Consumers in the Driving Seat: Challenges & opportunities

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Outline

- The energy sector is in transition: Why?
- Smart Energy: Equity, Efficiency, Value & Investment – what does that mean in practice?
- Basic electricity industry structure
- Are consumers in the driving seat?
  - If so, do they have the skills?
- What comes next?

World Energy Trilemma: Security, Sustainability, Equity

(www.worldenergy.org)

Figure 2
Top 10 Energy Trilemma Index performers overall and per dimension
Source: WEC/Oliver Wyman, 2014

WEC ranking out of 129 countries

Australia	13	AAD
Malaysia	26	ABC
Singapore	41	BBD
Philippines	58	BBC
Indonesia	69	ACD
Vietnam	87	BDD
Thailand	90	CCD

Security, Equity, Sustainability

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Energy, Growth & Sustainability: Five Propositions

Sorrell (2010), http://www.mdpi.com/2071-1050/2/6/1784

1. The rebound effects from energy efficiency improvements are significant and limit the potential for decoupling energy consumption from economic growth
2. The contribution of energy to productivity improvements and economic growth has been greatly underestimated
3. The pursuit of improved efficiency needs to be complemented by an ethic of 'sufficiency'
4. Sustainability is incompatible with continued economic growth in rich countries
5. A zero-growth economy is incompatible with a debt-based monetary system

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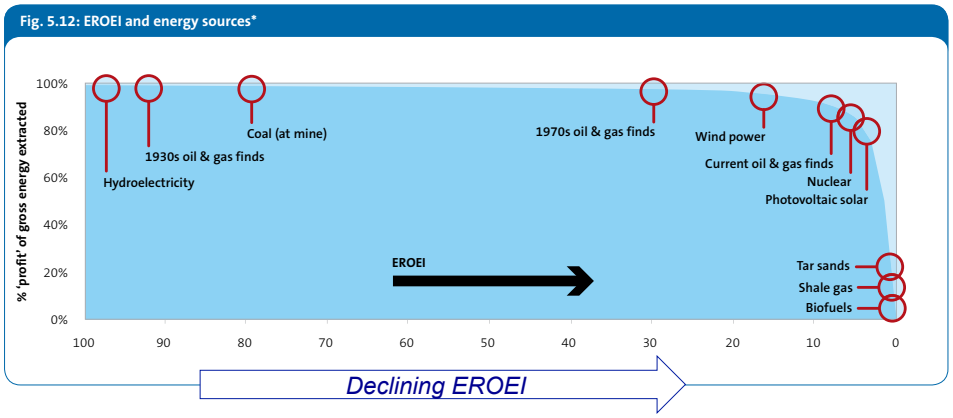
Trend of declining *energy return on energy invested* (EROEI)

(Perfect Storm: Energy, Finance & the End of Growth, Morgan, Tullett Prebon, 21/1/13)
http://www.tullettprebon.com/Documents/strategyinsights/TPSI_009_Perfect_Storm_009.pdf



The "best EROEI" energy resources tend to be developed & depleted first, thus as time goes by we experience diminishing returns from investment in new energy resources, which in turn depresses general economic growth

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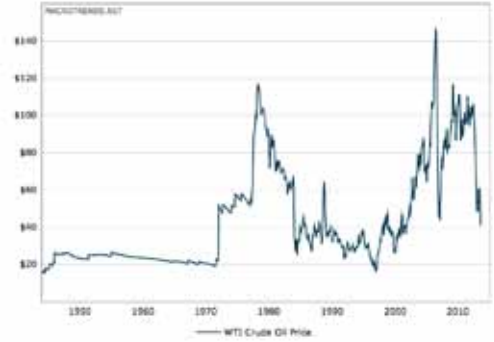
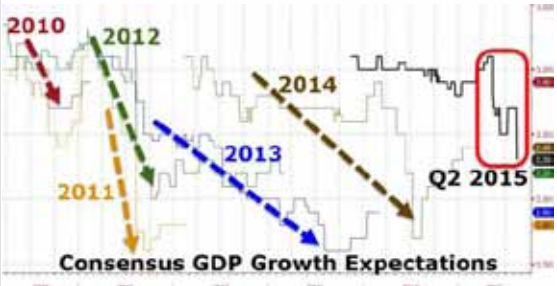
Top: WTI Oil price history (USD2015/barrel)
Bottom: Recent US GDP growth forecast trends



Recent oil price volatility between falling price ceiling (marginal affordability) & rising price floor (marginal production cost)



Forecasters continue to hope that US GDP growth will return to the historic "normal" level, which it is failing to do

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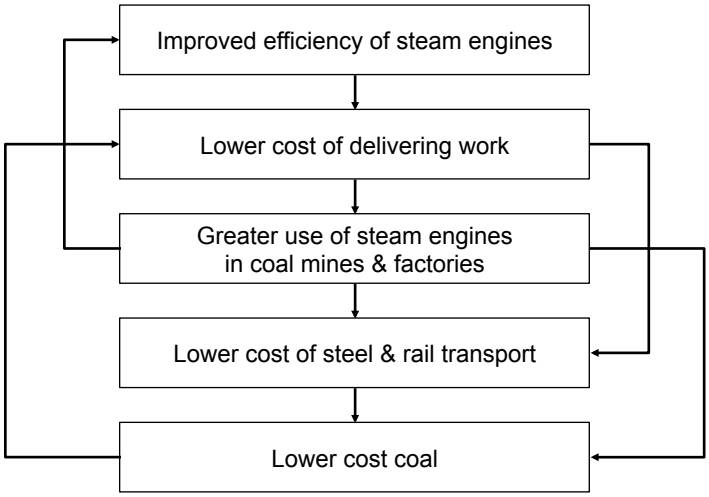
Positive feedback in coal-mining (& fossil fuels in general)

Based on Fig. 1, Energy, Growth & Sustainability: Five Propositions
Sorrell (2010), http://www.mdpi.com/2071-1050/2/6/1784



This strong positive feedback depends on the storability & versatility of fossil fuels & was more obvious for coal (first) & oil (best) than gas (last)

Solar & wind: key renewables for electricity generation, however both are *stochastic, non-storable energy fluxes*

- MIT Study on the Future of Solar Energy, 2015:
  (https://mitei.mit.edu/futureofsolar)
  - *Flexible fossil generators, demand management, CSP, hydro-electric facilities & pumped storage can help cope with these characteristics of solar output.*
  - *But they are unlikely to prove sufficient when PV accounts for a large share of total generation*
  - *R&D aimed at developing low-cost, scalable energy storage technologies is a crucial part of a strategy to achieve economic PV deployment at large scale*
  - *When distributed PV grows to account for a significant share of overall generation, its net effect is to increase distribution costs*

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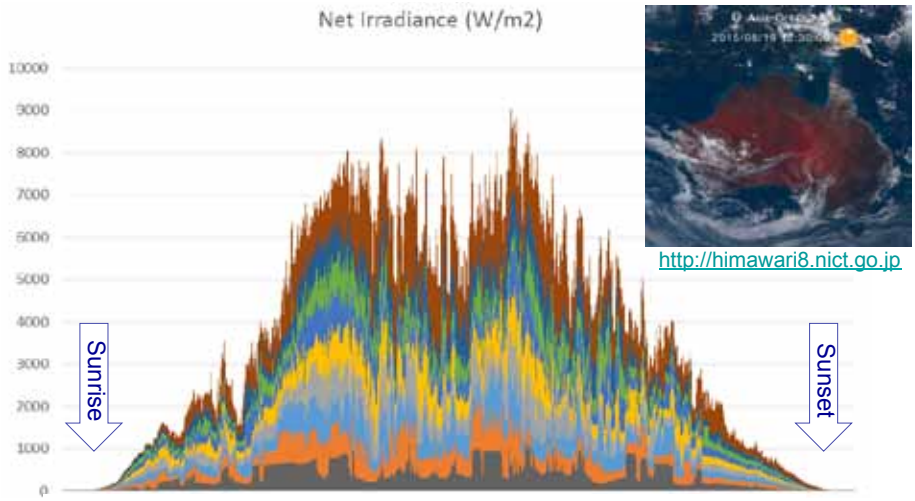
Solar resource at 9 sites in Alice Springs on 11/9/13, a cloudy, windy day

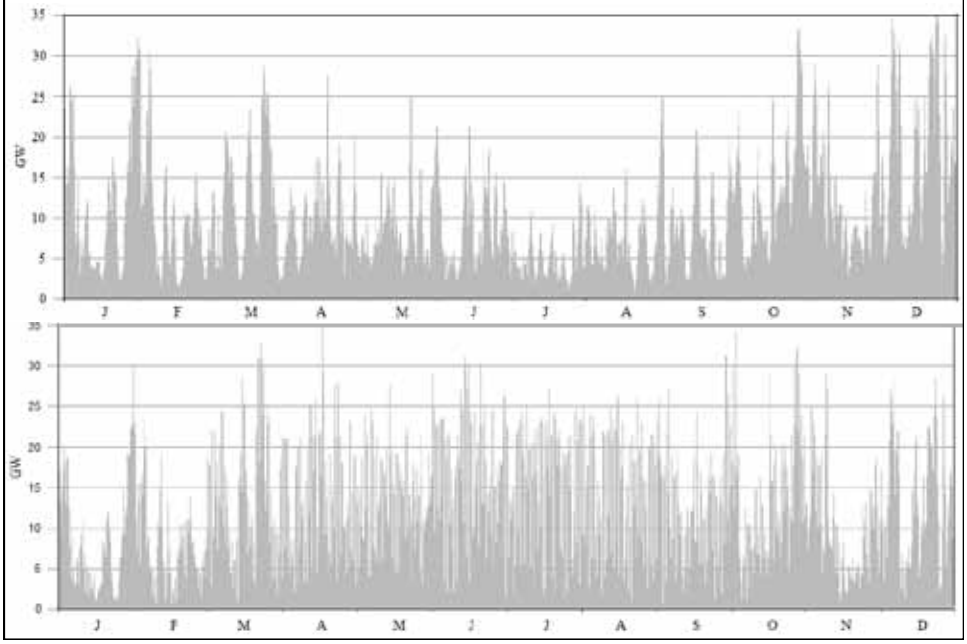
(CAT Projects, March 2015, Investigating the Impact of Solar Variability on Grid Stability)
http://arena.gov.au/files/2015/03/150302-Impact-of-Variability-Report-for-public-release.pdf



http://himawari8.nict.go.jp

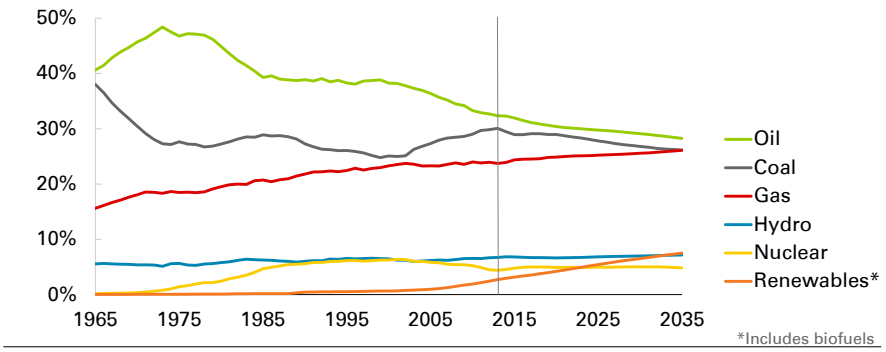
Notes: No solar resource at night; second-to-week-long variability due to cloud behaviour; seasonal variability depends on latitude & climate

Top: Wind in Denmark, Germany, Netherlands and UK, 2013
Bottom: Combined wind & solar in Germany, 2013
(Figs 6 & 13 in *How Much Wind And Solar Can Norway's Reservoirs Balance?*, Energy Matters)



(www.bp.com/energyoutlook)

Global shares of primary energy



Energy Outlook 2035

© BP p.l.c. 2015

Low demand growth despite lower fossil fuel prices: Squeeze between cost & affordability is exacerbating future uncertainty in supply/demand balance

IMOWA 2014 ESOO & GSOO electricity & gas forecasts: *low & uncertain growth* http://www.imowa.com.au

Table ES.1: Peak demand forecasts for different weather scenarios, expected case Electricity

Scenario	2015-16 (MW)	2016-17 (MW)	2017-18 (MW)	2018-19 (MW)	2019-20 (MW)	5 year average annual growth	10 year average annual growth
10% PoE	4,114	4,149	4,191	4,223	4,244	0.8%	0.8%
50% PoE	3,858	3,886	3,924	3,951	3,968	0.7%	0.7%
90% PoE	3,634	3,657	3,690	3,713	3,726	0.6%	0.7%

Table ES.2: Sent out energy forecasts Electricity

Scenario	2015-16 (GWh)	2016-17 (GWh)	2017-18 (GWh)	2018-19 (GWh)	2019-20 (GWh)	5 year average annual growth	10 year average annual growth
High	18,986	19,498	20,010	20,349	20,543	2.0%	2.5%
Expected	18,731	19,015	19,353	19,548	19,625	1.2%	1.3%
Low	18,541	18,705	18,931	18,970	18,893	0.5%	0.5%

Table ES.1: Domestic gas demand forecasts (TJ per day), 2015 to 2024 Gas: Base 0.3%pa; High 1.3%pa

Scenario	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Base	1,026	1,074	1,095	1,090	1,079	1,075	1,071	1,065	1,059	1,055
High	1,074	1,109	1,135	1,153	1,164	1,171	1,180	1,188	1,198	1,207

But PV will continue to grow – the only questions are how fast & with how many batteries? (IMOWA 2014 ESOO, http://www.imowa.com.au)

Figure 4.3: Installed solar PV system capacity, 2009-10 to 2024-25

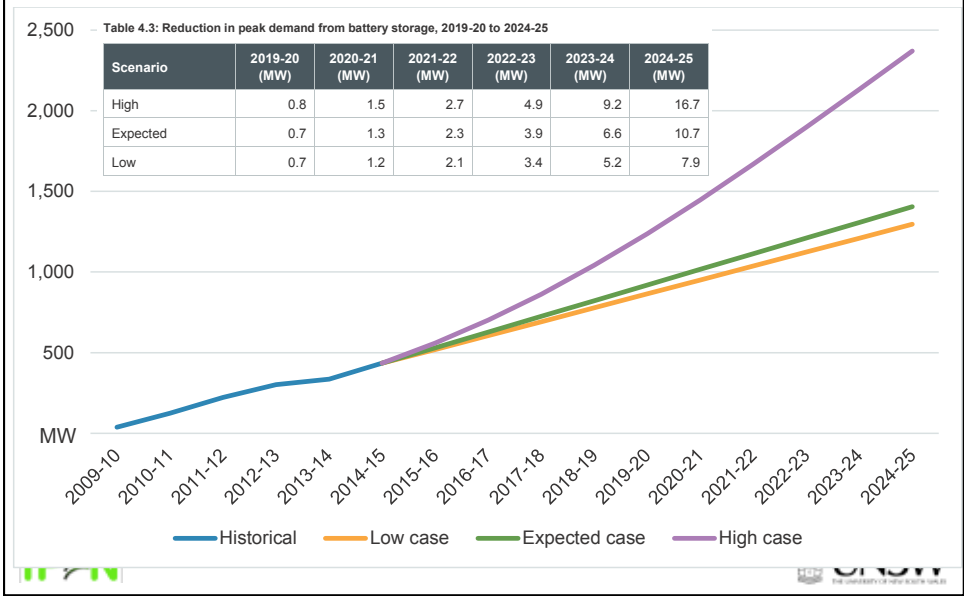


Table 4.3: Reduction in peak demand from battery storage, 2019-20 to 2024-25

Scenario	2019-20 (MW)	2020-21 (MW)	2021-22 (MW)	2022-23 (MW)	2023-24 (MW)	2024-25 (MW)
High	0.8	1.5	2.7	4.9	9.2	16.7
Expected	0.7	1.3	2.3	3.9	6.6	10.7
Low	0.7	1.2	2.1	3.4	5.2	7.9

AEMO assessment of rooftop PV (2015)

Top: 2015 National Electricity Forecasting Report Detailed Summary, June
Bottom: Renewable Energy Integration in South Australia, March Update

Table 5 Proportion of rooftop PV relative to residential and commercial underlying consumption

	Queensland	New South Wales	South Australia	Victoria	Tasmania
2014–15	5.7%	2.4%	8.4%	2.7%	3.0%
2017–18	9.1%	3.7%	11.9%	4.4%	4.9%
2024–25	16.0%	6.3%	22.1%	8.6%	11.0%
2034–35	20.2%	9.3%	28.5%	13.7%	17.4%

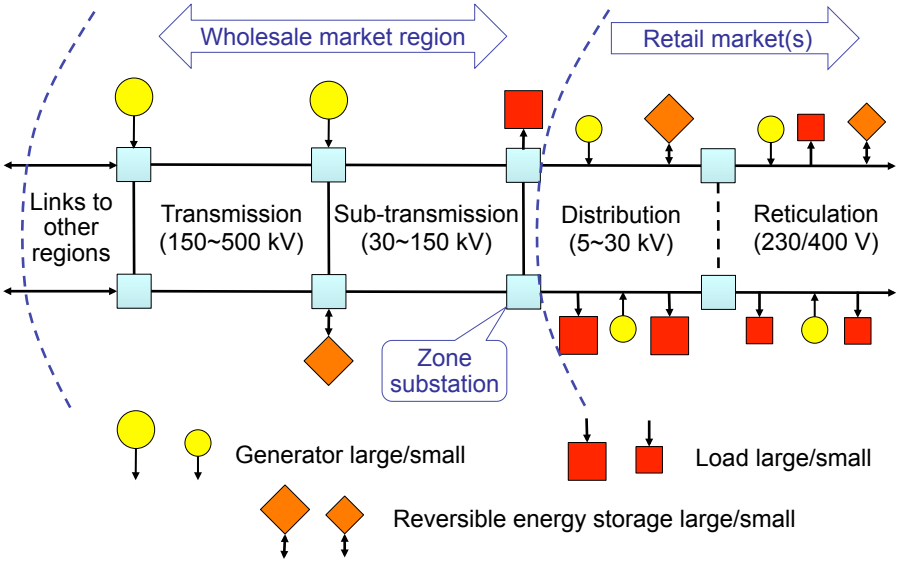
Balancing Area	Peak Demand	Annual Energy	Installed Wind (% peak)	Installed PV (% peak)
Texas	68,000 MW	340 TWh	12,400 MW (18%)	300 MW (0.4%)
NEM	35,000 MW	194 TWh	3,600 MW (10%)	3,440 MW (10%)
Ireland (all island)	6,600 MW	35.4 TWh	2,325 MW (35%)	1 MW (0%)
South Australia	3,400 MW	13.2 TWh	1,475 MW (43%)	565 MW (17%)
Hawaii (Oahu)	1,140 MW	7.0 TWh	99 MW (9%)	221 MW (19%)

Comment: South Australia already has high wind & rooftop PV penetration by world standards and it will continue to increase

Summary of *Smart Energy* issues & motivation

- Society is fundamentally dependent on energy:
  - Reducing energy services would have consequences
- The best of the fossil fuel era is behind us:
  - Cheapest resources developed first, climate concerns
  - Carbon capture & storage would further reduce EROEI
- Nuclear power brings complexity & high-impact risk
- Renewable energy technologies have drawbacks:
  - Hydro & bioenergy can have significant externalities
  - Ocean energy still under development
  - Solar & wind are distributed, non-storable energy fluxes:
    - Reversible energy storage & flexible energy resources can help
- *A smarter energy sector is not an option, it is a necessity*

Basic electricity industry structure & characteristics



- *Electric energy flows through the network at the speed of light*
- *Quality of electric energy flow must be continuously managed*
- *Shared network is best viewed as a **common-pool resource***

Private goods, public goods, toll goods & common pool resources

(Elinor Ostrom (2010, Revised 2009 Nobel Economics Prize address, American Economic Review 100, June 2010, http://www.aeaweb.org/articles.php?doi=10.1257/aer.100.3.1)

		Subtractability of Use: High	Subtractability of Use: Low
Difficulty of excluding potential beneficiaries	High	*Common-pool resources*: groundwater basins, lakes, irrigation systems, fisheries, forests, etc.	*Public goods*: peace and security of a community, national defense, knowledge, fire protection, weather forecasts, etc.
	Low	*Private goods*: food, clothing, automobiles, etc.	*Toll goods*: theaters, private clubs, daycare centers

Electricity networks

FIGURE 1. FOUR TYPES OF GOODS

Implications of key terms:

- Difficulty of excluding potential beneficiaries:
  - If high, then likely to require some form of *cooperative decision making*
- Subtractability of use:
  - If high, scarcity value may be able to (& perhaps should) *be monetized*
- Toll goods:
  - Non-rivalrous but small-scale goods & services that a club could provide while excluding non-members from consumption of benefits
- Common pool resources:
  - Need carefully designed rules, which can include markets

Clean restructuring pathway design

Zinaman et al, *Power systems of the future,* March 2015
http://www.nrel.gov/docs/fy15osti/62611.pdf

- Open access to transmission and efficient interconnection processes
- Appropriate screening criteria for prospective independent power producers
- Independent planning and dispatch
- A competitive wholesale market
- Clean energy incentives and trading schemes
- Forecasting and dispatch optimized for clean energy integration
- Platforms for demand-side participation

Comment: Good so far as it goes but will end-users (consumers) have the expertise, resources & incentives to participate effectively?

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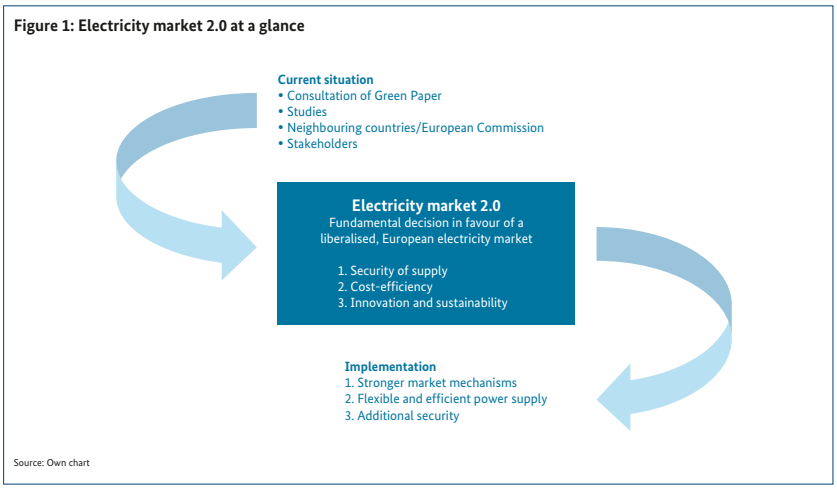
An electricity market for Germany's energy transition

http://bmwi.de/EN/Service/publications,did=721538.html

Figure 1: Electricity market 2.0 at a glance



Source: Own chart

Comment: Germany still focussed on efficient wholesale market design (it has rejected introducing a capacity market)

An electricity market for Germany's energy transition

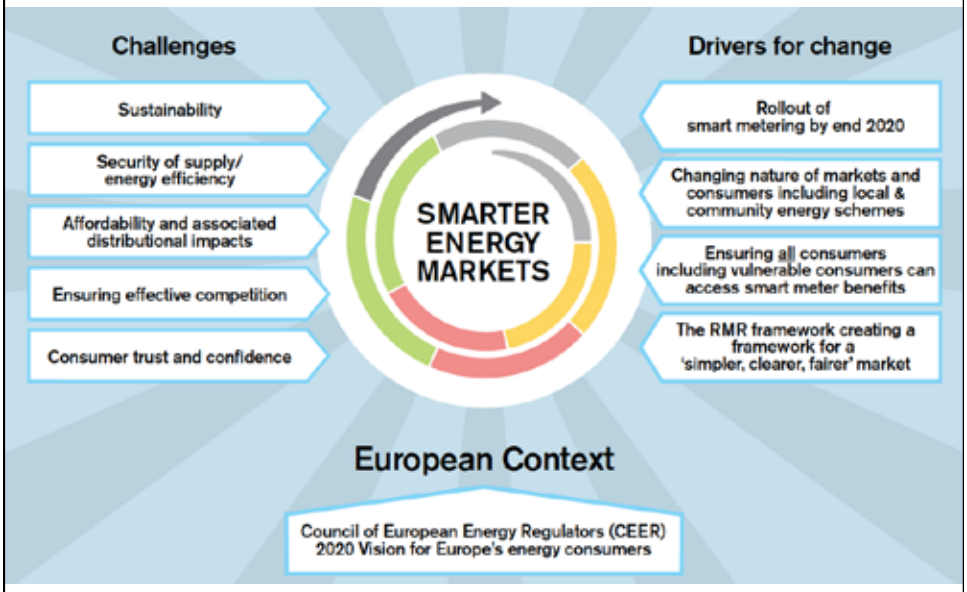
http://bmwi.de/EN/Service/publications,did=721538.html

Overview of the measures

Component 1 "Stronger market mechanisms": The measures packaged in component 1 strengthen the existing market mechanisms. The required capacities can thus refinance themselves and the electricity market can continue to ensure security of supply.	
Measure 1	Guaranteeing free price formation on the electricity market
Measure 2	Making supervision of abuse of dominant market positions more transparent
Measure 3	Strengthening obligations to uphold balancing group commitments
Measure 4	Billing balancing groups for each quarter hour
Component 2 "Flexible and efficient electricity supply": The measures of component 2 optimise the electricity supply at both European and national levels. They thus ensure a cost-efficient and environmentally compatible use of capacity.	
Measure 5	Anchoring the further development of the electricity market in the European context
Measure 6	Opening up balancing markets for new providers
Measure 7	Developing a target model for state-induced price components and grid charges
Measure 8	Revising special grid charges to allow for greater demand side flexibility
Measure 9	Continuing to develop the grid charge system
Measure 10	Clarifying rules for the aggregation of flexible electricity consumers
Measure 11	Supporting the wider use of electric mobility
Measure 12	Making it possible to market back-up power systems
Measure 13	Gradually introducing smart meters
Measure 14	Reducing the costs of expanding the power grid via peak shaving of renewable energy facilities
Measure 15	Evaluating minimum generation
Measure 16	Integrating combined heat and power generation into the electricity market
Measure 17	Creating more transparency concerning electricity market data
Component 3 "Additional security": The measures of component 3 provide additional security of supply.	
Measure 18	Monitoring security of supply
Measure 19	Introducing a capacity reserve
Measure 20	Continuing to develop the grid reserve

UK: Ofgem smarter (retail energy) markets programme

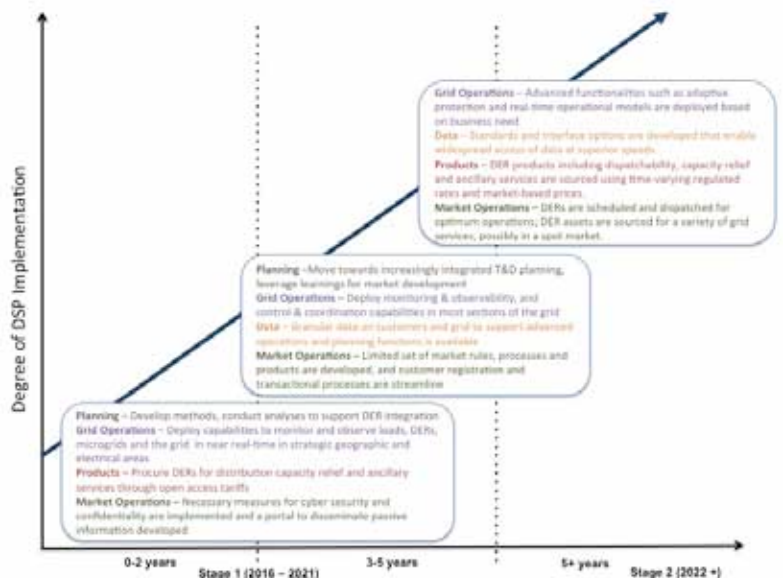
(https://www.ofgem.gov.uk/electricity/retail-market/market-review-and-reform/smarter-markets-programme)



Comment: Again, a market-based approach, with a focus here on retail market design

NY: Evolution of Distributed System Platform (DSP) retail market

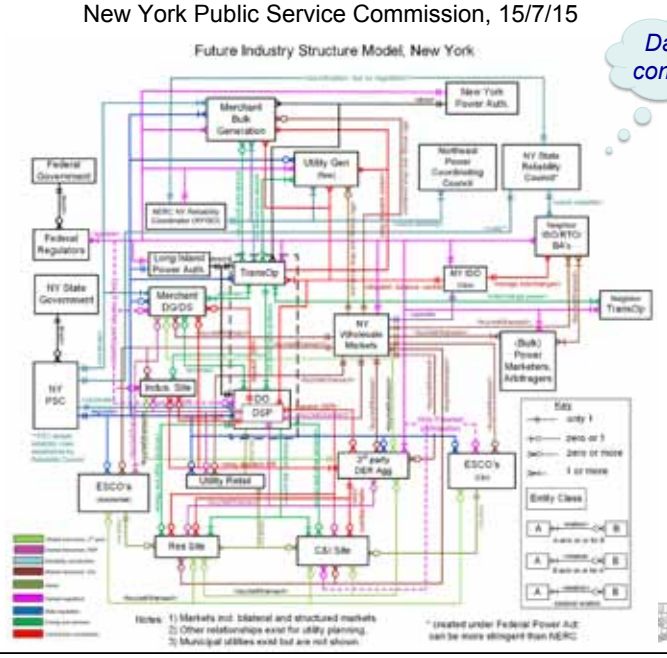
Fig. 1, Draft Report of the Market Design And Platform Technology Working Groups, New York Public Service Commission. 15/7/15



Comment: NYPSC wants distributors to manage resources connected to their networks

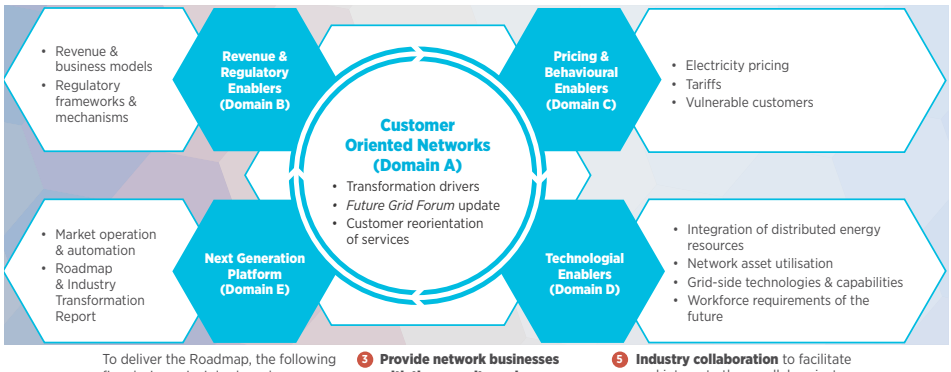
NY: Evolution of Distributed System Platform (DSP) retail market

Fig. 3, Draft Report of the Market Design And Platform Technology Working Groups, New York Public Service Commission, 15/7/15



Electricity Network Transformation Roadmap (Australia)

http://www.ena.asn.au/electricity-network-transformation-roadmap



To deliver the Roadmap, the following five design principles have been identified to inform all activities.

1. **Create new customer value** through service innovation which anticipate customer-oriented energy futures;
2. **Proactively inform Australia's electricity system evolution** to unshackle Australia's electricity market framework and its associated regulatory mechanisms, as well as allowing the full utilisation of all existing regulatory provisions;
3. **Provide network businesses with the capacity and resources to change, innovate and provide leadership** by building organisational capabilities to underpin success in a customer-oriented future;
4. **Enhance long-term asset productivity** by maximising the productive efficiency of the current electricity network businesses' $82b asset base for both traditional and new value-creating applications; and,
5. **Industry collaboration** to facilitate and integrate the parallel projects currently underway in the sector, foster innovation and strategically focus on the key knowledge gaps and barriers impeding timely and orderly network transformation.

Australia: Two strong recurring themes

Review of Governance Arrangements for Australian Energy Markets, Draft Report, July 2015

1. The pace of change in the energy sector has accelerated to a level that is arguably unprecedented. The principal underlying drivers that were most frequently identified were *continuing developments in digital and renewable technologies and their applications*, and in *policy responses to the assessed risks of harmful climate change*. Either driver would pose major challenges for the energy sector; when taken together, *they have created a policy environment that is more onerous and complex than it has ever been*.
2. There has emerged a '*strategic policy deficit*' which has led to *tendencies towards fragmentation, diminished clarity and focus in roles*, particularly in determining priorities, and a *diminished sense of common purpose*. These problems are most evident at the policy level, but they have also been identified across the market institutions as a whole.

Conclusions

- A smarter energy sector has become essential:
  - Driven by complexity & unintended consequences, with a key role for electricity in the emerging era
  - Consumers are more engaged by choice & necessity
- Consumers in the driving seat?
  - Putting under-educated & under-resourced consumers in the driving seat may not be a good idea
  - Careful industry design & stakeholder engagement required to successfully manage the growing complexity of the *common-pool resources* of the electricity industry:
    - In technical, social, economic & environmental dimensions
  - But who is responsible for, and capable of, providing the necessary leadership & industry design concepts?

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Hugh has been a Fulbright Senior Fellow at the University of California Berkeley, a Member of the National Electricity Tribunal, a Member of the New South Wales Licence Compliance Advisory Board, a Board Member of the Australian Cooperative Research Centre for Renewable Energy, an Associate Director of UNSW's Centre for Photovoltaic Devices and Systems, a Member of CSIRO's Energy Flagship Advisory Committee and a Lead Author for the IPCC Special Report on Renewable Energy Sources & Climate Change Mitigation, 2012.

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