ELECTRICITY NETWORK TRANSFORMATION ROADMAP 2017-27

Exploring the Beneficial Integration of Distributed Energy Resources & Digital Market Platforms for Energy – DAY 2

7- 8 July 2016
Energex, Brisbane

ena energy networks association

CSIRO

Important Notices

- **These slides are solely for workshop purposes only. The contents are designed to foster a diversity of thinking about future possibilities in Australia. They do not represent the official position of either the Energy Networks Association or CSIRO.**
- ‘Chatham house’ rules apply
- Competition and Consumer Act provisions apply
- Participants to make their own call on sharing commercially sensitive material

Acknowledgement

CSIRO and ENA wish to recognise the ongoing contributions of the following global thought-leaders:

Tabors Caramanis Rudkevich

In-scope / Out-of-scope

This workshop is intended to be:

- Exploratory and consultative; and,
- Designed for both shared learning and seeking stakeholder feedback on a range of quite technical matters.

In addition to transcending current issues, for efficiency the following are out-of-scope:

- Electricity Pricing (refer ENTR workshop on 25 July);
- Regulatory Frameworks (upcoming ENTR paper); and,
- Considerations of ‘who’ might perform new distribution system functions required in a High-DER future

ELECTRICITY NETWORK TRANSFORMATION ROADMAP

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Network Impacts of LV DER – Current Energex Case Study

Peter Price, Energex

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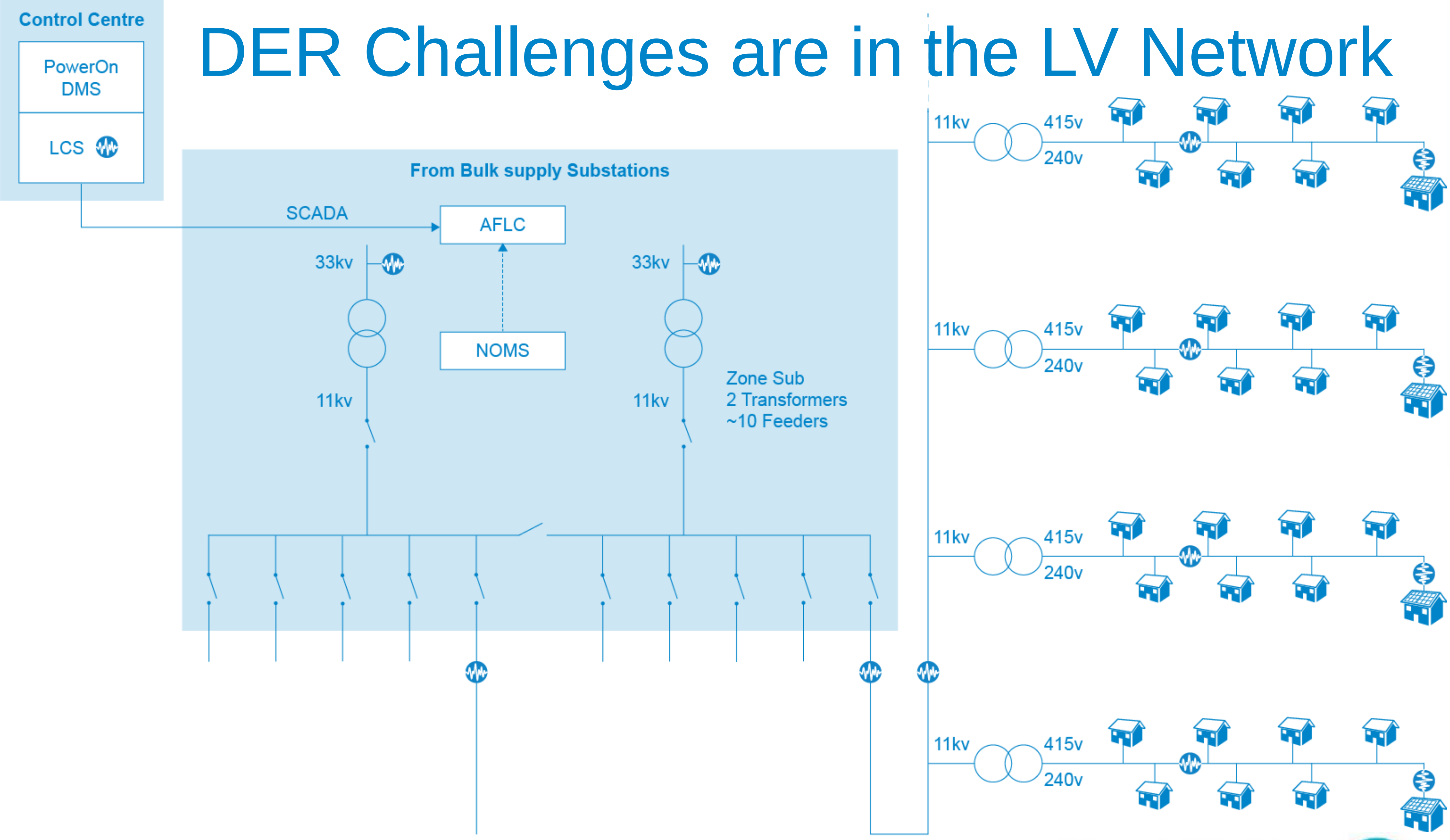
DER Challenges are in the LV Network



Legend
NOMS - Network Outage Management System
LCS - Load Control System

LV Underground Networks have a higher hosting capacity

Pre 1995 – OH LV, In older estates adhoc design

Post 1995 – UG LV to approved design standards

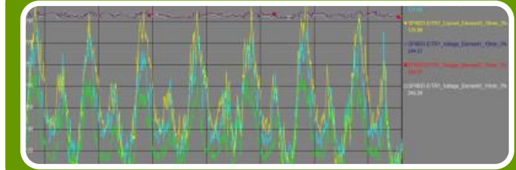
Simple solutions are proving effective to enable increased penetration of DER


Load & PV balancing across phases

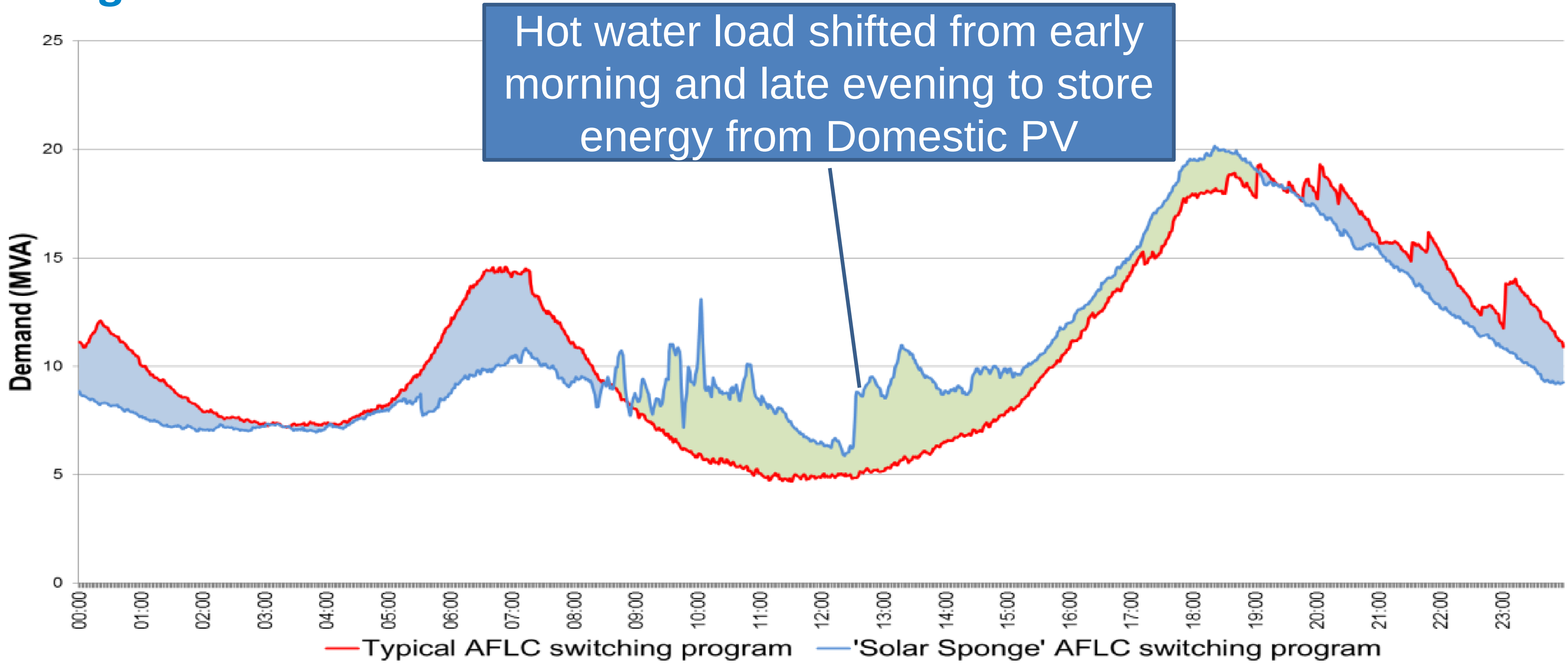

Implement updated inverter standards

Further develop DM capability to use HW load to mitigate duck curve


Continue work to confirm hosting capacity of the network


Further develop LV data analytics informed by Advanced meters

Using our Distribution Management System Software we can now use existing hot water load control as low cost option to integrate PV into the Energex network



Conventional Solutions are available

Install and additional pole transformer

ground-mounted 150kVA 3-phase device which connects in-line along an LV feeder to provide dynamic load voltage regulation

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ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2017-27

Grid Architecture & Control II

Stuart Johnstone, ENA

energy networks association

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SGAM – Communication Layer

SGAM – Smart Grid Architecture Model

Framework

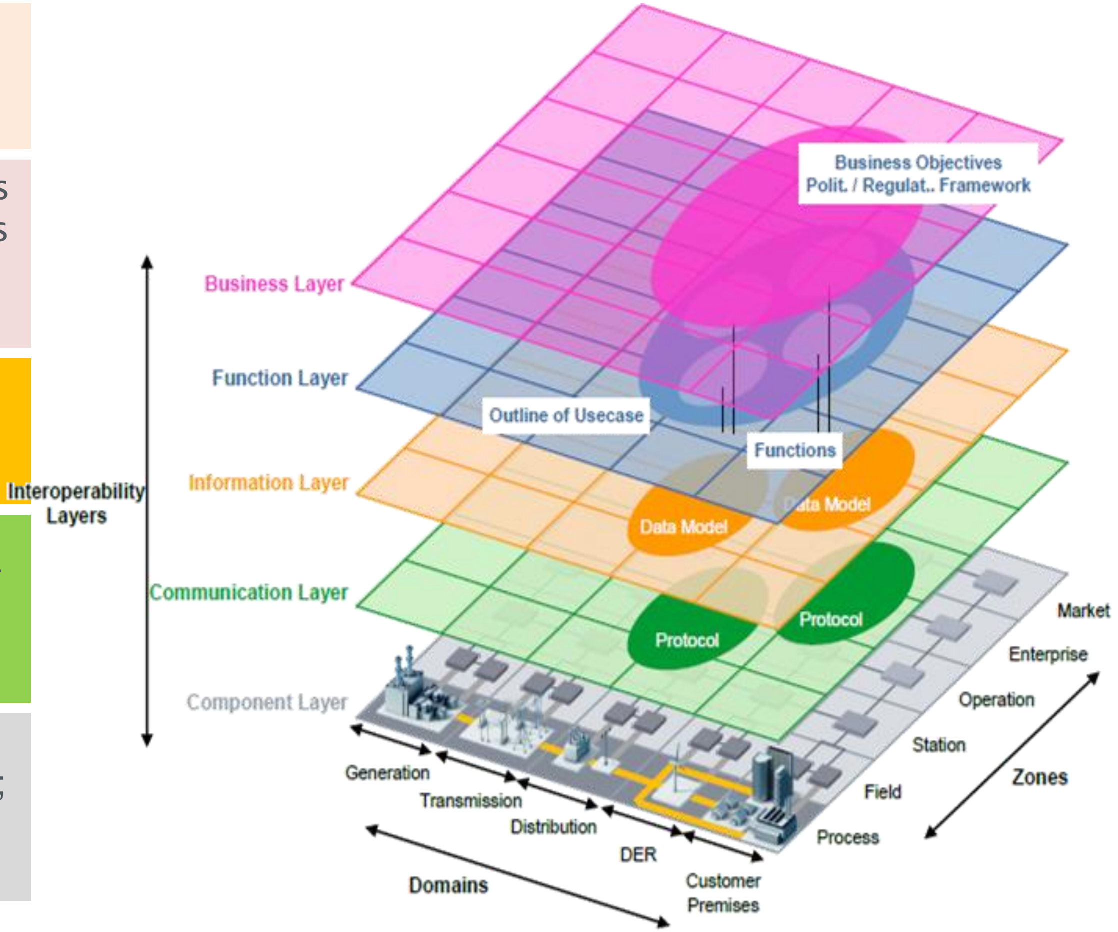
The business layer identifies the macro-level impacts of changes to the electricity sector on different businesses.

The function layer describes the key options for solutions to meet the business case. It is independent from information, communication and physical components.

The information layer describes the type of information that is being passed to achieve the required function.

The communication layer describes the protocols for the interoperable exchange of information, functions, service or data between components.

The component layer is the **physical** distribution of all participating components; including power system assets, protection, connections and computers.



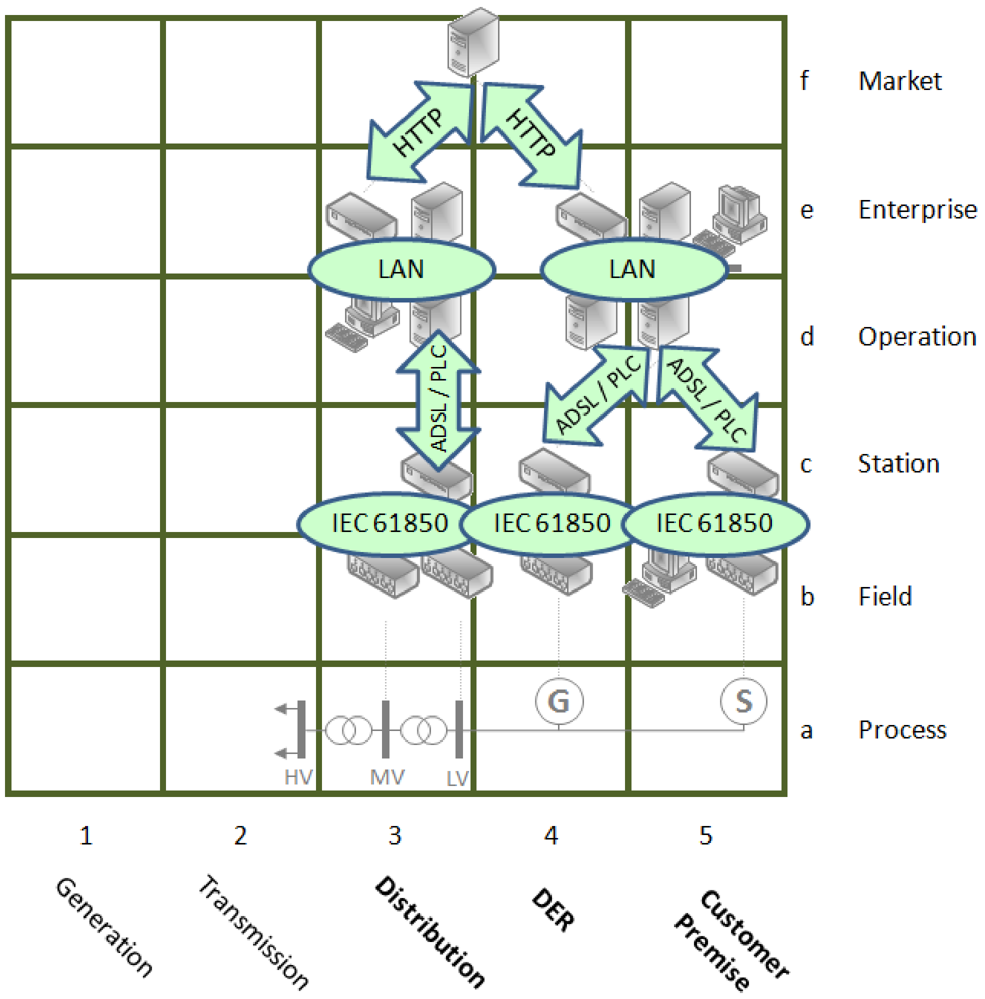
SGAM – Communication Layer

An overview:

- The communication layer describes the various communication channels and media within the smart grid
- It identifies protocols and mechanisms for the interoperable exchange of information between components within the use case context
- It can consider data models and related information objects
- It is important to consider the interoperability of the communications channels available and the information that is to be passed along them, in terms of criticality, speed and security
- It is important to consider the relevant actors, the links that exist between them and the ownership of these communications channels
- Remember that communication links can go across both zones and domains in the framework

SGAM – Communication Layer

Example



- Communication should consider the method of transferring information and the structure/protocol by which the transfer is dictated
- The protocols and mechanisms identified to enable communication should be mapped onto the communication plane

SGAM – Communication Layer

Some considerations:

- What are the speed and data requirements? Does it need to be real time, every 30 seconds, every 10 minutes etc?
- Should the communications be centralised and all feedback to a ‘control room’ function, or should it be localised in feedback loops at a distributed level? Will it be hierarchical such that it is only needed to be passed on up the chain by exception?
- What are the cyber security requirements to ensure the communications channels are secure?
- Where are the links in terms of which actors need to be connected to which systems?
- What are the possible ownership arrangements of the links and who needs to be able to access the channels to be able to send/receive data?

SGAM – Information Layer

SGAM – Smart Grid Architecture Model

Framework

The business layer identifies the macro-level impacts of changes to the electricity sector on different businesses.

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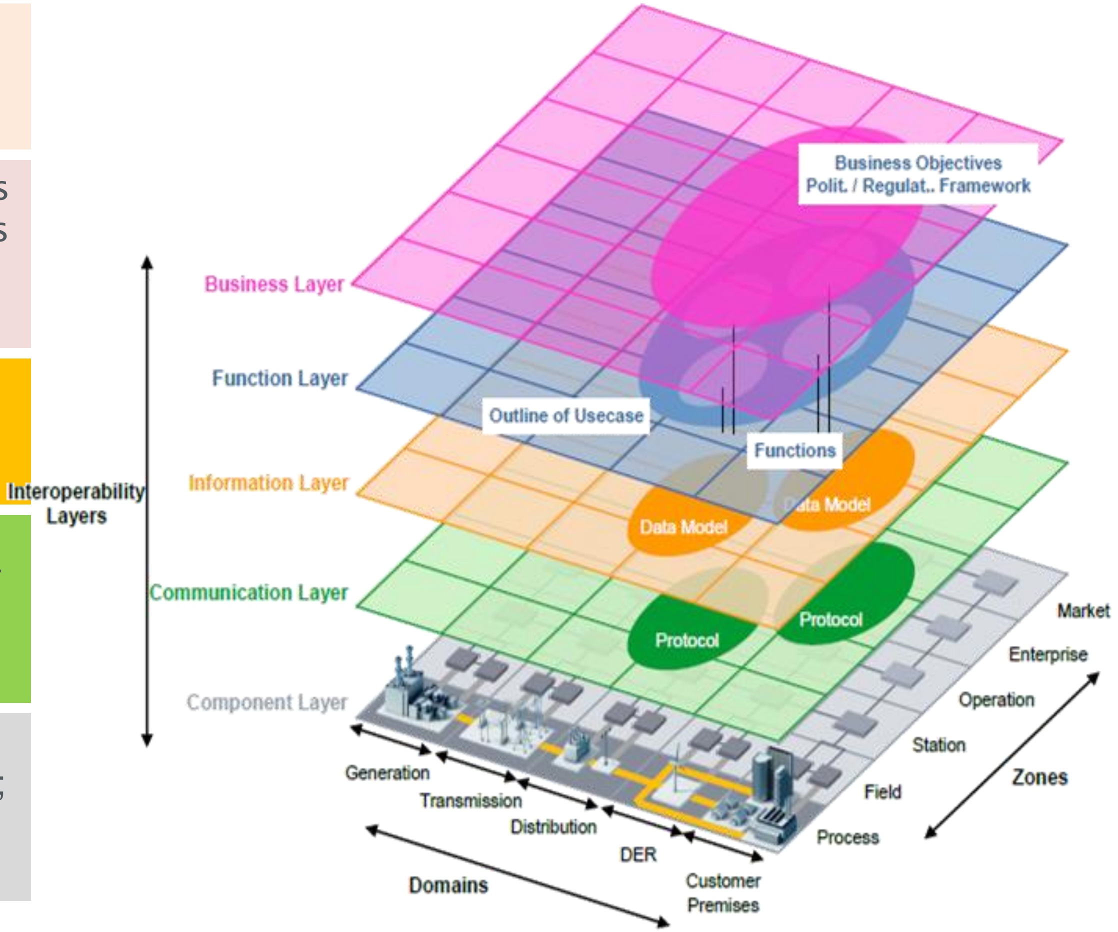

SGAM – Information Layer

An overview:

- This layer addresses what information would need to be passed between different physical layers of the network or actors to achieve the required functionality.
- An Information Architecture is an abstract representation of properties, relationships and operations that can be performed by an entity.
- It describes the information that is being used and exchanged between functions, services and components.
- It contains information objects and the underlying canonical data models.
- These information objects and canonical data models represent the common semantics for functions and services in order to allow an interoperable information exchange via communication means.

SGAM – Information Layer

What's included in the Information layer?

- **Integration and Interfaces**
  - A link between either two or more SGAM layers and between one or more zones/domains at plane level.
- **Information Forms**
  - These should allow for interoperability between all required systems and actors, and achieve the required functionality.
- **Data Models**
  - An important aspect of the information layer but should not be over considered; Utility data models are well established (IEC 61850 – substation automation) and strong initiatives to harmonize smart grids data models are underway.

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Architecture & Control Wrap up

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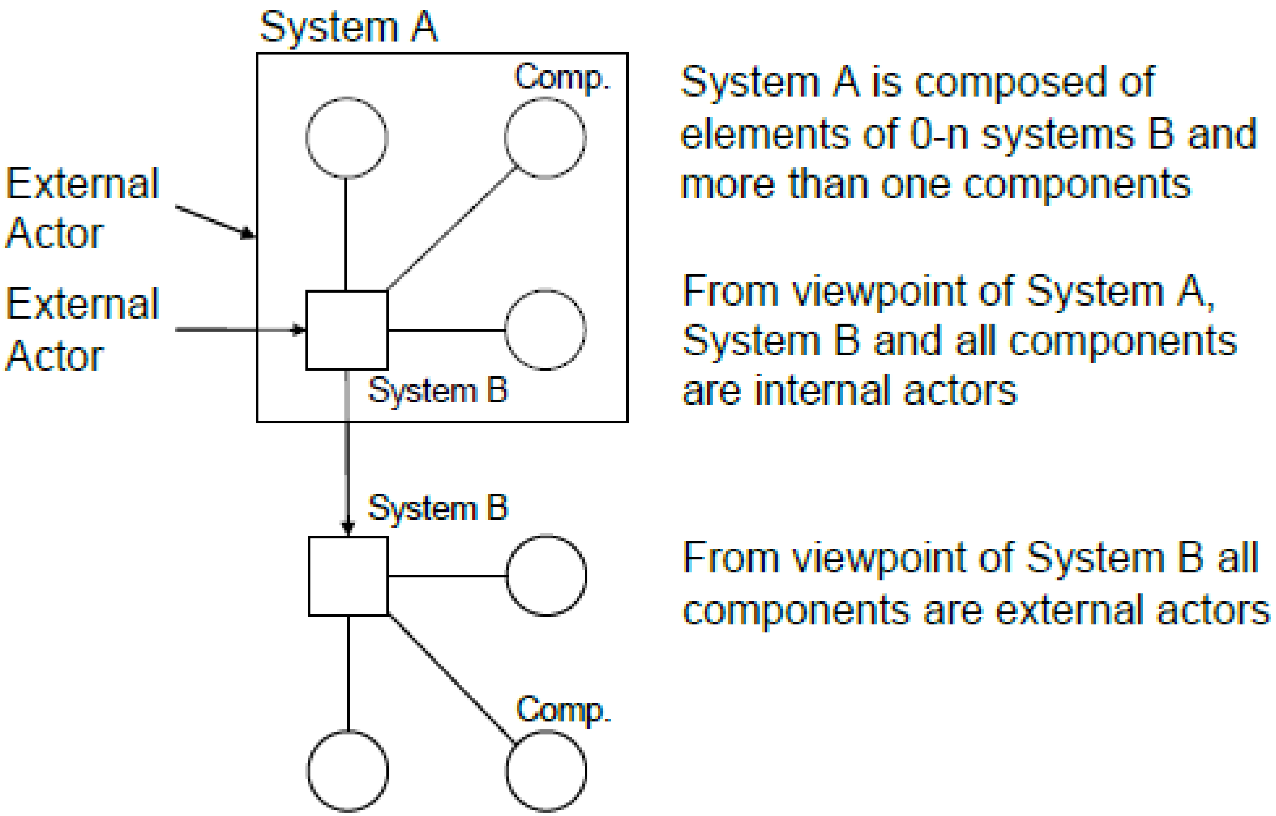
Grid Architecture - Next Steps

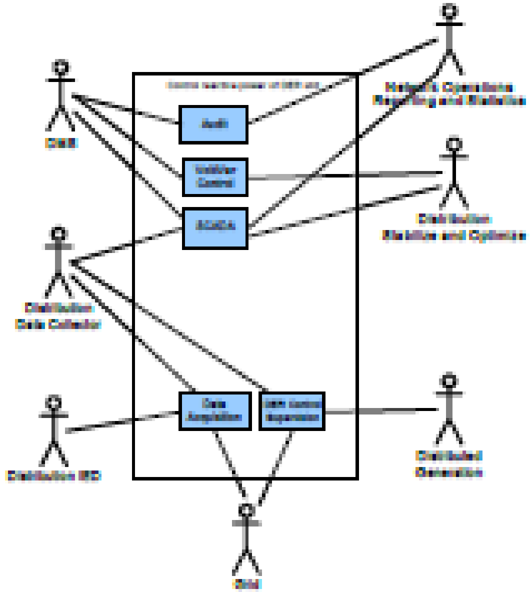


Information collected from workshop

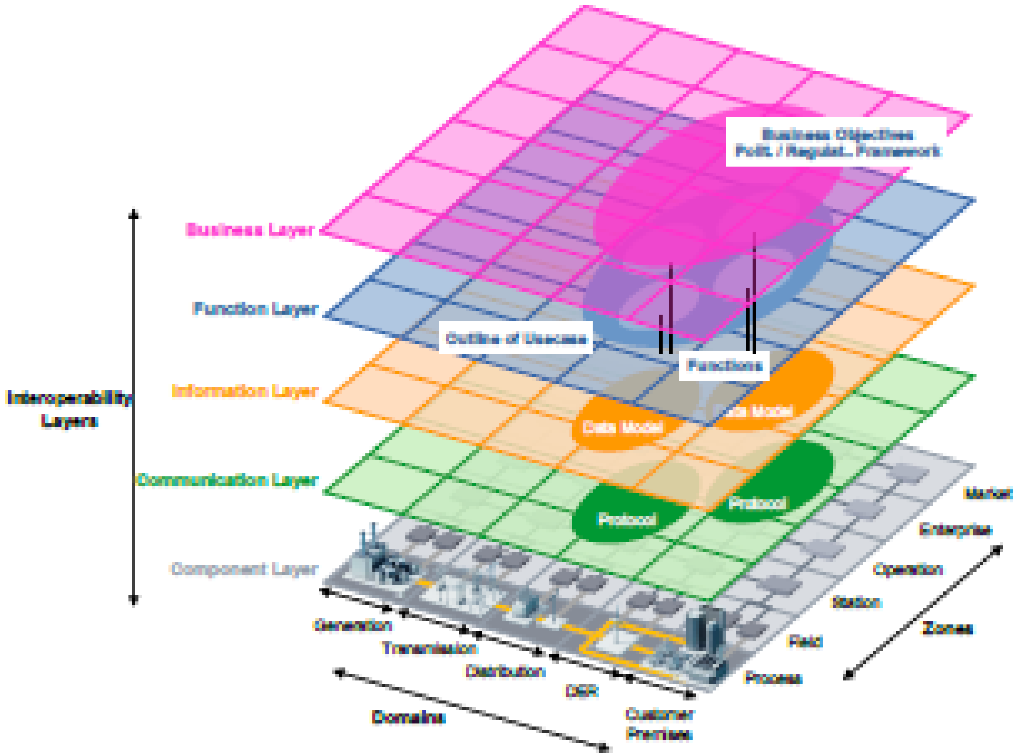
1. Will use the information collected at the workshop to map onto SGAM
   – Identify zones, domains and systems covering the use cases

Map to SGAM

Use Case

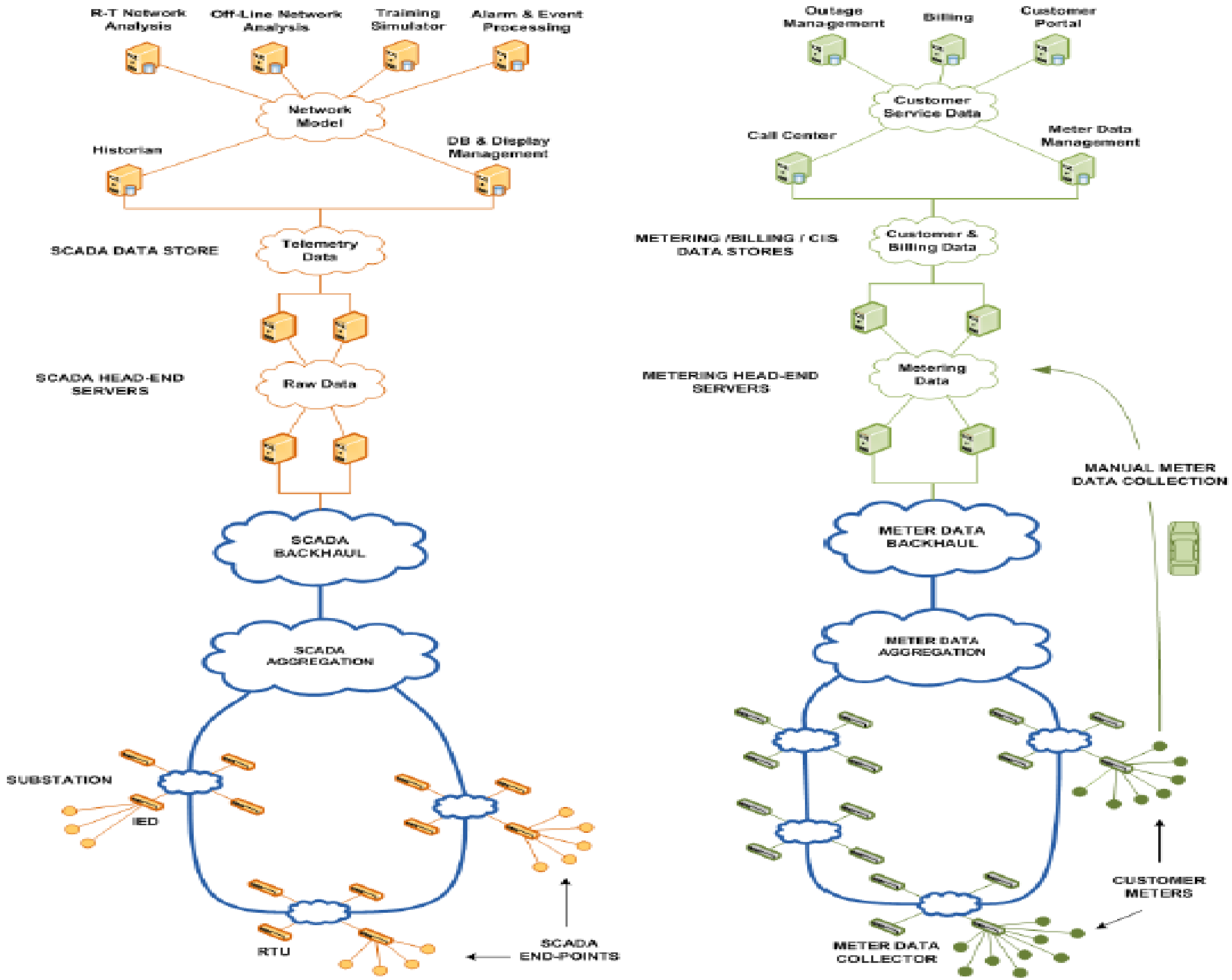


SGAM

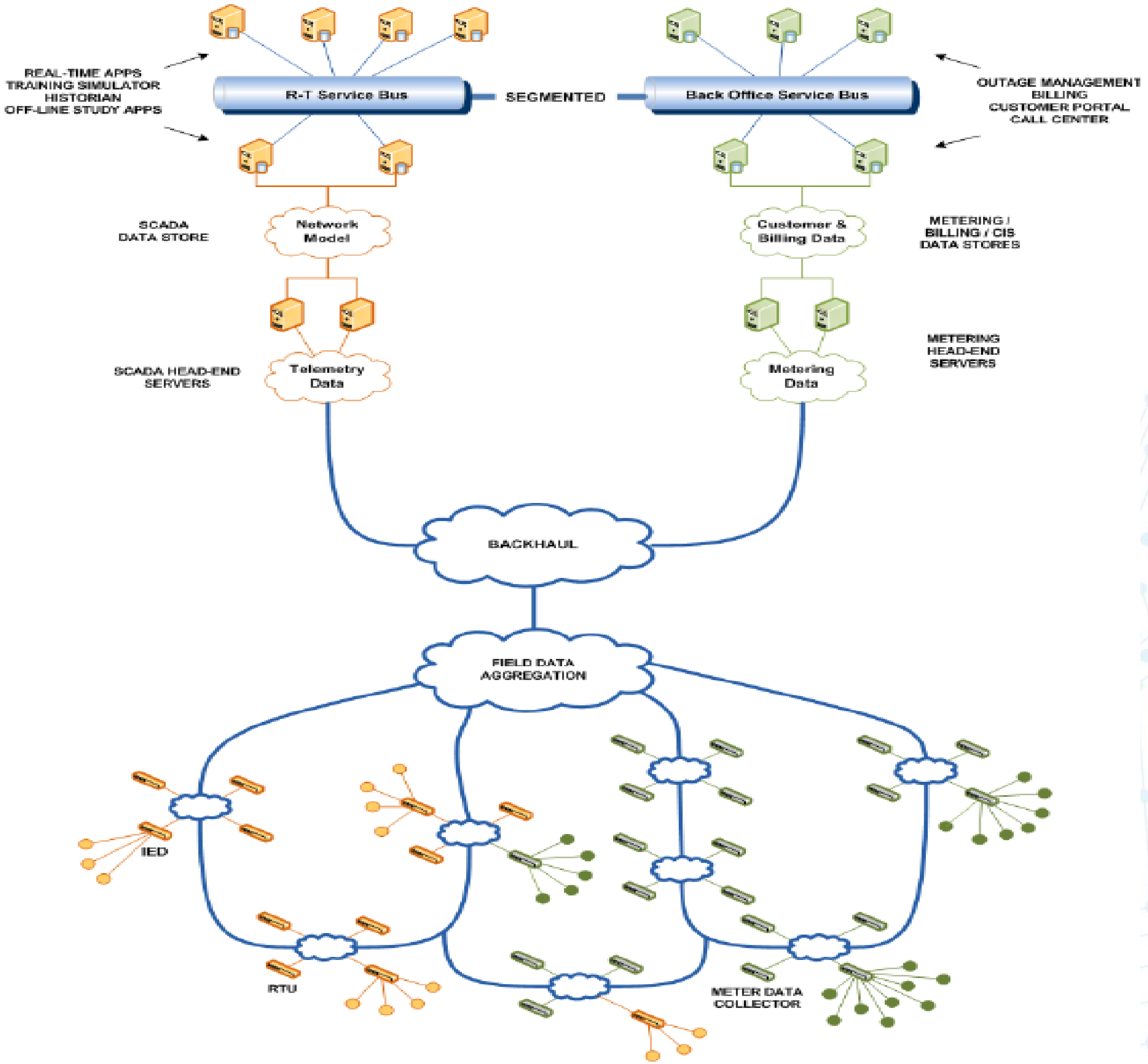


- Use Case Analysis
- Development Component Layer
- Development Business Layer
- Development Function Layer
- Development Information Layer
- Development Communication Layer

Example Arcitecture for EMS/SCADA system



Converged Communication Layer



Thank You !

Want to know more?

For more information on the Electricity Network Transformation Roadmap

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

or contact

Dr Stuart Johnston at ENA at **sjohnston@ena.asn.au**

or 02 6272 1513

ELECTRICITY NETWORK TRANSFORMATION ROADMAP 2017-27

Valuing & Incentivising DER Products

Technical & Economic Platforms for Energy

Mark Paterson, CSIRO

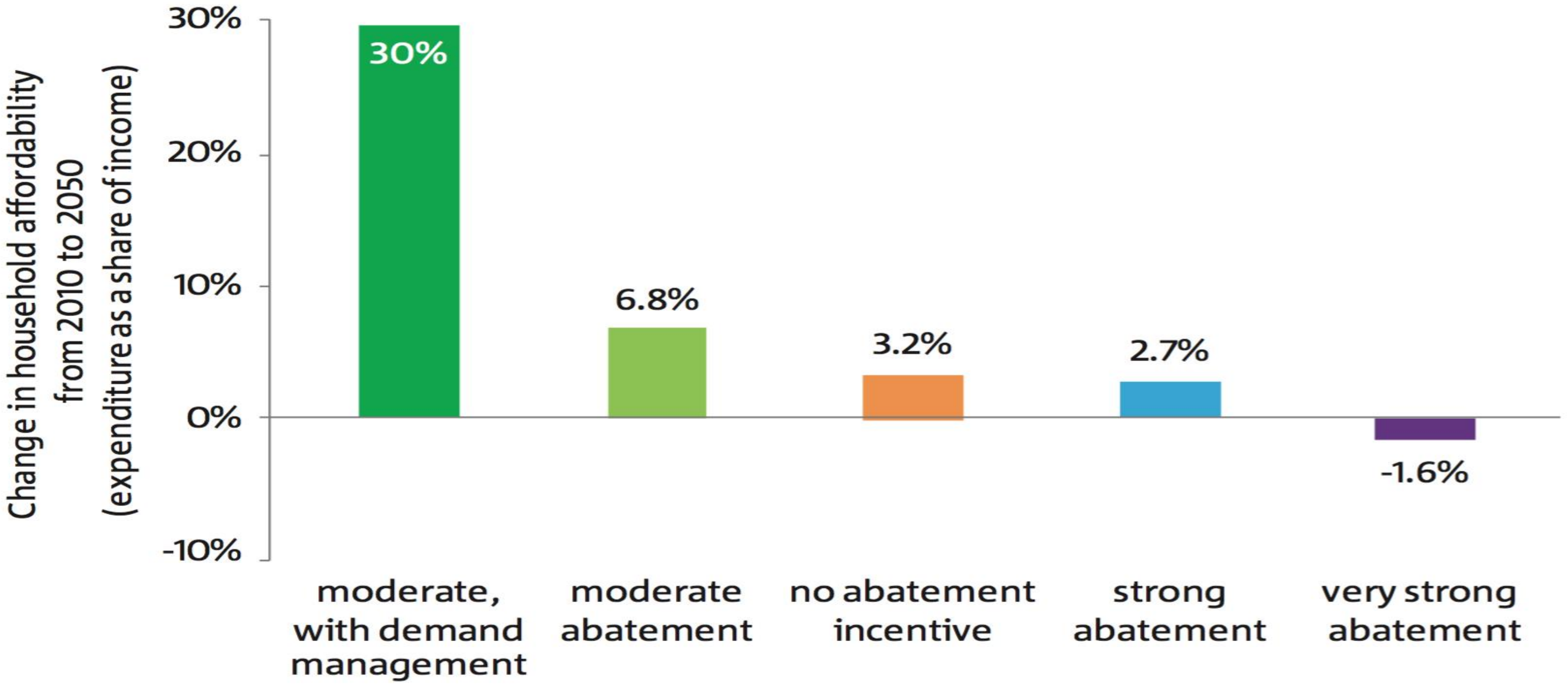
energy networks association

Agenda

1. The ‘system optimisation premium’
2. The heart of the future grid optimization challenge
3. Different approaches illustrated by key jurisdictions
4. The ‘Platform Revolution’ meets future grid optimisation?
5. Key Platform design principles for incentivizing DER integration
6. Considering the ‘Platform vs Platforms’ question

1. The ‘system optimisation premium’

Unlocking Australia’s electricity system ‘optimisation premium’ could improve affordability by at least 30%



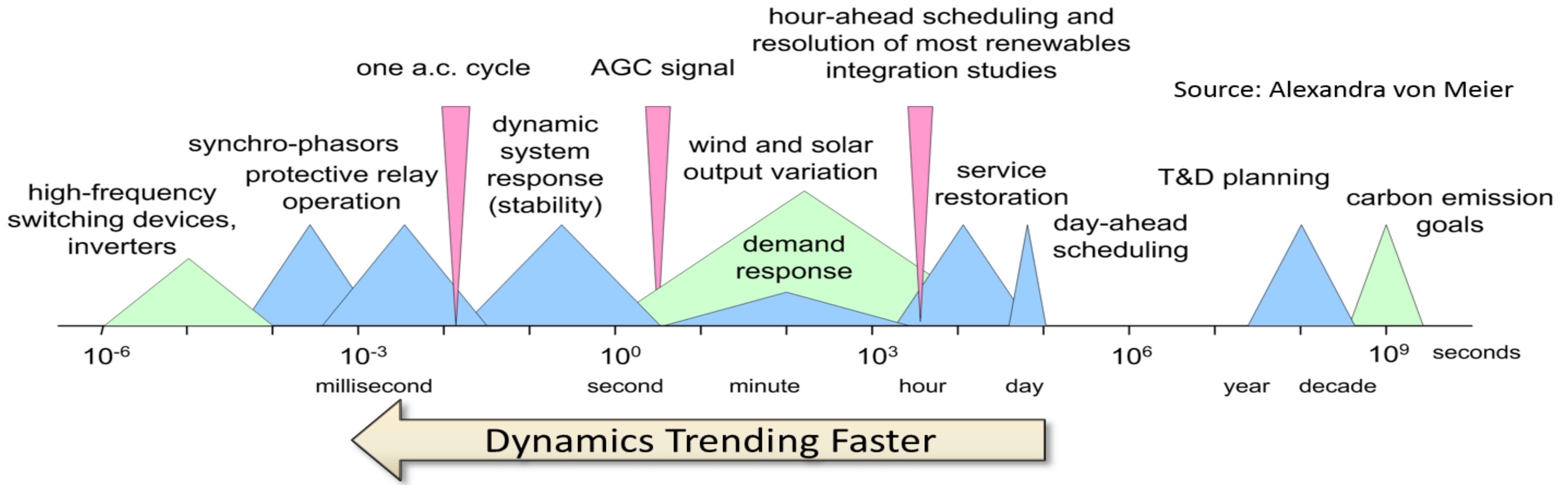
SOURCE: CSIRO Australian National Outlook 2015

DER-enhanced grid optimisation could become a valuable part of Australia's tradable 'value stack'

Whole-of-system value stack	Type
Customer & Societal options	Financial and non-financial
Wholesale market	Financial
Transmission networks	Financial
Distribution networks	Financial
Customer & Societal outcomes	Financial and non-financial

2. The heart of the future grid optimization challenge

Faster - More data - More endpoints!!



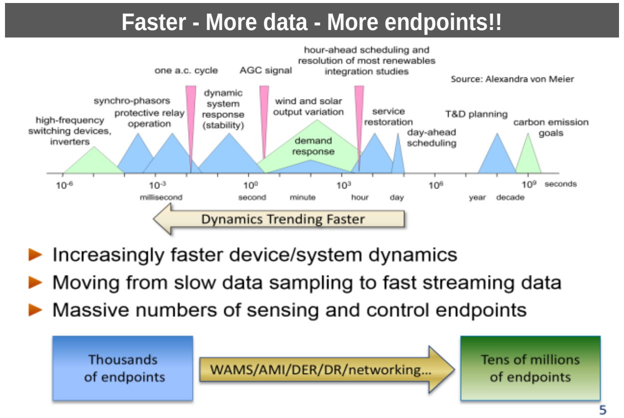
- Increasingly faster device/system dynamics
- Moving from slow data sampling to fast streaming data
- Massive numbers of sensing and control endpoints

Timing is everything…!

“The fundamental problem in operating an electric power infrastructure is **maintaining balance** between supply and demand.

“The physics of the electrical power system will force balance to be maintained; otherwise **imbalance** outside of the tolerance of the system will **cause the system to fail through a chain of events** resulting in blackouts.

“The key objective of the operators of the system is to supply power to loads reliably (within specified limits), thereby avoiding blackouts. To achieve this **objective actions** take place on a range of **time scales from years to milliseconds.**”



The Transactive Energy Framework (2015), GridWise Architecture Council

Wholesale Market-Control Spectrum

Wholesale markets have evolved over the past 20 years to incorporate a **variety of mechanisms** to enable competitive market participation/solutions including DER.

There is **no one single mechanism** to address the various power system needs, nor the various needs of market participants.

	Markets		*Controls*
Power System Needs	Long-term Planning & Investment	Residual & Real-time System Optimization	System Operations
Bulk Power System	Forward Contracts	Spot Markets & LMP	Contractual/Tariff based Ancillary Services (Operational Controls)

years | monthly | day ahead | hourly | 15 min | 5 min | 1 min | 1 sec | Sub-cycle

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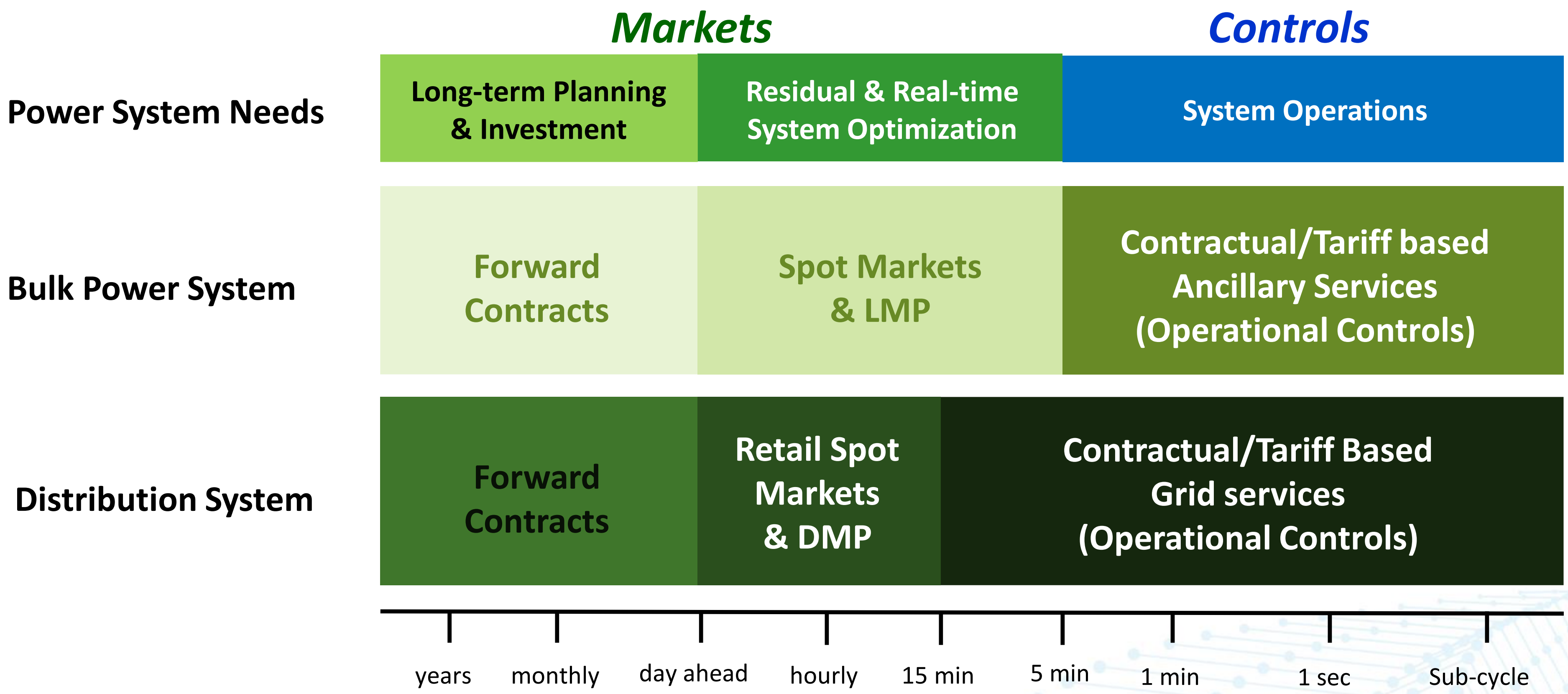
Distribution Market-Controls Spectrum

Distribution level markets may similarly have **distribution grid operational services** in the near term and **distribution retail energy markets** over time.



Evolving system operation objectives for a High-DER future

New operational objectives must be thought of as a **multi-objective optimization problem**. At a network level, these include achieving:

- Managing transmission congestion costs
- Provision of ancillary services, ramping, and balancing
- Peak load management
- Resource ramp management
- Minimisation of new transmission capacity
- Minimisation of new distribution capacity
- Management of distribution voltages from rapid fluctuations in solar PV system output
- Accommodation of new loads and integration of responsive resources, including energy storage

GRIDWISE Architecture Council

Adapted from the The Transactive Energy Framework (2015), GridWise Architecture Council

Revisiting the ‘Markets vs Controls’ (false) dichotomy

Market economists:
Just get the right market rules and prices and everything will work

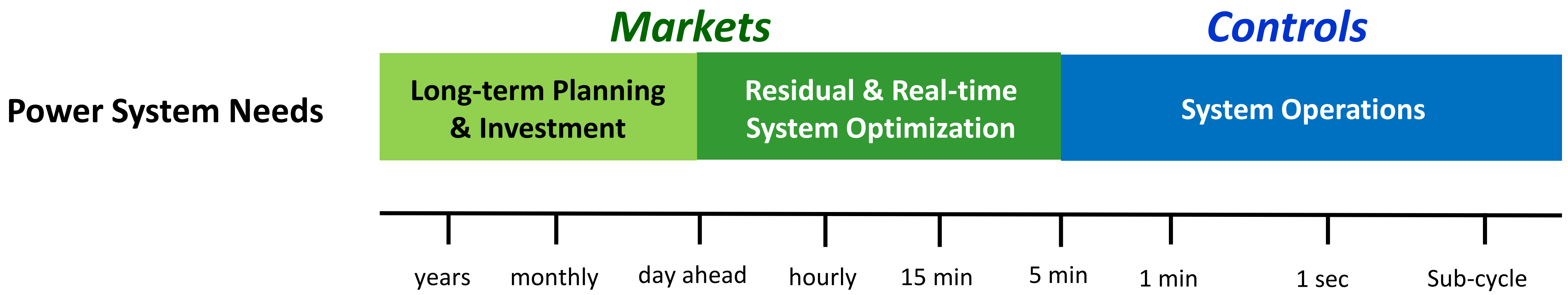
Control engineers:
Just set up and the right optimization equations and everything will work

Solution:

- **Control advocates** realise that markets as excellent sensors and optimization engines.
- **Market advocates** realise that markets do not handle grid physics and dynamics, so that controls are needed.
- **Both mechanisms are needed** – the architectural question is how they must be structured to interact and support each other

The ‘Transactive Energy’ construct

‘Transactive Energy’ is defined as: A system of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value as a key operational parameter.



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The ‘Transactive Energy’ construct (Cont’)

- ✓ **A system**

  of

- ✓ **Economic <u>and</u> control mechanisms**

  enabling

- ✓ **Dynamic balance of supply and demand**

  using

- ✓ **Value as a key operational parameter**

Transactive Energy Framework

GRIDWISE Architecture Council

3. Different approaches illustrated by key jurisdictions

Source: GTM Research

California’s approach to addressing the High-DER grid

1. **Distribution Resource Plans (DRPs) filed by utilities July 2015**

   Identify optimal locations for DER (integration capacity and locational net benefits); plan efficient distribution grid modernization

2. **Real-time operation and T-D interface coordination**

   Transition from one-way to multi-directional flows, diverse behaviour of DER, and ISO-DO coordination at the T-D interface

3. **Long-term forecasting**

   Forecast DER growth and its impacts on gross demand, with sufficient locational, temporal and load-shape granularity

4. **Align state forecasting, planning and procurement processes**

   Coordination between Energy Commission (CEC), Public Utilities Commission (CPUC) and CAISO

Not yet on the table: new utility business models; need for a new DSO entity; transactive markets on distribution; end-state vision

California's approach to addressing the High-DER grid

Current Market Attractiveness for DERs

	Western	Texas	Eastern				
Opportunity	**CAISO**	**ERCOT**	**PJM**	**NYISO**	**ISO-NE**	**MISO**	**SPP**
Market Size	45 GW	70 GW	162 GW	34 GW	27 GW	127 GW	47 GW
Retail Bill Management (Demand and Energy)	◕	◔	◑	◑	◑	◔	◔
Incentive Programs	◕	○	◔	◑	◑	◔	○
Energy Arbitrage	◑	◕	◑	◑	◑	◔	◔
Ancillary Service Market Participation	◔	◑	◑	◔	◔	◔	○
Capacity Market Participation	◑	○	◕	◑	◑	◔	○
Growth / Enhanced Value from Regulatory Reforms	◕	◔	◔	◕	◕	◔	○
OVERALL	◕	◑	◑	◑	◑	◔	○

Source: Strategen Consulting Internal Assessment

OPPORTUNITY LEVEL: ○ **LOW** ◔ ◑ ◕ **HIGH**

New York State's *Reforming the Energy Vision (NY REV)* provides a detailed end-state vision including digital market platform.

Objective: A transactional, distributed electric grid that

- Improves system efficiency, resilience, and air emissions
- Encompasses both sides of the utility meter
- Relies increasingly on distributed resources and dynamic load management

Defined "distribution system platform" (DSP) functions to include:

- Planning, operations and enabling of markets
- Improved temporal and spatial granularity of information
- Improved information accessibility to consumers and participants
- Greater transparency to grid needs to encourage innovation and investment

NEW YORK STATE OF OPPORTUNITY. | Reforming the Energy Vision

NY REV policy framework and vision

"REV will establish markets so that customers and third parties can be active participants, to achieve dynamic load management on a system-wide scale, resulting in a more efficient and secure electric system including better utilization of bulk generation and transmission resources.

"As a result of this market animation, distributed energy resources will become integral tools in the planning, management and operation of the electric system. The system values of distributed resources will be monetized in a market, placing DER on a competitive par with centralized options. Customers, by exercising choices within an improved electricity pricing structure and vibrant market, will create new value opportunities and at the same time drive system efficiencies and help to create a more cost-effective and secure integrated grid…

"…The reformed electric system will be driven by consumers and non-utility providers, and it will be enabled by utilities acting as Distributed System Platform (DSP) providers."

Track One Order, New York Public Service Commission

NY REV implementation priorities in 2016

- ✓ developing **liquidity in DER markets** by increasing the numbers of participants
- ✓ establishing **certainty and stability in DER markets** so that investments can be made with confidence
- ✓ developing **scale in DER markets** to increase the cost effectiveness of DER options
- ✓ creating mechanisms to **determine the full values of DER** and grid reliance to improve and ensure the cost effectiveness of DER investments
- ✓ establishing transparent **access to relevant data and system information**
- ✓ ensuring the maintenance of **consumer protections** and the extension of essential consumer protections into new types of transactions and commercial relationships
- ✓ Enhancing the **social equity** of the electric system to improve **general affordability**

REVing Up the Energy Vision in New York (2016), Zibelman

Texas' ERCOT Market Evolution: DREAM TF Proposal

Features	DER Minimal	DER Light	DER Heavy
Energy Settled at:	Load Zone SPP	Price at Local electrical bus(es)	Logical Resource Node (price at Local electrical bus(es))
Energy Market Participation	Self-responding	Self-responding	SCED-dispatched
Ancillary Service Market Participation	Not eligible	Not eligible	Eligible
Aggregation Allowed?	N/A	Yes	Yes
Metering Required	Single meter OK (15-minute revenue quality) at POI	Separate (dual) metering for Generation and native Load	Separate (dual) metering for Generation and native Load
Telemetry or telemetry-light to and from ERCOT	Not required	Real-time or near real-time with multiple attributes	Real-time or near real-time with multiple attributes
COP, Outage Schedule, Offers/Bids, etc.	N/A	Possible "light" version required	Required
CRR/PTP Implications	None	None	Yes

ERCOT

STRATEGEN
STRATEGIES FOR CLEAN ENERGY

First Wave and Second Wave pricing construct

The ENTR Interim Program Report (IPR) of December 2015 put forward a First Wave and Second Wave construct for electricity price transition:

First wave			Second wave
Highly volumetric tariffs Fixed | Usage (c/kWh)	**Improved fixed cost recovery** Fixed | Usage (c/kWh)	**Demand based tariffs** Fixed | Usage | Demand (c/kW)	**First Wave Reform PLUS** **Voluntary, localised Pricing options** + Demand management storage tariff + Back up supply charges + Critical Peak Pricing + Peak Time Rebates **Voluntary incentive (payment) options** + embedded generation incentives, credits or feed in tariffs + ancillary services payments
✗ Significant cross-subsidies between consumers ✗ Technology takeup (air-conditioning, solar, storage) driven partly by cost-shifting ✗ No reward to shift consumption off-peak ✗ No 'locational' reward to customers to reduce network costs (through demand management or embedded generation) ✗ No incentive for new energy markets and services	✓ Reduced cross-subsidies between consumers ✓ Reduced incentive for technology takeup (air-conditioning, solar, storage) to be driven by cost-shifting ✗ No reward to shift consumption off-peak ✗ No 'locational' reward to customers to reduce network costs (through demand management or embedded generation) ✗ No incentive for new energy markets and services	✓ Minimises cross-subsidies based on customer use of the network ✓ Economic incentives for technology take-up based on contribution to avoided network costs ✓ Reward to shift consumption off-peak ✗ No 'locational' reward to customers to reduce network costs (through demand management or embedded generation) o Some incentive for new energy markets and services	✓ Minimises cross-subsidies based on customer use of the network ✓ Economic incentives for technology takeup based on contribution to avoided network costs ✓ Reward to shift consumption off-peak ✓ 'Locational' reward to customers to reduce network costs (through demand management or embedded generation) ✓ Incentives for new energy markets and services

First Wave and Second Wave pricing construct (Cont')

- Unlike First Wave measures, the Second Wave measures are all focussed on achieving value through a **locational** incentive signal which is **dynamic in time.**

- The IPR recognised that Transactive Energy or Digital Market Platforms were just one of the most extended forms of the Second Wave measures that could be used for network optimisation and customer benefits.

- Other Second Wave measures which could be introduced more incrementally include:
  - Network tariffs (e.g. a DM storage tariff or Critical Peak Price)
  - Incentive Payments (such as a generation network credit scheme).

- Work Package 5 techno-economic modelling is further assessing the role Second Wave incentives may play.

4. The ‘Platform Revolution’ meets future grid optimisation?

“When a platform enters the market of a pure pipeline business, the platform virtually always wins.”

“The platform model underlies the success of many of today’s biggest, fastest-growing, and most powerfully disruptive companies, from Google, Amazon, and Microsoft to Uber, Airbnb, and eBay. What’s more, platforms are beginning to transform a range of other economic and social arenas, from health care and education to energy and government…

“Over the past two decades, we have come to recognize that powerful economic, social, and technological forces are transforming our world in ways that few people fully understand… **the platform business model is the leading embodiment of these forces**”

Pipelines,Platforms, and the New Rules of Strategy (2015), Harvard Business Review

Platform Revolution: How Networked Markets Are Transforming the Economy--and How to Make Them Work for You (2015), Choudary, Van Alstyne & Parker

What is an ‘economic platform’?

“An economic platform is a **digitised business ecosystem** that enables **value-creating interactions** between external producers, consumers and producer-consumers.

“The platform provides an **open, participative and dynamic infrastructure** for these interactions and sets **governance conditions** for them.

“The overarching purpose of the platform is to **consummate matches** among users and **facilitate the exchange** of goods, services, or social currency, thereby enabling value creation for all participants.”

Adapted from Platform Revolution: How Networked Markets Are Transforming the Economy--and How to Make Them Work for You (2015), Choudary, Van Alstyne & Parker

What is an ‘technical platform’ for DERs?

“A DERMS platform is an **advanced software based system**, potentially consisting of multiple components and subsystems, capable of se**nsing grid conditions**, and **monitoring and controlling the operation of DERs** to maintain electricity delivery to loads during all operating modes.

“A DERMS platform is expected to **enable the integration of a wide variety of flexible DER into real-time operations**. DERMS should be able to optimize DER performance at multiple layers in the system hierarchy (i.e., customer, feeder, substation) in order to provide optimal power system performance based on local or regional requirements. This includes **local optimization** as well as **distribution area, regional** and **system wide** power system optimization applications.”

Adapted from Pacific Gas & Electric (2015)

Why is this potentially 'game changing'?

"In the **twentieth-century industrial era**, giant monopolies were created based on supply economies of scale. These are driven by production efficiencies, which reduce the unit cost of creating a product or service as the quantities produced increase. These supply economies of scale can give the largest company in an industrial economy a cost advantage that is extremely difficult for competitors to overcome...

"In the **twenty-first-century Internet era**, comparable monopolies are being created by demand economies of scale… By contrast with supply economies of scale, demand economies of scale take advantage of technological improvements on the demand side—the other half of the profit equation from the production side. Demand economies of scale are driven by efficiencies in social networks, demand aggregation, app development, and other phenomena that make bigger networks more valuable to their users."

In other words, digitisation means much of the value creation is now occurring on the <u>demand-side</u> rather than the supply-side of the economy

Platform Revolution: How Networked Markets Are Transforming the Economy--and How to Make Them Work for You (2015), Choudary, Van Alstyne & Parker

Open Discussion

- Your reflections and clarifying questions?
- Do you generally agree with the Platform definitions put forward?
- Do you think Australia should be considering digital Platform solutions for unlocking grid value more actively?
- What other questions does this material raise for you?

5. Key Platform design principles for incentivizing DER integration

It has been noted that distribution-level markets may come in many flavours.

1. Wholesale energy, capacity and operational markets

- Wholesale spot markets mainly deal with residual balancing energy and system reliability
- DERs participate today in wholesale ISO/RTO markets; provide balancing energy, capacity, reserves, infrastructure deferment
- At larger penetration, DER wholesale participation will require enhanced coordination between DO and ISO at the T-D interfaces

2. Distribution operational markets (DO is sole buyer)

- DER services may reduce distribution utility operating & capital expenses, and support renewables & DER integration
- Voltage management, power quality, reliability & resilience, line-loss reduction, infrastructure deferment

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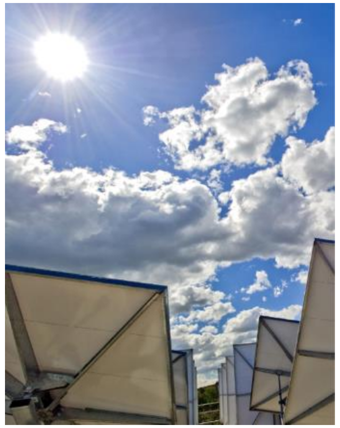
3. Distribution-level energy market (many buyers)

- Transactions among DERs, prosumers, customers, aggregators
- May be within a “local distribution area” (single T-D substation) & not rely on transmission grid, or across different local areas utilizing and scheduling transmission service through the ISO market

Distributed Energy Resources

Distributed RE Generation



Power Electronics

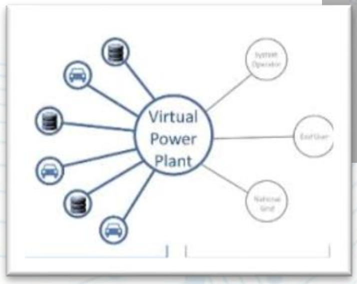
Demand Management & Load Matching

Energy Storage

Distributed FF Generation

Electric Vehicles

Microgrids & Virtual Power Plants



Core Electric Products from DER

Tabors Caramanis Rudkevich (TCR) propose that there are only three core electric products delivered by DER, recognizing that not all DER can provide all three:

- The ‘3 Rs’
  - **Real Energy**: measured in kWh, is the fundamental physical electric commodity delivered to retail customers
  - **Reactive Power**: measured in kVAR, sustains the electrical field in alternating-current systems while maintaining voltage within the limits specified for safe operation
  - **Reserves**: measured in kW, represent the potential to deliver real energy (kWh) at a point in the future
- The 3 Rs require tradeoffs
  - Tradeoff between producing real versus reactive power
  - Tradeoff between committing now to produce real power (now and forward) and being available to provide reserves

Core Electric Products – Examples

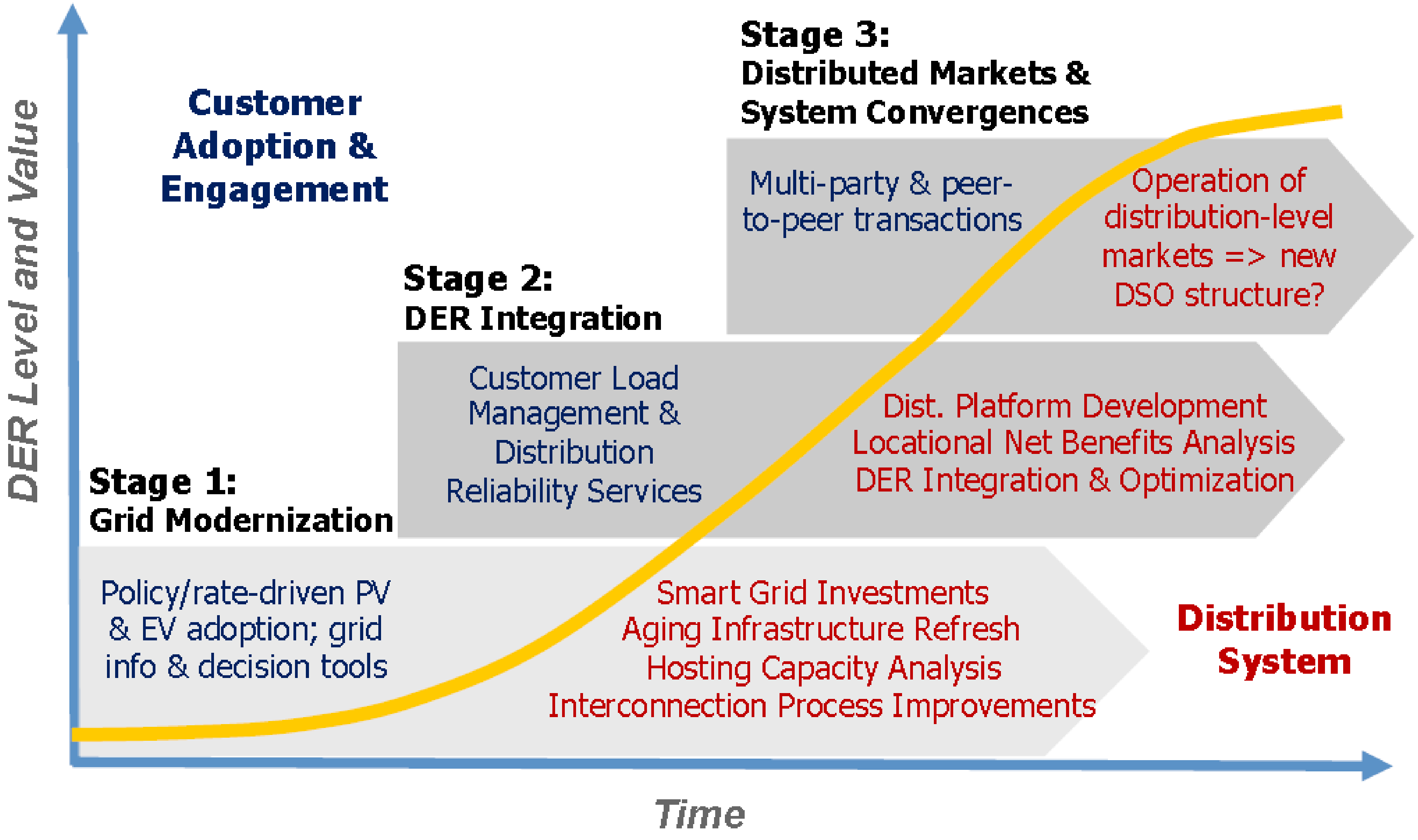
		Energy	Reactive Power	Reserves
	**Demand Response**	★		★
	**Distributed Generation**	★	★	★
	**Distributed Storage**	★	★	★

Core Electric Product Examples

Table 1. Technical Ability of DER Technologies to Provide Core Electric Products

Market Product		Demand Response	Photo voltaic	DG (fossil)	EV Charging	Storage
DA Energy	Delivered		Today	Today		Today
	Reduced (DR)	Future	Today	Today	Future	Today
	Time Shifted	implicit		Today	implicit	Today
RT Energy	Delivered		Today	Today	Future	Today
	Reduced	Today	Today	Today	Future	Today
	Time Shifted	implicit			implicit	Today
Wholesale Ancillary Services	Spinning Reserve	Future		Future	Future	Future
	Frequency Regulation (traditional)	future reg down only		Today	Future	Today
	Black Start		Future	Today		Future
Reactive Power	Var Support		with advanced inverters	with advanced controls	future with advanced inverters	Future with advanced inverters
	Voltage Control		with advanced inverters	with advanced controls	future with advanced inverters	
Reserves	Up			Today		Future but requires charge state held aside
	Down (DR)	Today		Today		

All options involve network transformation



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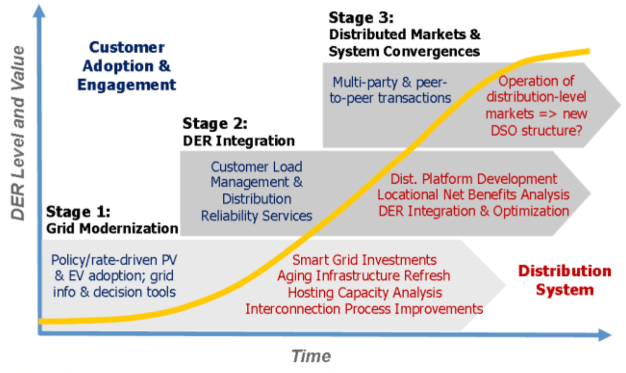
Stage 1 requires minimal enhancement of distribution system functions



Integrated distribution system planning

A. Scenario-based, probabilistic planning studies

- Scenarios capture range of DER growth over planning horizon
- Probabilistic methods model DER behaviour impacts on grid

B. Enhanced interconnection studies & processes

C. Hosting capacity = maximum DER penetration consistent with reliable & safe grid operation (per feeder from T-D substation)

D. Locational net value of DER

- Operating or capital expense reduction net of system costs
- Locational customer & societal benefits
- Assessed at T-D or D substation, feeder, or feeder segment

E. Integrated T & D planning

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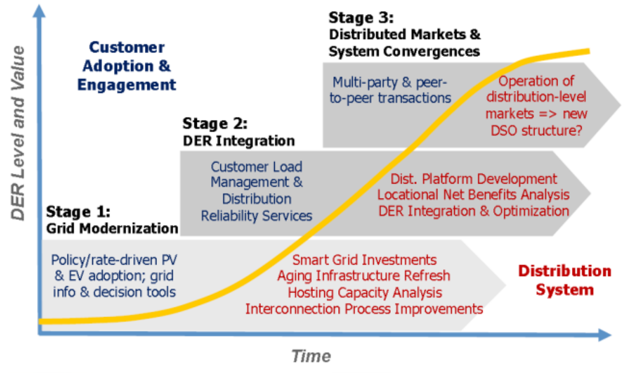
Stage 2 requires enhanced functional capabilities to ensure reliable distribution system operations.



Distribution system operations

A. Design-build & ownership of distribution grid

B. Switching, outage restoration, grid maintenance

- Fundamental safety & reliability responsibilities
- More complex reliability functions are needed with diverse DERs, DER aggregations, prosumers & multi-directional flows
- Seamless islanding & reconnection of microgrids

C. Physical coordination of DER schedules & dispatches

- Use of DERs for real-time reliability services, through dispatches or automated controls by the distribution operator

D. Coordination with transmission/wholesale at T-D interface

- Support DER participation in wholesale markets
- Assess pros & cons of managing DER variability at the local level (local real-time balancing) versus exporting variability to the transmission grid

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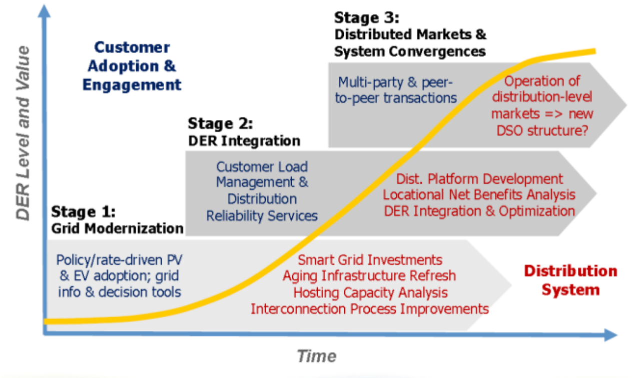
Stage 3 creates the greatest need for enhanced functional capabilities.



Distribution markets and market services

A. Sourcing distribution grid services

- Define needed services & their performance requirements
- Procure DERs to provide the services

B. Dispatch of DERs providing grid services

- Utilize DERs in real-time to support reliable grid operation

C. Aggregation of DERs for wholesale market participation

- Collaborating with other market actors

D. Creation & operation of distribution-level energy markets

- What is optimal degree of temporal & locational price granularity?

E. Clearing & settlements for inter-DER transactions

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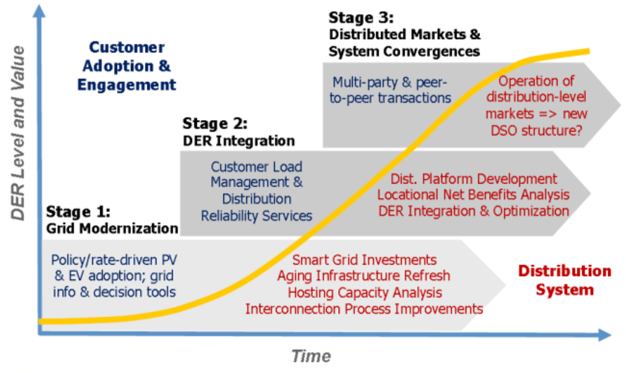
Stage 3 creates the greatest need for enhanced functional capabilities.

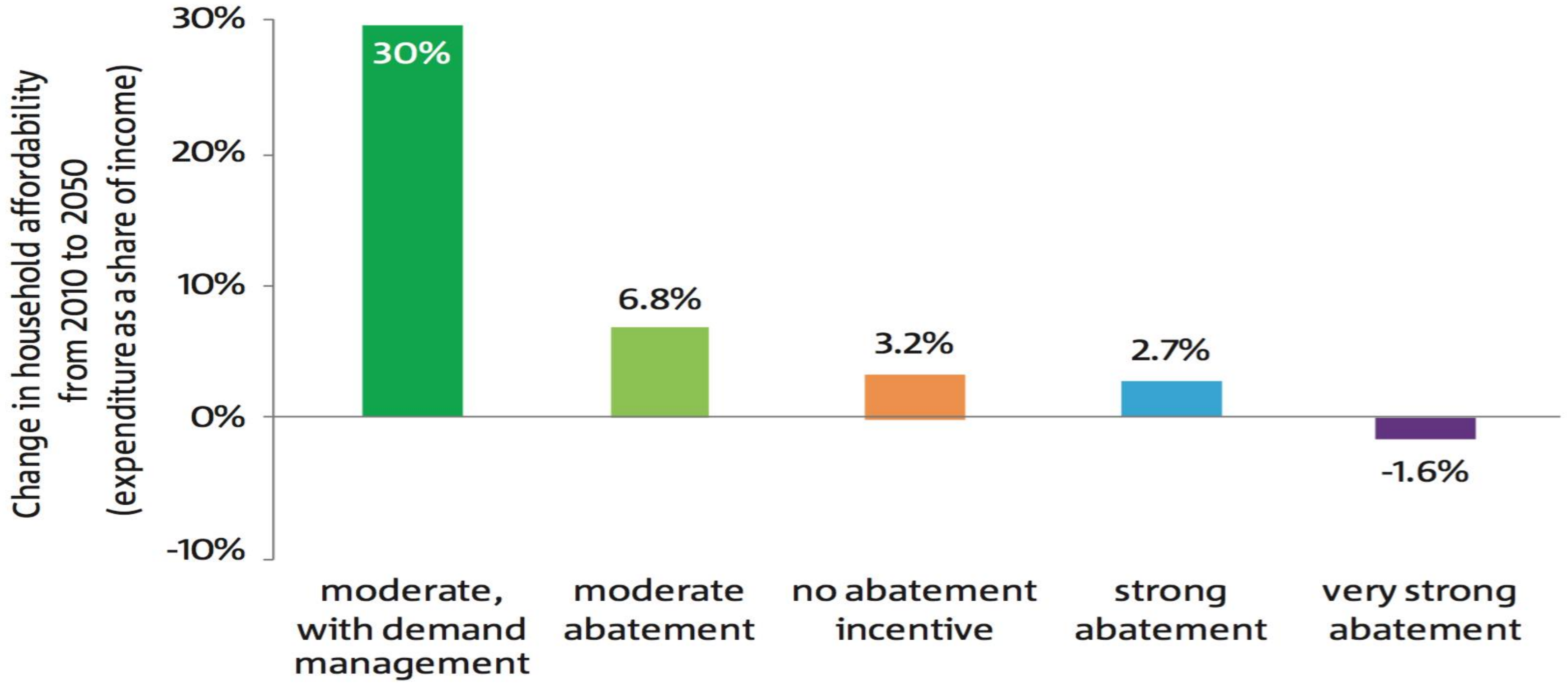


A Stage 3 Digital Market Platform may provide for the transaction of some key broad categories of economic value, differentiated in real time and by location, including:

- **Peer-to-Grid (P2G),** achieving real time network optimisation based on locational value; providing rewards for ancillary services.
- **Peer-to-peer (P2P),** with the participation of other Market Actors with their own platforms and customer-customer transactions.
- **DSO-TSO value exchange**

6. Considering the 'Platform vs Platforms' question

We know that there is a grid 'optimisation premium' that DERs can play a significant role in…



‘Platform vs Platforms’ (Con’t)

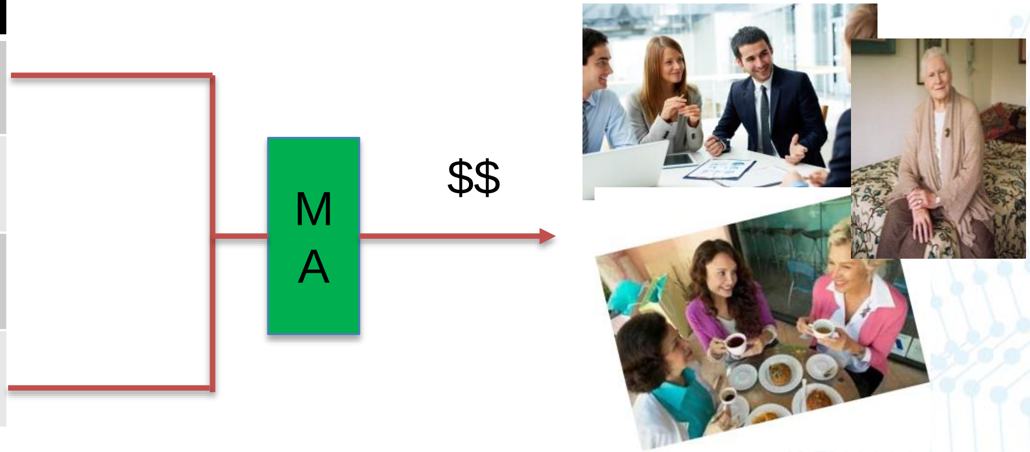
Yet many Market Actors suggest that monetising the entire ‘value stack’ from DER system-optimisation services is challenging

Source of value	Type & Access	
Wholesale market	Financial	✓✓✓✓✓
Transmission networks	Financial	✓?
Distribution networks	Financial	✓?
Customer self-consumption	Financial	✓✓✓✓✓

‘Platform vs Platforms’ (Con’t)

Market Actors (MA) are currently unlocking and bundling value from both the wholesale market and from self consumption…

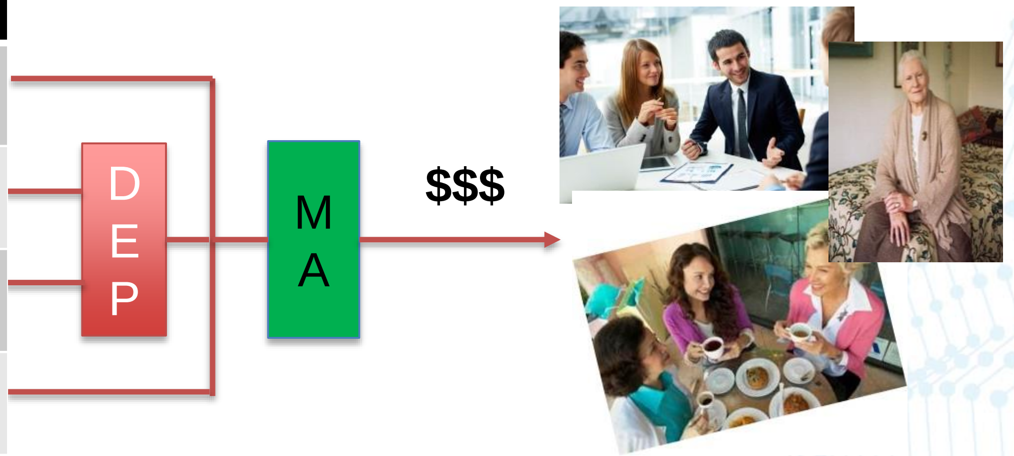
Source of value	Type & Access	
Wholesale market	Financial	✓✓✓✓✓
Transmission networks	Financial	✓?
Distribution networks	Financial	✓?
Customer self-consumption	Financial	✓✓✓✓✓



‘Platform vs Platforms’ (Con’t)

Hypothetically, what if a local Distributed Energy Platform (DEP) was also established to dynamically value and monetise DER grid-optimisation services?

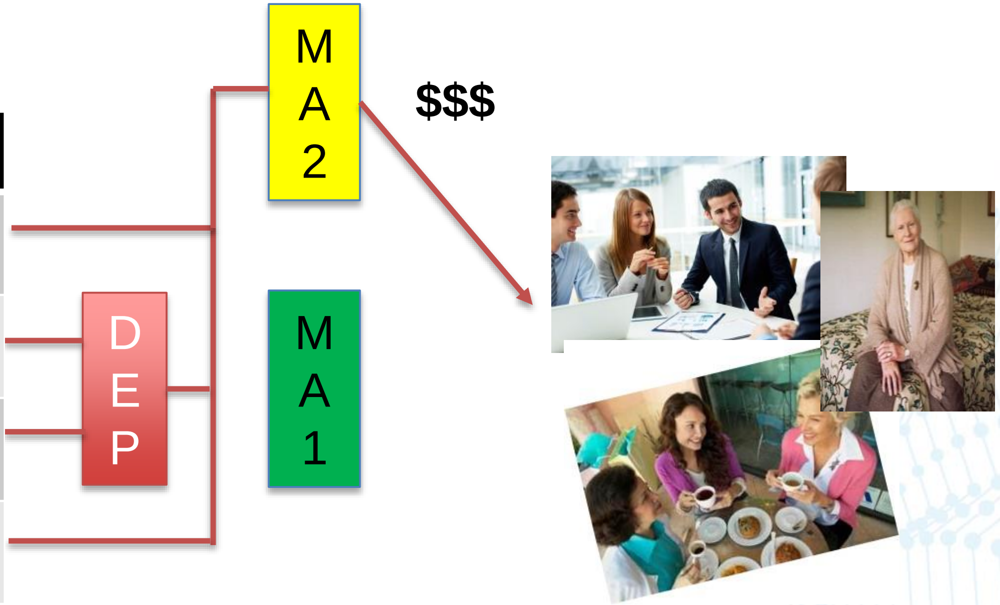
Source of value	Type & Access	
Wholesale market	Financial	✓✓✓✓✓
Transmission networks	Financial	✓✓✓✓✓
Distribution networks	Financial	✓✓✓✓✓
Customer self-consumption	Financial	✓✓✓✓✓



‘Platform vs Platforms’ (Con’t)

And that same local DEP (singular) provided all Market Actors (plural) greater ability to monetise grid-optimisation DER services in their customer value bundles?

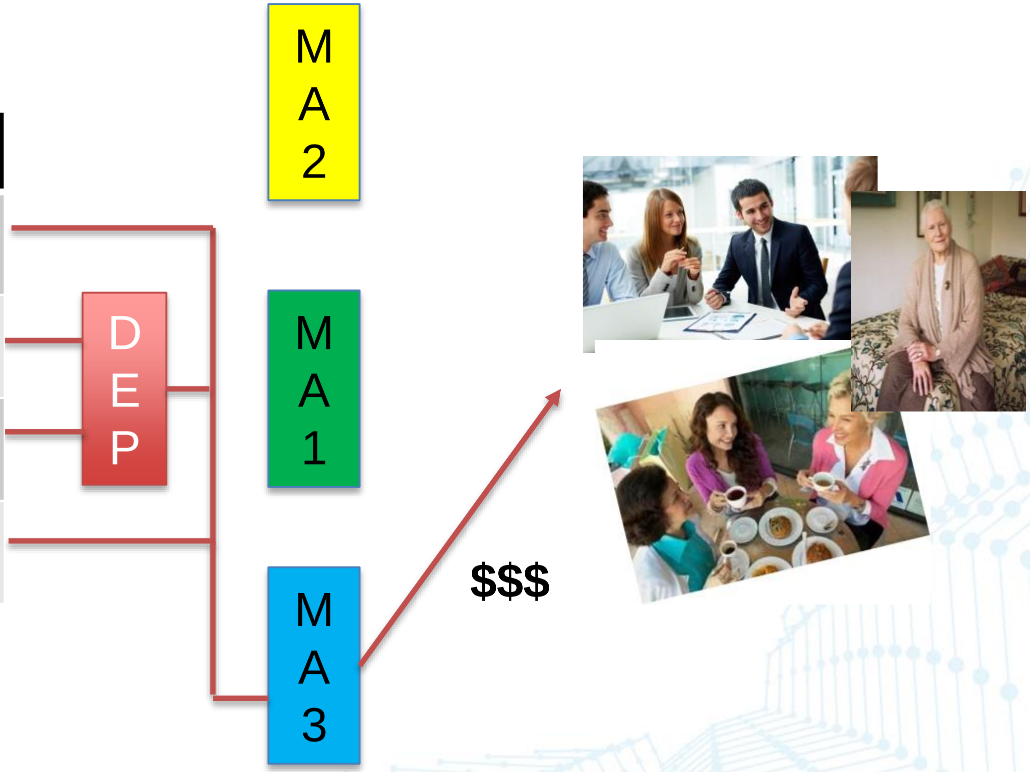
Source of value	Type & Access	
Wholesale market	Financial	✓✓✓✓✓
Transmission networks	Financial	✓✓✓✓✓
Distribution networks	Financial	✓✓✓✓✓
Customer self-consumption	Financial	✓✓✓✓✓



‘Platform vs Platforms’ (Con’t)

And that same local DEP (singular) provided all Market Actors (plural) greater ability to monetise grid-optimisation DER services in their customer value bundles?

Source of value	Type & Access	
Wholesale market	Financial	✓✓✓✓✓
Transmission networks	Financial	✓✓✓✓✓
Distribution networks	Financial	✓✓✓✓✓
Customer self-consumption	Financial	✓✓✓✓✓



Workshop Session

1. **Do you agree/disagree with the '3-Rs core electric products' that can be delivered by DER put forward by TCR:**

   a) **Real Energy**: measured in kWh, is the fundamental physical electric commodity delivered to retail customers

   b) **Reactive Power**: measured in kVAR, sustains the electrical field in alternating-current systems while maintaining voltage within the limits specified for safe operation

   c) **Reserves**: measured in kW, represent the potential to deliver real energy (kWh) at a point in the future

Workshop Session (Cont')

2. Which categories of Stakeholders and Market Actors might want to procure each of the core electric products or services from DERs?

a) For example: existing energy retailers, new market actors, large end-use customers, AEMO, DNSPs, TNSPs, others?

b) Choose two Stakeholders/Market Actors and brainstorm the main DER electric products they may want to procure.

Workshop Session (Cont')

3. **We have considered the HYPOTHESIS of a local Distributed Energy Platform (DEP) interoperating with a diversity of customer-facing Market Actor platforms.**

    a) Is this DEP concept plausible? Are there more plausible options?

    b) Assuming it is plausible, what local DEP design features would be critical for Market Actors to embrace interoperation between the DEP and their own customer-facing platforms?

    c) What would be necessary for the seamless interoperation of the local DEP and Market Actor's customer-facing platforms?

ELECTRICITY NETWORK TRANSFORMATION ROADMAP 2017-27

Next Generation Platform: Next Steps

John Phillpotts, CSIRO

energy networks association

Next Generation Platform

Why is this important?

'A significant opportunity lies in leveraging DER technologies to support grid needs, in other words, to align the goals of the grid operator and the customer. The challenge boils down to a) how we value benefits and costs brought to the grid by various DER technologies and b) how to best enable the financial transaction of these values.'

Alicia Abrams DNV GL

Next Generation Platform

This is a **Capstone Activity** aiming to ensure that ENTR supports:

- The need for more dynamic financial mechanisms and incentives for balancing supply and demand in an increasingly decentralised and volatile electricity environment;
- The growing range of value options and diverse services being sought and provided to customers by the electricity system; and,
- The potential for step-change improvements in both the range of innovative new customer-oriented services developed and the network efficiency/optimisation benefits delivered through well-designed market structures.

Key Questions we are seeking to explore (1):

- **Services & Value.** What range of energy and grid-support services will be provided in a highly distributed *potentially* ‘many-to-many’ electricity future, and by whom? How will these services be valued?
- **Markets & Institutions.** What are the options for future market designs and institutional roles and forms and how might they compare when subjected to an indicative cost-benefit review? Which options are best for attracting and driving customer-oriented innovation in the Australian context?
- **Enabling Infrastructure.** What system architecture, forecasting and planning alternatives may be needed to achieve high levels of system efficiency in a highly distributed ‘many-to-many’ future? What does distribution system planning look like in this environment?

Key Questions we are seeking to explore (2):

- **Monetisation & Transaction.** What standards and mechanisms will be required to monetise and transact the value of energy and grid services provided in a many-to-many environment where the network functions as a platform for exchange? What is the role of innovative approaches to pricing and what measurement and verification processes will be necessary?
- **Regulation & Standards.** What is the role of regulation and standards with the various combinations of market design and institutional form? What is the potential role of markets versus mandates in creating the future system?

Key Questions we are seeking to explore (3):

- **Transitionary Processes**. How might existing market and institutional forms evolve to become more ‘transactive’? What might be achieved through incremental changes, what may require step-change interventions and how might the transitionary options be funded?
- **System Coordination.** What will be the functional roles and responsibilities of networks and other market actors? What capabilities will be required to provide grid-side and customer-side coordination responsive to localised grid situational information? What are the pros and cons of different future system control constructs?
- **What is possible / achievable in the next decade?**

Next Generation Platform Outcomes:

- Outline potential role / function of grid in a high DER future
- Assess and outline functional requirements of a DSO
- Options for DER incentivisation and utilisation – with view to optimising network stability, value and operation
- Options for system architecture & DER coordination functionality
- Options for Digital Market Platform Functionality that:
  - **Incentivise millions** of consumer/producers to participate in and receive a share of the (dynamic, spatio-temporal) value created through millions of DERs providing whole-system optimisation services
  - **Instantaneously balance** dynamic demand requirements with supply from millions of distributed generation, energy storage and ‘virtual storage’ sources
  - **Optimise the utilisation** of multi-billion-$ system assets and minimise the need for expensive augmentation

ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2017-27

Wrap up & Next Steps

energy networks association

CSIRO

Next Steps:

- Circulate slides from these sessions, including worksheets
- Centralised Modelling and Pricing Modelling workshop 25th May – Melbourne
- Detailed work with external experts/agencies to build on workshop feedback and develop content
- Workshop content developed for Market Platforms mid-Aug (TBA)
- Roadmap content engagement Aug-Oct (TBA)