

CHAPTER 6

Global Energy Network and Information System

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(Global Energy Network and Information System)

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INTRODUCTION

The options to create and update national, global, and corporate energy strategies are so complex and rapidly changing that it is almost impossible for decisionmakers to gather and understand the information required to make and implement coherent policy. Yet the environmental and social consequences of incoherent policies are so serious that a new global system for the identification, analysis, assessment of possible consequences, and synthesis of energy options for decisionmaking is urgent.

With support from the Foundation for the Future (FFF), the Millennium Project explored the concept and design of such a system of collective intelligence that could be used by the policymakers, energy experts, and the general public around the world.

Concepts such as knowledge management and the emerging field of collective intelligence for just in time knowledge have been considered. Sources such as OECD's International Energy Agency, DOE's Energy Information Administration, Encyclopedia of Earth, and IEEE's data banks¹ have been reviewed, as well as the use of software applications such as knowledge visualization, dashboards, decision support systems, Google, Citizendium, Wikipedia, and Second Life to understand current and foreseeable future capabilities. This review helped to generate questions for energy and information systems expert interviews and solicited feedback from attendees of the FFF energy conference and the 32 Millennium Project Nodes around the world.

The results of these interviews and searches of previous literature, Internet, and institutional reviews have been integrated into this report. Participants from the FFF energy conference along with information system experts have been added to a listserv <global-energy@mp.cim3.net> to review and discuss the initial drafts of this report. In addition to improving the quality of the report, the members of the listserv would constitute an initial Global Energy Network that could become the basis of an organization to bring the new system into being.

This report proposes to create initial prototypes and conduct tests by the Millennium Project and collaborating organizations such as SRI International, MIT's Center for Collective Intelligence, and the Cyber Node of the Millennium Project.

1. THREE PHASES TO DEVELOP THE SYSTEM

Phase I. Conduct this pre-feasibility study under a planning grant from the Foundation for the Future (completed with this report)

Phase II. Create initial prototypes and test feasibility of the prototypes; (conducted with additional organizations in partnership with the Millennium Project)

Phase III. Establish the operational and sustainable system (move the system to Google, Inc., Microsoft, Oracle, SRI International or other implementers discovered during Phase II)

2. SOME INITIAL DESIGN CONCEPTS:

The Global Energy Network and Information System (GENIS) would be composed of two integrated elements:

- The Global Energy Network (GEN), providing communications and collaboration capabilities for a worldwide community of experts and others working on, or concerned with, energy issues;
- The Global Energy Information System (GEIS), a repository (knowledge base) and associated interactive access facility for as much of the world's total knowledge (actual content, pointers to external systems, and ability to mashup from other databases into one integrated set of outputs) about energy as can be accumulated.

The two components would work together to support a variety of needs, such as: politicians during energy hearings; policymakers creating national, bilateral, or multilateral energy strategies; business and university supporting R&D; media fact-checking; and the general public.

2.1 Global Energy Network (GEN)

A large and diverse set of leading energy experts from around the world would be invited to become members of GEN. The initial members of GEN during Phase II would be the participants in the Foundation for the Future's energy conference, plus the additional experts participating in Phase I and those contributing to create GEIS in Phase II. GEN would seek recommendations for new members from such sources as national academies of sciences and engineering around the world. Additionally, while creating GEIS, citation analysis and interviews will find additional members for GEN. An estimated 250 energy and energy-relevant experts across disciplines would be the goal for Phase II prototypes, and thousands during Phase III.

Peer networking around the world would help keep such experts abreast of the cutting edge of knowledge and hence improve their professional value and augment their own information systems and research. With a very small support staff, GEN would create and maintain the GEIS knowledge base and participate as "on-call" resources for consultations.

There would also be a public GEN (PGEN) for anyone who wanted to participate in the development of GENIS. Their contributions would be available – labeled as public contributions – within GEIS and available to GEN for potential inclusion in professionally peer-reviewed information.

Many computer-augmented collaborative systems exist and others will be invented prior to the establishment of the whole system of GENISⁱⁱ in Phase III. There are at least four modes of operation for GEN:

- Discussion of the most important global energy issues and associated decisions
- Collaboration to produce distilled information and ratings for priority listings in GEIS
- Identifying degree of expert consensus, and where there is not, identifying the range of views and pending issues
- Linking on call experts to support the political hearing example described below, or other “just in time knowledge requirements” in which material is being assembled and presented in real time that would have to be fast enough to prevent a roomful of high-level people from having to wait impatiently

The first three would also be separate activities within the PGEN, with the addition that, as some public members’ contributions are recognized, they could become members of GEN.

Until better semantic technologies are developed for multi-linguistic usage, language groups within GEN during Phase III would have to identify and develop different language areas of GEIS, oversee translation, and provide live translation for real time work. There would be a Chinese GEN, a Spanish GEN, etc. to address language issues for GENIS.

2.2 Global Energy Information System (GEIS)

The central concept of the GEIS design is that a very broad set of energy information would be continuously updated and organized into a single, coherent collection¹ of knowledge, with an interface reflecting the semantics of the field, viewed as a whole, and oriented towards making the knowledge easily accessible to experts and non-experts. This also includes the range of judgments where agreement is not verified and the justifications and research for the differing views.

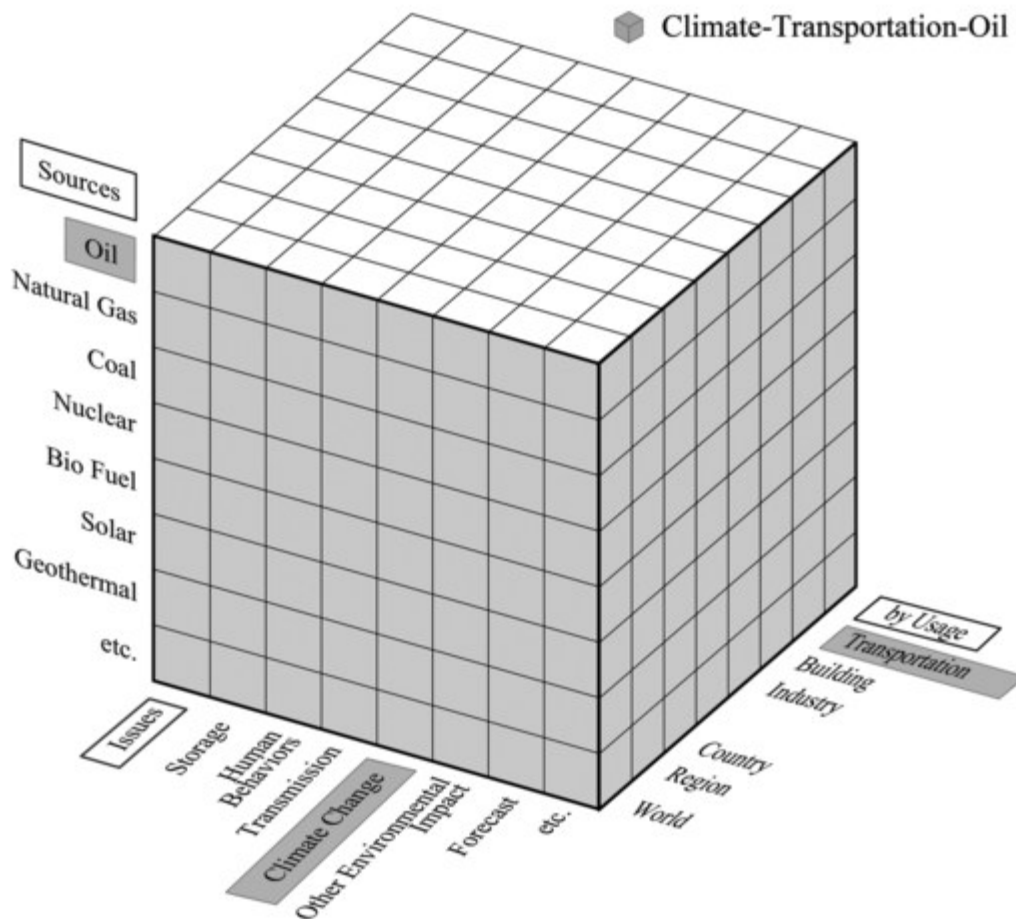
¹ In computer jargon: “federation” - A purpose of knowledge federation is to join together, organize, reconcile and present the fragmented pieces or sources of information that pertain to a given subject. The word ‘federation’ is used to distinguish this approach from integration. <http://folk.uio.no/dino/KF/KF.pdf> or <http://www.ai.sri.com/people/park>

It should be emphasized that the descriptions following are intended only to give an idea of the kind of interface that is envisioned. The actual capability will be designed only after careful investigation and experimentation.

Front Page: The front page could be a graphic representation of a taxonomy or map of the global energy elements. The front page of the global energy data base of the US Department of Energy's Energy Information Administration and OECD's International Energy Agency are shown in the appendix of this report. The front page might be a map of the global energy situation and future prospects arranged by: energy usage, sources, storage, transmission, forecasts, technology potentials, human behavior, major issues, and programs and models.

Another approach to the front page could be a three-dimensional table or cube:

Figure 1. Cube Interface



The first axis could be sources such as oil, coal, nuclear, biofuels, solar, geothermal, etc. The second axis could be uses or demand for the world, region, country, and categories such as transportation, buildings, and industry. The third axis could be issues such as storage, human behavior, transmission, climate change, other environmental impacts, and forecasts.

Elements of the Main Page: Each element of the main page would have its own front page with subsets, and subsets of those, etc. Ideally, these subsets could have their own overview that could be an expert and non-expert wiki, an argument structure or issues map, and possibly ontologiesⁱⁱⁱ as a graphical interface (a solar ontology, transportation ontology, etc.). Next to the display of each item would be a column with options such as:

- Overview (GEN wiki, article, and/or argument structure Figure 3 below)
- Links to specific problems and opportunities
- Data and forecasts
- Computer simulations, models, programs if available²
- Expert Ratings in wiki (via GEN using Real Time Delphi)
- Unresolved Issues wiki – Range of Expert views (via GEN using Real Time Delphi)
- Open non-peer-reviewed wiki (via PGEN)

Here is an example of an information unit with these attributes in the column to the right:

Figure 2 Example of a unit of information with column of choices about the information

<p>World Record solar cell efficiency achieved</p> <p>Spectrolab, a subsidiary of Boeing, announced the development of a new solar cell that can convert 40.7% of the sunlight into electricity. The conversion efficiency of today's conventional solar cells is between 12% and 18%. The Department of Energy claims that 'this breakthrough may lead to systems with an installation cost of only \$3 per watt, producing electricity at a cost of 8-10 cents per kilowatt/hour, making solar electricity a more cost-competitive choice</p> <p>Link to the article</p>	<p>Issue overview</p> <p>Problems and opportunities</p> <p>Data and forecasts</p> <p>Computer simulations, models</p> <p>Expert ratings</p> <p>Unresolved issues</p> <p>Open non-peer-reviewed</p> <p>Comment on this item</p>
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Members of GEN and PGEN plus a small staff would contribute to these attributes for each unit of information as possible. In the full GENIS in Phase III, expert committees of ten people or so from GEN would review specific areas of information giving numeric ratings (using the Real Time Delphi software of the Millennium Project) as to authoritative quality and importance of the topic or information along with comments. These can be put next to the information unit to show the status of expert consensus and commentary. Additionally, a map of different views could be displayed. The ratings for the unit of information would appear when a person clicks on the side column's item "expert ratings" as shown above. Other attributes such as related simulations, forecasts, etc. can also appear next to the information in the right column as shown above.

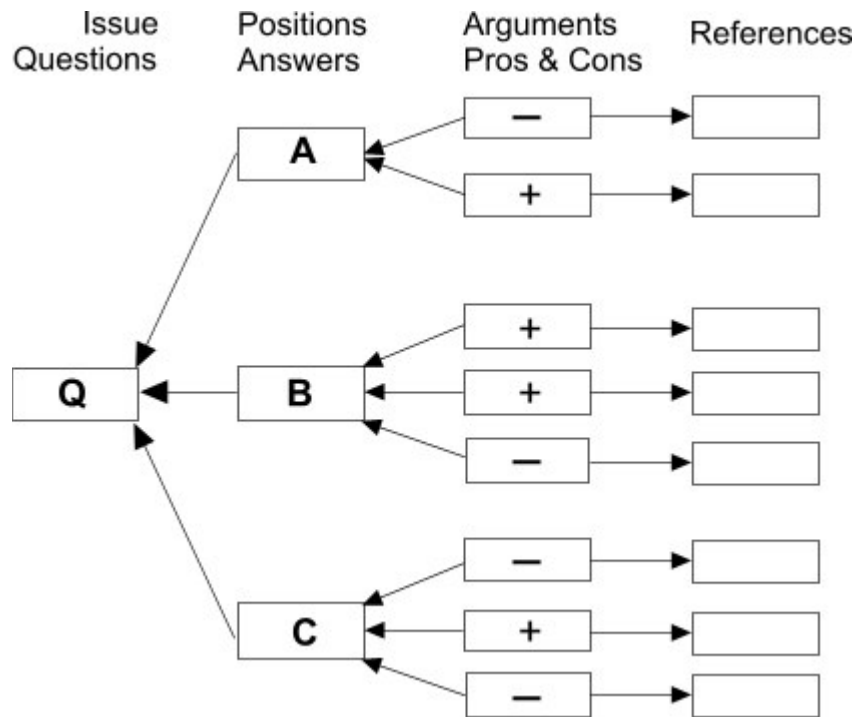
When there is no expert consensus (as defined by the numerical spread of ratings from the Real-Time Delphi of a GEN panel, or by a display of different positions in argument software as

² Eventually, individuals could propose policies that could be tested at least to first level to see initial impacts. To use such models or simulations, a participant would have to provide information about the policy under test, e.g. timing, cost, source of supply, etc. together with ranges of uncertainty. With the participant's permission, their inputs and ranges could be discussed by GEN or PGEN discussion areas or added to a Real-time Delphi so that judgments could be collected and organized.

illustrated in Figure 3), the range of views on the unresolved issues would be added under the attribute ‘unresolved issues’ or possibly as the overview of the issue. The general public could add to the open non-reviewed sections much like the Wikipedia or a public version of a wiki argument.

One application that was developed nearly twenty years ago (CM/1) would present and organize overviews of the inter-relationships of (1) issues (or questions), (2) range of positions on each issue, (3) arguments for and against each position, and (4) references for the arguments. Here is a simple diagram of the user interface for such a system that could be updated by GEN and GENIS staff to keep track of the evolving picture of many energy issues.

Figure 3 Argument structured information overview of an issue (See appendix A.3 for a more sophisticated version).



Source: Peter and Trudy Johnson-Lenz, www.johnson-lenz.com based on early on CM/1 by Jeff Conklin of CogNexus Institute

Using the structure above prevents repetitions as can occur in blogs, structures the overview for decisionmakers better than a page or two of wiki text, and exposes assumptions and relationships more clearly than conventional data bases. Hence, where possible, overviews would be updated in structured argument software as well as overviews in wiki or text articles.

The GEIS knowledge base (KB) would contain as much energy knowledge as can be accumulated, either explicitly or in the form of pointers to external sources. Working with

national academies of sciences, national science teachers associations around the world, and other such organizations should be explored to review content, create mashups to fill gaps in the GEIS, and to contribute to specific language GENs.

In addition to conventional approaches to federated searches and mashups, services like Deep Web Technologies <<http://www.deepwebtech.com>> could be used to create a federated search portal so that single point searches of all of their data that is not visible via the usual search engines can be found. A topic map portal can also provide a federated search capability without the necessity of subscribing to the services of others.³

Key information from such sources as the International Energy Agency of OECD, the Energy Information Administration of the US Department of Energy, Google, www.worldwidescience.org^{iv} with its federated searches, etc. would be found, organized, and made available in this dynamic knowledge repository. This would contain not only articles but also organized data. It would contain or have pointers to:

- Qualitative data about all the classes of entities (experts, research, institutions, communities, and other energy-related resources).
- Quantitative data; e.g., statistics by country, energy source, etc.
- Ability to mashup information from external data bases into consolidated output
- Special areas of the listed information such as current issues and unresolved questions, containing "all" the information about that issue or question from a full range of perspectives. Each issue or question will be a network of related and interacting knowledge structures. This body of knowledge can be displayed in a "dashboard" reflecting the current state of that knowledge and expert views on the issue's various aspects (definitions, trends, current status, etc.). See example section below: *How a Complex Issue Could be Tracked*.
- Provision for users to set up "new items" alerts

These components would be linked, as possible to "Wikipedia-type" articles by both GEN and PGEN, in addition to the constantly changing more technical or specialized main content, and areas for additional comments.

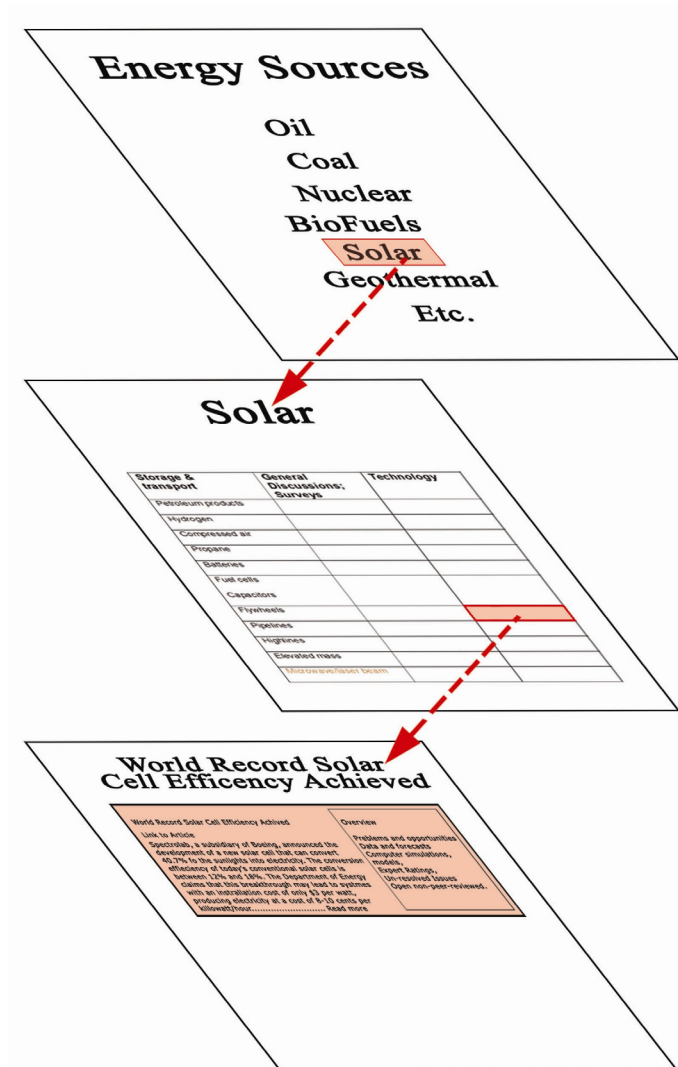
GEIS would also have an Application Programming Interface (API) to run or link to computer simulation models and other related programs. Such programs might help a country, industry, or individual determine their carbon footprint, or forecast energy supply and demand. Other applications could help non-experts make an informed decision, taking them through a programmed learning module. Many new energy-environmental analysis programs are appearing on the Web, and would be linked to GEIS.

³ Jack Park of SRI working with Topic Maps adds: "In essence, we are talking about a socially-crafted search engine that automatically maintains order in its records, very much like Mahalo: <http://mahalo.com/> which offers a fairly decent indication of what is possible."

The MIT Center for Collective Intelligence would bring to GEIS “families of interconnected models that could serve to organize discussion, pointing to where the most important uncertainties are, and helping to determine the combined impact of many different assumptions from many separate conversations.” Such simulation choices would be available on the right-hand column of information units as shown in figure 2.

Those who prefer not to use key word searches could click on the area of interest on the front page and then by quickly clicking through a hierarchical trail find the desired information. For example, after clicking on Energy Sources (both current and potential) and solar which would then show a two-dimensional matrix of buttons for solar options vs. their attributes such as definitions, current usage, forecasts, advantages, disadvantages, pending issues, etc. and then further clicking through to get a specific item:

Figure 4. Recursive linked interface.



Where possible graphic presentations will be used to show structure and flow within networks of energy-related elements.^v

Another option to the user interface development to explore during Phase II is the possibility of a split screen approach: one view would show the KB map with the logical "neighborhood" of the information and the other would contain the requested output. The user could click either on the map to move elsewhere (near or far) or on an output element to move to a more or less detailed view of that data, including the possibility of a user-defined or default dashboard display.

The conventional keyword search function would also be provided so the expert user wouldn't have to click through the whole system to find what is being sought, but would instead go right to the selected term(s). The easy usability of the system will grow with each user's increasing familiarity with the structure of GEIS.

It should be noted that GEIS would contain "locations" for not only elemental entities and topics, but also for problems or issues, so that, e.g., "disposal of waste from nuclear plants" could have a node. An advantage of the interactive map approach is that this node can appear in the display "near" any number of different other points, e.g. nuclear power, dirty bombs, waste heat disposed of in fresh water near the nuclear plants – and fresh water depletions from use in cooling towers, etc. Any location in the knowledge space could be the home of a wiki on that subject. As shown previously on the solar cell example, information units can also have buttons for users to add data, information, comments, and to protest and explain why.

A nice feature to explore, but not required for the system, is a trace-back function that would show the user where the unit of information could have been found along different inquiry paths. For example, a list of such paths could be shown on, say, the upper left hand corner of the unit that when clicked on would allow one to see other connections to that information.

3. BRINGING GEIS AND GEN TOGETHER TO PRODUCE GENIS (Global Energy Network and Information System)

The following are some examples to illustrate how the two systems could be merged.

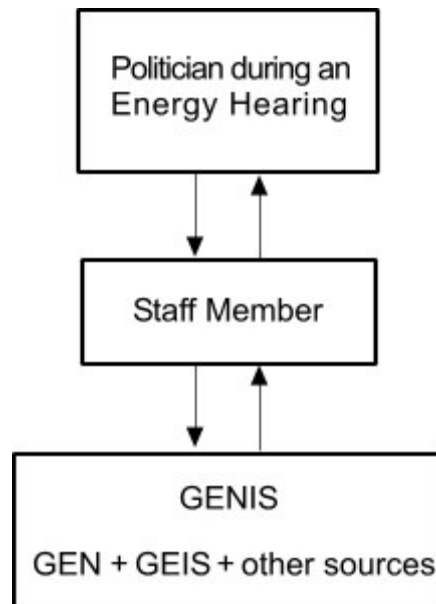
3.1 How a Politician Might use GENIS during a Hearing on Energy

- Legislator's staff member makes an appointment via the Congressional Research Service to have the Global Energy Network (GEN) on call with a specific skill set during a Congressional hearing on energy.
- The selected members of GEN then create a mashup of the required info, e.g., wind energy construction and Google maps, government contracts and current energy

legislation, current research, unresolved issues, definitions, current DOE research, etc. The option to use the Real-Time Delphi could also help bring the state of the art to light on any option, and could be used to prioritize the importance, urgency or order in a list of information units.

- The science member of the politician's staff runs GENIS during the hearing, producing the tailored dashboard (shown below) for the politician during the hearing, while using instant messaging with the politician, and communicating with the GEN member on call.

Figure 5. Politician, staff member, GENIS flow diagram



The legislator's science staffer communicates with GENIS to anticipate and respond to the needs of the legislator while listening to the hearing. GEN members on call could also have streaming audio to listen to the hearing. GEN produces information in the dashboard cells of the staffer. The staffer edits and sends the dashboard to the legislator's computer screen. An example of a one-page dashboard display with nine areas is illustrated below.

Figure 6. Energy Dash Board Example for a question during a legislative hearing

Definition 1. Space solar power satellites convert sunshine, microwave to electric grids on earth 2. SSP variations - manufactured on earth, orbit, or moon	Current Status 1. Nagoya Robotics software to support orbital manufacturing 2. NSF research results 3. Japan's national goal	Legislation 1. Pending energy bill S-123 allocates \$10 billion for SSP R&D 2. Current NSF/NASA/IPRI provide \$5 million for university research
Advantages 1. Unlimited energy source 2. No GHGs or nuclear waste 3. Managing day/night base load on global basis	Disadvantages 1. Public fear of health effects from beam 2. Large-scale dependency, space junk	Unresolved Issues 1. Health impact research 2. Protection from space junk 3. Earth to orbit launch costs 4. Design options
Forecasts 1. NASA Fresh Look study estimates that... 2. Nagoya University study estimates that...	Staff/GEN Misc. Why hasn't this been done already? When could this provide 1/2 the world's electricity?	Next Steps 1. Demonstration of wireless transmission from Space Shuttle 2. Health and environmental impact studies

The staff refreshes the congressman's dashboards as needed during the hearing, while in instant messaging contact with both the on-call GEN members and the congressman.

There can be many variations in applications of GENIS and the composition of dashboards customized by the users. For example, a GEN member's dashboard could have the GEIS output in each cell. The GEN member would enter a term or terms in a single entry space. Say the member enters the phrase Space Solar Power, and then instead of producing the normal long Google-like list, the search would automatically split into seven or so separate searches. Each search would add a different term such as definition, current status, legislation, etc. (definition space solar power, current status space solar power, etc.). The results of the parallel searches would then be displayed in separate lists in the appropriate cell of the GEN member's dashboard.

The GEN member quickly selects an item or two, edits them, and sends the second version of the dashboard to the politician's science staffer. The staffer then further edits for the politician similar to the example above, and it is then displayed on the computer screen of the politician during the hearing. The politician then asks questions as he sees fit to those testifying in the hearing room, such as, "Would collaboration between NASA and Nagoya University help to narrow the design options?"

GEN could perform this work under an Indefinite Quantities Contract (IQC)-like agreement from the Congressional Research Service. To prepare for being on call the GEN managers might conduct computer mashups of experts, organizations, research projects, and skill sets. If their requirements were more general, and needed to be less costly, then a general mix of GEN experts could be accessed at any given time. If, for example, one wanted views from ten experts on

some general energy questions, and 2% of GEN members were online at any given time around the world, then there would have to be 500 members of GEN to make this kind of option available.

The US Congress held a hearing in Second Life opening new possibilities for integrating GENIS with legislative decisionmaking to be explored in Phase II.

3.2 Another Variation

During an energy hearing, a Department of Energy official states that nuclear energy is an important option to produce electricity without CO₂ emissions and can be used to support hydrogen production, water desalination, etc. Knowing that this will come up in the hearing, a Congressional staffer accesses information on how many plants would have to be built over how many years to substantially reduce CO₂ emissions. The staffer compiles key advantages and disadvantages, and shares with GEN for feedback. On the day of the hearing the staffer enters the key elements as the legislator needs to see them on the legislator's energy dashboard. GEN members on call could also be watching or listening to the hearing online, sending information to the staffer in anticipation of what might be needed to know next. Hence the staffer could use GENEIS to anticipate needs as well as respond to testimony.

3.3 Use in Decisionmaking with On-line Real-Time Delphi

An organization needing to make an energy decision could contract with GENIS to use the Real Time Delphi^{vi} software of the Millennium Project to collect judgments from a panel of the organization and GEN using GEIS as necessary. The online questionnaire could have criteria for the decision, a list of decision options, scales to rate the options, and space for participants to anonymously enter the reasons for their ratings. All this can be available in real-time. In classical Delphi, the judgments collected in one round of a questionnaire are fed back to the participants in subsequent rounds of questionnaires. By contrast, Real-Time Delphi is roundless and answers generated are fed back to participants in real time. This allows an organization to say that a decision will be reached by a specific deadline, avoiding countless face-to-face meetings without resolution. This approach is an added feature to help GENIS support decisionmaking.

3.4 How a Complex Issue Could Be Tracked

A user of GEIS could create a specific space of saved categories and update them regularly to find out the current status of, say, energy and greenhouse gas emissions issues. This password-protected user's private space could have a decision tree program. The user would have different decision trees for different possibilities that would be updated, including tradeoffs, legislation, and other factors that are relevant to each element in the decision trees. Another option could be the use of the argumentation software in Figure 3.

Complementing this could be a set of current data, with projections of 10 and 25 years that would be continually updated in areas such as

- Energy needs by world, continent, and countries
- Power supply by each of the current major sources by world, continent, and country
- GHG emissions based on power supplied by each of the current major sources, displayed by world, continent, and country
- Alternative energy sources to meet the production needs by world, continent, and country
- Potential science and technology breakthroughs required to deliver adequate power to replace current environmentally damaging sources (what breakthroughs and probable year for the breakthrough)
- Potential methods to mitigate GHGs by cost estimate of research, infrastructure construction, and unit cost to consumers of power for all methods identified

Such structures for issues management could be made available to others. The GEN or PGEN member would draw on GEIS data and participate in discussion groups to update their information tracking. As patterns become significant, then they could be shared for consideration to be added to GEIS. It must be emphasized that GENIS itself will be ideologically neutral – it will provide only the infrastructure – other can use it to come to their own conclusions. It is not a normative system, but one that could be used by others to create normative positions.

3. 5 Public Variation—Individual Collective Intelligence System

The user would go to the GENIS Web site, decide what cells he/she wants for their personal dashboard, and then begin entering terms or using maps of energy ontologies and taxonomic maps to click through systematically to find the needed information. As references are selected, and then within the selected references, key text, graphs, or other media are selected, the user can store and display the results in his/her own dashboard or other custom display system, such as the issue argument map shown in figure 3. Participating in PGEN discussion groups allows for feedback on this information so that an individual can return many times to their “space”, deleting or editing some items or adding new items. This could create an accumulative collective intelligence customized for and by that user. Such storage could be shared with others and added to the GEIS.

An additional nice feature to explore would be the possibility that the individual’s dashboards could be updated automatically as new information becomes available so that on returning to their dashboard, the individual would always see the current situation and information.

4. NOTES FOR PHASE II

The next phase would produce prototypes that should address three cases of usage of GENIS:

- Politician(s);
- Collaboration among energy experts; and
- Non-expert public use or journalists for background and fact checking

We expect to take advantage of “Semantic Web” technologies (e.g., OWL) as needed to make the knowledge stored in GENIS automatically available to a wide range of other systems.

During an energy-related conference, a group could be connected to work quickly together to mashup important elements, which could lead to groups that could later be supported through <et.gov> to further support the development of GENIS.

Those with models of collective intelligence who have expressed interest in collaborating in Phase II designs for the prototypes include:

- SRI International’s Topic Maps (Jack Park)
- MIT’s Center for Collective Intelligence (Tom Malone)
- Millennium Project’s Cyber Node Early Warning System (Frank Catanzaro)
- Bootstrap’s improve the improvement system (Doug Engelbart)
- Open University’s Knowledge Media Institute (UK) (Simon Buckingham Shum)
- CogNexus Institute’s Dialogue Mapping and Issue Mapping (Jeff Conklin)
- James Disbrow, DOE’s Energy Information Administration
- CIM3’s Collaborative Work Environment & Collaborative Ontology Development System infrastructure (Peter Yim)

Ending Comment:

There are a wealth of ideas being generated by these and other leaders in collective intelligence as this document is being completed; and hence, it is reasonable to assume that some elements of Phase II prototypes could turn out even better than those described in this Phase I paper.

Nevertheless, it is the consensus of those who have participated in this study, that creating Phase II as described in Phase I will be a major step in the evolution of collective intelligence. The basic design of GENIS can be applied to support a broad range of applications from a potential global situation room on climate change to a collective intelligence for other subject areas or even a country.

ⁱ IEEE energy data bases are not free and would require some special arrangement to use for GEIS since they are based on downloads which would be difficult to forecast. IEEE's current rates are: Level E - 150 article downloads for US\$2,995

Level 1 - 350 article downloads for US\$4,995

Level 2 - 800 article downloads for US\$9,995

Level 3 - 1,750 article downloads for US\$17,495

ⁱⁱ A 2001 paper by Keiichi Nakata [http://www.ii.ist.i.kyoto-](http://www.ii.ist.i.kyoto-u.ac.jp/sid/sid2001/papers/preprints/jsai2001wsnakatapaper.pdf)

[u.ac.jp/sid/sid2001/papers/preprints/jsai2001wsnakatapaper.pdf](http://www.ii.ist.i.kyoto-u.ac.jp/sid/sid2001/papers/preprints/jsai2001wsnakatapaper.pdf) presents a proposed design for a collaboration system with very much the same goals as GEN and also coincidentally aimed at public discussion of environmental issues, and <http://kmi.open.ac.uk/sbs/csca> (also 2001) is a portal to "Computer-Supported Collaborative Argumentation". The Japanese-proposed system had the added feature of an attached suite of simulation and analysis programs.

ⁱⁱⁱ On this point, one interviewee said: *an ontology, as an expression of attributes of a concept into logical language that a machine can interpret, would put machines to work for the system (saving great cost), but I don't think anything would happen short of a major recognition that "ontological engineering" is a key enabler to help us bring machines into the fold to help resolve this "energy" challenge, and major funding going into developing solutions in that direction!*

^{iv} Gives references from 17 databases. British Library articles have to be purchased, hence this is not fully useful for realtime work, but can be used to build the info system pending copyright issues.

^v Where possible, pictures of the field of study would be included, where the picture/graphic might be considered the face of a cube, and the layers behind the face would mine specific topics behind each node. (Two examples of this family of graphics are:

<http://www.visualknowledge.com/wikikey/A24181S6651504> and another at

<http://www.eia.doe.gov/emeu/aer/diagram1.html>).

^{vi} <http://www.realtimedelphi.org/> and for an article on Real Time Delphi see

http://www.realtimedelphi.org/delphi_article.htm

Appendix E: Global Energy Network and Information System

1 Some examples of user interface front pages

2 Maps as a Formal Information Model and front page

3. An Issues Map as front page

Table of Contents—*2008 State of the Future*

1 Some examples of user interface front pages:

1.1 DOE's Energy Information Administration's data base front page:

<u>Petroleum</u>	<u>International</u>
Crude oil, gasoline, heating oil, diesel, propane, jet fuel, and other petroleum based products...	Country energy information, detailed and overviews...
<u>Natural Gas</u>	<u>Forecasts & Analyses</u>
Exploration and reserves, storage, imports and exports, production, prices, sales...	Monthly and yearly energy forecasts, analyses of energy topics, financial analyses, Congressional reports...
<u>Electricity</u>	<u>State & U.S. Historical Data Overview</u>
Sales, revenue and prices, power plants, fuel use, stocks, generation, trade, demand & emissions...	Monthly and yearly energy statistics allow for comparison across all fuels and sectors...
<u>Coal</u>	<u>Households, Buildings & Industry</u>
Reserves, production, prices, employment and productivity, distribution, stocks, imports and exports...	Energy use in homes, commercial buildings, manufacturing and transportation...
<u>Nuclear</u>	<u>Environment</u>
Uranium fuel, nuclear reactors, generation, spent fuel...	Greenhouse gas data, voluntary reporting, electric power plant emissions...
<u>Renewable & Alternative Fuels</u>	<u>Energy Kid's Page</u>
Includes hydropower, solar, wind, geothermal, biomass and ethanol...	Classroom projects, games, energy basics...

1.2 International Energy Agency (of OECD) Topic Page or data base front page:

Coal	Environment
Clean Fossil Fuels	Fusion Power
Climate Change	Greenhouse Gases
Demand Analysis	G8
Electricity	Natural Gas
Emissions Trading and CDM	Non-OECD Countries
Energy Efficiency	Oil
Energy Market Reform	Renewable Energy
Energy Policy	Sustainable Development
Energy Projections	Technology
Energy Security	Transport

1.3 Open Directory Project's front page for Energy:

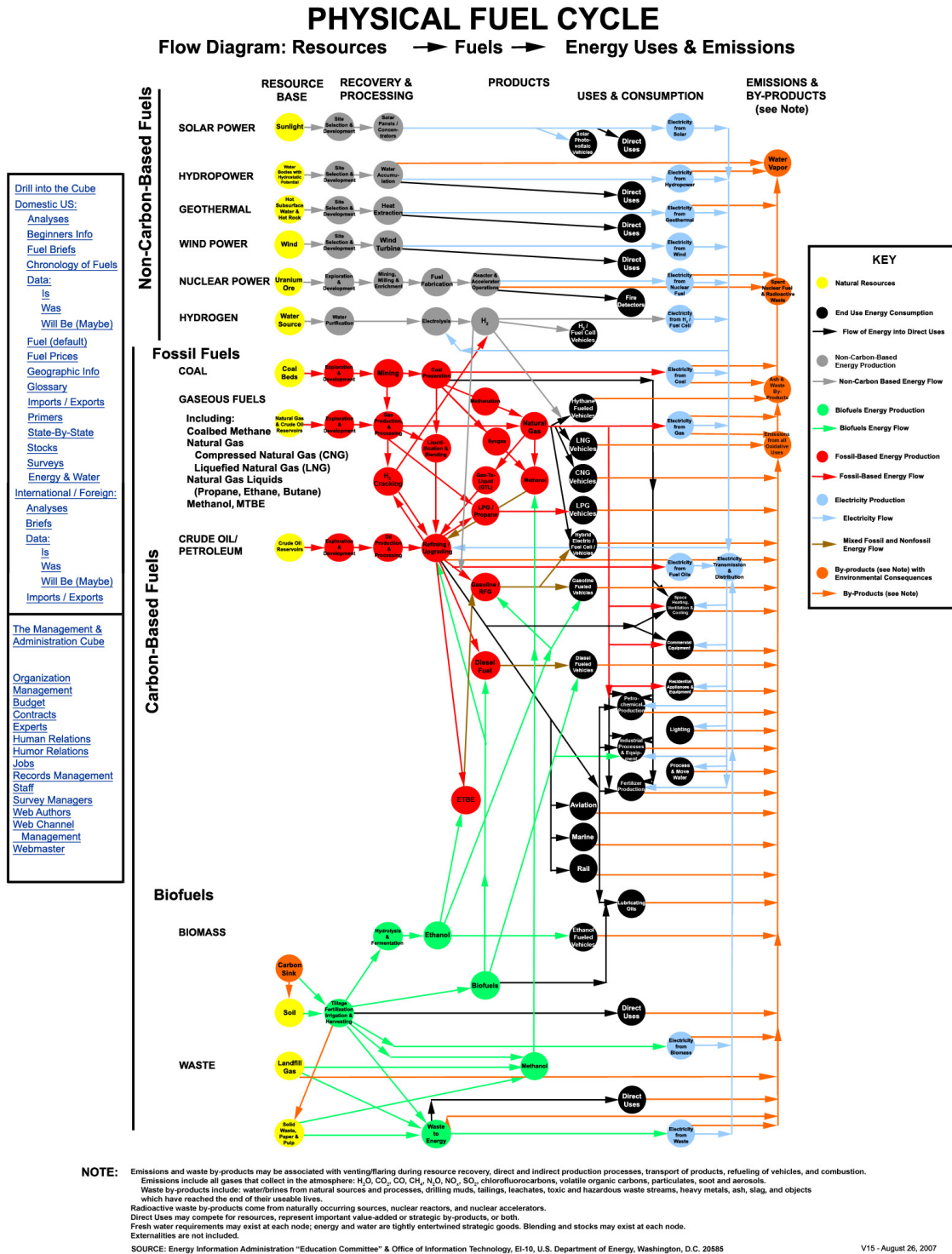
[Top](#): [Science](#): [Technology](#): [Energy](#) (1,957)

[Description](#)

- [Cogeneration](#) (24)
- [Conservation](#) (94)
- [Devices](#) (244)
- [Economics and Policy](#) (36)
- [Electricity Generation and Distribution](#) (27)
- [Environment@](#) (117)
- [Fossil Fuel](#) (35)
- [Fusion@](#) (101)
- [Geothermal](#) (16)
- [Hydrogen](#) (127)
- [Nuclear](#) (269)
- [Renewable](#) (398)
- [Social Issues@](#) (83)
- [Storage](#) (209)
- [Transportation](#) (137)
- [Unproven Concepts](#) (48)

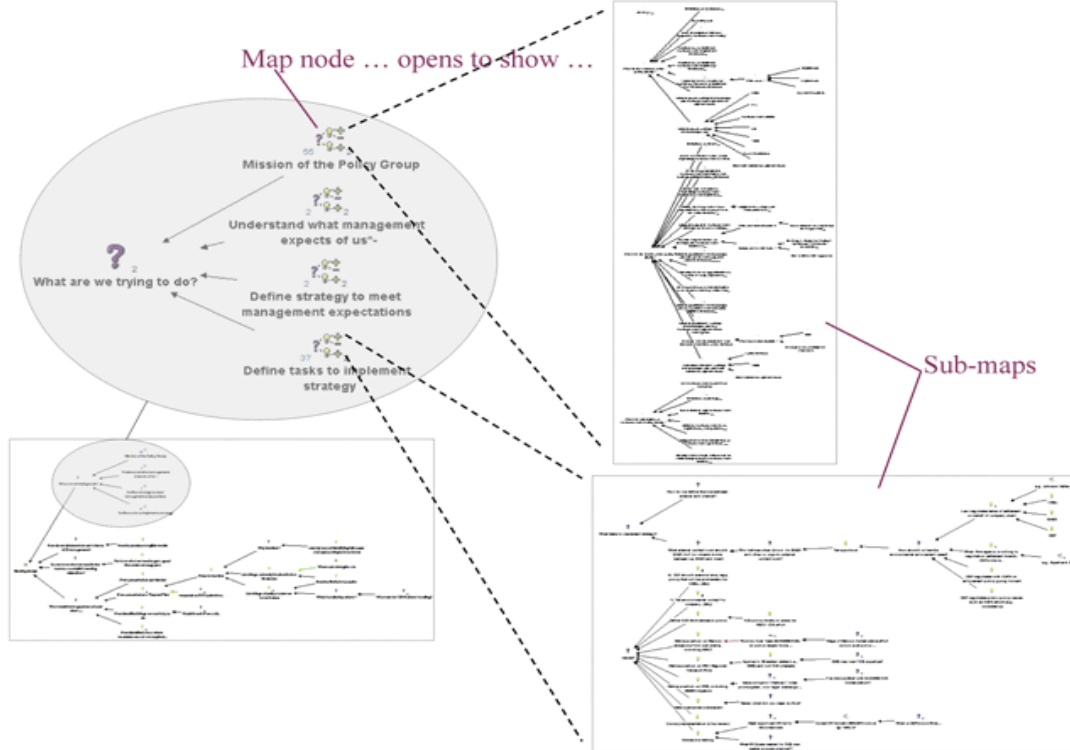
2. Maps as a Formal Information Model and front page

Maps as a Formal Information Model and front page: Some maps of the energy picture are excellent for the expert, but could be too complex for the public user, such as the Flow Diagram below. Overview maps like this can be available as an option rather than as the main interface.



3. An Issues Map as front page

Compendium Maps from a Strategic Planning Session



Source: http://www.cognexus.org/compendium_maps.htm