

Renewables and storage in electricity distribution: disruption or value add?

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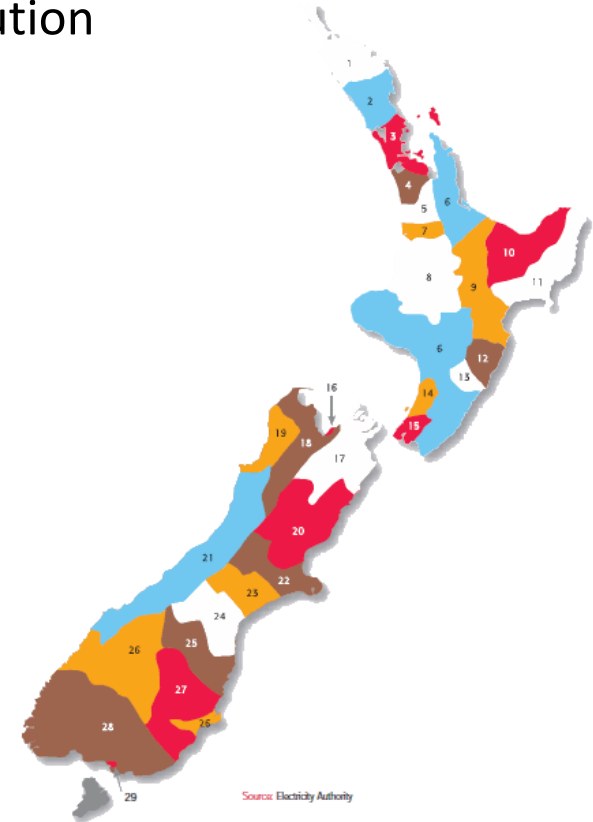


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Presentation Outline

- Context of Innovation in NZ electricity distribution
 - NZ electricity industry
 - Innovations in NZ distribution networks
- The global context of distribution regulations
 - Evolving regulatory framework
 - Changing operation environment
 - The need to support innovation
 - UK and US regulatory initiatives
- Business drivers to innovate
 - Role of Trials and Demonstrations



Source: Electricity Authority



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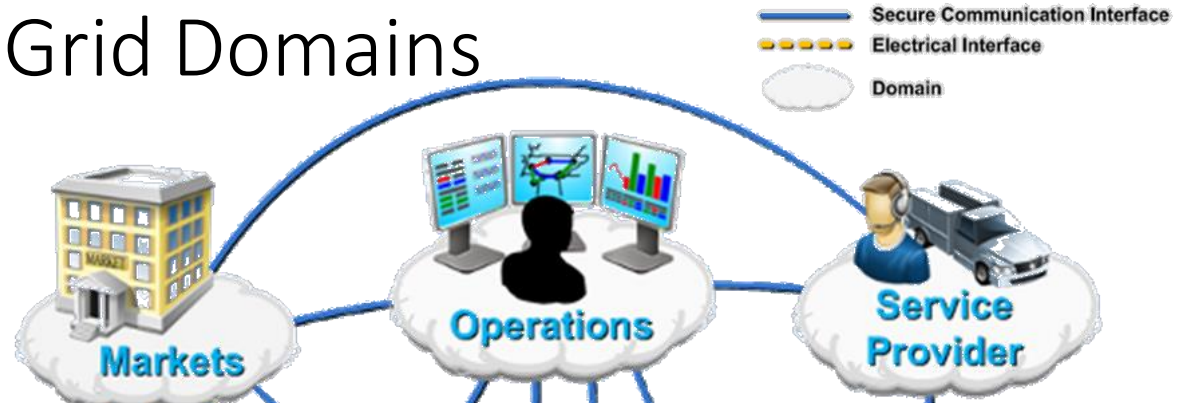
Renewables and storage in electricity distribution: disruption or value add?

'Smart/Smarter' Grid Domains

- ❑ Innovations in NZ distribution network
 - Innovations in NZ electricity industry
 - Applicable innovations in NZ distribution networks

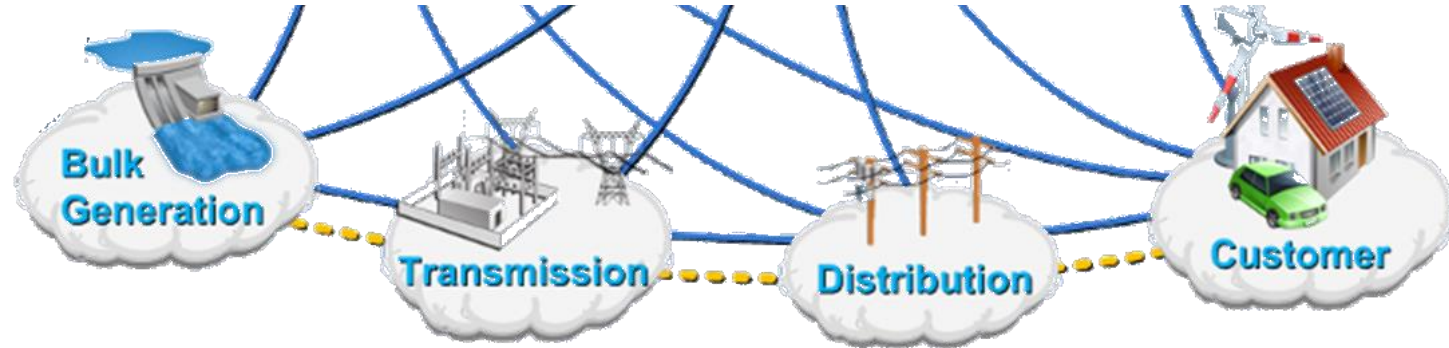
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Asset Innovation: New Equipment, New Infrastructure, New Software

Functional Innovation: Control Method, Business Process, Pricing Methodology



Ref: Dollen (2009)



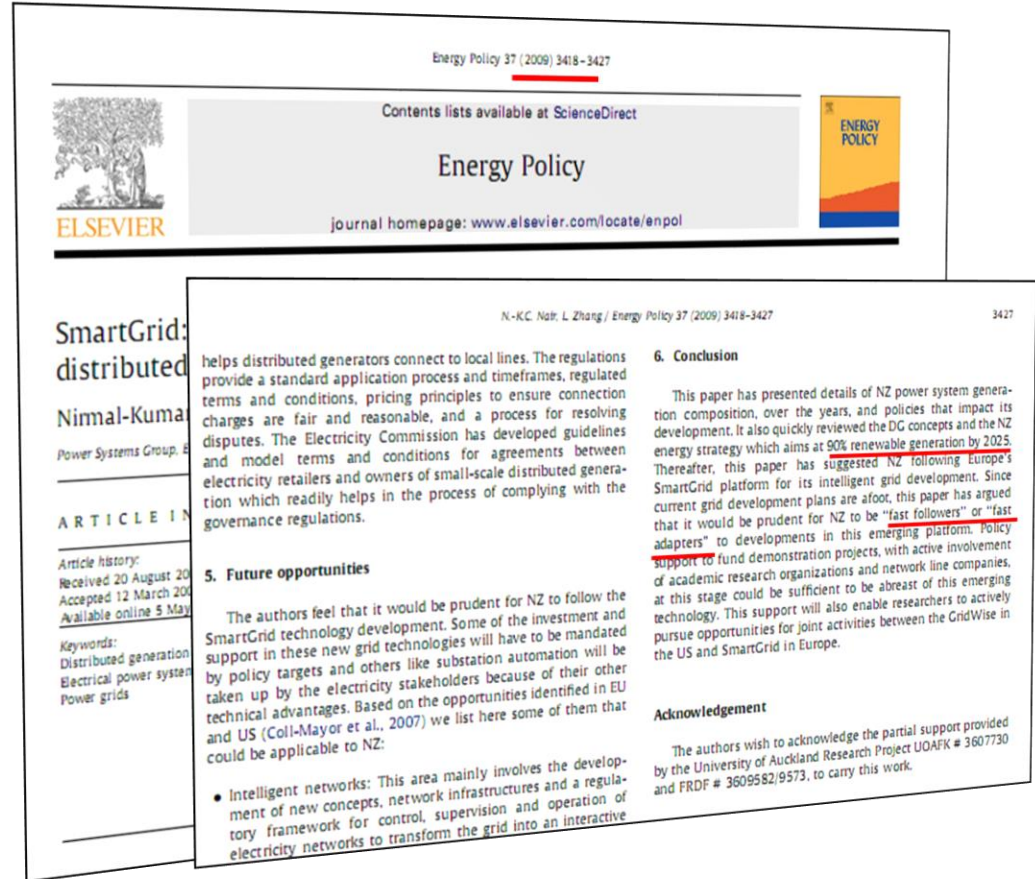
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Bulk generation policy drivers

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Generation

- Renewable portfolio management



Hydro
Wind
Geothermal

.....



90% Renewable by 2025



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Operations Innovation

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Generation

- Renewable portfolio management

Transmission

- Scarcity pricing → Encourage investment in last resort generation and voluntary demand response.
- Demand-side participation

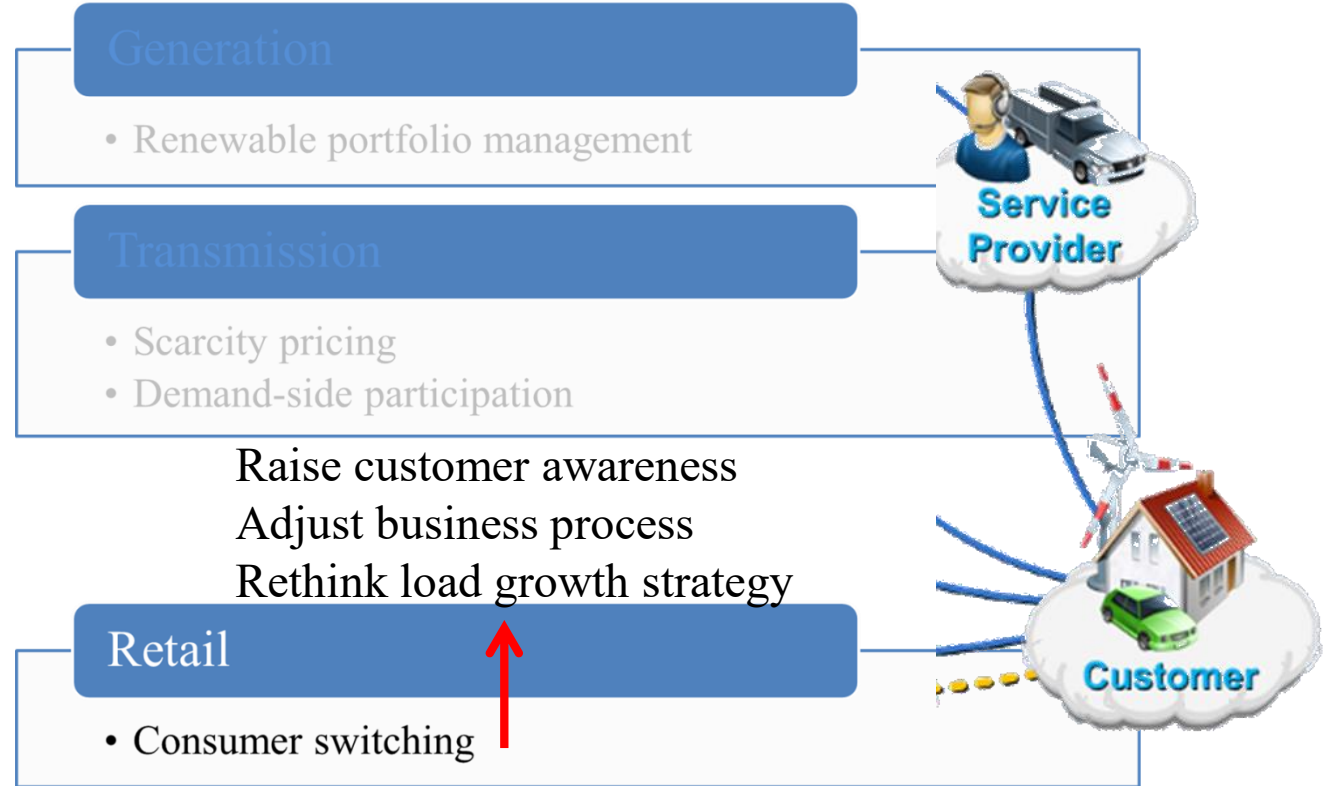


Has value due to hydro reliance



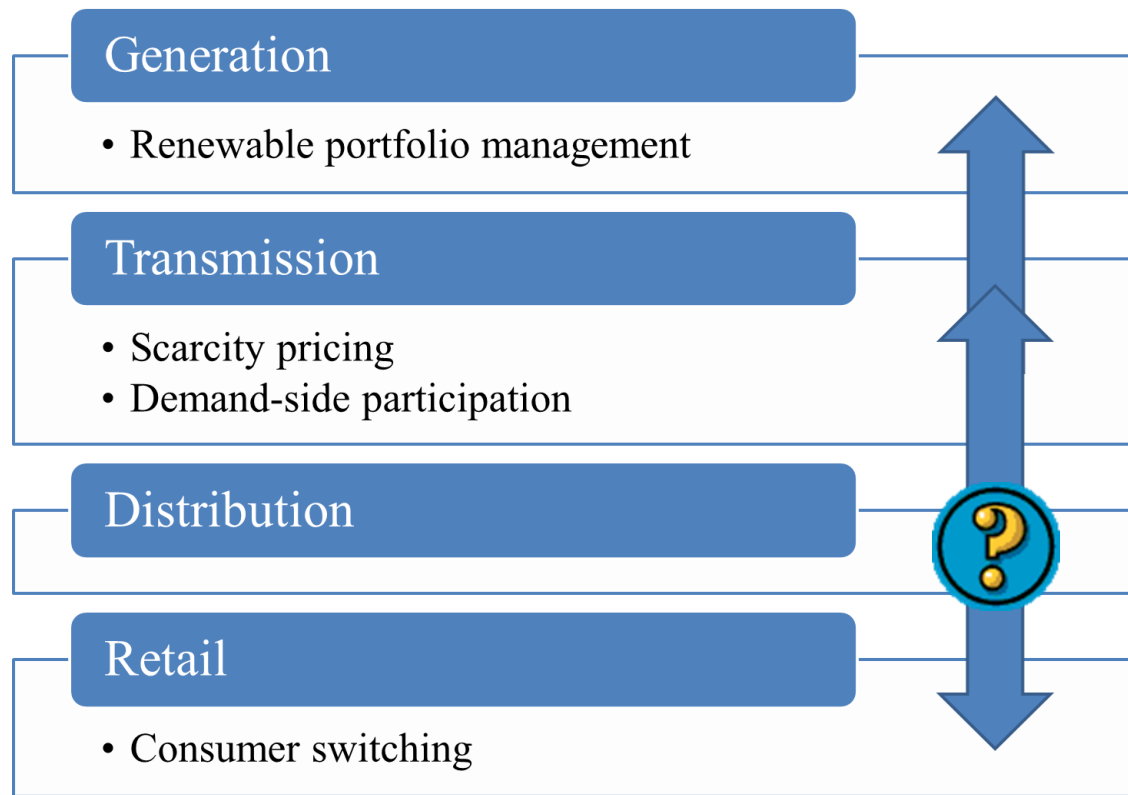
Service Innovation

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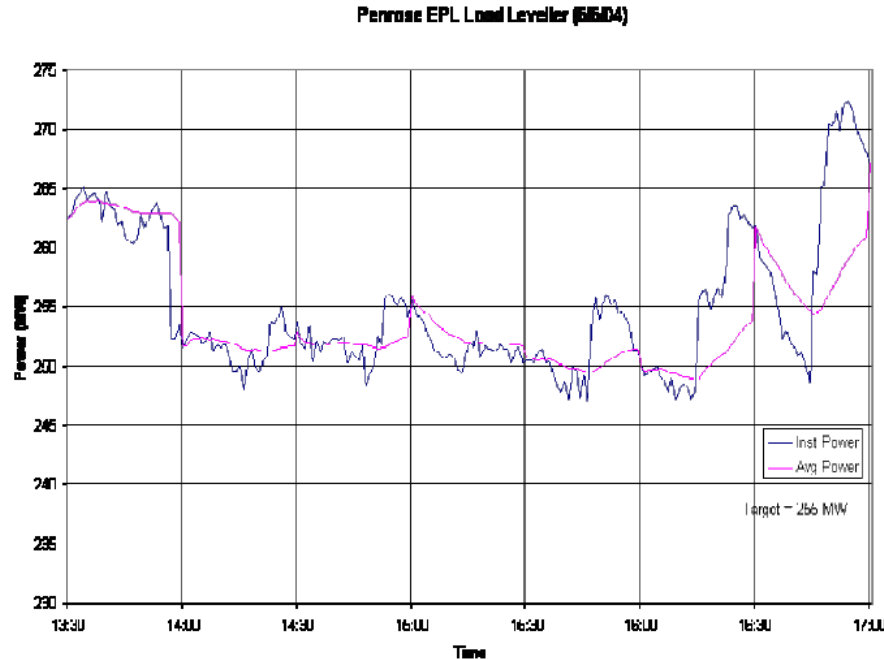
Distribution Innovation

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Existing switching management

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Typical Load Leveller Pattern using Ripple Controller

Ref: Nair, Nayagam, & Francis (2008)

Obligation to connect

Hot water cylinder control

Automation, communication
& protection

Voltage regulation & reactive
compensation

Distribution software &
database

Automated billing

Load shedding



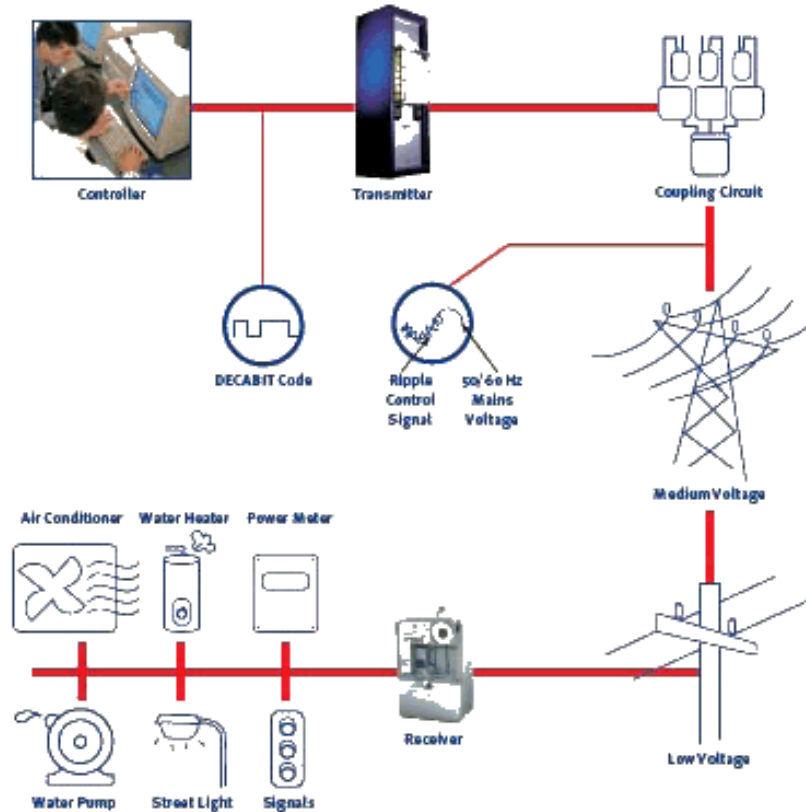
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Network Innovation: Load control

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Smart
load
control

Ref: Nair, Nayagam, & Francis (2008)



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Inverter-based energy systems

IEEE 1547,
IEC 61850,
AUS/NZ 4777

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Potential Benefits

Loss reduction
Upgrade deferral

Voltage improvement
Increasing reliability



Potential Challenges

Generation technologies
System protection
System frequency

Changes to power flow
Power quality
Voltage level control



Ref: Nair & Zhang (2009)



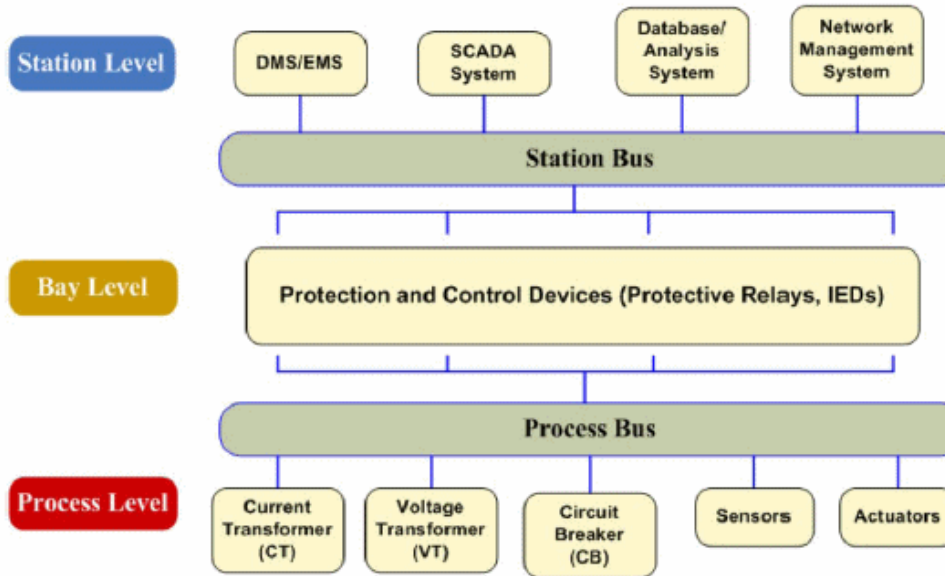
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Network Innovation: Substation

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Three-layer architecture for SAS in IEC 61850.



IEC 61850

Ref: Nair & Zhang (2009)



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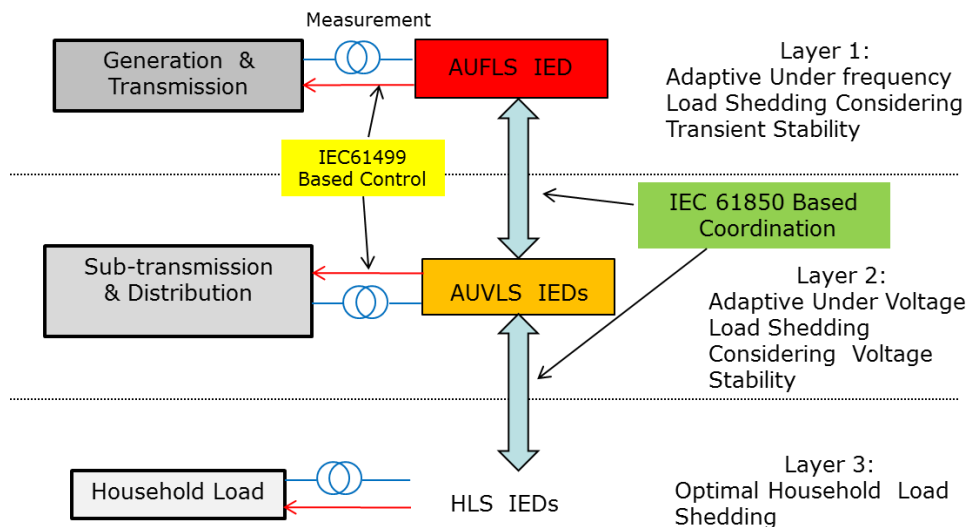
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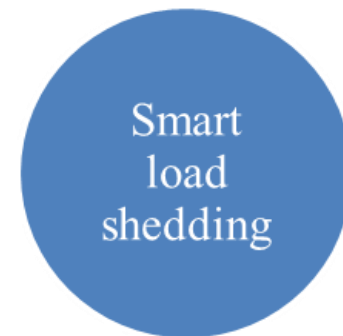
Network Innovation

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Scarcity Pricing, Interruptible Load, Distributed Storage, Reliability Preference



Ref: Mollah (2011)



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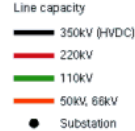
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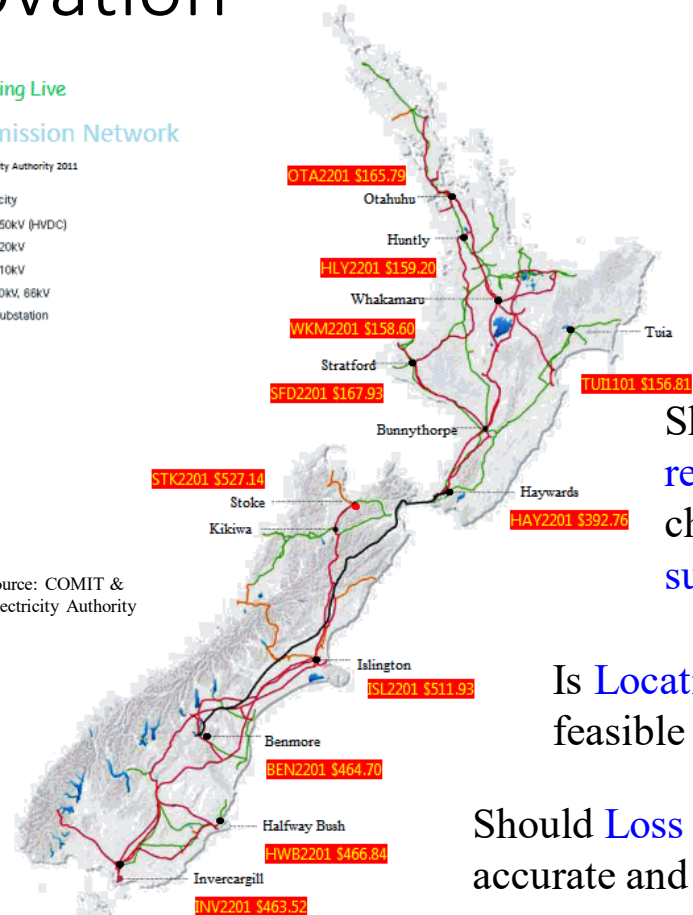
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Streaming Live Transmission Network

Source: Electricity Authority 2011



Source: COMIT & Electricity Authority



Will **Long-run Average Incremental Pricing** be implemented?

Should **lower residential fixed charge** and **rural subsidy** be lifted?

Is **Locational Marginal Price** feasible in distribution networks?

Should **Loss Allocation** be more accurate and specific at ICPs?

Dynamic pricing



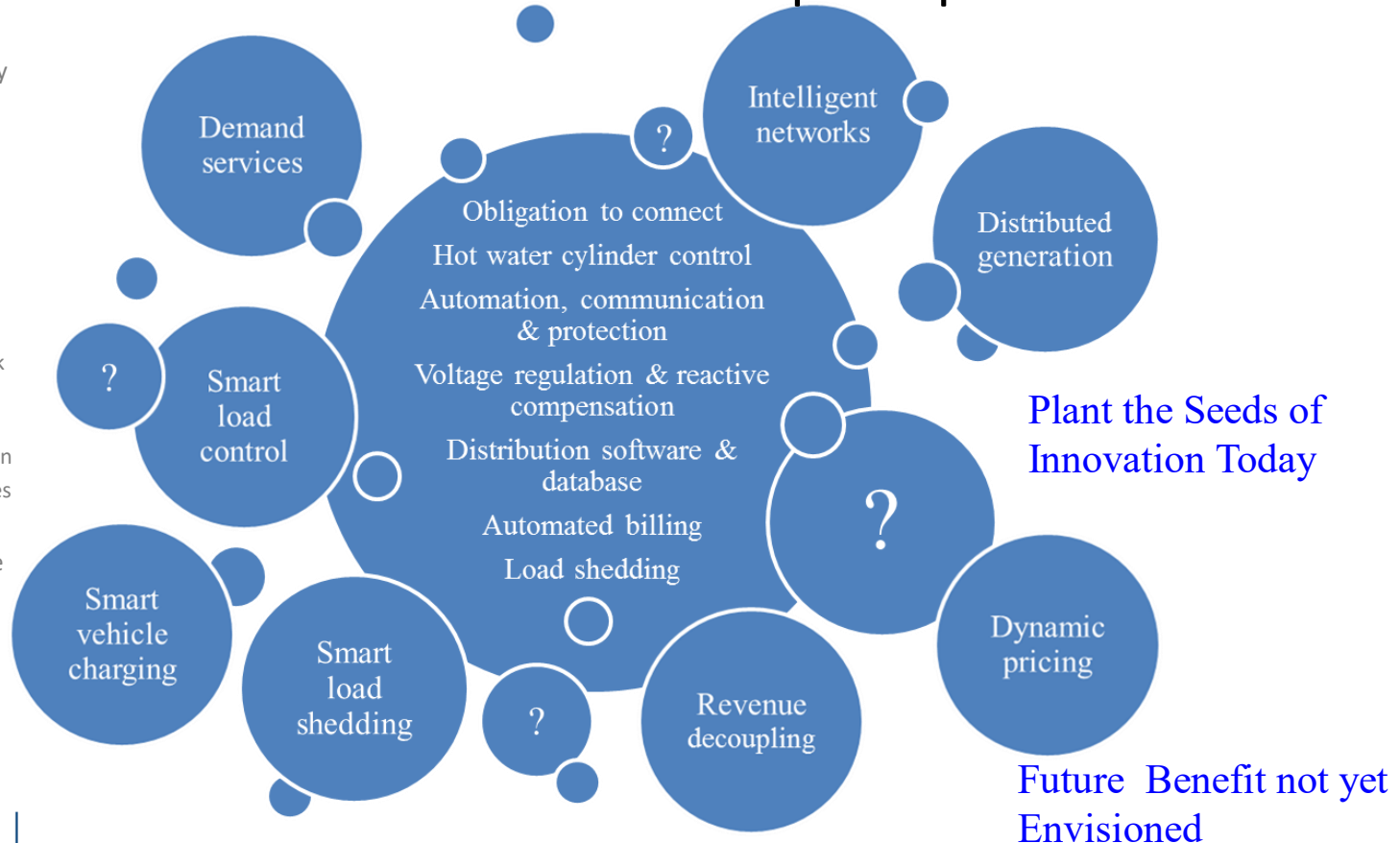
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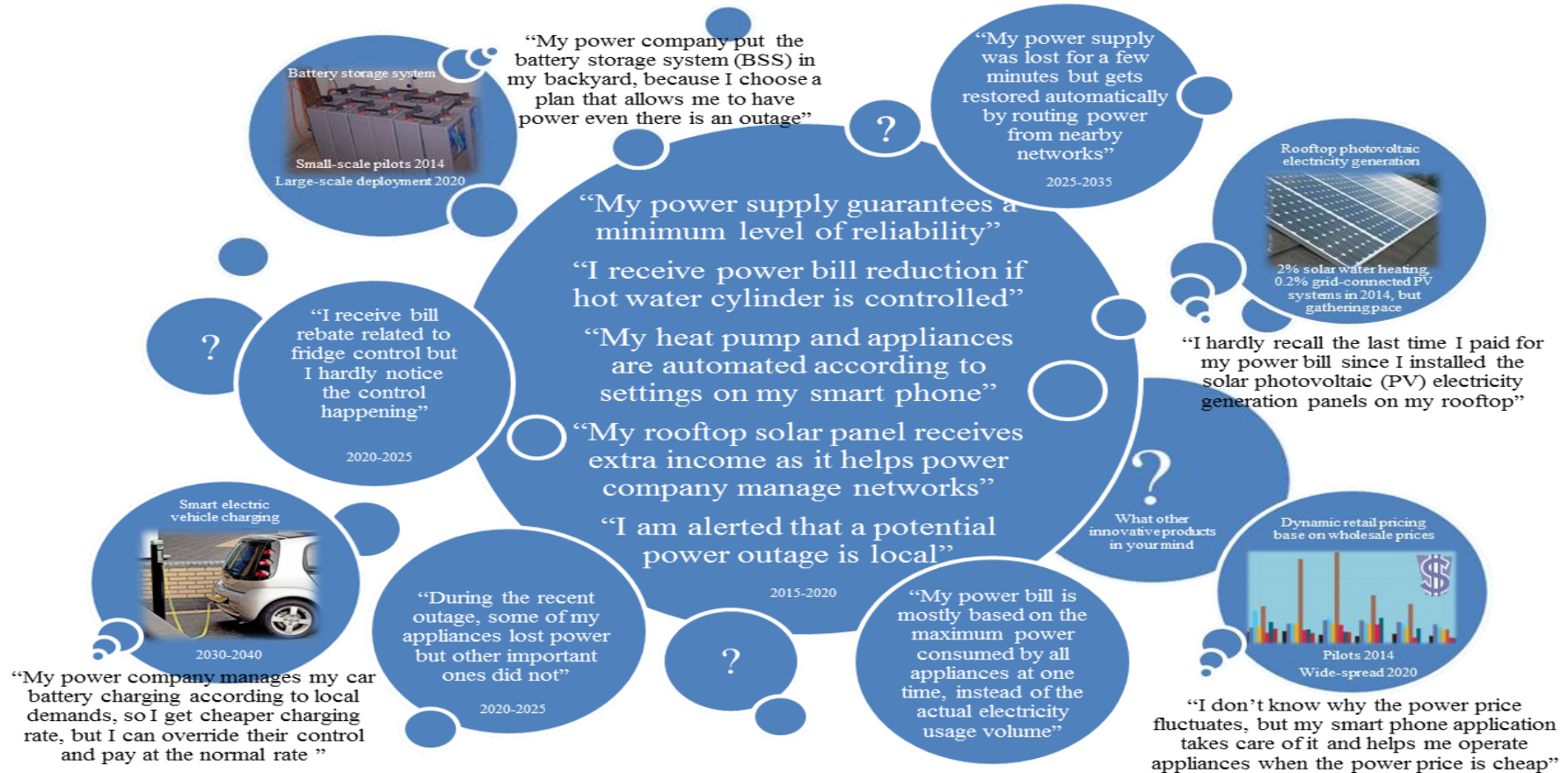
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Smart Grid- Distribution Network perspective

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Smart Grid – Prosumer perspective



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Network Expansion

Rate of return regulations

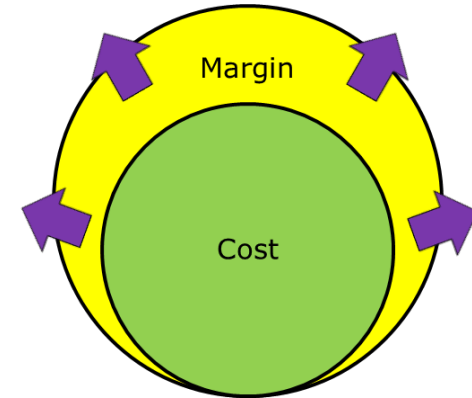
- Cost of service

During 1st half of 20th century

Productive inefficiency

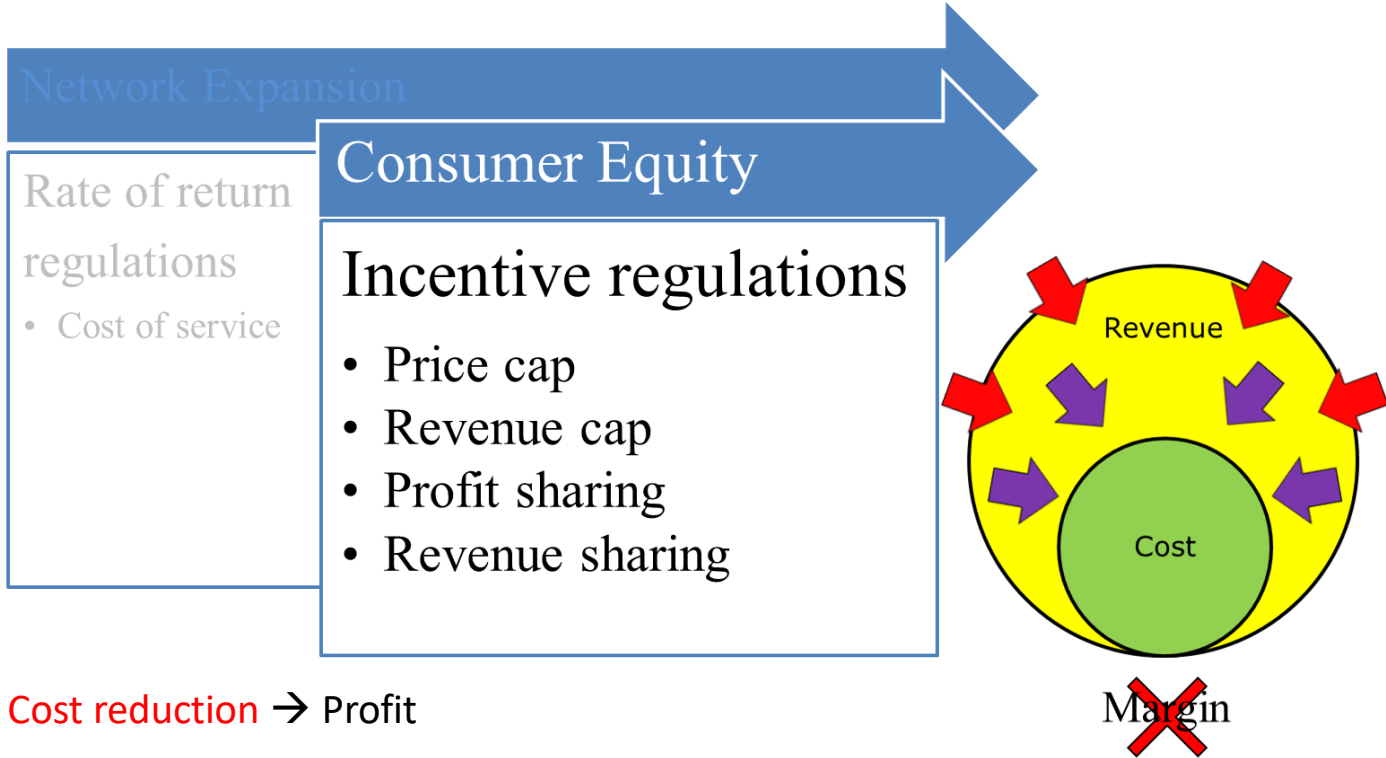
Avoid risk-taking

Lack R&D investment



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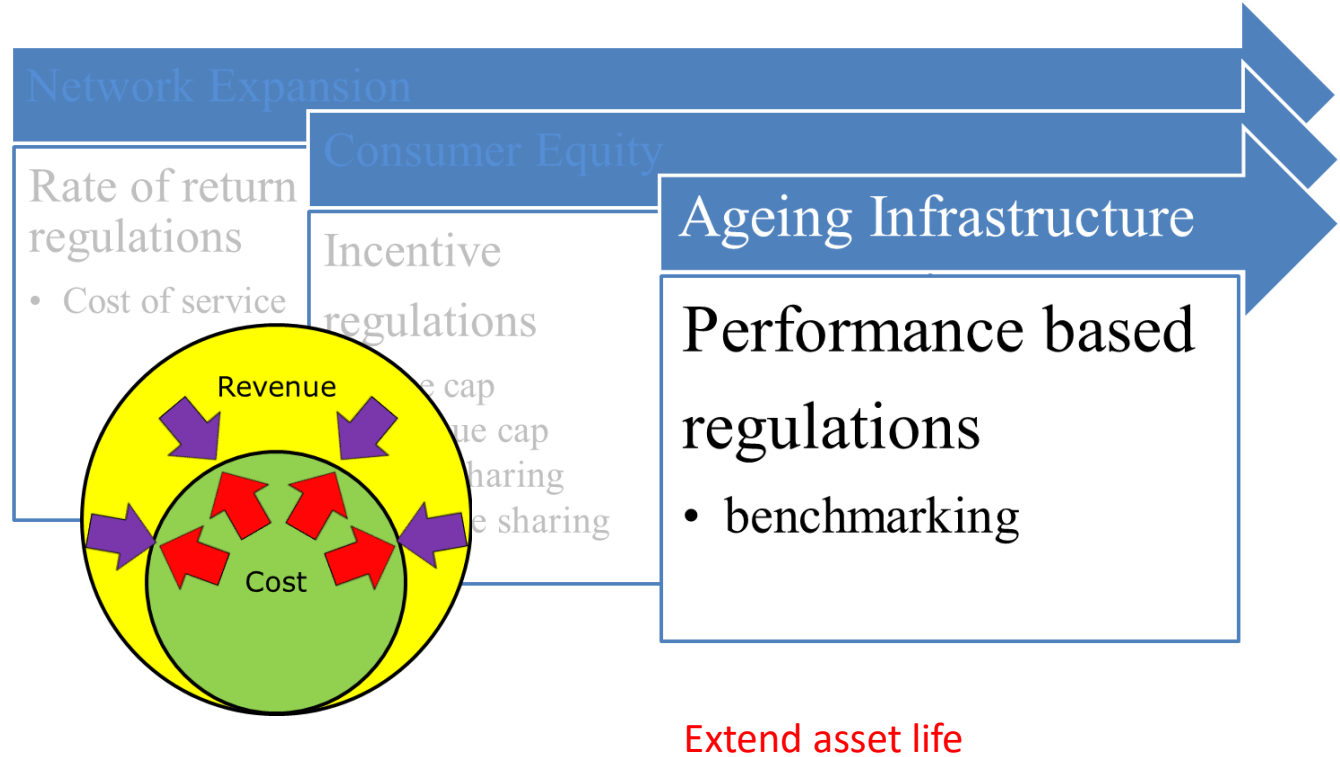
Cost reduction → Profit

Network Efficiency → Profit



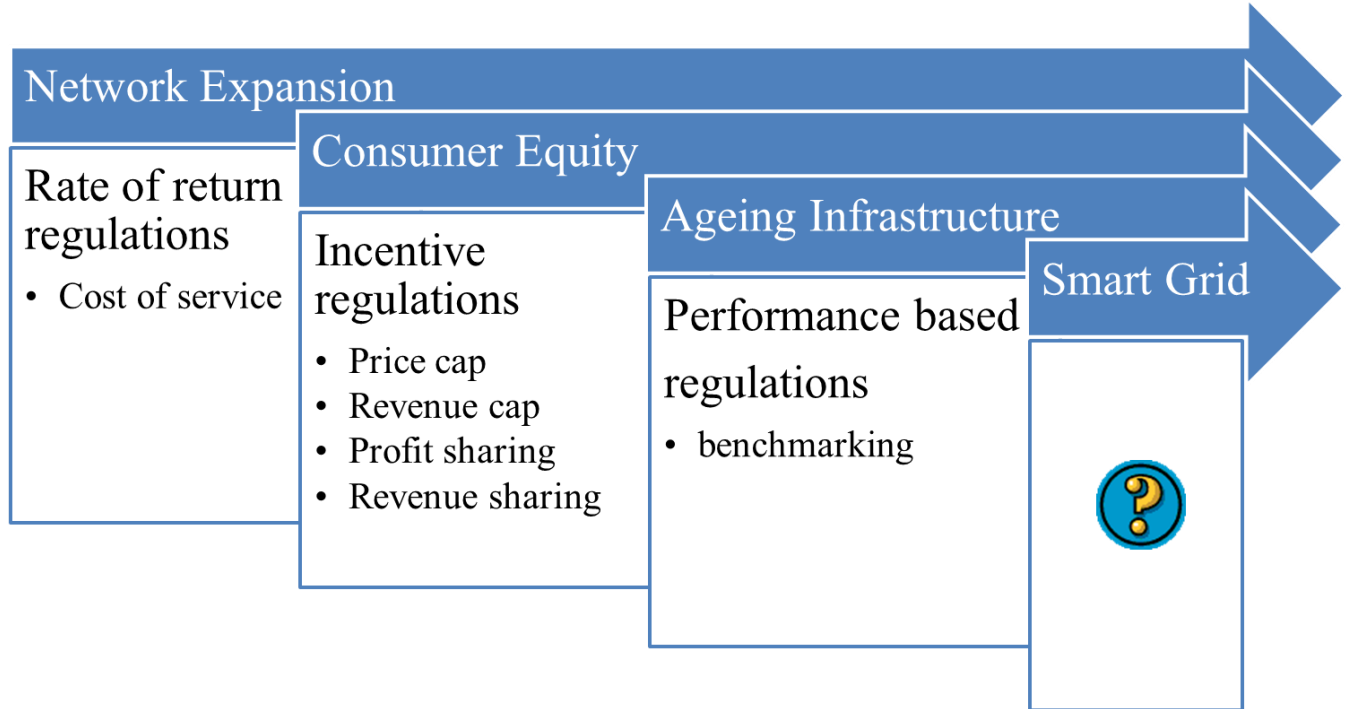
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Changing Environment

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- State and regional government executives → Ministers, Local Councils
- Industry regulator → Electricity Authority
- Competition regulator → Commerce Commission

Overlapping
Authorities



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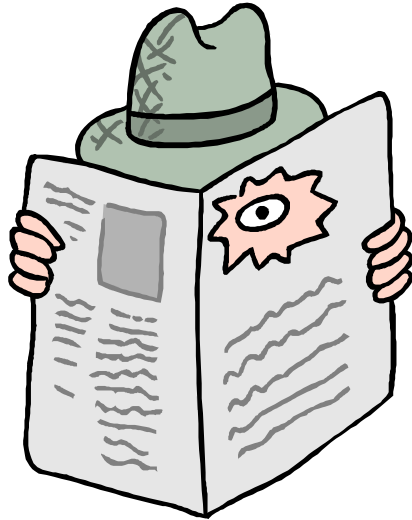
Economic &
Financial
Pressure

- Tough credit environment
- Under-investment
- Insufficient innovation fund



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Uncertain Social Reaction

- Privacy invasion
- Unexpected media reaction
- Lack of experience and understanding



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Technology Advancement

- Demand Side Resource
- Energy efficiency
- Electric Vehicle

Financially
Risky

Electric Vehicle, Heat Pump, Photo-Voltaic, Home Storage, Home Automation & Display, Electric Vehicle Charging, Lighting Efficiency, Home Insulation, Smart Meter, Time-of-day Pricing, Two-way Communication, Integrated Energy Supplier, Aggregated Demand Services, Virtual Power Plant, Dynamic Charges, Integrated Ripple Control, Substation Automation, Distributed Generation, Fault Limiter, Demand Response, Distributed Storage, Load Balancing, Load Prioritising

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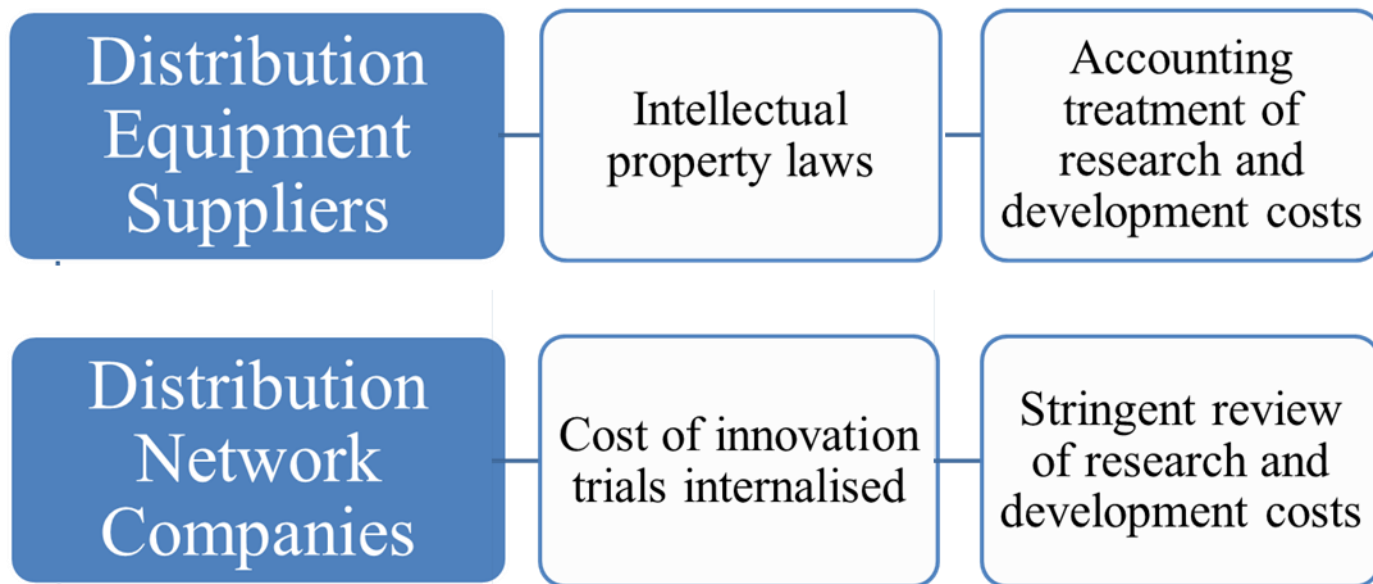
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Ref: Scott (2010)

Innovation Risk

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No industrial scale risk-benefit sharing, or cost offset



Efficient Resource

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New service capacity (Traditional case)

- Company growth
- Larger asset base
- Quality improves
- More room to cut maintenance cost
- Short-term efficiency



Case formed

Efficient resources (Innovation case)

- Revenue shrinks
- Long-term efficiency
- Quality may improve



No business case



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Global Development

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- UK: RIIO
 - Revenue using Incentives to deliver Innovation and Outputs
 - Office of the Gas and Electricity Markets (OFGEM)
 - 2015
 - Features
 - Forward looking innovation
 - Flexibility in the long-term
 - Customer funding for small projects
 - Competitive bidding of central funding



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- US: EEPS
 - **E**nergy **E**fficient **P**ortfolio **S**tandard
 - Reduce higher cost of constructing new peak generations
 - Provide options for consumers to control energy costs
 - Aggressively funded efficiency programs



Business Drivers

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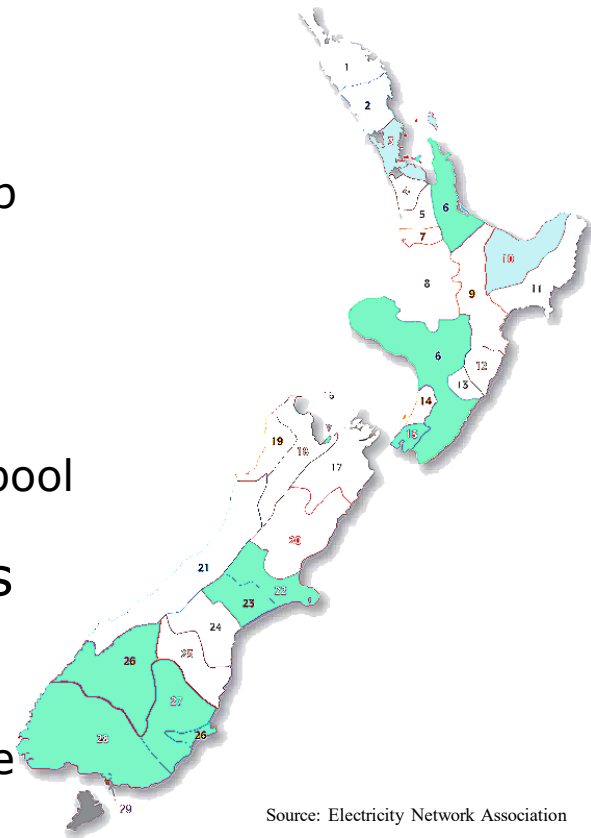
- Broaden revenue source
 - Upstream investment deferral
 - Contract of superior reliability performance or efficiency
- Govt. institution partnership
 - Public communication
 - Building sector
 - Transport energy independency



NZ Relevant Business Drivers

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- Ownership structure
 - Trust (customer) ownership
 - Public ownership
- Innovation risk sharing
 - Jointly R&D costs recover pool
- Enhanced review process
 - Longer pricing interval
 - Predictable review outcome



Source: Electricity Network Association



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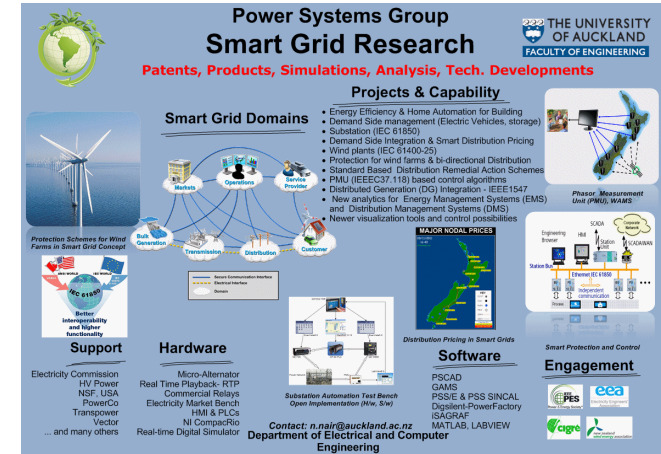
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Role of Test beds: R&D

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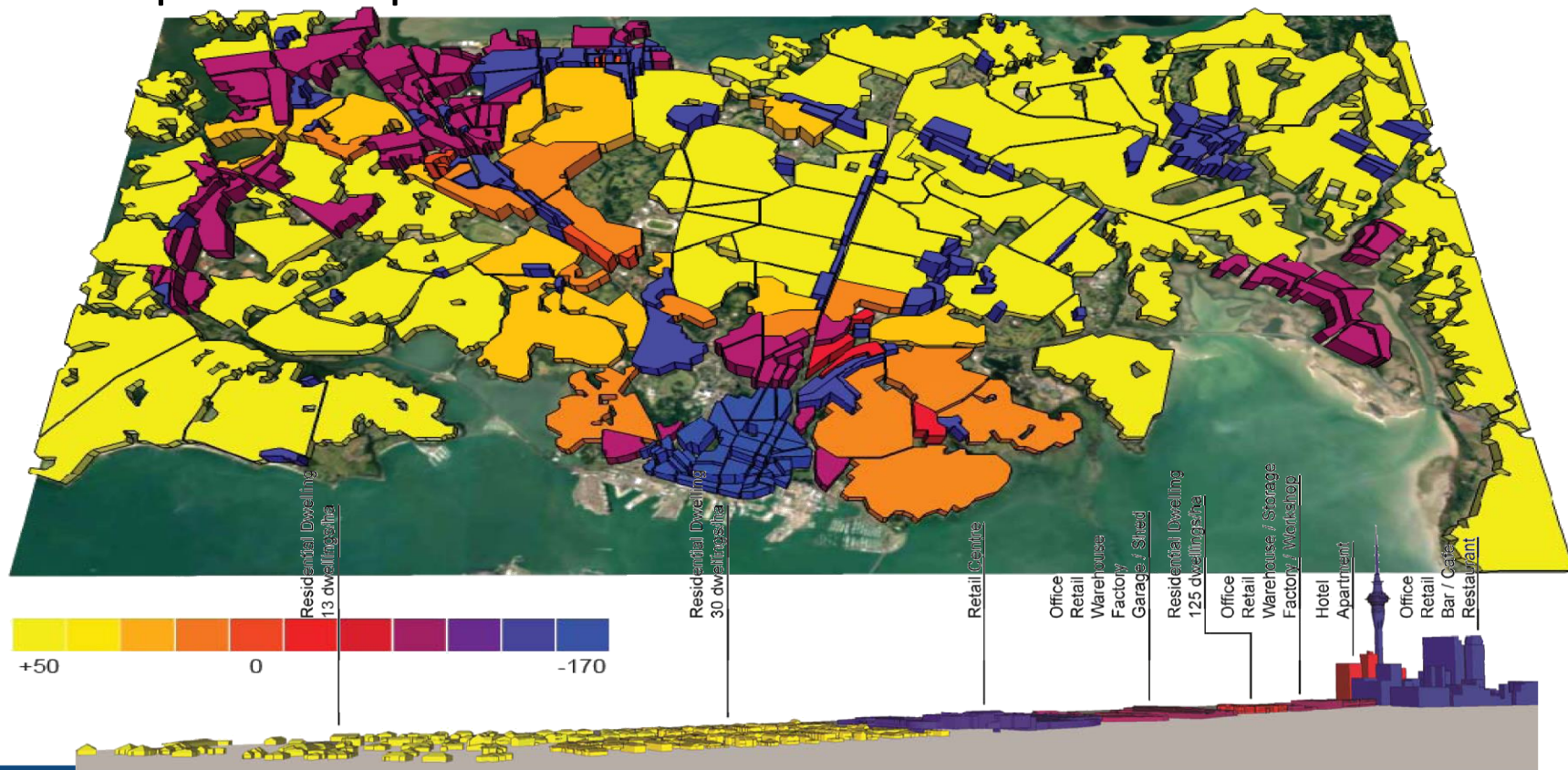
- Unbiased opinion
- Research
- Practical test bed
- International experience
- Innovation forum: Start-ups
- Life-long learning & workforce development



Rooftop solar potential

Solar energy generation potential
(kW h/m² floor area/year)

Ref: H. Byrd, B.Sharp,
N.Nair , et. al (2013)



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Role of Trials: RDD (*Research, Development & Deployment*)

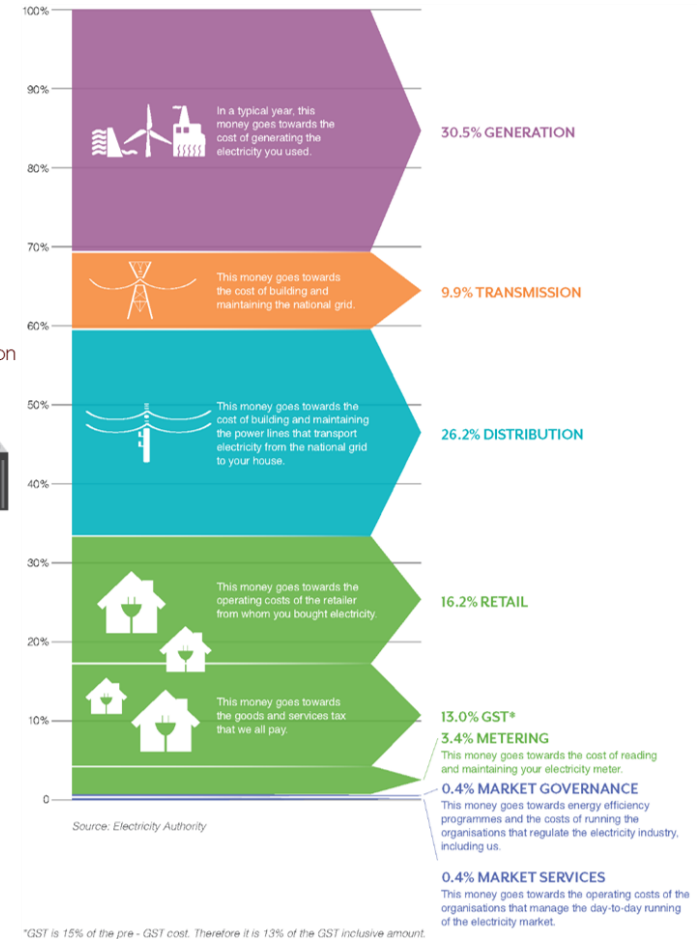
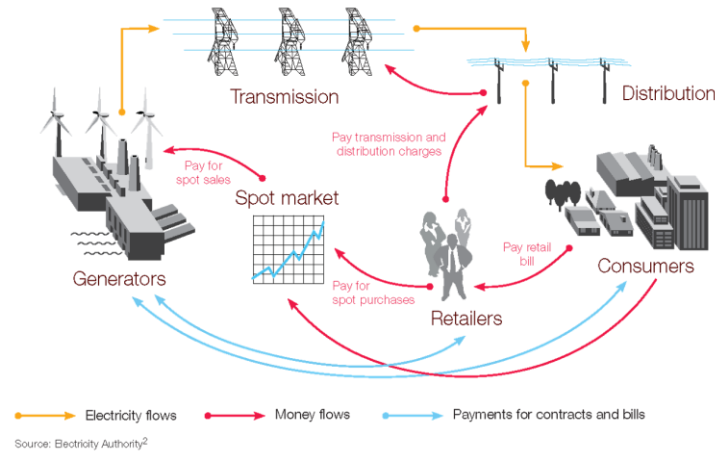
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- Vector Sun Genie Trial began in 2013
- Leasing option: a 3-5kW PV system coupled with a 10.7kWh Li – ion battery system
- 289 systems deployed
- Extended to schools
- Evolved into Tesla JV
- Clustered trials
- Grid battery trials
- Peer-to-peer trial



NZ Electricity Stakeholders and their price share

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UK Peer-to-Peer Transaction Exemplar

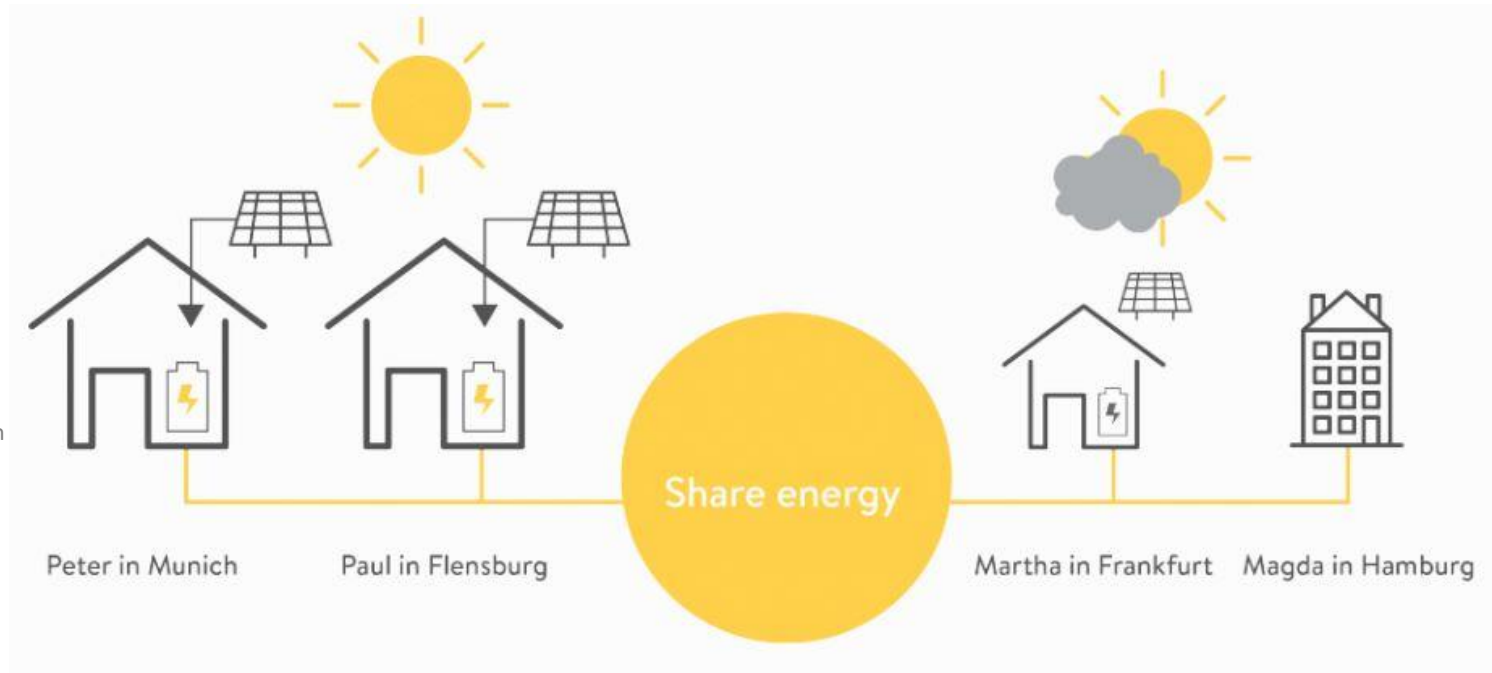


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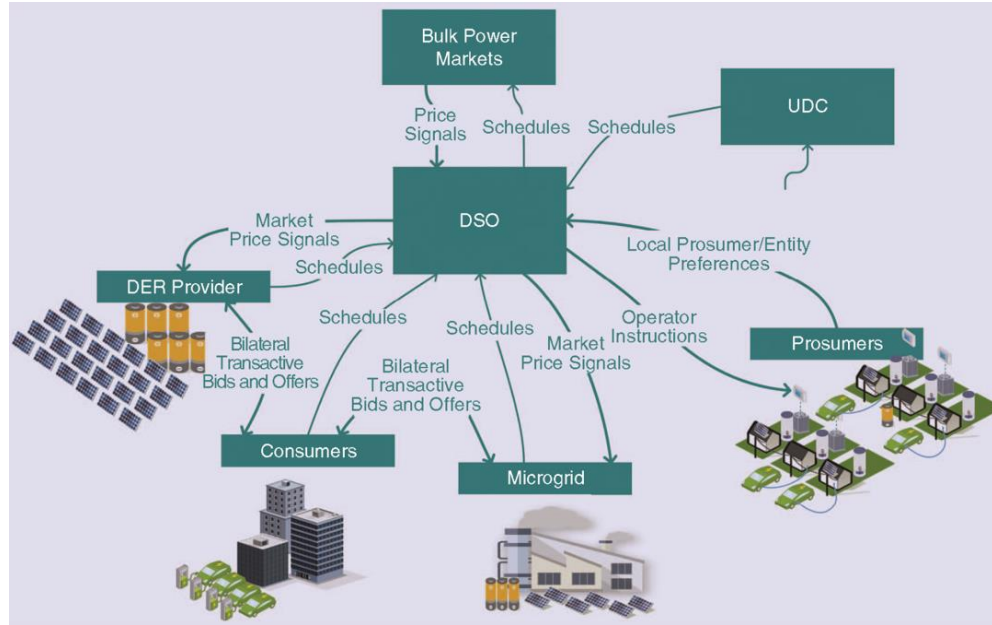
Germany Peer-to-Peer Transaction Exemplar

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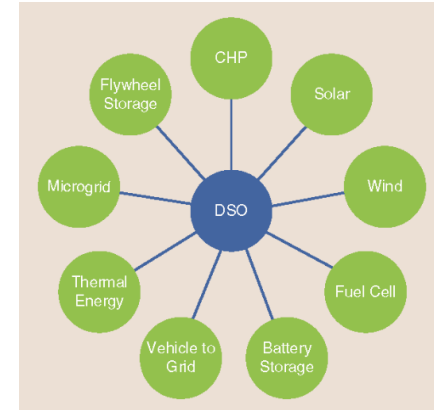


Transactive Energy Framework for Energy Management

- ❑ Innovations in NZ regulatory framework
 - Innovations in NZ electricity industry
 - Applicable innovations in NZ distribution networks
- ❑ The global context of distribution regulations
 - Evolving regulatory framework
 - Changing operation environment
 - The need to support innovation
- ❑ Business drivers to innovate
 - Role of trials and demos



Newer Assets



IEEE power & energy magazine may/june 2016



THE UNIVERSITY OF
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Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

ENGINEERING
DEPARTMENT OF ELECTRICAL
AND COMPUTER ENGINEERING

California's Locational Net Benefit Analysis (LNBA)

SDG&E

SCE

PG&E

SDG&E Components		SCE Components		PG&E Final Value Components			
1	Energy	1	Energy	6a	Generation Energy and GHG		
8	Environment	Category	Specific Investments	2015	2016	2017	2018 GRC (2018-2020)
2	T&D Losses	Distribution Automation	#1 Automated Switches w/ Enhanced Telemetry	\$500K - \$1M	\$3 - \$5M	\$35 - \$60M	\$185 - \$320M
3	Generation		#2 Remote Fault Indicators				
4	Ancillary Services	Substation Automation	#3 Substation Automation	\$1.3 - \$1.6M	\$5 - \$10M	\$25 - \$45M	\$185 - \$320M
5	T&D Capex		#4 Modern Protection Relays				
7	Distribution	Communication Systems	#5 Field Area Network	\$100 - \$200K	\$2 - \$5M	\$5 - \$10M	\$270 - \$470M
9	Avoided Distribution		#6 Fiber Optic Network				
10	Avoided Distribution Cost	Technology Platforms and Applications	#7 Grid Analytics Platform	\$10 - \$13M	\$65 - \$100M	\$55 - \$85M	\$215 - \$375M
11	Societal		#8 Grid Analytics Applications				
12	Public Safety		#9 Long-Term Planning Tool Set				
			#10 Distribution Circuit Modeling Tool				
			#11 Generation Interconnection Application Processing Tool				
			#12 DRP Data Sharing Portal				
			#13 Grid and DER Management System				
			#14 Systems Architecture & Cybersecurity				
		Grid Reinforcement	#15 Distribution Volt/VAR Optimization			\$140 - \$215M	\$550 - \$1,100M
			#16 Conductor upgrades to larger size				
			#17 Conversion of circuits to higher voltage				

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Summary

New business models/players to create values for energy management

Regulators	Utilities	Service Providers	Consumers/Prosumers
<ul style="list-style-type: none"> • Developing Policy Decisions • Relating to Energy Assets, Energy Production, Distribution, and Consumption • Evaluating Which Transactive Approach May Offer Significant Program Benefits • Implementing Best Practices and Improved <u>Value</u> for All Parties 	<ul style="list-style-type: none"> • Connecting with Customers, ISOs, and Partners • Developing a Value-Based Approach to Energy Supply • Providing <u>Value</u> with a Transactive Approach so All Parties Have a Fair Mechanism to Assess Value Based on Time of Use and Costs 	<ul style="list-style-type: none"> • Partnering with Customers to Provide a Consistent Value Proposition for Their Offerings • Ensuring the Highest Quality/Cost <u>Value</u> for Their Contracts with a Transactive Approach 	<ul style="list-style-type: none"> • Engaging with Energy Providers and Service Organizations Through Transactive <u>Value</u> Programs, Incentives, and Partnerships • Delivering Demand Response, Load Shedding, or Similar Programs to Service Providers and Utilities

Source: "The View from the Top of the Mountain" IEEE Power & Energy Magazine, May/June issue



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Renewables and storage in electricity distribution: disruption or value add?

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Wellington, 23 May 2017



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