DISTRIBUTED GENERATION & MICROGRIDS

What are we going to talk about…

- What is 'Distributed Generation' and why it matters
- The 'Smart Grid' and the evolution of 'Microgrids'
- Storage and its role
- Please ask questions and share your thoughts!

Distributed Generation

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The Basics

- *In its simplest form, Distributed Generation (DG) is the generation of electric power within the existing network, thus adding new generation points into the 'grid'. Hence DG's are sometimes referred to as embedded generation or decentralized generation.*
- *The emergence of the DG is a relatively new phenomena and has since proved disruptive for the traditional utility operators and their long entrenched business models.*
- *Its rise to prominence owes a great deal to the emergence of renewable energy technologies, the internet and to some extent natural gas's (CHP systems) increasing penetration to the electricity generation market.*
- *In general, DG brings the generation of electricity much closer to the point of actual consumption, therefore creating considerable added value beyond a simple capacity increase.*

Distributed Generation - Underlying Tech

- *DG's are an evolution of the existing, centralized electricity grid and require the possibility (both financially and technically) of generating power on-site, or close to its final utilization point. In a rough order of occurence and installed capacity, DG's are made up of the following technologies;*
  - *Combined Heat and Power (CHP) systems*
  - *Solar PV*
  - *Small scale wind*
  - *Solar PV + Chemical Storage*
  - *Biogas Applications*
  - *Fuel Cells (FC)*
- *As technology shows incremental improvements or new innovations occur, the frequency of deployment and preferences of tech combinations may change but Solar PV + Chemical Storage appears to assume the dominant market player, favored both by legislations and finance providers.*

Distributed Generation

- Grid v2.0

- *One of the critical enablers of DG's is the increasingly more intelligent grid and the sophisticated tools for monitoring generation and consumption.*
- *A Smart Grid allows increasingly higher quantities of disparate energy generation points to integrate seamlesly into the grid. The so called 'penetration limit' of renewables into the electricity grid has increased substantially since the 80's when the term was first used to define how much renewable capacity could be safely 'embedded' without jeopardizing the grid's sound operation.*
- *The sizes of individual DG's have risen from a couple of hundred kW's to multiple MW's. This change is the result of greater integration of storage as well as better hybridization of systems (CHP's combined with wind and/or solar PV) once again made possible by hardware and software developments.*
- *It is important, for retaining perspective, that DG's were also made possible by the deregulation of the energy markets and giving greater power of self-generation to consumers.*

Distributed Generation

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Grid v2.0
The U.S Example

*Timeline / Deployment**

- 2005 – 2015 => Roof top solar
- 2008 – 2015 => Demand response
- 2009 – 2015 => Smart metering
- 2010 – 2015 => Residential EMS/BMS
- 2011 – 2016 => EV charging networks
- 2012 – 2017 => Microgrid prototypes (US)
- 2013 – 2018 => Smart grid / SCADA
- 2014 – 2019 => Phasor network build-out
- 2015 – 2020 => Grid scale storage
- 2010 – 2030 => Renewables, T&D, EVs

**Approximate time frames for bracketing the 'hype curve' and building momentum*

Distributed Generation

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Generate Where You Consume

- *The consumers and investors saw the potential benefits of being able to generate their own power and once the legal restrictions were removed (early 80's to 90's in the U.S) the CHP markets (particularly at an industrial level) saw a massive capacity increase, thus bringing the generation much closer to the point of use.*
- *Small scale wind was also rising in popularity during the same years and a considerable number of WT's (3kW – 300kW) were installed through out U.S and some of western Europe. Some of these systems operated on island mode and were used primarily for irrigation. Larger wind (MW scale) also claims its role.*
- *The availability of cheaper PV systems brought the, once niche solar market, to the attention of both consumers and investors. New financing models, mostly for rooftop applications were being introduced, FIT tariffs were offered by increasingly more 'eco sensitive' governments and solar became a global hype.*
- *Increasingly and in particular accross the EU, central grid operators chose to allow DG's to make the investments (grid scale wind and solar) needed to bring new capacity online and the DG market has flourished over the last decade.*

Distributed Generation

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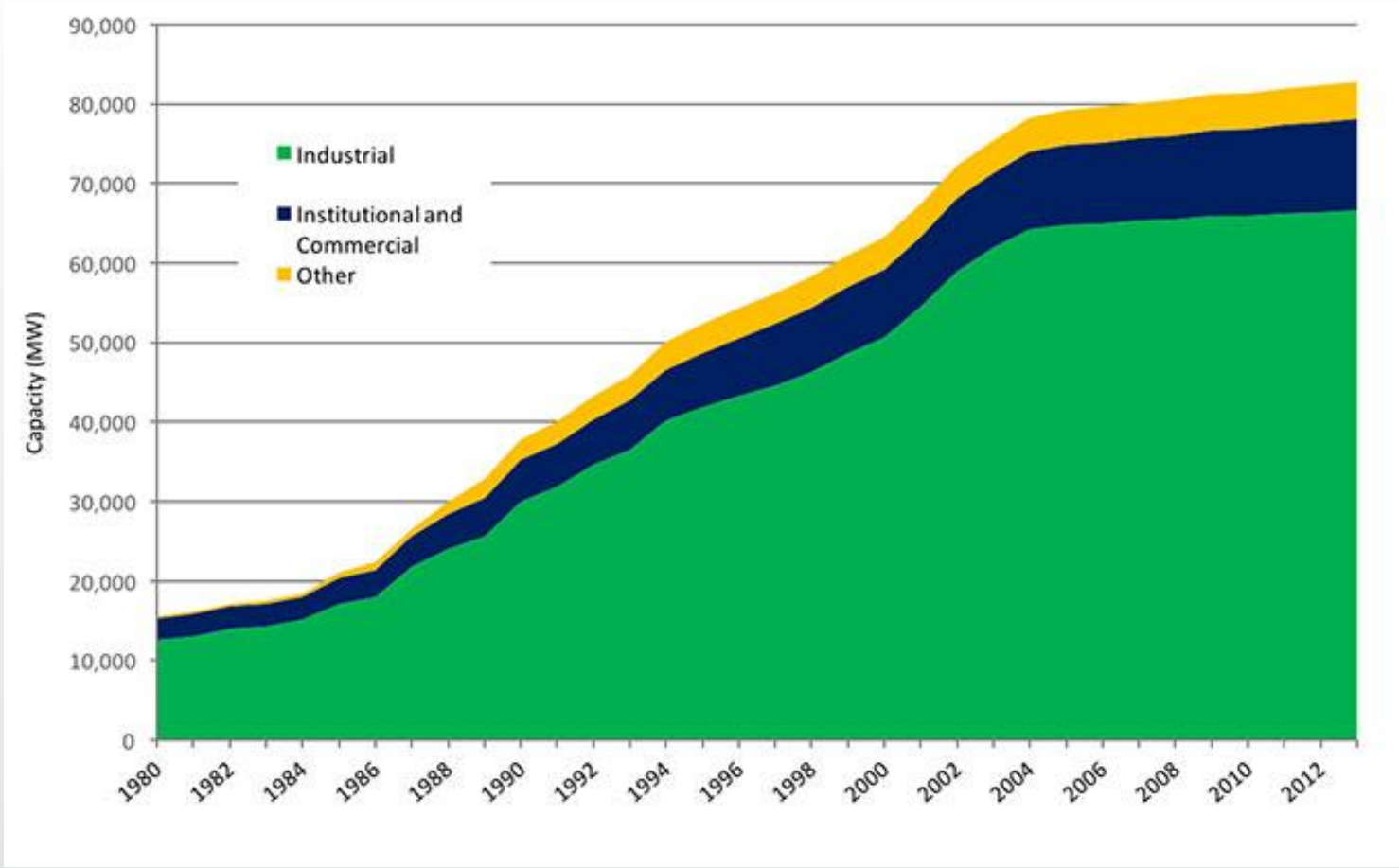
Generate Where You Consume



Distributed Generation

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The Benefits

- *One of the primary reasons that DG's have become very successful is that they offer a potential win-win situation for all of the stakeholders. Even the 'Utilities are suffering from increasing number of customers going net-zero' arguement is only valid for operators who are unable to adapt their business model.*
- *So who gets what;*
  - *Consumers*
    - *Good ROI, offers room for making a profitable investment*
    - *Reduced reliance on the grid, increased self-sufficiency*
    - *Community building and greener community*
    - *Green smugness (it is real!)*
    - *Increased EV penetration at neighborhood level*
  - *Regulators*
    - *General public support (though there are many NIMBY cases)*
    - *Cleaning up of the electricity generation*
    - *Creates new skilled jobs*
    - *Reduces the governments responsibility to build central electic plants and eases the strain on the public budget*
    - *Reduced the requirement of building new transmission lines*

Distributed Generation

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The Benefits, continued

- *So who gets what;*
  - *Utilities*
    - *The old business model is extinct. DG's and Microgrids will force the utilities to start thinking out of the box solutions.*
    - *Conventional resources and in particular coal is in a downward spiral. Between April 16 and April 19, 2018, UK (the country that sparked the industrial revolution and most effectively utilized coal for decades) went without firing a single coal plant for 55 hours. There is a strong possibility that 2020 will be coal's final decade before its ultimate sidelining.*
    - *Smart utilities will use their existing advantages to bring higher amounts of renewables and DG's into their portfolio while investing in their clients' or face demise.*
    - *New developer types and innovation comes into the market*
  - *And all the other stakeholders*

Players

- Utilities (T&D)
- Networking giants
- HAN vendors
- Analytics firms
- Power systems
- EMS/BMS solutions
- Storage vendors
- EV charging networks

Distributed Generation

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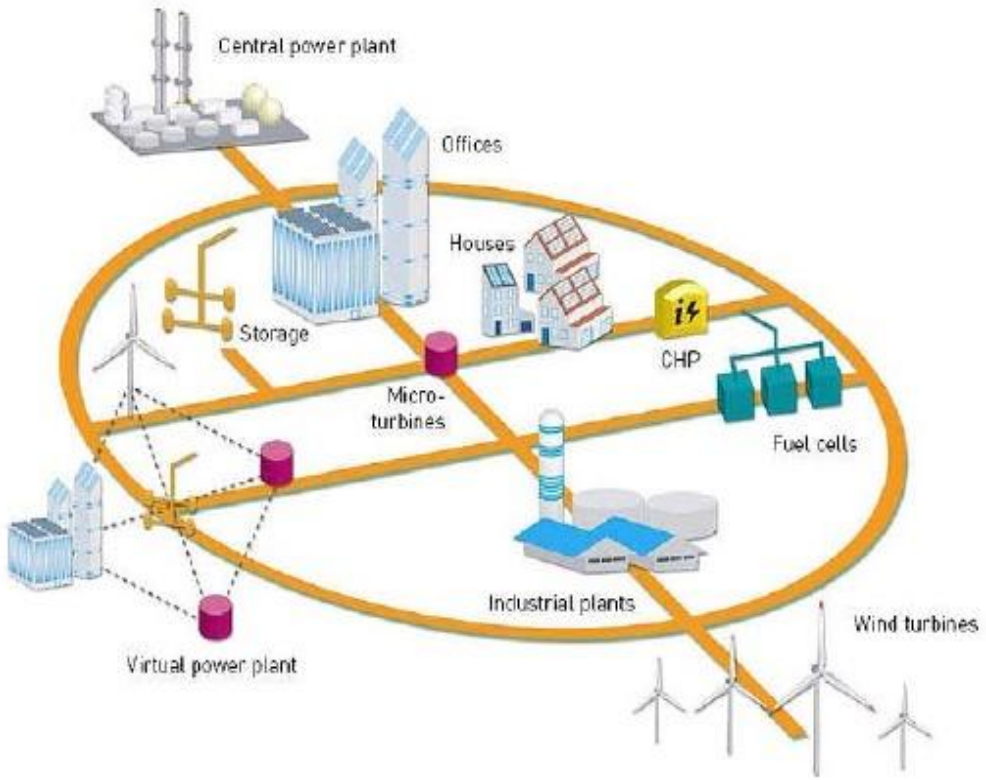
Microgrids

Smart Grid / Micro Grid



Distributed generation (localized) in micro grids and part of a larger smart grid

Distributed Generation

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Microgrids

- *In essence the Microgrid is a living grid, capable of generating its own power to meet its own demand but it is only a fraction in size of the actual grid.*
- *Microgrids are almost always connected to the distribution network but can and do perform all of the essential tasks without the grid's support for extended periods.*
- *Through their connection to the larger grid, microgrids can perform services such as demand response, load time shifting, voltage regulation while also adding 'resilience' and making the generation of electricity much more 'sustainable'.*
- *Extreme weather events and their increasing frequency have proven the value and importance of reducing the reliance on the central grid. Consider Puerto Rico's Hurricane Maria or the disaster caused by the Haiyan Typhoon. A well designed Microgrid can not only serve its community but also the larger grid as well.*

Microgrids & Storage

- *Storage, with its unique ability of appearing both behind and in-front of the meter thus able to address the requirements of consumers and utilities simultaneously, offers an ever increasing number of possibilities;*
  - *Load balancing*
  - *Energy quality*
  - *Islanding*
  - *Resilience of the network and the individual consumers*
  - *Localizing and reducing costs*
  - *Cleaning up the environment*
  - *Increased renewables penetration*
  - *Opening up the EV market*
  - *Peer 2 peer electricity sharing and allowing BTC*
  - *New jobs*
  - *And more…*

Microgrids
&
Storage

Storage of Renewables

- Grid storage
- Local storage
- EV storage
- Batteries
- Flow cells
- Tiered storage

Thank you for listening
& your participation!