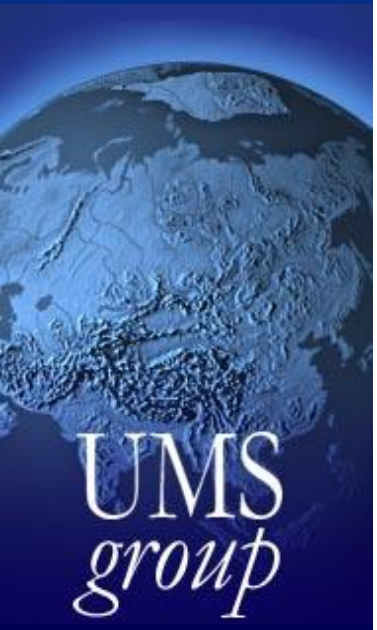


Americas
Asia Pacific
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# *Disruptive Technologies facing the Electric Utility Industry*

**Major challenges for asset managers in managing a new landscape of business and asset risk, incorporating new technologies and market models**

*AMC, Technical Meeting, 15 Oct 2014*
*Sydney, Australia*

*Tony Saker / Ed de Vroedt*
*UMS Group Asia Pacific*

# Confidentiality

# Contents


1. Defining the Challenge For Electric Networks
2. Future Scenarios and Possible States
3. New Market Designs: Transition & 4 Market Scenarios
4. Signposting
5. Key Considerations Going Forward

# 1. Background and Defining The Challenge For Electric Networks

**Distribution networks are experiencing challenges that may be defined as generational and unforseen since electricity networks began over a century ago. The significant drivers for change can be summarised as follows and will be major challenges for asset managers who need to manage a new landscape of business and asset risk:**

- **Disruptive technologies are emerging that may compete with utility-provided services**, i.e solar photovoltaics (PV), battery storage, fuel cells, geothermal energy systems, wind, micro turbines and electric vehicle (EV) enhanced storage.

- **As the cost curve of these technologies improve, they directly threaten the centralised utility model**. Residential and commercial utility customers can now generate some or all of their own power economically instead of drawing from the grid.

- Threat to centralised utility service model is likely to come from **new technologies or customer behavioural changes that reduce load.** There is a longer term threat of fully exiting from the grid (or customers solely using the electric grid for backup purposes) that increases the risk of irreparable damages to revenues and growth prospects.

- Due to the variable nature of Decentralised Energy Renewables (DER) technologies, there is a perception that customers will always need to remain on the grid. While we would expect customers to remain on the grid until a fully viable and economic distributed non-variable resource is available, there may be a day when battery storage technology or micro turbines would **allow customers to be electric grid independent.**

# 1. Background and Defining The Challenge For Electric Networks

**Distribution networks are experiencing challenges that may be defined as generational and unforseen since electricity networks began over a century ago. The significant drivers for change can be summarised as follows and will be major challenges for asset managers who need to manage a new landscape of business and asset risk:**

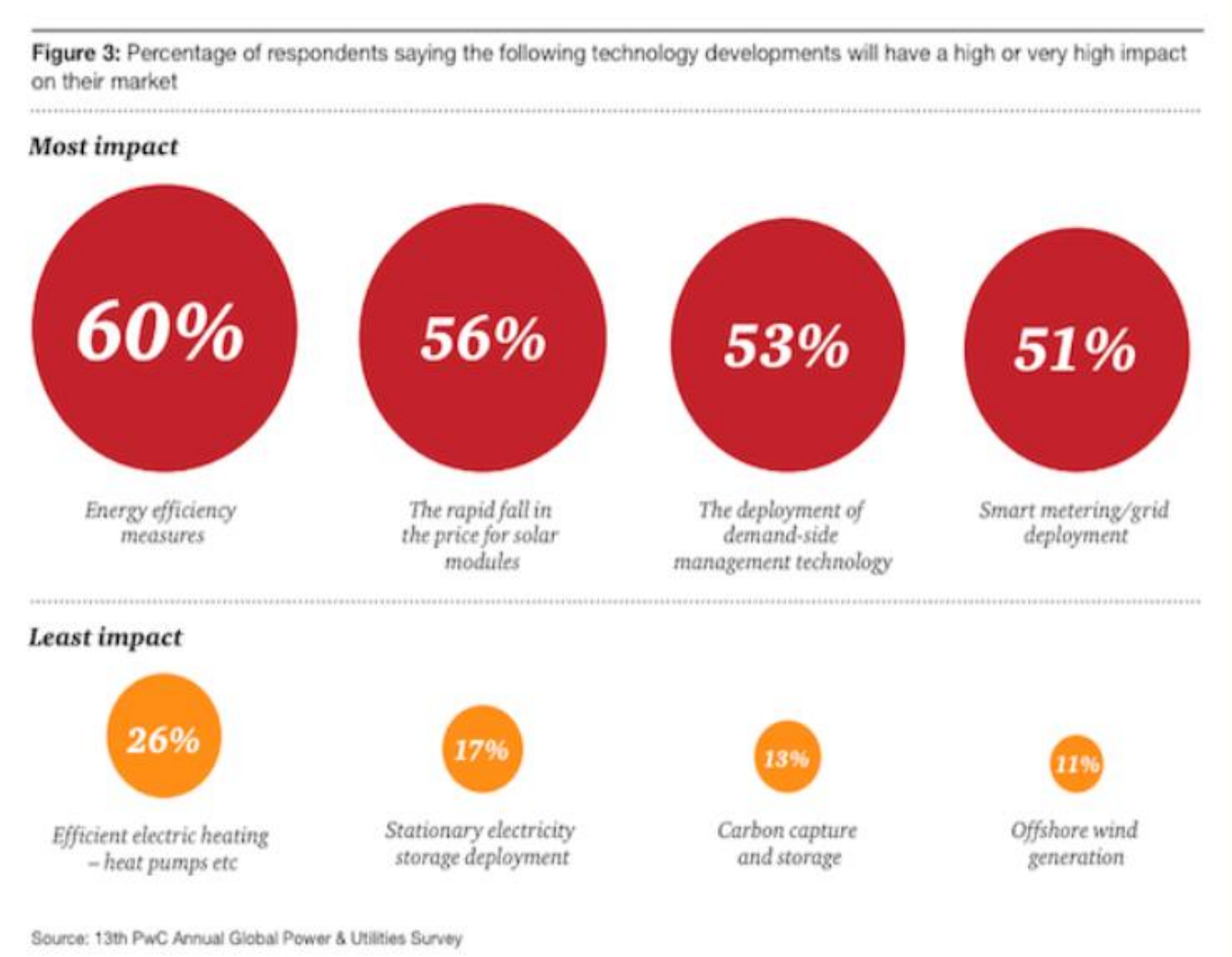
- **We see increased customer, regulatory and political interest in demand side management (DSM) technologies**. The cheapest watt is one you don't have to generate and the most expensive watt is the one that has to be generated at peak times. There is a drive for efficient load shifting away from peak times.

- **Rising electricity prices** in developed markets.

- **Financial Risks** to distribution utilities created by disruptive challenges:
  - **Declining utility revenues** - as DER and DSM programs continue to capture "market share".
  - **Increased costs** - higher costs to integrate DER, the cost of providing interconnection and back-up supply for variable resources will add to the utility cost. If not addressed in the tariff structure, the provision of these services will create additional lost revenues and will further challenge non-DER participants in terms of being allocated costs incurred to serve others.
  - **Lower profitability potential** over the long run - increasing subsidies for DSM and direct metering will result in the potential to reduce profitability.

# 1. Background and Defining The Challenge For Electric Networks

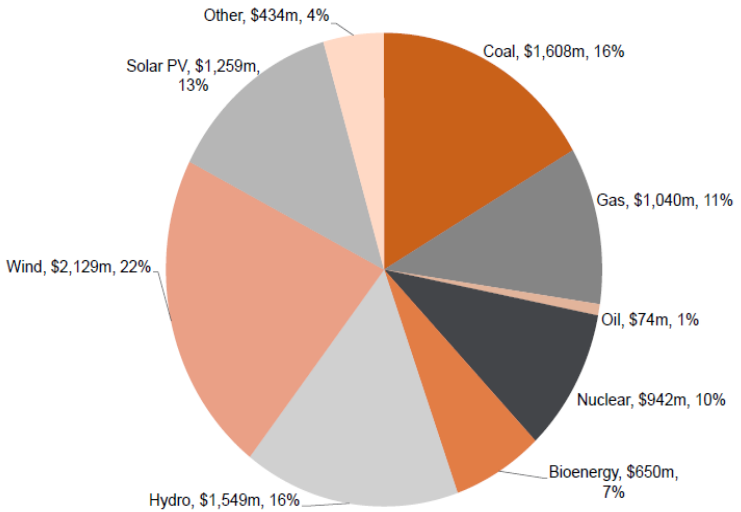
**A number of technological and customer behavioral changes are required for consideration eg, the changing mindset of the customer as shown**



# 1. Background and Defining The Challenge For Electric Networks

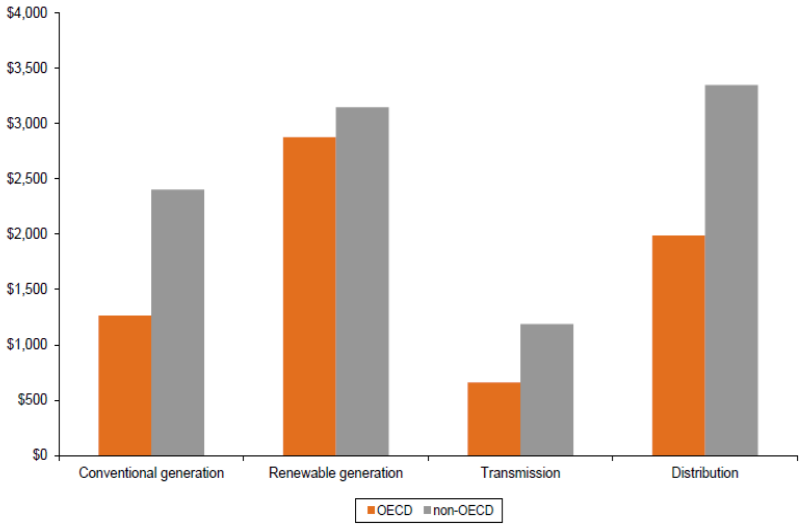
**A number of technological and customer behavioral changes are required for consideration eg, 51% of global investment is in renewable energy generation as shown**

Figure 19. Split of $9.7trn global investment in power generation by technology




Source: World Energy Outlook 2012© OECD/ IEA 2012

Figure 20. Split of investment in generation, transmission and distribution by OECD and non-OECD




Source: World Energy Outlook 2012© OECD/ IEA 2012

# 1. Background and Defining The Challenge For Electric Networks – Emerging Technologies

**A number of technological and customer behavioral changes are required for consideration eg, San Diego Gas & Electric (SDG&E), USA, integration of smart grid and renewable energy**

- SDG&E is installing smart grid technologies on the electric grid which includes devices that are able to integrate renewable energy i.e., wind and solar.
- As we may know, renewable energy is naturally intermittent, thus pose some challenges for the utility. To solve this issue, SDG&E is deploying a **voltage stabilizer** called “dynamic var device” which will level out the voltage drops caused by fluctuating solar generation. SDG&E also installed 5 batteries (3 small units in the community and 2 large units at a SDG&E substation), which will provide power when output from renewable sources fluctuates or becomes temporarily unavailable.
- SDG&E also received numerous awards for this effort: Named one of the "Top Ten Best North American Utilities" award for smart grid development from Greentech Media, One of four utilities highlighted for successful smart grid customer engagement efforts in a report by the Smart Grid Consumer Collaborative, named "Most Intelligent Utility" for three years in a row by Intelligent Utility magazine, and the POWER magazine's prestigious "2012 Smart Grid Award" for the nation's most advanced smart grid

## 7 Solar Innovations identified by Sustainable Industries.com

- An article “7 new solar innovations that could change the world” from Sustainable industries is very interesting:

- Bringing light to developing countries. There were still a lot of people around the world who have no access to electricity and are just using kerosene lamps, which apparently, is dangerous to health and to induce unwanted fire. There were companies who developed small, solar charging lamps that can replace the kerosene lamps. On some higher scales some companies are developing clean energy microgrids, a small group of solar panels which provide electricity to 2-4 LED lights and a cell phone charger for up to 100 household.

- Infrared solar. A group of MIT researchers have pioneered a new carbon-based solar panel that can harness the light in the infrared range. Luckily, the new carbon cells are transparent, meaning they could be transposed on top of silicon-based cells to gather both infrared and visible sunlight. The cells are made of carbon nanotubes which are highly absorptive while needing very little material.

- Building integrated photovoltaics. Building integrated photovoltaics (BIPVs) are thin-film solar panels built smoothly into building materials like roof shingles, curtain walls, facades, or windows

## 7 Solar Innovations identified by Sustainable Industries.com

- Solar leaf. Made from a thin silicon solar cell, the leaf is dropped into water where it separates hydrogen and oxygen molecules that are collected and connected to fuel cells that produce electricity. The leaves can't collect energy as efficiently as traditional solar PVs, but are incredibly cheap to make.

- Solar-powered mobile gadgets. Solar power on mobile gadgets is still in its novelty phase, but expect to see more innovations in the next few years. There are currently over 1 billion smartphones in use around the world. While the energy usage of charging a smartphone is small for each individual, collectively we are contributing 10 trillion pounds of CO2 each year.

- Solar-powered transportation. The fastest growing electric car company, Tesla Motors, has been making exciting progress recently as they posted their first quarterly profit in 2013 Q1 and repaid their Department of Energy loan nine years early in May. And finally someone made environmentally friendly cars look good. New innovations in solar fueled charging could complete the solar to transportation chain.

- New solar manufacturing processes. While not as flashy as fuel-cell leaves or solar airplanes, new innovations in the manufacturing process of the silicon solar panels that currently permeate the market could have the biggest impact in bringing production costs low enough to compete with fossil fuels.

## MIT Innovative Battery prototype

- Recently, researchers from Massachusetts Institute of Technology (MIT) unveiled a prototype battery, which is membrane-free and rechargeable, that could accommodate large scale energy storage, support renewable energy use, and is cheaper.
- By eliminating the need for expensive membranes and delivering a power density an order of magnitude exceeding lithium-ion batteries and up to three times greater than other membrane-free systems, it will be capable of overcoming issues of energy storage, cost, and performance.
- The researchers present a palm-sized prototype of the battery but claimed that it can be scaled up to match a utility-size energy storage need and support the usage of intermittent renewable energy.

## Energy Storage

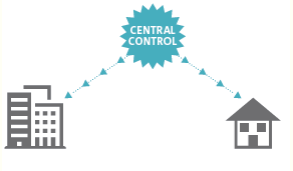
- China currently hold the world's largest battery, which helped them integrate a solar and wind farm infrastructure into a smart grid. The battery bank is a size of a building and can store up to 36MWh of power. The bank was built as a joint venture between solar and electric car company BYD and the State Grid Corporation of China to improve a large wind and solar electric installation's efficiency by 5-10%.

- Duke Energy's 402-KW battery project at the Rankin substation has been chosen by PowerGrid International magazine as its Project of the Year. The battery bank would enable Duke Energy to integrate the local power grid with renewable energy and to fill-in any variations in power flow from the connected solar power plant.

- Vector is a listed New Zealand utility operating the distribution network in Auckland. Vector has rolled out a solar battery leasing package that offers rooptop solar, lithium-ion batteries and control devices at no extra cost to consumers. They intend to expand the roll out to other homes and commercial businesses.

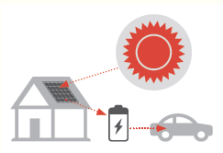
# 2. Future Scenarios and Possible States

**We see changes appearing to head, in varying degrees, generally in the direction of the following 5 scenarios: *Source : CSIRO Future Grid Forum***




1. **Set & Forget** - sustained high prices are pushing customers to decide on a level of demand that best suits them. Demand measures like centralised control, on- site storage, advanced metering etc are set in place and then left alone.

2. **Rise of the Prosumer –** customers are empowered to become more actively engaged in their electricity supply. Uptake and impact of on site generation technology is significant. This is a key and emerging customer segment that needs to be proactively managed



3. **Leaving the Grid –** volume based pricing still dominates and energy efficiency is encouraged but peak demand still grows giving rise to lower network utilisation but increasing retail prices. Service providers rise to offer alternatives and invite consumers to leave the grid. By 2030 disconnection becomes a mainstream option as on site storage costs reduce


4. **Renewables Thrive** –reducing costs of renewable technologies along with incentives by government means 100% renewables by 2050 for centralised control/basis of electricity generation, and use of on site storage capacity to cover renewable supply gaps

**Decentralised Energy Market -** Decentralised Energy (DE) technologies optimise the use of local resources and reduces the need for large-scale energy supply infrastructure. The three elements of DE is efficient use of energy, peak load management and distributed generation. The lowest-cost deployment of DE could unlock $billion of savings per year for electricity consumers by 2020.

Primary Source: CSIRO

# Contents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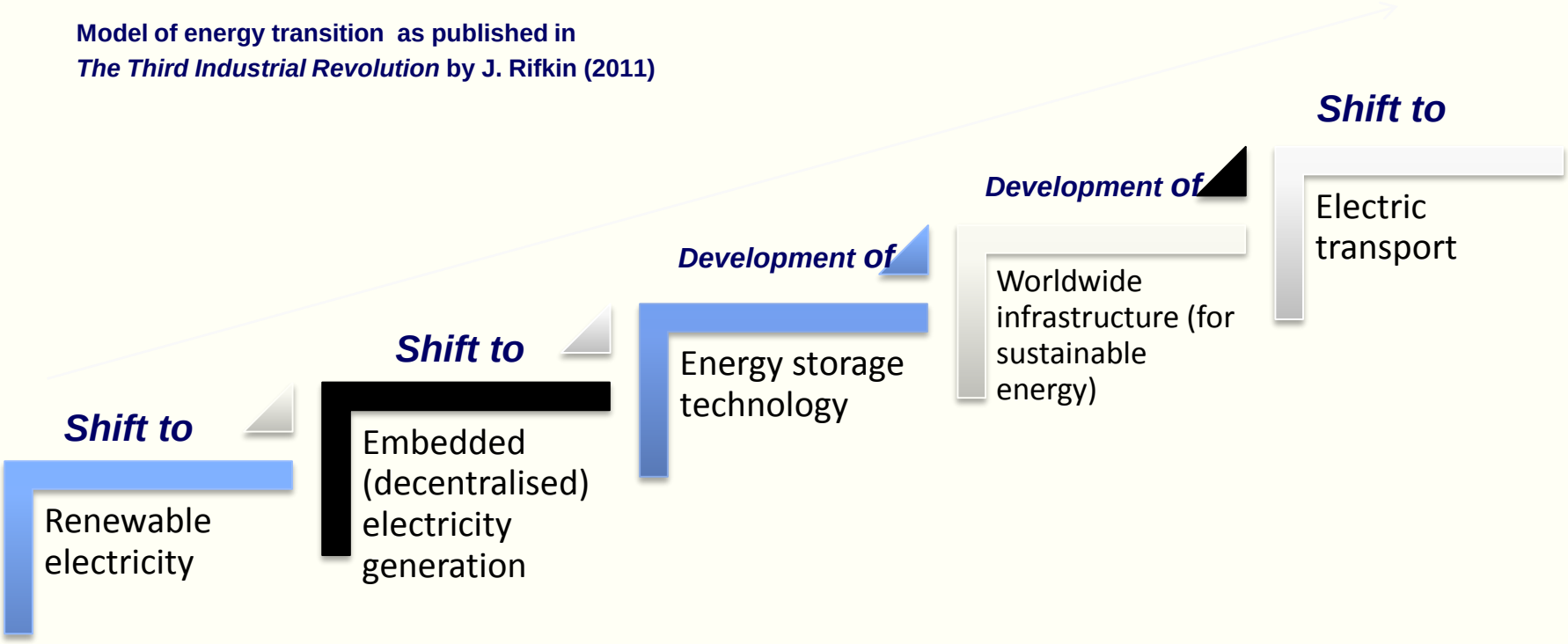
# 3. New Market Designs: Transition & 4 Market Scenarios

Jeremy Rifkin published a theory that the energy transition from fossil fuels to renewables occurs in five different stages

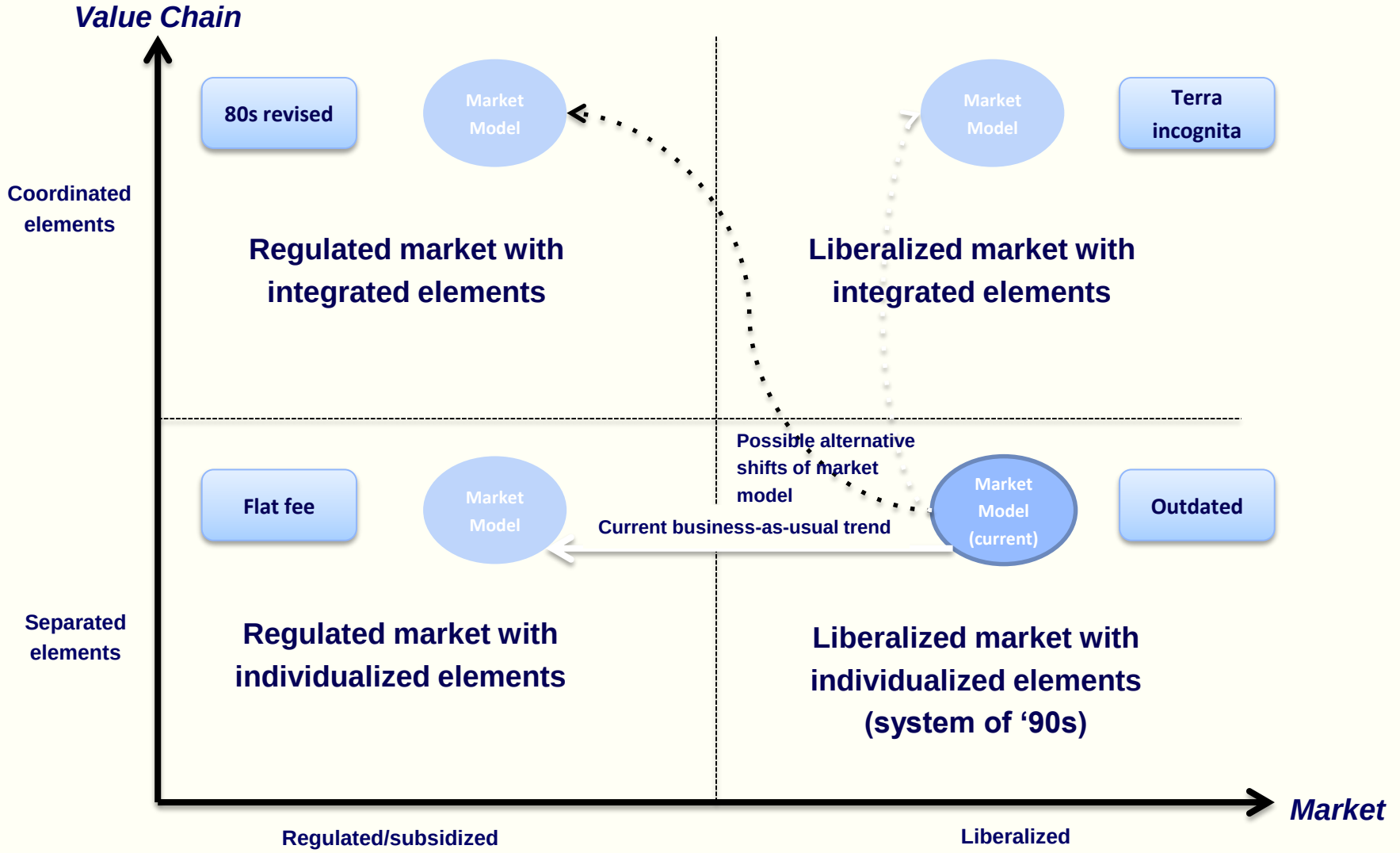
**Model of energy transition as published in *The Third Industrial Revolution* by J. Rifkin (2011)**




***What does each phase mean for the business strategies?***

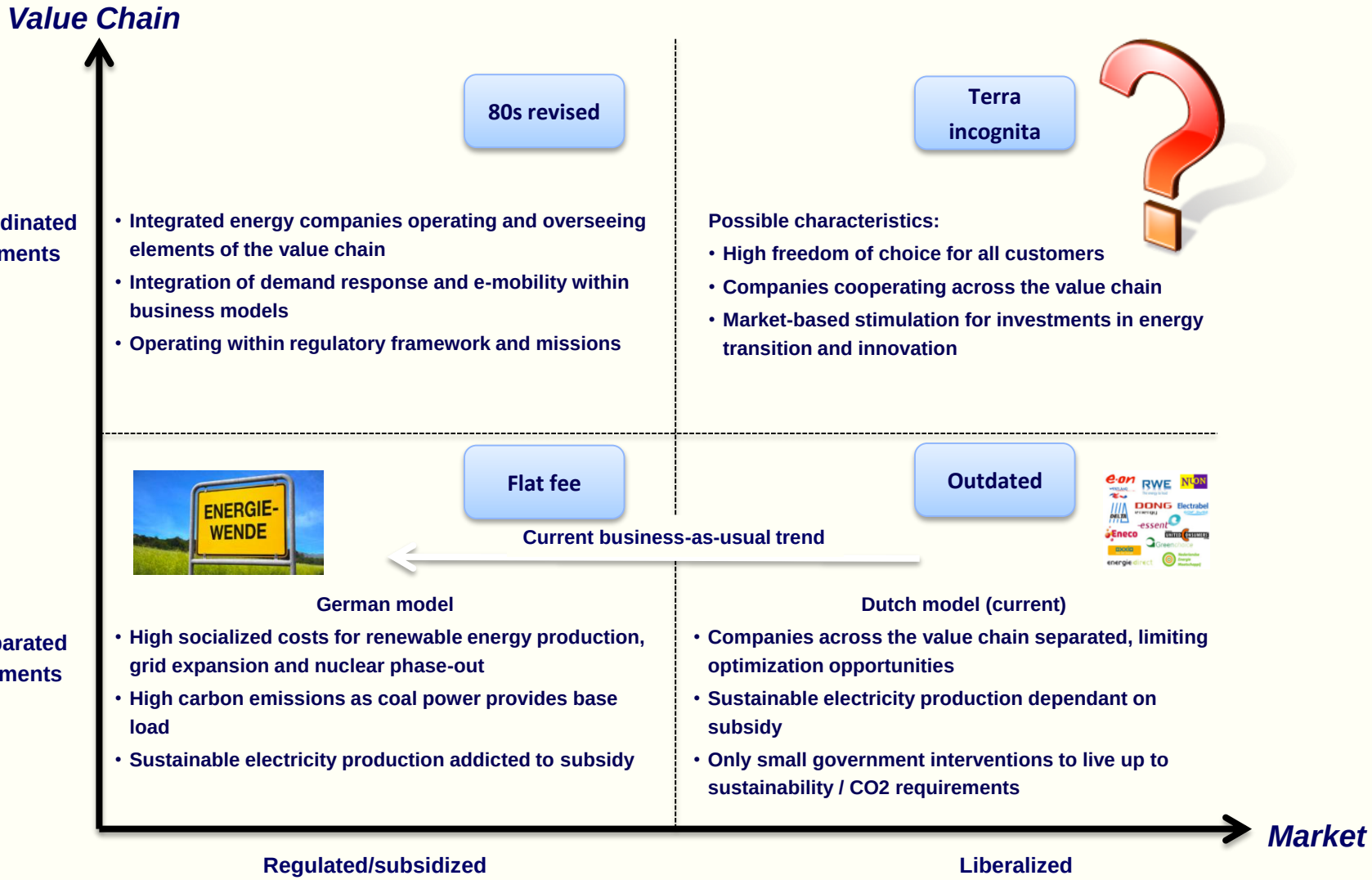
# 3. New Market Designs: Transition & 4 Market Scenarios

The trade-off of value chain integration and regulation/liberalization provides four different market model scenarios



# 3. New Market Designs: Transition & 4 Market Scenarios

There are different examples for each scenario which reflect the specific characteristics of the market model type




UMS Group | Value drivers for new market model

# Contents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# 4. Scenario Planning and Signposting

1. To compensate for the uncertain nature of the future, the method of **scenario planning** is used in the planning process. Based on the results of the scenario planning and other planning efforts, **signposts** (trigger mechanisms) are identified to provide guidance for planning efforts as the future unfolds. Though scenario planning does not predict the future, it enables preparation for future outcomes and to identify actions that need to occur to achieve desired outcomes and strategies.

2. **New market models** are emerging for the electric utility industry. The complex nature of future challenges and the many strategies that could be developed to meet these challenges will mean that evolving information will need tracking to ensure that strategies remain valid and are corrected as needed.

3. **Signposting** can provide the necessary strategic information with an approximate time frame to allow Electric Utilities to better understand how to react to triggers and review strategies.

# 4. Scenario Planning and Signposting

**Our recent work in Scenario Planning and Signposting revealed evidence of important triggers and signs that may influence future scenarios for electric utilities. Some of the key triggers and signs are:**

1. Australian companies hiring or implementing **customer engagement software** from firms such as Tendril and Opower.

2. **Smart Grid technologies,** this is due to the $100 million Smart Grid Smart City project ran trials of a range of 'smart' technologies for households and with electricity suppliers. More than 17,000 houses monitored energy use with smart meters and other technology to test usage patterns and weigh up greater energy efficiency.

3. Companies offering products and services as a **platform for consumers to trade.**

4. Utilities are changing **business models.**

5. **Proliferation of electric vehicles** and likely reductions in battery costs.

6. **Distributed generation** is declining and acceleration of customers leaving the grid will be dependent on levelised cost.

7. Technology is in place to enable **large scale renewables and storage**

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# 5. Key Considerations Going Forward

**An important set of questions come to the fore in addressing the new world scenarios including:**

- What signposts are being developed to indicate important technological and customer behavioural trends and how ready is the asset and risk management organisation in responding?
- Which scenario is most likely and when is it likely to occur?
- How do we define success strategies?
- Should we adopt defensive or offensive strategies?
- What are the no regret strategic options?
- What are likely to be losing strategies?
- What is the impact of the market / regulatory constraint on these options?

***We see significant risks and opportunities emerging for the Network Asset Owner and Manager …***

# 6. Contact details


**Anthony Saker**
*Principal/Managing Director*

UMS Group Asia Pacific
Macquarie House
Level 13
167 Macquarie Street
Sydney NSW 2000
Australia

Office: +61 (2) 8667 3109
Mobile: +61 (4) 3988 5539
Fax: +61 (2) 8667 3200

asaker@umsgroup.com
www.umsgroup.com

**Ed de Vroedt**
*Director of Consultancy*

UMS Group Asia Pacific
Macquarie House
Level 13
167 Macquarie Street
Sydney NSW 2000
Australia

Office: +61 (2) 8667 3109
Mobile: +61 (4) 3838 8879
Fax: +61 (2) 8667 3200

edevroedt@umsgroup.com
www.umsgroup.com