Proposed Smart Grid Vision for South Africa

Presented to AMEU Members by
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Process followed to date

- SANEDI put together the original discussion and circulated to policy workgroup members for comment.

- Policy work group met on the 30 October 2012 and had robust discussions which has lead to a further revision of the document.

- The revised document was circulated to the Policy Working Group members for comment.

- Comment was received from 2 members.

- Policy Work Group met on 15 April to review the proposed changes.

- The latest changes have been made and this is the version circulated to the SASGI members for approval.

- At a meeting on 17 April it was decide to workshop the document.

- At a workshop held on the 22 May 2013, the document was approved by SASGI members.
Process going forward

⚠️ Document is signed off by SASGI and sent to the DoE
# Vision document framework

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Comprehensive Framework to guide the Smart Grid implementation in South Africa

1. Vision
2. As Is Analysis
3. Gap Analysis
4. Strategy and Roadmap
5. Business Case and Value Proposition
6. Required Functionalities
7. Implementation Guidelines

Pilot Findings

ENERGY INNOVATION FOR LIFE
Historic energy system (conceptual)

**UTILITY**

- Hydroelectric
- Coal/Natural Gas
- Nuclear

**Power Flow**

- Consumer

**Information Flow**

- Periodic Information Flow
- Continuous Information Flow
Transformed energy system (conceptual)
As presented in Smarter Energy for Smarter Cities, by IBM Global Energy and Utilities Industry
Policy context

- DME universal access plan
- DoE Strategic plan
- DST 10 year innovation plan
- National Energy Efficiency Strategy for SA
- Climate Change response strategy
- Industrial Policy action Plan 2010-13
- IRP, 2010
- Energy act 2008
- OHSA, 2009
- White paper on renewable energy, 2003
- NPC
Smart Grid relevance to South Africa: Drivers of Change

- Growing energy demand
- Capacity expansion and diversified energy mix
- Energy independence and security
- Environment and climate change
- Economic growth
- Policy and regulation
- Technology advancement
- Increased efficiency through grid operations
- Advanced customer services and consumer empowerment
- Infrastructure reliability and security
- 21st century power quality
# Smart grid response to industry challenges

## Operational Efficiency
- Integrated distributed generation
- Optimised network design
- Infrastructure visibility and control
- Improved asset and resource utilisation and optimisation
- Skills development
- Sustainable job creation
- Knowledge management

## Enhanced Energy Efficiency
- Reduced technical and non-technical losses
- Enables DSM offerings
- Improved load and VAR management
- Complements national energy efficiency policies and objectives
- Supports IRP 2

## Improved Customer Satisfaction
- Reduction in outage frequency and duration
- Improved power quality
- Empowers customers to manage consumption patterns
- Facilitates customer self-service
- Reduced energy costs
- Community upliftment

## Supports National Green Agenda
- Integrates RE generation and embedded/distributed generation
- Enables wide adoption of alternative energy options
- Further reduces GHG emissions via DSM, peak saving, and electrification of public transport
- Complements climate change policy and GHG legislation (inventory, reporting requirements)
Smart grid as an enabler to address industry challenges
A definition that SASGI has incorporated into the smart grid framework documentation:

The European Technology Platform Smart Grid (ETPSG) defines the smart grid as follows:

A Smart Grid is an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies.

Based on ETPSG definition, Smart Grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies to:

- Better facilitate and manage the connection and operation of all sources of energy.
- Give consumers more choice so they can help to optimise energy use;
- Provide consumers with greater information and choice of supply;
- Significantly reduce the environmental impact of the whole electricity supply system;
- Deliver enhanced levels of reliability and security of supply.

Smart Grids deployment must include not only technology, market and commercial considerations, environmental impact, regulatory framework, standardization usage, ICT (Information & Communication Technology) and migration strategy but also societal requirements and governmental edicts.
Proposed SASGI Smart Grid Vision for South Africa

An economically evolved, technology enabled, electricity system that is intelligent, interactive, flexible and efficient and will enable South Africa’s energy use to be sustainable for future generations.

Clarity is provided on the meaning of certain of the words in the vision statement below.

- **Economically Evolved** – affordable electricity system that meets the growing needs of the economy
- **Technology enabled** – fit for purpose ICT, processes, sensors, systems and applications
- **Intelligent** – from data to knowledge
- **Interactive** – ability to monitor, control and manage using two way communications throughout the complete value chain
- **Flexible** – appropriate, scalable and adaptable based on common standards
- **Electricity system** – the complete value chain of all interconnected equipment and components from generation to end use
- **Sustainable** – optimised and affordable from environmental and economic perspectives
Smart Grid Objectives

Implementation of a national smart grid in South Africa aims to enable the following objectives:

- 20% sustainable reduction in South Africa’s peak energy demand relative to the 2012 national baseline.
- 100% grid availability to serve all critical loads as defined nationally and by each utility.
- 40% improvement in system efficiency (measured against the national and local 2012 technical and non-technical losses baseline) and asset utilization to achieve a load factor of 70%.
- 8 GW electricity capacity integrated into the Distribution networks from renewable energy sources.
- Improved service delivery and service reliability to customers to achieve a customer satisfaction index that exceeds 80%.
Cost and Benefits

- Financial
- Technological
- Societal
- Environmental

SMART GRID BENEFITS

ENERGY INNOVATION FOR LIFE
Scope of the smart grid Vision (systems view)

KEY SUCCESS FACTORS

- Performance
- Principal characteristics
- Key technology areas
- Metrics
A Systems Perspective

**Key Success Factors** – The broad goals of the smarter grid.

**Performance** – What the grid must do to succeed.

**Principal Characteristics** – What features and functions are essential to meeting performance requirements.

**Key Technology Areas** – Which technologies support the desired characteristics?

**Metrics** – How progress is measured and compared to the desired level of performance, to ensure that the key success factors are ultimately achieved.
Smart Grid Key Success Factors (KSFs)

The key success factors for the smarter grid establishes a basis for specific performance requirements and for measuring progress and benefits. They are rooted in the consensus of stakeholders who agreed on its broad goals.

Internationally they have converged on the following key success factors:

- **Reliable** – A reliable grid provides power dependably, when and where its users need it. It provides ample warning of growing problems and withstands most disturbances without failing. It takes corrective action before users are affected.

- **Secure** – A secure grid withstands physical and cyber-attacks without suffering massive blackouts or exorbitant recovery costs. It is less vulnerable to natural disasters.

- **Economic** – An economic grid operates under the basic laws of supply and demand, resulting in fair prices and adequate supplies.

- **Efficient** – An efficient grid takes advantage of investments that lead to cost control, reduced transmission and distribution electrical losses, more efficient power production and lower costs of ownership.

- **Environmentally friendly** – An environmentally friendly grid reduces environmental impacts through initiatives in generation, transmission, distribution, storage and consumption.

- **Safe** – A safe grid does no harm to the public or to grid workers and is sensitive to users who depend on it for life safety.
Smart Grid performance requirements

If we want the grid to succeed as described in the previous section, it must meet certain performance standards. The following are seen as five essential requirements:

- **Emergency response** – A smarter grid provides advanced analysis to predict problems before they occur and to assess problems as they develop. This allows steps to be taken to minimise impacts and to respond more effectively.

- **Restoration** – It can take days or weeks to return today’s grid to full operation after an emergency. A smarter grid can be restored faster and at lower cost as better information, control and communications tools become available to assist operators and field personnel.

- **Routine operations** – With a smarter grid, operators can understand the state and trajectory of the grid, provide recommendations for secure operation, and allow appropriate controls to be initiated. They will depend on the help of advanced visualisation and control tools, fast simulations and decision support capabilities.

- **Optimisation** – The smarter grid provides advanced tools to understand conditions, evaluate options and exert a wide range of control actions to optimise grid performance from reliability, environmental, efficiency and economic perspectives.

- **System planning** – Smarter Grid planners must analyse projected growth in supply and demand to guide their decisions about what to build, when to build and where to build. Smarter grid data mining and modelling will provide much more accurate information to answer those questions.
Principle Characteristics of a Smart Grid

In the systems view, the smart grid:

– Enables Active Consumer Participation
– Accommodates All Generation and Storage Options
– Enables New Products, Services, and Markets
– Provides Power Quality for the Digital Economy
– Optimises Asset Utilisation and Operates Efficiently
– Anticipates and Responds to System Disturbances
– Operates Resiliently Against Attack and Natural Disaster
Smart Grid Technology areas

- Advanced Control Methods
- Integrated communications
- Advanced components
- Decision Support and improved interfaces
- Sensors and measurement

ENERGY INNOVATION FOR LIFE
Envisaged smart grid initiatives and interfaces for South Africa
Illustrating the correlation between applications and key success factors

- AMI
- CS
- DR
- DMS
- AO
- TA
- DER
- ICT

Reliability
Economics
Efficiency
Environmental
Safety
Security

ENERGY INNOVATION FOR LIFE
Indicative smart grid sequencing roadmap

- Customer Enablement: CE should produce benefits quickly with relatively short implementation timeline. Empowers the customer and enables grid interaction.
- Advanced Distribution: Improves reliability and enables self-healing. Addresses congestion and integration with DER and other interfaces.
- Advanced Transmission: Helps utilities reduce costs and operate more efficiently.
- Advanced Asset Management: AAM extended implementation timeline requiring an early start, but benefits will accrue as implementation progresses.

**ENERGY INNOVATION FOR LIFE**
Accumulation of benefits (conceptual) as smart grid components are incorporated.

- **Customer Enablement**: CE should produce benefits quickly with relatively short implementation timeline.
  - Empowers the customer and enables grid interaction.
- **Advanced Distribution**: Improves reliability and enables self-healing.
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Smart grid benefits accrue as components are integrated and synergies of system components are exploited. But a point of plateau is reached where further investment delivers small returns.
Correlating the prioritised applications with the four functional areas:

<table>
<thead>
<tr>
<th>Generation</th>
<th>Transmission</th>
<th>Distribution</th>
<th>Industrial</th>
<th>Service</th>
<th>Residential</th>
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<tr>
<td><img src="image1" alt="Generation" /></td>
<td><img src="image2" alt="Transmission" /></td>
<td><img src="image3" alt="Distribution" /></td>
<td><img src="image4" alt="Industrial" /></td>
<td><img src="image5" alt="Service" /></td>
<td><img src="image6" alt="Residential" /></td>
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</tbody>
</table>

**Information and communication technology (ICT) integration**

**Asset / System Optimization (AO)**

**Advanced Asset Management (AAM)**

**Advanced Transmission Operation**

**Transmission enhancement applications (TA)**

**Advanced Distribution Operation**

**Renewable and distributed generation integration / Distributed Energy Resources (DER)**

**Distribution Management System / Distribution Automation (DMS)**

**Consumer Enablement**

**Demand Response (DR)**

**Advanced Metering Infrastructure (AMI)**

**Customer Side Systems (CS)**

ENERGY INNOVATION FOR LIFE
## A “System of Systems”

<table>
<thead>
<tr>
<th>Principle Characteristic</th>
<th>CE</th>
<th>ADO</th>
<th>ATO</th>
<th>AAM</th>
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</thead>
<tbody>
<tr>
<td>Enables Active Consumer Participation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
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<td>Accommodates All Generation &amp; Storage Options</td>
<td>✓</td>
<td>✓</td>
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<td>Provides PQ for Digital Economy</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Optimizes Assets &amp; Operates Efficiently</td>
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<td>✓</td>
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</tr>
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Comprehensive view of smart grid applications in each functional area
5 evolutionary steps to achieving the Smart Grid

**Step 1: Intelligent Device Infrastructure**
- AMI, or Smart Meters
- Distribution Automation Devices
- Demand Response Devices
- Substation IED Controllers

**Step 2: Communications Infrastructure**
- Enterprise Communications System for rapid and accurate transmission of data
- Integration of fibre and mesh broadband networks

**Step 3: Integration**
- Corporate IT systems integrated to allow rapid processing of data
- Open architecture based design to facilitate sharing of information

**Step 4: Analytical Infrastructure**
- Development of new data analysis capabilities
- Increased ability to display information (in form of dashboards)

**Step 5: Optimisation**
- Capability of real-time optimisation of the distribution network performance
- Decisions based on near real-time information, no longer only historical data

**Accelerated by DoE-EU donor funding**

**Energy Innovation for Life**
THANK YOU
Example of AMI deployment