A Role for Hydrogen as a Sustainable Fuel Gas

Stewart Island Energy Futures Workshop

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Conventional Electricity Supply

- Dispatchable central generation (5 gensets)
- Distribution (19km MV, 4km 230/400V)
- Maximum demand (~400kW)
- Relatively easy to match supply to demand
- Relatively easy to maintain

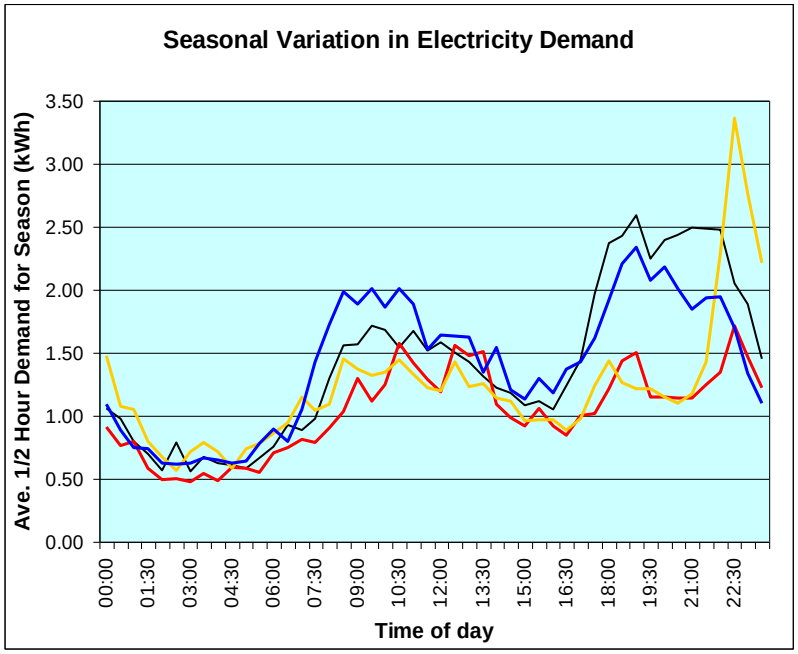
5kW/m2 – can be sited anywhere (within reason!)

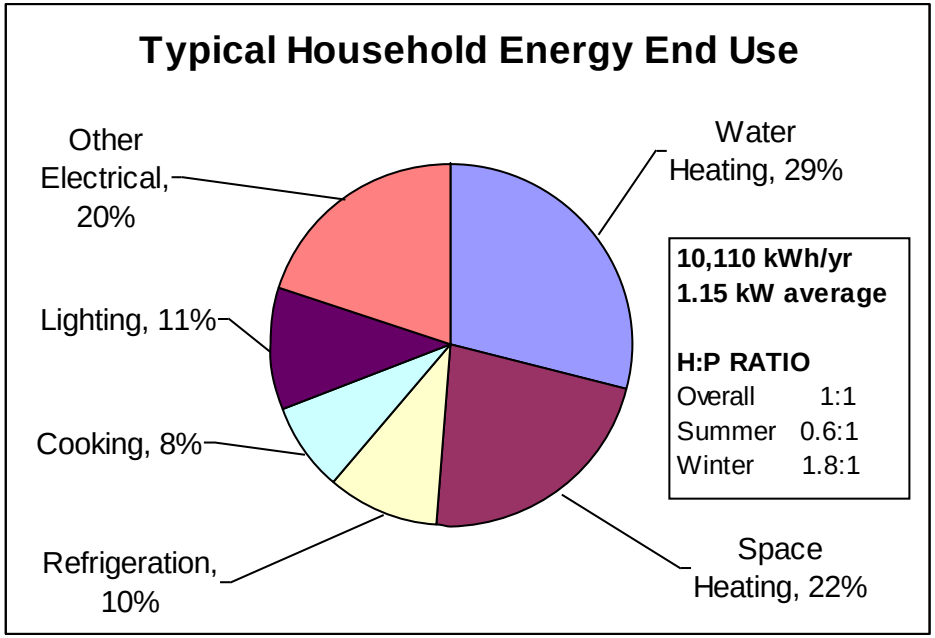
5,000 kW/line - unsightly (but accepted as part of the landscape)

1kW/house ave - (note ADMD is 3-4kW/house)

Typical NZ Energy Demand

- Electricity demand
  - Annual diurnal profile
  - Seasonal peaks
- Heat and power energy mix
  - Typical 1:1 heat to power ratio
  - Plus winter heating demand





Introduction of Renewable Electricity Generation

- Intermittent generation - storage is required
- Not so easy to match to demand
- Generation assets are more exposed to the environment
- Not so easy to maintain

100W/m2 ave - Wind turbines require open hilltops or ridges

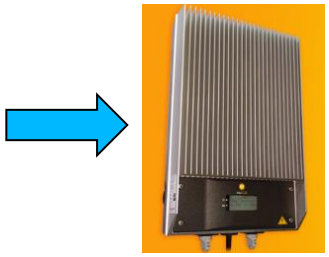
10W/ m2 ave - Solar PV arrays require un-obstructed sunny locations (angled at ~45 deg.)

Batteries have a short life, are large, and require ongoing maintenance

The Future - Distributed Renewable Energy

- Grid-connect many small scale systems at wherever there is a useful resource
- Hydro, wind, PV, wave
- Inverter connected – simple and maintenance free
- **But** the storage issue remains ….

Many hydro, wind, solar PV sites (close to the network)



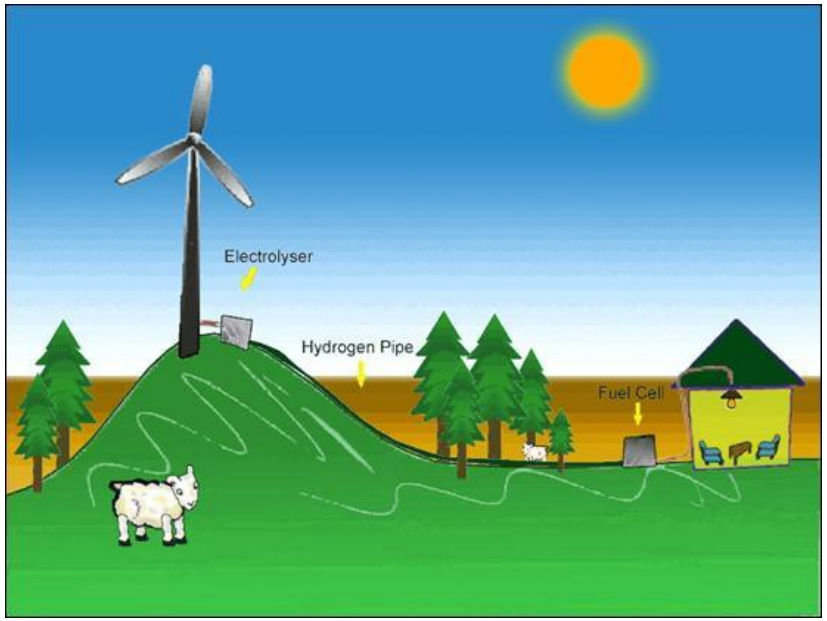
Many EnaSolar grid connect inverters

Many homes just like yours

Share supply and demand via the existing distribution infrastructure

Production of Hydrogen Fuelgas to Help Address the Storage Issue

- Surplus renewable energy ⇒ make hydrogen fuelgas from water and store it
- Insufficient renewable energy ⇒ use the hydrogen fuelgas
- IRL's solution: transport and store it in plastic pipes at 4 bar



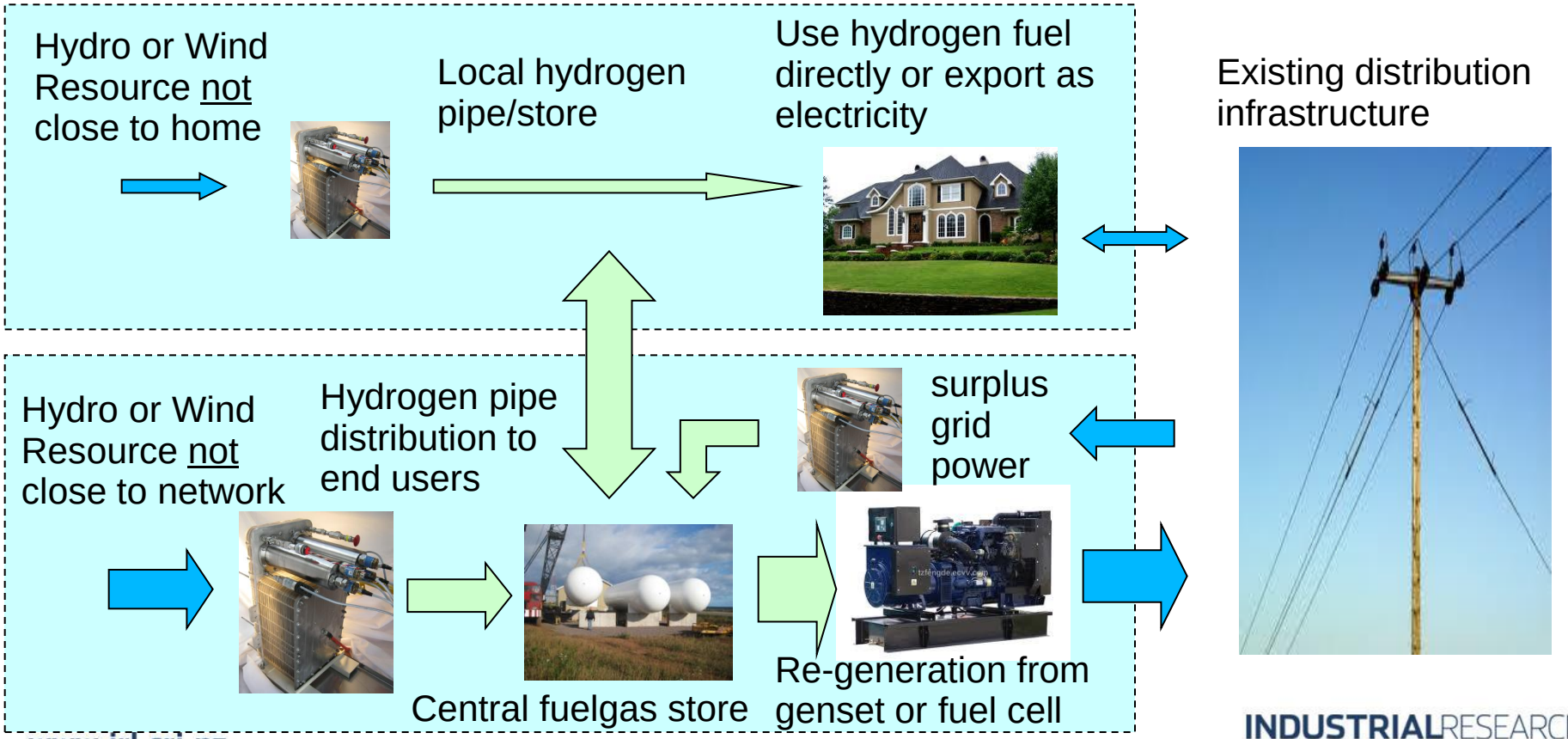
- Reliable low cost storage for matching intermittent supply to variable demand
  - Lifetime 30 years plus
  - At 4 bar we get 12kWh/m3 HHV clean fuelgas energy
  - Potent cost 1c/kWhstored
  - But:
    - Conversion losses
    - Hydrogen is best used directly

The Concept

- Distributed production of hydrogen as a renewable energy storage vector (green fuelgas)
- Use the hydrogen in heating, cooking, fuel cells and vehicles

Hydrogen Integration Options

- If no electrical distribution lines are available, produce the fuelgas directly at the resource site
- At larger scale, store the fuelgas at a central location and distribute by pipeline



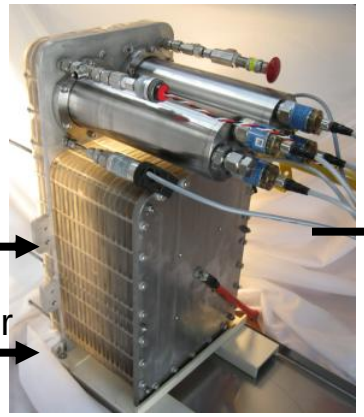
Use of the Hydrogen Fuelgas

- Cooking
  - Pure hydrogen: very hot, colourless flame
  - Blended with LPG, natural gas, biogas (up to 30%)
  - Hydrogen BBQs available “off the shelf”
- Heating
  - Pure hydrogen: special hydrogen gas heater appliances necessary
  - Blended with LPG, natural gas, biogas (up to 30%)
- Electricity production
  - Dual fuel gensets or direct air-mixed induction
  - Fuel cell generators
- Future transport applications
  - Must be compressed to high pressure (350 and 700 bar)
  - Fuel cell scooters, quad bikes, etc

Pilot System – Totara Valley

water

Power



hydrogen

hydrogen

air

Power to grid

Current Status

- Commercialisation
  - ESG Energy
  - Tecnico (Tony Pearson)
  - Somes Island demonstration project

P1 green energy demonstration module (ESG Energy)

Electrolyser and buffer storage pipe

Somes Island, Wellington Harbour (DOC)

Recommendations for SI

- Don’t attempt the big hit with a high cost - high risk centralised solution
  - Focus on low environmental impact, aggregated ecofriendly micro energy solutions
- Immediately introduce a customer efficiency/conservation programme
  - Insulation, heat pumps, etc.
- Systematically introduce inverter connected microgeneration to complement and gradually displace diesel fuel generation
  - Multiple technologies and multiple sites – the more the better
- Consider during selection of sites the option of hydrogen for transmission-storage

Recommendations for SI

- Commission a techno-economic resource-technology study on the cost benefits of uptake of dispersed microgeneration for wind, PV and hydro (eg 100 x 3kWnom systems installed over the next 5 years)
- Commission a study on LV/MV grid stability impacts of microgeneration
  - Two way power flow
  - Penetration levels of concern
  - Means of mitigating effects
- Assess the combination of central battery and hydrogen storage and the best location for these systems
  - Local or distributed use of hydrogen fuelgas?
  - Use of hydrogen for diesel genset performance enhancement

Recommendations for SI

- Single ownership of the system (SDC) means that an innovative approach should be feasible
- Must Dos
  - Offer realistic incentives to customer/users for use of their energy resources
  - Work out a fair microgeneration ownership, maintenance and energy payment model
  - Operate an integrated maintenance programme on all systems (no matter how small) as a requirement of signup
  - Take an incremental approach so the any technical or market problems so they can be addressed at small scale early on

Distributed and Hydrogen Energy

- Benefits of dispersed microgeneration
  - Redundancy: one failure won't bring the system down
  - Diversity: can ride through poor intensity on one site
  - Inverters can now provide built-in automatic voltage management (required by law in Germany)

- Benefits of Hydrogen fuelgas
  - Cost effective transport and storage
  - Efficient if used directly
  - Supplement LPG use