SIEMENS

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Dear Mr Hall

Integrated Smart Energy Grids for the Central Queensland Coal Network

Siemens submitted a letter to the Queensland Competition Authority (QCA) on 25 September 2012, highlighting the key benefits of rail electrification and of using electric locomotives in the Central Queensland coal networks (CQCN). In addition to this submission, Siemens strongly believes that an Integrated Smart Energy Grid in Queensland will yield long term capital expenditure reductions and superior efficiencies. The purpose of this submission is to picture Queensland's future energy network utopia and supplement information which will assist stakeholders with strategic investment decisions.

1.0 Background

On 27 July 2012, the QCA issued a draft decision rejecting QR Network's (QRN) draft amendments to the current Access Undertaking (DAAU) for the operation of trains under electrified rail infrastructure in the CQCN.

It appears to Siemens that the majority of stakeholder discussion subsequent to the release of the QCA's draft decision has so far only concentrated on the relevant efficiency benefits of rail electrification.

Siemens has noted that this discussion is limited by the fact that it has considered the CQCN as a discrete system and does not envision the CQCN as a part of an Integrated Smart Energy Grid. The discussion does not consider the potential ramifications of any decisions on the energy requirements of the CQCN presently and into the future.

Siemens is a leading provider of sustainable and efficient energy solutions at every position of the energy supply chain and is therefore uniquely positioned to inform on the potential benefits of making timely investment decisions.

Siemens strongly asserts that the potential efficiency benefits of an integrated, non-passive, smart and efficient power grid servicing the needs of all energy stakeholders in Central Queensland (i.e. mining, residential, rail, agriculture and ports) significantly surpass the benefits of rail electrification when taken in isolation and hence should not be discounted as part of the ongoing discussions on the merits of the DAAU.

It is essential that QCA and all stakeholders consider this fact when deciding on the future for rail electrification in the CQCN, as making suboptimum decisions at this time will confine energy stakeholders in Central Queensland to technology that has a limited life span and will limit the possibility of realising the full value proposition of Smart Grids in the future.

It is also important to note that the future concept of Smart Grids is no longer a pipe dream and can be achieved using the technology that is already generally available.

2.0 Integrated Smart Energy Grids of the Future

Today the energy industry faces major challenges to cope with the future needs of electrical power:

- Stringent emission reductions goals;
- An over-reliance on unsustainable, unreliable and aging energy sources;
- Limitations in current energy transmission and distribution networks;
- An emerging passive energy usage culture;
- An inherent focus on localised discrete systems rather than considering the ultimate integrated vision and long term benefits when considering investment;
- Smarter demand from consumers not matched by smarter supply;
- Peak energy demands driving investment; and
- Degradation of power quality due to renewable energy source integration.

In traditional power networks, generation capacity is increased to match the increasing load profile; however this philosophy is no longer deemed sustainable. The use of renewable energy resources together with the electrification of transportation leads to a paradigm shift, essentially reversing the philosophy behind the operation of current power systems. The principle of 'generation follows load' has been inverted to 'load follows generation' by the introduction of new technologies such as distributed generation, demand side management and advanced metering.

Power systems infrastructure requires major capital investment with lifetimes spanning several decades. Hence wholesale changes to the systems cannot be made without defining a distinct migration path. The correct migration path will transform the passive power networks of today into active, efficient Integrated Smart Energy Grids of tomorrow.

The above challenges and industry trends coupled with sustainability drivers are as a result revolutionising the energy sector. The concept of Smart Grids has been established as a result of this drive for change.

Smart Grids utilise innovative technology and transition the shift from an open loop controlled system to a closed loop adaptive system involving bidirectional communications and controls. This concept enhances the possibilities of designing an efficient, sustainable energy system whilst envisaging a low carbon economy. It is important that we address these challenges carefully before we commit to strategic investment decisions and not limit ourselves to technology that will impede efficiency opportunities. Smart Grid implementations will enable the incorporation of these concepts through the use of technology that is available today.

3.0 Future of the Queensland Energy Supply

It is important to understand the dynamics of the present Queensland energy network and visualise what this network may look like in 2030. Once we are able to picture this future vision, we can work backwards to see how we can bring this vision into reality, essentially creating opportunities with technology available today.

3.1 Existing Power Generation Sites and Transmission Network of Queensland

The existing power generation sites and the transmission network are shown in Figure 1 below. Approximately 70% of the State's energy is generated by coal fired power stations, which is in contrast to the Federal Government's low carbon economy footprint initiatives. It is also evident that the majority of these generation sources are located far away from the CQCN, thus contributing to significant transmission network losses. The maintenance costs of these aging generation assets and transmission network upgrade costs are a severe economical burden and are deemed unsustainable in the long run. It is also important to note that deferring such capital investment exposes considerable risks on reliability and availability of supply.

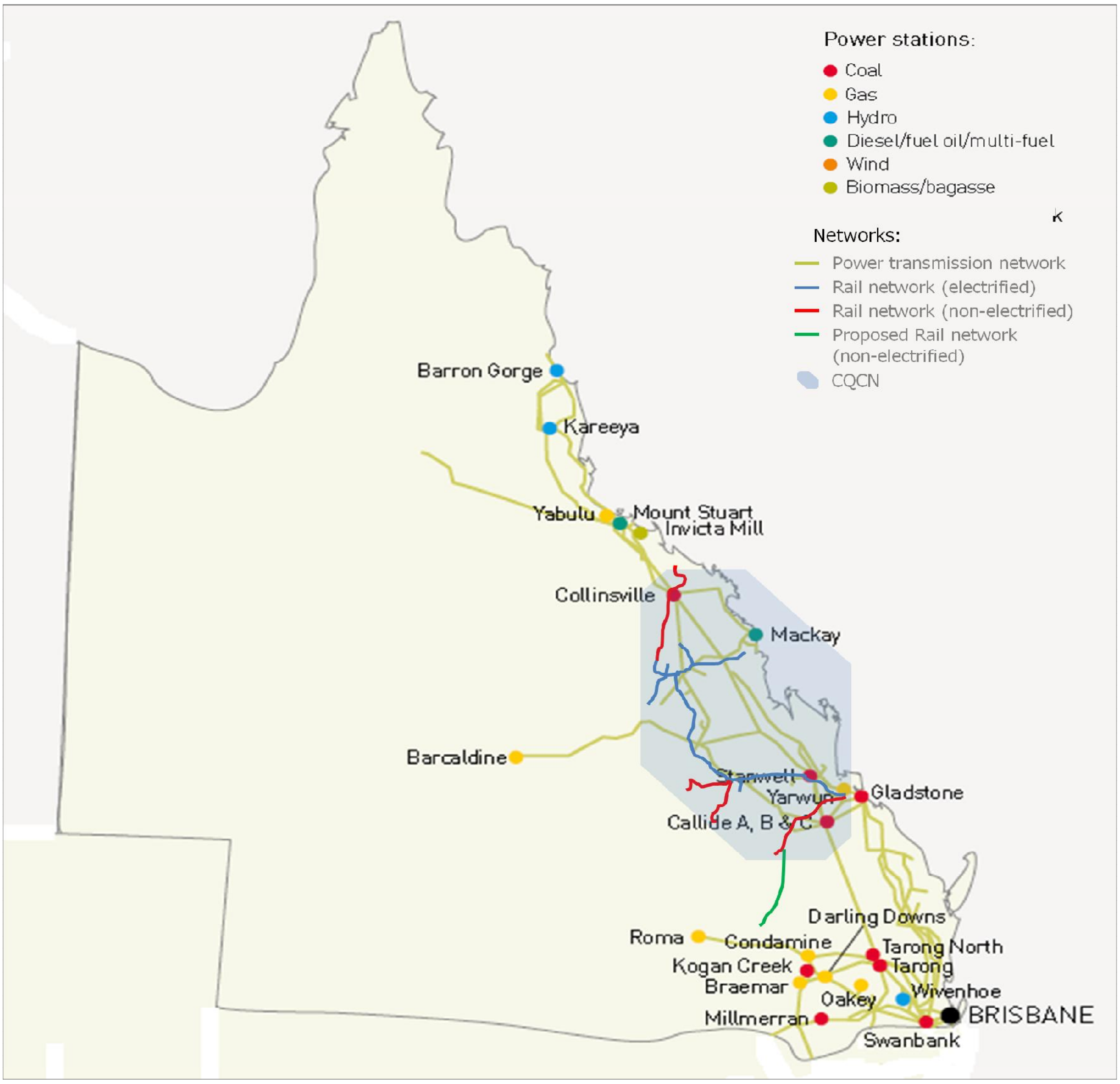

Figure 1: Queensland map showing current power infrastructure in relation to the CQCN

3.2 Preview of the Future Integrated Smart Energy Grid of Queensland

Can we imagine the elements of an energy sector utopia? Siemens can envision the CQCN connected by one large scale integrated, smart, adaptive, sustainable, efficient power grid connecting all major end users (such as mines and ports) to all energy sources (existing and future generation assets). We can picture that the electrified rail network will be inter-connected to the transmission power grid thus facilitating bi-directional power flow of energy between generators and consumers.

Table 1 below illustrates the future generation sources in Queensland and their proximity to the CQCN. It is an interesting trend to note that nearly 25% of the projects currently either under development or proposed consist of renewable energy generation such as solar and wind farms. For example, Coopers Gap, Bowen and Crows Nest wind farm projects are all large scale projects with capacities between 200 – 750MW. These projects are clearly targeted towards meeting emission reduction goals and portrays a blueprint of a sustainable future.

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Project	Generation Type	Nameplate Capacity (MW)	Proximity to coal rail infrastructre	Commissioning Start Date
Bowen	Wind	120-240	Within Newlands coal rail system	TBA
Braemar 3	OCGT	500	Close to proposed Surat coal rail system	Dec-13
Burdekin Falls Dam	Gravity Hydroelectric	37	Close to Newlands coal rail system	Jan-15
Coopers Gap	Wind	350	Close to proposed Surat coal rail system	TBA
Crediton	Wind	40-90	Within Goonyella coal rail system	TBA
Crows Nest	Wind	200	Close to proposed Surat coal rail system	TBA
Darling Downs Stage 2	OCGT	500	Close to proposed Surat coal rail system	May-14
Forsayth	Wind	70	600km from Newlands coal rail system	Nov-13
High Road	Wind	35	500km from Newlands coal rail system	Dec-12
Kogan Creek (Solar Boost)	Solar Thermal	44	Close to proposed Surat coal rail system	Jul-12
Spring Gully	CCGT	1,000	Close to proposed Surat coal rail system	Jan-19
Wandoan Power Project	IGCC	504	Within proposed Surat coal rail system	2017/18
Westlink Power Project	OCGT	~334 (up to 1,000 for full project)	Within West Moreton coal rail system	Jun-14
	OCGT			Jun-16
	OCGT			Jun-18
Windy Hill II	Wind		500km from Newlands coal rail system	TBA
Blackwater	Compression Reciprocating Engine	29.4	Within Blackwater coal rail system	Aug-12

Table 1: Power infrastructure under development in Queensland in relation to the CQCN

3.3 Potential Benefits of an Integrated Smart Energy Grid

- Reduction in Transmission & Distribution Network Capital Expenditure

  Inter-connectivity of the electrified CQCN, the transmission power grid and consumer sites not only enhances the overall system efficiency, but also potentially eliminates the need for major capital expenditure upgrades. The CQCN can act as an intermediate sub-transmission network and distribute energy to the local consumers.

  Furthermore, the emergence of various localised, intermittent distributed power generation sources further enhances efficiency by matching smart demand with smart supply; for instance, if a coal mine's demand is less, then the excess supply can be exported back onto the distribution network for other consumers such as the CQCN. Such distributed energy sources shall comprise of co-generation, tri-generation, solar and industrial peaker power plants. The CQCN would facilitate this bi-directional transfer increasing the efficiency benefits, whilst deferring the need for capital intensive distribution network upgrades.

- Real Time Energy Trading

  This electricity spot market open trading will enable consumers to purchase energy from renewable generation sources and contribute to the Federal Government's 2020 20% renewable sourced electricity target. At a localised level, consumers and buildings can supplement their energy requirements by Solar PV installations on their roof tops and benefit from state based grid feed-in tariff regimes. In return this will promote the creation of competitive pricing market models and sustainability.

- Demand Side Management

  The "load follows generation" paradigm shift is largely attributed to the modification of consumer demand profiles. As per Figure 2 below, demand side management encourages the use of less energy during peak periods and defer until off peak periods. Through the efficient roll-out of smart metering programs, the users now have up to date real time data about their consumption patterns. Both the distribution network and the electricity consumers derive financial initiatives through such measures. The network operators can curtail load and defer asset investments, while the consumers receive incentive payments via smarter usage. This mechanism also addresses the challenge of peak energy demand driven investment.

Figure 2: Demand Response Event

- Continuity and Reliability of Supply

  A Smart Grid's backbone comprises of robust, redundant communication and information technologies to enhance the grid reliability. Through the use of a mixture of generation sources and self healing network capabilities, overall system reliability is enhanced. These self healing networks utilise innovative fault detection, isolation and restoration techniques, essentially minimising the loss of supply to a few power system cycles thus ensuring a much higher degree of reliability than conventional systems of today.

- Energy Regeneration by Braking Locomotives

  As mentioned in our previous submission, locomotives can improve their energy efficiency through the use of electrical energy generated by the traction motors when used to brake the train (dynamic braking). In the case of an electric locomotive, the majority of the dynamic braking energy can be regenerated back into the electrified infrastructure to be consumed by other locomotives in the section or exported back onto the distribution network for other consumers.

- Intelligent linking to the operational systems of end-users

  Integrated Smart Energy Grids could be linked into the train control and scheduling systems of QRN or the operational systems of miners to balance demand and supply to provide further efficiency benefits.

3.4 Innovative Smart Grid Offerings from Siemens

- Demand Response

  Automated demand response management system (DRMS) is a tailored solution, which enables consumers to dispatch load as the most economic power supply, avoiding generation bottlenecks through peak load reduction on the demand side. This solution will make the Integrated Smart Energy Grid more reliable by planning and delivering demand response events with greater control, speed, and accuracy, thus ensuring grid stability through the efficient use of existing network infrastructure and selective load dispatch.

- Virtual Power Plants (VPPs)

  The VPP concept optimises the overall energy management by efficiently controlling the generation mix of the various plant types, shifting energy consumption into times of economic energy supply and furthermore leveraging storage to balance the energy system.

  Future distributed energy resources envisaged in the CQCN such as solar, wind and natural gas will be integrated into a Decentralised Energy Management System (Figure 3), facilitating central control. Then generation is carefully balanced through efficient integration of storage and loads.

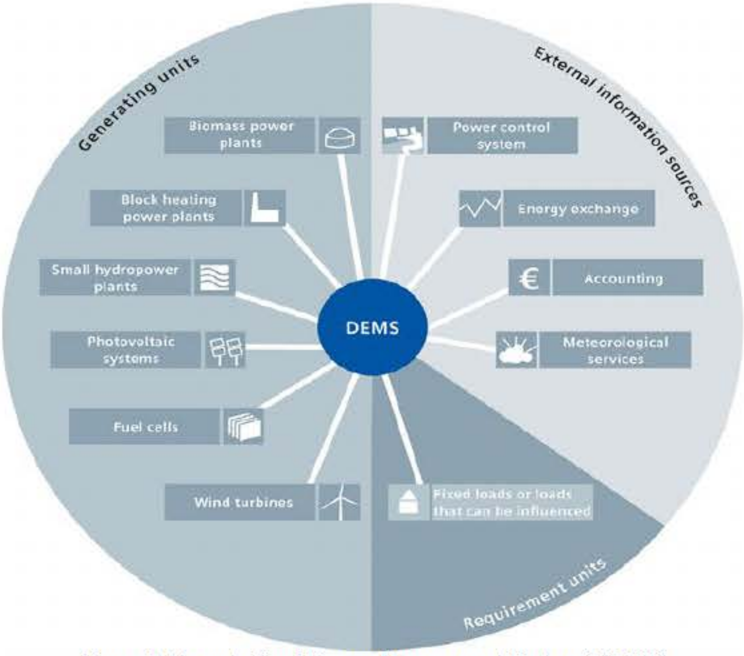

Figure 3: Decentralised Energy Management System (DEMS)

- Microgrid – Large Island Grids

  Microgrids enable optimal integration of renewable energy sources by detailed operation planning and have the ability to include multiple input parameters such as weather forecasts and market price scheduling data. The system, which has a point of common coupling is designed to operate in an islanded configuration and focuses on the integration of a high proportion of renewable energy sources (Figure 4) by balancing energy fluctuations and permitting black starts. The concept is targeted towards low carbon emissions and security of energy supply.

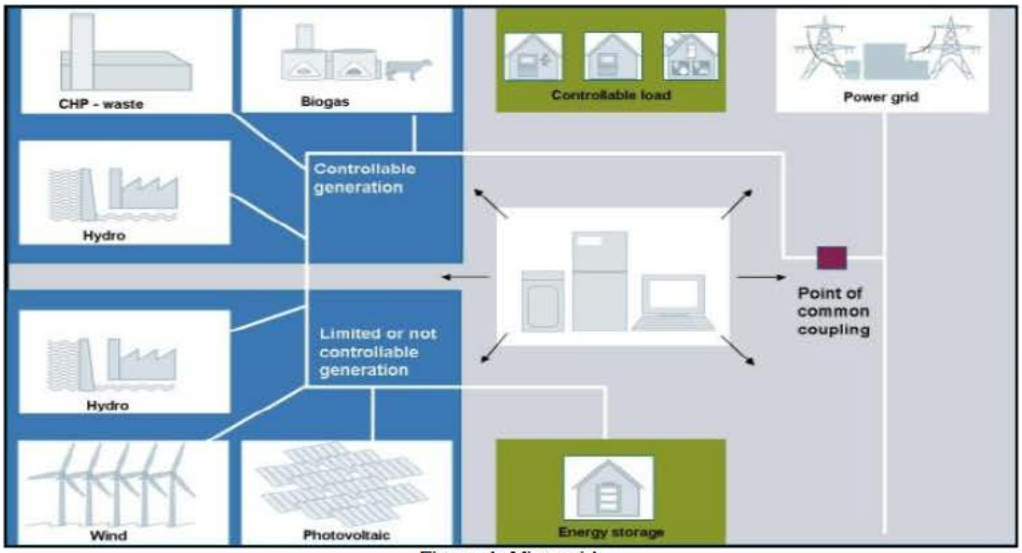

Figure 4: Microgrid

3.5 Smart Grid Case Studies

- Integration of Renewable Energy and Electromobility - Project Irene

  Project Irene targeted the challenges distribution networks will face by 2020 through the establishment of a future vision research and development project. Siemens partnered with AUW and two German universities to implementation this German government funded initiative. High in-feeds of distributed renewable generation and uptake of electric vehicle usage were some of the associated challenges. The Siemens solution addressed the following aspects;

  - Installation of a measurement and control system with high in feeds from renewable sources
  - Coordination and management of electric vehicle charging
  - Control active and reactive power from PV
  - Storage of solar energy in different sized stationary batteries
  - Voltage regulation via distribution transformer tap changer control

- Flexible Electricity Network to integrate the Expected Energy Evolution – Project Fenix

  The main objective of Project Fenix combined the different types of Distributed Energy Resources. However, the output capacities of these resources were low for individual participation in the Energy market. The DEMS system receives the daily schedule of the DERs, aggregates with cost and prices, and offers to the market. If all or part of the offer is accepted, DEMS will deaggregate the accepted generation capacity to each of the sources taking into consideration the network constraints from the transmission and distribution network operators.

- Ultra high speed fault location, isolation and service restoration system for A&N Electric Cooperative, Tasley Virginia U.S.A.

  The primary objective of this project was to ensure continuity and reliability of supply to a critical health facility and Siemens implemented a state of the art tailored, technology solution. The existing system at A&N Electric took up to an hour of service outages for identification of a fault. Once identified, manual dispatch, isolation and restoration was necessary. The implemented solution based on the Siemens Distribution Feeder Automation (SDFA) system allowed A&N to locate, isolate and restore in less than 500ms. This cutting edge technology allowed restoration of service to the unaffected areas, minimise outage and dispatch times.

4.0 Conclusions

The inherent use of renewable energy resources along with the electrification of rail networks leads to a paradigm shift in the approach of the energy industry to energy demand. This shift also presents a number of challenges which can be addressed by the introduction of new Smart Grid technology concepts such as distributed generation, demand side management and advanced metering.

As a leading provider of sustainable and efficient energy solutions, Siemens can picture an energy utopia for Queensland comprising of a large scale energy grid inter-connecting the electrified CQCN and the transmission power grid, thus facilitating bi-directional power flow of energy between generators and consumers. Through the use of innovative technology the CQCN can realise significant efficiency and sustainability benefits and defer capital expenditure programs.

In consideration of the above, we recommend QCA carefully assess the future vision of an Integrated Smart Energy Grid prior to making any investment decisions and not allow the CQCN to be confined to technologies that will limit future system integration.

Yours sincerely,

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