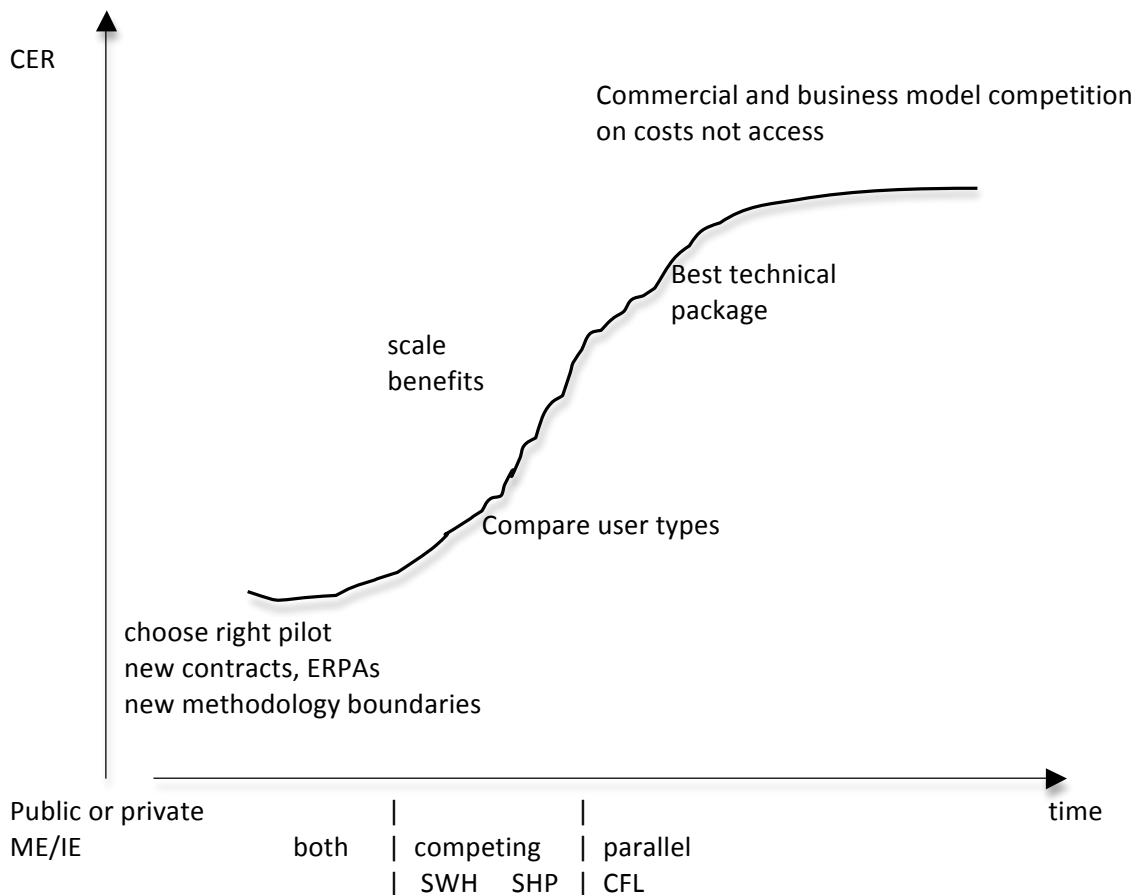
One half of submitted biogas PoA is public because fuel source and electricity sale are risky. The other half is public because users sharing biogas supply requires local credibility. All stove PoA are private because dependent on subsidies and/or PR value. Most composting PoAs are private because of novelty and lack of income. SHP private and public compete because of national state of the finance sector. SWH in India and South Africa are private but in Tunisia and Vietnam public. CFL lightbulbs are public in India and Senegal but private in Mexico and the general income levels is a main factor.

Thus for biogas and composting, the private or public question reflects who gets value and whether it is monetized. Almost everywhere there is no choice between the two solutions. This is a different group from stoves and SHP because the private or public question follows from the profitability factors. Therefore it is possible under specific circumstances to initiate a public or a private CDM and influence the other solution.

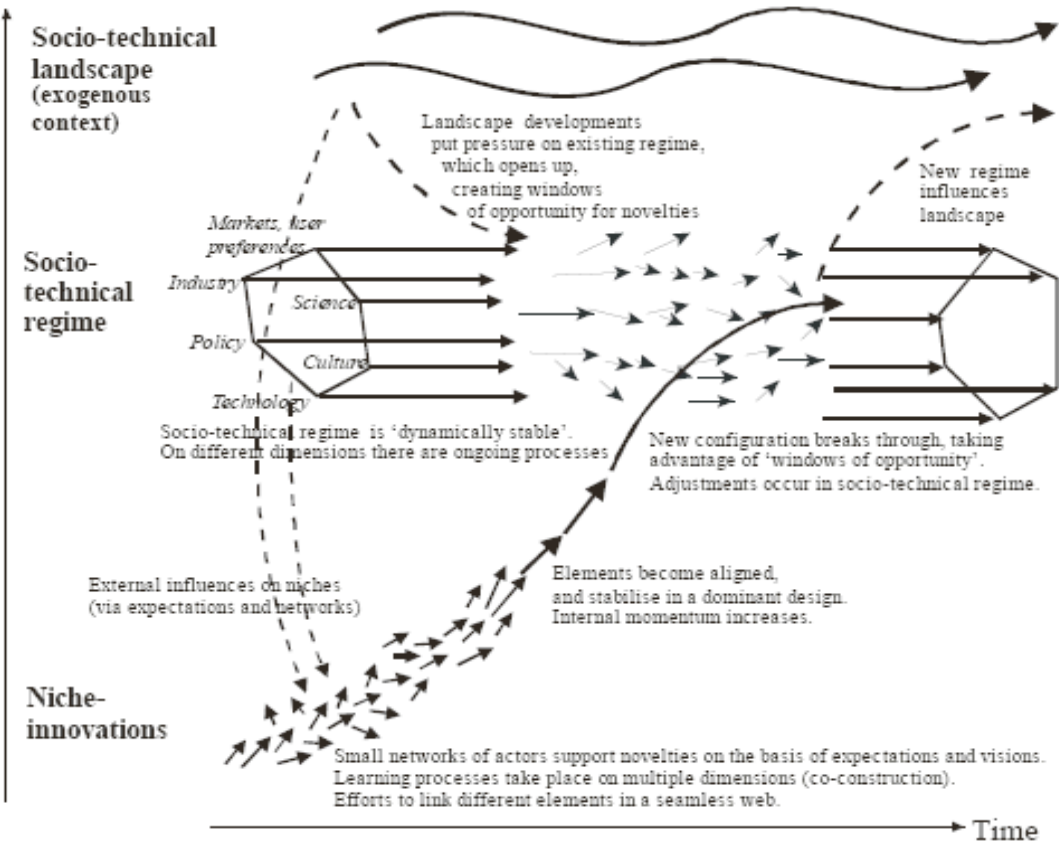
Phases in PoA evolution



PoAs are complex arrangements and the set of contracts between many types of actors is crucial. It is always possible to modify all parts of the whole but often the operations chain gets its final shape first on the user side, then installer etc., and the last part to reach its final shape is the carbon investors' role. This sequence also resembles the typical S-curve shape of product development. With increasing scale of PoAs, different tasks in the PoA design become clearer.



When PoAs bring major technological changes, the systemic characteristics of PoAs are more and more affected by the general socio-technical regime in an economy. The regime hampers the PoA expansion until the factor costs of the PoA in turn manage to affect the regime. The leading school of research for technological evolution is summarized in the graphic below.



Source: Geels and Schot 2007, Sociotechnical pathways