WorleyParsons
resources & energy

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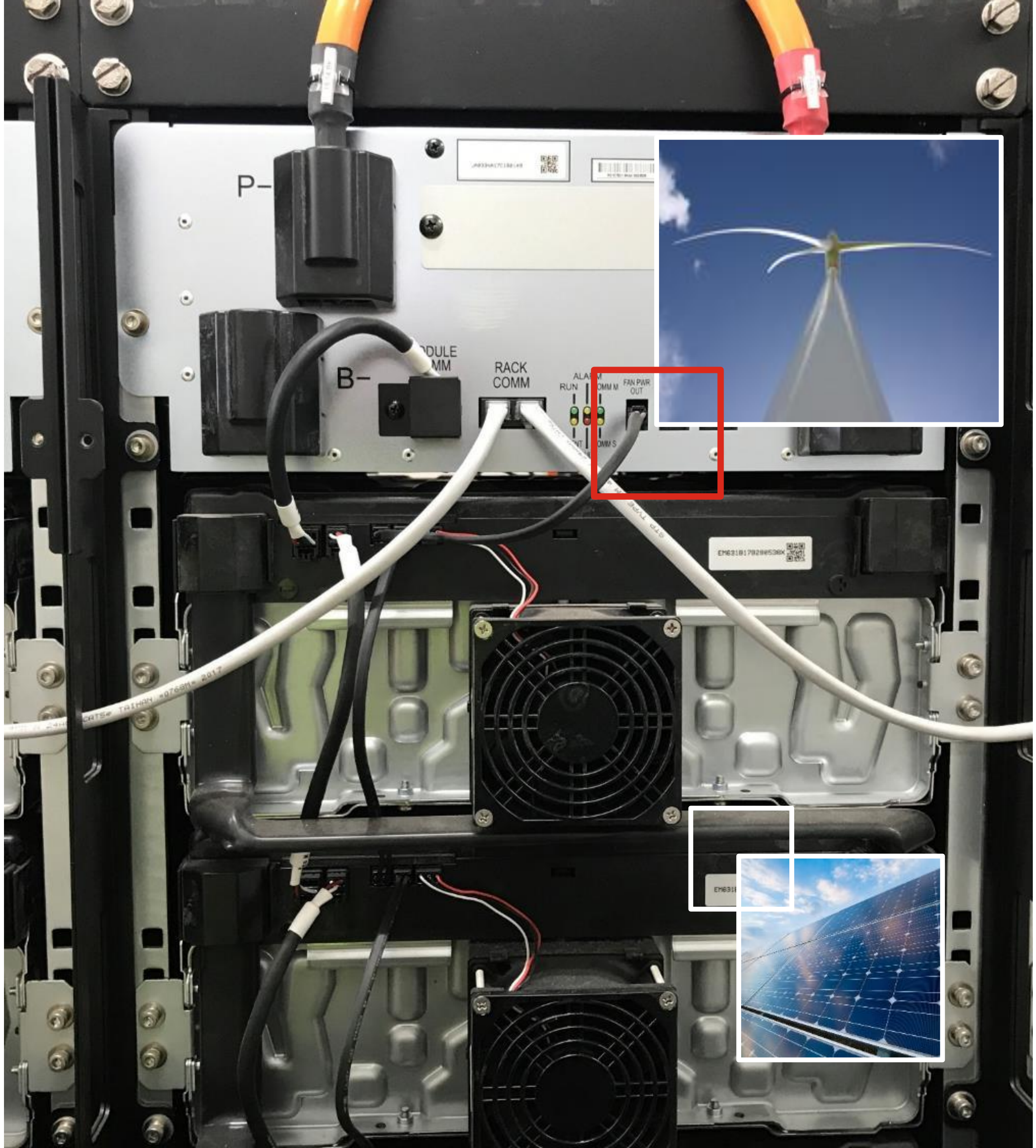
Integrating and optimizing renewables in microgrids

Lessons learned from Australia

Prepared for Microgrid 2.0
By Tristan Jackson, Director, Smart & Distributed Energy
29 Oct. 2018



Agenda for today

- Brief background
- Case studies
  - Esperance
  - Coral Bay
  - Exmouth
  - DeGrussa Mine
- Modelling approaches
- Lessons learned

Photo: Courtesy TransGrid

Smart & Distributed Energy systems experience

80+

Smart & Distributed Energy projects designed and implemented worldwide

Across both urban and remote settings:

- Hybrid systems featuring >95% energy from renewable generation
- Mines
- Islands
- Critical infrastructure
- Remote communities
- Airports & Marine ports
- Real estate

Australian Antarctic Base at Mawson – two, Enercon E33 low temperature purpose designed turbines installed in 2003 - U_{max} around 250km/h, Temp < -30

8th November 2017, turbine failure

When you push the boundaries – in this case wind at their engineering limits – sometimes things break and there are obviously serious issues around such. Should this stop us trying though?

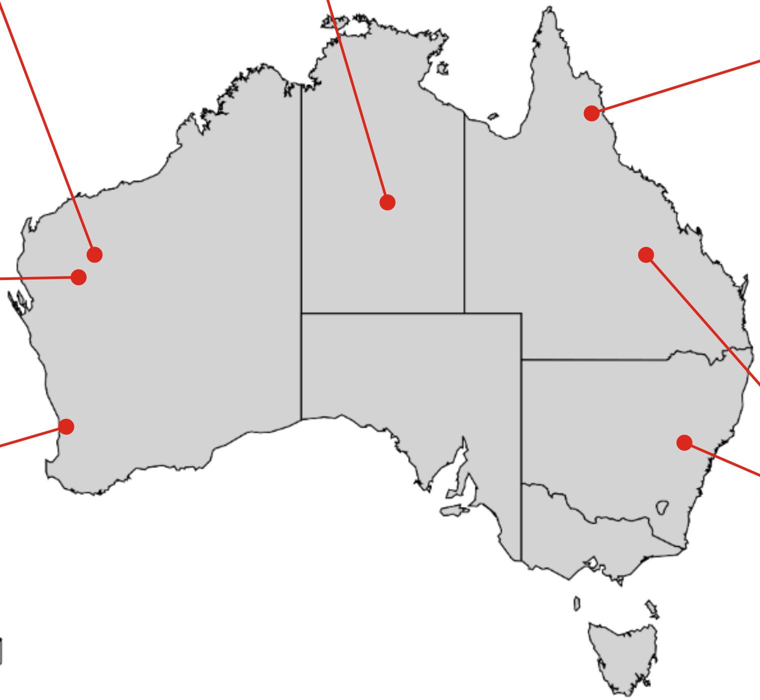
Australia – a few example projects

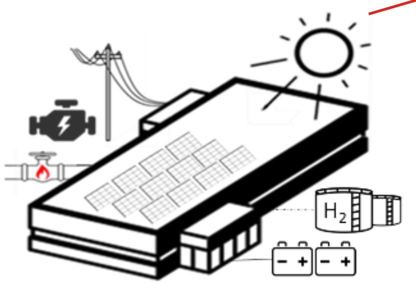
Assessment of project for funding support – use of existing spinning reserve battery for solar balancing

Delivery project management support for 5MW/3.4MWh battery for solar smoothing

Project management, control logic analysis, grid studies, procurement and development assistance for 55MW$_{AC}$ solar + 20MW/ 80MWh battery project

Due diligence & lenders engineer for solar + battery + diesel micro-grid





Concept design and delivery owners engineer for grid connected C&I solar + battery + hydrogen electrolysis + gas/H2 engine micro-grid

Concept design and financial assessment for behind the meter batteries, coal mining operations

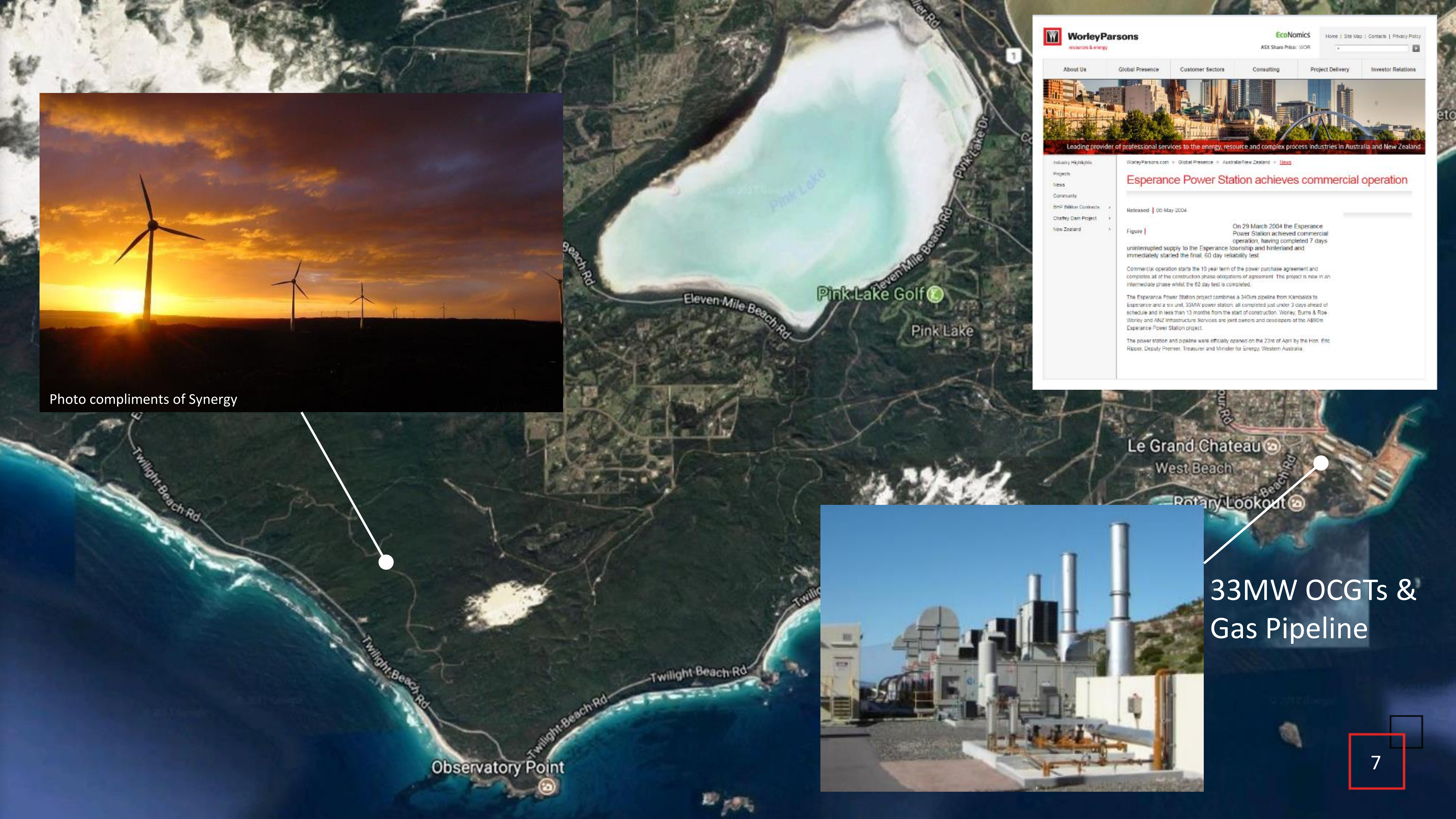


Photo compliments of Synergy

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EcoNomics
ASX Share Price: WOR

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Esperance Power Station achieves commercial operation

Released | 06-May-2004

Figure |

On 29 March 2004 the Esperance Power Station achieved commercial operation, having completed 7 days uninterrupted supply to the Esperance township and hinterland and immediately started the final, 60 day reliability test.

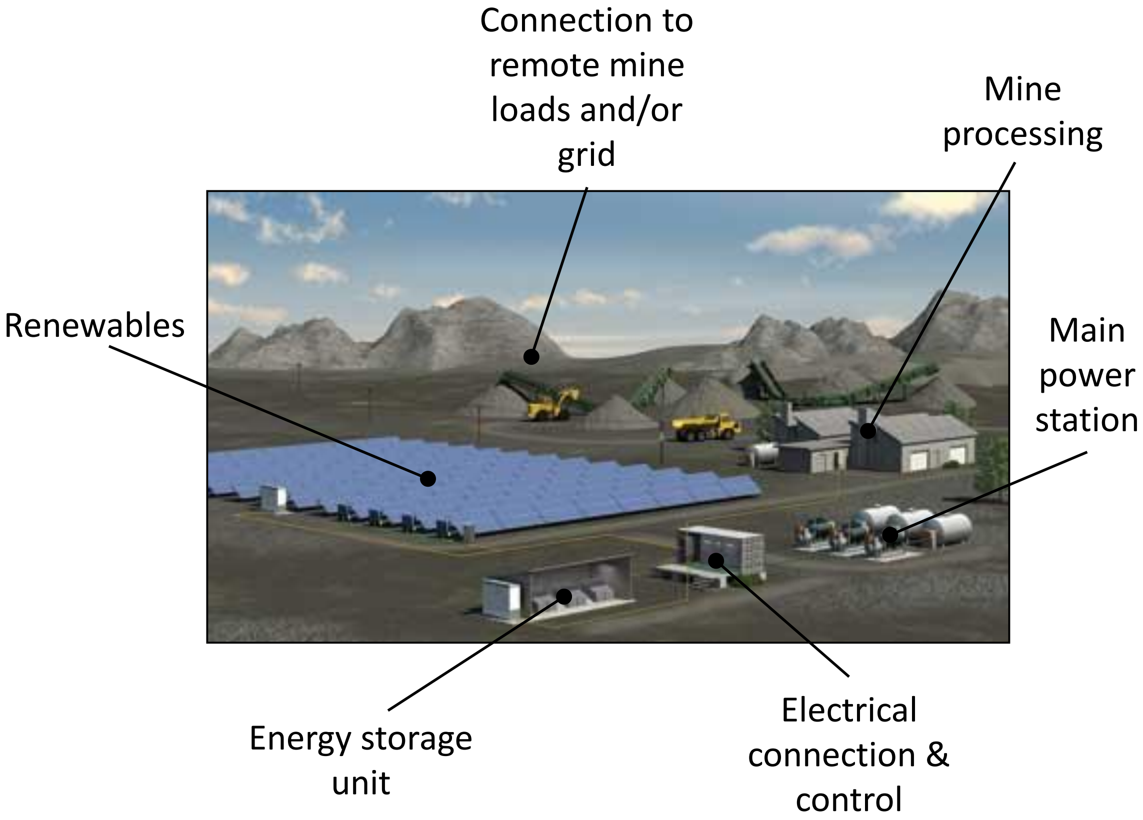
Commercial operation starts the 10 year term of the power purchase agreement and completes all of the construction phase obligations of agreement. The project is now in an intermediate phase whilst the 60 day test is completed.

The Esperance Power Station project combines a 340km pipeline from Kambalda to Esperance and a six unit, 33MW power station, all completed just under 3 days ahead of schedule and in less than 13 months from the start of construction. Worley, Burns & Roe Worley and ANZ Infrastructure Services are joint owners and developers of the A$90m Esperance Power Station project.

The power station and pipeline were officially opened on the 23rd of April by the Hon. Eric Ripper, Deputy Premier, Treasurer and Minister for Energy, Western Australia.

33MW OCGTs & Gas Pipeline

Small, islanded microgrids



Exmouth power station

- Dual gas/diesel system of 8MW capacity commissioned in 2006
- "Mini wind farm" to use small tilt down wind turbines in a severe cyclone environment
- Photo: one of the 10kW machines (there are 3)

Coral Bay

- 7x 320kW low load diesels
- 3x 225kW wind turbines
- 1 x 500 kW flywheel energy storage
- Commissioned in 2007

Coral Bay

The low load diesels are specifically designed to operate down to 10% loading for extended periods

The flywheel is for spinning reserve and to control ramp rates from the induction generator based wind turbines

Average wind penetration is around 45% but it can run for extended periods for higher than 95%

DeGrussa Mine

- Large operational energy demands, using a 19MW diesel-fired power station to provide electricity to the gold and copper mine

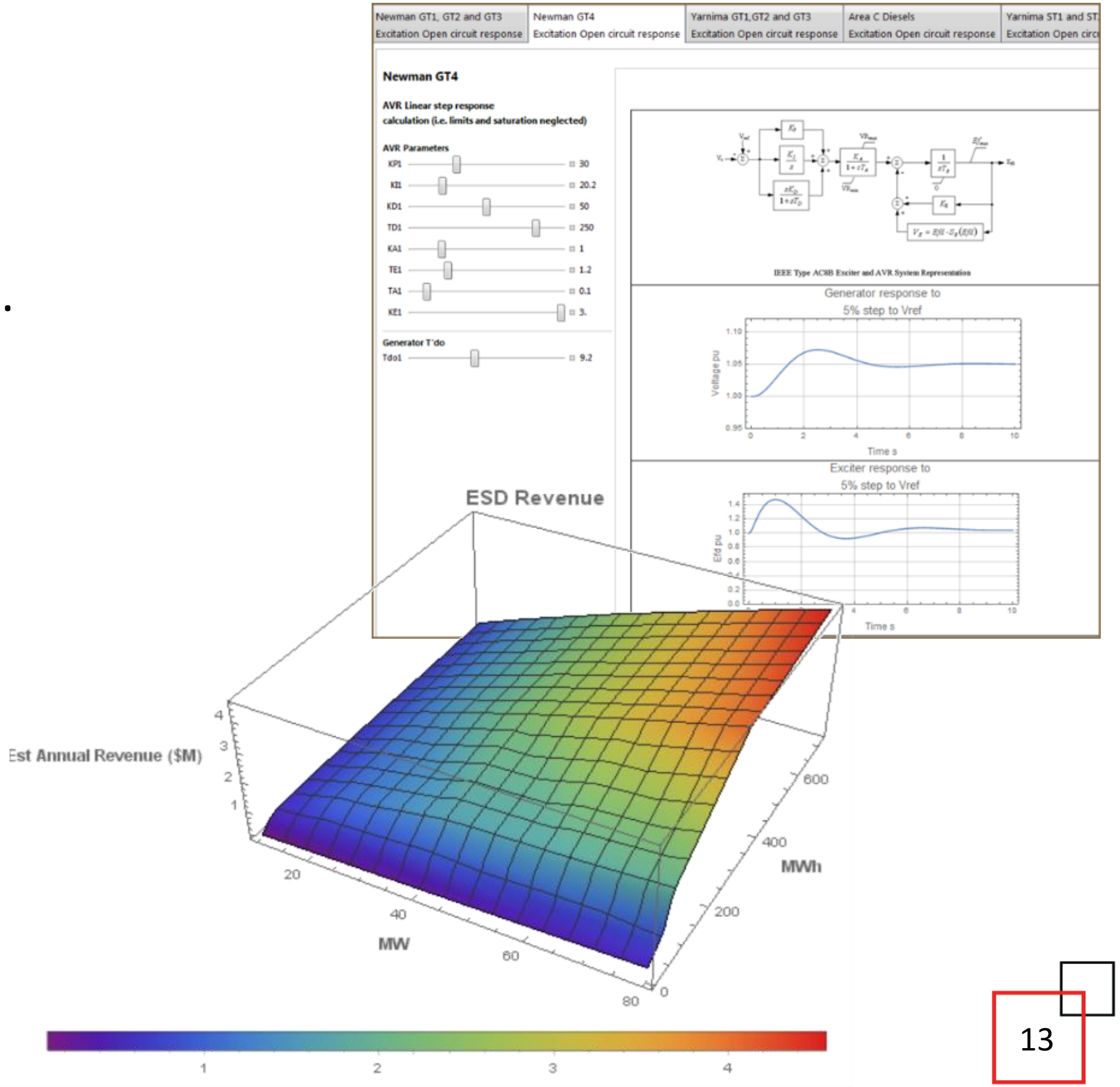
- They wanted to supplement the power station with 10.6MW of photovoltaics (PV) and a 4MW lithium-ion battery system in order to reduce their overall energy generation costs

System Modelling Approach

Packages used by WorleyParsons in Australia

- PSS/E, PTI Technologies Inc.
- PSS/ADEPT, PTI Technologies Inc.
- ETAP PowerStation, Operation Technology Inc.
- ERACS, ERA Technology Ltd
- Matlab
- Mathematica, WOLFRAM
- CDEGS “Current Distribution Interference Grounding and Soil”
- EMTP “Electromagnetic Transient Program”

- Bespoke software written if required for specific project issues



Specific DER & Microgrid Modelling: XENDEE

BANKABLE DER & MICROGRID PROJECTS

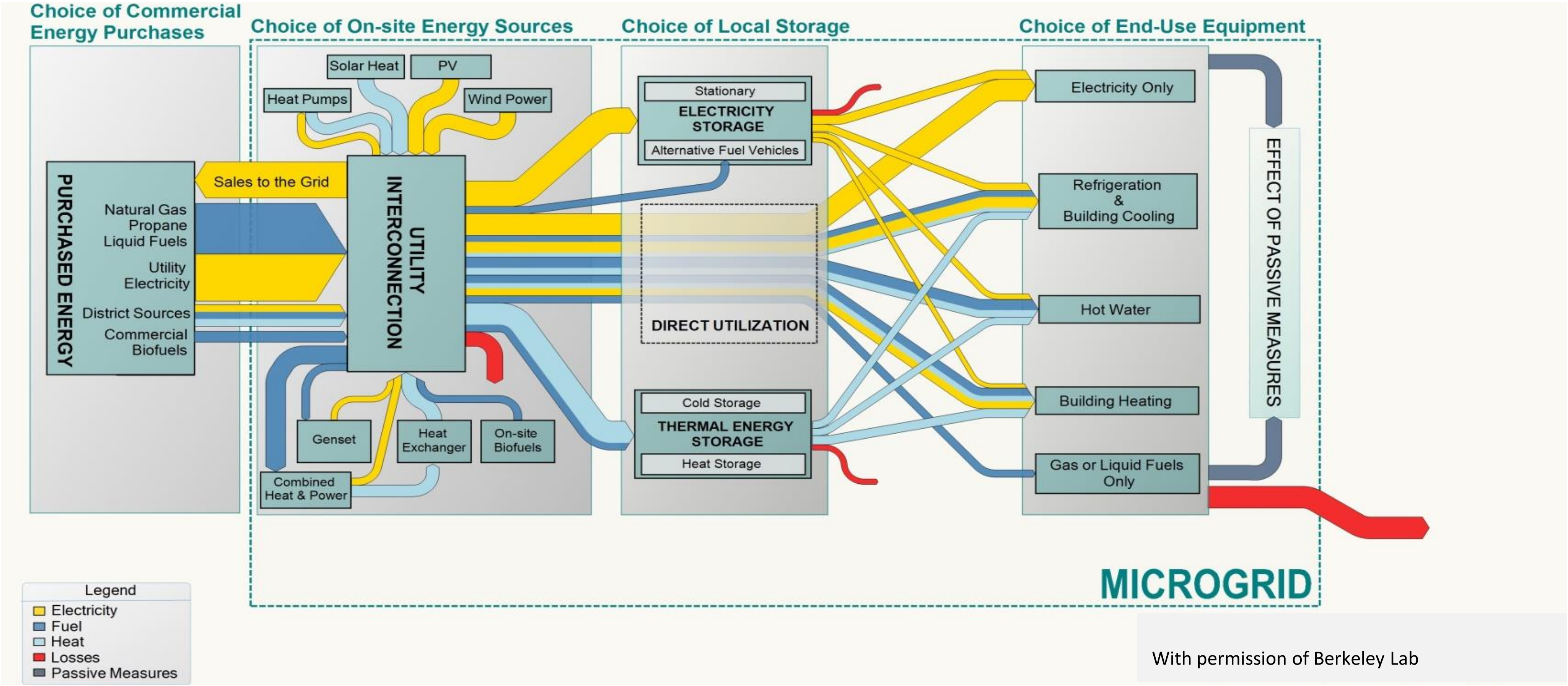
- Integrated End-to-End Investment and Technical Planning Platform
- Economic and Financial Optimization + Power Flow Analysis
- XENDEE Score: Getting DER Projects Down to a Single ‘FICO’ Number

Natural Gas Generator Solution: LCOE of $0.1180/kWh

Solar PV	PV Capacity	BESS	BESS Capacity	Generator	NatGas GenSet Capacity	Number of Generators	LCOE ($/kWh)
	8,792 kW		2,929 kWh		5,000 kW	10	$0.1180

Reduce Planning Errors | Increase Speed to Deploy | Increase Profits

Why Economic Optimization and not just Simulation?



With permission of Berkeley Lab

XENDEE Process

PLAN — Advisian + XENDEE
BUILD — Services
RUN — Integrated Solutions

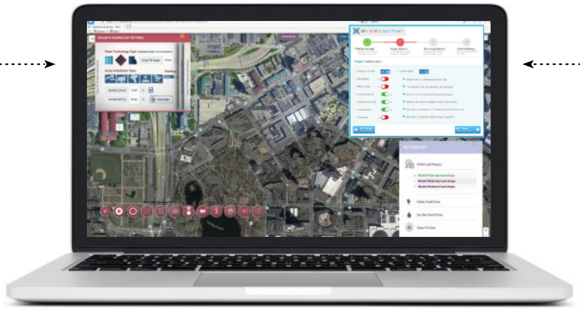
For **your energy** project
- Microgrid
- Battery Energy Storage
- Electric Vehicles
- Alternative Energy System

Your priorities

- Cost Savings
- Emissions Reduction
- Resilience & Reliability
- Safety & Security

XENDEE PLATFORM

Your data
- Location
- Facility type and use
- Energy use mix/cost
- Load profile



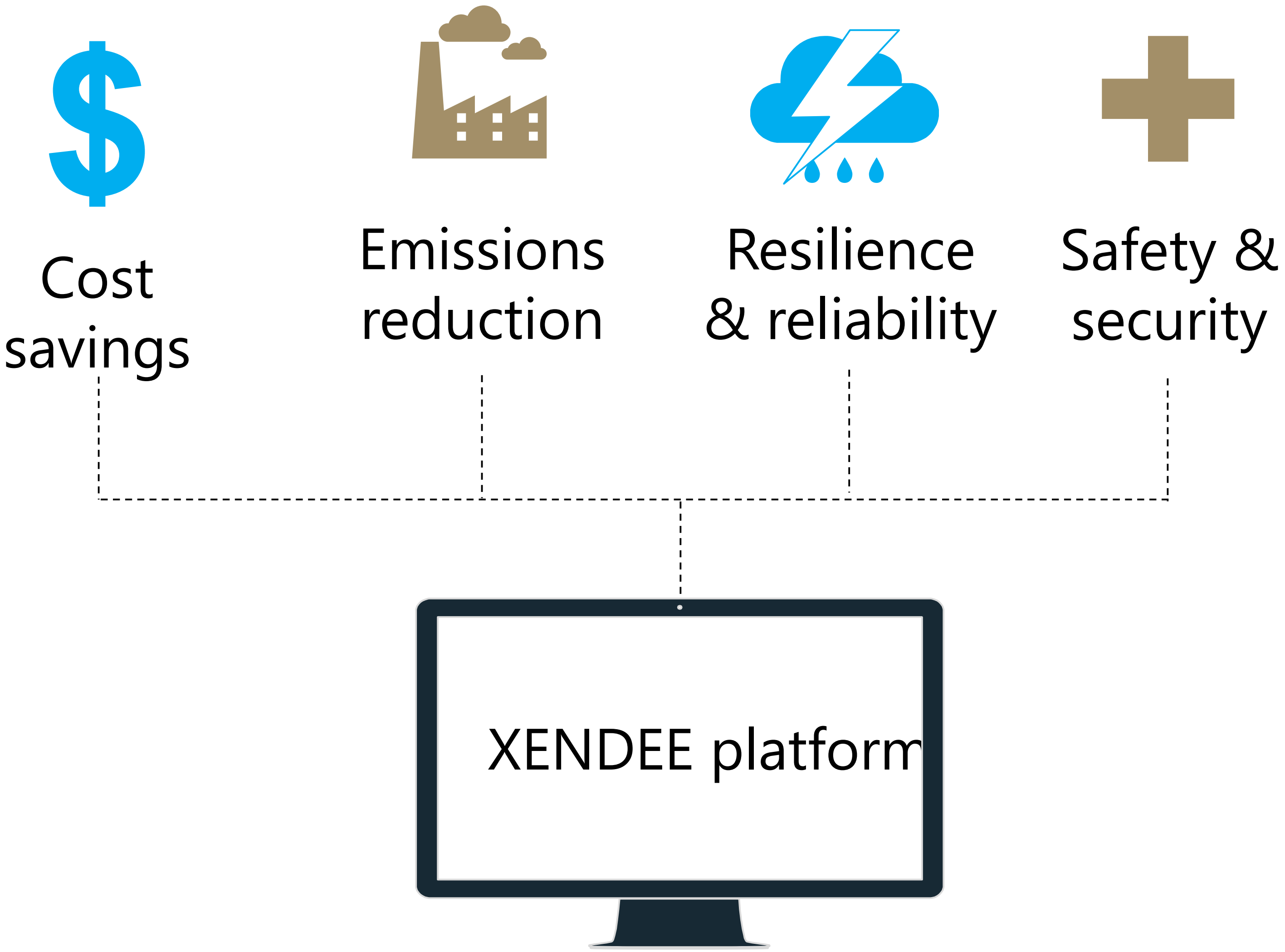
Platform data
- Energy pricing
- Solar and wind data
- Vendor data
- Geospatial analysis

Technical & Financial Optimization

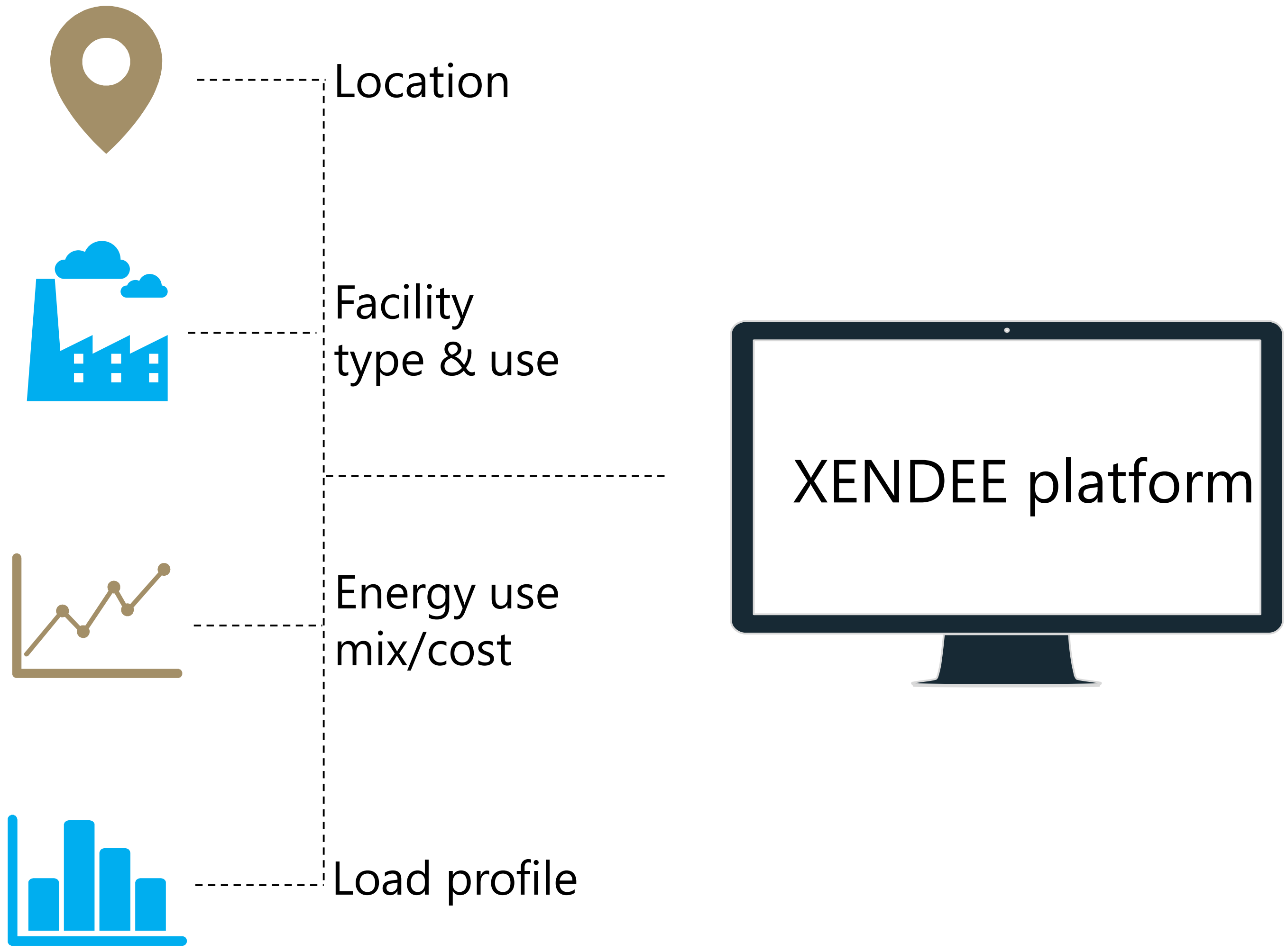
Fast, reliable results

- **Financial pro forma**
- **Customized system design**
- **Technical report**
- **Optimized operations**

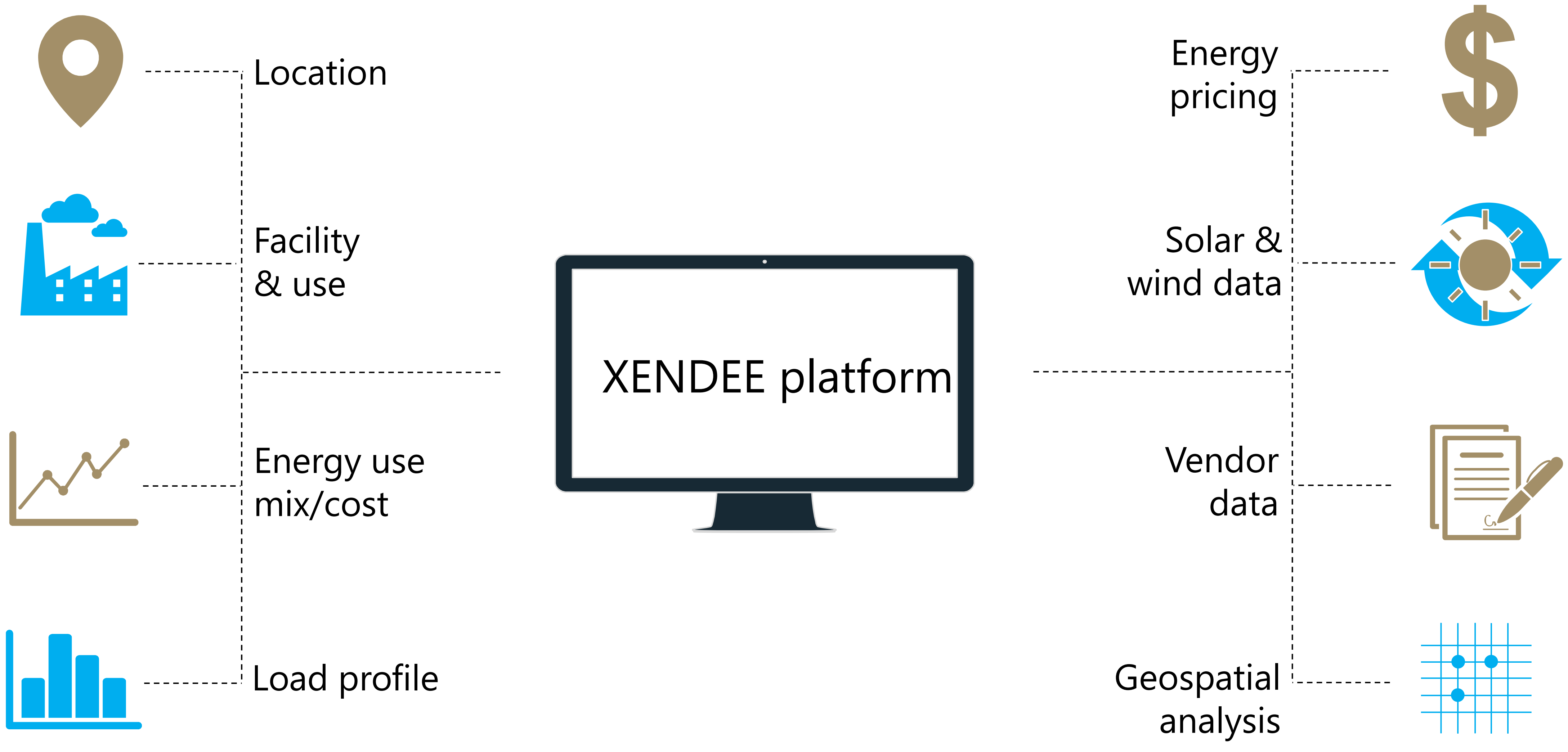
Step 1: Set your priorities



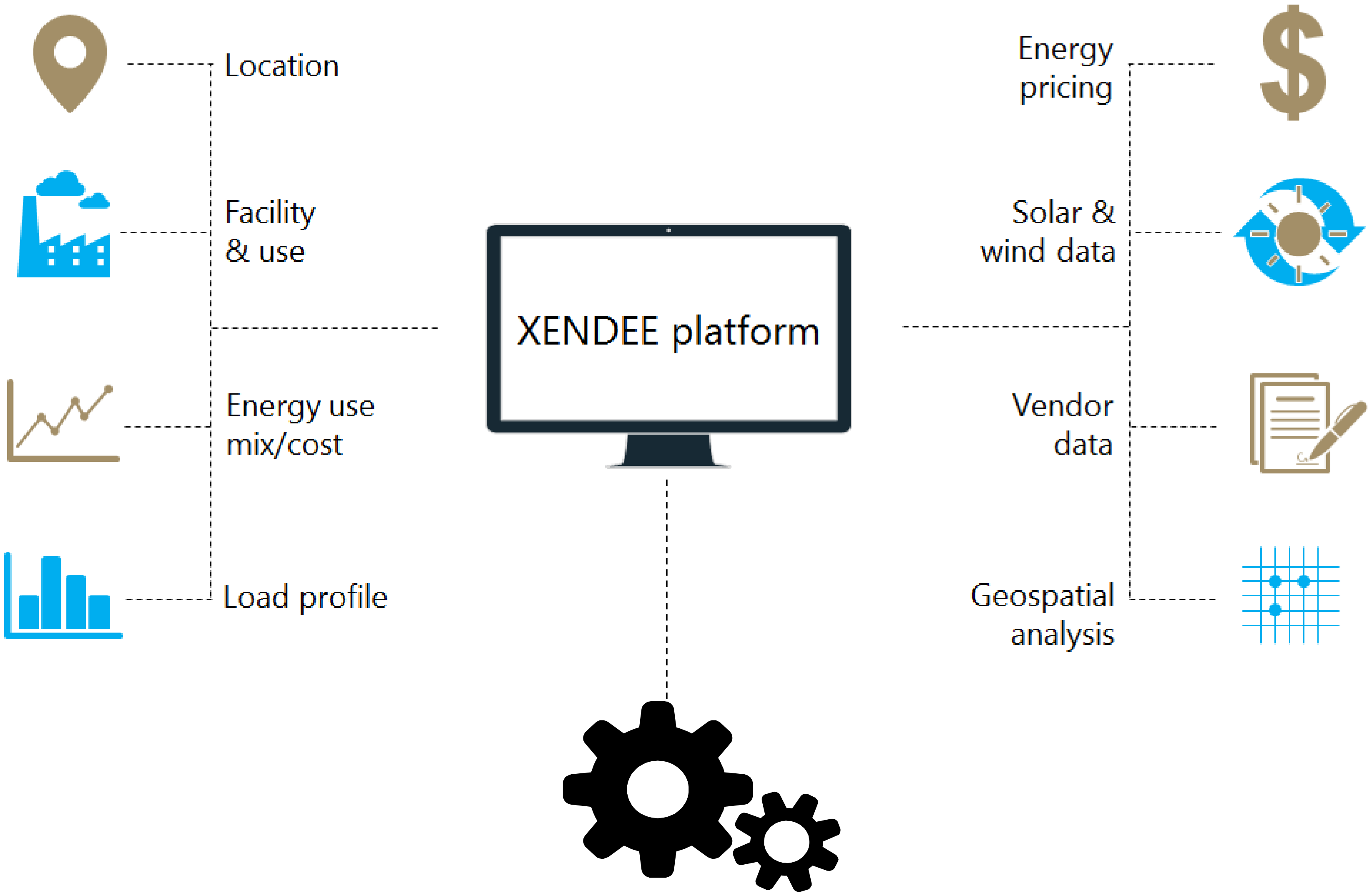
Step 2: Input site-specific data



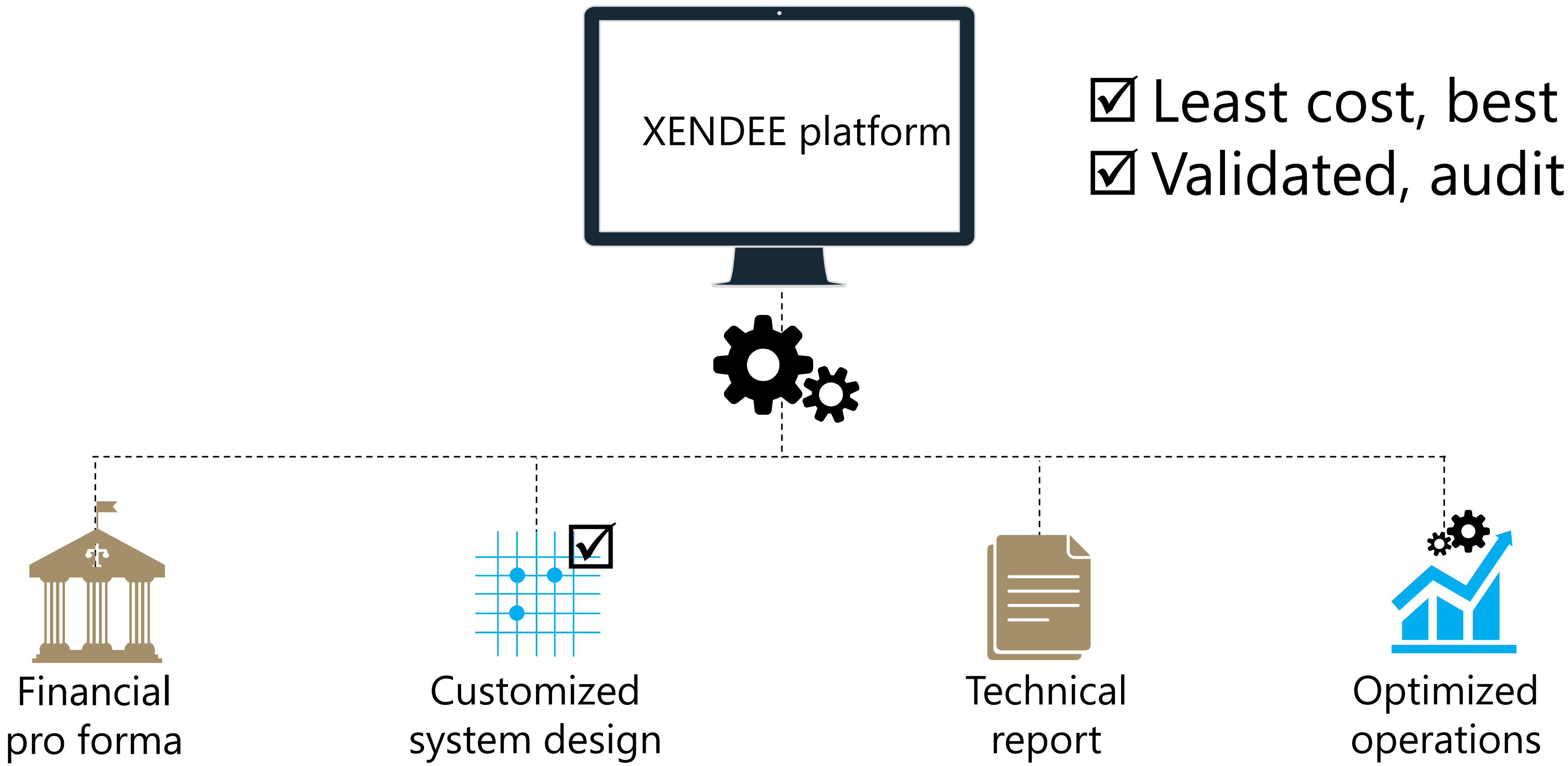
Step 3: Apply platform data



Step 4: Run technical & financial optimization



Step 5: Fast, reliable results



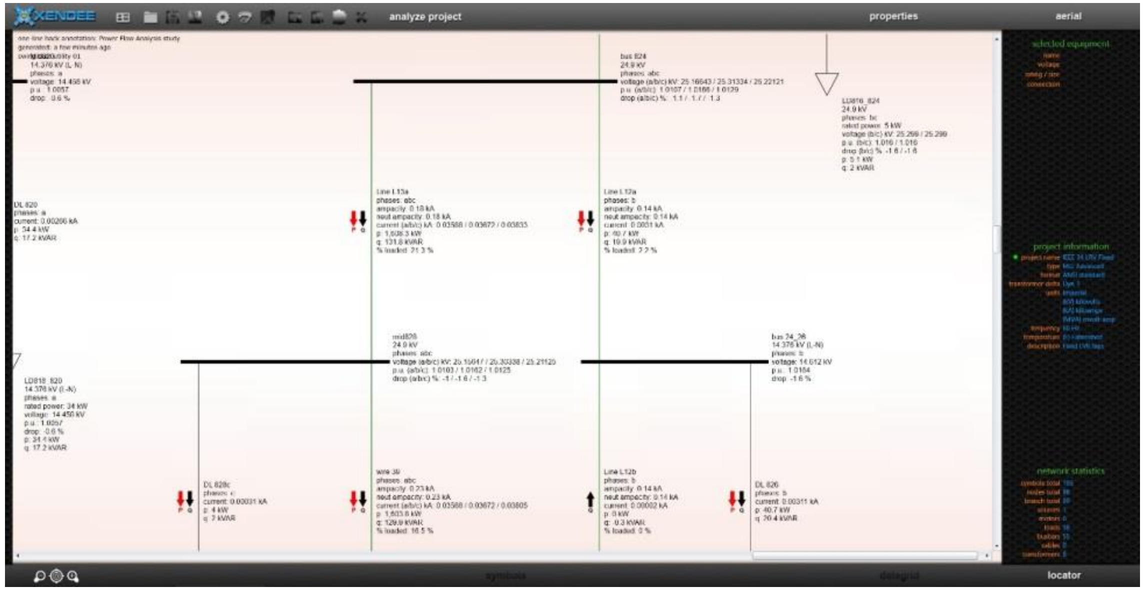
☑ Least cost, best fit solutions
☑ Validated, auditable results

8760 Power flow

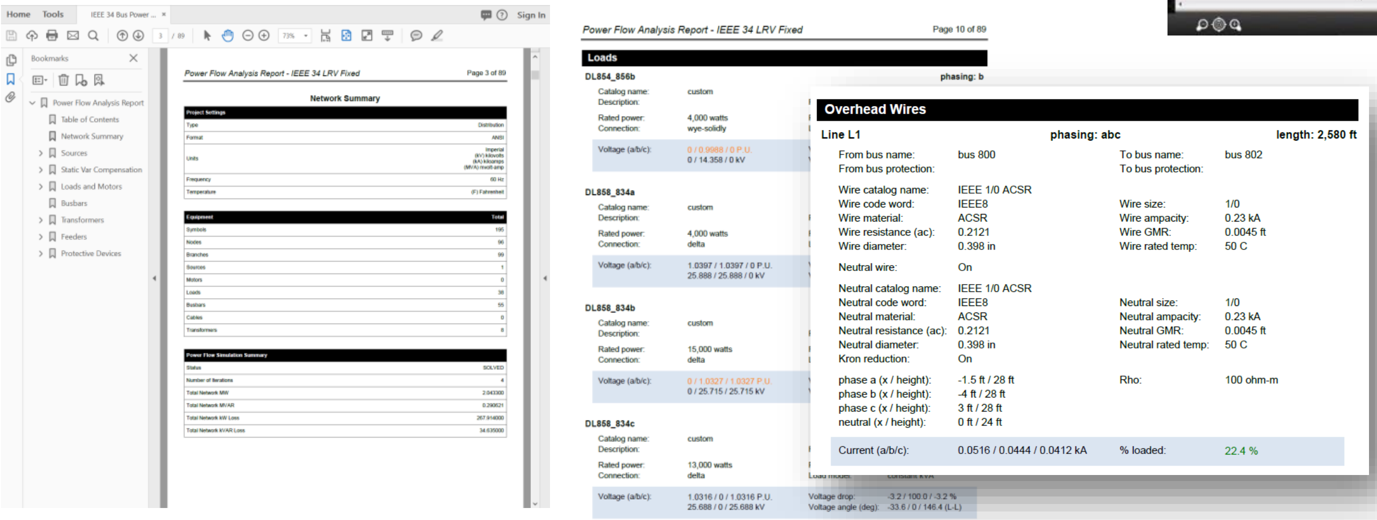
Integrated deep-circuit power flow analysis:

- Automatic one-line generation
- Quasi-static time-series simulation
- Distribution system planning
- Google maps integrated for GIS views

Power Flow Reporting on One-Line Diagram

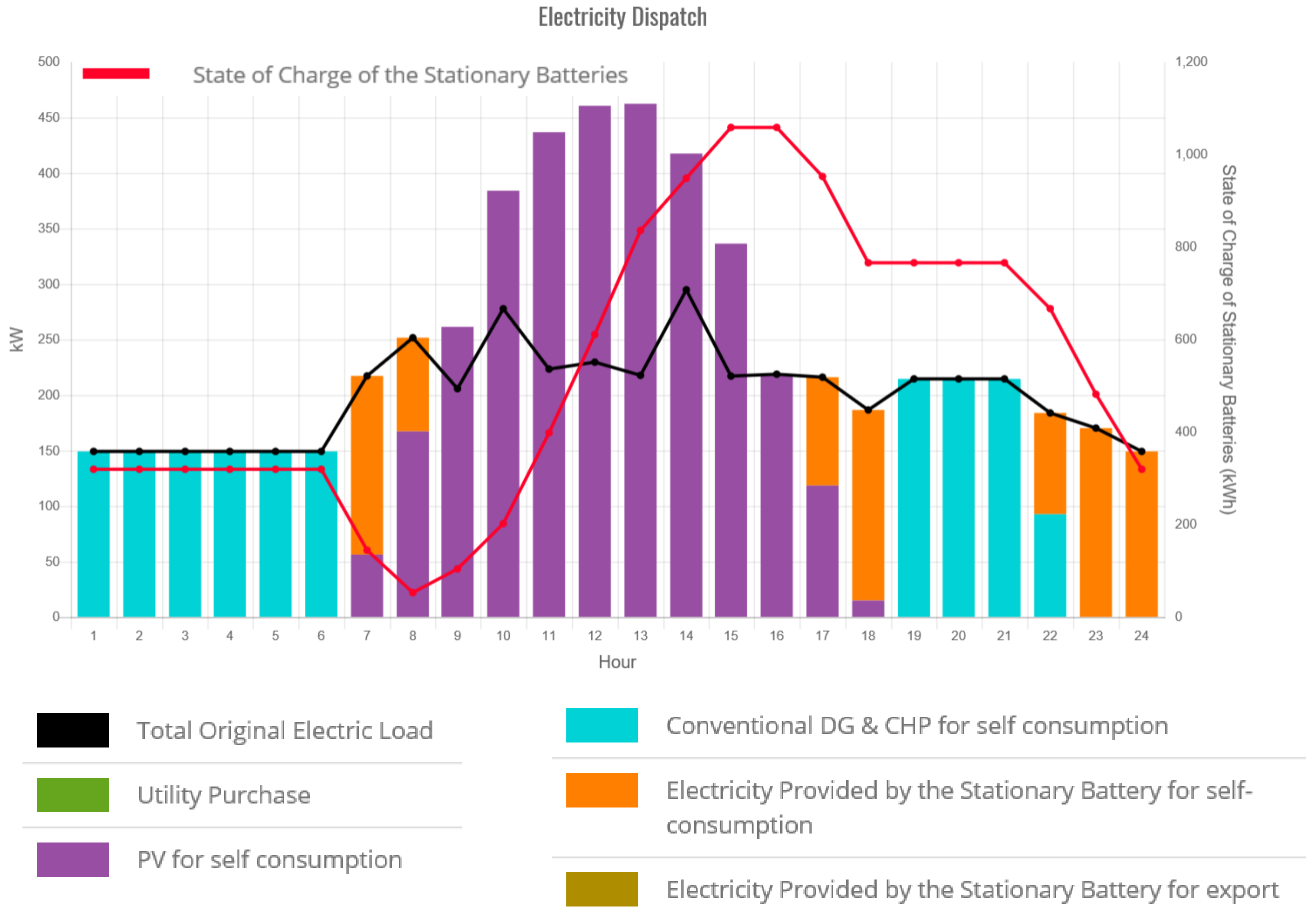


Automatic Report Generation

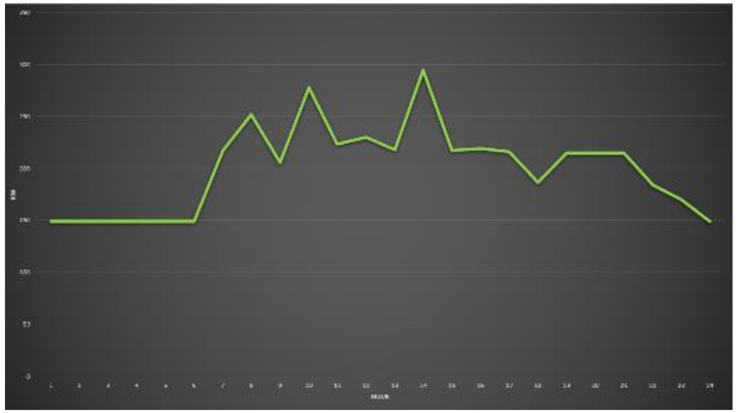


Sequence of operations

Most Optimal Sequence of Operation Logic Output (September outage day)

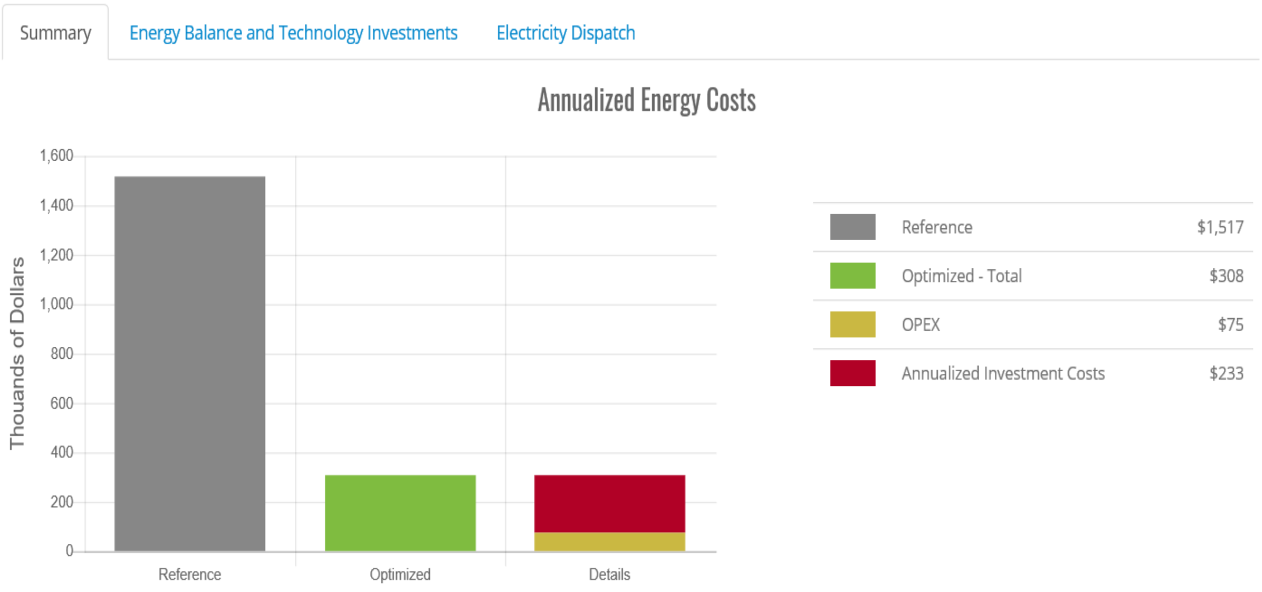


Load Shape (September day)

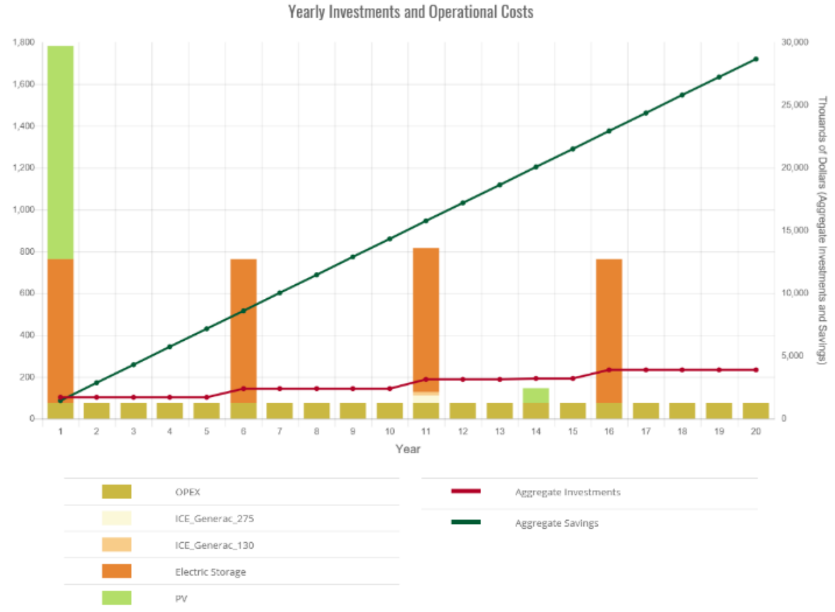


Summary report

Summary: Annualized Energy Costs ($000s)



Summary: Yearly Investments and Operational Costs



Lessons learned

- Optimize for the use case (*not* redundancy everywhere)
- Renewables + Storage are competitive now
- Hybrid systems offer the greatest flexibility and cost competitiveness
- Specialized software for system optimization can save up to 90% of soft costs
- Consider the full range of technology options (remain technology agnostic)

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