NJ Board of Public Utilities
EMP Innovative Technologies
Working Group

Energy Master Plan (EMP) Working Group Recommendations on the Four Questions Related to Innovative Technologies and their Relationship to Energy Technology Needs in the State of New Jersey

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19 September 2011

To: Lee Solomon, President, New Jersey Board of Pubic Utilities

From: The BPU EMP Innovative Technologies Working Group

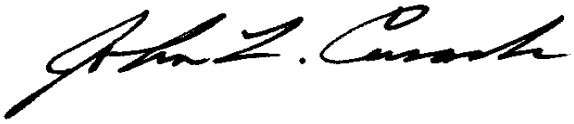
Date: 19 September 2011

Subject: NJBPU EMP Innovative Technology Work Group- Task Assignment

In response to your request to comment upon four key questions regarding the development and commercialization of innovative energy technologies in the State of New Jersey, we are please to submit this report to you, and welcome any comments or questions that you or your fellow Board members may have.

I would like to thank the members of the Innovative Technologies Working Group for their work in helping assemble these responses to your questions. I would point out that all information presented here in response to these questions represents our personal opinions, no the opinions of the organizations that we work for, and have been assembled through an extensive process of Working Group meetings and discussions. However, they are no means comprehensive in nature, but rather a quick overview of the questions posed to the Working Group. We did not always agree on every issue, but I do believe we achieved a wide consensus reflected in the text of this document.

Sincerely Yours,



John L. Cusack, Working Group Chair,
on behalf of the Innovative Technologies Working Group

The New Jersey Board of Public Utilities (NJBPU) is seeking the recommendations of the NJBPU EMP Innovative Technologies Working Group on the following four questions related to Innovative Technologies and their relationship to Technology Needs in the State of New Jersey:

1. Given New Jersey's entrepreneurial and academic prominence what technology areas do you see our state focusing on related to energy efficiency, generation and storage?

2. Can you provide recommendations regarding the near term viability of the following technologies contributing to NJ's energy infrastructure?

Fuel Cells
Tidal
Storage (pumped hydro, thermal, compressed air, flywheels)
Smart Grid
Smart Metering
Others?

3. What role can/should a business incubator network serve in facilitating the development of these and other technologies, how should it be structured?

4. Are there specific regulatory or legislative barriers to development of innovative energy technologies?

The answers to these four questions are contained in the following short Report summarizing the comments, discussions and analysis made as part of several meetings of the Innovative Technologies Working Group over the past three months.

***Question #1**:*
Given New Jersey's entrepreneurial and academic prominence what technology areas do you see our state focusing on related to energy efficiency, generation and storage?

Working Group Response:

Methodology of Answering this Question:

Because of the time constraints and other obligation of the Working Group members, we decided to adopt an expert panel analysis matrix approach, where members of our Working Group would fill in a Technology Assessment Matrix that listed the energy/environmental efficiency, generation and storage technologies and solutions that are of interest to NJBPU and the Working Group experts on one axis of the Matrix, and listed the potential key areas of impacts of, and on, those technologies, across the other axis.

The Working Group agreed that the following six impact/value categories should be listed in the Matrix:

Impacts <u>of</u> the Technology on Key Sustainability Issues (i.e., environmental, social and economic impacts):

- The Environment
- Society (including jobs)
- Economic Development

Impacts <u>on</u> the Technology from Regulatory and Development Issues:

- Regulations and Policy
- Research Investment
- Business Incubation

During our initial meetings, the Working Group added a number of technologies/solutions to the list suggested in the NJBPU's question #2. Here is the list of the technologies/solutions, grouped in five sub-group categories:

Energy Efficiency Technologies (9):

- Advanced Metering
- Advanced Building Automation & Controls
- Energy Monitoring Systems & Management
- Grid Integrated Auto Switching for Distributed Generation
- Energy Audits
- Demand Response technologies
- Monitoring-based Commissioning
- LED Lighting
- Direct Load Control

Energy Efficient Building Technologies (3):

- Mass Wall Building
- Weatherization
- Energy Recovery Ventilation

Renewable Energy Technologies (11):

- Tidal Power/Micro Hydro Power
- Wind Turbines
- Solar PV
- Solar Thermal
- Geothermal Heat Pump Systems
- Biomass Waste-to-Energy Systems
- Bio-fuels
- Fuel Cells (Natural Gas)
- Hydrogen Fuel Cells
- Large Scale Cogeneration Plants
- Nuclear

Energy Storage Technologies (7):

- Pumped Hydro
- Thermal
- Compressed Air
- Thermal Adsorption
- PCM
- Chemical Thermal Storage
- Fly Wheels

Other Solution Approaches (3):

- Increased Education, Awareness & Training of students/citizens
- Testing & Verification by Independent 3rd Parties
- Market Development by (NJ) Government Purchasing

We then asked Working Group members to fill in that Matrix, using a "High", Medium", "Low" answer approach that was then converted into numerical scores. The total scores were added so that each technology/solution had a total score, and then the technologies were rated from top ("1") to bottom ("33") within the list of all 33 technologies/solutions, and also ranked in order within the 5 sub-groups.

The results of that analysis are shown in Table 1, "Overall Technology/Solutions Ratings & Rankings", presented below.

Table 1 - "Overall Technology/Solutions Ratings & Rankings"

Category	Technology (smart grid solutions noted as SGS)	Description	Impact of Technology on:			Impact on Technology:			Totol Score	Rand in class	rank amon all
			Environment (high = good,	Society (jobs..) (high = good,	Economic Dev (high = good,	Regulations (Policy)	Research Investment	Business Incubation			
Energy Efficiency (9)	Advanced Metering (SGS)	automatic collection of consumption & status data, diagnostics, from water meter or	48	33	25	45	30	30	211	2	5
	Advanced Building Automation and controls (SGS)	digital, automated 2-way controls for devices in bldgs	48	40	33	35	30	25	211	2	5
	Energy Monitoring & mgmt (SGS)	technology to enable utility bill tracking, real-time energy use reading, building simulation and modeling, carbon and sustainability	48	38	33	45	38	30	232	1	2
	Grid Integrated auto switching for DG (SGS)		35	20	20	30	20	20	145	7	27
	Energy Audits		30	36	31	34	22	22	175	4	17
	Demand Response (SMG)	Shave peak load which cuts dirty generation use and capital costs	41	26	26	31	27	17	168	5	21
	Monitoring based commissioning (MBCx)		25	15	15	16	11	11	93	8	31
	LED Lighting		40	30	25	30	21	21	167	6	22
	Direct Load Control (SGS)		20	10	10	10	10	10	70	9	33
EE - Bldg Technologies (3)	Mass Wall Building	Bldg enclosure combining thermal	45	33	33	33	30	25	199	1	10
	Weatherization	Reduces amount of energy consumed, which makes renewable energy a larger % of energy supply	35	35	25	25	20	20	160	3	24
	Energy Recovery Ventilation (ERV)	Fan activated recovery system with no loss to the HVAC system - to supply fully filteretd conditioned fresh air to the building 24 X &.	40	30	25	25	25	25	170	2	19
Renewable Energy (11)	Tidal Power/Micro-hydro		40	35	35	38	35	30	213	1	3
	Wind Turbines		38	35	35	38	33	21	200	3	9
	Solar PV		43	40	35	35	33	26	212	2	4
	Solar Thermal		43	40	30	35	28	20	196	4	11
	Geothermal heat pump systems		35	30	30	40	35	25	195	5	12
	Bio-mass (Waste to energy)		40	33	35	31	30	21	190	7	14
	Bio-fuels	Including bio-reactor concept	33	35	30	26	35	25	184	9	16
	Fuel Cells	Use natural gas fuel cells as backup power and as storage mechanism for off peak power	40	31	30	30	30	28	189	8	15
	Hydrogen Fuel Cells	Reverisble fuel cells for off-peak storage in form of hydrogen	40	35	30	30	30	28	193	6	13
	Large-scale cogeneration plants	use of a heat engine or a power station to simultaneously generate both electricity and useful heat	35	30	30	38	21	17	171	10	18
	Nuclear		16	16	25	16	23	6	102	11	30
Energy Storage (7)	Pumped hydro	type of hydroelectric power	30	26	25	35	30	17	163	2	23
	Thermal	Princeton water thermal project	30	30	25	25	25	20	155	3	25
	Compressed air	PSEG and other pilot projects	30	25	25	31	33	25	169	1	20
	Thermal Adsorption		15	15	15	15	15	15	90	7	32
	PCM	Organic, Inorganic, Eutectics & Hygroscopic materials	20	20	20	15	20	15	110	6	29
	Chemical Thermal Storage	Use of Fuel cells	20	20	20	15	28	23	126	5	28
	Fly wheels	Beacon Power	30	25	30	25	25	19	154	4	26
Other, Infrastructure dev, etc. (3)	Increased Education	Colleges, universities, school	45	40	35	35	26	26	207	3	8
	Testing & Verification by Independent third parties	Colaboration with NJCAT and higher education	48	35	38	38	38	38	235	1	1
	Market devopment by NJ (Govt) Purchasing	Encourage life cycle costs instead of initial capital costs	45	40	35	35	30	26	211	2	5

The top ten highly rated overall technologies/solutions therefore were:

1) Testing & Verification by Independent 3rd Parties
2) Energy Monitoring Systems
3) Tidal Power/Micro-Hydro Systems
4) Solar PV
5) Advanced Metering
(tie) Advanced Building Systems and Controls
(tie) Market Development by (NJ) Government Purchasing Policies
(8) Increased Education, Awareness & Training
(9) Wind Turbines
(10) Mass Wall Building Systems

Besides the Matrix Analysis, the Working Group also wanted to comment that, in general, smaller scale, distributed generation, storage, renewable energy and energy efficiency systems were more likely to be commercialized quickly, and have a larger impact in both the short- and long-run, than larger traditional technologies that required large sites, extensive permitting, and very long lead times to reach implementation (one of the reasons that nuclear energy finished 30 out of 33 technologies in the Rating Matrix.) The Working Group felt that small scale systems could be quickly implemented with the correct support and incentives from the State of New Jersey, and create the most jobs, new businesses and economic activity within the state.

Therefore, the Working Group would suggest that highlighting and prioritizing the top 4-5 technologies in each of the sub-sectors of Renewable Energy, Energy Efficiency and Energy Storage should also be considered by the State, in addition to the top 10 list of all technologies/solutions.

Question #2:
Can you provide recommendations regarding the near term viability of the following technologies contributing to NJ's energy infrastructure?

Fuel Cells
Tidal
Storage (pumped hydro, thermal, compressed air, flywheels)
Smart Grid
Smart Metering
Others?

Working Group Response:

Using the analysis inherent in the Technology Assessment Matrix in answer to question #1, the Working Group looked at comparing the average ratings of the one Smart Metering technology, three Smart Grid technologies, the one Tidal/Micro Hydro Technology listing, the 7 Storage technologies and the two Fuel Cell Technologies that are in Table 1.

The results are summarized below in Table 2- "A View of the Near-term Viability of 5 Key Technologies", along with comments on these technologies made during our Working Group meetings.

Table 2- "A View of the Near-term Viability of 5 Key Technologies"

Technology Group	Average Matrix Score	Comment
Tidal	213	Near-term viability high, but limited number of suitable sites in New Jersey.
Smart Metering	211	Could have great impact, but question of rapidly changing technology & who will pay could hurt near-term viability.
Smart Grid	196	Could also have great impact, but needs to be integrated with smart metering and distributed generation to be viable in the near-term. Also who pays is an issue.
Fuel Cells	191	Fuel cells have been in use for several years in NJ, but reliability and maintenance issues have hurt their near-term commercialization.
Storage	136	Very important, especially to balance renewable energy generation with demand, but large-scale use is more viable in medium-term. Small-scale storage could be potentially implemented more quickly.

To summarize these comments, Tidal Power should be encouraged for the limited sites available, Smart Grid and Smart Metering technologies should be looked at together and have a potential to reduce energy losses and improve New Jersey's energy efficiency, Fuel Cells need to be able prove that their long-term maintenance costs can be significantly reduced in newer versions, and Energy Storage may be viable in the near-term for small-scale applications (such as plug-in Hybrids that can feed the grid, or using fuel cells for both storage and backup power) but larger-scale storage approaches either need more technology development work (flywheels) or have site location and permitting problems (like pumped storage).

The Working Group's thoughts on the "Other" category is essentially reflected in the expanded list of 33 technologies/solutions that the Working Group had developed and put together for Table 1 on page 5.

***Question #3**:*

What role can/should a business incubator network serve in facilitating the development of these and other technologies, how should it be structured?

Working Group Response:

The following are summaries of the key points made by individual Working Group Members to this question:

- There are a number of key factors that determine success in establishing and operating incubators. Business incubators are more likely to be successful if they are supported by a broad partnership that includes both public and private sector sponsors and stakeholders, including research institutions, venture capitalists, support service companies and technology users. Notably, the ability to leverage private sector contributions, whether in the form of finance or other types of support (e.g. technical and marketing expertise, access to facilities, access to investors) is critical. Another critical factor in the success of every business incubator is its staff, who must be entrepreneurial themselves and be very qualified to both help the companies grow, and to handle the incubator's own business functions.

- Perhaps following the model used by the Clean Energy Alliance (in which NJ has three of the 12 partners; NJMC, Rutgers Eco-Complex and NJIT-EDC) would assist the incubators to be commercially successful. The structure necessary to facilitate the development of these technologies considering the complexity and players involved in the energy market is also complex and not cheap. Thus, everything revolves around funding and accountability. Seed funding from the State is a must and perhaps a plus to get a substantial involvement of private investors. Protocols for accountability and thorough technical/commercial evaluation of where to put the money while minimizing bureaucratic expenditures and unnecessary delays to commercialization are also a must. The involvement of third party technology evaluation agencies should be considered as part to the technology incubator daily operations.

- A business incubator network should promote the advancement of energy technologies by providing the technology companies with the appropriate regulatory requirements and funding sources that exist in NJ that are important to commercialization of the respective technologies. The incubators should, through a PPA or MOU, be linked with either a State supported center or State approved institutions, which will be used as the demonstration site(s) for evaluating the performance of the respective technologies. In addition, the performance claims of the technologies must be verified by an independent third-party entity such as NJCAT.

- The best role would be to provide advice and counsel, screen technologies on the basis of feasibility and potential, and provide a support platform for innovation and new concepts – be it a new use of existing technologies, or the development of new technologies. Incubators can be very helpful in moving science and technology off of the shelf and out of the laboratory and into implementation and the incubators should work with companies involved in the energy business that can either use or will produce the technology. The incubators and/or NJBPU should support the work that is being done in the field or in pilot programs, and should ensure that the technology is sufficiently verified so that it can meet regulatory requirements and market needs.

Incubators will need some sort of continued and expanded economic support from the State of New Jersey, either through the NJ Economic Development Agency and/or the NJBPU, to be financially viable, a corporate tax deduction for companies that work with incubators would be one mechanism to get the incubators financed.

- While several of the developers of emerging and immature energy technologies reviewed by this working group could possibly benefit from a business incubator network, significant research and analysis is needed before any definitive decisions could be made in support of this approach. Therefore, a reasonable recommendation would be to explore this concept through other means outside of this working group, perhaps in a partnership between NJBPU, NJDEP, NJCAT, and the New Jersey Business Incubator Network. Relationships should also be built with energy and environmental incubators in adjacent states (and their funding agencies and supporters), as there is no sense in re-inventing the wheel 2-3 times within a few hundred miles of each other.

- Solutions to global problems like climate change and fossil fuel use may require technical, regulatory and business partnerships with business incubators that extend well beyond the boundaries of the State of New Jersey to a regional, national and global level. The work of the global Greentech Cleantech Cluster Association (GCCA) across 15 countries and 8 US states, or the 41 business incubators in the Business Incubator Association of NY State, might be a good starting point for partnership discussions.

Question #4:
Are there specific regulatory or legislative barriers to development of innovative energy technologies?

Working Group Response:

Here is a summary of the responses of the Working Group's individual members to this question:

- One of the goals of energy technology has been to deliver benefits to all customers through innovation on the grid. These innovations will enable the offering of more choices and lower costs to customers as well as creating a more efficient and more reliable electricity network. The regulatory and legislative process should encourage innovation and recognize that technology will play a larger role in our energy future. As this technology is deployed, utilities should be allowed to recover their reasonably incurred expenditures for the implementation of any programs and policies prescribed by policymakers.

- In order for energy technology to achieve its potential, it must be recognize that capital investment in infrastructure to support, among other things, transmission and distribution system reliability, transportation efficiency, and emissions reductions will be needed as New Jersey's utilities modernize their systems. Implementation of these elements will help ensure the State's energy goals are achieved and sustained.

- Policymakers should enact policy's that supports the appropriateness and reasonableness of providing additional incentives to Electric Distribution Companies (EDC's) for capital investment to their transmission and distribution systems including: (1) a surcharge mechanism that enables the EDC's to receive full recovery of and on investments without filing a base rate case; (2) an after-the-fact true-up to reconcile estimates with actual costs, and (3) other recovery mechanisms acceptable to the EDC's and to regulatory authorities.

- Some group members mentioned the lack of incentives, and what it can be perceived as lack of enforcement, as reasons that hinder development of many of the technologies discussed by this Working Group. This is a reality and to fix it requires a daunting effort at several levels, from the Governor's office, through governmental agencies, the legislature and the regulated business and customer community. Actualizing a permitting process to the new realities we are facing from a project/State life cycle perspective is highly desirable. Stopping subsidies for inefficiency, and implementing short-term financial incentives for promising technologies to get them off the ground, are also desirable. New Jersey's academic research community should work shoulder to shoulder, and with a very practical and pragmatic sense, with regulatory bodies and technology certification agencies to get this right at once.

- The legislative/regulatory barriers are those that allow "business-as-usual" to have tax advantages and easier oversight from regulations, which create no incentive to invest in new innovative technology solutions. Incentives should be changed to strongly support innovative solutions to be developed, verified and commercialized, rather than hinder them.

- Currently, from the DEP's perspective, we believe there are no specific regulatory barriers to the development of innovative energy technologies. However, to reduce the timeframe of the permit review process for emerging technologies such as those described as Class I and Class II renewables, BPU should collaborate with DEP to ensure that the regulatory pathway and resources exist to advance the energy related goals of the State. Also, BPU should only support energy technologies that, in addition to satisfying the energy performance claims, result in the least impact to the environment and human health.

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- Not aware of any current barriers, but it is important that legislation and/or regulations remains consistent, and provides an environment where technology businesses and industries can grow and be sustainable over time. Unclear legislation or regulation and constant changes in policy direction can adversely impact development of innovative energy technologies.

Working Group Report Summary

The Working Group seemed to reach a consensus that getting energy technologies that are cost-effective, protect the environment, and that can be quickly verified, receive regulatory approval and be marketed, commercialized and put into operation, will be the ones that the State of Jersey and NJ BPU should prioritize in the State Energy Master Plan. The ratings listed in Table 1 on page 5 and the answers given to your four questions should give some rough guidance towards implementing a process for systematically identifying, investing in and verifying promising new energy technologies. Not all of them will work or reach commercial

success, but that is why New Jersey needs to have a diverse portfolio of technologies available for use, rather than placing all of the State's eggs in one basket.

The Working Group also believes that BPU should consider establishing a formal energy technology development and approval process that uses existing state resources such as NJDEP, NJEDA, NJCAT, private industry, utilities, the venture finance community, and the college and university academic research centers around the state to identify, encourage, fund, incubate and move rapidly to market promising energy and efficiency technologies and solutions that have been verified for their performance, have low environmental impacts, are cost-effective/efficient and reduce energy costs and reduce volatility in energy prices.

Some of this technology identification and development work may need to be done in partnership with resources from outside of the state, as New Jersey may not be able to solve all of our energy problems on our own, but we do need to strive to have a balance so that clean technology R&D, manufacturing and service jobs and economic activity increase in New Jersey, and keep New Jersey as a leader in energy and environmental technology development and commercialization sector.