Enterprise GIS: Delivering Competitive Advantage for Offshore Wind Farms

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Introduction

There is a compelling need for an Integrated Sea Information System (ISIS) to accelerate the €6.4 Trillion European Offshore Wind Industry.

ISIS will
Reduce the Risk of developing, constructing and operating Offshore Wind.

To create ISIS we need new, Policies, Regulations, Standards, greater collaboration and innovative Technologies.
Geospatial Information Challenges of Offshore Wind Energy

- Mainstream’s Vision
- Offshore Wind Developers’ Data needs
- Mainstream’s IT Strategy
- ISIS: Reducing Project Risk
Geospatial Information Challenges of Offshore Wind Energy

• Mainstream’s Vision
  • Offshore Wind Developers’ Data needs
  • Mainstream’s IT Strategy
  • ISIS : Reducing Project Risk
Mainstream Renewable Power was founded by Dr. Eddie O’Connor in February 2008.

“Our vision is of thriving economies and communities liberated from the restrictions of fossil fuels, using renewable energy as their mainstream source of power. “

Mainstream develops, constructs and operates large-scale Wind and Solar projects.

The world is experiencing a once-off historical transition to sustainable fuels: Each one of our 195 countries must go through it.

4 fundamental issues drive this transition:

- Climate change
- Ever-increasing Demand for Energy
- Rising Fossil Fuel Prices
- Energy Security

These 4 key drivers influence the pace of the transition to sustainability.
“British adventurer and swimmer Lewis Gordon Pugh has become the first person to swim in the icy waters of the North Pole.”

16 July 2007
In 2009 China surpassed US to become world’s largest Energy Consumer

Driver 2: Exploding Global Demand for Energy

- China is adding **100,000 MW** to its grid annually
- Equivalent to ‘Adding Germany’ each year
- By 2030, China & India will add ‘23 Germanys’

**Projected oil consumption, 1980–2030**
Million barrels oil equivalent per day

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**Projected oil consumption in percent growth, 2010–2030**

- United States: 11%
- China: 80%
- India: 96%

Driver 3:
Rising Fossil Fuel Price

1,600% Oil Price Rise 1997 – 2007..... Will it do it again by 2020 ?
Driver 4: Security of Supply

Europe will become dependent on large gas imports, cash outflows without EC intervention...

... Via a continent-wide grid for natural gas yet no equivalent for electricity exists yet.

Source: EGL 2007

European Commission has intervened to catalyse the switch to sustainable energy.
Crisis, what crisis?

A transition to Sustainable Energy permanently extracts us from the Energy Crisis.
Mainstream’s Business Model

- **Sustainability as a business** is what we do at Mainstream: large wind & solar.

- Mainstream’s business model spans 4 key areas:
  1. Government Policy
  2. Project Development
  3. Project Construction
  4. Asset Operation & Maintenance

3 Revenue Streams =

- Profit from sale
- Long-term O&M contract
- Asset out-performance fee

A sustainable pipeline of Renewable Energy Projects secured
Mainstream’s 14,000+ MW Projects’ Pipeline

- 845 MW: Canada
- 947 MW: USA
- 994 MW: Chile
- 420 MW: Scotland
- 1,000 MW: Germany
- 6,000 MW: England
- 4,086 MW: South Africa

11 Office, 150 Employees, 8 Countries
"...We can get 100 percent of our energy from wind, water, and solar (WWS) power. And we can do it today—efficiently, reliably, safely, sustainably, and economically...

...The obstacles to this transformation are primarily social and political, not technical or economic...

Dr Mark Delucchi
University of California

230,000 MW Wind Power installed globally by December 2011

25% of this in China
20% in USA
12% in Germany
9% in Spain

Supergrid is the key technology for this transformation
Europe’s Energy Mix in 2050

2050 Energy Mix

- Wind: 50%
- Solar: 30%
- Nuclear: 10%
- Other Renewables: 10%

Where is the Wind Resource?

1,800,000 MW of installed Wind Power needed
  - Based on projected 2050 energy requirements

200,000 MW from Onshore Wind: the limit
  - Europe is the most crowded Continent

1,600,000 MW from Offshore Wind
  - Plenty of space to grow further
  - Achievable at €3,600,000.00 per MW

Investment:

- €5.8 Trillion for Offshore Wind Turbines by 2050.
- €0.6 Trillion for associated Offshore transmission and distribution: Supergrid.

Supergrid is the key enabler for the Renewable Energy Future.
Europe’s Supergrid in 2050

7 Innovation Trajectories are needed;

1. Bigger Wind Turbines
2. HVDC Transmission Cables
3. Supernode
4. Next-Generation Civil Engineering
5. Bigger Construction Vessels
6. Bigger Ports
7. Better IT:
   - Intelligent Market for Energy
   - Risk Management & Modelling
   - Real-time Pervasive Monitoring

An electricity transmission system, mainly based on HVDC, designed to facilitate large scale sustainable power generation in remote areas for transmission to centers of consumption, thereby enhancing the energy market.
Innovation # 1: Bigger Wind Turbines

Turbines will get bigger: 20 MW

Floating Turbines will be viable

Bigger, Better turbines are needed

Source: Garrad Hassan

Dr Eddie O'Connor, Mainstream Renewable Power C & F Offshore Summit London, April 2009
Innovation # 2:

HVDC Transmission Cables

Overhead Cables

- 400 kV AC line
- 320 kV DC line

Sea Cables

- Three 400 kV AC cables
- Two 320 kV DC cables

Mr. Gunnar Asplund, ABB
HVDC Supergrid - Technology and Costs
Marseilles, March 2009

HVDC uses proven technology
In 2011, only 30% of all power generated uses power electronics somewhere between the point of generation and end use.

By 2030, 80% of all electric power will flow through power electronics.

Mr Joe Corbett, Mainstream Renewable Power
Detailed design of the Supernode
Marseilles, March 2009

Supernode is a proven concept
Innovation # 4:

Next Generation Civil Engineering

Offshore wind Jack-up

Crane Capacity
1 000 tonnes

Project Load
7000 – 10 000 tonnes

Mr Fenno Leeuwerke, Hochtief Construction
Building at Sea and 3rd Generation of Ships
Marseilles, March 2009

Bigger, Stronger Jack-up Technology
Innovation # 5:

Bigger Construction Vessels

Mr Fenno Leeuwerke, Hochtief Construction Building at Sea and 3rd Generation of Ships Marseilles, March 2009

Bigger Ships for bigger loads
Innovation # 6:

Bigger Ports & Better Logistics

Requirements for UK’s Offshore Plans;

• Develop two completely new ports
• One on either coast of the UK
• More than transport nodes
• Focal point for regional development
• Centres of excellence for R + D
• Training centres for technologists/technicians
• New manufacturing centres

Dr Eddie O’Connor, Mainstream Renewable Power
C & F Offshore Summit
London, April 2009

An entirely new approach to Logistics is needed
Innovation #7: Better IT

- Hi-Speed Wireless Communication
- Power Distribution Management
- Supernode Power Controls
- Monitoring & Controlling Risk
- Surveying & Modelling the Sea

Reduce Project Risk & create the Intelligent Market
Geospatial Information Challenges of Offshore Wind Energy

- Mainstream’s Vision
- **Offshore Wind Developers’ Data needs**
- Mainstream’s IT Strategy
- ISIS : Reducing Project Risk
What Offshore Developers Need

Mainstream’s fundamental belief is that marine data is a Public Good.
  - It should be collected once and used many times.

Key needs:

Accessibility and Management:
  - Clear policy of ownership, licensing & access for all publicly funded data collection
  - Single point of access to marine data and information
  - Discourage cost-recovery pricing from public bodies

Data Standards and Quality control:
  - Common standards across jurisdictions and disciplines
  - Ensure the above is addressed in publicly funded data collection contracts

International Coordination:
  - Harmonised approach across the EU in relation to all of the above:
  - Links provided and maintained to EU/global databases and initiatives

Benefits of improved data management:
  - Measurable reductions in costs to find, access and retrieve data
  - Wider and more reliable data and information upon which to base assessments
  - Mechanisms to share results and data with stakeholders

Developers want to reduce Project Risk
4 EU Directives in particular impact industry:


- **INSPIRE Directive** – ‘adopt measures for the sharing of data sets and services between public authorities for the purpose of public tasks and the Environmental Information Directive’

- **Birds and Habitats Directive** – ‘establish a network known as Natura 2000 (SPA, SACs)

- **Data Collection Framework for Fisheries** – ‘collect, manage and provide high quality fisheries data for the purpose of scientific advice, mainly for appropriate fisheries management decisions’

There are many initiatives underway
Marine Knowledge 2020

Marine Knowledge 2020:
Marine Data and Observation for Smart and Sustainable Growth
Launched 13 September 2010
Led by Iain Shepherd

Key Objectives
This Initiative from the Commission will ensure the following are achieved:
• Data from the **EU-supported** research programmes are more available for re-use
• **Common** standards and policies
• **Contribute towards** an interoperable global marine knowledge system

Cost
• **€1,400.0 Million** spent per year by all stakeholders on Marine data collection in Europe
• **€ 110.0 Million** spent per year by EU on marine data collection
• **€ 18.5 Million** additional allocation per year for EU’s Marine Knowledge 2020 initiative

Offshore Developers will contribute to Marine Knowledge 2020
Mainstream’s Vision
Offshore Wind Developers’ Data needs
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ISIS : Reducing Project Risk
A company operating exclusively in the **Renewable Energy Sector**

A **New company**, established in early 2008

A company operating **Globally**, 11 offices in 8 countries

A company **growing fast**, a Big Company by 2014

**Accessible Data Management** is key to the success of Mainstream

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A Secure, Sustainable IT Strategy delivered via a 16 Step Process
### 8 Business Systems to meet Business Process needs

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## Step 2: Identify Business Priorities

### Mainstream Business Priorities vs Business Systems

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<th>Step</th>
<th>Description</th>
<th>DM System</th>
<th>F&amp;HR System</th>
<th>GIIS</th>
<th>PMS</th>
<th>AMS</th>
<th>PPS</th>
<th>CRM System</th>
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<td>1</td>
<td>Develop &amp; construct Robust Pipeline.</td>
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<td>Monitor other ‘fuel-free’ technologies.</td>
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<td>Partner with Local Developers.</td>
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<td>Leverage Central Expertise.</td>
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<td>Offshore position as Early-Stage Partner.</td>
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<td>Sell projects to Utilities &amp; Investors.</td>
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<td>Recycle cash from Sale of Assets.</td>
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<td>Seek liquidity event / IPO for investors.</td>
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**Underlying Standard IT technology:**

- Management Information always available.
- Business Intelligence & Reporting System
- Service Excellence.
- Standard PC / Print / Wireless Access / Telephony / Video Conferencing

**Business Systems Prioritised to meet need**
Step 3: Define Business Systems Vision

Business Need
- Deal Making
- Cash generation & Management
- Project Execution

Integrated Business Systems
- Geospatial Information
- Asset Management
- Predictive Performance
- Finance & HR
- Customer Relationship Management
- Project Management

Value
- Collaboration & Fast Replication
- Efficient Work Flow
- A Single Version of the Truth
- Faster Decision-Making
- Increase Personal & Team Productivity

8 Integrated Business Systems to deliver Value
Step 4: Map Applications Architecture

A Systems Map informed by Smart Energy Reference Architecture (SERA)
Step 5: Build Core IT Infrastructure

SCHEMATIC

PARTNERS
- Microsoft: Software
- Eircom-Orange: Communications
- HP-DSS: Hardware

STANDARDS
- Microsoft: 32 Products
- HP: Client & Infrastructure h/w
- Cisco: Data
- Intel: Infrastructure Architecture

PRINCIPLES
- Align with SERA
- Understand what you Outsource
- Build for global growth
- Build for 24 x 7 availability
- Build for Security
- Standardise components
- Configure not customise
- Partner with 4 Strategic IT vendors
- Service Level Agreements

A Private Cloud built for High Availability, Security, Performance
### IS Support for Mainstream Offices
- **8** Offices
- **120** HP PC’s & Laptops, standard devices
- **6** Nortel Phone Systems, standard handsets
- **8** Polycom Video Conference Sets
- **16** HP MFP Print Devices

### Single IS Service Desk
- **7777@mainstreamrp.com**
- **276** User Accounts
- **1,600** Request tickets per annum
- **2,000** Incident tickets per annum

### Strong IT Infrastructure
- **3** Database Clusters – SQL Server : HP Proliant
- **68** Servers in Production – : HP Proliant
- **14,000 GB on 2 synchronised SAN devices : HP EVA**
- **2** HP LTO Tape Library Devices : HP Devices
- **18** RF & Wireless Access Points : Cisco
- **69** LAN Devices & Switches: Cisco
- **6** sites connected via MPLS WAN circuits
- **4** sites connected via ADSL WAN circuits

### Secure IS Facilities
- **2** Datacentres for Hosting (Eircom)
- **7** Server rooms – 5 dedicated and 2 x shared
- **9** Facilities with Aircon, UPS Power, Monitoring

### Enterprise Applications
- **Finance & HR**
- **Document Mgt**
- **Reporting**
- **Email & Calendar**
- **XRM**
- **Dev. Analysis**
- Microsoft Dynamics AX 2009
- Microsoft SharePoint 2007
- Microsoft Performance point
- Microsoft Exchange 2007
- Microsoft Dynamics CRM
- ESRI ArcView 3 (Microsoft Partner)

### Client Software
- **Browser**
- **Email & Calendaring**
- **Productivity**
- **Project Management**
- **Process Modelling**
- **Remote Access**
- **Meetings**
- **Unified Comms**
- **PC Operating System**
- **Anti-Virus**
- Microsoft Internet Explorer 7.0
- Microsoft Outlook 2007
- Microsoft Office 2007
- Microsoft Project 2007
- Microsoft Visio 2007
- Microsoft Terminal Services
- Microsoft Live Meeting
- Microsoft Office Communicator
- Microsoft Windows 7
- Microsoft ForeFront

### Infrastructure Management
- **Databases**
- **System Integration**
- **Server OS**
- **Server Virtualisation**
- **Operations Mgt**
- **Configuration Mgt**
- **Service Mgt**
- **Security Mgt**
- **Data Backup Mgt**
- Microsoft SQL Server 2008
- Microsoft .NET Framework 3.5
- Microsoft Windows Server 2008
- Microsoft Hyper V 2009
- Microsoft Operations Manager 2007
- Microsoft Configuration Manager 2007
- Microsoft Service Manager 2007
- Microsoft ISA Server 2006
- Microsoft Data Protector v3

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**A Secure, Sustainable IT roadmap, capturing Business Value**
Enterprise GIS at Mainstream: Enabling Growth

Business Process v Technology:

Visualise Maps:
- ArcGIS Explorer

Analyse Maps:
- ArcGIS Desktop

Project Mgt tool:
- ArcGIS viewer for FLEX

Project Mapping:
- ArcGIS Map for SharePoint

Published Map:
- ArcGIS Map for SharePoint

Technology Layers:

GIS Client Applications; 16 Users
- ArcMap / ArcGIS Explorer
- SharePoint & Web Browser
- Google Earth

GIS & Web Server
- Network (Web) Server
- GIS Application Server
- Spatial Object Manager (user)
- Spatial Object Container (user)

SQL Server (Database)
- Spatial Data Engine
- 25 GB data

An Integrated GIS Approach aligned with SERA
Enterprise GIS Portal:

**BUSINESS ADOPTION OF GIS**

- 67 Development Projects tracked
- 8 Countries with Projects
- 16 Users
- 25 GB Data

**LAYERS**

- 50+ per Development Project
- Layers are grouped into 6 themes:
  - Base Map
  - Constrain Features & Buffers
  - Wind / Solar Plant Layers
  - Land Parcels
  - Survey Boundaries
  - As-Built Infrastructure

**BUSINESS BENEFITS**

- Fast, Single GIS Portal
- Clear Visualisation
- Simple, fast Queries
- Single, Central Storage of Data
- Global Accessibility

A Scalable, Secure, Integrated GIS Approach
Geospatial Information Challenges of Offshore Wind Energy

• Mainstream’s Vision
• Offshore Wind Developers’ Data needs
• Mainstream’s IT Strategy
• ISIS: Reducing Project Risk
The Offshore Wind Development Process

• The emerging € 6.4 Trillion investment in Offshore Wind needs to be delivered efficiently and effectively by 2050.

Offshore Developers need to...
• Identify & Mitigate Risks
• Accelerate Surveying
• Accelerate Construction
• Connect & Distribute Power

Information needed:
• Surveying
• Modelling
• Turbine Control
• Power Distribution
• Project Documents
• Risk

Reducing Risk is all about Digitising Decision-Making
Vision: Integrated Sea Information System: ISIS

Offshore Data Types

- Depth Bathymetry
- Wrecks Magnetometer
- Seabed Sidescan Sonar
- Sub-Strata Boomer
- Mapping ESA Satellites

Wind
- MetMast, Lidar

Foundations
- Geotechnics

Waves & Currents
- Oceanography

Flora & Fauna
- Ecology

Regulatory Reports
- Consultancy

Collect Data
Store Data
Visualise Data
Identify Patterns
Run Scenarios

ISIS

• Integrated view of marine data
• Predict Project Risk
• Mitigate Project Risk

ISIS Digitises & reduces Project Risk by converting Data into Wisdom
## ISIS: 5 layers to the Challenge

<table>
<thead>
<tr>
<th>ISIS Layer</th>
<th>Value</th>
<th>Technology Maturity</th>
<th>Specific Requirements</th>
<th>Reference Standard</th>
<th>Areas for improvement</th>
<th>Wind Farm Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5. Risk Scenario</strong></td>
<td>Identify Project Risk</td>
<td>Low</td>
<td>Vectorise parametric data and predict the future, Run various scenarios to identify best-fit result.</td>
<td>to be defined</td>
<td>Develop new technology</td>
<td>X X X</td>
</tr>
<tr>
<td><strong>4. Visualisation and Modelling</strong></td>
<td>Allow accurate presentation of real world</td>
<td>Medium</td>
<td>Presentation of n dimensions over time, with colour shading to display parameters (surfaces, currents, etc) and exclusions (sealanes, wrecks, etc)</td>
<td>to be defined</td>
<td>Develop new technology</td>
<td>X X X</td>
</tr>
<tr>
<td><strong>3. Data Aggregation</strong></td>
<td>Provide a single source of validated reference data with time and GPS stamps</td>
<td>Medium</td>
<td>Data Historian for time-series data, linked to RDBMS for query/reports</td>
<td>ODBC compliant</td>
<td>Adoption of data historian technology</td>
<td>X X X</td>
</tr>
<tr>
<td><strong>2. Communications</strong></td>
<td>Provide a reliable mechanism to transfer data from Instruments to Database</td>
<td>High</td>
<td>Buffering, compression, Send-Receive confirmation, TCP/IP, CSV-ASCII file format,</td>
<td>Complies with EIA232</td>
<td>Encryption, Wireless Communications</td>
<td>X X X</td>
</tr>
<tr>
<td><strong>1. Instruments</strong></td>
<td>Provide accurate measurement of key parameters</td>
<td>High</td>
<td>Ruggedised Instruments, Self-powered, Linear, meet range and resolution requirements, IP addressable</td>
<td>Complies with ANSI/ISA TR77.70.01.2010 Tracking &amp; Reporting of Instrument and Control Data</td>
<td>Self calibrating instruments, suited to North Sea Environment</td>
<td>X X X</td>
</tr>
</tbody>
</table>

**ISIS will deliver enhanced risk management, decision-transparency, compliance**
The ISIS Consortium has 18 Member Organisations

Innovative programming of critical inter-dependencies/topic drivers

Topics of Interest

- User Requirements
- Funding
- Policy & Regulation
- Stakeholders From Marine
- Technical/Academia

Technical Design Office

Program Management Office

ISIS Steering Council

Longer Term Program of Projects

Early Quick Wins

ISIS High Level Vision
ISIS Use Case 1: Coordination of Offshore Measurements

Coordination of measurement efforts and a centralized access to measurement information enables an efficient use of offshore resources on a pan-European scale:

for example coordination of offshore wind power project planning and cross-border grid connections. (Picture NASA)

Benefits:

• Increased certainty from met masts and other energy data collection devices
• Cross-correlation of energy data to provide an energy resource covering locations throughout the sea area covered
• Establishment of the levels of certainty that can be ascribed to various measurement systems, comparison between ‘old’ and ‘new’ methodologies and establishment of their cost/benefit ratios
• Establishment of a redundant/robust grid of measurement systems
• Increased insight in the value of offshore wind sites (‘asset value’), delivering essential information on the return of societal investments into offshore wind power
• Increased insight into long-term wind speed trends

ISIS will deliver better coordination of Offshore Data Collection
ISIS Use Case 2: Meteorological Buoy Data Synchronization

European waters are monitored on a national level using met buoys, capturing a wealth of data – but different data with different measurement standards, time stamps and accuracies. A shared data format allows for the development of a pan-European grid, allowing the development of information that is crucial to capture offshore energy in a sustainable way. (Picture Trinity House)

Benefits:

• Potential to be able to more accurately forecast sea states from one location to another
• Examination the interplay between sea state effects in various locations in real time
• Synchronized real time data, achieving maximum reliability of sea condition measurements across large areas
• Validation of applicability of sea state models

ISIS will deliver better data synchronisation
ISIS Use Case 3:
Overlaying of Existing and Future Offshore Infrastructures

Existing infrastructures can be overlooked when constructing new infrastructure. For example, air force low fly-zones can impact the shipping routes of jack-up vessels used for the installation of new offshore wind turbines.

**Benefits:**

- Integrated presentation of data
- Identify risks earlier, cheaper
Innovation is inhibited by data licence issues:
- Data licence issue throughout European waters
- Over 400 legal entities have licensed ownership of data in Britain
- Need EU Data Ownership Policy

Innovation is inhibited by regional data strategy variation:
- National data archives are at different levels of maturity
- Low Interoperability of data and metadata across EU
- Need EU standard for data archives

Role for Government:
- Build on existing progress made by data communities
- Provide sustainable funding for Innovation
- Provide framework for licensing and re-use of data

Role for ICT Standards:
- Build on existing ISA standards in other Sectors (eg Manufacturing)
- Align relevant IEEE / IEC / ISA standards for computer & electrical devices
- Provide framework for developing integrated standards across supply chain

Barriers are in 3 areas; Technical, Standards, Policy
Conclusion

There is a compelling need for an Integrated Sea Information System (ISIS) to accelerate the €6.4 Trillion European Offshore Wind Industry.

ISIS will Reduce the Risk of developing, constructing and operating Offshore Wind.

To create ISIS we need new, Policies, Regulations, Standards, greater collaboration and innovative Technologies.
Mainstream 's Business Model
http://www.mainstreamrp.com/

Mainstream’s Innovation : A winner in the 2011 Computerworld Innovation Awards
http://www.eiseverywhere.com/ehome/CWHONORS2011/35791/?&

Mainstream’s Innovation: 2011 Harvey Nash CIO Seminar “ A New Age of Innovation “

Mainstream’ IT Strategy: Described by Silicon Republic
http://www.siliconrepublic.com/strategy/item/14728-in-the-mainstream

Mainstream & Intel: joint White-Paper & Video on Offshore Wind Farms
http://www.youtube.com/watch?v=oOlWSWujw8s

Mainstream & Microsoft: Blog on SERA adoption & link to SERA document
http://www.microsoft.com/industry/manufacturing/utilities/default.mspx ( see ‘Spotlight’ Section )

Friends of the Supergrid : driving policy and standards
http://www.friendsofthesupergrid.eu/

Energy Trends : Oil refinery bottleneck report from Richard Branson & from US Military
http://smallwarsjournal.com/blog/2010/03/joint-operating-environment-20-1/

IEEE September 2011 : 100 % Renewable Future

Fortune September 2011 : The need for a Federal Approach to Supergrid

The Economist September 2011 : Arctic Sea Ice is melting faster than the Climate Models predict
http://www.economist.com/node/21530079

Innovation Value Institute
http://www.ivi.ie/