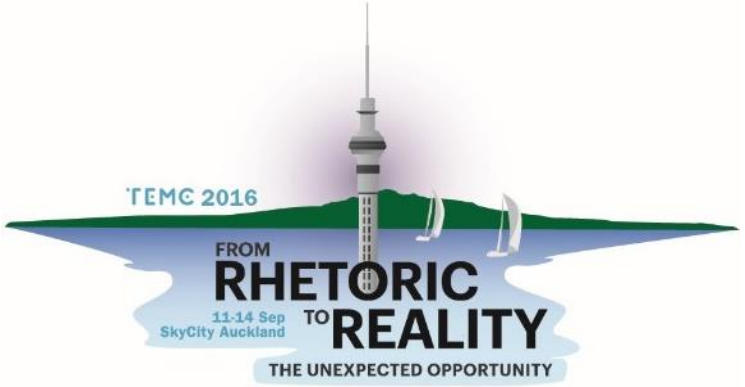

Campus Energy Systems

An International Perspective

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QUT

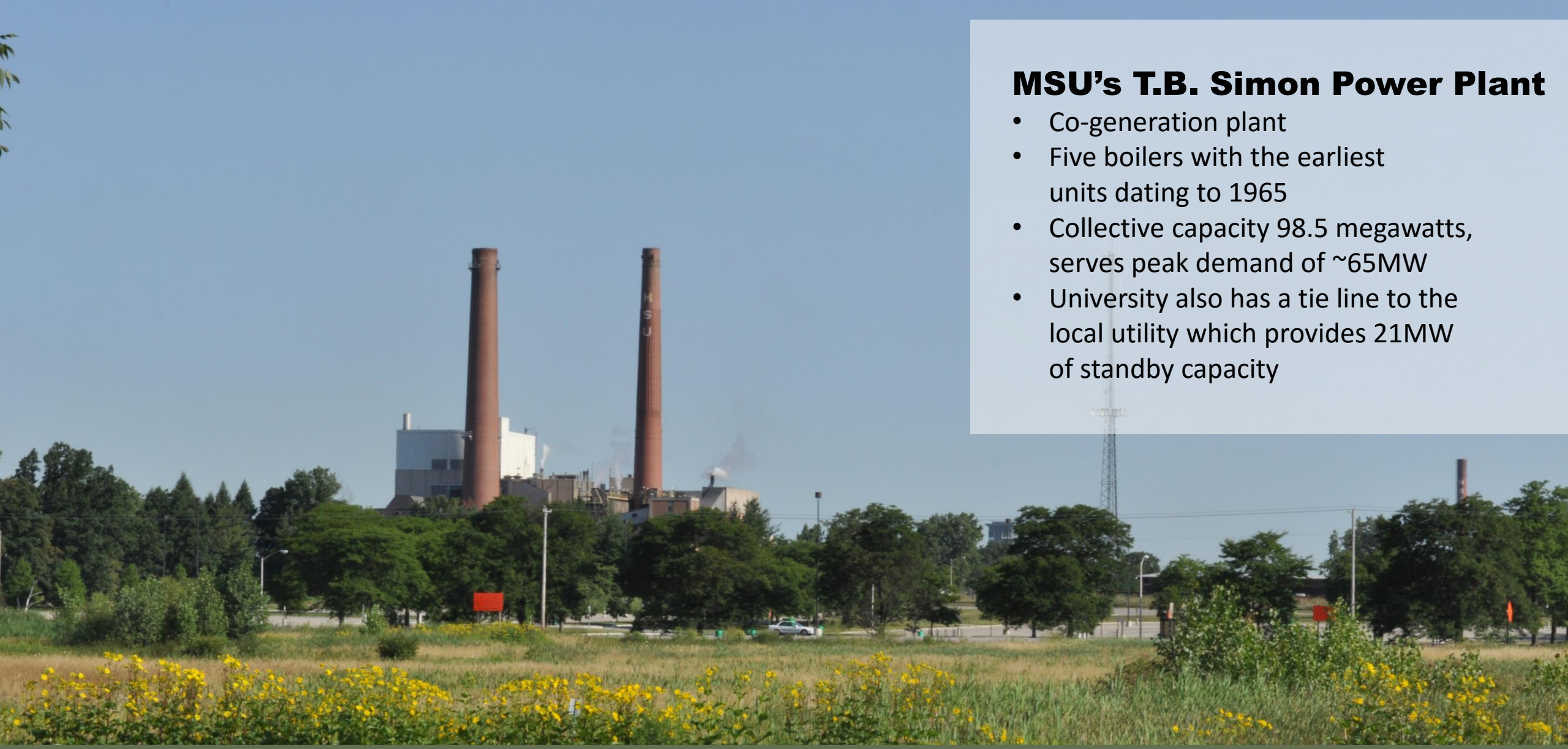
1. INTRODUCTION
2. ENERGY CHALLENGES, OPPORTUNITIES AND STRATEGIES FOR UNIVERSITIES
3. ALIGNING LEADERSHIP IN TECHNOLOGY WITH INSTITUTIONAL STRATEGY
4. CASE STUDY 1 – USA PERSPECTIVE, MSU
5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE, QUT & UQ
6. CONCLUSIONS, SUMMARY AND QUESTIONS

2. ENERGY CHALLENGES, OPPORTUNITIES AND STRATEGIES FOR UNIVERSITIES

UNIVERSITY OVERVIEW

- Founded in 1855
- One of 18 Land Grant Universities in the Association of American Universities / Among Top 100 Research Universities Globally
- 200 programs of study and 17 degree granting colleges
- Approximately 50,000 students (77.4% Ung, 22.6% Grad)
- More than 2,400 faculty (70% Tenure System)
- 5,200 acres (2,100 acres built campus)
- 22.9 million GSF and more than 545 buildings
- Significant research and research support space

2. ENERGY CHALLENGES, OPPORTUNITIES AND STRATEGIES FOR UNIVERSITIES



MSU's T.B. Simon Power Plant

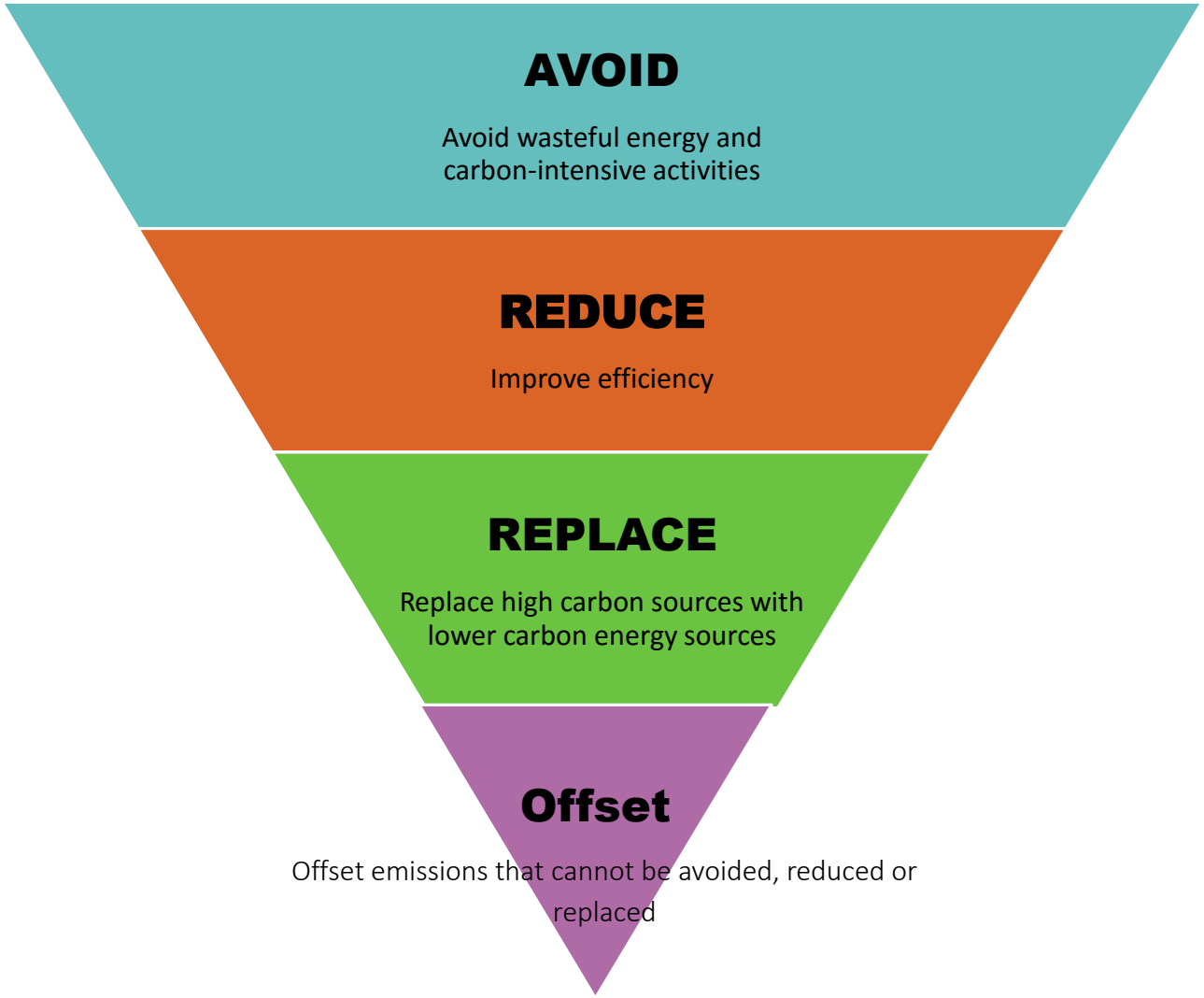
- Co-generation plant
- Five boilers with the earliest units dating to 1965
- Collective capacity 98.5 megawatts, serves peak demand of ~65MW
- University also has a tie line to the local utility which provides 21MW of standby capacity

2. ENERGY CHALLENGES, OPPORTUNITIES AND STRATEGIES FOR UNIVERSITIES

OUR ENERGY CHALLENGES

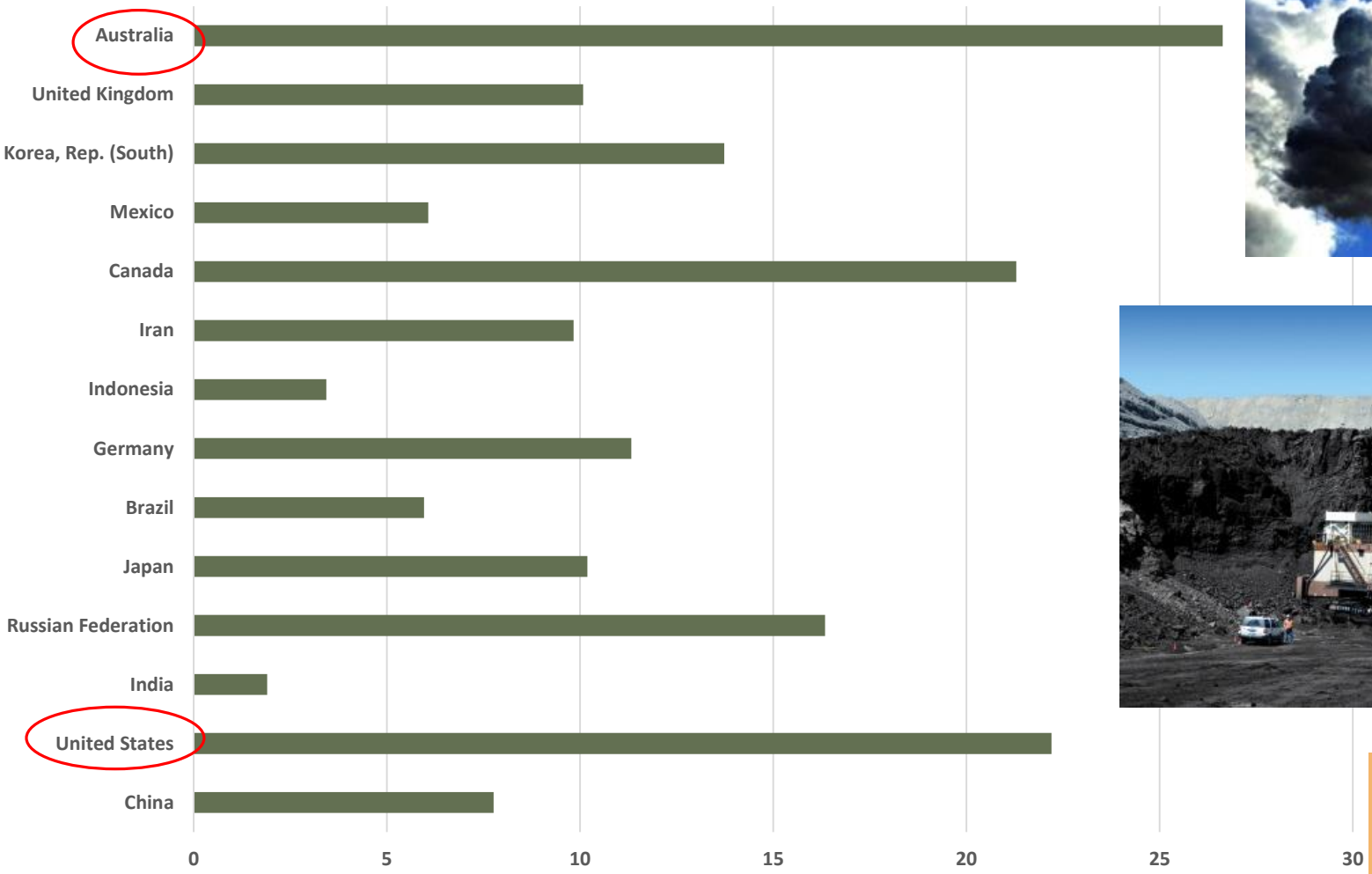
2. ENERGY CHALLENGES, OPPORTUNITIES AND STRATEGIES FOR UNIVERSITIES

OUR ENERGY OPPORTUNITIES



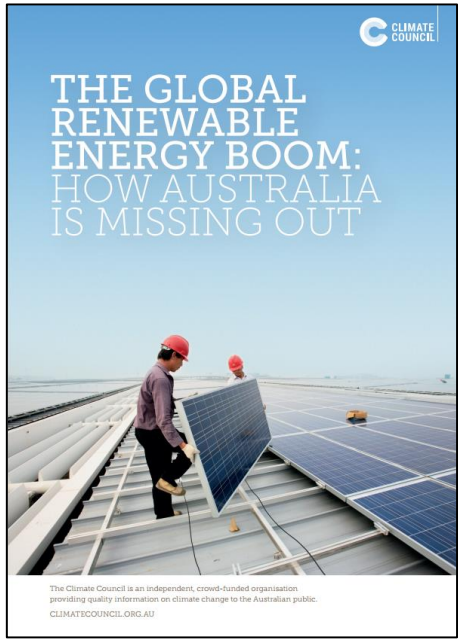
2. ENERGY CHALLENGES, OPPORTUNITIES AND STRATEGIES FOR UNIVERSITIES

Total emissions per capita (tCO2e Per Capita)



Data from World Resources Institute 2010

2. ENERGY CHALLENGES, OPPORTUNITIES AND STRATEGIES FOR UNIVERSITIES



Australia has excellent renewable energy resources, but is missing out on the global renewable boom due to policy uncertainty

Renewable energy is booming globally, with strong growth in investment and jobs. In contrast, though, Australian jobs and investment in the renewable sector have fallen sharply.

Countries with consistent long-term renewable energy policies are attracting growth.

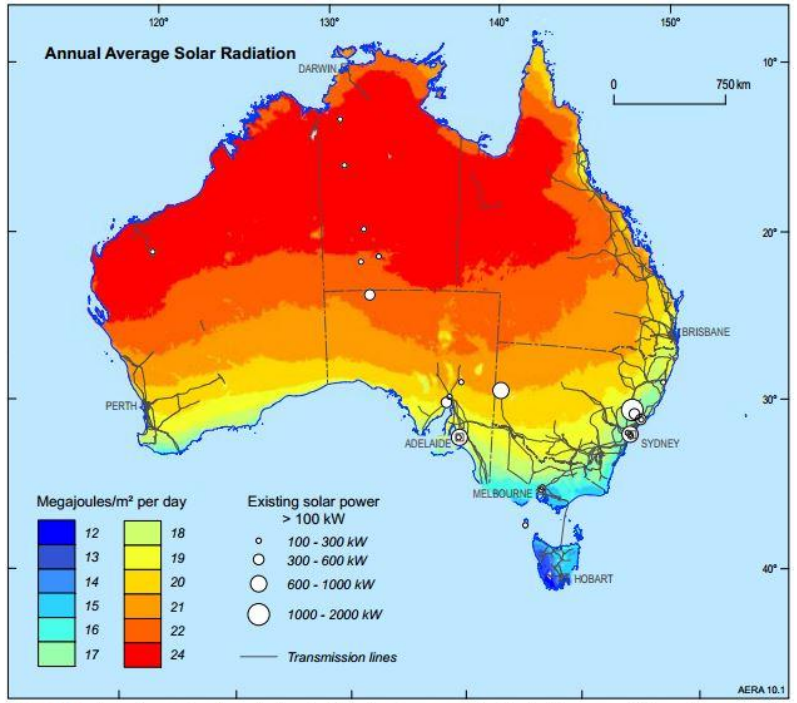


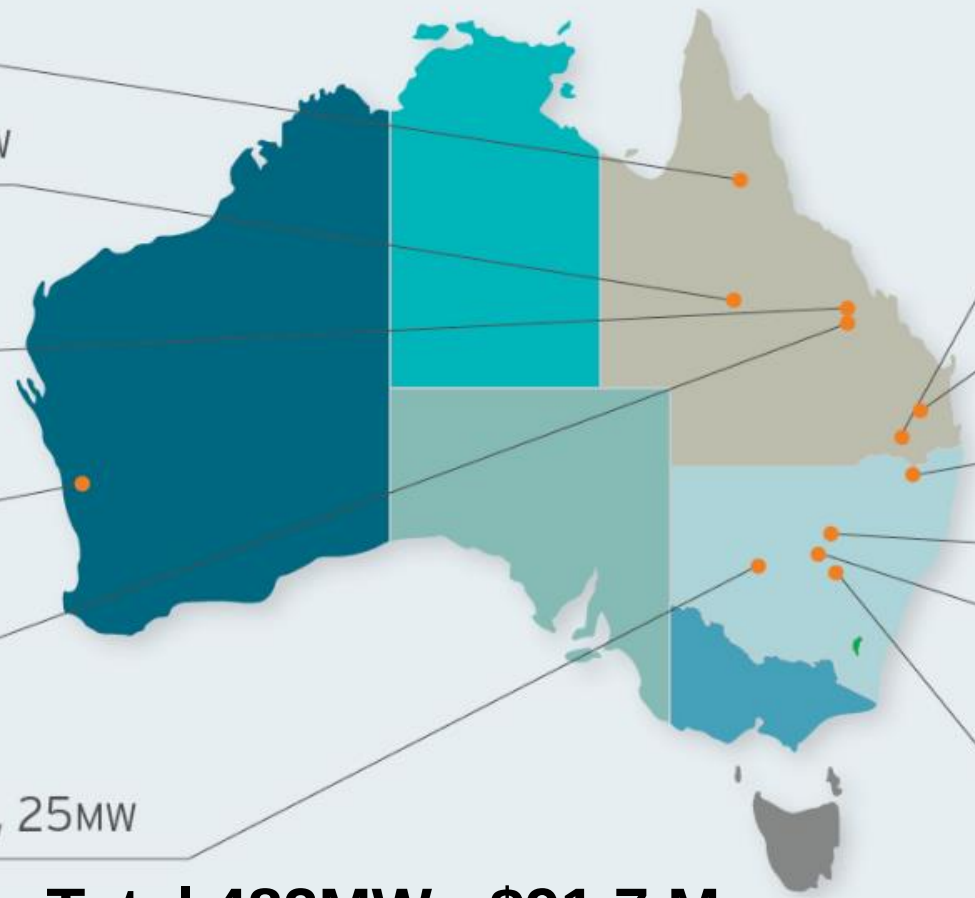
Figure 10.1 Annual average solar radiation (in MJ/m²) and currently installed solar power stations with a capacity of more than 10 kW

Source: Bureau of Meteorology 2009; Geoscience Australia

2. ENERGY CHALLENGES, OPPORTUNITIES AND STRATEGIES FOR UNIVERSITIES

AUSTRALIAN SOLAR'S BRIGHTEST DAY

PLANNED BIG SOLAR FARMS



Kidston Solar Park, 50MW

Longreach Solar Farm, 15MW

Collinsville Solar Power Station, 42MW

Emu Downs Solar Farm, 20MW

Whitsunday Solar Farm, 58.1MW

Griffith Solar Farm (Neoen), 25MW

Oakey Solar Farm, 25MW

Darling Downs Solar Farm, 110MW

White Rock Solar Farm, 20MW

Dubbo Solar Hub, 24.2MW

Manildra Solar Farm, 42.5MW

Parkes Solar Farm, 50.6MW

Total 482MW - $91.7 M

ARENA

AGL Broken Hill Solar Plant
155MW

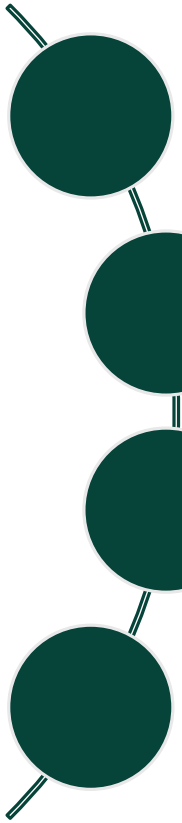
AGL Nygen Solar Plant
102MW

Lakeland solar and storage project - $42.5M

- **10.8MW**
- **1.4MW/5.3MWh LI battery storage**

Published by Lakeland Solar & Storage Pty Limited - A Conergy Group company

MSU'S ENERGY IMPERATIVES



Facility for Rare Isotope Beams (FRIB)

Requires a reliable 18-20 MW power source on a limited timeline.

Reliability and Cost

Low-cost, highly reliable energy strategy that is based on full costing of the infrastructure and long term cost of the operating budget.

Energy Transition Plan

Goals for renewable energy, health and the physical environment within constraints of maintaining reliability and capacity for growth.

Tightening Regulations

Current EPA coal regulations require a ~$1 million investment in Sorbent Injection by 2017 to provide short-term flexibility. Additional regulations expected.

3. ALIGNING LEADERSHIP IN TECHNOLOGY WITH INSTITUTIONAL STRATEGY

ENERGY STEERING COMMITTEE

Students, faculty, and staff with a passion for the charge and expertise in environment, engineering, economics, health and behavior.

3. ALIGNING LEADERSHIP IN TECHNOLOGY WITH INSTITUTIONAL STRATEGY

MSU'S ENERGY TRANSITION PLAN

GOAL 1

Improve the physical environment

GOAL 2

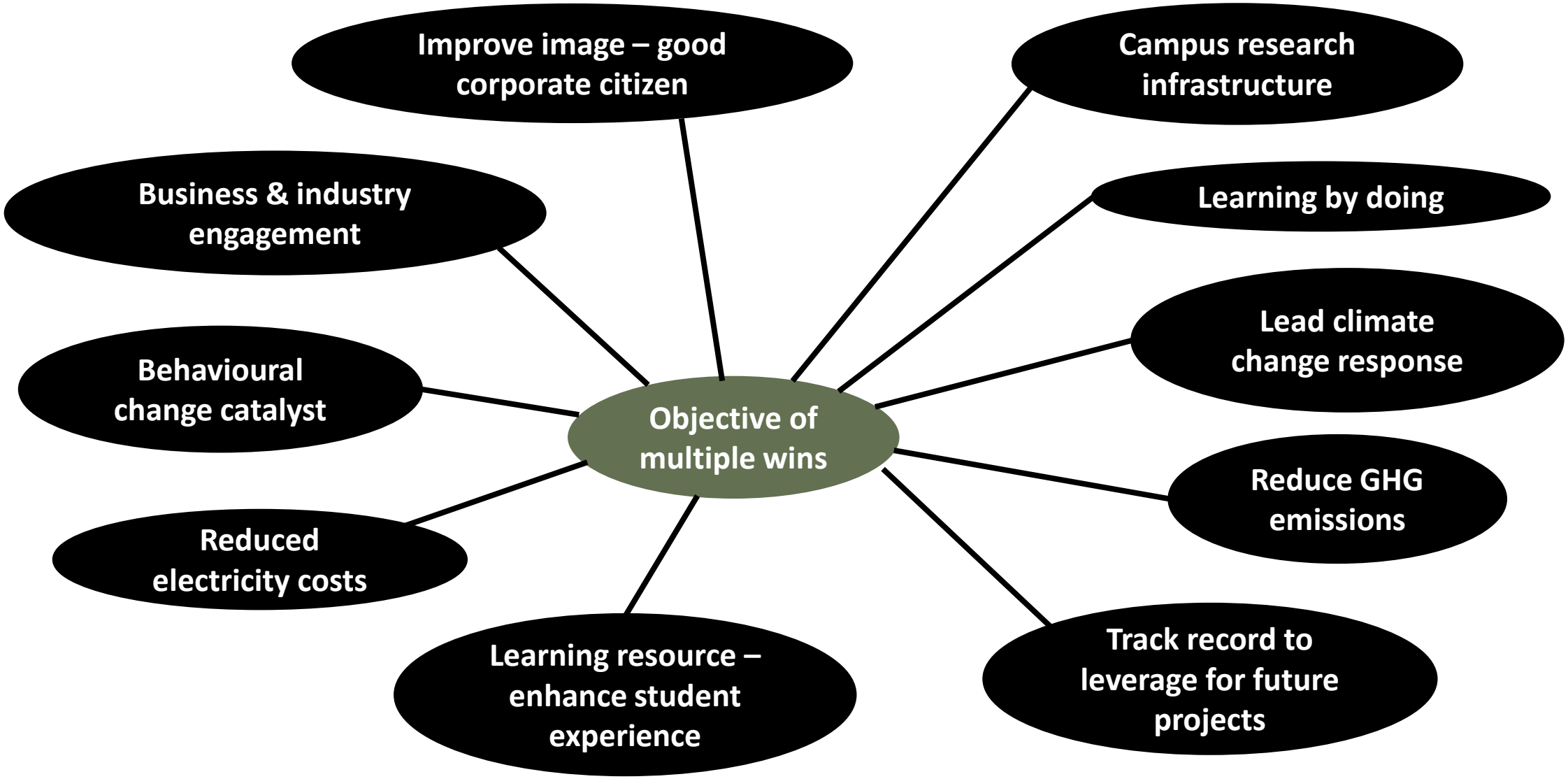
Invest in sustainable energy research and development

GOAL 3

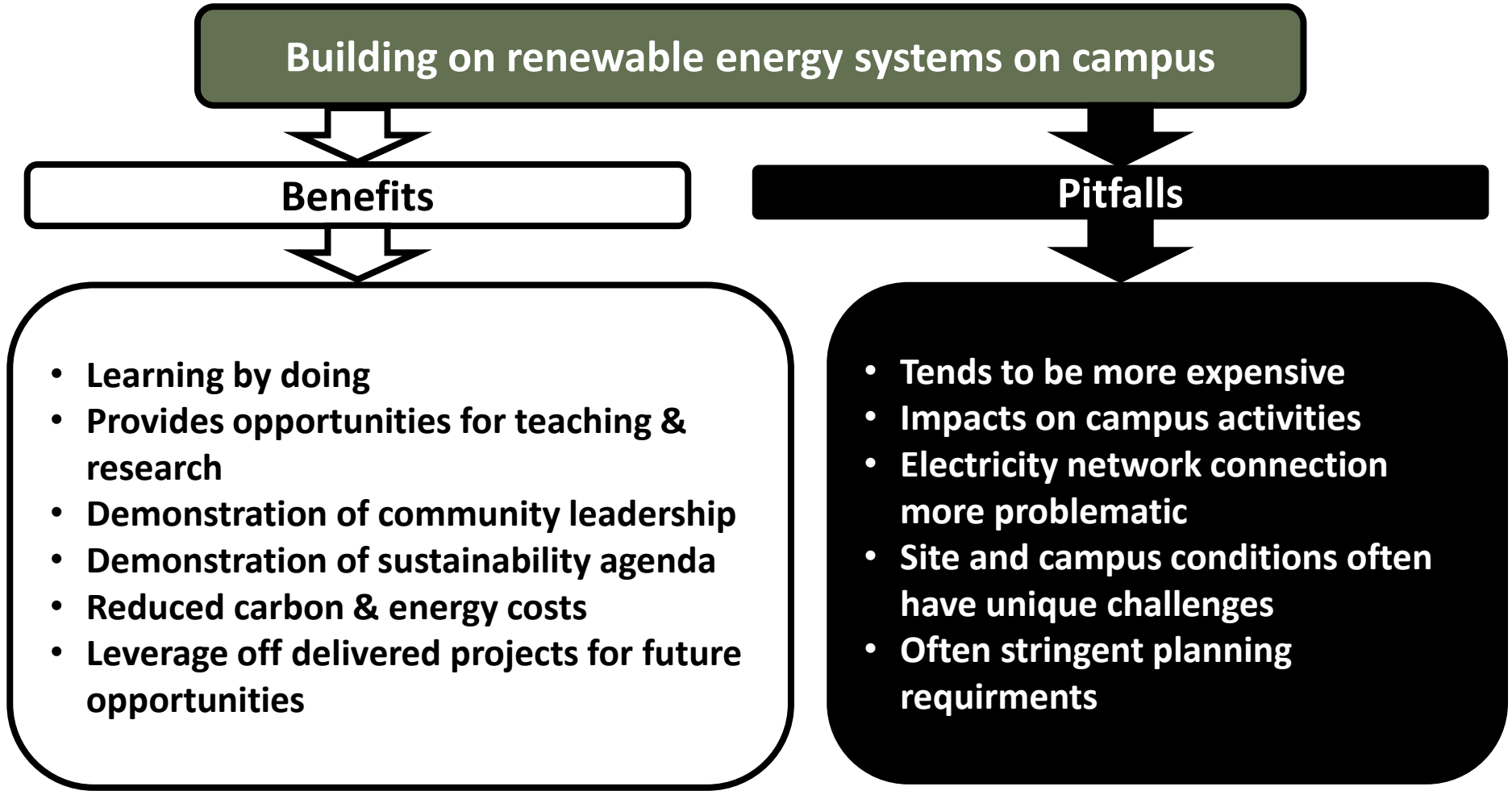
Become an educational leader in sustainable energy

3. ALIGNING LEADERSHIP IN TECHNOLOGY WITH INSTITUTIONAL STRATEGY

WHY DO RENEWABLE & LOW CARBON PROJECTS ON CAMPUS?

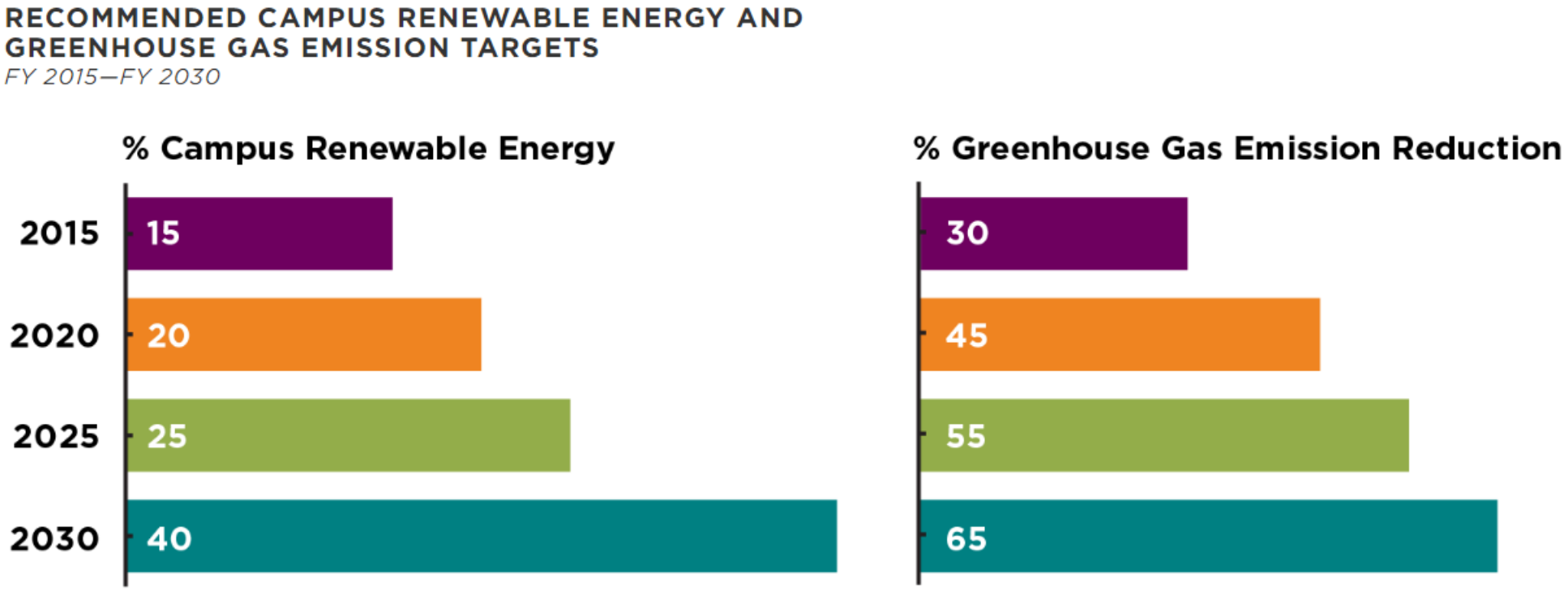


3. ALIGNING LEADERSHIP IN TECHNOLOGY WITH INSTITUTIONAL STRATEGY – OZ PERSPECTIVE



3. ALIGNING LEADERSHIP IN TECHNOLOGY WITH INSTITUTIONAL STRATEGY – OZ PERSPECTIVE

Energy Transition Plan Targets



4. CASE STUDY 1 – USA PERSPECTIVE, MSU

Substation
50 MW Substation with 138 kV tie-line

Switch-house
Interface to connect FRIB, Power Plant and new substation

Upgrade Simon Plant Boiler 4 to burn Natural Gas

Natural gas upgrade to meet Consumers Energy contractual loads

Utilize substation for a portion of campus load to balance and improve efficiency of T.B. Simon Plant

Engage a National Energy Consultant to evaluate efficient and flexible options for aging plant infrastructure

Work with Customer First Renewables to assess green energy options

Upgrade Aging Plant Infrastructure
- Invest in affordable and efficient power
- Retain flexibility to produce electricity and/or steam as required by any changing campus needs
- Lifespan allows planned obsolescence

Meet Sustainability Goals

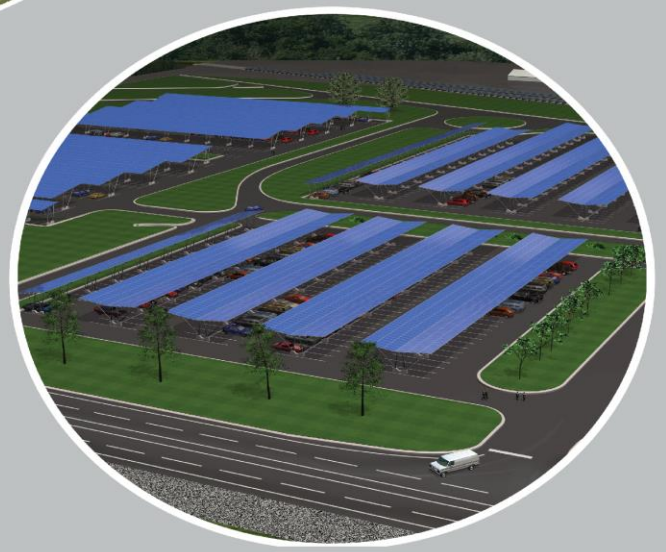
Grow alternative sources of green energy

Breakthrough Technologies
- Keep flexibility in planning to incorporate future technology innovations

Energy Leader
- Take a leadership role in energy research

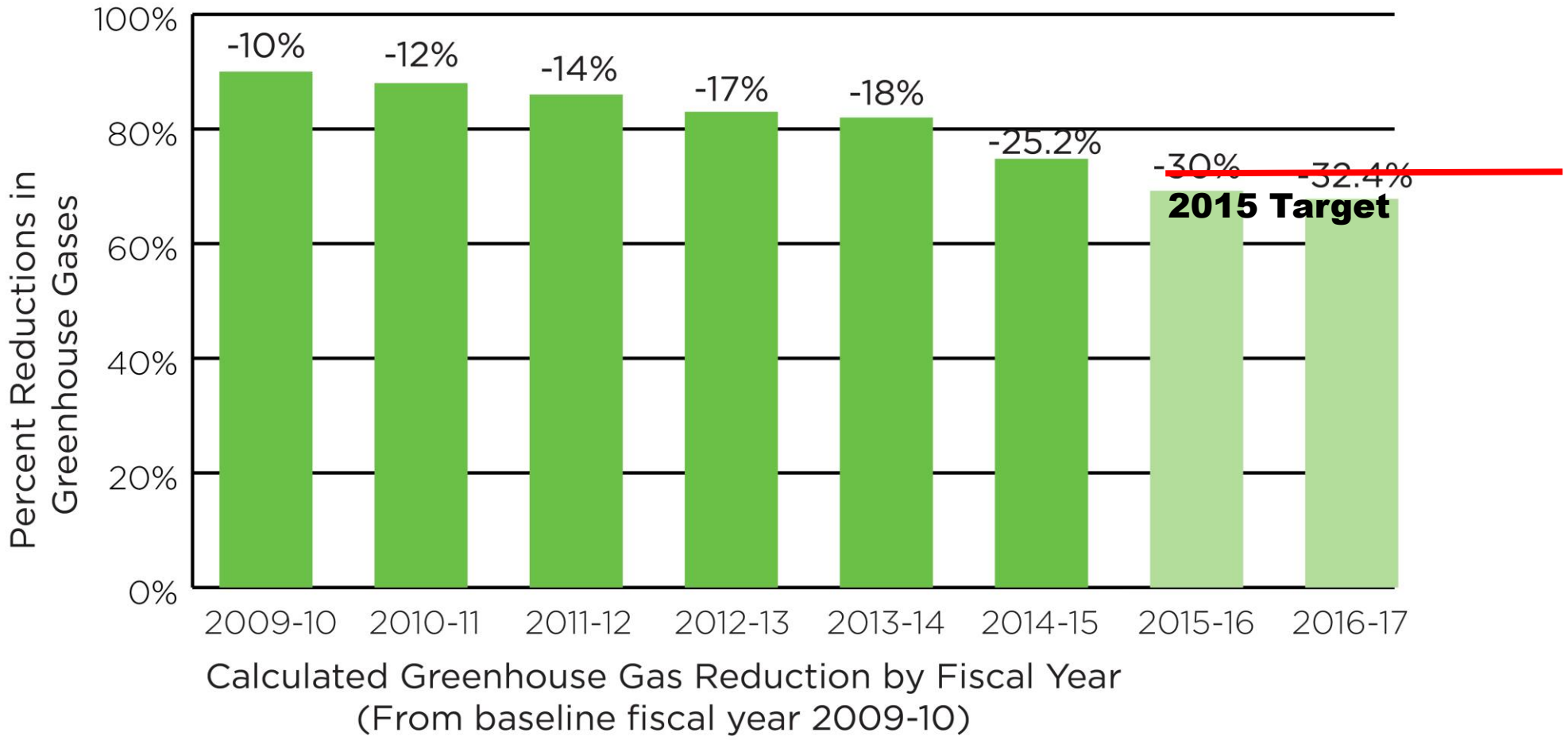
4. CASE STUDY 1 – USA PERSPECTIVE, MSU

FORWARD PROGRESS



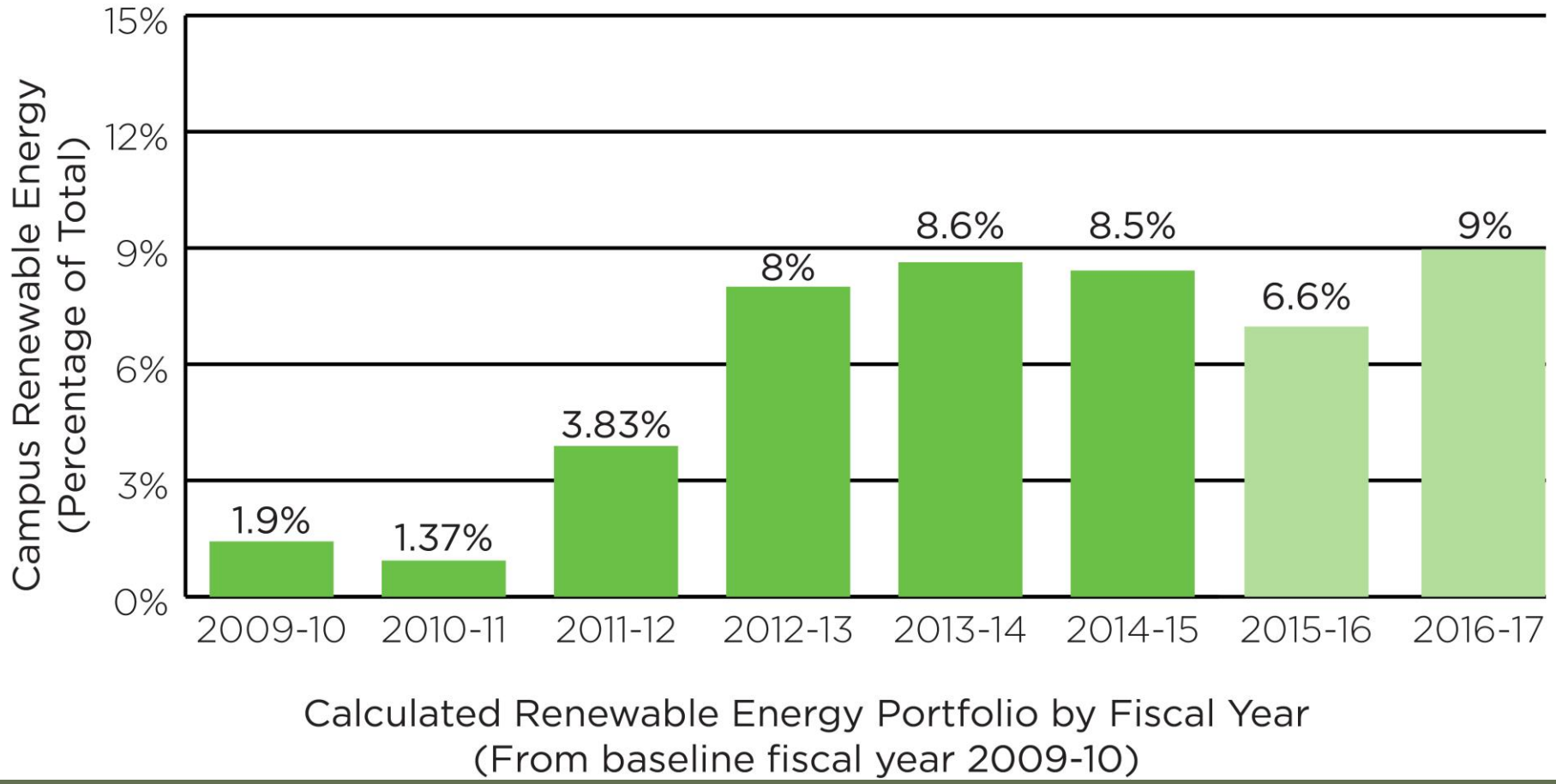
4. CASE STUDY 1 – USA PERSPECTIVE, MSU

REDUCTION: GREENHOUSE GAS EMISSIONS



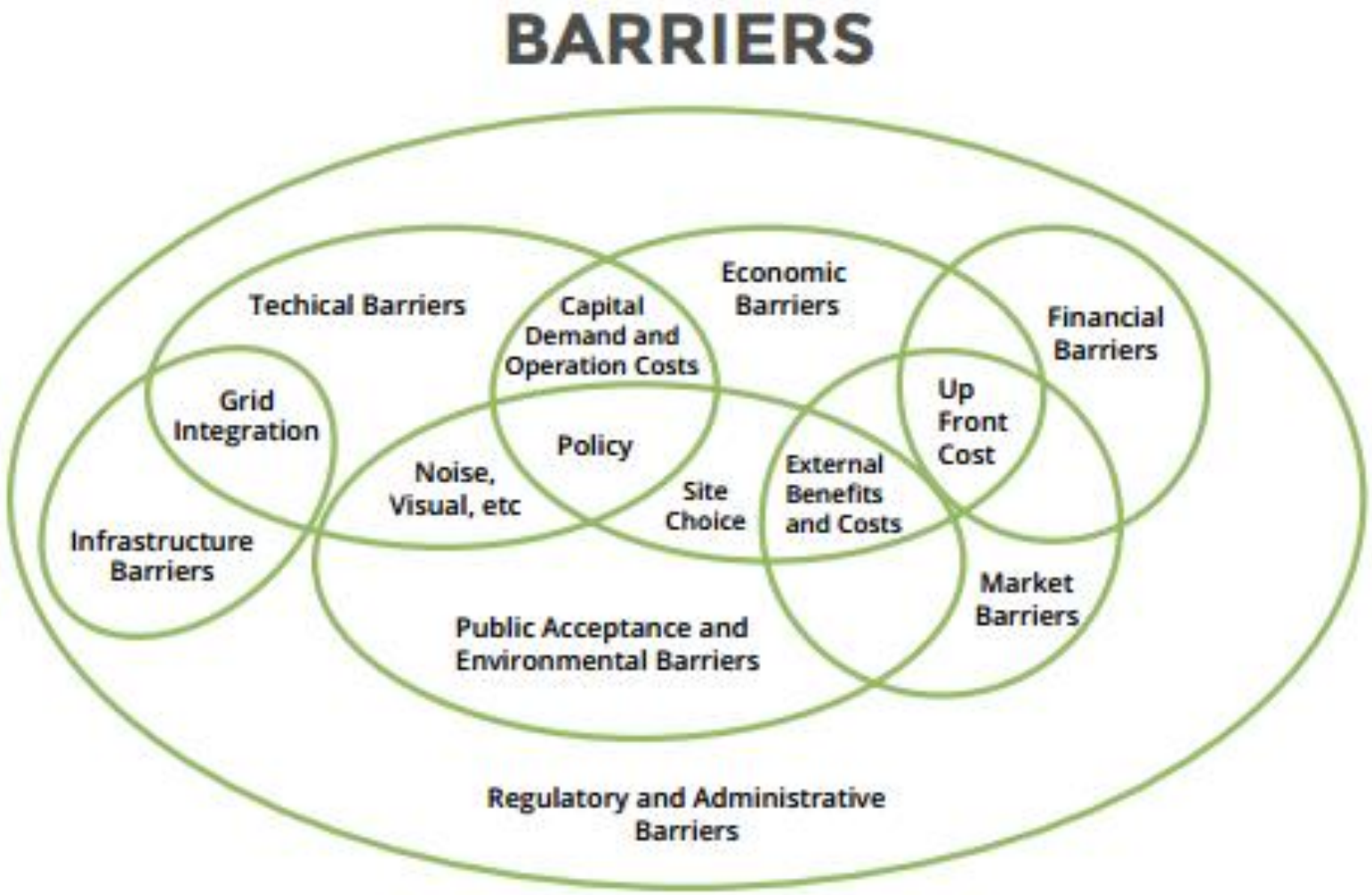
4. CASE STUDY 1 – USA PERSPECTIVE, MSU

RENEWABLE ENERGY PROFILE



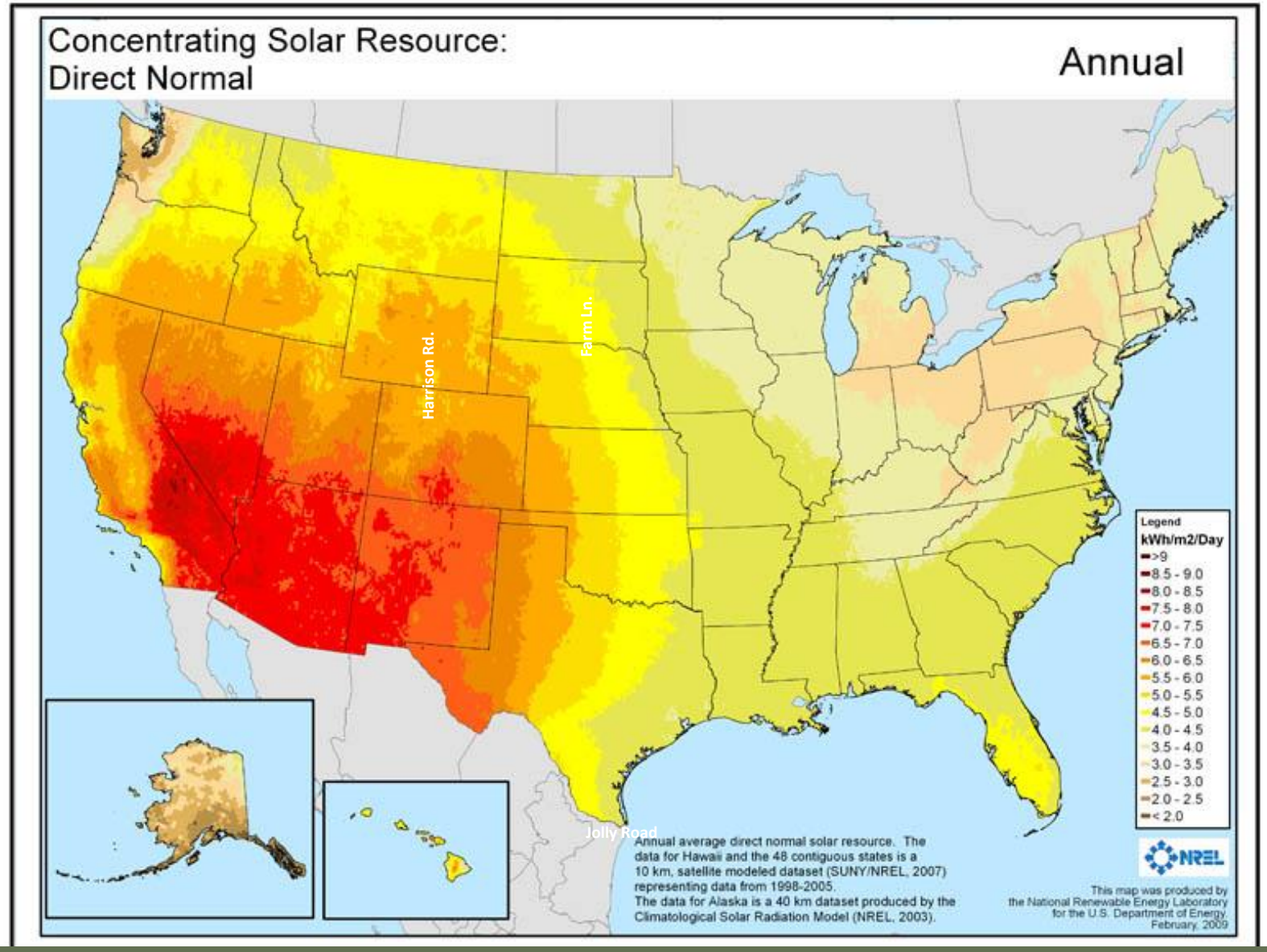
Calculated Renewable Energy Portfolio by Fiscal Year
(From baseline fiscal year 2009-10)

4. CASE STUDY 1 – USA PERSPECTIVE, MSU



Institute for Energy Innovation, Barriers to Advanced Energy in Michigan (2015)

4. CASE STUDY 1 – USA PERSPECTIVE, MSU



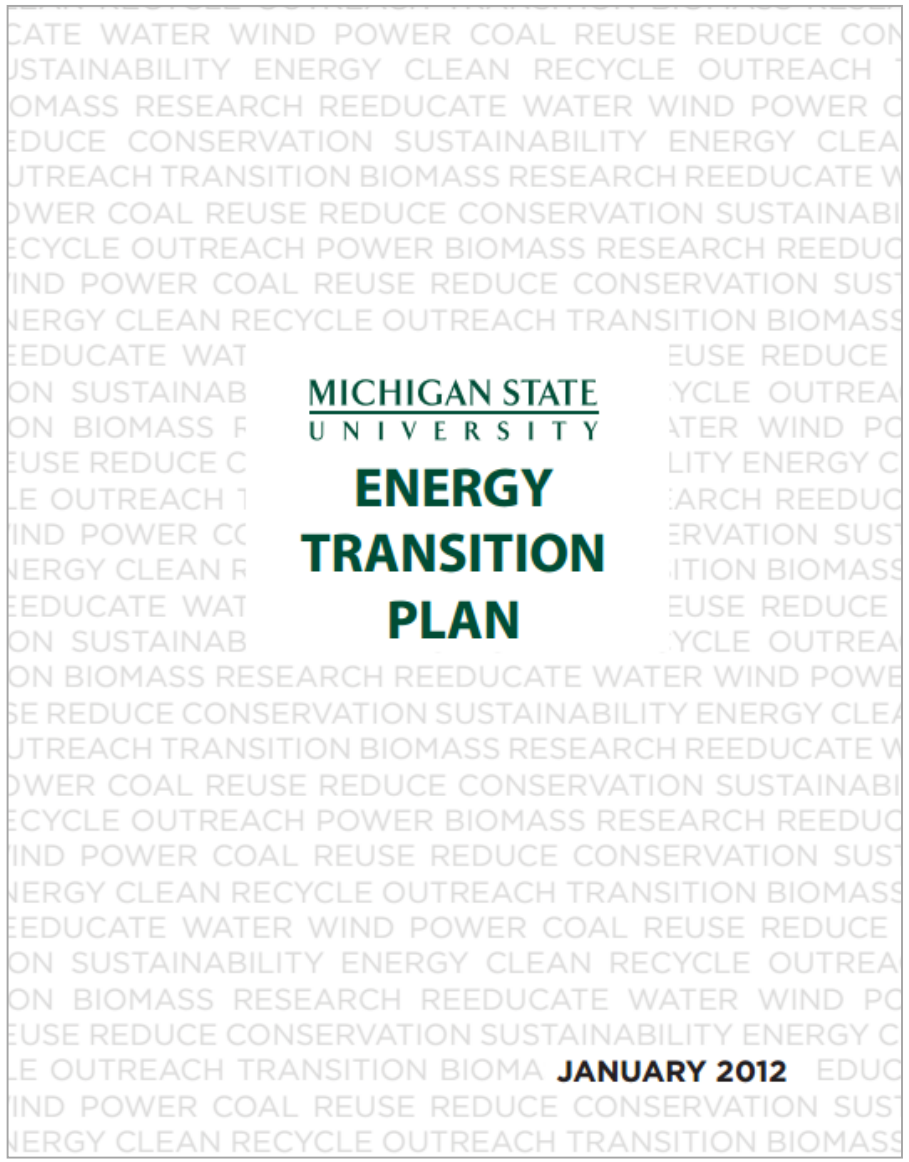
4. CASE STUDY 1 – USA PERSPECTIVE, MSU

Moving into solar with a proposed 10 MW carport solar solution

10 MW carport solar project

- ✓ **Financial benefits** to MSU by allowing MSU to purchase power at a fixed price over the next 25 years.
- ✓ **Advances the Energy Transition Plan** by improving the environment, investing in sustainable energy research and development, and positioning MSU as a leader in the realm of sustainable energy.

4. CASE STUDY 1 – USA PERSPECTIVE, MSU



A LIVING DOCUMENT

- The plan is based on projected campus growth, campus energy needs, cost effectiveness, reliability, implications for MSU's cost structure and a number of alternatives in terms of emerging technologies.
- Plan will be reviewed, updated and adjusted every five years.

Define “Sustainability”

Consider sustainability as a core competency.

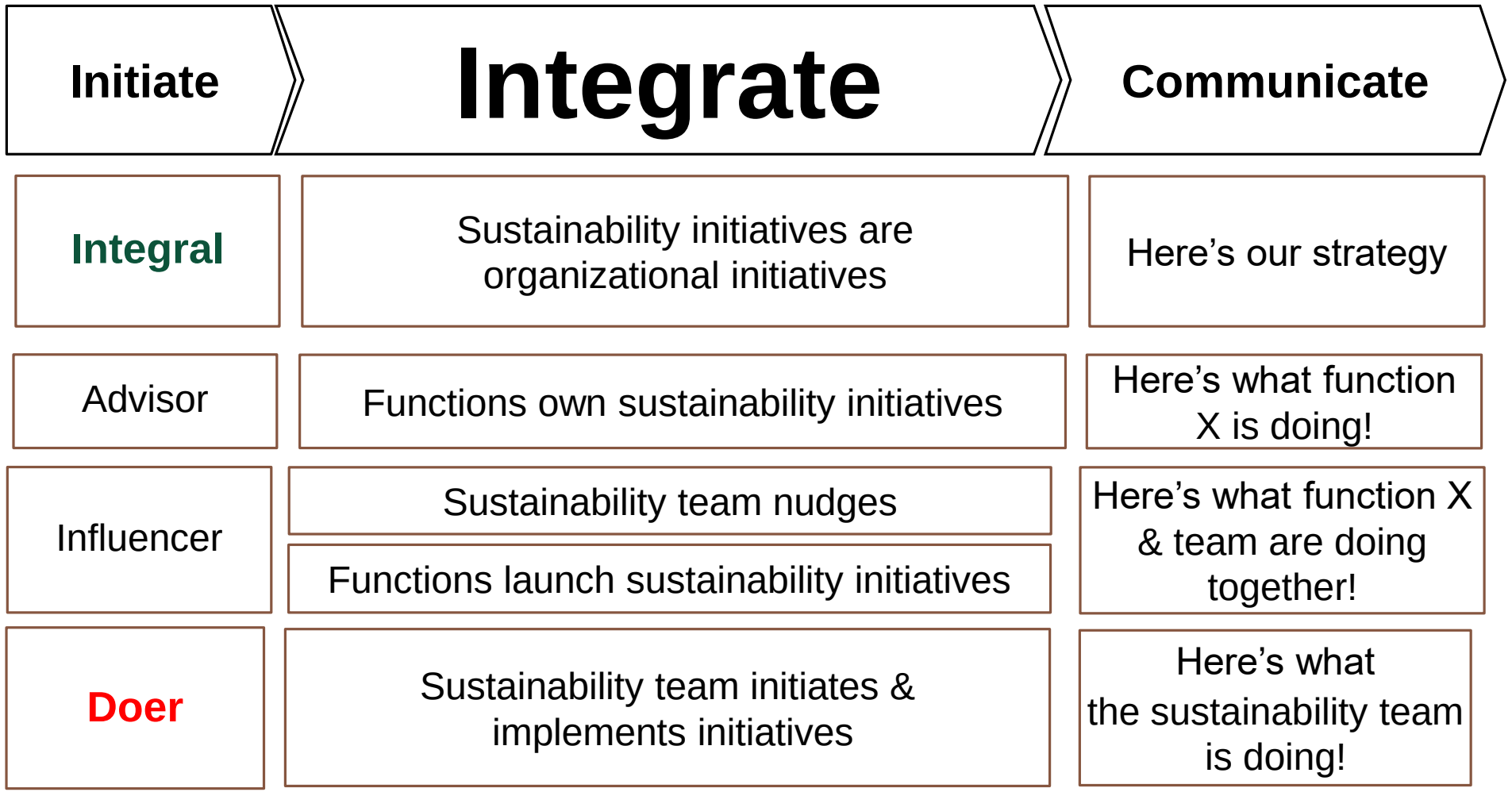
Cultivate the ability of the University to **prosper long term**, to be sustained into the future. (Economic)

Cultivate the ability to **grow while reducing** our environmental footprint. (Environmental)

Enrich the ability to win long term support from society and our stakeholders for the first two imperatives. (Social)

4. CASE STUDY 1 – USA PERSPECTIVE, MSU

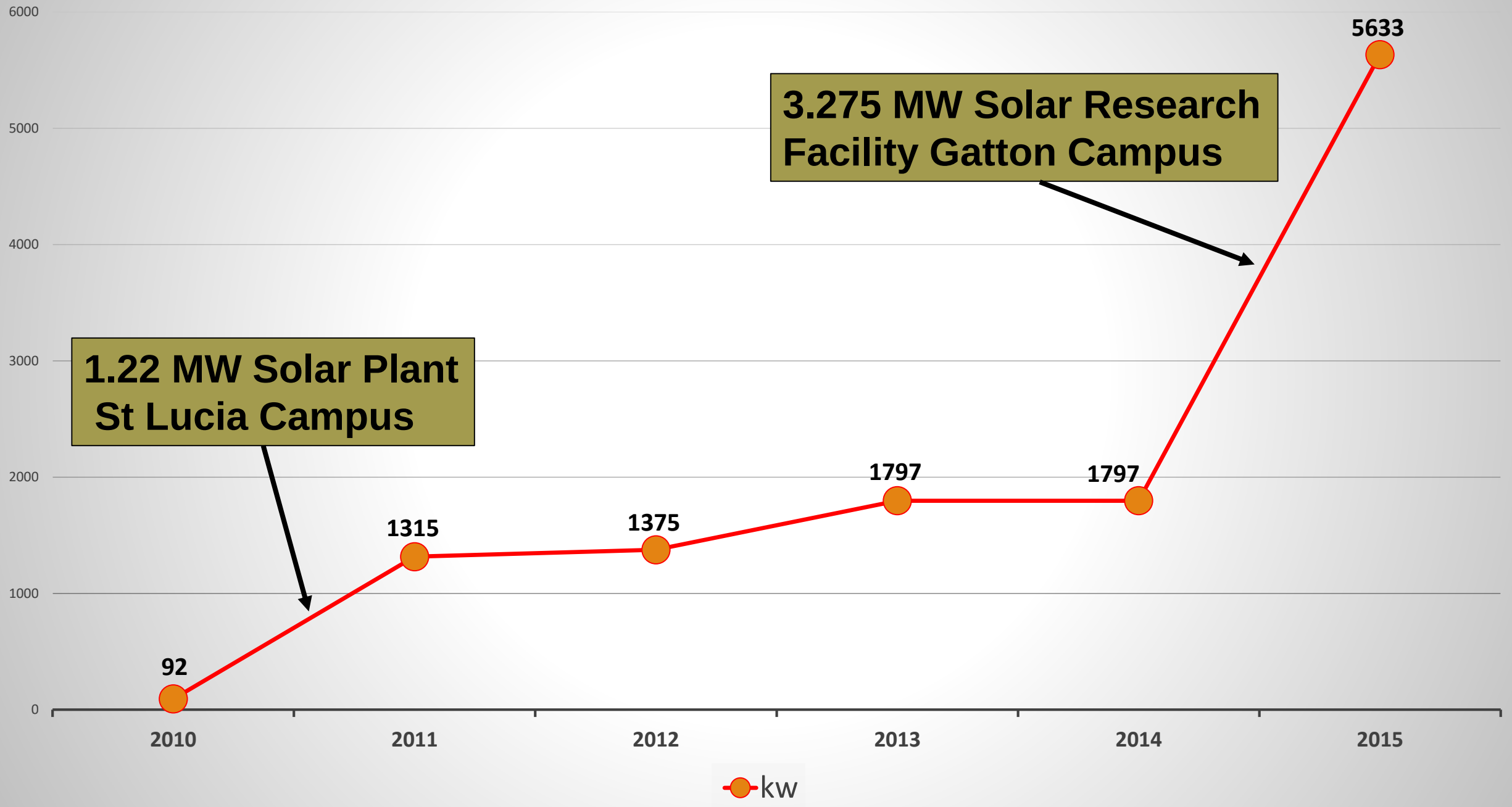
Sustainability Maturity Level



4. CASE STUDY 1 – USA PERSPECTIVE, MSU

5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE

UQ PV Growth


6000
5000
4000
3000
2000
1000
0
2010
2011
2012
2013
2014
2015
92
1315
1375
1797
1797
5633
1.22 MW Solar Plant
St Lucia Campus
3.275 MW Solar Research
Facility Gatton Campus
kw

Over 2,000 solar panels lost in the flood

5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE (UQ St Lucia)

Two identical systems ideal for research trials

5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE (UQ St Lucia)

LESSONS LEARNT – PLANNING STAGE

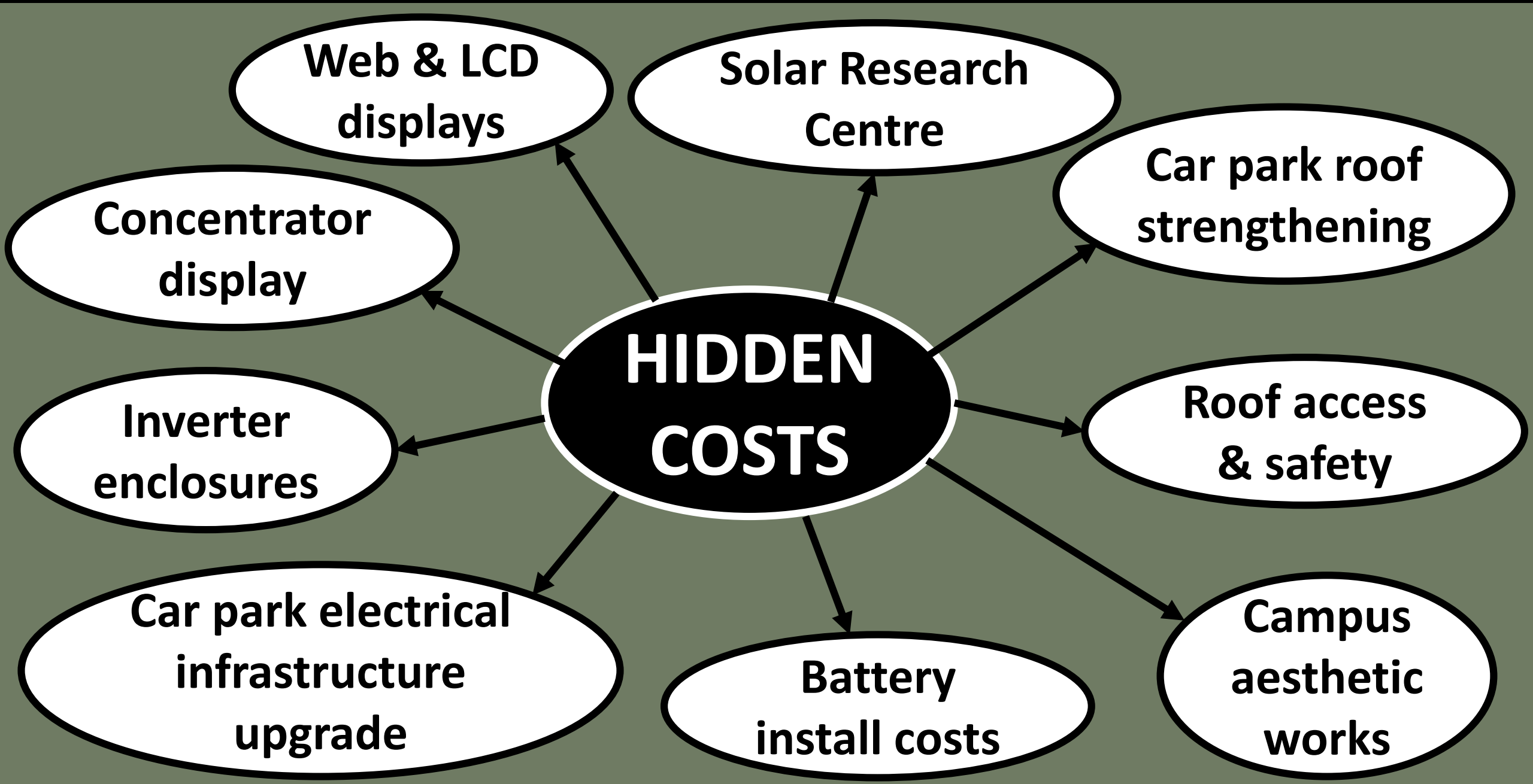
Procurement

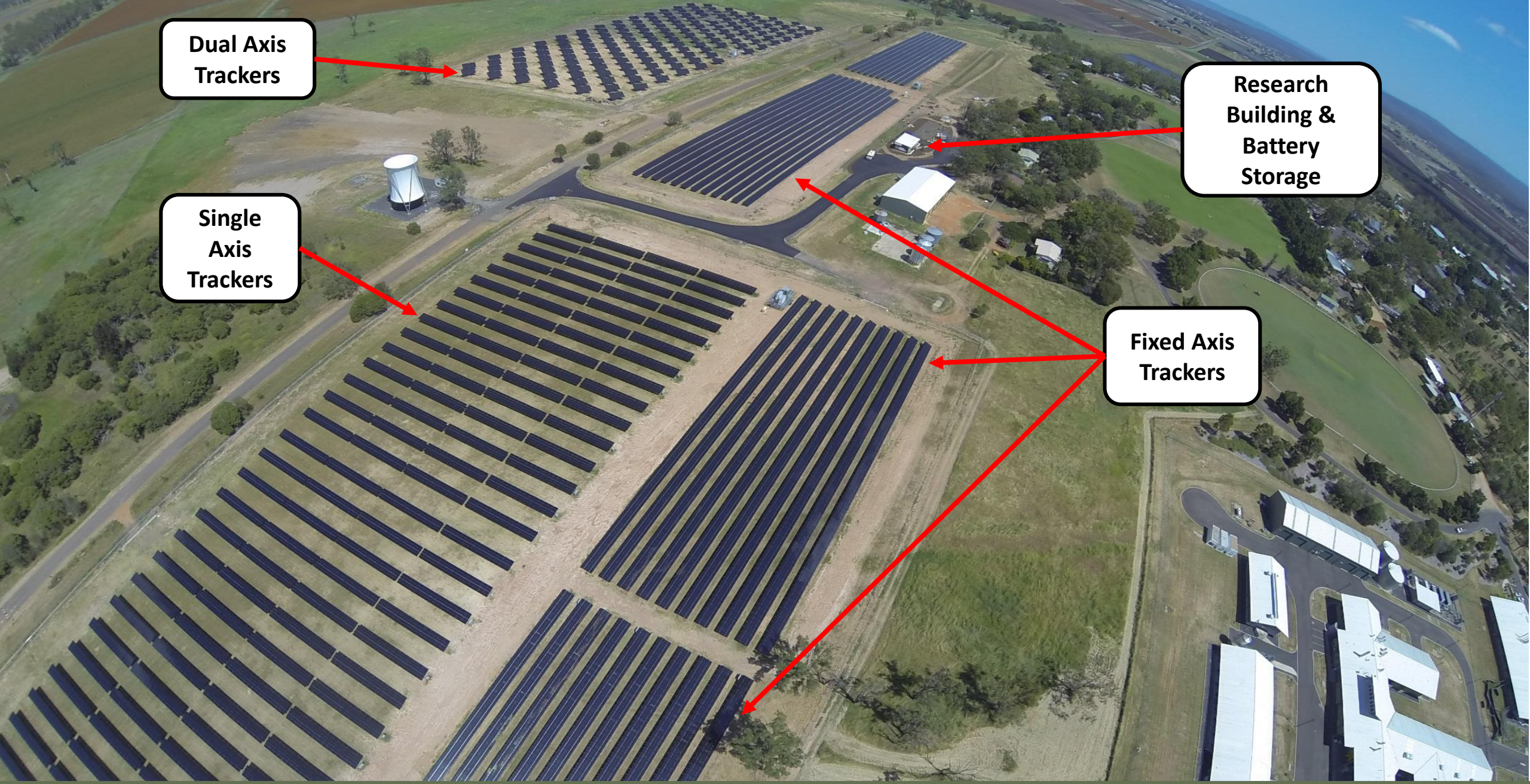
- During planning stage panel prices dropped from $8W to $4W

- Immature market in Australia – larger solar companies had little local deployment capability

EOI process revealed consortiums had unattractive joint offerings – negotiations led to new partnerships saving UQ $800K which also led to more favourable research opportunities

LESSONS LEARNT – CONSTRUCTION STAGE





5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE
UQ Gatton Solar Research Facility

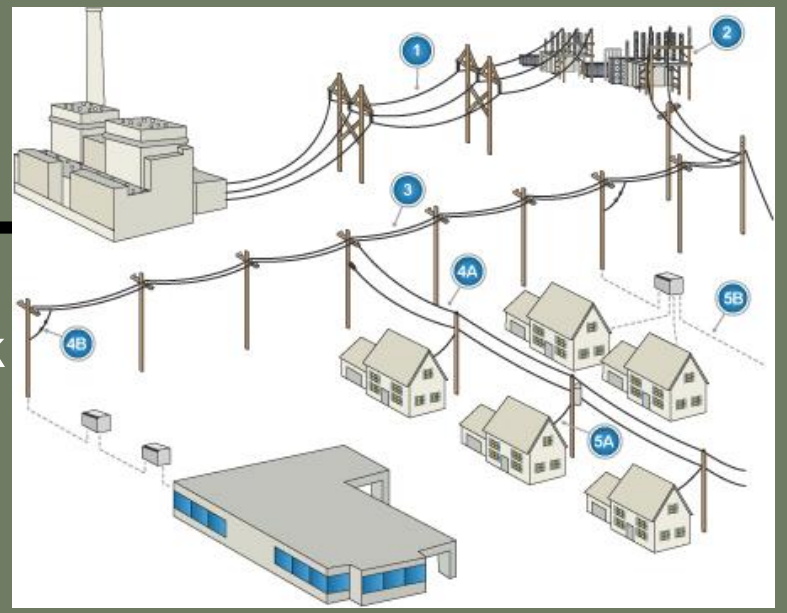
3.275 MW solar array
37,000 panels
10 hectares site
600 kWp Lithium Ion battery

2 x 380kWh Kokam Lithium Ion batteries

LESSONS LEARNT – CONNECTION AGREEMENT

LI Battery

Future 33KV Campus Supply
(Transmission Network)



11KV Residential
Distribution Network
Supply

11KV Solar Supply

UQ Gatton
11KV
Switchboard

Gatton Solar
Research System

Capacitor
Bank

Standby Diesel
Generator

UQ Gatton
Campus Load

Existing PV

ELECTRICAL SUPPLY CONTROL SYSTEM

Future Lithium Ion Battery

Network Supplier Control Room

Gatton Solar Research System

UQ Gatton 11KV Switchboard

Capacitor Bank

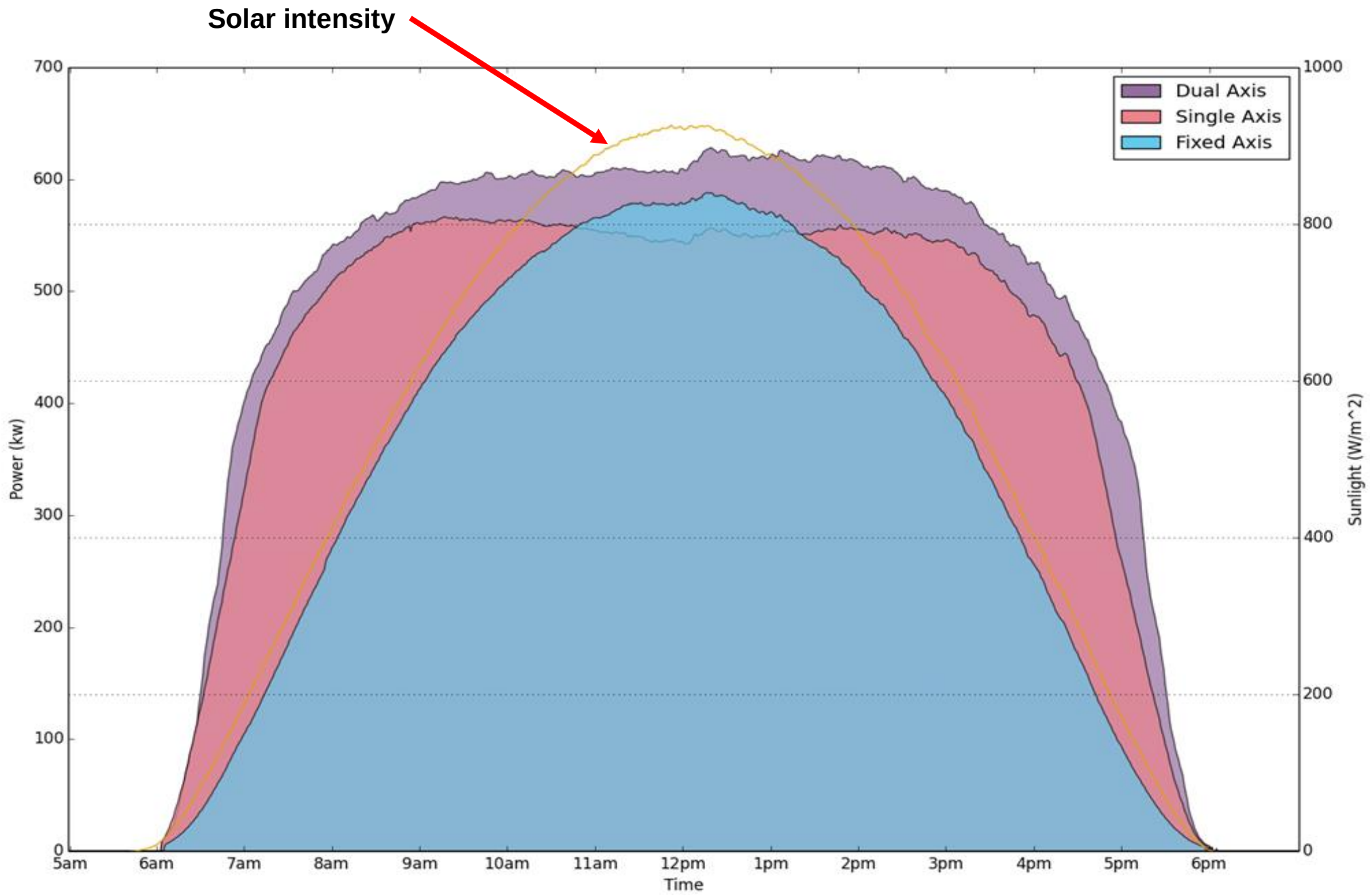
Standby Diesel Generator

Solar Power Plant Controllers

Network regulation control

Voltage
Power factor
Flicker
Harmonics

Central Control System


Solar intensity
Dual Axis
Single Axis
Fixed Axis
Power (kw)
Sunlight (W/m^2)
Time
0
100
200
300
400
500
600
700
0
200
400
600
800
1000
5am
6am
7am
8am
9am
10am
11am
12pm
1pm
2pm
3pm
4pm
5pm
6pm

LESSONS LEARNT

High voltage Connection - $2.5M

Central control system

Learning by doing

Battery procurement

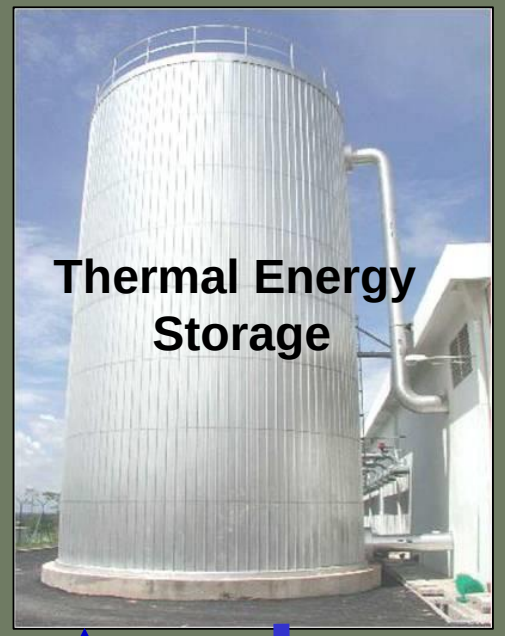
Single & dual axis tracker technologies

STORING SOLAR ENERGY AS CHILLED WATER

Solar energy supply

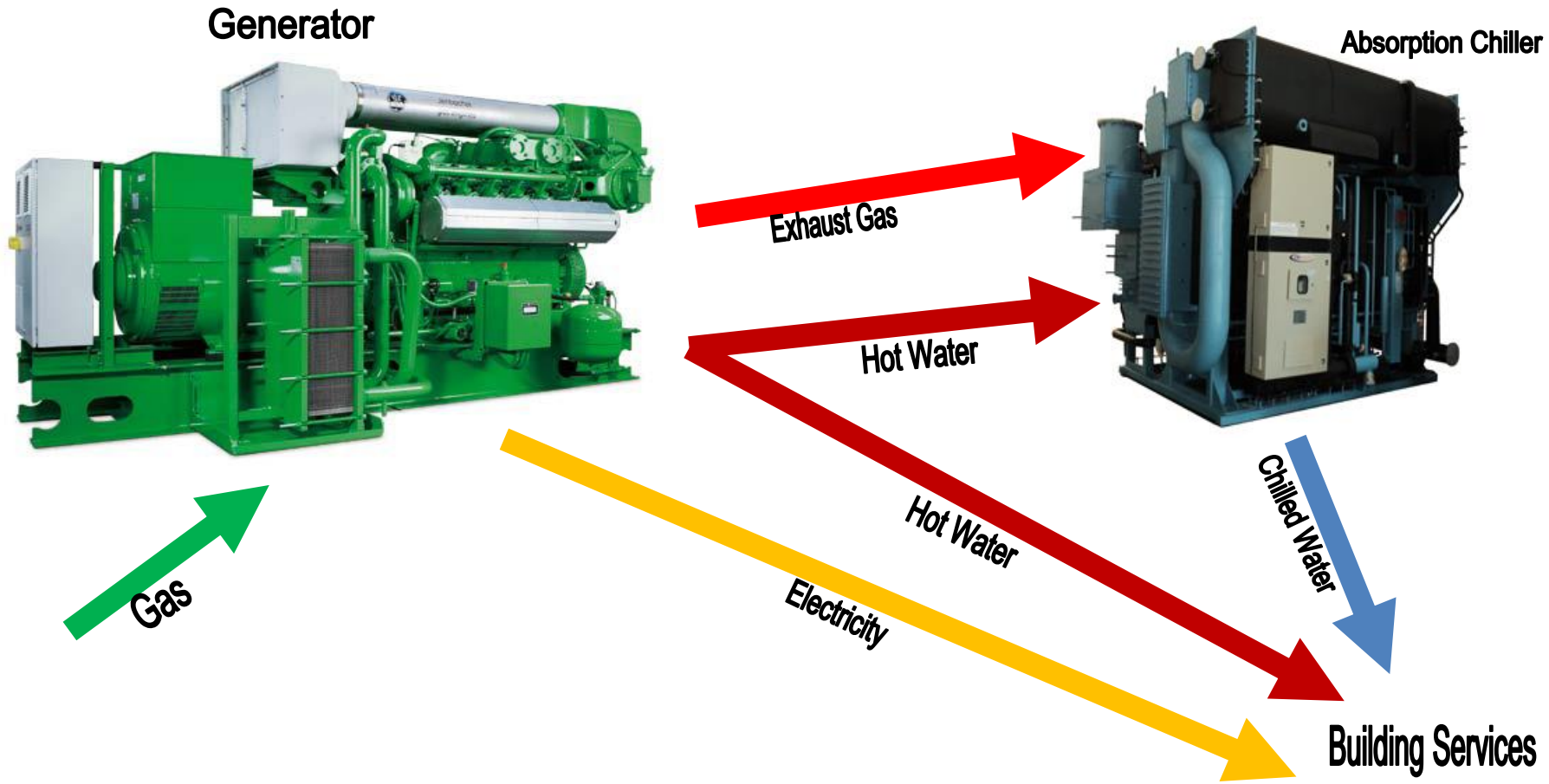
Electrical network supply

Chilled water supply



Campus chilled water reticulation

5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE (UQ Gatton)



Source: Geoff Woods QUT

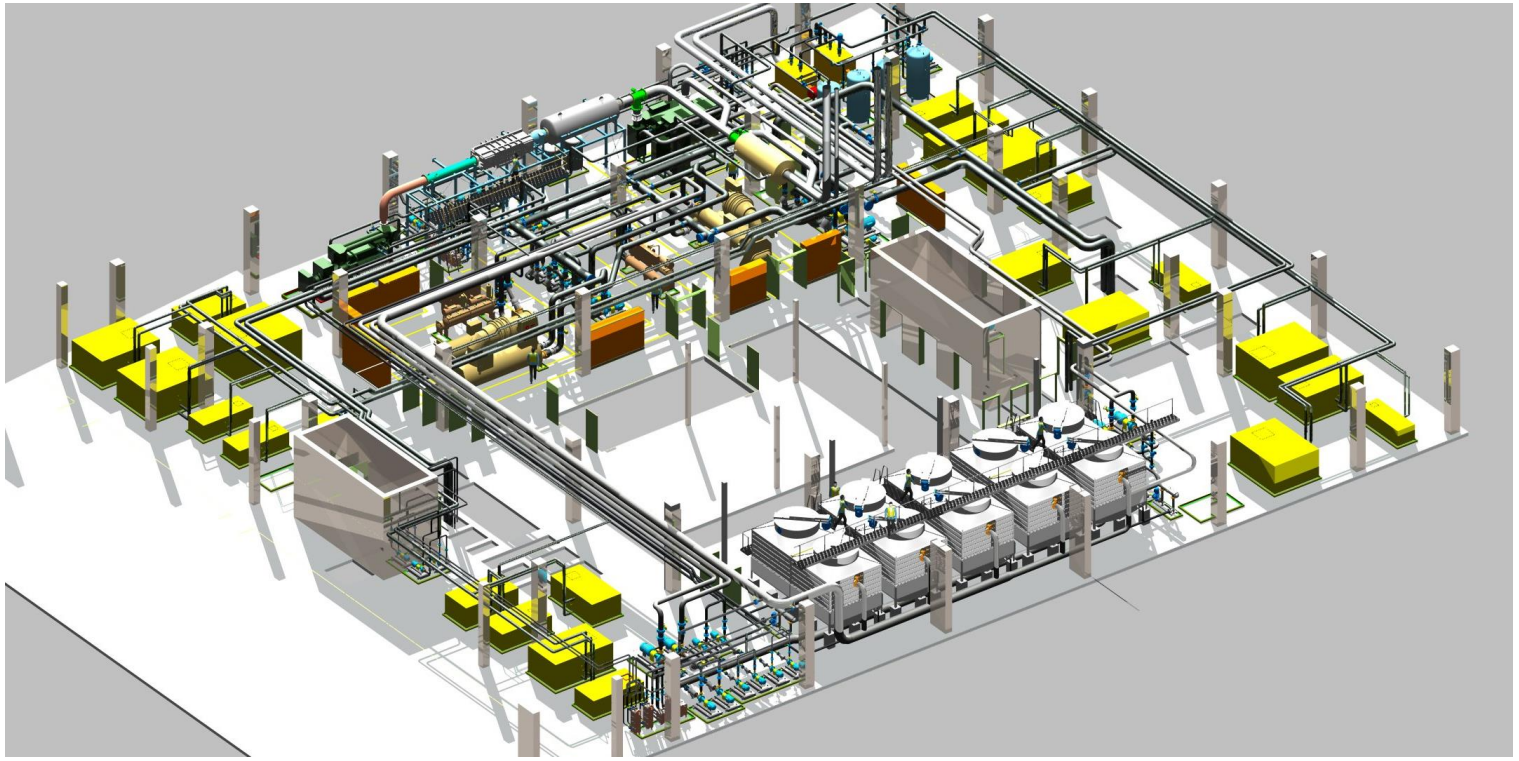
5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE
QUT Trigeneration System

THE GOOD

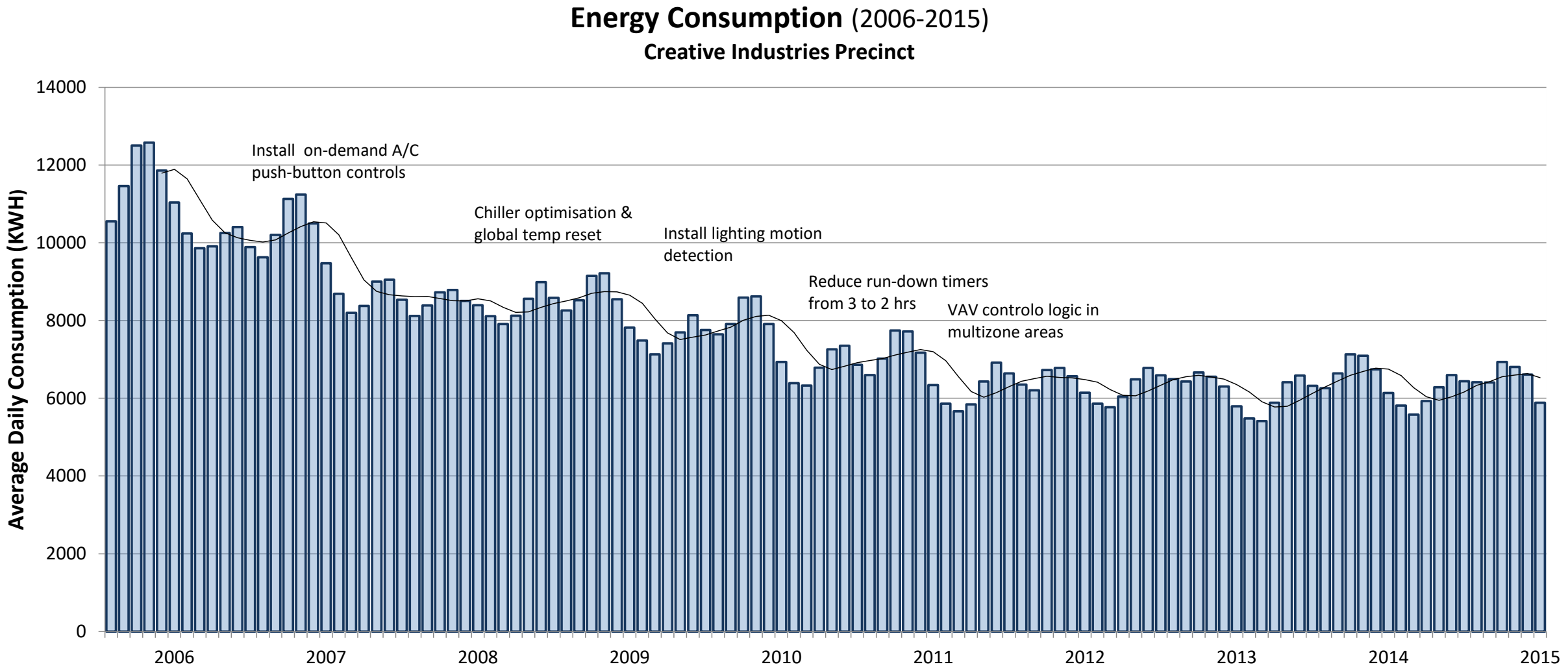
THE BAD

AND THE UGLY

984 TCO^2-e pa Reduction



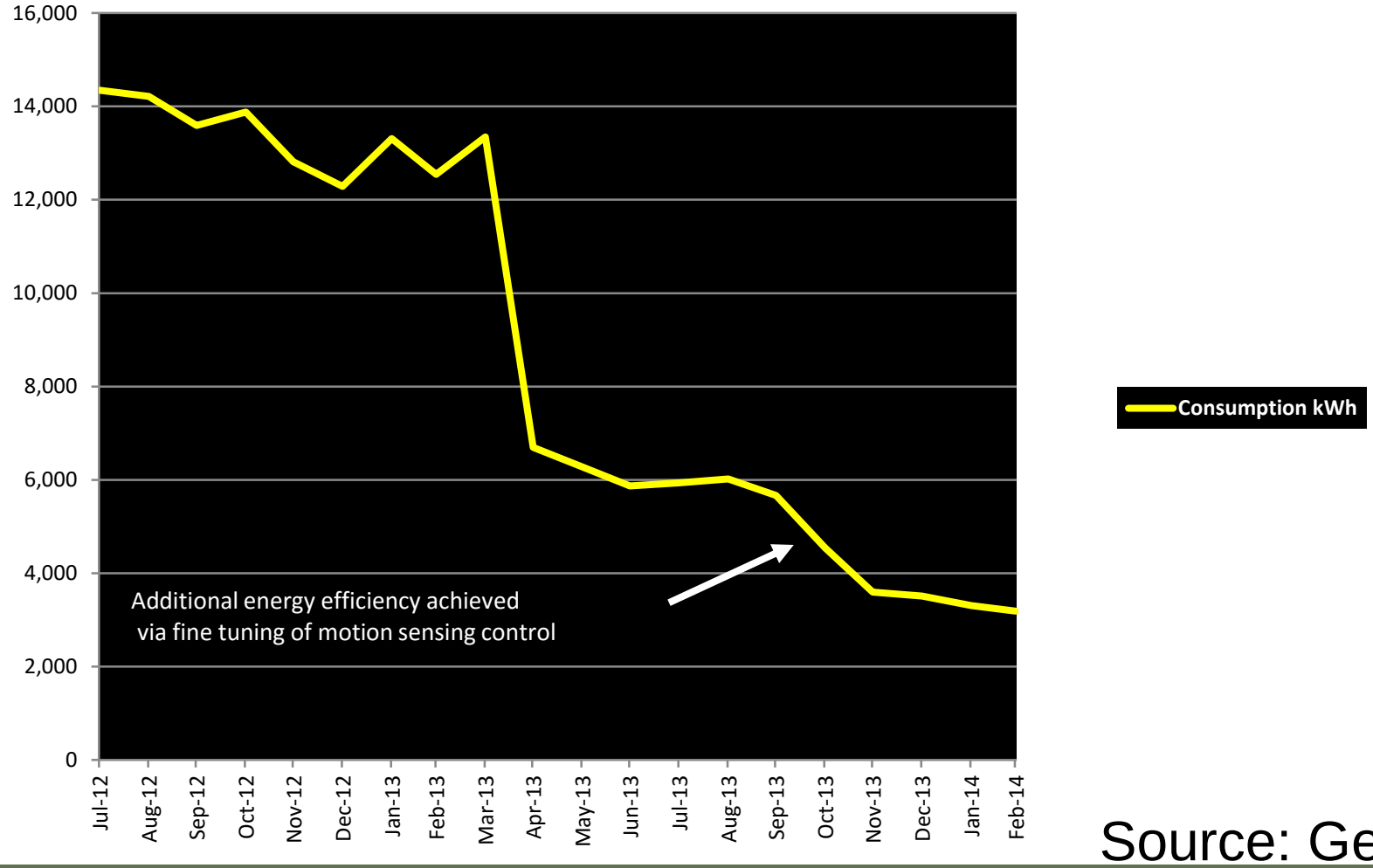
$381K pa rise in energy $



Source: Geoff Woods QUT

5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE
QUT Energy Efficiency Case

Under Freeway Car Park (GP)
LED Lighting Upgrade (April 2013)
"Before/ After" Monthly Electricity Consumption



Source: Geoff Woods QUT

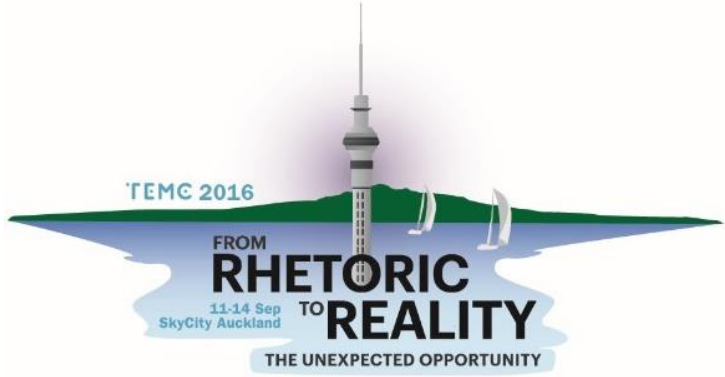
5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE
QUT – Energy Efficiency Case

5. CASE STUDY 2 – AUSTRALIAN PERSPECTIVE

LESSONS LEARNED

WHAT'S NEXT?

6. CONCLUSIONS, SUMMARY AND QUESTIONS



Questions?

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