Distributed Renewable Energy and Conviviality

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Abstract – **In this paper distributed renewable energy generation (particularly multi-agent systems) is compared to other modes of generation and analyzed from the broadest context of sustainability. The article is focused on Ivan Illich's concept of conviviality.**

Keywords – **Conviviality, Distributed electricity generation, Multi-agent systems, Sustainability.**

I. Introduction

Engineers and other specialized professions tend to observe phenomena in a narrow sense from the point of view of problems they usually face in their work. This article is an observation of distributed renewable energy generation (multi-agent systems as examples) and comparisons to other energy generation technologies.

II. Conviviality

Conviviality is in the meaning used in this paper mentioned by Illich [1]. It means creation of a "friendlier" society focused on solving and easing of people's problems rather than eternal growth as a measure of any success. Illich recognizes two watersheds or possible phases in development of an institution and infrastructure. The first (earlier) watershed is when there is a need for dealing with a specific problem. The second watershed is when an institution developed during the first stage gets big (this tendency is partially driven by an assumption that the eternal economic growth is necessary), when its inertia is too big for it to respond to changing circumstances (Nooteboom [2], Lund [3]), and when the people actually serve it more than it serves to the people. Radical monopoly [1] is when a specific approach to education, health, transportation, and others (e.g. energy) is taken for granted as the only way to get things done. It is based upon sparseness of knowledge and different professions and organizations and institutions trying to establish (and then protect) their prestige as important for the whole society. As a measure against these tendencies Illich also suggested deschooling [4] (knowledge and its availability rather than hiding behind diplomas and societal positions).

There are six principles in building a network to change a system [5]:

1. Start by understanding the system you are trying to change.
2. Involve both funders and nonprofits as equals from the outset.
3. Design for a network, not an organization – and invest in collective infrastructure.
4. Cultivate leadership at many levels.
5. Create multiple opportunities to connect and communicate.
6. Remain adaptive and emergent – and committed to a long-term.

These principles should exist as much as possible on all levels including the strictly technical part. In the context of PowerMatching City and EcoGrid (described later in this paper) this means that, with providing technologies needed for a more effective use of distributed and distributed renewable energy, they are also "Trojan Horses" [6] needed for a wider approach toward a transition into a (hopefully) more sustainable society. In order to create a network with a looser hierarchy and more adaptable network, engineers and managers should also bear in mind how these technologies are introduced. It seems to the author of this paper that they should be open source as much as possible. A really sustainable technology or societal "design" [6] means that it won't be an obstacle for future development and that there won't be a need for a drastic ad-hoc redesign. Agent societies, opposed to centralized organization, in principle seem to be a tool for conviviality needed to provide a context around which a network (rather than organization) committed to a long term can develop. What we need to understand is that distributed (renewable) energy should not be just another opportunity for big globalized business with enormous profit in hands of a limited number of people (still a mere definition of success in the modern world). This is a unique case where an actual technological network of agents (described later in the paper), if successful, resembles a societal network described above. This is exactly what is described by Hill [6] when he mentions that the way a specific instance is being designed has to bear in mind the next wider system, different time intervals needed for specific parts of the system to be developed (new agents can be added and removed at will, individual components can be improved over time). In case of long-term thinking it seems there should be a more open source (in order to avoid radical monopoly, sparse knowledge, and too big reliance on success and failure of a specific company, especially when companies existing in the free market tend to last shortly) approach and willingness to share and cooperate.

In order to create a strategy that can work both now and in the future (anticipation [7]), one needs to understand what is happening in the global situation at the moment and what future tendencies are. A "Black Swan" [8] is an unplanned event that drastically changes society and economy and makes projections (inductions) about the future pointless. Also, such an event is usually relatively simple to explain after it has happened. The current financial crisis is an effect of temporally spread events and it looks very much like a series

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of events predicted by Illich [1]. Radical monopolies combined with the second watershed within many businesses and institutions will, according to Illich (and it seems that he was right), as long as people do business and politics in the usual way, cause a very deep crisis – not an economic, but a crisis of the industrialized society itself. Distributed renewable energy with its long-term focus must not be just another opportunity for making profit or one more radical monopoly prone to the first and second watershed. It should be an important component for transition toward a more sustainable society.

The role of renewable energy is to provide a supplement for something that already exists and there is a big need for systems thinking [9]. Unexpected dynamics is "expected" and there are very long chains and complex interactions between causes and effects. In order to deal with complexity, a solution also needs to be complex [7].

Tools for conviviality are methods and technologies and ways they are used within the socio-environmental in order to prevent society as we know it to become irreversibly non-functional. Non-convivial tools might cause dramatic changes in the global society and its collapse (there is a similar approach by Tainter [10]). Differentiation between convivial and non-convivial tools, besides the fact that such a quality can hardly be put into parameters and numbers, is very difficult especially with specialization in the modern society in which competition and profit are the very definition of success.

The new economy is a concept that was popular in economics at the end of 20th and beginning of this century. The main focus was on the internet as a new way of making profit. As an unplanned outcome of that technological bubble (an innovation attractive for new investments in research in development that eventually doesn't result in expected profit) is the world becoming "flat" [11]. Instead of focus on profit, the new economy also provides new networks and connections. For instance, let's use here an example of virtual social networks. Myspace [12] has appeared as the first social network and it was a platform for emergence of Youtube and Photobucket. Facebook has come later. The designers have failed to recognize the power of networks and interconnections. When they noticed the fast growth of Youtube, at first they had blocked it on Myspace and later, because complaints from its users, withdrew their decision. At the beginning Myspace was bigger than Facebook because it was focused more on creative people (willing to try something like a virtual social network before the rest of population) and had a better search engine and better features for design of individual websites. Facebook was from the beginning focused on everyone (not just creative individuals) and real-life networks of friends (those we know what we can talk about and share) as the first reason why someone would join. This "detail" hasn't been recognized by the creators of Google+ (created with intents to destroy Facebook, regardless of what Facebook members think about such an idea). Also, the creators of New Myspace (an answer to a big migration of people from later made a fatal mistake: they created a totally new social network and, instead of upgrading the old Myspace with a new design, decided to ignore all networks and contents already existent there. The success of a network depends much more on the larger context than on its esthetic appeal and functionality of particular components. It is not such a tragedy (if we ignore the lost opportunity to create something akin to the Global Brain) if these things happen in the realm of virtual friendship as it would be in the energy sector. Infrastructure cannot tolerate such missteps and a lack of will to collaborate when needed. A really sustainable approach to a technology should last for a long time in all possible future changes in the social context (preindustrial→industrial→postindustrial→ …), technological improvements, and environmental, economic, and managerial crises.

III. Centralized and Distributed Energy Generation

A supergrid is a centralized example of renewable energy. This concept is focused on centralization. For instance, wind always blows somewhere and larger geographical areas can provide smoother characteristics of interconnected wind turbines. Also, supergrids could provide energy transmission and distribution from areas rich with wind to areas with big demands for energy. On the other hand, supergrids can in the stages of building and maintenance be time and money consuming (Perhaps "too big to fail" is actually just "too big".) and face uncertainties in the process. The main reason why an idea about a supergrid should be rejected is probably when energy is supposed to be generated on a territory of one nation (presumably from the "Third World") in order to be consumed by another nation (presumably more economically strong and insisting on keeping this status) because such an arrangement would for a reason look like colonization. Distributed renewable energy and utilities smaller than supergrids could improve their characteristics if combined with other technologies [13] such as combined heat and power (CHP), vehicles to grid, and smart grids. There are pros and cons in both approaches (bigger vs. smaller utilities), but the centralized option (besides the fact that it is preferable in business as usual) should be chosen only in cases when it really is superior because of its aforementioned characteristics.

Energy, regardless of its portion in the gross domestic product (GDP), is very important in the modern society and economy. The economic growth in recent times is driven by energy. Energy will also be needed in order to provide a relative economic stability in the future. Electrical energy will particularly be important as machines and vehicles switch from fossil fuels. When (and if) the global society begins taking sustainability more seriously, the transition towards renewable energy and the way it is achieved will play an important role. Renewable energy is not supposed to provide a necessary amount of energy, but rather to achieve the new "status quo" (an amount of energy perceived as necessary) which is an outcome of the economic growth fueled by relatively cheap fossil fuels. Even though we tend to take some of its aspects, the modern global society is designed in a very specific way. Business persons interested in renewable energy will, while succeeding or failing in their work,

significantly contribute to writing a new story or "myth" necessary for people to collectively define a more sustainable future. This means how they will interact with local communities and other business processes, what will motivate them (profit or something else) to continue their work, and how they will (or not) share their knowledge and collaborate. Different approaches to sustainability should converge in the future and support each other. Anticipation (reaction to future events) is preferred to reaction to the past. While business as usual is focused on profit, sustainability of the future society, if it happens, will be focused on a combination of energy efficiency, interactions, and energy generation mix. The sustainable future will be difficult to quantify, but also more real than the still present "Ponzi scheme" (short-term thinking and ignorance of the future and limits to growth) nowadays known as entrepreneurship. Complexity in a society is a result of problem solving. Both organizational complexity and the number of different components within a society are outcomes of accumulated problem solving over time. Precisely defined and big organizations (Such as supergrid?) are prone to problems with inertia (a lack of adaptability) and diminishing marginal returns (the main reason of past societies failing and collapsing). The chosen approach to renewable energy must not be a cause of future societal degradation and diminishing marginal returns (for instance because of too big bureaucracy developed for its implementation and regulation). Some obstacles to a bigger penetration of renewable energy into the energy sector are price (especially if the price of fossil fuels doesn't take into account their limited amount and effects on the environment), capacity credit, variability, and the inertia of power networks.

The Big Infrastructure [14] model is an outcome of specific socioeconomic and technological contexts from the past. A traditional approach uses aggregated load forecasts and is focused on centralized costs and a distributed approach is focused on local conditions and generally shorter distances between generation and consumption. The idea that many customers will result with a smoother and more predictable load has a limited value for a really big number of customers when each new customer contributes proportionately less to the peak load. It is doubtful how much the size in big systems can contribute to marginal costs of electricity generation. Also, there are reports about blackouts and there is a need for administration (with doubtful results) in big systems. Huge generating units under construction can consume a lot of time and money. This is especially important for renewable energy utilities in which expenses are concentrated in construction and maintenance and less electricity generation itself (they work on freely available energy resources rather than fossil fuels). This aspect can be especially problematic for prediction of future demand for electricity [14] if a power plant, once built, is too big. Renewable energy components such as individual wind turbines and photovoltaic are modular, meaning they can be added and dismantled one by one and this characteristic makes them different from conventional power plants. Big renewable power plants would resemble conventional power plants in their relatively reduced modularity and risks of large-scale blackouts. On the other hand, in order to have the access to more fine-grained information about the system there is a need for advancements in information and control technologies. For making decisions (which approach to choose) in this context it is not enough to apply the "engineering method" [14] (the old method used for dealing with new and drastically different problems) that approaches to this challenge as to an isolated system with controlled variables.

There is a difference between complexity and complicatedness [15]. Complicatedness (a big number of components) doesn't necessarily result in organizational improvements. The new organizational structures more functional under new circumstances (if this happens) will emerge as an outcome of information quality (including the access to information – the approach to the new economy described in this article). This time the crucial component of the next transition (compared for instance with industrialization and resources exploitation from the past) is very difficult to assess (or even perceive as important) across the whole system, even more so if the system is ever-changing.

IV. Multi-agent Systems

A relatively new (especially for real-life applications) approach to information and control technologies that could be used distributed electricity generation are multi-agent systems (MAS). Agents can also be used for distributed restoration of the power system in order to overcome the computational complexity and shorten the restoration time. Agents [16] are special autonomous software components used for simulation of human decision making. They cooperate with humans and other agents in order to achieve specific tasks. Important parts of their behaviour are communication and negotiations during which they make decisions needed for problem solving. Coordination between them is made by various approaches such as organizational structuring, contracts, and planning. During the process the agents are asked whether they can and "want" (artificial intelligence) to perform actions and they send messages about their decisions. The FIPA standard is used for communication between different agents and any multi-agent system needs to obey it. Sometimes agents are designed from scratch and there are also a number of multi-agent system platforms such as JADE and JASON [17].

PowerMatcher [18] is a multi-agent control concept for distributed generation. It is based on market-based control in which many agents negotiate and trade on an electronic market. The idea behind is a unification of microeconomics and control theory in a multi-agent theory. Dynamic pricing is used in order to handle scarce resources (matching supply and demand) when needed. With flexible energy demand [19] variable renewable energy becomes more competitive. Applications of PowerMatcher are EcoGrid, both used in real-life test beds [19].

One possible complaint about PowerMatcher would be that it is a multi-agent system built from scratch. JADE (Java Agent Development Framework) is a currently very popular freeware platform for agents. Perhaps in order to create a context for popularization and future research and

development of PowerMatcher it should have been better if it had been created for instance on JADE [16], especially because there is already a lot of third-party software developed in order to improve its performances (see social networks in this article). Also, since the main goal of PowerMatcher is sustainability rather than radical monopoly and accumulation of profit in hands of a limited number of people (the same mechanism drives companies to both temporary successes and short lifetimes), pros and cons of at least limited open source should be considered. The virtual infrastructure (the backbone of the hypothesised new economy) will differ from its physical counterpart in its lifecycle and interactions with the rest of the system. A wrong approach to this emerging scientific theory should not stand on the way toward long-term decision making and sustainability.

Another approach similar (also a multi-agent algorithm) to PowerMatcher is suggested by Mets et al. [20]. It uses historical price information and is focused on maximization of renewable energy generation or reduction of loads for externally supplied power.

In this paper distributed renewable energy (particularly multi-agent systems is analyzed as a possible tool for conviviality (the term used by Ivan Illich) or sustainability in a broader context which includes society, organizations, and institutions. This technology is compared to other energy technologies and between different approaches to distributed electricity generation. The focus is on structural similarities between Illich's approach to conviviality and structures of multi-agent systems. This work does not provide definite answers on the subject, but it does mention hints and possible challenges in the context of networks and interactions.

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