Applications of Renewable Gas in Microgrids: Lessons Learned

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Distributed and decentralized control and optimization present a new paradigm of Energy Management

Centralized

Distributed

Decentralized

Stone Edge Farm Microgrid Project

Mission

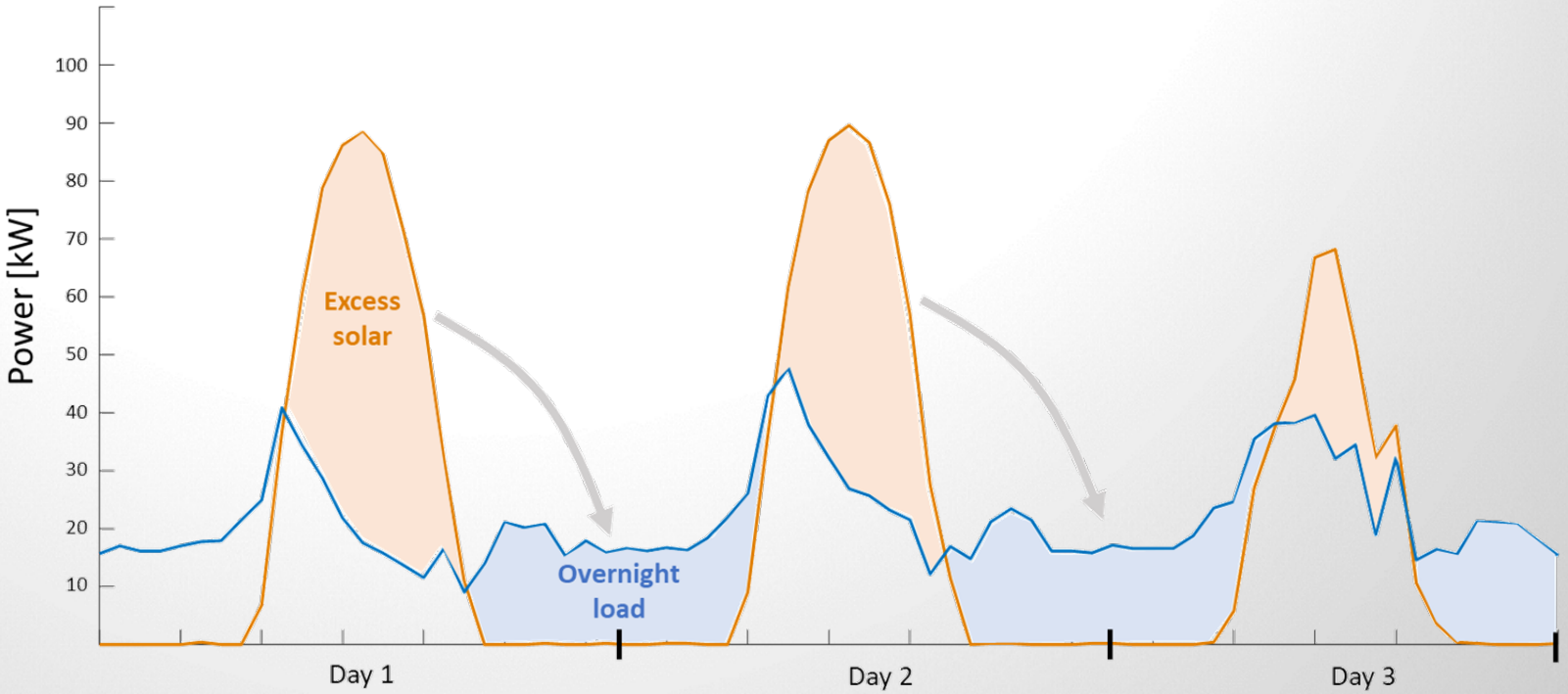
Achieve full energy sustainability and independence using technology innovation

Wide variety of DERs

- Solar panels with soft-curtailment
- Batteries
  9 different types have been tested
- Gas turbine with CHP
- Hydrogen system
  Electrolyzer, H2 storage, fuel cells
- Controllable loads
  Evs, motor/pumps, HVACs

Energy Storage Components

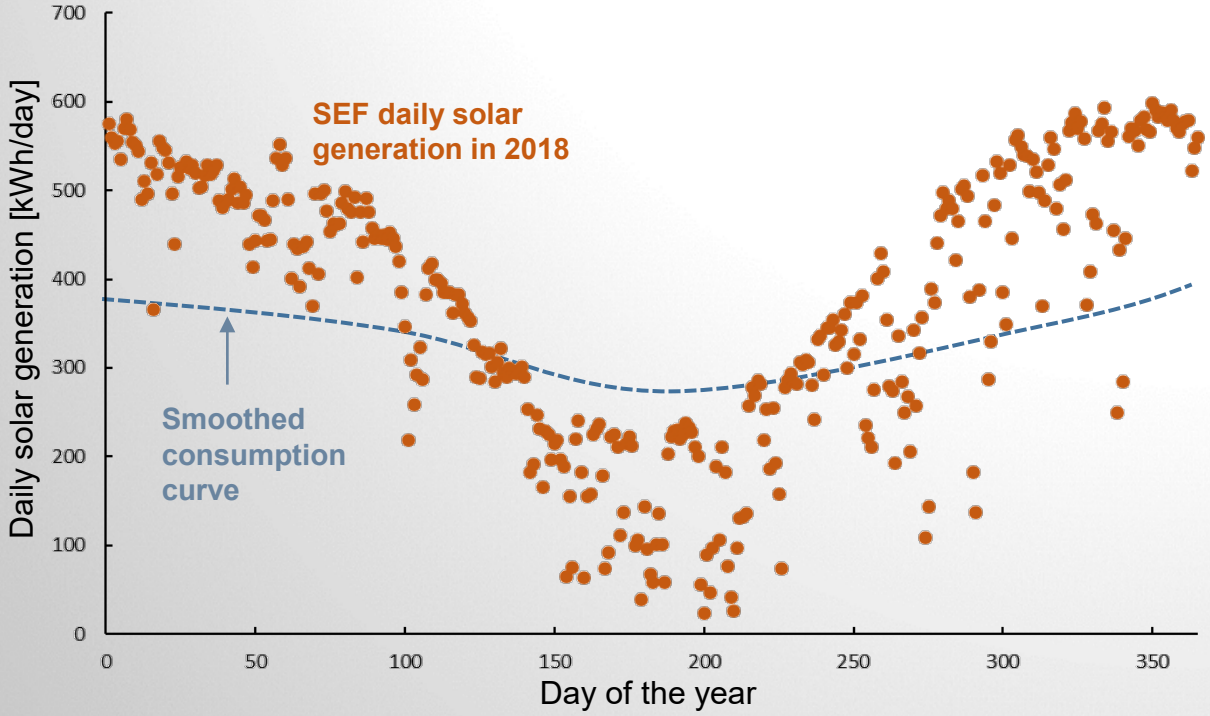
Use of Batteries for short-term (hourly, daily) imbalances between solar generation and consumption

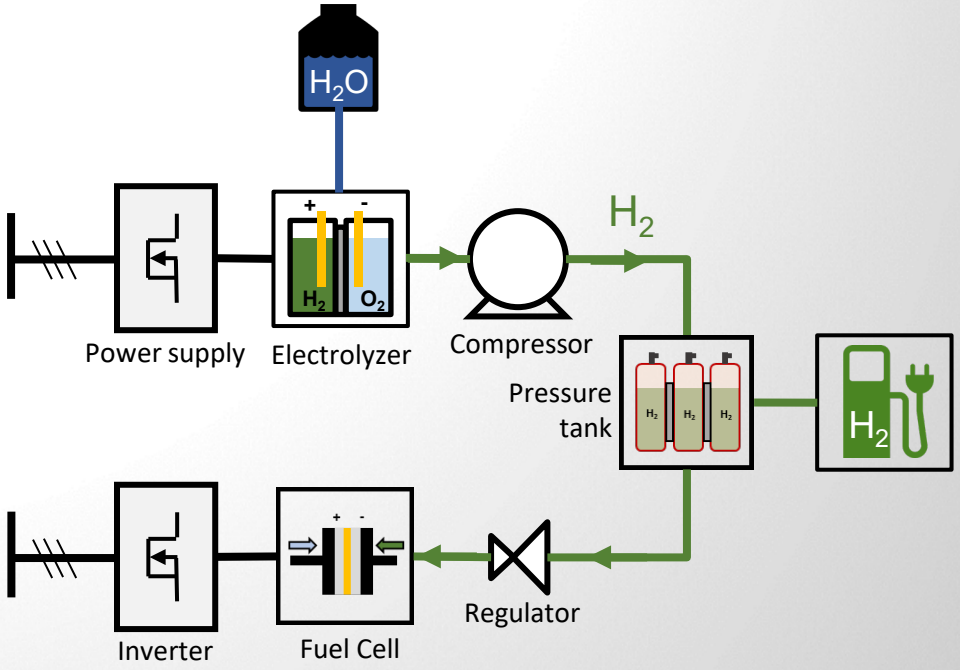


Typical operation: *Store the excess solar energy during the day and use it to power overnight loads*

Energy Storage Components

Use of Renewable Gas for long-term (seasonal) imbalances





Typical operation: *Store excess solar in the summer months, and then use the energy during the winter*

Used Technologies

Alkaline Electrolyzer

Low temperature electrolyzer

Capacity: 12 kg per day output at 30 psi

PEM Electrolyzer

Low temperature electrolyzer

Capacity: 60 kg per day output at 300 psi

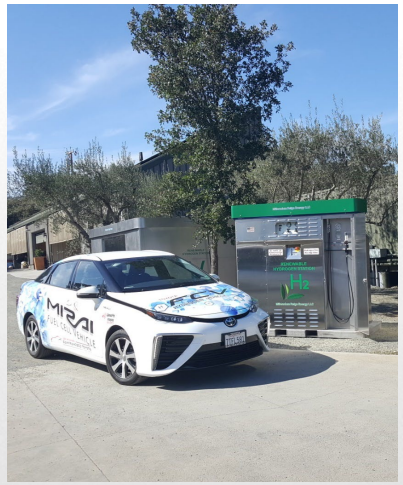
PEM Fuel Cell

Low temperature fuel cells

Capacity: 2.2 kW per unit (x 12 units)

Input pressure: 8-12 psi

Hydrogen Fueling Station



Fueling station providing 4 kg of H2 at 6500 psi

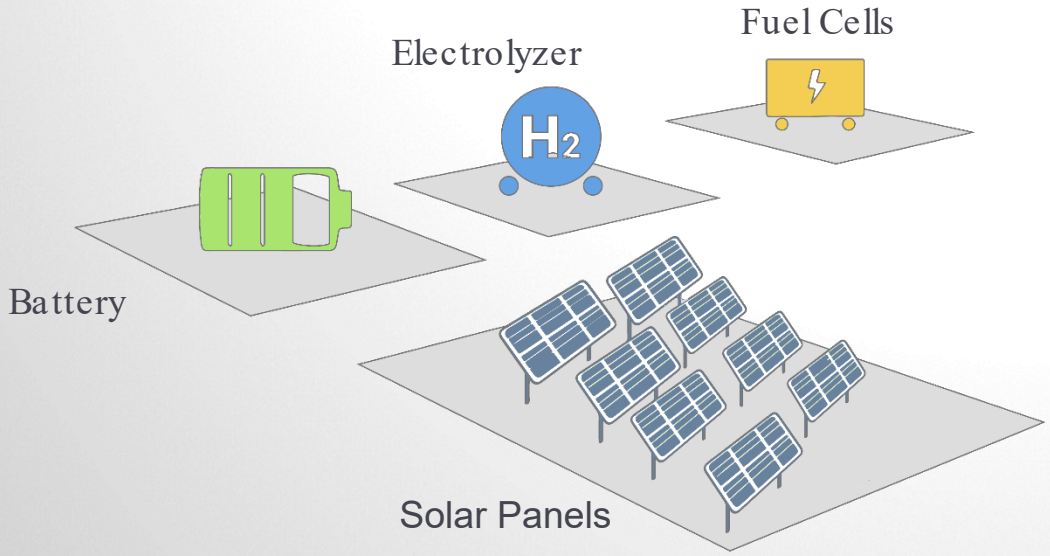
Used with 2 Toyota Mirai and 1 Honda Clarity

Fueling time was ~10 min for 200 miles

And more…

In the process of acquiring a SOFC bi-directional electrolyzer / fuel cell device

A Microgrid is a collection of disparate energy resources that were not designed to work together



Main Challenges

- Non-Standardized Ecosystem
- Complex Systems
- Rigid Structure

Challenges

Non-Standardized Ecosystem

- Diversity
- Customization

- Multiple objectives
- Multi-energy

- Evolving System
- Continuous updates

- Systems are constructed with a variety of technologies:

Vendor variety

- **Interoperability**
- **Function diversity**

- Microgrids are typically ones-offs:

Different, customized projects

- **Size Differences**
- **Architecture variety**
- **Source variety**

Challenges

- Diversity
- Customization

Complex Systems

- Multiple objectives
- Multi-energy

- Evolving System
- Continuous updates

- Each project has different objectives and priorities:

Priority tradeoffs
- **Economic**
- **Environmental**
- **Resilience**

- Microgrids have to deal with various technologies:

Various energy types for loads and storage
- **Electricity**
- **Heat**
- **Hydrogen**
- **Water**

Challenges

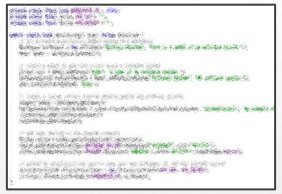
- Diversity
- Customization

- Microgrids need to be able to grow organically:

Evolving Needs	Evolving System
Ex. Load increase: • Electrified house • New EV • New production line	Ex. System growth: • Increased solar energy • More fuel cell capacity

- Multiple objectives
- Multi-energy

- Software updates from vendors impact performance:

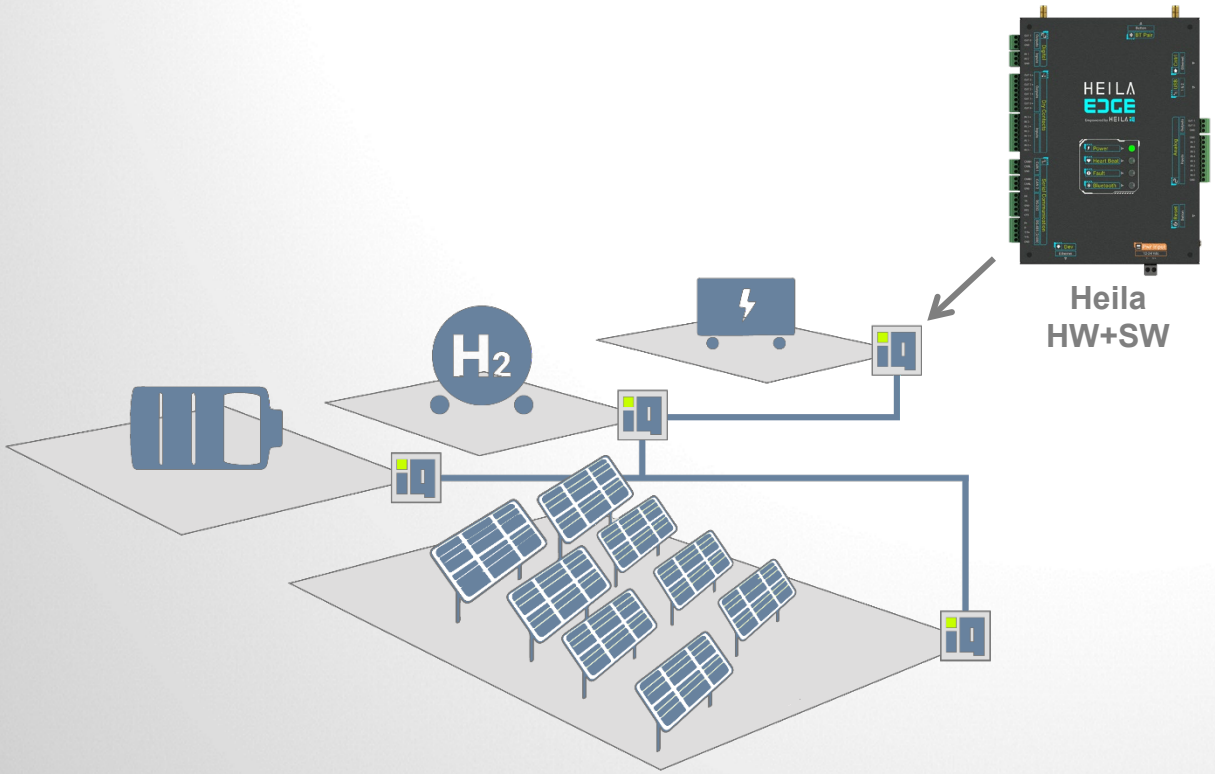


New firmware

Rigid Structure

- Evolving Systems
- Continuous updates

HEILA aims to solve microgrids main challenges by creating Microgrid "objects" or building blocks



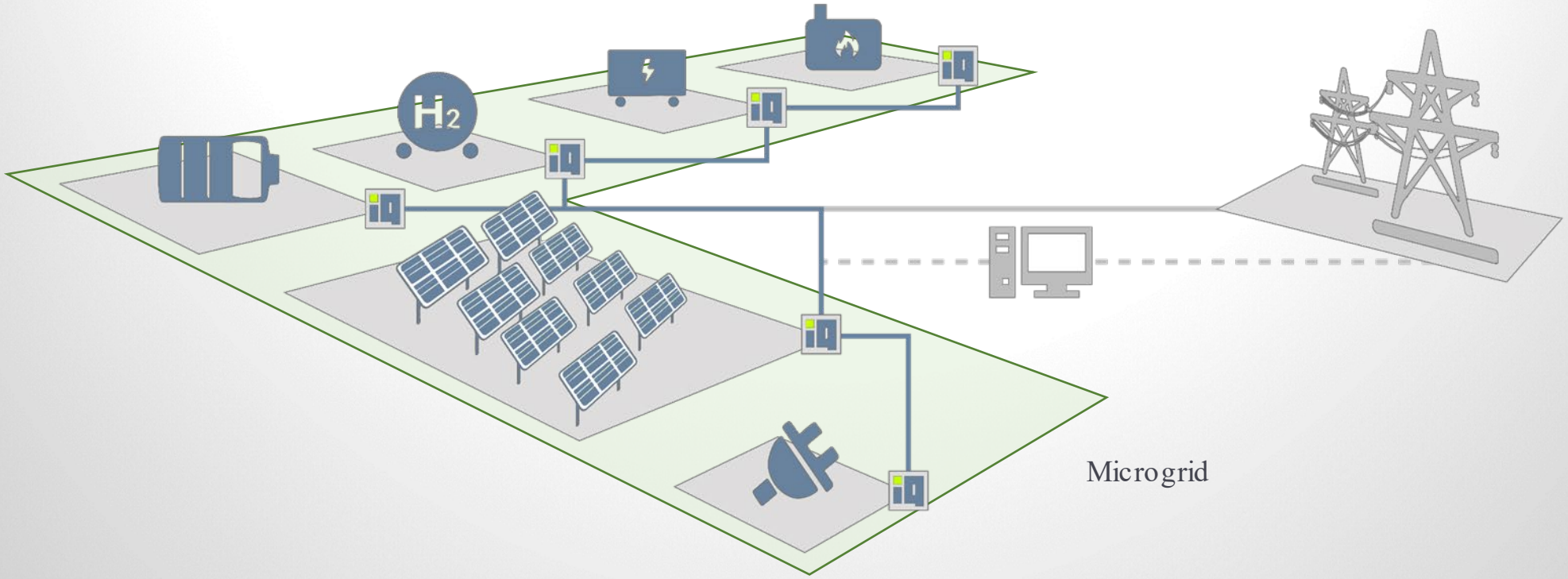
Solutions

Standardize disparate energy resources

Encapsulate complexity as single entity

Simplify scalability of the system

Main goal: control the microgrid as a single entity



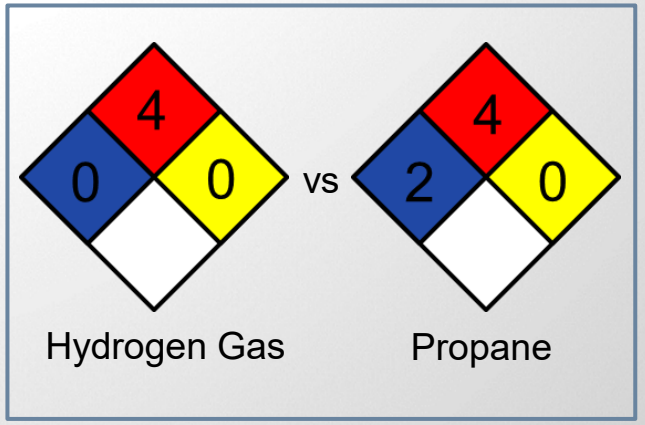
Microgrid

Regulatory Challenges in dealing with Hydrogen systems:

- Main observed challenges:
  - Complex permitting due to lack of understanding of hydrogen systems
  - Strict setback rules
  - Lack of standardized emergency procedures
  - Few projects to use as reference
- Regulation for hydrogen vehicles is less strict than for stationary hydrogen storage
- Larger setbacks and harder permits than propane

Applicable codes

NFPA Classification



Using Lessons Learned in other projects

Location: California

Type: Microgrid

Sector: Commercial

Fuel Source: Hydrogen with Electrolyzer + Fuel Cell

Key Drivers:
Resilience
Off-Grid Operations

Location: California

Type: Microgrid

Sector: WWTP

Fuel Source: Biogas

Key Drivers:
Economic Optimization
Grid Services

Location: New Mexico

Type: Microgrid

Sector: Military

Fuel Source: Natural Gas, Biogas

Key Drivers:
Economic Optimization
Grid Services
Resilience

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