



# MSc Renewable Energy Systems and the Environment

## Data Centres and Renewable Energy



**Aim:** To evaluate the feasibility of building data centres in remote Northern Scotland, powered **wholly or largely** by renewable energy

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# Context

## Pros:

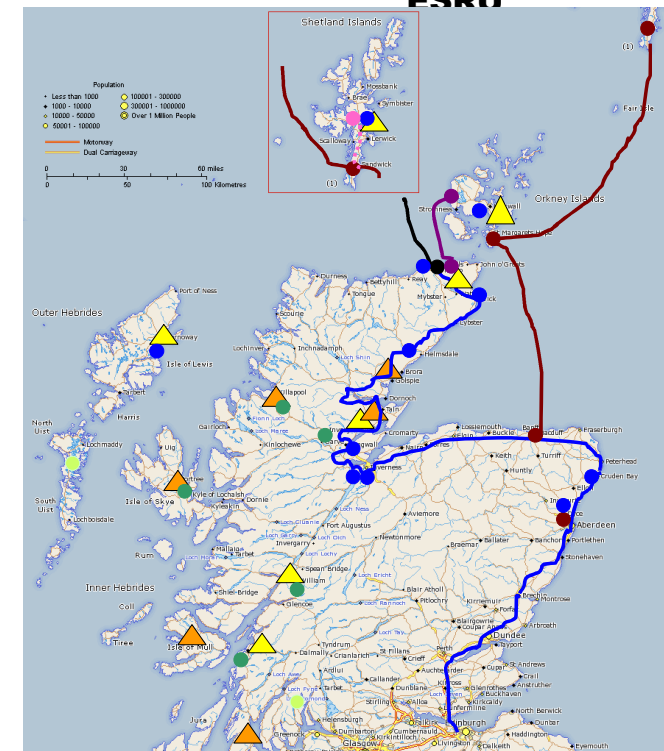
- Fibre optic networks exist – Shetland, Orkney, Caithness/ NE coast
- Environmentally, politically and socially secure
- Skills base & competitive labour market,
- Low temperatures allow 100% free cooling
- Plentiful supplies of renewable energy

## Cons

- Weak grid – low voltage distribution
- Client wariness – distance, power availability
- New industry in region

## Project approach

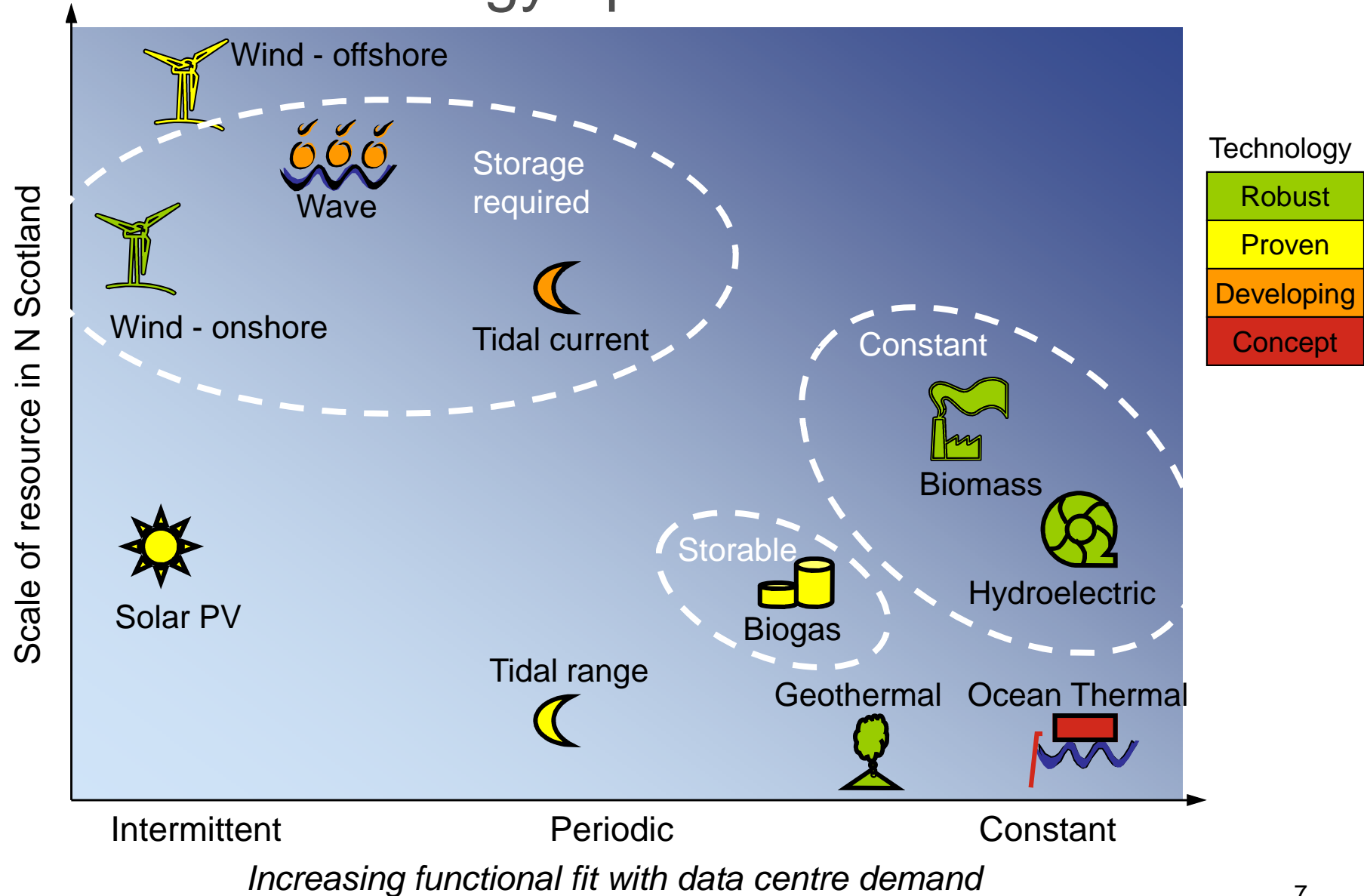
- small, container-sized demonstrator
- low risk, can be scaled up
- 250kW IT / 320kW total demand



Map: <http://www.itraveluk.co.uk/maps/scotland.html>

- ▲ Population 5,000-10,000
- ▲ Population 1,000-5,000
- FARICE-1 cable
- Linkage to main C&W network
- SHEFA-2 cable
- New link SHEFA-Lerwick
- Known/ poss telecom access

# Renewable energy options



# Energy supply solutions – no storage

Option	Requires	Issues
Hydroelectric	Example conditions: 50m head, 1m <sup>3</sup> /sec min flow 150m, 0.35m <sup>3</sup> /sec	<ul style="list-style-type: none"> <li>• resource location specific</li> <li>• river flows fluctuate</li> <li>• needs transmission lines to road</li> <li>• 1400t annual CO<sub>2</sub> savings</li> <li>• net cost ~ 2p/kWh</li> </ul>
Wind + Biogas (Anaerobic Digestion)	1.5MW wind turbine 1250 t/ month mixed waste AD capacity 58500m <sup>3</sup> gas storage	<ul style="list-style-type: none"> <li>• 65% energy from wind</li> <li>• needs enough people plus eg food processing industry</li> <li>• 8100t annual CO<sub>2</sub> savings</li> <li>• net cost ~ 4p/kWh</li> </ul>
Biomass (boiler + CHP plant)	1.6MW boiler 320 kWe CHP plant 10-11 t/day woodchip	<ul style="list-style-type: none"> <li>• 950ha managed forest nearby</li> <li>• backup generator 4-20d/year</li> <li>• no subsidies (FITs)</li> <li>• cost ~16p/kWh+</li> </ul>

# Energy supply solutions – with storage

Option	Requires	Issues
Tidal current + Pumped storage	Max spring velocity = 3.45m/s 3 x 500kW MC turbines Reservoir: eg 200m head, 10m dam, 1.1 ha	<ul style="list-style-type: none"> <li>• storage for 5 days</li> <li>• resource location specific</li> <li>• maintenance &amp; reliability issues</li> <li>• net cost ~ 45p/kWh</li> </ul>
Wind + Hydrogen storage	2.3 MW wind turbine H <sub>2</sub> production: 655m <sup>3</sup> /hr H <sub>2</sub> storage: 900m <sup>3</sup> at 250bar	<ul style="list-style-type: none"> <li>• turbine stationary ~ 70 d/yr</li> <li>• H<sub>2</sub> store for 35 days</li> <li>• H<sub>2</sub> runs 6 days at a time</li> <li>• Compressed gas or metal hybrid storage - very expensive</li> </ul>
with excess production	2 turbines 2/3 production capacity 1/3 storage	<ul style="list-style-type: none"> <li>• net cost halved to ~90p/kWh</li> <li>• excess electricity for 950 households</li> </ul>
Wave + Hydrogen storage	Pelamis at 750kW H <sub>2</sub> production & storage greater than wind	<ul style="list-style-type: none"> <li>• 40% of energy delivered in winter; 10% in summer</li> <li>• maintenance &amp; reliability issues</li> <li>• most expensive: ~200p/kWh+</li> </ul>

# So what?

## Scaling up:

- Feed-In Tariffs apply only up to 5MW generating capacity
- storage problems and costs scale proportionately
- wind (and wave): seasonal variations are challenging

## Grid connection:

- peak loading stress where distribution system is weak
- multiple, very large data centres could meet same stress

## Best direction – supply storage to cover peak load hours

- small to medium size: wind, biogas and grid
- large size: tidal current with pumped storage

See: <http://www.strath.ac.uk/esru/degrees/renewablenrg/>

