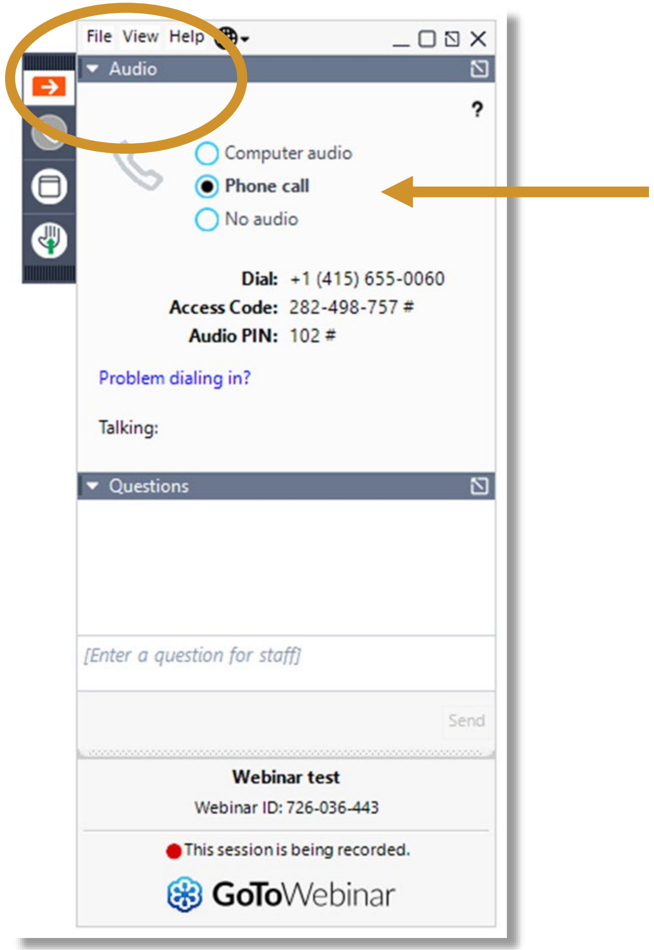
Welcome to

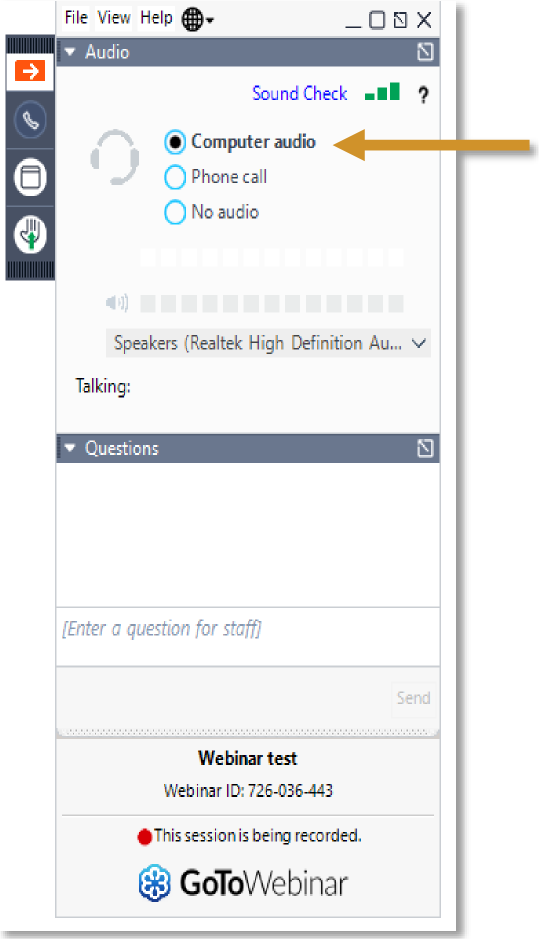
De-Risking DERs & Microgrids in Australia

System Design, Safety & Bankability

Our presentation will begin at the top of the hour. See you soon!

Can’t Hear the Audio?





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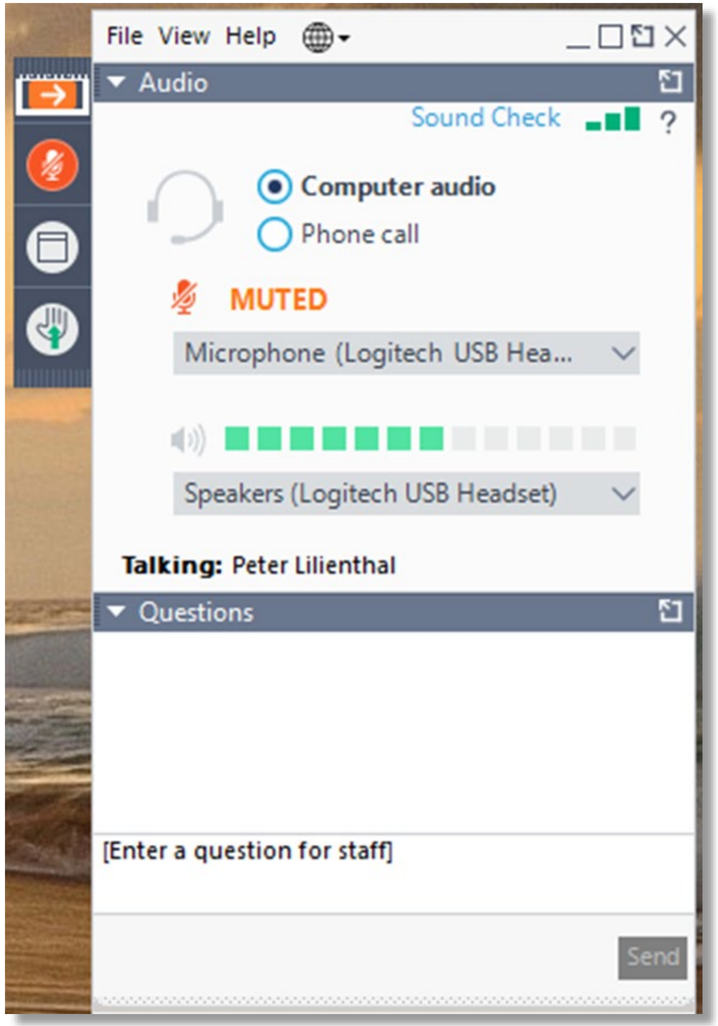
Your Questions Are Welcome



HOMER Energy by UL

De-Risking Microgrids & DERs in Australia

System Design, Safety & Bankability

Farhad Mollahagahi

Head of Country
Australia & New Zealand,
UL Renewables

Peter Lilienthal

Founder, HOMER
Energy by UL/ Global
Microgrid Lead, UL

James Trudeau

Global Business
Development Manager,
Integrated Energy
Systems, UL

David Mintzer

Head of Microgrid
Advisory Services, UL

HOMER Energy
by UL

Agenda

- **Growth & Need in Australia** – Farhad Mollahagahi
  Head of Country in Australia & New Zealand, UL Renewables
- **Design Considerations & Project Development** – Peter Lilienthal, Ph.D.
  Global Microgrid Lead, UL Renewables & HOMER Energy Founder
- **Energy Storage: Great Benefits, Great Risks** – James Trudeau
  Global Business Development Manager, UL
- **Project Finance** – David Mintzer
  Head of Microgrid Advisory Services, UL
- **Q&A** – Marilyn Walker, Ph.D.
  Global Lead, Hybrid Power Systems, UL Renewables & HOMER Energy Founder

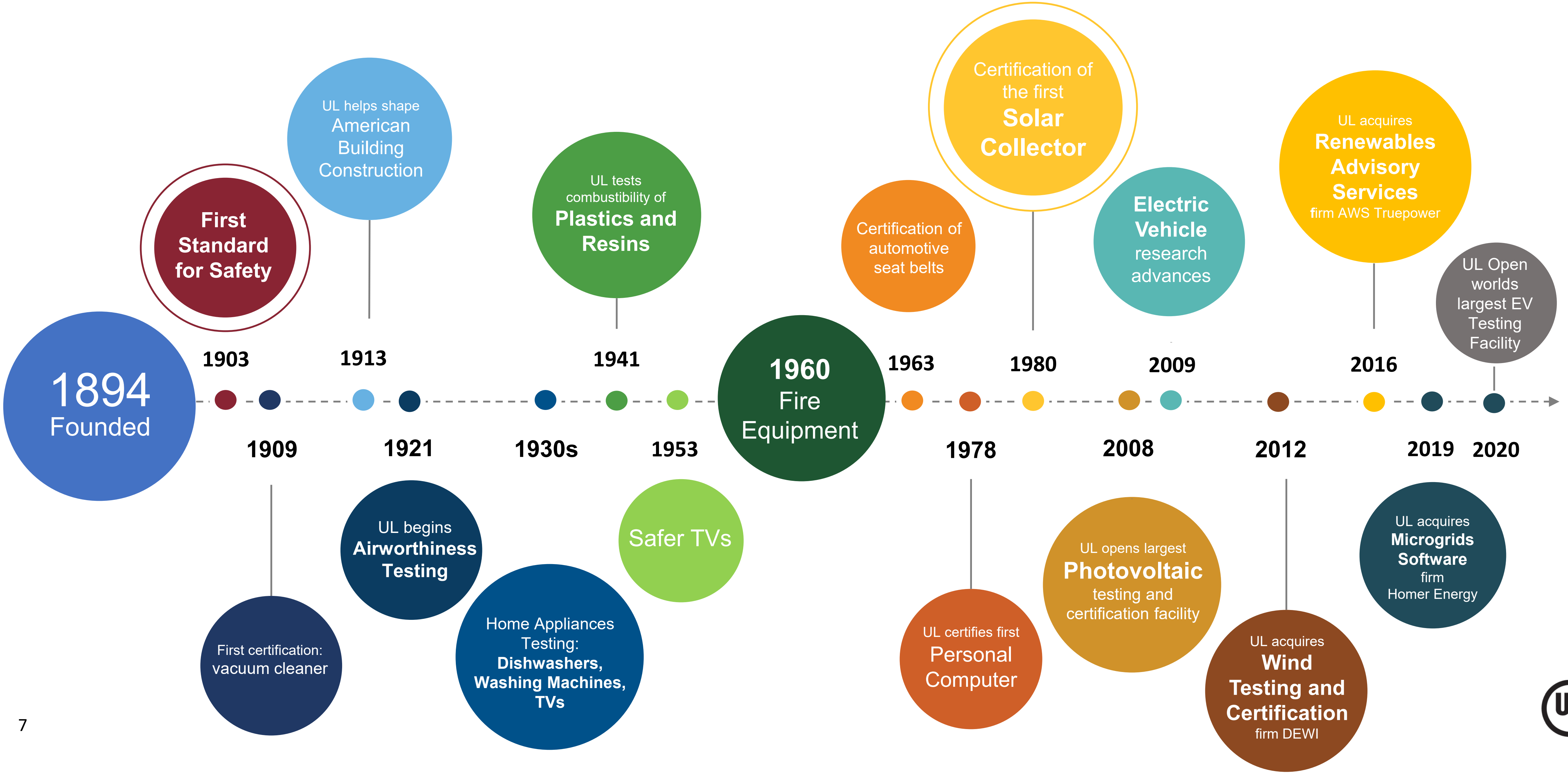
HOMER Energy by UL

We Are a Global Force for Good

At UL, our mission of working for a safer world since 1894 is at the core of everything we do.

- Advancing safety through careful research and investigation
- Preventing or reducing loss of life and property
- Promoting safe living and working environments for all people

UL – A History of Trust



UL operates in more than
140
COUNTRIES

200,000+ MW
Total megawatts assessed

500+
RENEWABLE ENERGY EXPERTS

35+ *years of*
EXPERIENCE IN RENEWABLE ENERGY

ADVISED 90%
OF THE WIND INDUSTRY'S TOP PROJECT DEVELOPERS AND PLANT OWNERS

INDEPENDENT/OWNER'S ENGINEER FOR
500+
WIND AND SOLAR PROJECTS SINCE 2012

Forecast provider for
70+ GIGAWATTS
OF INSTALLED RENEWABLE ENERGY PROJECTS

UL Renewables

- **Market compliance to technical advisory,** and engineering services across project life
- **Meet challenges of wind, solar, energy storage** and emerging technologies like **green hydrogen**
- Confirm compliance and provide assurance **assets are safe, reliable and top performing investments**
- Testing, Inspection and Certification
- Wind and Solar Resource
- Due Diligence
- Grid Code Compliance
- Operational Performance Assessment
- Structural Integrity and Life Extension
- Digital Solutions
- R&D
- Cybersecurity

Hybrid, Microgrid FTM/BTM

Grid Code Compliance

Independent Engineering / Due Diligence

Testing/Inspection/ Certification

Resource Assessment

Digital Solutions

Project Testing / Quality

Operational Asset Management

Microgrids: Why Australia?

- **Tyranny of distance**

Vast size and dispersed power needs favors microgrids over centralised generation and distribution

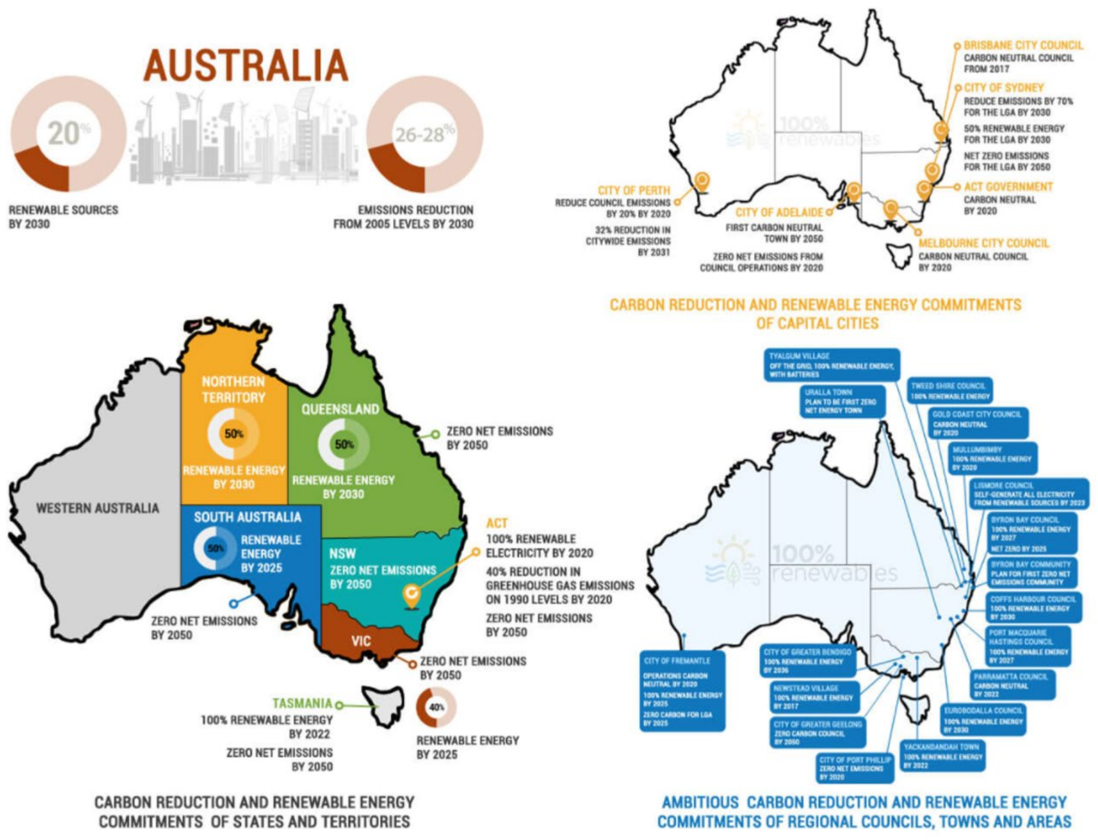
- **Environmental hazards and risk of attack**

Microgrids potentially cost-effective for system resilience in the face of increasing environmental hazards like bushfires and cyclones

- **Growing use of renewable energy**

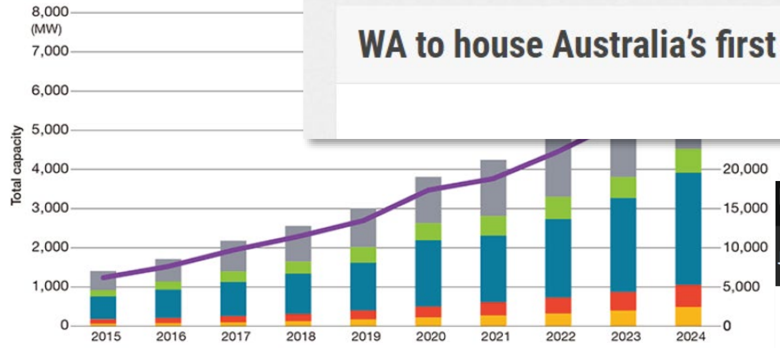
Cost reductions, technological evolution and increased acceptance promote uptake of renewable energy by individuals, businesses and communities

Localisation of energy production provides foundation for a customer- driven move towards microgrids



Source:100%Renewables

Recent Advances Increase Hybrid Energy Projects



Source: Navigant Research

> *"The global microgrid market will rise from $9.8B in 2013 to $35B by 2020"*
> —Transparency Market Research

WA to house Australia's first renewable hydrogen microgrid

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Renewable energy trial in Victoria's north-east aims to become template for nation

Gold Fields to run Agnew mine on renewable energ

June 20, 2019 | News | Alex Gluyas

Fortescue mines powered by renewables

Fortescue Metals Group has signed a deal with Alinta Energy to convert its Chichester Hub iron ore operations in the Pilbara in Western Australia to renewable energy

Hazardous waste facility now 100% renewably powered in daytime thanks to solar microgrid

A Hybrid Systems Australia solar and battery energy
remote Sandy Ridge hazardous waste clean up facility

Australia's largest privately owned shopping mall signs PV deal

The Narellan Town Centre, a shopping mall outside of Sydney, is set to undergo 40 million (USD 29.9 million) solar transformation with the signing of a 30-year partnership with CEP.Energy.

Cattle farming WA town recogni advanced distributed energy resource microgrid

Onslow, a tiny coastal town in the Pilbara region of Western Australia known for its cattle farms and gold mines, has this week been recognised for having one of the world's most advanced microgrids.

APA Group moves into microgrids

Gruyere gold mine adds solar and battery with new hybrid microgrid

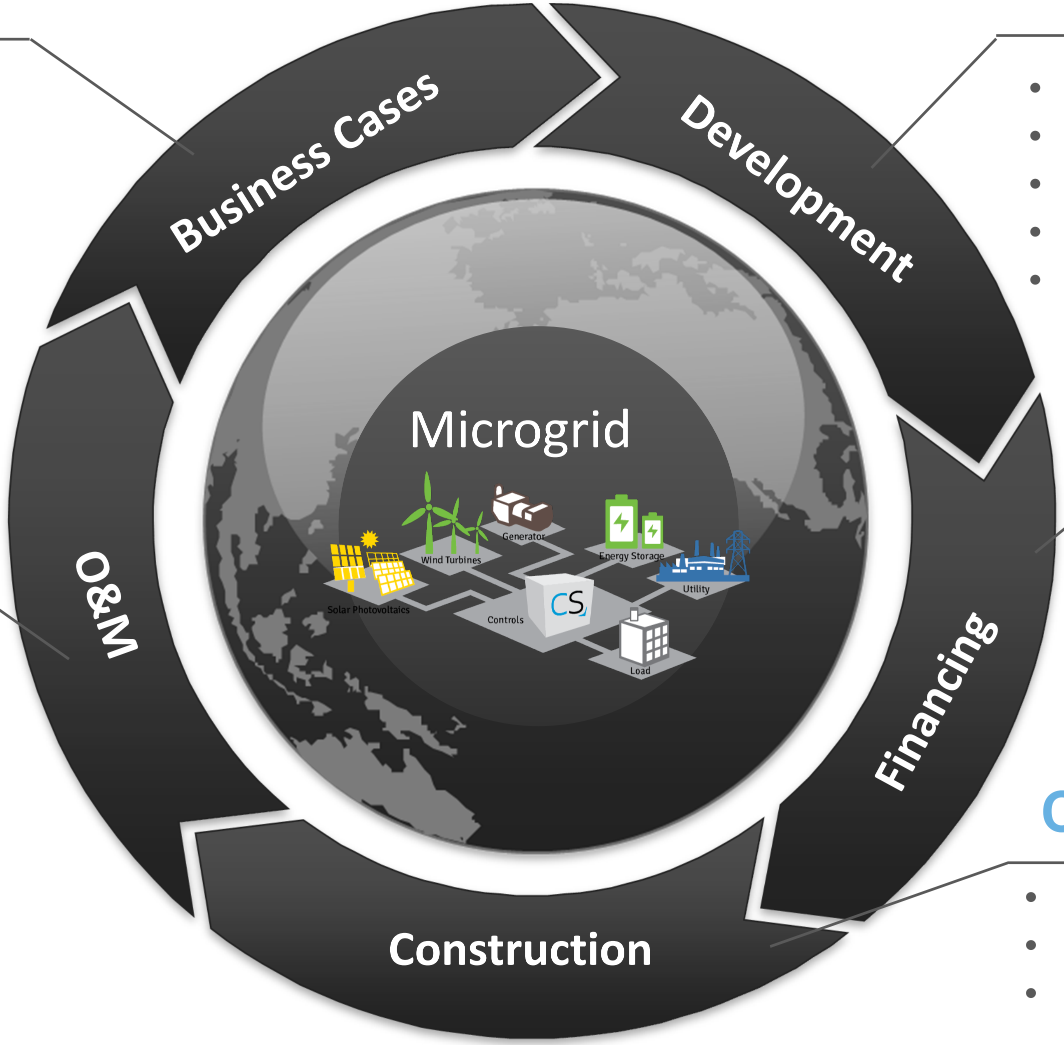
UL Advisory Services for Microgrid Project Lifecycle

Business Cases

- Technical feasibility
- **Technology selection**
- **Optimal sizing & configuration**
- Economic viability
- Risk analysis
- Policy & strategy advisory
- Training

O&M

- Condition monitoring
- Predictive Maintenance
- **Safety & risk advisory**
- Performance evaluation
- **System extension advisory**
- Contract renegotiation



Project Development

- System specs development
- **3rd-party design review**
- **PPA / contract review**
- Financing advisory
- Grid impact analysis

Project Financing

- **Bankability study**
- **Due diligence**
- Asset transferring

Construction

- Owner's engineering
- Risk management
- Safety advisory

HOMER Energy by UL

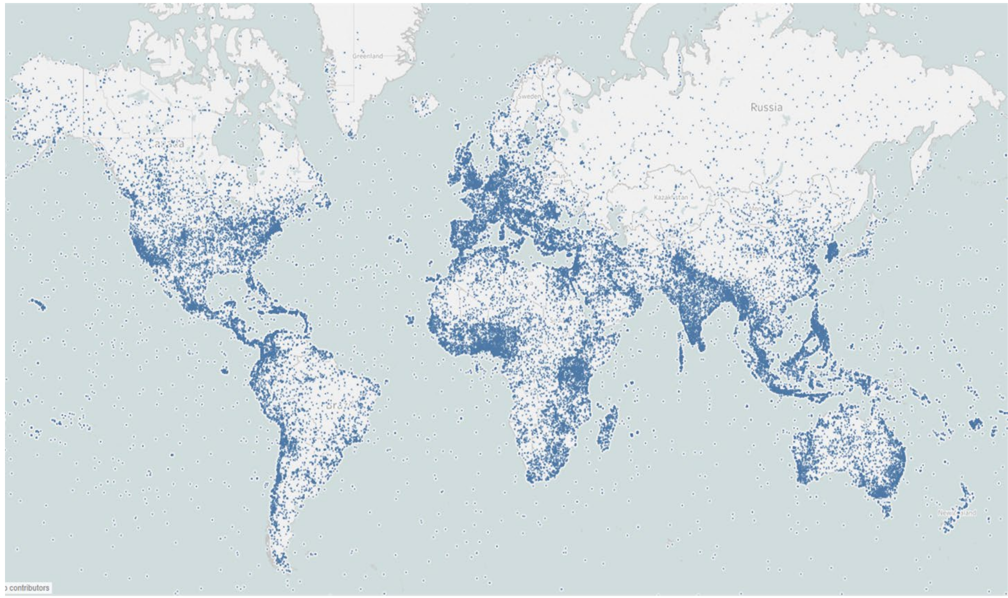
Presented by Peter Lilienthal, Ph.D.
Global Microgrid Lead, UL
Founder, HOMER Energy by UL

Designing hybrid systems for over 25 years

- 1992 – 2008 at NREL
- 2009 – HOMER Energy created; exclusive license

De-facto global standard

- >250,000 people have used HOMER
- >100,000 opted-in to our hybrid system design network



Global data

- >3 million HOMER files
- >75,000 projects modeled since 2014

Microgrid/ Hybrid System Optimization & Design in HOMER®

Inputs

Economics

Load Profile

Site-Specific Renewable Resources

System Components

Analysis

HOMER Pro / HOMER Grid

- Sensitivity
- Optimization
- Simulation

Results

Economics & Engineering

System Sizing

Performance Details

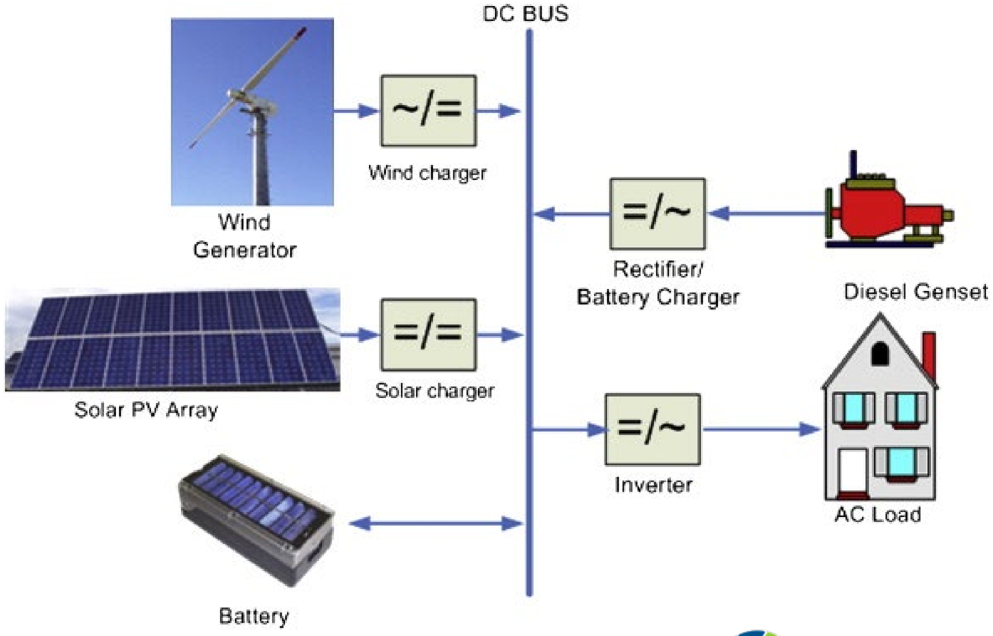
Financials

Proposal & Detailed Reports

Why Hybrid Systems?

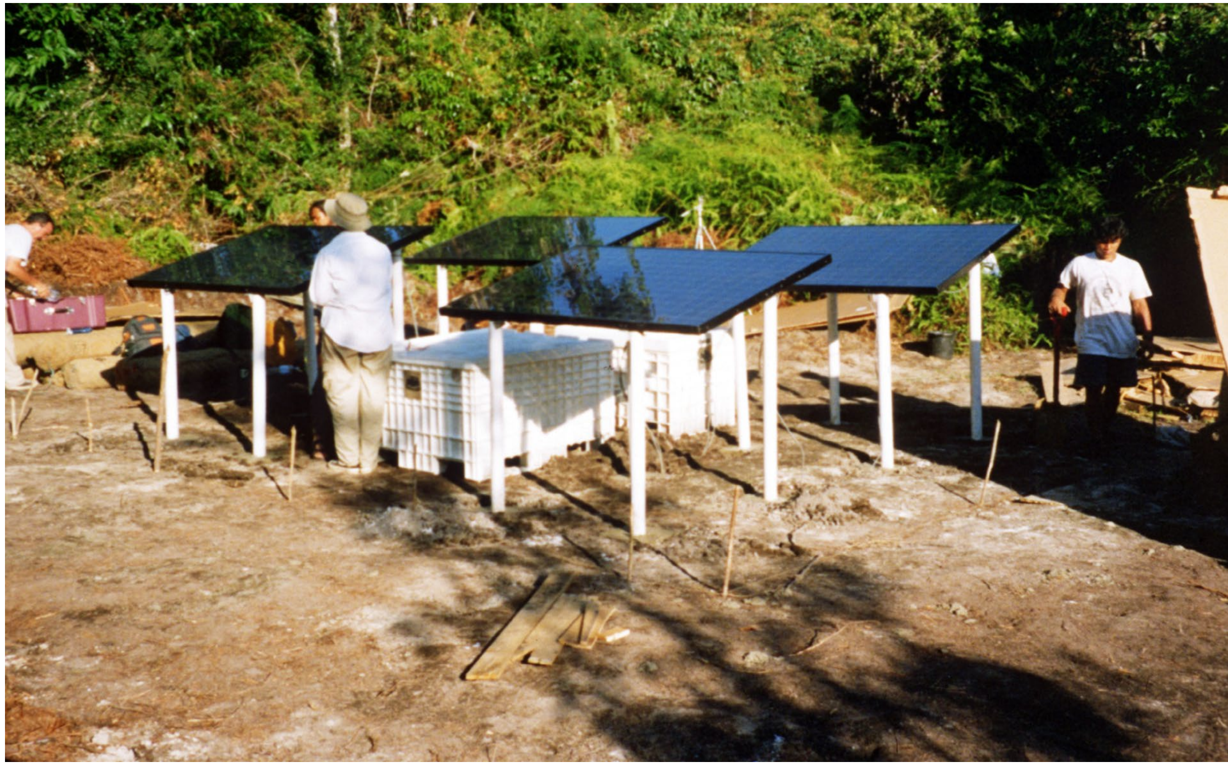
- Solar and wind don’t stand on their own
- Dispatchable generation, batteries or both

- AC-coupled or DC-coupled
- Substantial design trade-offs



Types of Hybrid Systems

- Isolated systems
- Grid-connected systems
  - Edge of grid
  - Behind-the-meter
  - Utility-scale; Front-of-the-meter



Isolated Systems

- Aboriginal villages
- Remote mines
- Livestock stations

- Design issues
  - Very small 100% renewable systems
    - Load management
  - Larger systems
    - Diesel; backup or backbone
- Retrofitting existing diesel systems
  - Control upgrades

Edge-of-Grid

- Uniquely Australian challenge
- Some existing distribution lines have these problems
    - Tens of kilometers with low loads
    - Voltage support
    - Line losses
    - Reliability
    - Maintenance

Behind-the-Meter Systems

Use solar for:

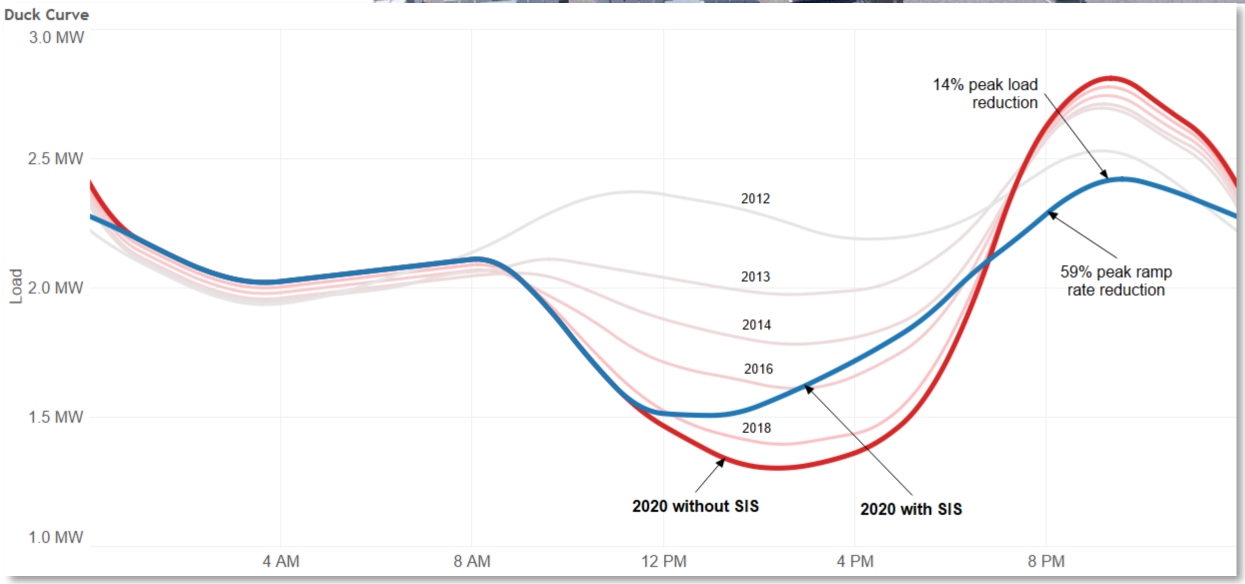
- Public messaging
- Energy charges

Need hybrids for:

- Reliability
- Resilience
- Demand charges

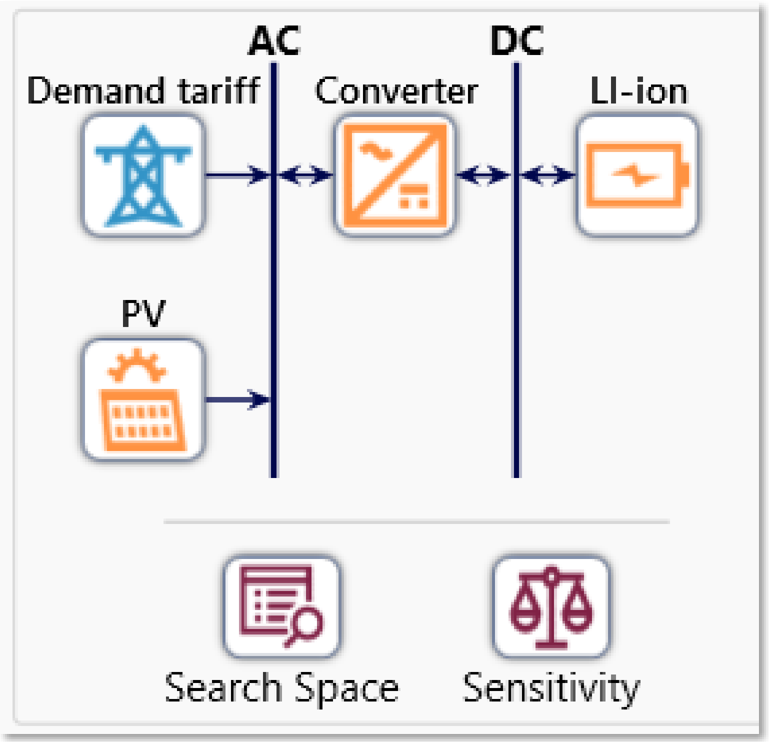
Utility-Scale Systems

- Front-of-the-meter
- Lowest cost electrons
- Interconnection limits
- Contractual requirements
- "Duck Curve"
  - Evening ramp
  - Minimum loading
- Batteries add complexity



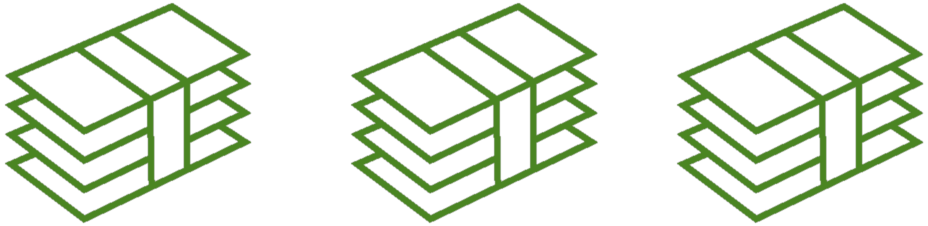
Designing Hybrid Systems

- Degrees of design freedom
  - PV sizing
  - Battery sizing
  - Tariff structures
  - Contract structures
  - Regulatory issues
  - Reliability
    - Backup requirements
- Lots of trade-offs
- Sensitivity analysis



Financing is the Key

Hybrid minigrids are clearly preferable,
but they require capital up front,
and financiers are concerned about risks.



Energy Storage Systems:
Understanding and Mitigating Risks

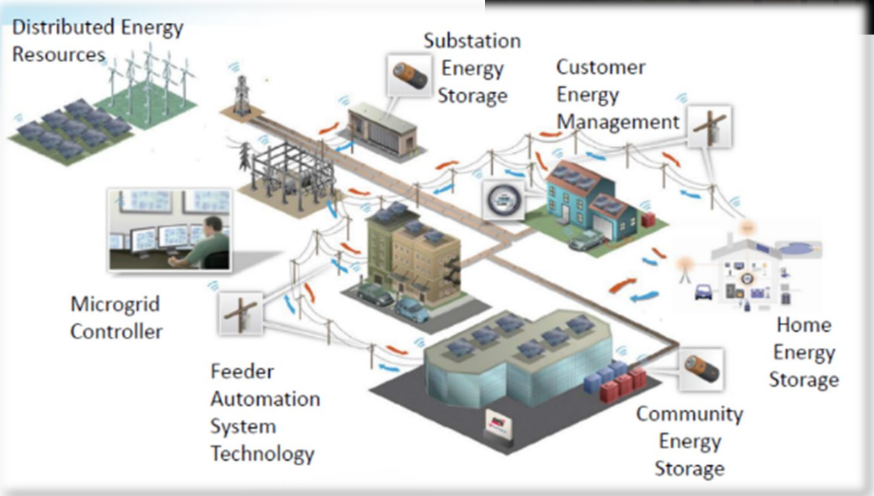
Presented by James Trudeau
Global Business Development Manager,
Integrated Energy Systems, UL

Energy Storage – What is it?

- Energy Storage can be electrical, chemical, or mechanical
- Lithium-ion batteries are over 95% of the energy storage market
- Energy Storage can serve loads ranging from small homes to minigrids to large utility scale projects
- The definition of Energy Storage has been changed by international fire codes like NFPA 855 and IFC 2021. It now includes battery systems for UPS, telecom, and any application over 20 kWh in size.

Energy Storage – Great Benefits

- Enables wider use of renewable energy
  - Solar
  - Wind
  - Reduces variability of renewable energy
- Improves electric grid stability
  - Voltage
  - Frequency
- Enables broader microgrid usage
  - Can be connected to the grid
  - Or completely off grid
- Provides improved reliability for end users
- Replaces fossil fuel power plants
  - Combined with solar it replace diesel generation
    - Reduces energy costs from $0.45 to $0.15/kWh
  - Reduces ground and air pollution



Energy Storage – Great Risks

28 Major
ESS Fires
in South Korea
2017 – 2020

Energy Storage – Great Risks

APS ESS System Explosion in 2019

Energy Storage – Great Risks

Thermal Runaway – 25 Lithium-Ion Cells

Energy Storage – Great Risks

Thermal Runaway - 25 Lithium-Ion Cells

Let's do the math…

- A single 18650 Li-Ion cell is about 10 WH
- 25 cells is about 250 WH
- A typical ESS module has 5,000 WH
- A typical rack has 10 modules for 50,000 WH
- A typical rack has over 200 times more energy than the 25 cells in the video
- A typical 2 MW container has over 3,000 times more energy than the 25 cells in the video

Energy Storage – Risk Mitigation

3 Layer Safety Approach

Installation Codes

NEC: National Electric Code (NFPA 70)

NFPA 855: Standard for the Installation of Stationary Energy Storage Systems

IFC 2018 / 2021: International Fire Code

Battery Safety Certification Standards

UL 1973: Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications

UL 9540: Energy Storage Systems and Equipment

Testing for Performance or Safety

UL 9540A: Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

Energy Storage – Risk Mitigation

It Is All About Risk Management!!!

The use of good installation codes and equipment standards, coupled experienced independent project oversight and accurate modeling is critical to managing the risk profile of energy storage projects.

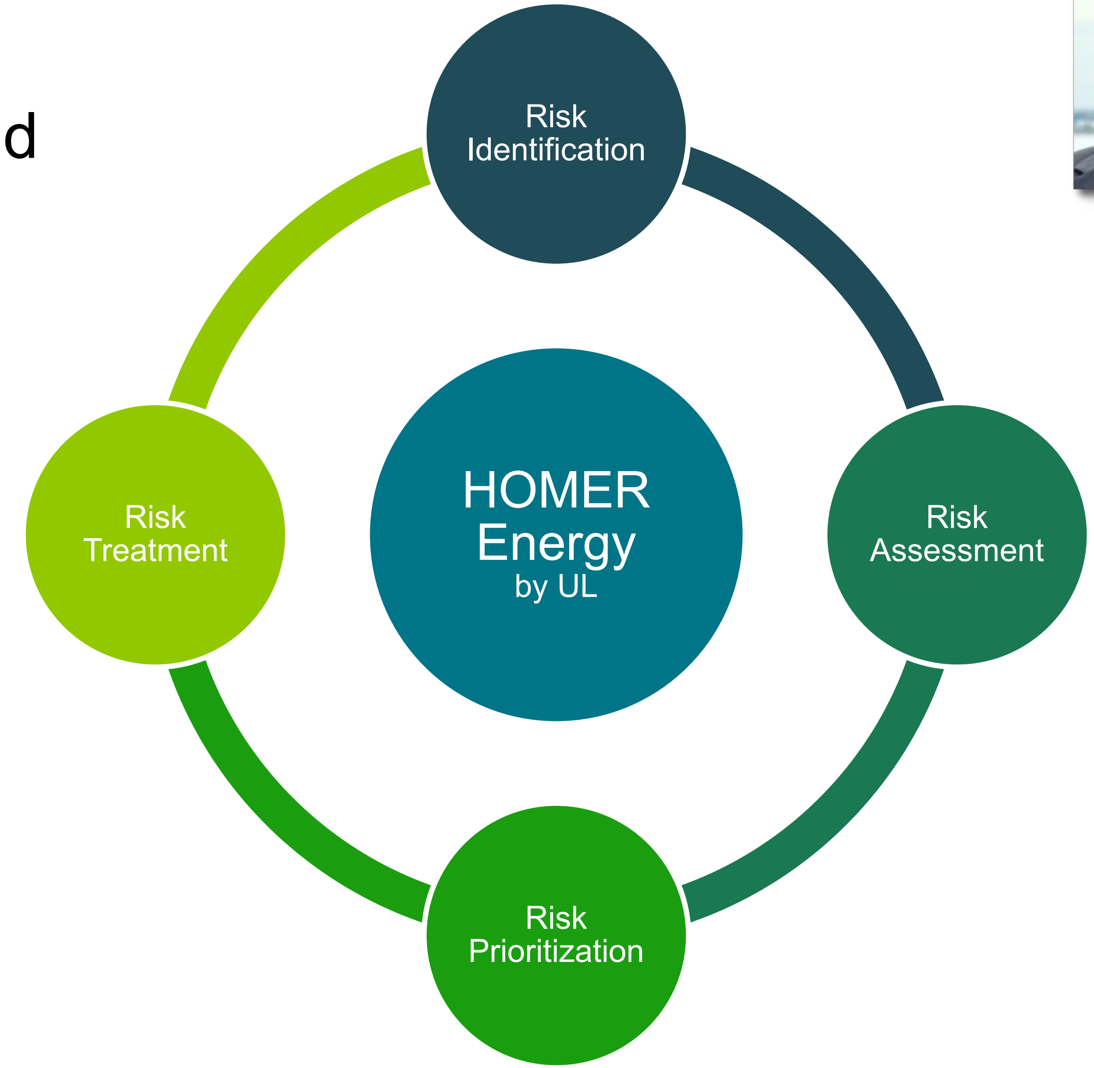
The risks are:

- Financial Risks
- Operational & Performance Risks
- Safety Risks
- Environmental Risks

Project Bankability

Presented by David Mintzer
Head of Microgrid Advisory Services, UL

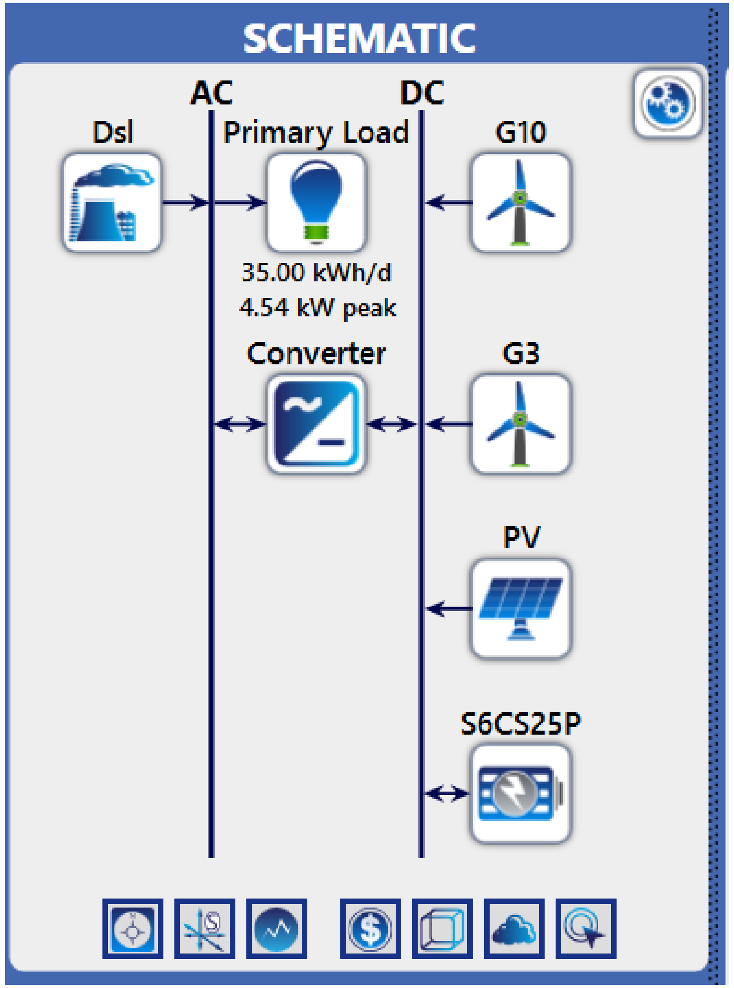
- Distributed generation & microgrid projects provide a variety of services to a diverse user base
- Projects are usually financed
- Obtaining funding is largely an exercise in risk management



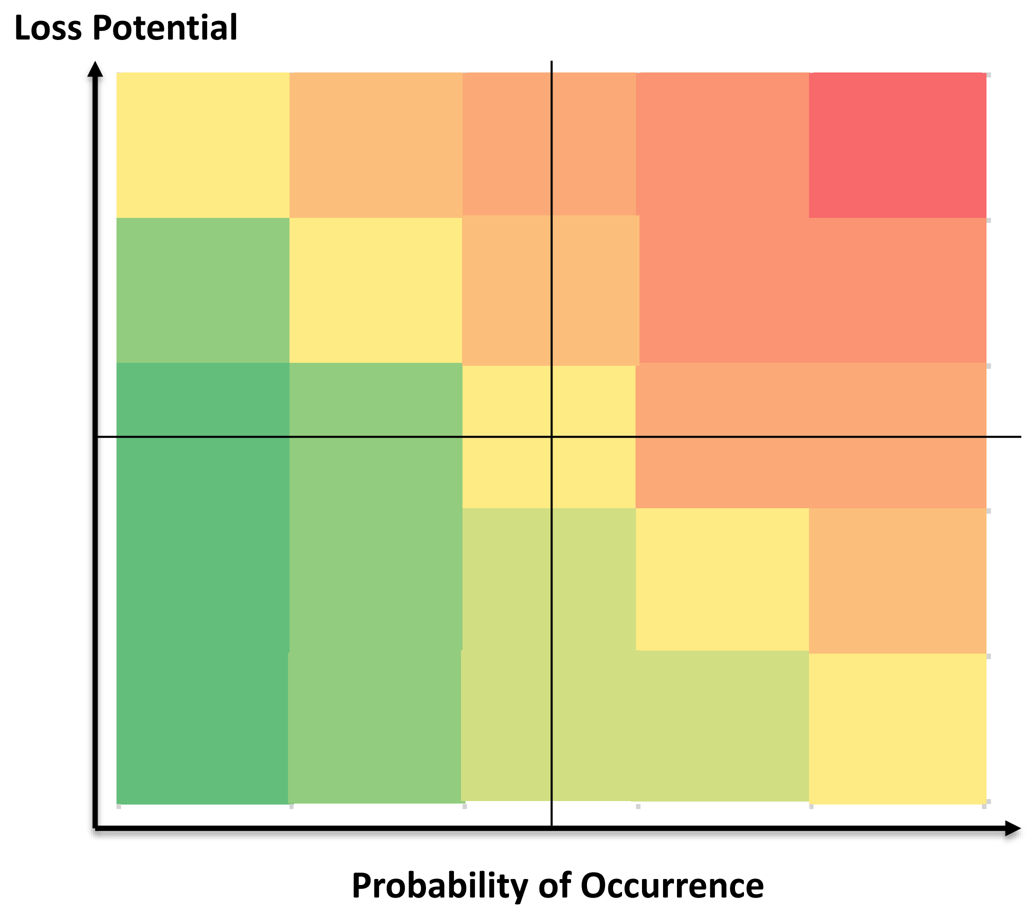
System & Functional Risks

A system is only as smart and strong as the weakest element

- **Generating Equipment**: Many technologies, each with pros/cons
- **Power Electronics**: Connection to loads, gen. sources, grid
- **Management System**: Controls energy flow
- **Safety Concept**: Technology and regulatory requirements
- **System Integration**:
  - Building a reliable, running system out of above components
  - One of most underestimated system contributions
- **Construction**: Turning ideas into reality, execution
- **Operation**: Keeping system running, serve customer
- **End-of-Life Concept:** sustainable and economical



Identification/ Assessment/ Prioritization



Level 1 - Avoidance
Unacceptable risk potential, sophisticated tools recommended

Level 2 - Transfer
High risk potential, measures necessary

Level 3 - Reduction
Medium risk potential, usage of measures recommended

Level 4 - Tolerance
Low risk potential, proofing measures of risk mitigation

Mitigation – Example

Simulation Results

System Architecture: Diesel (8.00 kW) HOMER Cycle Charging
PV (50.0 kW) Generic 1kWh Li-Ion (100 strings)
Generic 3kW (20.0) Converter (4.00 kW)

Capacity Shortage (0.00 %)
Scaled Average (3.00 m/s)

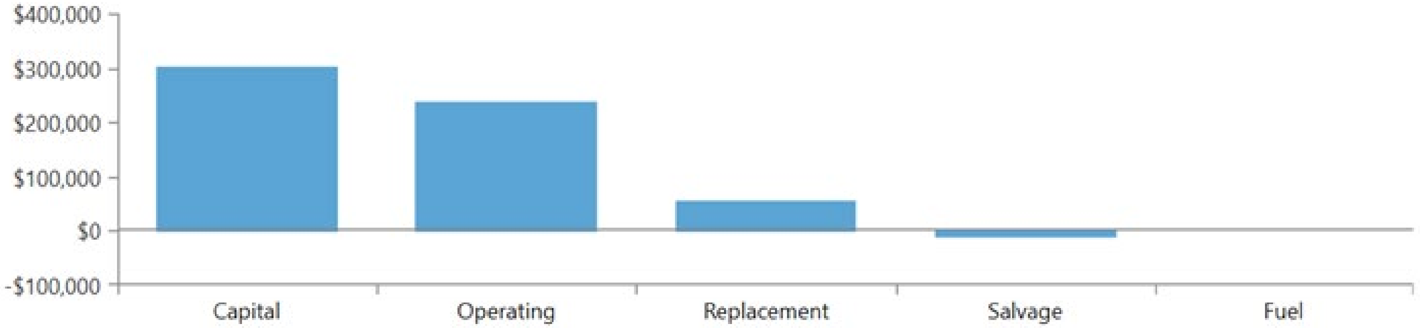
Total NPC: $589,785.80
Levelized COE: $3.57
Operating Cost: $22,068.10

Emissions

Cost Summary | Cash Flow | Compare Economics | Electrical | Fuel Summary | Diesel | Renewable Penetration | Generic 1kWh Li-Ion | PV | Generic 3kW | Converter

Cost Type
- Net Present
- Annualized

Categorize
- By Component
- By Cost Type



Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
Converter	$5,000.00	$1,594.04	$517.10	$0.00	-$898.34	$6,212.80
Diesel	$6,500.00	$0.00	$240.45	$0.00	-$1,113.35	$5,627.11
Generic 1kWh Li-Ion	$55,000.00	$12,728.21	$129,275.17	$0.00	-$2,395.58	$194,607.80
Generic 3kW	$182,000.00	$43,275.93	$45,569.50	$0.00	-$8,144.97	$262,700.46
Other	$6,000.00	$0.00	$0.00	$0.00	$0.00	$6,000.00
PV	$50,000.00	$0.00	$64,637.58	$0.00	$0.00	$114,637.58
System	$304,500.00	$57,598.18	$240,239.80	$0.00	-$12,552.23	$589,785.75

Simulation Report

Time Series Plot

Other...

Summary

Presented by Farhad Mollahagahi
Head of Country, Australia & New Zealand
UL Renewables

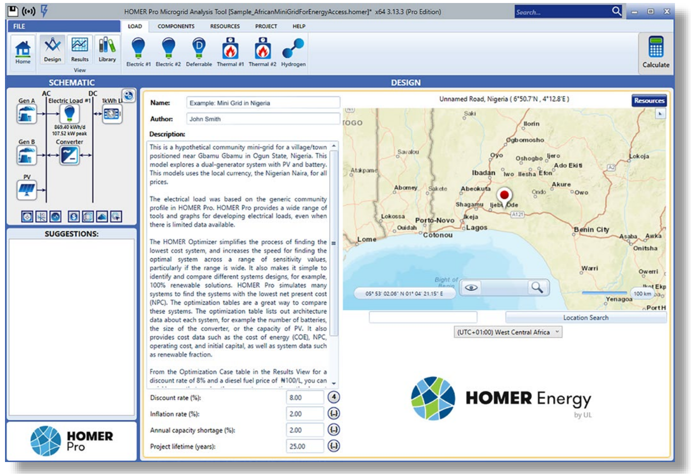
Risk Mitigation

- Microgrids and Distributed Energy Systems are needed to fill electrical needs in Australia
- For a project to be bankable from a technical perspective great care should be taken in the development phases :
  - Project Design – needs of the user and funders must be fulfilled
  - Equipment Selection - especially hybrid design with energy storage devices
  - Risk Identification and Mitigation – demonstrate managed risks

Need help with your project?

Software Solutions → Advisory Services

HOMER Pro Modeling Software



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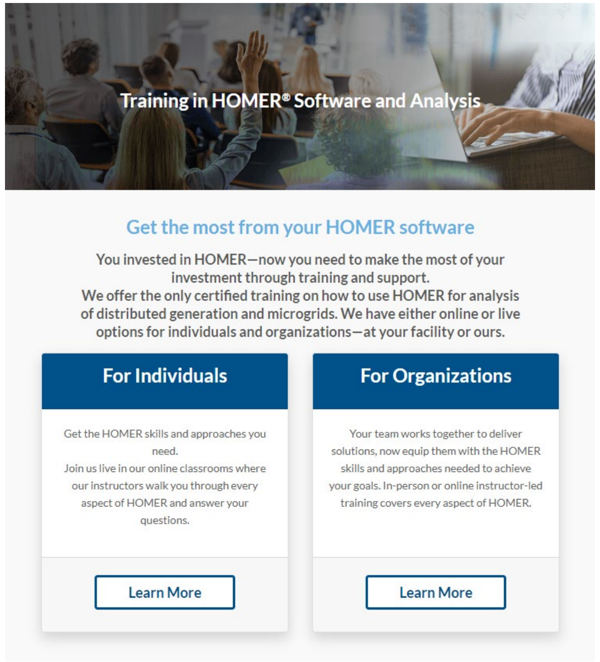
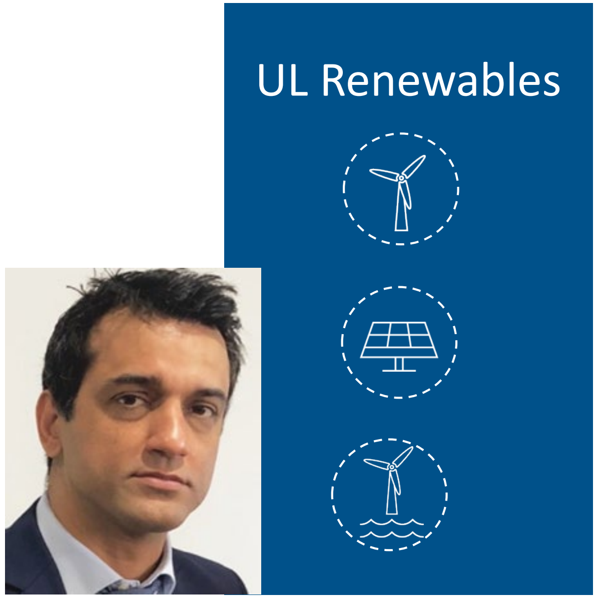
HOMERenergy.com/TryPro

Training & Premium Support



Support@HOMERenergy.com

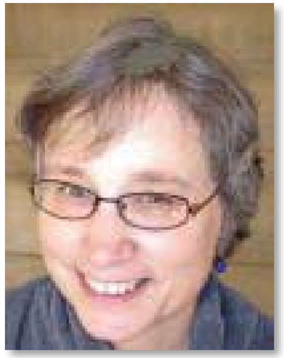
Project Consulting Services



Farhad Mollahagahi
Farhad.Mollahagahi@ul.com

Questions & Answers

Panelists



Moderated by Marilyn Walker, Ph.D.
Global Lead, Hybrid Power Systems, UL Renewables
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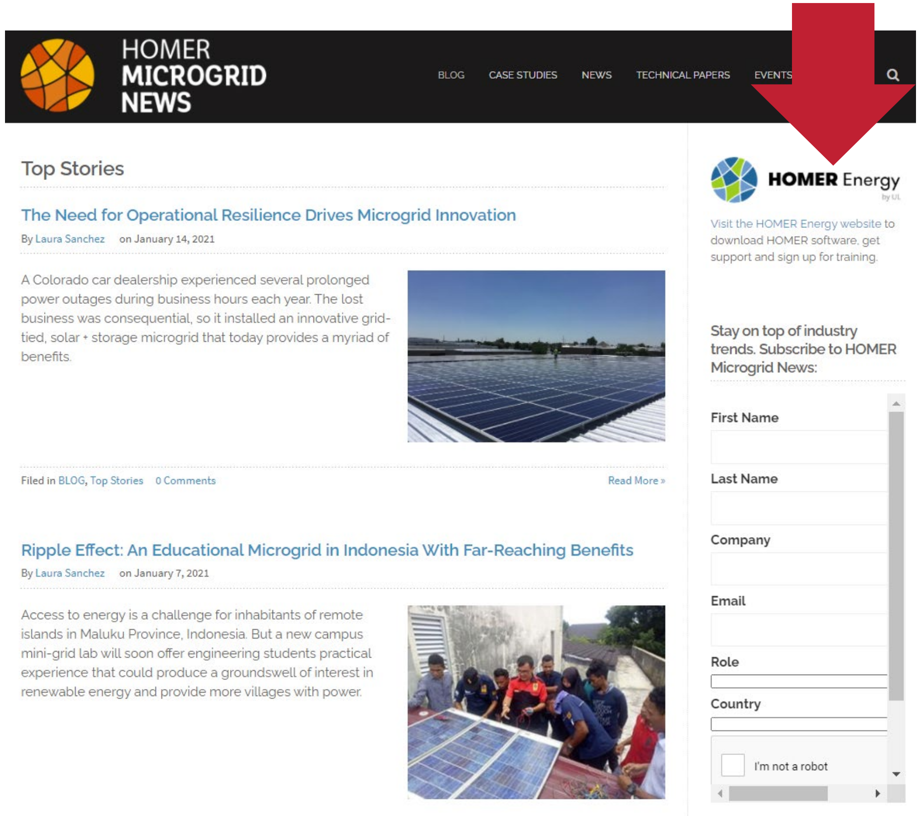
  Discover how modelling your products with HOMER SaaS API can increase sales.
- **Modeling Wind for Island Applications**
  Learn how HOMER Pro models medium-sized wind projects to provide power for island energy.
- **All About Energy Storage: the Heart of the Energy Transition**
  Learn how to model battery life, degradation, thermal impacts and the economics of evolving storage technologies to maximize your IRR.



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