# Sustainable Energy Systems for Communities

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# Let’s start with where we are now

- 6 Renewable energy trends to watch in 2019
  - Forbes.com

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# Energy storage (1)

- Batteries at different scales
  - We're up to 100 MW already


# Not only about batteries

- Hydro
  - Micro, pico, and pumped-storeage
- Biomass
- Hydrogen
- Superconducting flywheels
- Supercapacitors
- Smart grids

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# Microgrids and AI (2)

- Quicker design, and better operation

**Advisian (WorleyParsons Group) and XENDEE, Inc. Announce Exclusive Partnership**

October 16, 2018 08:04 AM Eastern Daylight Time

LOS ANGELES--(BUSINESS WIRE)--Advisian, the global advisory and consulting business line of the WorleyParsons Group, and XENDEE, Inc., announce an exclusive agreement to design and deliver advanced distributed energy systems.

@Advisian partners with @XENDEE to provide best-in-class integrated #energy solutions.

Tweet this

Advisian, WorleyParsons, and XENDEE are connecting their complementary strengths to answer the need for fast, affordable and reliable microgrid feasibility studies, and optimized, bankable energy projects.

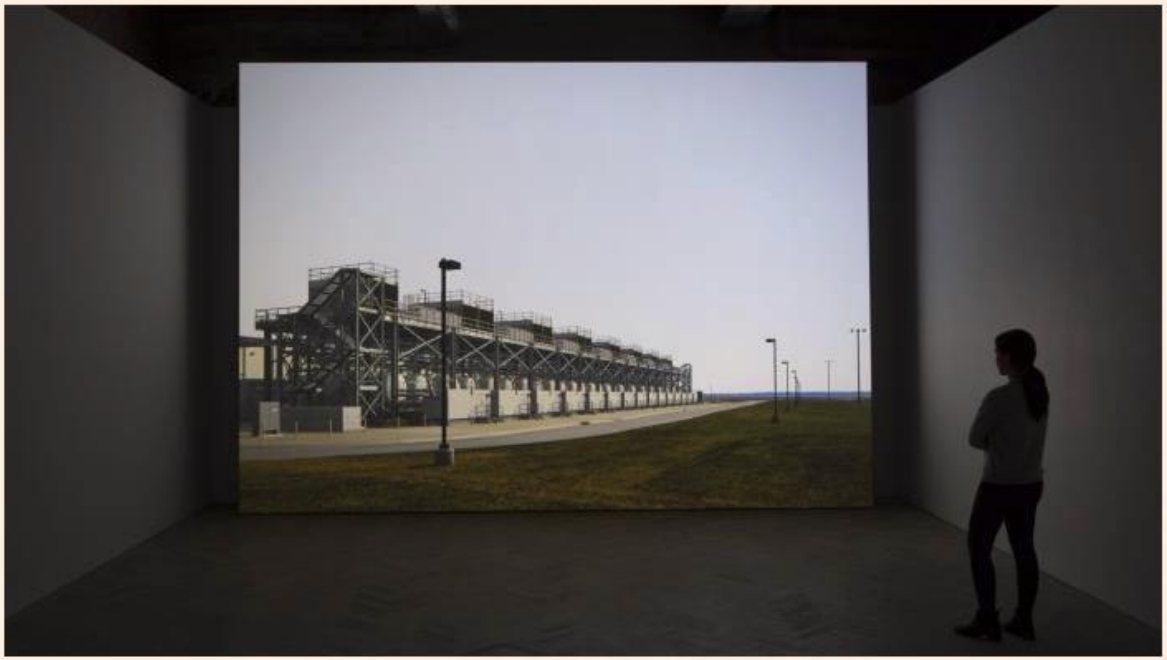
XENDEE's award-winning team has developed an advanced toolkit for microgrid and distributed energy system design and optimization. Advisian will support roll out and scaling of the XENDEE capability worldwide, and WorleyParsons will develop and deliver complete projects. Together, they offer turnkey solutions with up to 90% reduction in time to results.

"Using the XENDEE platform, complex energy systems can be designed in hours to days rather than the industry standar to months. XENDEE designs are bankable and auditable, giving confidence in least cost, best fit, and profitability," says Advisian Director of Smart & Distributed Energy, Tristan Jackson.

# AI already for the larger (smarter) grid: Allowing for prosumers to participate

## DeepMind and National Grid in AI talks to balance energy supply

Google's machine learning technology likely to better predict UK electricity demand



**Madhumita Murgia** and **Nathalie Thomas** MARCH 12, 2017

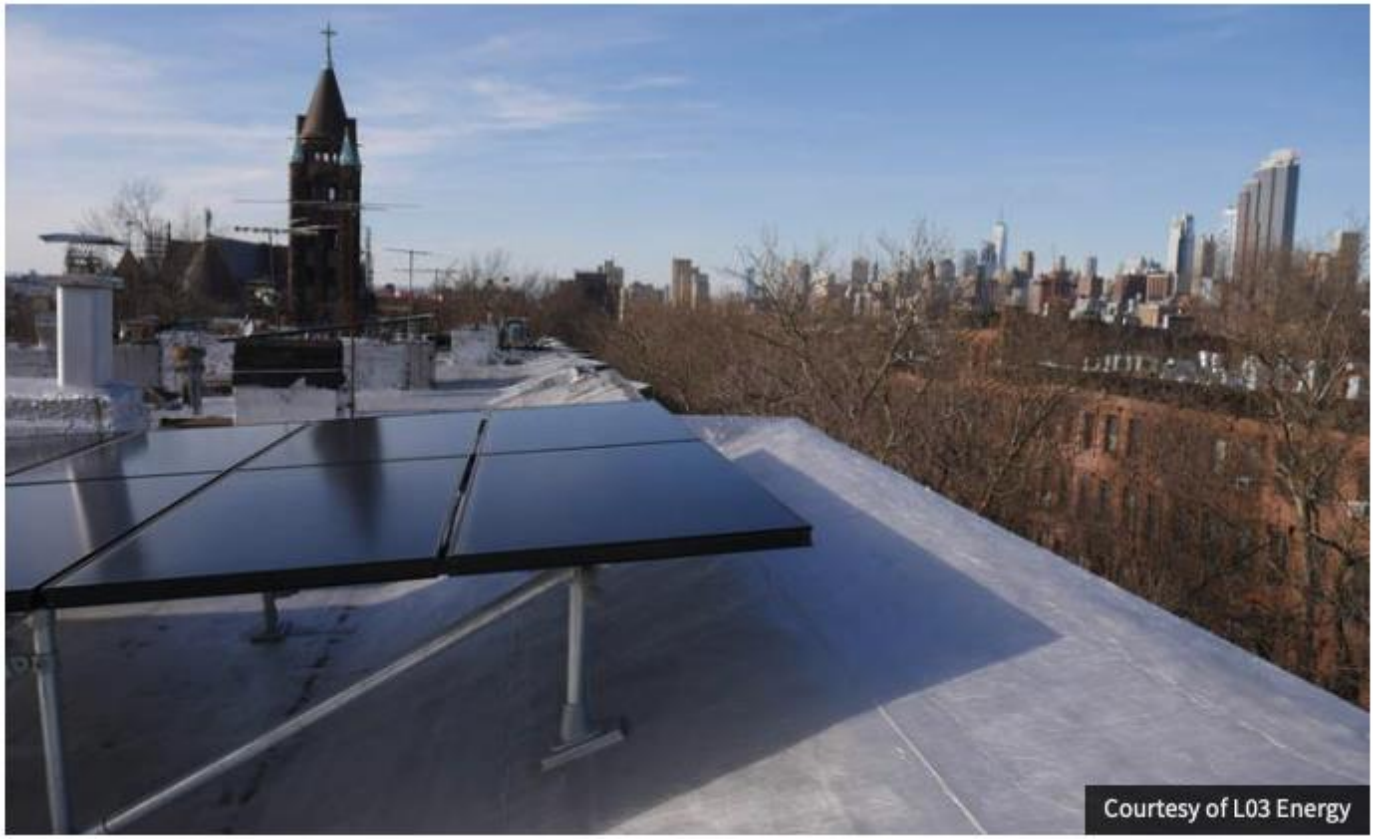
18

Google's DeepMind is in discussions with the UK's National Grid to use artificial intelligence to help balance energy supply and demand in Britain.

# Energy Blockchain and IoT (3)

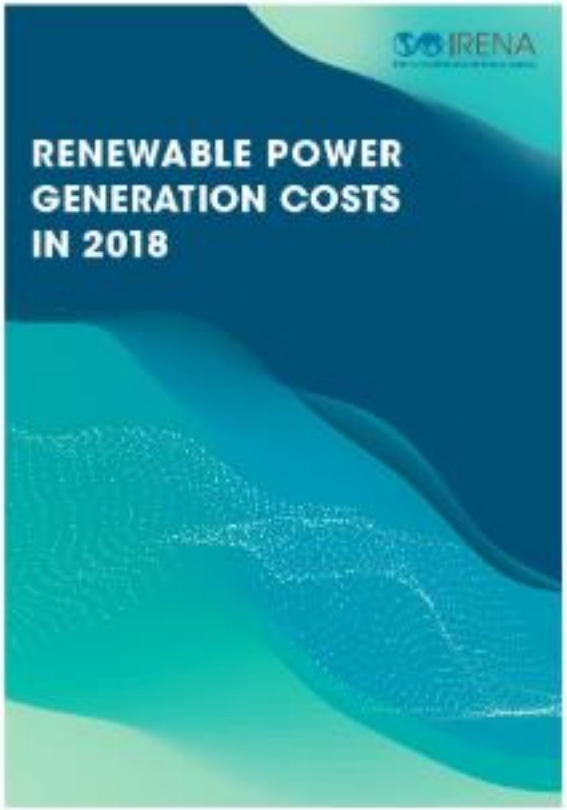
## A microgrid grows in Brooklyn — is this the future of energy?

Alec Appelbaum
Tuesday, July 11, 2017 - 2:30am



# Grid parity and falling costs (4)

- Solar and wind have reached parity in both price and performance in many regions
  - New technologies continue to hone their competitive edge



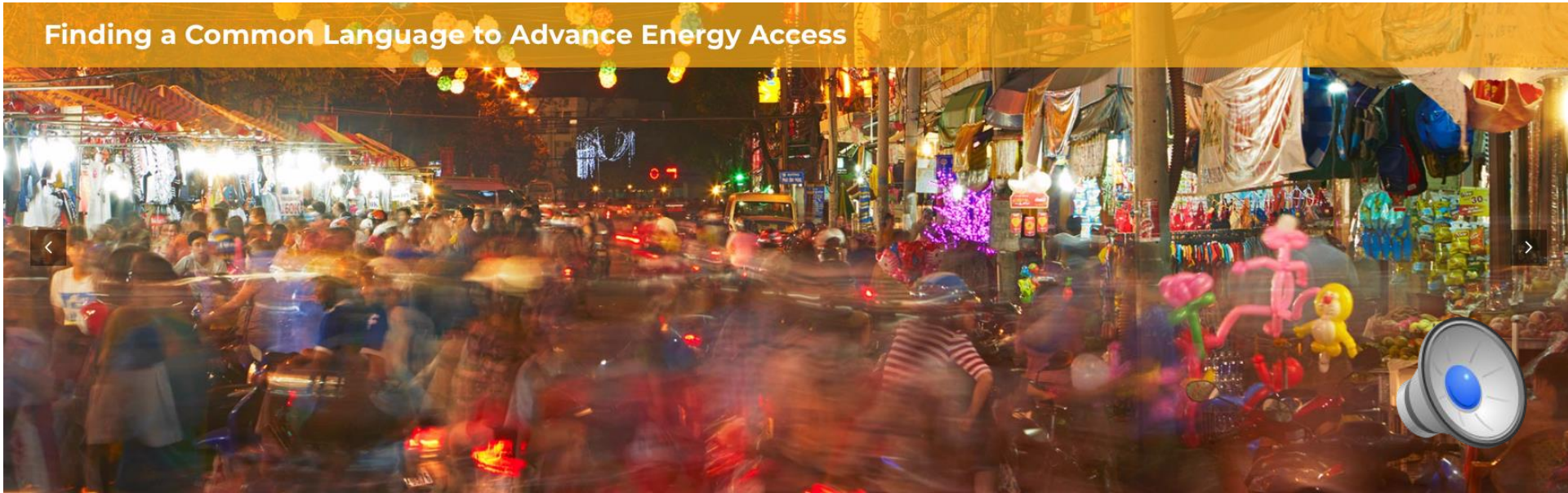
# Big commitments (5)

- Over 100 global cities get at least 70% of their electricity from renewables
  - Over 40 operate on 100% renewable electricity
- 158 companies have committed to transitioning to 100% renewables



# Energy access advances in communities on the periphery (6)

- A billion people live without electricity
- Hundreds of millions have unreliable and prohibitively expensive energy sources
- seforall.org

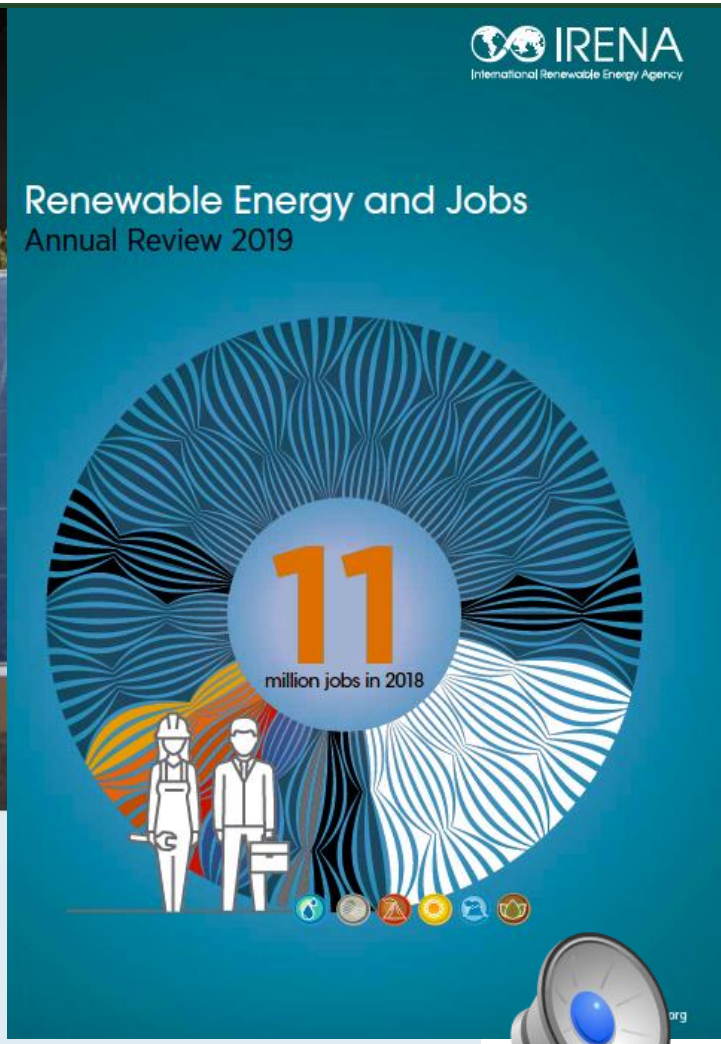


# Transition trends are all opportunities for resilient communties


## Our Technology

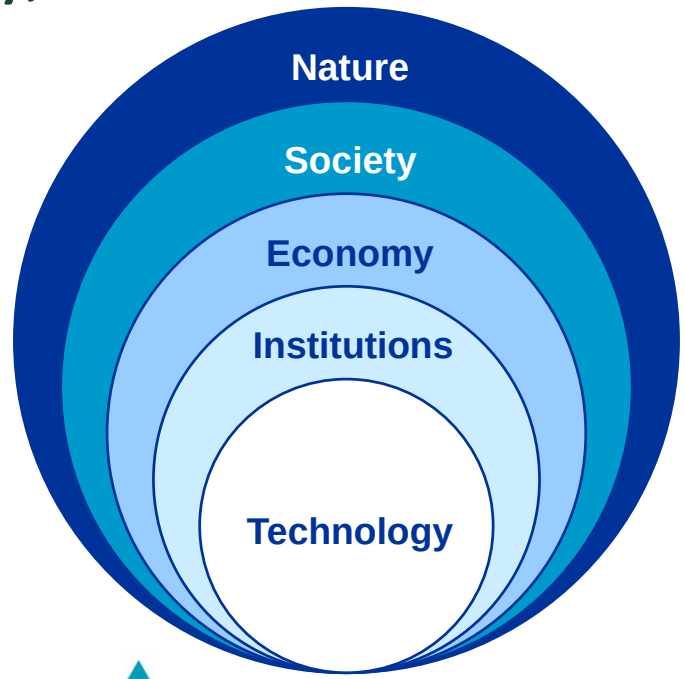
HOME / **OUR TECHNOLOGY**

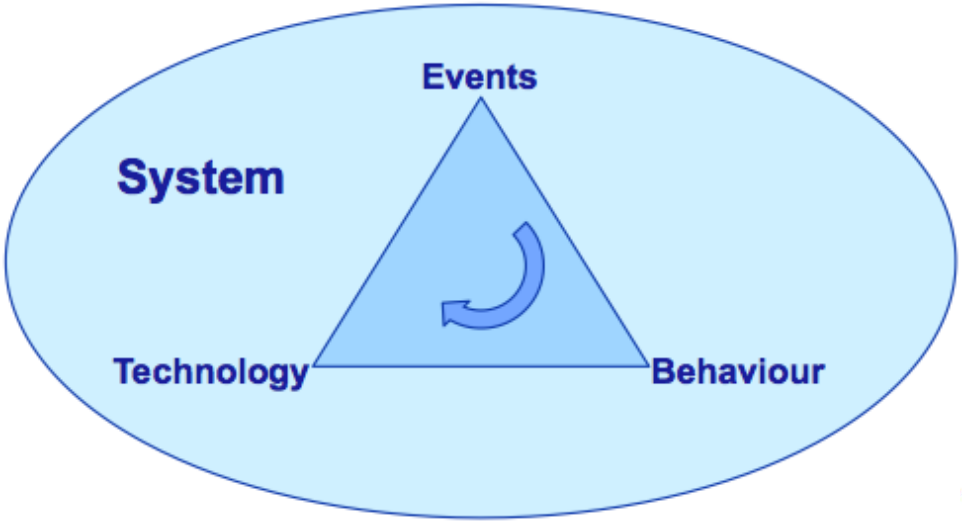
IEEE Smart Village values innovation to drive efficient power, education, and entrepreneurial endeavors. From transportable solar panels, to remote Internet access methods, a wide range of technologies are needed to empower a village.



# Systems perspective

- **Transdisciplinarity** covering a range of engineering, sustainability, and scientific **principles**





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# Strategic approach

**Top-down** → **Policy- and decision-makers**

**Integration** → **Strategic intervention**

**Bottom-up** → **Communities / Society**

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# Case study: Microgrids

- A distinct, small-scale, resilient power grid that provides a platform for the integration of DERs and loads, and facilitates the use of DRPs

- But…

- It must be sized optimally


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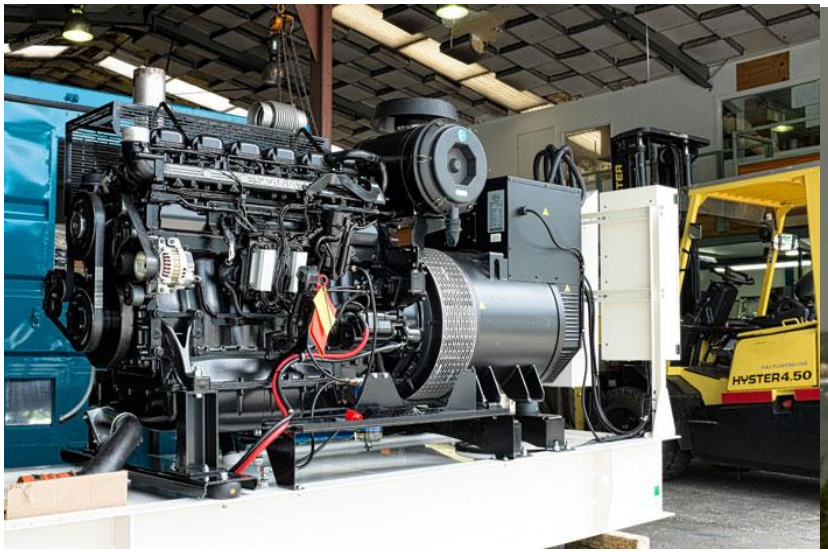
# Case study: Stewart Island

- Provide a cost-effective, environmentally-friendly, sustainable solution for the transformation of the Stewart Island's fossil fuel-based energy economy into a 100 percent renewable energy economy

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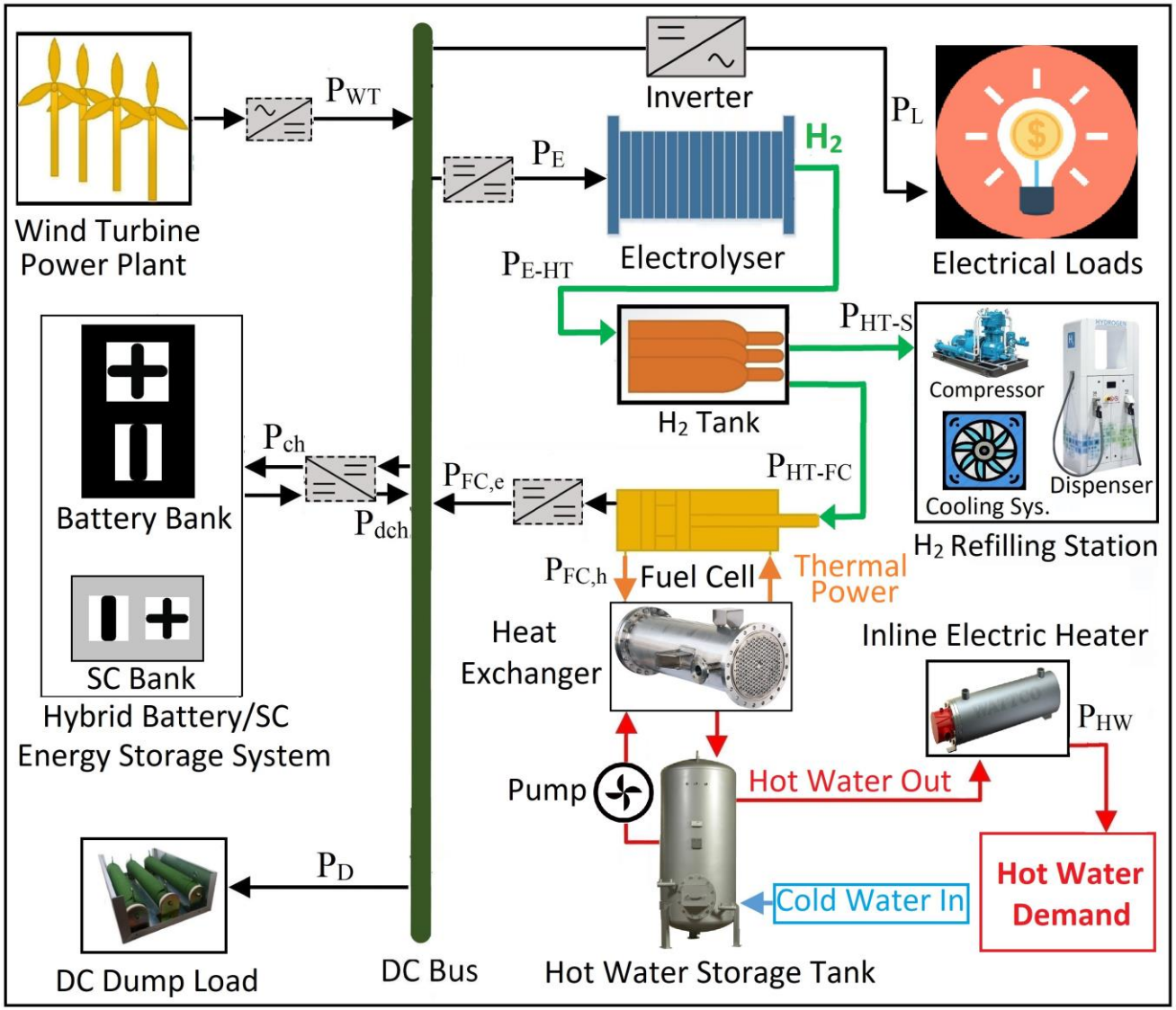
# Case study: Stewart Island
# Possible multiple energy carrier grid

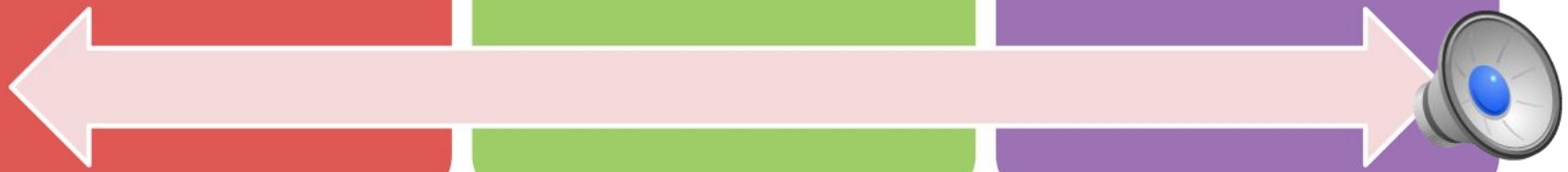


# Case study: Stewart Island
# Possible multiple energy carrier grid

Fuel Cell: high energy density, but low power density


Battery: intermediary level of both energy and power densities


Super-Capacitor: high power density, but low energy density



# The costs

| Component | Rated capacity | | | | Efficiency [%] | Lifetime [years] |
|---|---|---|---|---|---|---|
| **WT** | 100 kW | $120k/unit | $100k/unit | $4.6k/unit/year | N/A | 20 |
| **SC modules** | 3.23 Wh | $32/module | $32/module | $0.5/module/year | 95 | 10 |
| **Battery packs** | 7.5 kWh | $630/pack | $600/pack | 20/pack/year | 90 | 12 |
| **Electrolyser** | generic | $1k/kW | $1k/kW | $20/kW/year | 60 | 15 |
| **$H_2$ reservoir** | generic | $470/kg | $470/kg | $9/kg/year | 98 | 20 |
| **Fuel cell** | generic | $1.1k/kW | $0.9k/kW | $28/kW/year | 50 | 5 |
| **Heat exchanger** | generic | $100/kW | $90/kW | $2/kW/year | 90 | 15 |
| **Hot water tank** | generic | $0.5/L | $0.3/L | $0/L/year | 96 | 15 |
| **Inline electric heater** | generic | $1k/kW | $1k/kW | $8/kW/year | 97 | 15 |
| **$H_2$ refilling station** | generic | $6k/kg $H_2$/h | $5k/kg $H_2$/h | $180/kg $H_2$/h/year | 95 | 20 |
| **Electric loads' inverter** | generic | $350/kW | $300/kW | $7/kW/year | 90 | |

# Verification of cost-effectiveness

- Levelised cost of electricity = NZ$0.20/kWh
  - Existing electricity tariff = 0.26/kWh
- Levelised cost of hydrogen = NZ$6.97/kg $H_2$
  - NZ$8.91/kg $H_2$ to NZ$14/kg $H_2$
- Levelised cost of hot water = NZ$0.0091/L
  - NZ$0.0077/L to NZ$2.8/L

# Visit our activities

- https://www.victoria.ac.nz/sustainable-energy-systems
- https://www.facebook.com/Chair-in-Sustainable-Energy-Systems-188584781734860

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