Available online at www.sciencedirect.com
ScienceDirect
Journal of Cleaner Production 15 (2007) 294–302
Journal of Cleaner Production
www.elsevier.com/locate/jclepro

Partnerships in creating agile sustainable development communities

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Accepted 3 February 2006
Available online 21 April 2006

Abstract

The key to clean, renewable and healthy futures for society(s) can be seen in the need to consider how all infrastructure areas such as water, waste and transportation, energy are treated. And to focus attention on the emerging commercial technologies (such as hydrogen fuel cell vehicles) that will be available regionally and then globally within the next five to ten years. Planning and investing now for that future will prove to be prudent and cost effective. Public-private partnerships, known as ''civic markets'' can create and provide ''funds'' such as public bonds along with private sector innovation and markets on the regional, state and national levels. Similar bond funds have been passed by the electorate in California, most recently for stem cell research (USA$3 billion). Public support to promote funding for sustainable communities has also been demonstrated with bond funds for water, forests and land preservation.

''Agile energy systems'' are flexible and adapt to change effectively and efficiently for economic, environmental and social benefits, the triple bottom line. However, there needs to be collaboration between the pubic and private sectors in creating them. Such civic markets can from new associations of communities, cities and nation-states that might be useful to plan public policies and create the ''government market'' in terms of procurement and coordination of public resources for renewable energy on-site and central grid power generation. One suggestion is to form an ''Association of Agile Energy Cities or communities.''

Keywords: Sustainable development; Civic markets; Partnerships; Standards and codes

1. Introduction and background

The California energy crisis and similar energy crises globally make it clear that extreme public policies: regulate versus de-regulate; public ownership versus privatization/liberalization are not the answers [1]. These simplistic economic theories provide misleading policy approaches that miss the actual realistic needs of communities and environmental concerns of society itself [2–4]. Infrastructure systems play the critical role [5]. And they must be a combination of both public and private concern, ownership, finance and operations [1,6–15]. Such an approach are known as creating a ''civic core'' and need to be ''agile systems'' that thus encourage and meet public standards, rules and companies for civic market goals such as a renewable energy portfolio standards, economic accounting for society that includes health, welfare and education as well as economic development and job creation [1].

California is a good example, since it went through de-regulation or ''liberalization'' or ''privatization''. These concepts are similar but not the same. In the USA, de-regulation has different meanings [1]. The European Union has other definitions, but basically they all mean that the major ''central power companies (known as ''public utilities'' in the USA) sold off major aspects of their power generation, including non-in-state supplies such as plants and energy contracts in nearby states. In short, the public monopolies become private ones. Today, the California Public Utility Commission (CPUC) must regulate the energy sector but in an entirely different manner than prior to de-regulation in 1996 and after the energy crisis in 2000–01.

The California legislature and CPUC must create and enforce regulatory definitions of renewable and alternative energy public policy, while emphasizing fuel diversity to benefit from State tax and renewable energy credit programs [6–9]. That is, government needs to provide private sector

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0959-6526/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jclepro.2006.02.008

incentives such as tax breaks, tax shifts, grants, feed in laws, rebates and focus on financial leverage mechanisms as matching funds for new technologies to be commercialized [1]. Above all, the public sector must help finance (public bonds for example) renewable energy technologies for local and community on-site power generation. This means in many cases, that the new advanced technologies in renewable energy as well as storage devices; hydrogen and infrastructure will need active government participation [16–18].

If the government offers incentives or mandated requirements such as with Renewable Energy Credits (RECs), Green Tags or Carbon Credits, etc., these must all be predictable in terms of length and scope if they are to have value in enticing private sector investors [19]. For example, tax credits that have to be ''renewed'' every two years are severely limiting to equity investors; though they do have significant value to project investors that can get in under the time constraint but then are viewed with uncertainty in the eyes of new entrepreneurial ventures and corporations [20]. Business markets need certainty in terms of rates, tariffs and contracts in order to be partners with the public sectors. Instead, governments or local communities must provide feed in laws or long term contracts for renewable energy generation aside from direct access and on-site power generation that create local distributed generation systems [21].

2. Agile energy systems

''Agile energy systems'' [1] are flexible and adapt to change effectively and efficiently for economic, environmental and social benefits, the triple bottom line. Formation of a new Association of communities, cities and nation-states might be useful to plan public policies and create the ''government market for procurement and coordination of public resources for renewable energy on-site and central grid power generation''. As one reviewer [22] of the book summarized it, agile energy systems have the following features, which could become the basis for the ''Association of Agile Energy Communities (A2EC)'' and contain ideas and areas of regional organization and structure such as diversity which means diversified and renewable energy sources which thus make agile systems less vulnerable to disruption and more reliable.

Another area is balance for agile systems since they emphasize the best use of energy, not just amount of power available. Balance involves promoting conservation; encourage shifting of use to non-peak times, and reducing consumption not just selling power. Most importantly, there must be local or distributed generation along with redundancy or back up from the central grid [5,23,24]. Agile systems are therefore independent yet interconnected to the power systems in regions. Hence, they find ways to avoid bottlenecks in delivery power that integrates energy, which are traditionally separated. For example, co-generation integrates electricity and heat systems. Hydrogen pairs technologies: e.g. wind-produced electricity can be stored in hydrogen fuel cells and then used for transport fuel [25,26]. More is presented on hydrogen as an on-site power storage medium for stationary and vehicle power in the following section.

At this point, note that agile energy systems are smaller, often on-site or distributed in locations close to where energy is needed and coupled especially with renewable resources. Neighbourhood scale systems are ideal because they recognize environmental costs and can be linked to the grid [24]. Hence, an agile system links the community to other organizational levels such as regional, national and even global areas, all the while being mindful of the public good as a primary goal.

Government, at all levels, needs to implement public policies that create and oversee ''agile communities.'' In short, governments must recognize the diversity of communities in terms of both energy needs but also in their sources of energy production. In every region of the world, there are different strengths in sources of energy. This paper is only concerned with energy sources that are renewable, but it recognizes that some regions have more fossil fuels than others as well. Global and world priorities must be, however, on renewable energy sources for local energy generation. Climate change and global warming now clearly dictate that priority.

Given that goal for renewable energy generation for agile communities, the focus needs to be on what regions have strengths in geothermal, biomass, solar, wind and water resources. The American Council on Renewable Energy recognized this strategy of renewable energy having its strengths based on a regional approach during the summer of 2005, when it conducted a series of ten regional meetings [27]. However, there needs to be advanced technologies introduced to provide storage and energy sources for energy. Today, new technological advances in fuel cells, flywheels, ultracapacitors and hydrogen make this goal both cost effective and doable today [28]. Below, more of these ideas on how agile communities become a reality are explored.

Government and industry sectors need to be clear, concise and consistent for market rules, standards, codes and operating protocols in order to achieve the goals of society in the civic market. Regulatory systems have provided guidance and rate structures along with incentives that can encourage new agile energy systems in California [21,29–33]. Five principles are outlined for the framework of the ''civic market'' which expresses the collaboration of the public (civic) and private (market) sectors together [34] as:

- *Oversight of existing utilities*. The traditional energy regulatory framework is close to micro-management as all aspects of the utility are regulated – for example, prices are set, specific technologies are mandated. A new model of oversight would not replace existing utilities or micromanage them, but help them move towards being agile systems by the right combination of incentives and mandates. One example is long term contracts issued by the state for renewable power and distributed power. Another is working on helping intermittent power producers use the grid for backup connections and for intermittent power. In short, the power utilities have a role in supplying back up power for communities. That role is significantly different, however, from its traditional role as the main energy generator and transmitter.

- *Transitional finance strategies*. The transition from the regulated systems to the agile system needs tools for dealing with unknowns and negative unintended consequences. The energy mess cost California by the end of 2003 at least $40 billion and continues to climb into 2005. One major public utility company went bankrupt (Pacific Gas and Electric) and the other, Southern California Edison was in receivership. Both have only recently emerged from these legal and financial constraints [29–31]. During the energy crisis of 2000–02, the State signed long-term energy contracts at inflated prices, which cannot legally be rewritten. Hence, innovation is more difficult due to these huge costs. Yet energy rates are the most significant finance mechanism for the transition from central grid to agile energy communities as they are collected and then need to be redirected for local and on-site power generation [21]. Such utility ''direct access'' rules from the CPUC would encourage the creation of distributed energy systems and buildings to develop and use renewable energy generation sources [32,33].
- *Civic-Markets*. Public ownership may not be the right solution. Rather investments from public sector pension funds would allow public influence in the new form of utilities and local agile energy systems. This is critical in setting public policy today from the CPUC for the entire state and how it impacts the local community. One of the most contentious issues is ''direct access'' whereby local communities (college campuses, shopping malls and office complexes) must all pay a ''fee'' (read penalty) to generate on-site power. This can be seen whereby government and the private sectors can provide leadership together in ''green power'' in public buildings as will be demonstrated below.
- *Innovative and advanced renewable technological systems*. Governments and businesses can develop market mechanisms to direct the market to innovative technologies through new regulations, codes and standards. The public sector needs to set these standards so that businesses know the longer-term goals for their own financing and strategic needs. Moreover, the two sectors can best work out what these goals will be rather than develop opposing ideologies that only lead to legal actions from both parties. For example, sustainable building codes as well as ''green hydrogen'' can become significant factors in energy production and material efficiencies for future planning. But government can develop other strategies including procurement, zoning, credit and tax incentives and even special privileges such as California allowing hybrid vehicles (with special markers meeting high standards) to travel in special commuter highway lanes.
- *Agile energy communities are the ''Next Economy''*. Agile energy systems, aside from providing a cleaner environment also mean new opportunities for economic development such as jobs and business development. New and advanced emerging technologies as well as environmental solutions lead to regional clean energy systems. Aside from the research and development being done throughout California, the state is emerged in its ''Next Economy'' which includes sustainable development (renewable energy technologies) along with life sciences (stem cell research), nanotechnology and hydrogen among others [35]. While the State's academic institutions lead the world in these and other areas, the new technological discoveries create new entrepreneurial companies. Private and public investments along with supporting public policies, strategies and programs mean that agile communities have become a reality.

2.1. On-site and distributed energy generation

As a key part of providing diverse energy systems, on-site generation is critical and cost effective. The contemporary concept that has captured the attention of both the business community and public are ''green buildings''. For example, the Economist [36] outlines the future energy ''grid'' when it discussed green and sustainable buildings. Renewable energy generation along with conservation and greater efficiency means that local clusters of buildings can be self-energy powered or sustainable – not needing either transported energy or grid connections:

> Today's enthusiasm for green architecture has its origins in the energy crisis of the 1970s, when architects began to question the wisdom of building enclosed glass-and-steel boxes that required massive heating and cooling systems… (Several) forward-thinking architects began to explore designs that focused on the long-term environmental impact of maintaining and operating a building, looking beyond the so-called ''first costs'' of getting it built in the first place. This approach has since been formalised in a number of assessment and rating systems, such as the BREEAM standard introduced in Britain in 1990, and the LEED (Leadership in Energy and Environmental Design) standards developed by the United States Green Building Council (USGBC) starting in 2000. The LEED standards are intended to produce ''the world's greenest and best buildings'' by giving developers a straightforward checklist of criteria by which the greenness of a building can be judged.

Agile energy communities are also ones that have power generation from central plants and regional or community systems such as college campuses, office complexes and apartment buildings [1,21,23,24] along with a central grid for back-up and emergency power supplies. One of the interesting aspects of examining agile communities globally is that new approaches and programs for renewable energy can be seen in operation throughout the world. Here the USA and California need to pay attention. For example, in Denmark, wind turbines often provide local power for farms and small communities [37–40].

However, such applications of wind for American communities have not occurred. Nor have wind generation been allowed offshore in the USA. Debates on the topic are now common in California and the New England region of Cape Cod where wind turbines have been proposed off the coast there. But larger applications of wind power, other than ''farms'' consisting of hundreds and even thousands of turbines supplying the general grid are far more common in the USA.

These systems exist in California and now mid-western states where there is open farmland and high winds. The idea is still the same however: large numbers of wind turbines supplying a grid and then being transmitted to distant towns and communities. While these renewable energy generation systems are green and sustainable, they are not agile in the sense of supplying power to homes or even clusters of buildings. Both systems need to be built [40].

2.2. Central power grid generation

The end of the fossil fuel era, which is within 20–30 years by almost all predictors, can be readily seen with the reduction of dependence upon the central power grid [36]. As Appendix A demonstrates [41], the change from central plants to more regional or on-site generation is occurring today. This ''distributed energy model'' [24] appears very similar to the ''internet''.

There is much more that can be said about this but most have that is covered in ''Agile Energy Systems'' and elsewhere. However, agile energy systems demonstrate the future will be a combination of on-site and central power generation. The future is here NOW today. Consider now finance. Where is the money for all this?

Today, the energy economic model is a ''private'' one of the older public utility. While energy companies historically were founded in communities to supply power, it was discovered within a few decades that larger power plants could deliver cheaper power over transmission lines. In America, Thomas Edison and subsequent companies founded by his partners were the epitome of this ''business development model'' early in the last century [4]. However, like fossil fuels (oil and gas) and other raw materials, these private monopolies came under strict regulatory laws from the Sherman Anti Trust Act, due to their ''under fair'' business practices. The result was a break up of the companies into what we have today.

However, under USA President Reagan and UK Prime Minister Thatcher, governments moved to ''de-regulate'' and ''privatize'' many different sectors (energy, telecom, airlines among others). The result has been a disaster in many sectors, with energy being the latest in California. In short, certain public sector monopolies, especially in vital infrastructures, should NOT be de-regulated or privatized. Other models exist such as ''agile energy systems'' [1].

The problem today is how to finance the local or distributed energy generation needs of communities? The conventional model or either a public or private energy generation system meant that funding could come from ratepayers or initial funding from bond funds (debt instruments that the public paid back through their monthly energy bills). On-site power, distributed generation or combined heat and power systems, can rely upon local power sources, be they renewable (solar, bio mass, wind or water) and not necessarily a central plant. While there are certainly central local plants that provide power for heating and cooling, there are also homes, shopping malls, and government buildings that can rely heavily on renewable or sustainable energy systems.

It is this more local and on-site power generation that will require more partnerships between the public and private sectors. It also means that the conventional energy paradigm is going to change dramatically. It may mimic the internet [41] or simply become diverse [42] and more distributed [23,24].

The future is hydrogen [43–50]. Perhaps The Hydrogen Economy by Jeremy Rifkin [43] popularized the effort to think about ''green'' hydrogen as being the future paradigm [1] to solve the world's energy problems. In any case, many scholars and now political leaders have also begun to emphasize the need for a hydrogen economy. Former EU President R. Prodi [23] led the global political agenda in 2003 and was quickly followed by President Bush the next year. However, there is a very significant difference between the two approaches.

As Rifkin put it, Prodi has called for ''green'' (renewables such as geothermal, water, wind and solar electrolysis) hydrogen and Bush has focused on ''dirty'' (fossil fuels, coal, nuclear) hydrogen [15,16]. The differences can be seen in the differences in funding between the EU and USA approaches to hydrogen. While both Nation-states claim to be allocating over $2.3 billion (about the same in EURO) to hydrogen, the USA has over 70% of the funding for dirty hydrogen. The EU has just the opposite allocation of its resources [10–14].

Then there are those who claim that it is either too costly [51,52] or is in fact not environmentally friendly [53]. Both issues have been effectively been rebuked or proven mistaken [18,25,26,44–49,54]. In fact, by the end of 2005, significant collaborations are expected by several prominent opposing perspectives on hydrogen to create a ''green hydrogen agenda'' that is both commercial and financially viable in the short term – not 25–30 years from now [18].

The issue however will be global so as to be creative and conduct research that turns into new entrepreneurial businesses. While these new technologies and businesses will need government incentives and financial support, they will be well received in the market place but both consumers and public politic makers concerned about environmental issues such as global warming and climate change. Global economic and business indicators are becoming more apparent daily as major corporations declare the need for renewable energy technologies and local power systems for both power and fuel generation and usage [55,56].

2.3. Hybrid to hydrogen fuel cell vehicles

Consider now just the transportation sector. Waste, water, and the environment are all impacted by this sector. At another time, further discussion can be given to them. However, the transportation sector is in the middle of a ''paradigm change'' [1,6,7,10–18,28,48,55,56]. As with any new technological innovation, the commercialization for the mass-market debate has begun in earnest about hydrogen fuel cell vehicles. What is critical in this debate is not to lose sight of either the end goal (a clean green plant) or the historical reality about any new technology. The key is that government be the market driver. Below I discuss finance in some degree but there are many other publications and examples. The critical path is

form public-private partnership and together figure out how best to achieve the common endgame goals.

The future is here now. And shortly (within 5–8 years), hydrogen fuel cell cars will be commercial and in the mass market [18]. The State of California is in the middle of this paradigm change [1]. Under the leadership of Governor Schwarzenegger, a Hydrogen Highway RoadMap Report [16,17] was completed (see web site: http://www.hydrogenhighway.org). Again, note that main stream journals and magazines now revolution the ''green revolution'' as being global [36]:

> There is more to the Prius than clever marketing, however. To understand why, it is necessary to look under the bonnet at the way different kinds of hybrids work – for not all hybrids are the same. The simplest kind is the ''stop-start'' or ''micro'' hybrid, which is not generally regarded as a true hybrid because it relies solely on an internal-combustion engine for propulsion. As the ''stop-start'' name implies, the engine shuts off when the vehicle comes to a halt. An integrated starter-generator restarts the engine instantly when the driver steps on the accelerator. All of this increases fuel efficiency only slightly, typically by around 10%. But few modifications to a conventional design are required, so it costs very little. In Europe, PSA Peugeot Citroën has just introduced a stop-start version of the Citroën C3, which sells for roughly the same price as a similarly equipped conventional C3.

The Economist (Dec 04) goes on to say:

> Hydrogen fuel-cell vehicles promise to be the cleanest mode of transportation, eliminating harmful tailpipe emissions altogether. But despite much publicity, and the fact that most carmakers are working on the technology, fuel-cell cars will not appear in significant quantities any time soon. America's National Academy of Sciences, which advises the government on new technologies, recently estimated that the transition to a ''hydrogen economy'' will probably take decades, since many challenges remain – in particular, how to produce, store and distribute hydrogen in sufficient quantities.

Unfortunately, however, The Economist, like many popular press outlets, did not thoroughly check both some of its resources and data. The data, for example, from the National Academy of Sciences is both limited and skewed toward American industrial interests and the data itself limited in actual fact and what international corporations are actually doing today. The time frame for Hydrogen fuel cell vehicles is more likely in 5–8 years. Finally, the pathway, as the California Hydrogen Highway RoadMap Report due by 1 Jan 05 will document must first install hydrogen power stations within 3–5 years before the number of vehicles are ready for the mass market.

In late fall of 2004, the Milken Institute in California [18] adjourned a one day ''Innovation Laboratory'' to address the issue of how to finance the hydrogen highway? Appendix B outlines both the participants and tasks that were identified. At the end of the day, a report was made from each of the six sub-working groups. From a policy paper that was released in March 2005 [18]. Basically, that paper and work with Governor Schwarzenegger's staff lead to a small amount of funding from the State legislature in the summer of 2005 to get the hydrogen highway started. Bottom line: the costs were not that high especially when public–private partnerships are formed.

3. Financing the renewable energy future

Again as The Economist noted in Dec 04, there are the conventional energy conservation programs that reduce costs:

> Going green saves money by reducing long-term energy costs: a survey of 99 green buildings in America found that on average, they use 30% less energy than comparable conventional buildings. So any additional building costs can be recovered quickly: according to the USGBC, the 2% increase in construction costs required to achieve a LEED gold rating typically pays for itself in lower running costs within two years. The traditional approach of trying to minimise construction costs, by contrast, can lead to higher energy bills and wasted materials…
>
> Green buildings can also have less obvious economic benefits. The use of natural daylight in office buildings, for example, as well as reducing energy costs, also seems to make workers more productive. …Lockheed Martin, an aerospace firm, found that absenteeism fell by 15% after it moved 2500 employees into a new green building in Sunnyvale, California. The increase in productivity paid for the building's higher construction costs within a year.

However, renewable energy generation positively impacts fuel diversity needs through the time-sensitive sequenced portfolio approach. The bi-partisan EndGame or societal goal are non-fossil, renewable energy conversion to hydrogen due to both world wide abundant supply of these and the nation-state vision to be ''energy independent''. California, for example, has plentiful supplies of renewable power sources for generation and given the energy crisis and recent experiences since then in the energy sector, the State and various regions certainly want to be energy independent.

For example, the time frame is critical as natural gas reforming for hydrogen should be seen as near term solution (3–5 years) until the electrolyzing costs (from wind, solar, water etc.) for hydrogen will be at parity with today's natural gas prices. Wind is already there and solar systems close behind. The transition to renewables is vital because future fossil fuel costs will remain difficult to control and its supply limited or located in politically sensitive regions. The hydrogen highway finance policy paper demonstrates that collaborative solutions can be found [18].

Nation-States, such as California, must start with creating ''government driven markets:'' State and Local governments need to set specifications and issue competitive contracts for procurement of clean and green vehicles (defined as anything that moves from fork lifts to golf carts to mass transit buses, planes and trains). For hydrogen, these may initially be H2 internal combustion engine vehicles, but soon to transition to

non-fossil fuel produced hydrogen fuel cell vehicles as these advanced technology(s) mature and become more commercially competitive.

Additionally, the role of government is to lead. One critical role is to mitigate ''risk''. For example, investors along the technology-maturation spectrum often interpret technology risk differently. A public-sector sponsorship of high-risk R&D will tend to see less risk than a venture capitalist, than will a project financier who wants to see well documented, technical verification and acceptance in the marketplace. VC's will accept well-defined technical risks. Project financiers, on the other hand do not like to accept any technology-based risk. Bottom line – its important for the right kind of investor to assume the kind of risk that they are expert at assuming.

One critical approach would be for government ''matched risk''. This could be accomplished in part through insurance, credit enhancement and back-up mechanisms. Another would be support for the education and training of people in hydrogen (e.g. an academic ''Hydrogen Center or Institute'') for fire and safety staff which would make California the world leader in ''intellectual capital'' and lead to research, technologies, innovations and entrepreneurial new business ventures.

California must make regulatory definitions of renewable and alternative energy public policy while emphasizing fuel diversity to benefit from State tax and renewable energy credit programs. That is, provide private sector incentives such as tax breaks, tax shifts, grants, rebates and focus on financial leverage mechanism as in the 1990s when federal funds were offered as matching funds for new technologies to be commercialized.

However, if the government offers incentives or mandated requirements such as with Renewable Energy Credits, Green Tags or Carbon Credits, etc these must all be predictable in terms of length and scope if they are to have value in enticing private sector investors. For example, tax credits that have to be ''renewed'' every two years are severely limiting to equity investors; though they do have significant value to project investors that can get in under the time constraint but then are viewed with uncertainty in the eyes of new entrepreneurial ventures and corporations. Business markets needs certainty in terms of rates, tariffs and contracts.

National facilities throughout California, such as the proposed Base Closures in 2006, are perfect public resources for implementing green and clean hydrogen stations for on-site peak load power. Regional, City and Nationally owned or controlled properties such as facilities from Departments and Agencies for Transportation, Environment, Natural Resources and Energy can be used as hydrogen power stations now (next 3–5 years) and thereafter converted to hydrogen refuelling stations within 5–10 years [25].

Public-private partnerships can create and provide ''bond funds'' on the regional level and much like the similar bonds in California and elsewhere for the public to support and promote funding for hydrogen. Perhaps there needs to be a ''Hydrogen Finance Authority''. Consider also the possible use of ''Intellectual Property'' rights gained by the national, regional or local bond or government grant financing as an economic development incentive mechanism.

Technology also must be advanced through matching goals and appropriate public-private collaborations from national, state and regional departments and agencies such as Energy, Defence, Education, Labor and EPA for R&D focusing on systematic analysis, demonstration projects, and prototypes to determine where the greatest impact can be achieved for near-term medium to high risk research. New technologies must have more demonstration and prototype system models that can be turned into commercial and retail operations. Examples of near term commercial applications are fuel cell forklifts, buses as in the European Union program, or fleet vehicles as in Japan.

Finally, societal benefits need to include not only quantitative health and social costs, but also focus on job creation and new business ventures. The creation of new positions in public school teachers, training for fire and safety areas of hydrogen which stand out as key areas for any region or community to take leadership positions both nationally and globally.

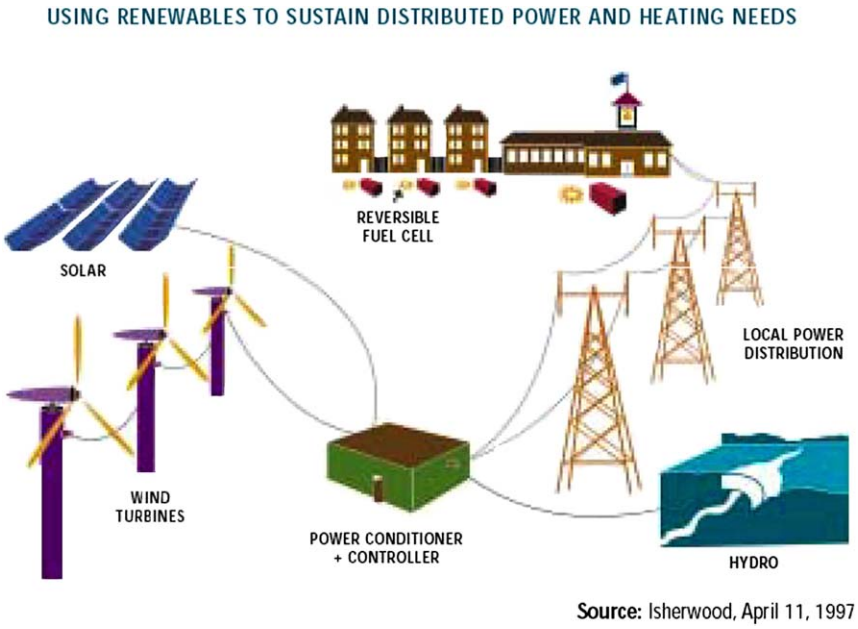
4. Conclusion: an Association of Agile Energy Communities (A2EC)

Agile energy communities are a threat to the established approach to governance. Nation-state tends to want to control and centralize power and authority. The traditional energy (and other sectors such as water, waste, environment, etc) infrastructure as it development in the 20th Century became more administrative and focused on central power plants. To be fair, the development of renewable energy sources was slow and costly until only the last decade. But the administrative and political conventional power plants exist today and with de-regulation or privatization have been transferred (sold) from public sector control to private sector companies. The result has been both chaos and outright financial ruin. To move energy from the public sector oversight to private sector monopolies is a classic economic mistake.

Instead, local and regional energy sources need to be created, leveraged and combined with new technological advances to create agile communities. Such communities should provide local power to clusters of buildings and to individual homes, businesses and office complexes as well as shopping streets and malls, colleges, public buildings, and apartment buildings among others. This model works and exists globally. There are corporations who work in this area and associations, which provide data and information.

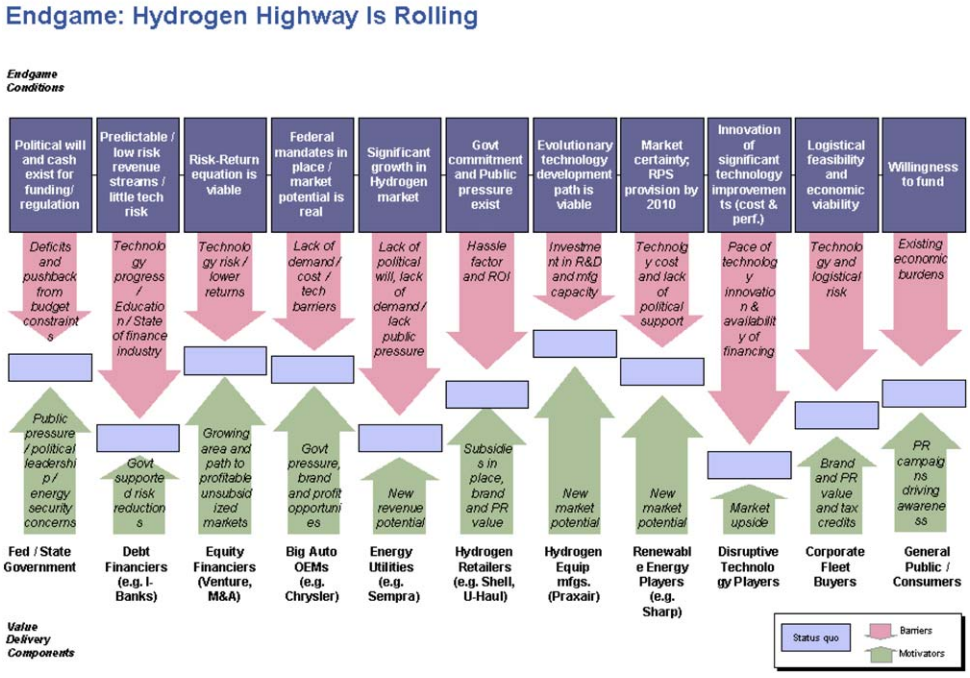
In the end, agile communities must also develop waste, water, transportation and telecommunications for their regions. These communities need to be interconnected with other communities, which redefine the conventional central power plants that exist today. The historical role of central energy plants must change. Downsizing, providing back up and redundant power among other things, is a new and different role for ''public'' and now ''private'' utility companies. Today, the immediate transition to the agile communities will be difficult and painful (smaller companies mean reduced workforce and income) but necessary for a less polluted environment and cleaner world for tomorrow.

Appendix A. Distributed energy generation (Source: [5])



Appendix B. Financing the hydrogen economy (Source: [18])

Endgame Graph
From Cross Cutting Panel
Copyright
Monitor Group



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