INSTITUTE FOR SUSTAINABLE FUTURES

CSIRO Intelligent Grid Cluster

THINK.
CHANGE.
DO

CSIRO National Research Flagships

- **Food Futures Flagship**
- **Light Metals Flagship**
- **Preventative Health Flagship**
- **Water for a Healthy Country Flagship**
- **Wealth from Oceans Flagship**
- **Energy Transformed Flagship**

Flagship Collaboration Fund

- A$114.5 million to 2011 to reinforce the development of collaborative partnerships

CSIRO Energy Transformed Flagship

BHAG

"…focusing on research to halve GHG emissions and double the efficiency of Australia's new energy generation technologies"

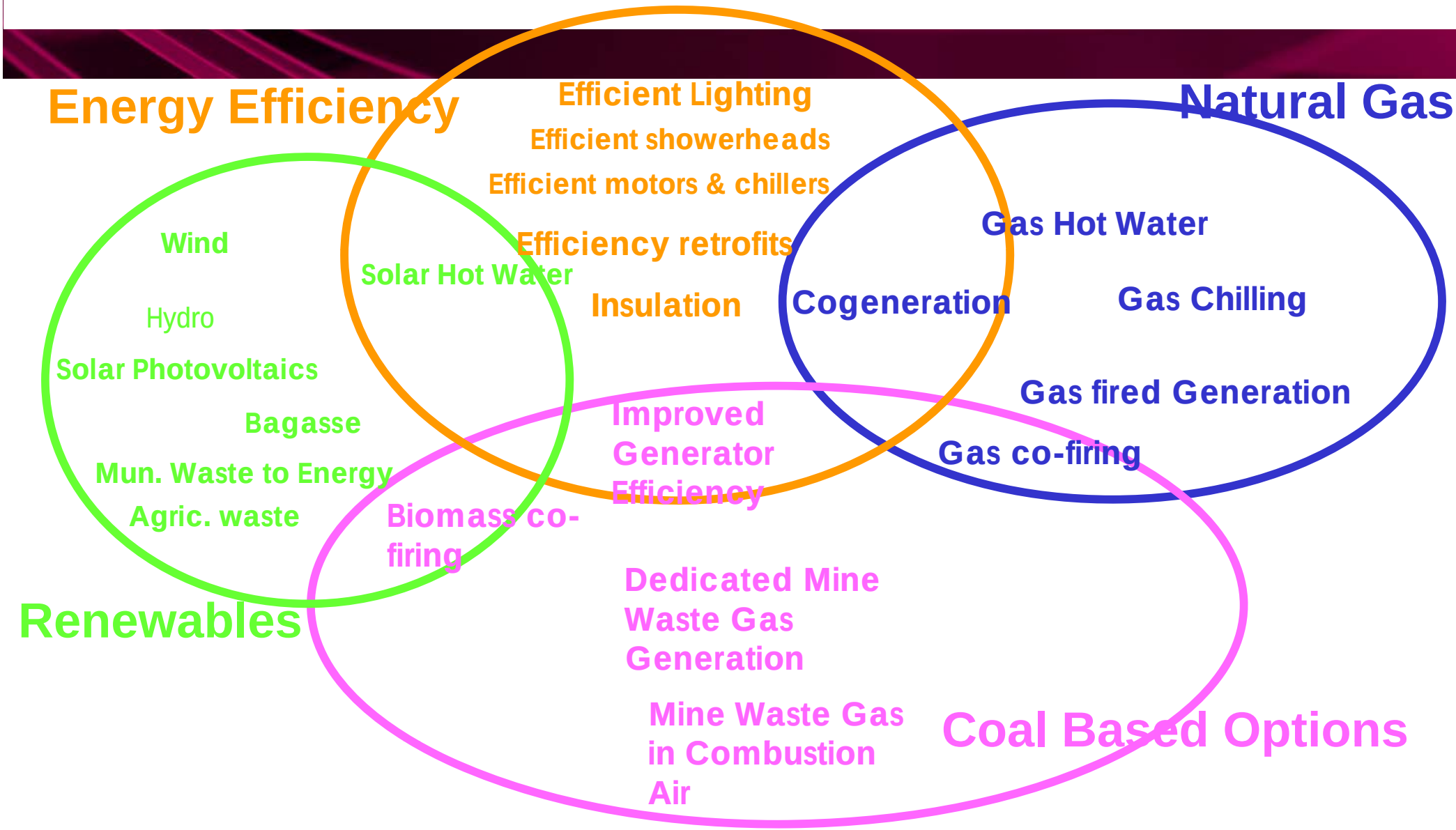
Four Themes:

- Energy Futures
- Low Emission Electricity
- Low Emission Transport
- **Distributed Energy**

“Intelligent Grid” and “Distributed Energy”

- **Intelligent Grid:**
  - *Using information, communications and control technologies to integrate the electricity network with “distributed energy” resources*
- **Distributed Energy:**
  - *decentralised generation and use of energy -e.g, solar panels, microturbines, fuel cells, cogeneration, demand management, smart meters, dynamic pricing*

Distributed Energy Options



CSIRO Intelligent Grid Research Cluster:

- 3-Year Collaborative Research Project: Jan ‘08 - Dec 2010
- 5 universities (UTS, QUT, UniSA, Curtin, UQ)
- UTS (ISF) cluster leader
- Funding: $9.5 million ($3.4m from CSIRO)

“Intelligent Grid” Projects

	University	*Project*
P1	*UQ – Saha*	*Control methodologies of Distributed Generation for enhanced network stability and control*
P2	*UQ- Burrage, Liebmann*	*Market and Economic modelling of the impacts of Distributed Generation and Local Co-operating agent based Demand Side Management*
P3	*QUT & Curtin - Ledwich, Ghosh*	*Optimal Siting and Dispatch of Distributed Generators*
P4	*UTS – Riedy, Dunstan*	*Institutional Barriers, Stakeholder Engagement and Economic Modelling*
P5	*Curtin – Stehlik*	*Intelligent Grid **Social Impacts***
P6	*UniSA – Saman*	*The Intelligent Grid in New Housing estates*
P7	*QUT- Ghosh*	*The operation of DG in a mini grid*

Three Dimensions: Technological, Economic and Social

Technology:

- P1: Control methodologies of DG for enhanced network stability and control
- P3:Optimal siting and dispatch of distributed generators
- P7: The operation of DG in a mini grid

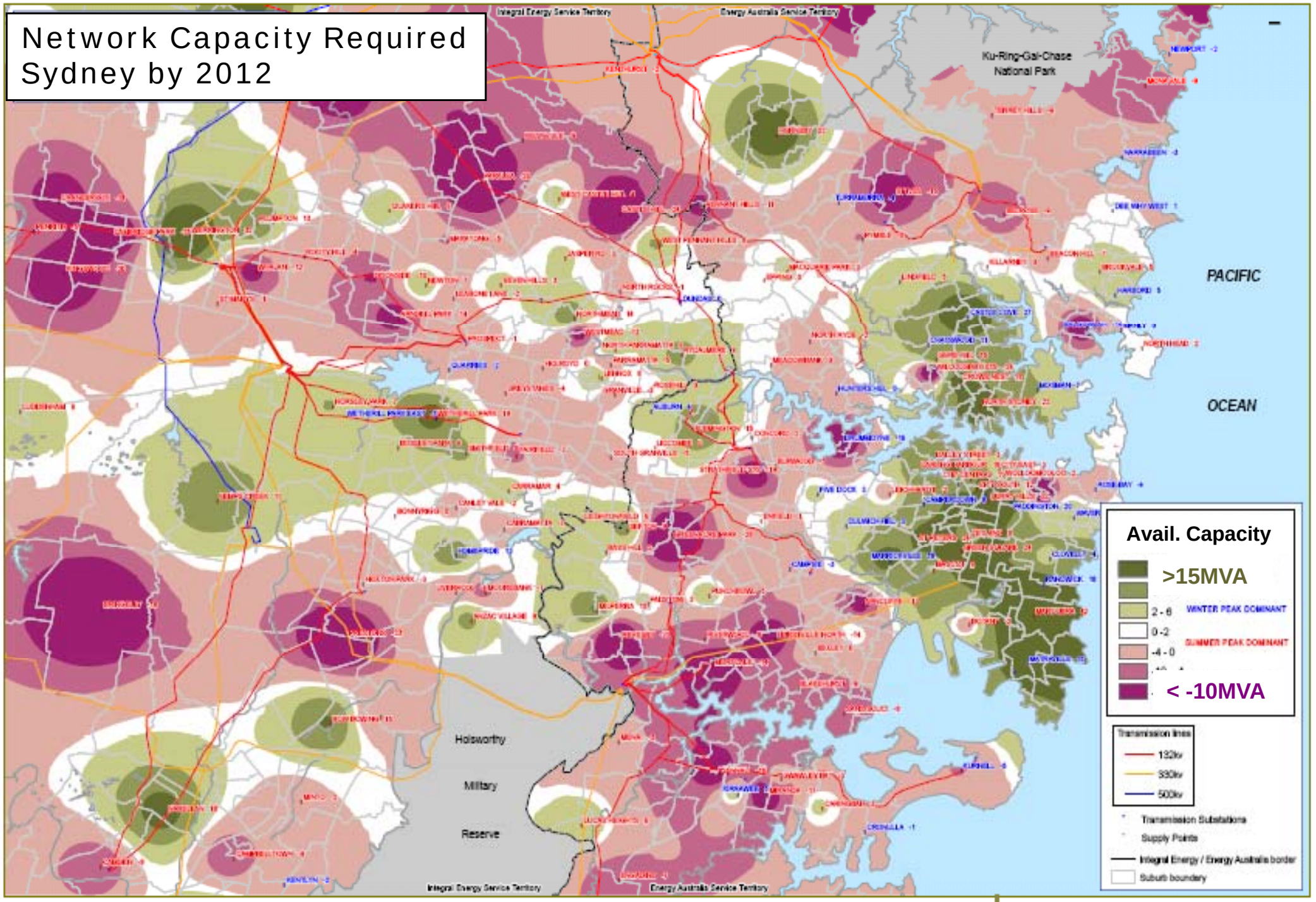
Economic :

- P2: Market and Economic Modelling of the impacts of DG and Local Co-operating agent based Demand Side Management
- P4: Institutional Barriers, Stakeholder Engagement and Economic Modelling

Social

- P5:Intelligent Grid Social Impact
- P6:The Intelligent Grid in New Housing Estates

Network Capacity Required Sydney by 2012



Data Source: Integral Energy 2006
Energy Australia 2005

Note: figures based on 2004/5 committed firm capacity minus forecast peak demand in 2011/12

0 2.5 5 10 15 20
Kilometers

Note: shaded areas are provided for illustrative purposes only. Actual areas serviced by each zone substation are not shown.

Substations - Available Capacity (MVA) for 2011-12

Coordinate System: GCS - AGD66
Author: Chris Loty

P1 (UQ): *Control methodologies of Distributed Generation for enhanced network stability and control*

Prof Tapan Saha, et al.

Outcomes :

- Comprehensive model of DG system for power system stability.
- Software for evaluating new DG technologies re system security
- Proper control design to integrate DG with existing large power grid.
- Understanding of the security issues of integration of distributed generation in the National Electricity Market (NEM) Grid

P2 (UQ): Market and Economic modelling of the impacts of DG and Local Co-operating agent based DSM

Dr Ariel Liebman, et al.

Outcomes :

- Comprehensive understanding of the impacts of distributed energy in the Australian electricity system- including direct and flow-on economic benefits
- The development of price response schemes for consumers & utilities
- Market simulations software
- Recommendations on market structure and regulation.
  - Specifications for Carbon trading schemes
  - Cost benefit analysis framework.
  - Market risk management models and software algorithms.

P3 (QUT and Curtin): Optimal Siting and Dispatch of Distributed Generators

Prof Gerard Ledwich, Prof Arindam Ghosh

Outcomes :

> Optimised siting of DG to maximise distribution network reliability

> Better management of distributed generators to avoid or eliminate oscillation and harmful feedback

> Improved protection systems to facilitate integration and management of islanded DG supplies

> Reduced network losses and GHG emissions by optimal siting of DG

> Controller for optimized performance for gas turbines and inverters

P4 (UTS): “Institutional Barriers, Stakeholder Engagement and Economic Modelling”

Towards a comprehensive framework for recognising and incorporating the full benefits and costs of distributed energy options

P5 (Curtin): Intelligent Grid Social Impacts

Prof Daniela Stehlik

Two WA Case Studies: Walpole and Albany

Outcomes :

> monitoring framework;

> Decision support tools to support the local stakeholders in on-going dialogue to assist future project development: ‘community score card’;

> A framework for research in volatile environments;

> Ongoing Industry/government/community engagement focusing on DE.

P6 (Uni SA): *The Intelligent Grid in New Housing estates*

Professor Wasim Saman

Outcomes :

- Data and insights into how residential users interact & respond to distributed energy and intelligent control, and how behaviour might be modified
- Two year monitoring data on, behaviour trends and energy use
- Hard evidence of the benefits of the greater use of intelligent features and distributed generation which will inform utilities, planning authorities, developers and policy makers
- Increased understanding of the benefits and practical challenges of incorporating distributed energy options in new housing estates
- Greater government, industry and community awareness of the role of distributed energy in reducing peak demand, greenhouse gas emissions
- An integrated technical, environmental, social and economic evaluation of the impact of intelligent and distributed energy features in the housing sector.

P7 (QUT): The operation of DG in a mini grid

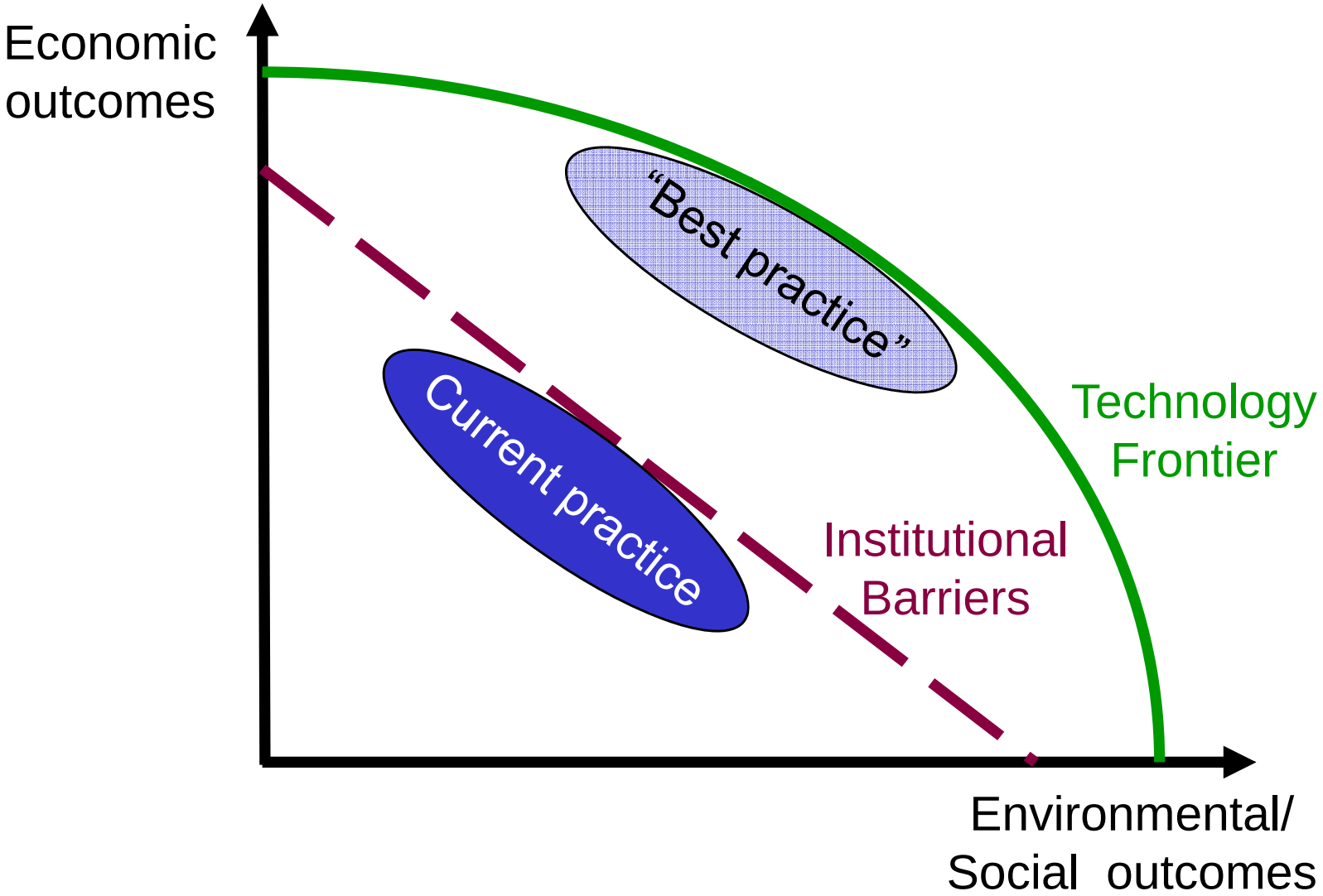
Prof Gerard Ledwich, Prof Arindam Ghosh

To construct, simulate and operate power electronics interfaced micro grid

Outcomes :

- Methodologies to define, and demonstrate control strategies that will ensure the most efficient, reliable operation the microgrid.
- To define appropriate protection and grounding policies that will assure safety of operation
- A determination of switching control strategies of DG supplied inverters for operation in voltage, current and power control mode.
- Construction of a DG based microgrid with protecting devices like solid state breakers.

Addressing Institutional Barriers: A framework



P4: Proposed approach - Tasks

1. Review Benefits of and Barriers to Distributed Energy (DE)
2. Report on economic regulatory barriers to DE development and propose solutions
3. Calculating dynamic localised avoidable network costs
4. Develop a Robust Transparent D.E. Evaluation Model
5. Business deliberation on Intelligent Grid and DE

(6. Intensive engagement with other Cluster elements)

Task 1. Review of Benefits and Barriers to Intelligent Grid and Distributed Energy options

Some Institutional Barriers (and market failures)

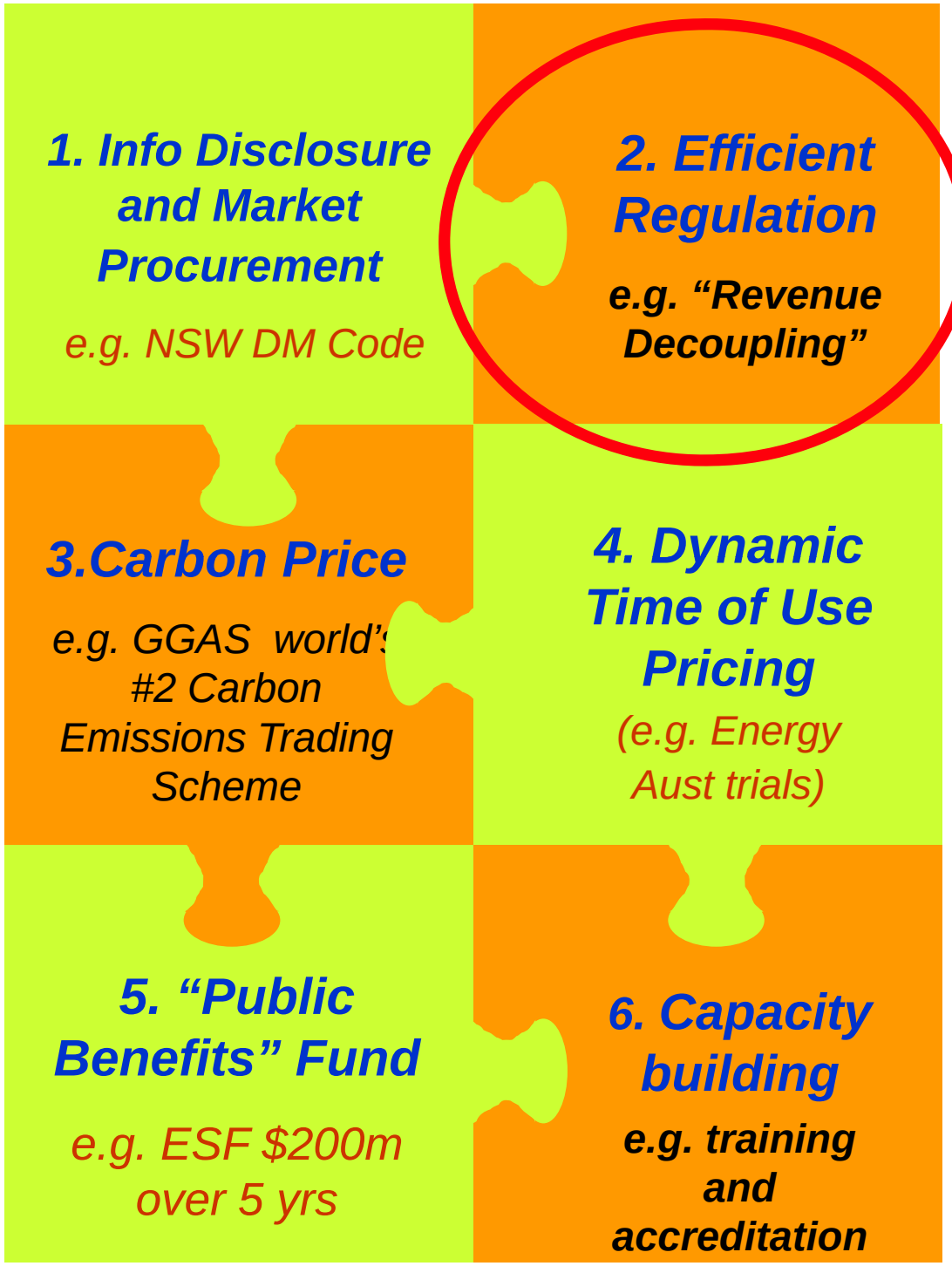
1. Imperfect Information
2. “Regulatory failure” and inefficient incentives
3. External Costs excluded
4. Inefficient pricing (not cost reflective)
5. High transaction costs
6. Underdeveloped market for Distributed Energy

Addressing the Institutional Barriers:

A Coordinated Approach

Barriers

1. Imperfect Information
2. Regulatory failure
3. External costs
4. Inefficient pricing
5. High transaction costs
6. Underdeveloped DE market



Task 2. Report on economic regulatory barriers to DE development and propose solutions

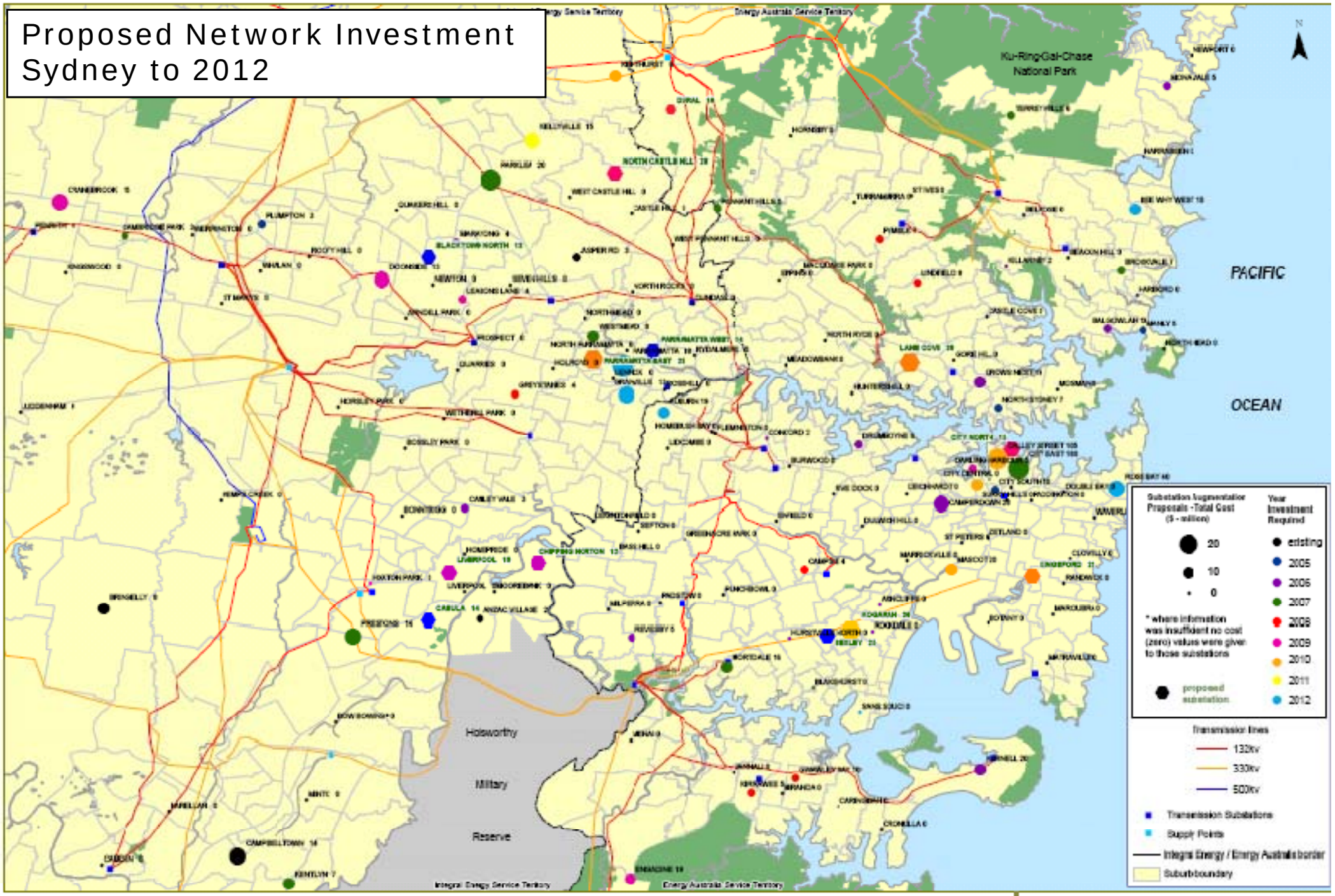
- Economic Regulation is a crucial, but often overlooked, barrier
- Provides key incentives network businesses, who are responsible for most investment in electricity supply.
- These incentives often place network businesses' financial interests in conflict with
  - interests of consumers, the economy, the environment
  - AND the longer term interests of the network itself
- e.g. price cap discourages DE through kWh sales foregone
- This task will focus on strategies for aligning incentives
  - Provides a key input for Task 5 Deliberations, below

Task 3: Calculating network benefits of DE

- Network costs ~= 50% of *average* electricity supply cost,
  - and potentially much larger share of *marginal* supply costs
- Avoided network costs potentially the largest source of value for DE
- Current network capital expenditure in NSW ~$2b p.a.
- But network businesses tend to be focussed on providing network capacity rather than DE
  - Monopoly regulation tends to support this focus
  - Discerning the value of avoidable network costs to support DE is therefore difficult
  - Greater transparency required, therefore:

Dynamic Avoidable Network Cost (DANCE) Model

Proposed Network Investment Sydney to 2012



Data Source: Integral Energy 2006
Energy Australia 2005

IE=$498m

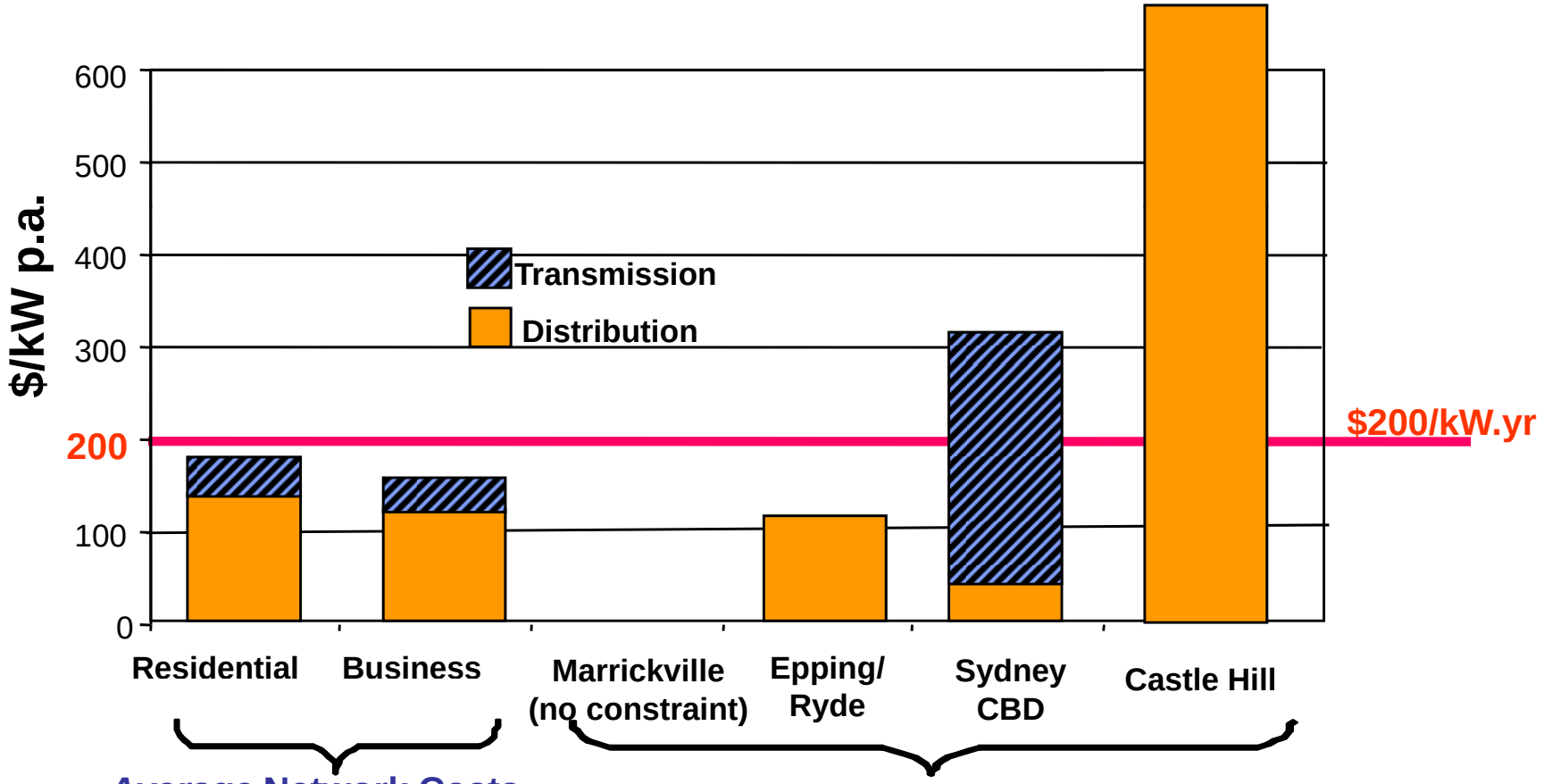
15 20

EA=$955m

Integral Energy / Energy Australia Sydney Zone
Substations Proposed Investment by 2011 / 12

Coordinate System: GCS - AGD66
Author: Chris Loty

What are the Avoidable Network Costs?

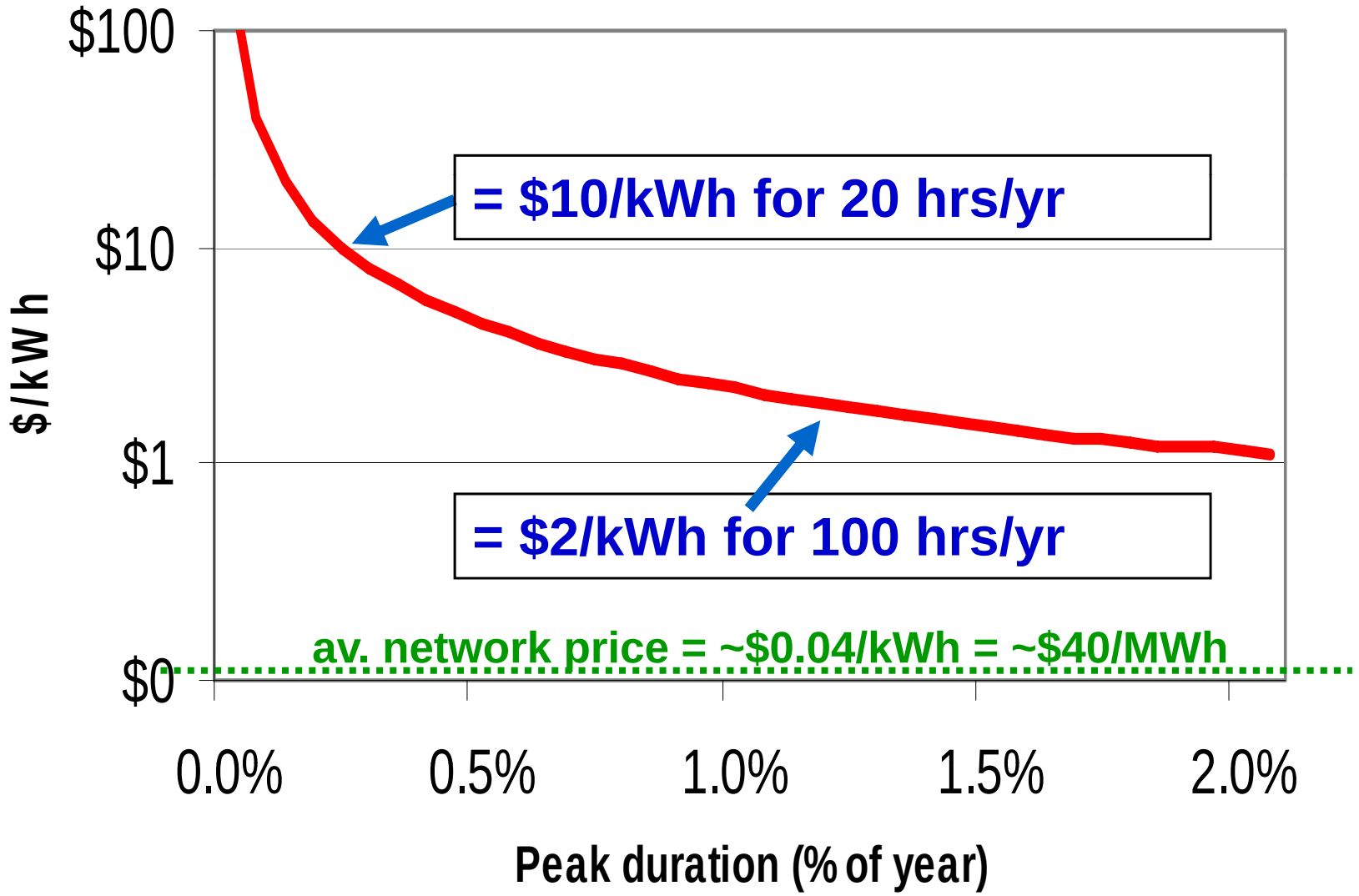


= average annual network charge / average peak demand

= incremental annualised network cost / incremental peak demand

Source: SEDA (see IPART DM Issues Paper)

What is $200/kW.yr worth in $/kWh?



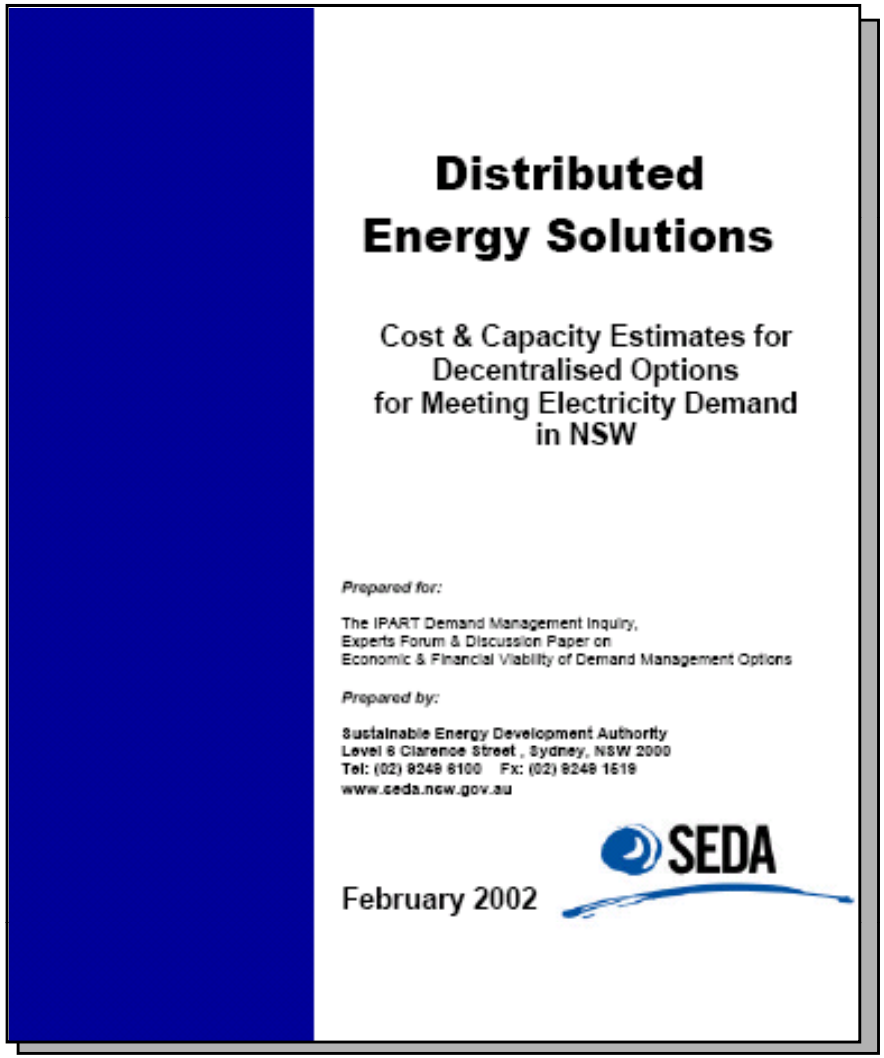
Task 4: Robust, Transparent D.E. Evaluation Model

Details and Costs of Distributed Energy (D-CODE) Model

> **Not another model…?!**
  - ***Yes*** (but transparent and accessible, not “black box”)
  - ***and No*** (instead, a “meta-model” to provide a common language for assessing, comparing and understanding existing models)

> A common platform for different DE resource data sets
  - Conservative vs generous assumptions, small vs large scale, flexible technology scope
  - Allows choice of default DE resource database or customised data
  - Includes simple optimisation function
    - (e.g. MS Excel linear programming)

Builds on “DES Compendium” precedent



- Inventory of Distributed Energy Resources for NSW
- Intended to demonstrate large potential for DE
- 35 technology options
  - Fossil fuel, renewable and demand management
- Range of cost and technical characteristics
- Highly influential (GGAS & ESF)

http://pandora.nla.gov.au/pan/38856/20031120/DESCompendium.pdf

Distributed Energy Solutions Compendium

(available at: www.seda.nsw.gov.au)

- **Developed by SEDA for IPART Demand Management Inquiry**
- **Following figures are *not* definitive (we invite comment)**
- **Each case *is* different**
- **The real world is much more interesting than generic estimates**
- **However, good estimates are required to inform both the market, and policy making**

Task 5: Deliberation on Intelligent Grid and DE

- Establish a process to assess and address organizational, institutional and cultural barriers and solutions
- Two key stakeholder groups - customers and network & retail businesses, including dialogue with each other
- Processes designed and implemented to allow informed deliberation on barriers, opportunities and implications for these stakeholders
- Complements existing work with citizens (eg CSIRO Energy Futures Citizen Juries, State of Texas Deliberative Polls)

Outcomes

1. Increased understanding of real benefits of DE options
2. Clearer evaluation of the value of DE options in network development
3. More effective public debate on the role of distributed energy options
4. More streamlined & consistent consideration of DE options in policy

↪ higher financial value for distributed energy options in investment decisions

↪ accelerated uptake of cost effective demand management, distributed energy and time-of-use pricing

↪ and consequent economic and environmental benefits

Thank you…