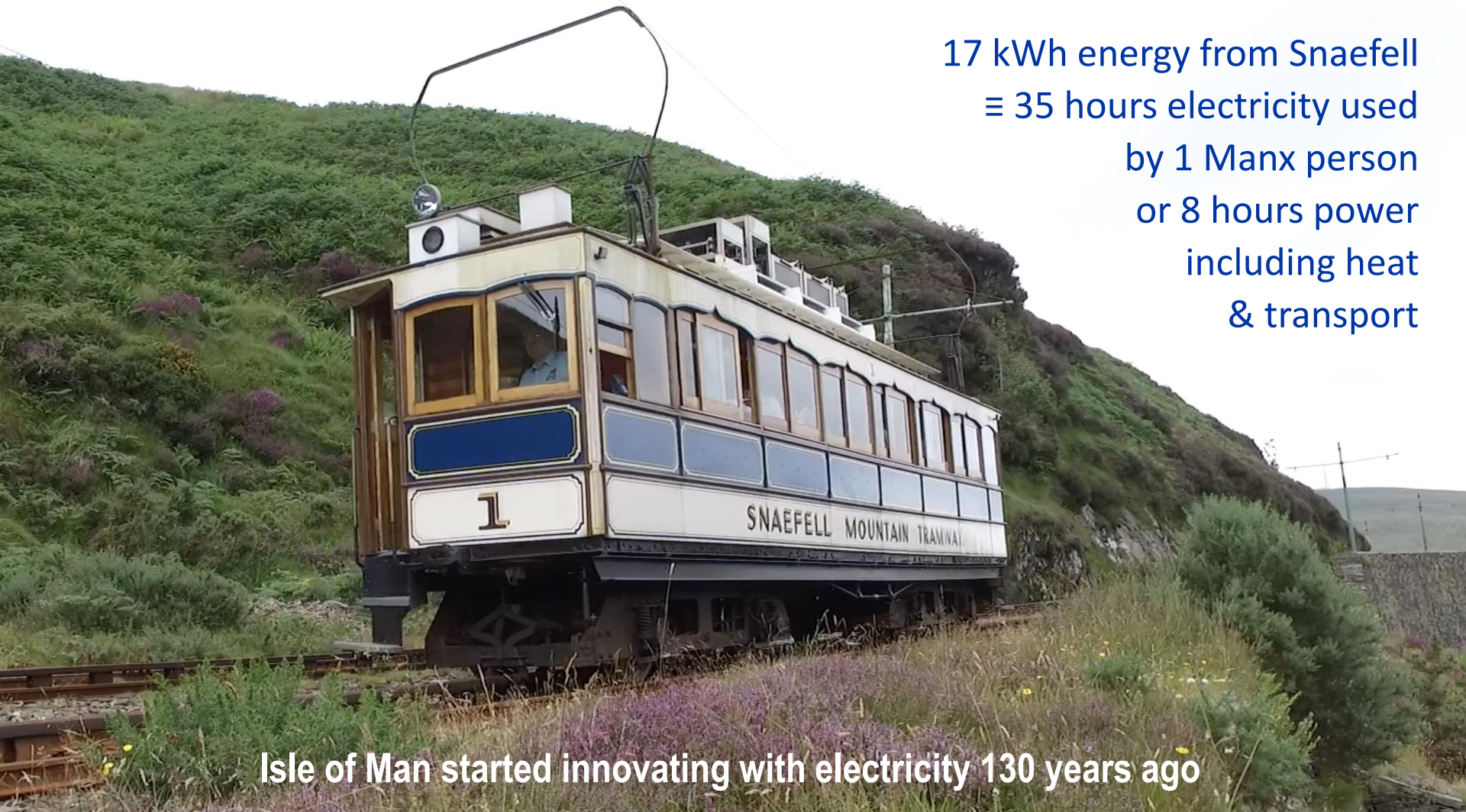




Welcome to the Low-Carbon Island conference

17 kWh energy from Snaefell
≡ 35 hours electricity used
by 1 Manx person
or 8 hours power
including heat
& transport



Isle of Man started innovating with electricity 130 years ago

Options for Sustainable Power on the Isle of Man

3

Dave Quirk, Ralph Peake, John Boucher

Government prioritises & enables

Industry embraces Island's needs

Mutual benefit through collaboration



≥1500 Laxey Wheels needed to power the Island

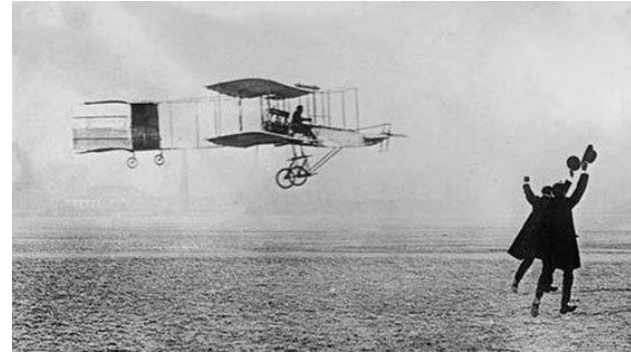
Grateful thanks to

4

- Manannan Energy
- Zurich, KPMG, Peel Group, MMC
- Phil King, Simon Clague, Adrian Dobbins & Mike Newby
- IoM Government Chief Minister & Deputy Chief Minister
- Poul Østergaard, Henrik Lund, Filipe da Silva, Felipe Camara & DTU Offshore
- Dave Armstrong, Gary Myers, Mike Quirk, Charles Guard
- Rebecca Keeley, Maya Sengupta Gledhill
- Mark Shimmin



- Commitment to NZE in <28 years
 - We can benefit from renewable energy now
 - Time is of the essence
 - Which path is best?



- Commitment to NZE in <28 years
 - We can benefit from renewable energy now
 - Time is of the essence
 - Which path offers most benefit?

Lots of valid reasons why low-carbon power looks difficult
But changing perceptions of what is affordable & resilient

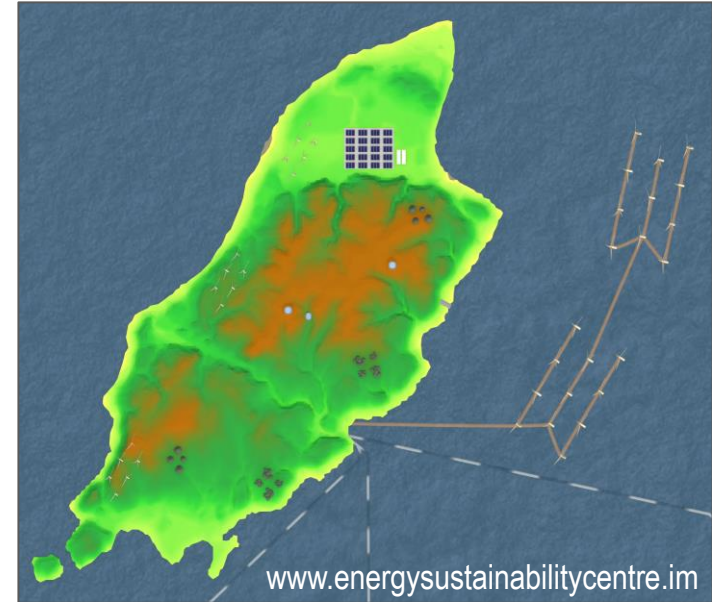
- Can Island's gas & oil power plants be replaced by renewables?
 - If so, how to transition? If not, what to do instead?



- Commitment to NZE in <28 years
 - We can benefit from renewable energy now
 - Time is of the essence
 - Which path offers most benefit?

Lots of valid reasons why low-carbon power looks difficult
But changing perceptions of what is affordable & resilient

- Can Island's gas & oil power plants be replaced by renewables?
- No regret decision
 - Wind & solar power
 - Energy storage
 - Export facility



Isle of Man's situation

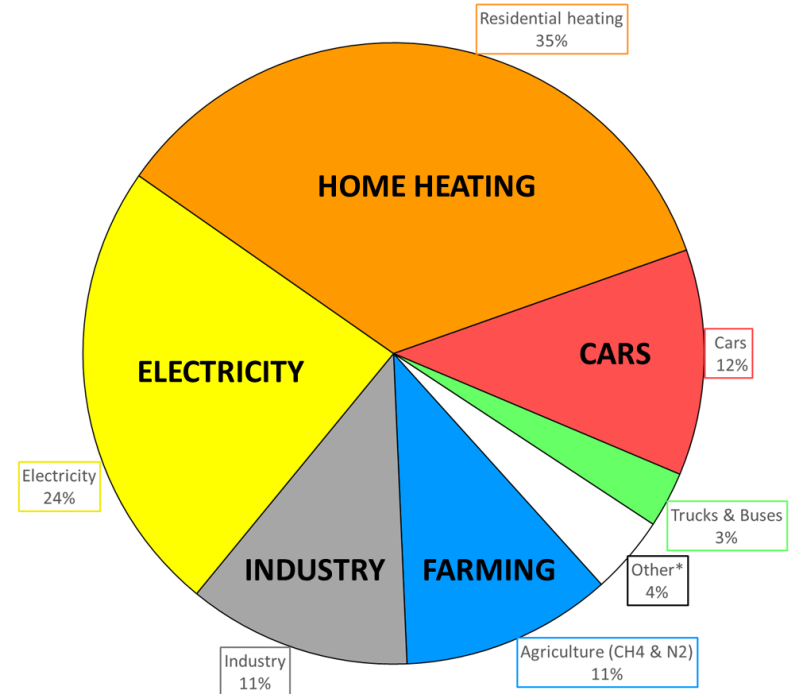
- Annual ½ million tonnes of CO₂ from use of fossil fuels
 - Same as CO₂ captured by 1250 km² forest



2500 Meary Vegg

Isle of Man's situation

- Annual ½ million tonnes of CO₂ from use of fossil fuels
 - Power consumption c.1300 GWh per year

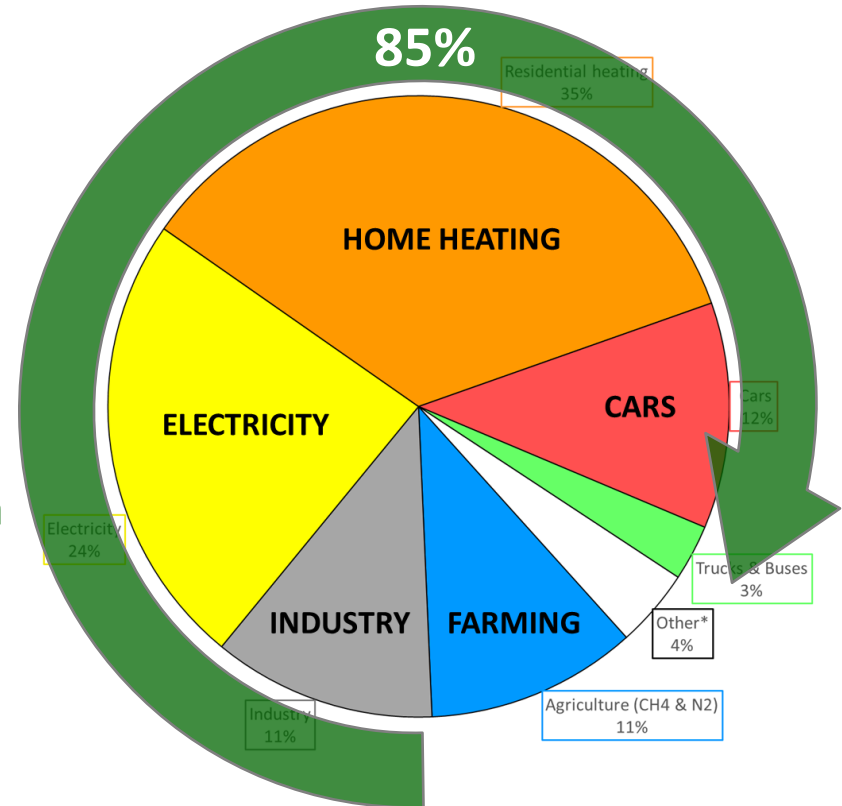


Isle of Man's situation

10

- Annual ½ million tonnes of CO₂ from use of fossil fuels
 - Power consumption c.1300 GWh per year
- Enviably renewable energy resources*
 - Predictable costs & value

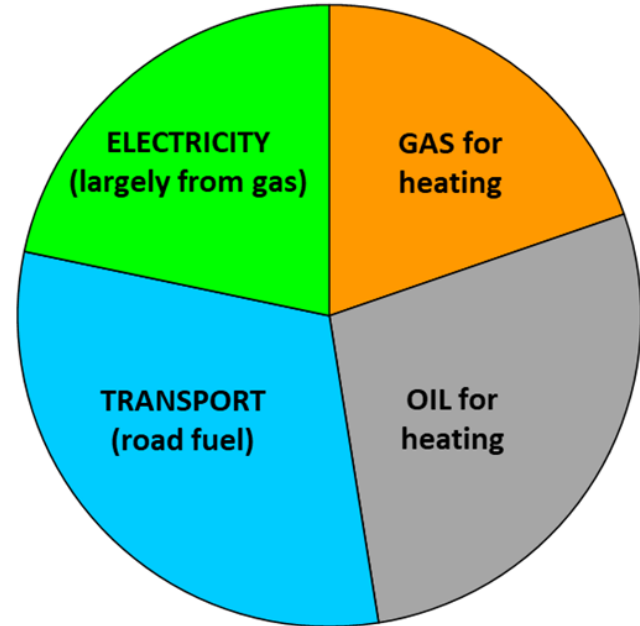
**Wholesale
electrification**



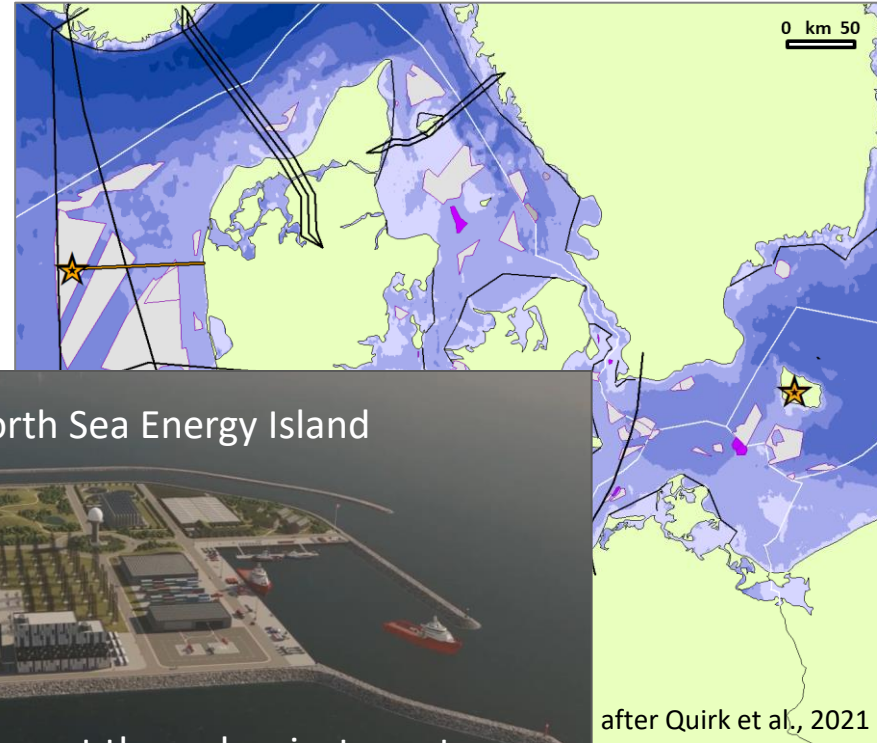
* Wind & solar is the cheapest generated power

- Annual ½ million tonnes of CO₂ from use of fossil fuels
 - Power consumption c.1300 GWh per year
- Enviaible renewable energy resources*
 - Predictable costs & value
- High & volatile gas & oil prices
 - Winter supply worries

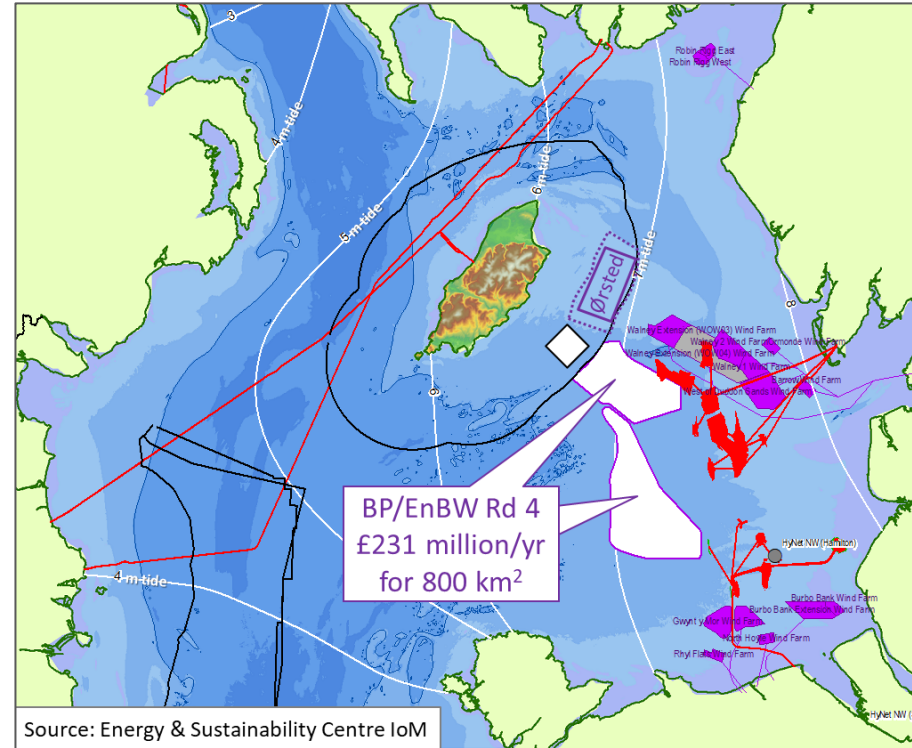
**Manx renewable
energy resource
≈70,000 GWh/yr**



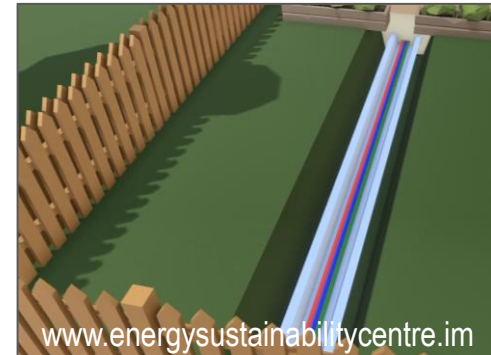
- Annual ½ million tonnes of CO₂ from use of fossil fuels
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 - Winter supply worries
- Value of Island's location



- Annual ½ million tonnes of CO₂ from use of fossil fuels
 - Same as CO₂ captured by 1250 km² forest
- Enviable renewable energy resources
 - Predictable costs & value
- High & volatile gas & oil prices
 - Winter supply worries
- Value of Island's location

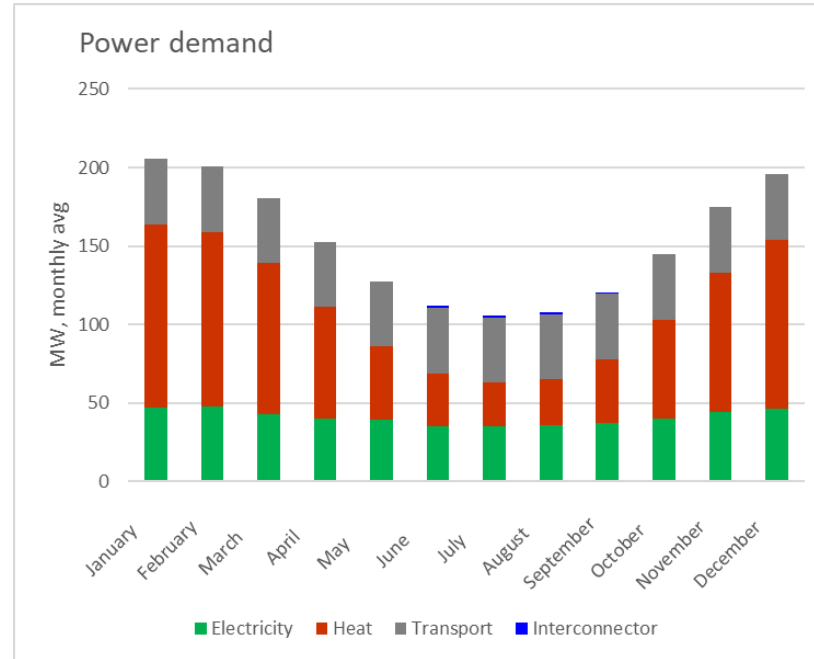


- **Is the energy transition doable?**
 - Can the IoM be self-sufficient in renewable energy?
 - How to pay for new infrastructure?
- **What are the benefits to IoM?**
 - Is affordable energy realistic?
- **What is motivating us?**
 - Can Manx houses be as warm & dry as Denmark?
 - Can we replace Pulrose & Peel power stations?
 - How to help the economy... & avoid carbon penalties?
 - What do businesses & new industry need?
 - How to be responsible global citizens?
- **Would you accept a fixed price for green power?**



What is the energy transition?

15



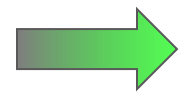
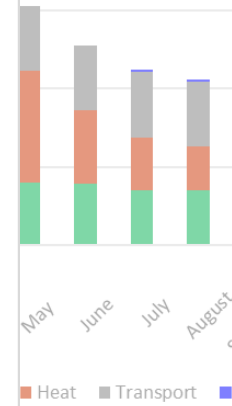
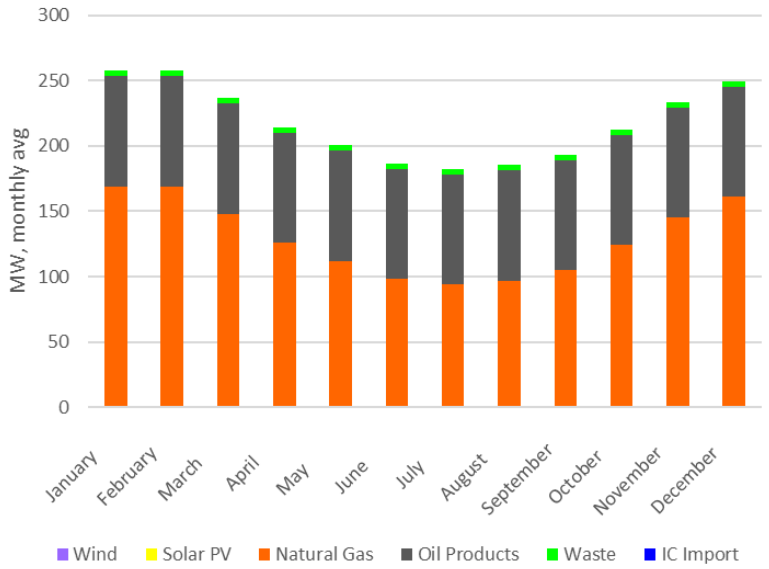
What is the energy transition?

Power demand

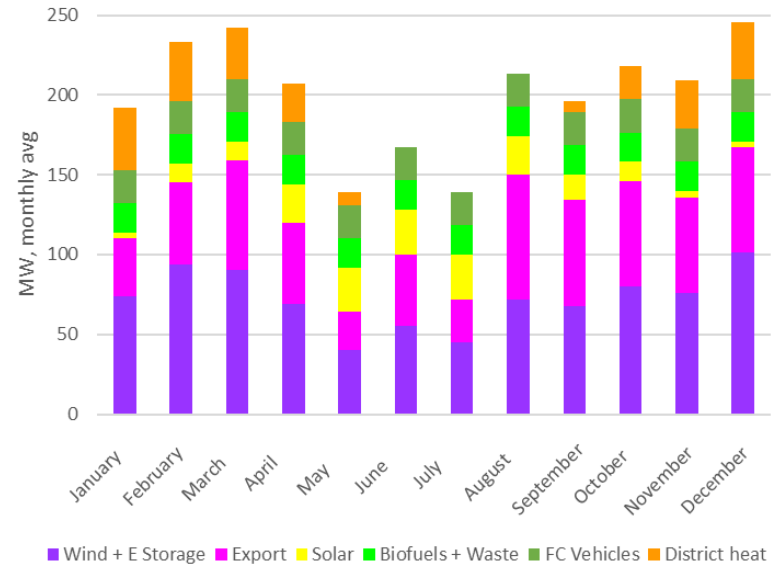
250

200

Current situation - most power from gas & oil

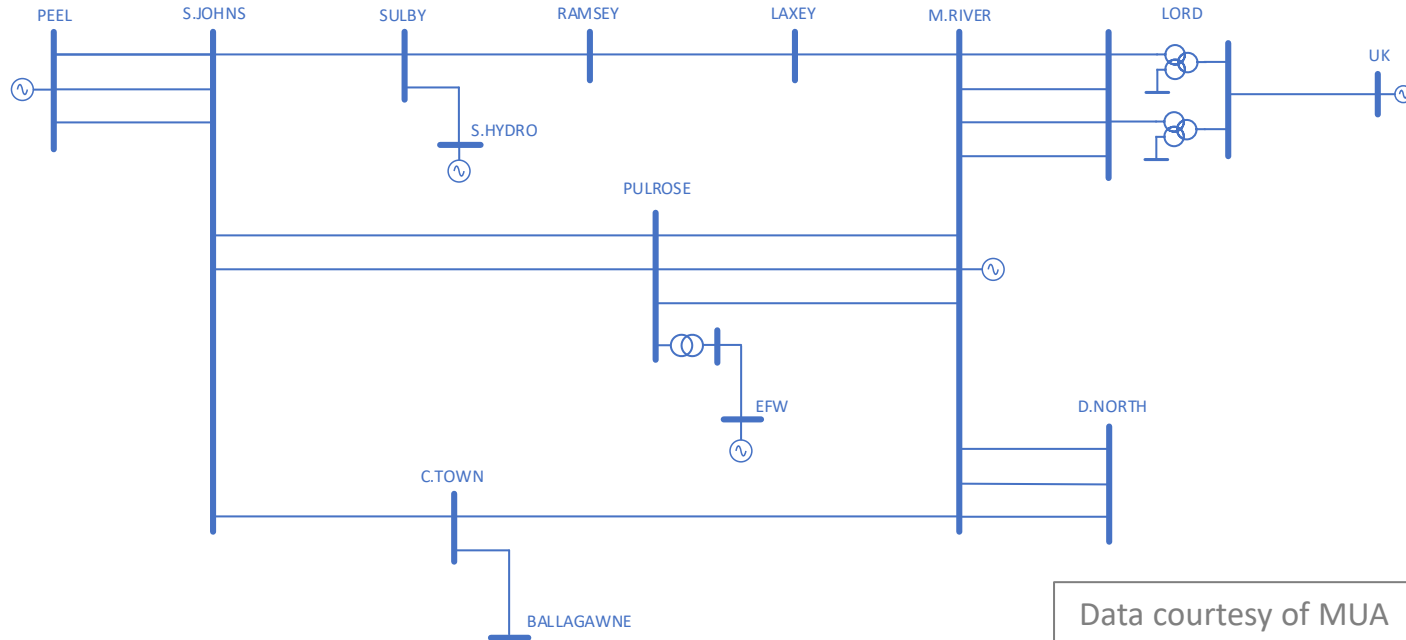


Power supply (electricity from wind, solar, storage)



But not that simple

- The electricity grid is truly a wonder
 - Power at a flick of a switch
 - The largest, most complicated human construction



But not that simple

18

- The electricity grid is truly a wonder
 - Power at a flick of a switch
 - The largest, most complicated human construction
- Fossil fuel power plants are flexible & provide heat ... ignoring emissions & costs
- Wind & solar energies are intermittent



The diagram illustrates the components of a power system, showing a hierarchy from Network Components (NC2, NC3) to a Power Plant (PP4) and Power Electronics. It also includes a table of key performance indicators for Power Electronics.

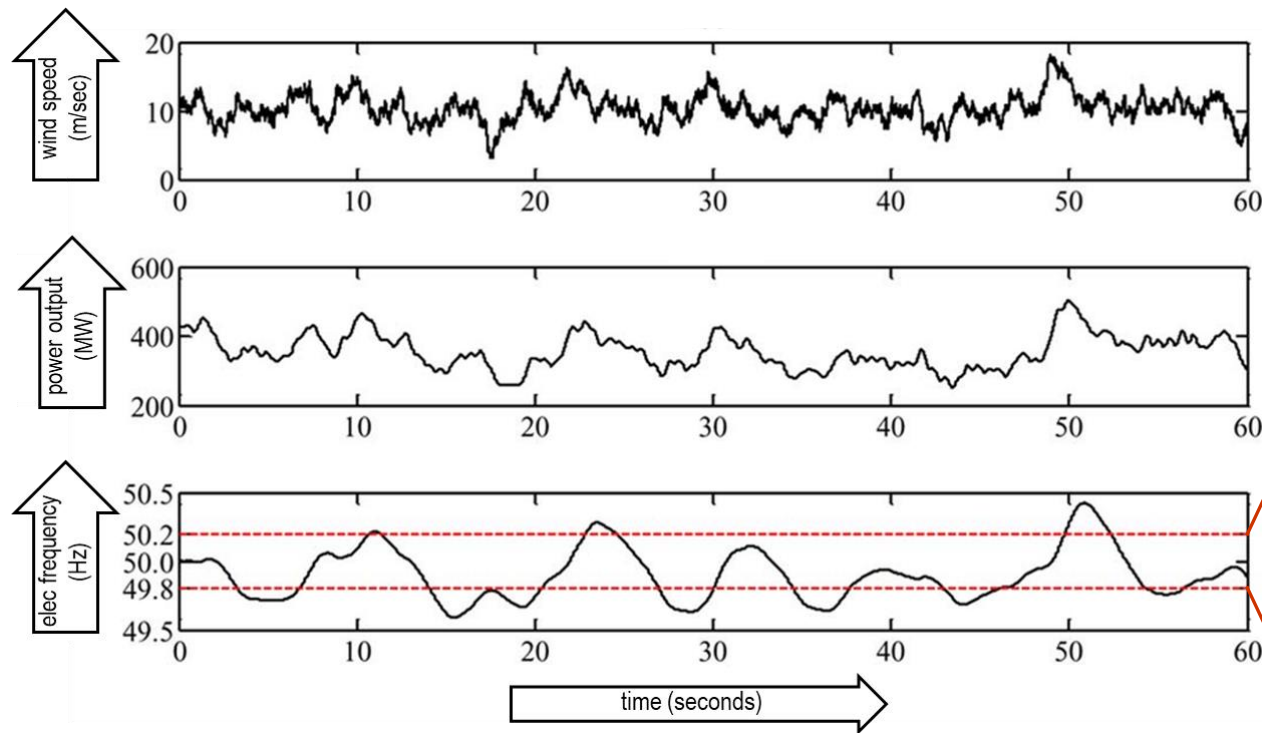
Parameter	Value	Unit / Note
Total 20 year cost	180	£ million for 100 MW
Surface area of facility	<0.1	km ² for 100 MW
Annual CO ₂ emissions	2	000 tonnes avg for 1 TWh
Operating life	15	years
Economic benefit	2 ☆	added cost to renewables
Controllable supply?	3 ☆	dependent on storage

Additional information: Ancillary services using smart electronics. Provides active & reactive power control, frequency & voltage control, synthetic inertia and fault ride-through capabilities.

Part of a viable system with Energy Storage ES6 & Network Component NC2 or NC3

Any variation in supply or demand can affect the stability of the grid

19



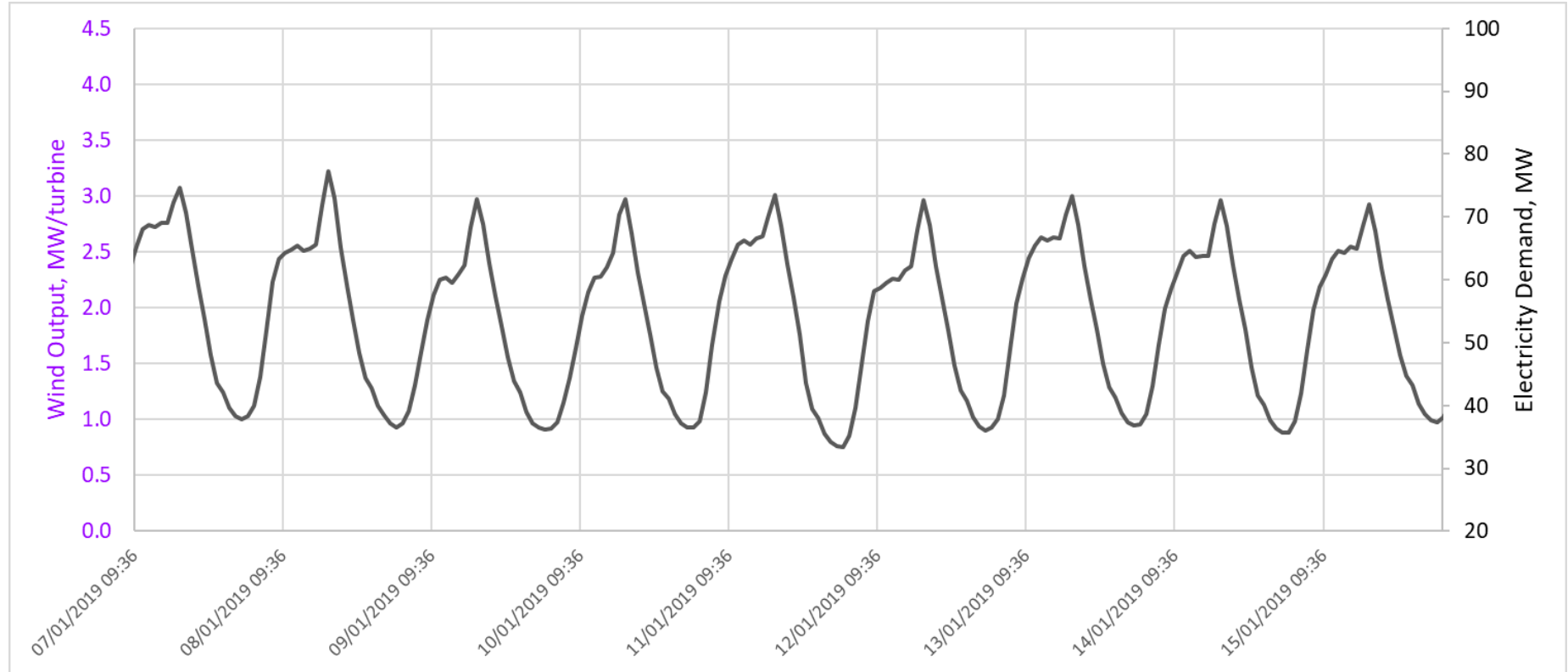
From www.energy.sustainabilitycentre.im
after Jiang et al., 2014

Ancillary services are used to avoid blackouts (batteries, synchronous condensers, power electronics, etc.)

- The electricity grid is truly a wonder
 - Power at a flick of a switch
 - The largest, most complicated human construction
- Fossil fuel power plants are flexible & provide heat
...ignoring emissions & costs
- Wind & solar energies are intermittent
- Electricity demand is variable

Variation electricity demand over 8 days in January

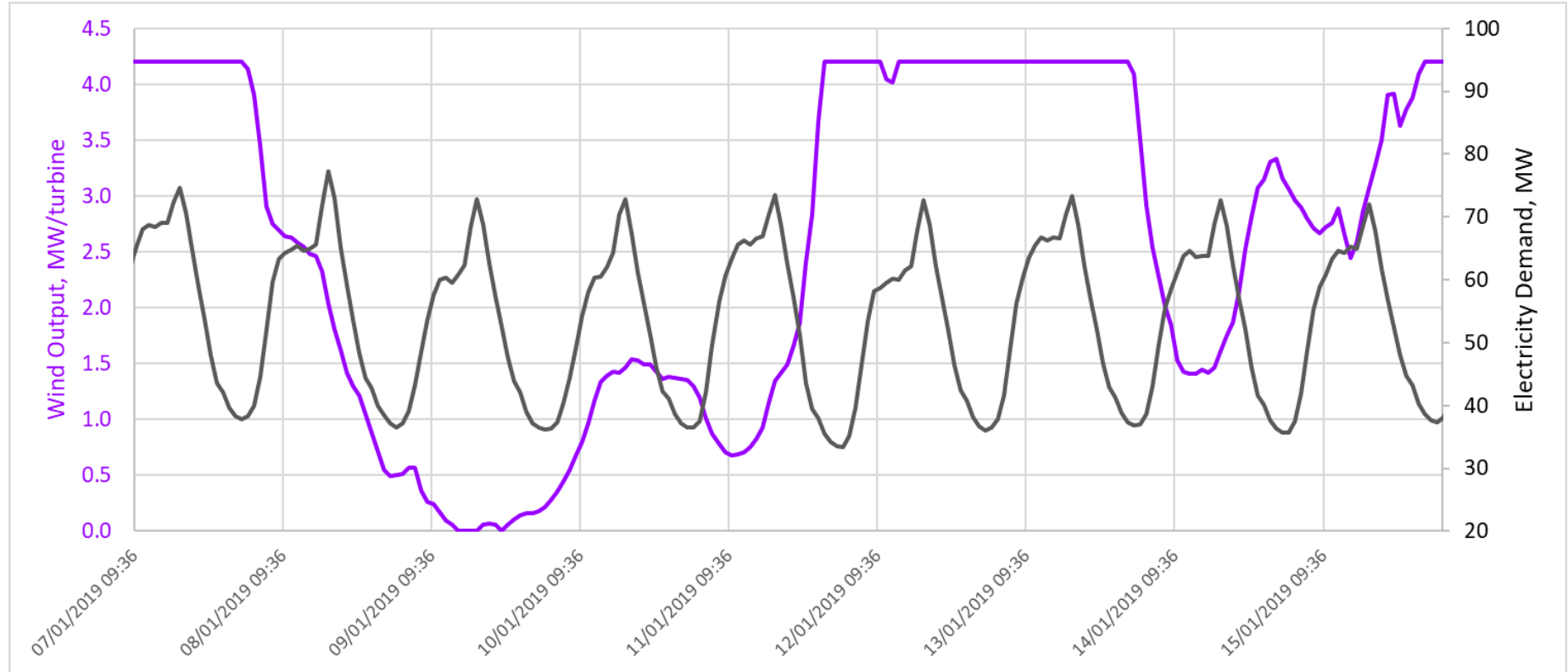
21



Data courtesy of MUA

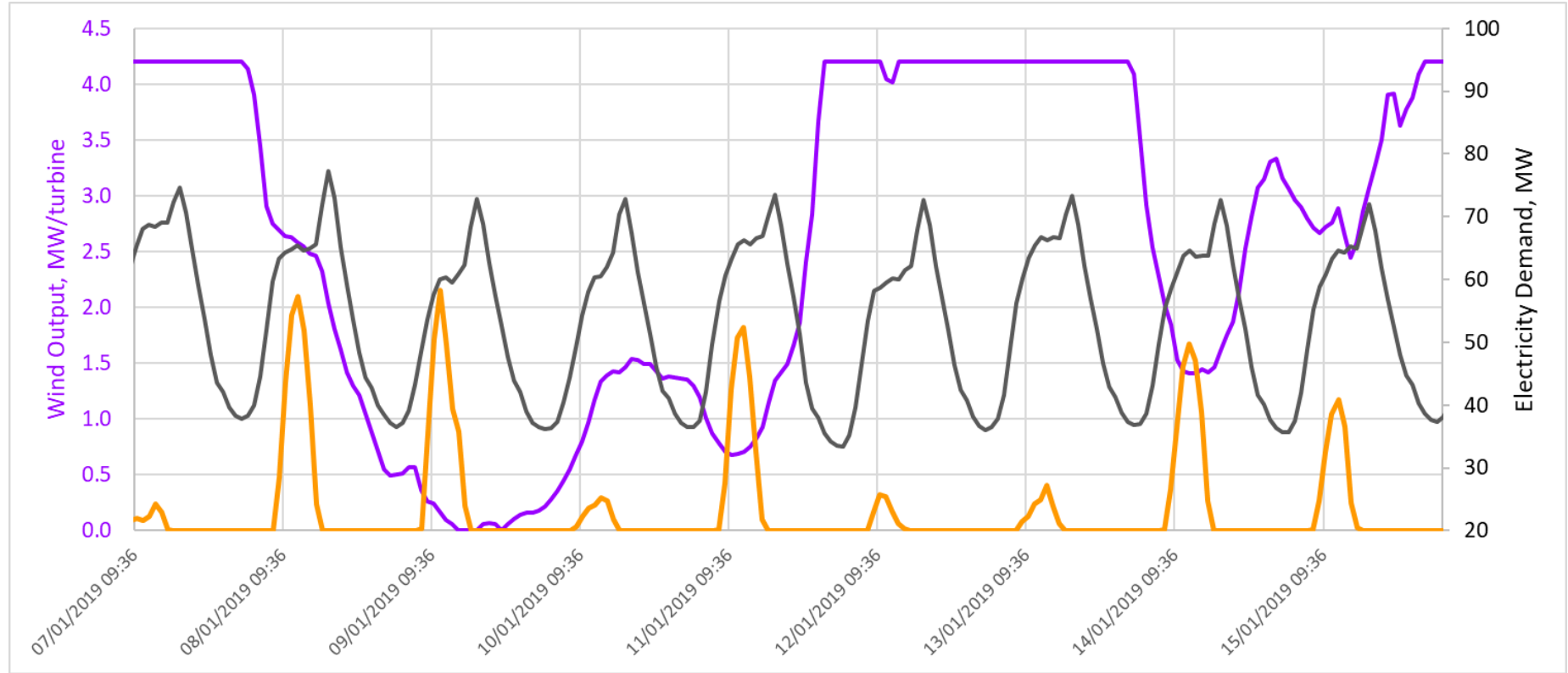
Variation in wind power over 8 days in January

22



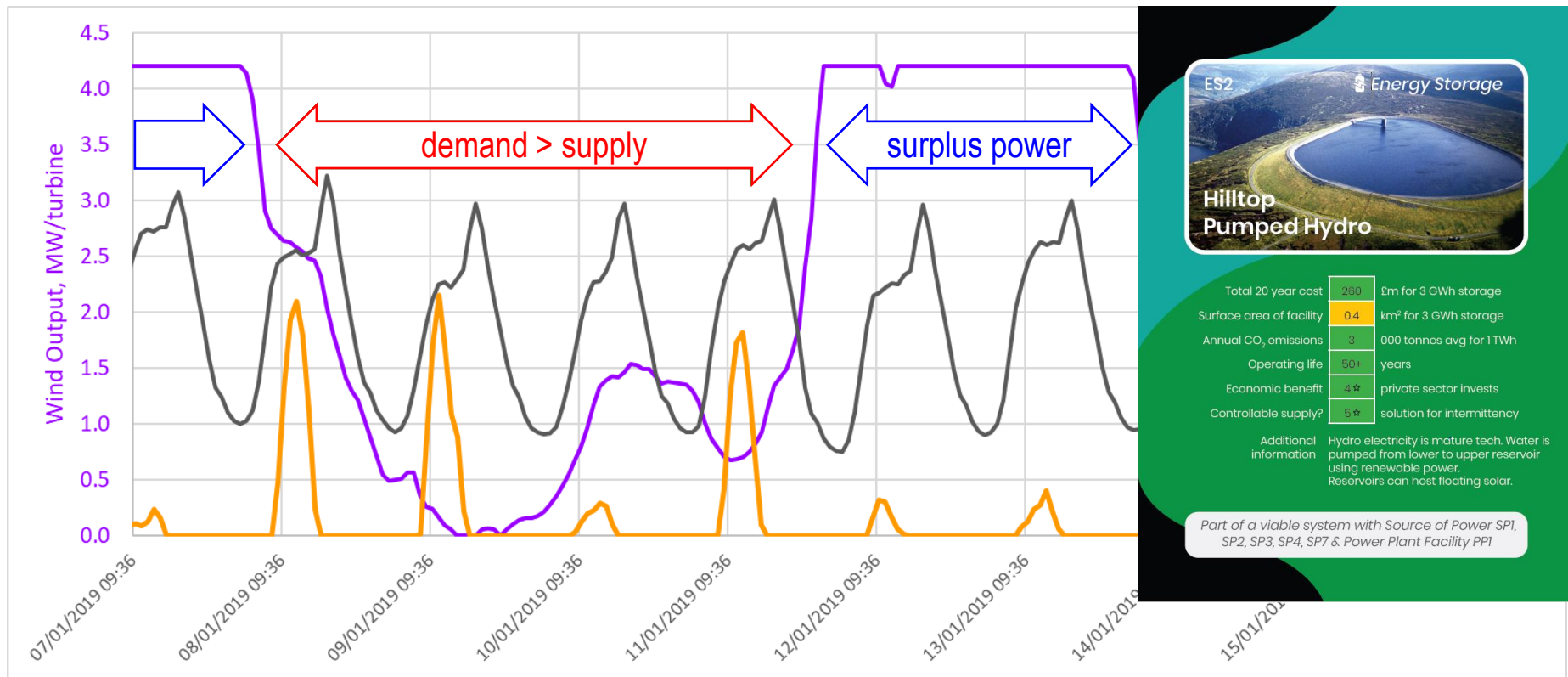
Variation in solar power over 9 days in January

23




Turn on power plant, import electricity or build energy storage

24



- The electricity grid is truly a wonder
 - Power at a flick of a switch
 - The largest, most complicated human construction
- Fossil fuel power plants are flexible & provide heat ...ignoring emissions & costs
- Wind & solar energies are intermittent
- Electricity demand is variable
- Tidal, wave power & nuclear are not commercial
 - Immature & expensive (+ radioactive legacy)



SP7 ⑦ Source of Power

Small Modular Nuclear Reactor

Total 20 year cost	1800	£ million for 1 TWh/year
Surface area of facility	0.4	km² for 1 TWh/year
Annual CO ₂ emissions	19	000 tonnes avg for 1 TWh
Operating life	30	years
Economic benefit	3 ☆	no local advantage
Controllable supply?	3 ☆	constant but inflexible

Additional information Nuclear fission is mature technology. Issues with public acceptance, safety, radioactive waste & decommissioning. Provides baseload power but inflexible.

Part of a viable system when combined with Energy Storage ES1, ES2, ES3, ES4, ES5, ES6, ES7

But not that simple

26

- The electricity grid is truly a wonder
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- Fossil fuel power plants are flexible & provide heat ...ignoring emissions & costs
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- Electricity demand is variable
- Tidal, wave power & nuclear are not commercial
 - Immature & expensive (+ radioactive legacy)
- Wrong geology for geothermal (+ expensive & risky)



BE2 Bonus Element

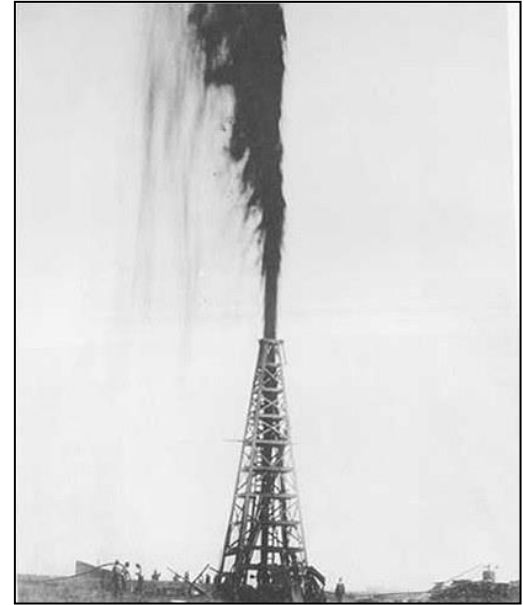
Seawater-Sourced Heat Pump

Total 20 year cost	1200	£ m, incl 10p/kWh electricity
Surface area of facility	0.1	km ² (onshore only)
Annual CO ₂ emissions	5	000 tonnes avg for 1 TWh
Operating life	40	years
Economic benefit	4★	warm, dry houses
Controllable supply?	2★	may need more heat

Additional information Refrigerant is fed through a network of pipes on the seabed to extract heat. An electric compressor in the plant warms water by about 30°C.

Provides continuous residential heating to communities via district heating scheme

- The electricity grid is truly a wonder
 - Power at a flick of a switch
 - The largest, most complicated human construction
- Fossil fuel power plants are flexible & provide heat ...ignoring emissions & costs
- Wind & solar energies are intermittent
- Electricity demand is variable
- Tidal, wave power & nuclear are not commercial
 - Immature & expensive (+ radioactive legacy)
- Wrong geology for geothermal (+ expensive & risky)
- What is the best way to transition?



If only we weren't fossil fuel-dependent

- Can we blame geology, Texas or Henry Ford?
- A simple path is not always the right one

- Compiled data* on all energy transition options
 - generation, storage, costs
- Built digital models using state of the art software
 - EnergyPlan & PowerFactory
- Simulated & optimised paths to future energy systems
 - roadmap to low-carbon IoM

The screenshot displays the EnergyPLAN 16.0 software interface. The title bar indicates the file path: "EnergyPLAN 16.0: Base22_IoM_EnPLANinput_JBDQ_24Aug22.txt". The interface includes a menu bar (Home, Add-On Tools, Help) and a ribbon with various icons for file operations, settings, and simulation. The main window is divided into two panes. The left pane, titled "Overview", shows a hierarchical tree structure of the model components, including Demand, Supply, Balancing and Storage, and Cost. The right pane, titled "Electricity Demand and Fixed Import/Export", contains a table of parameters and their values, along with buttons for changing distributions and a small schematic diagram.

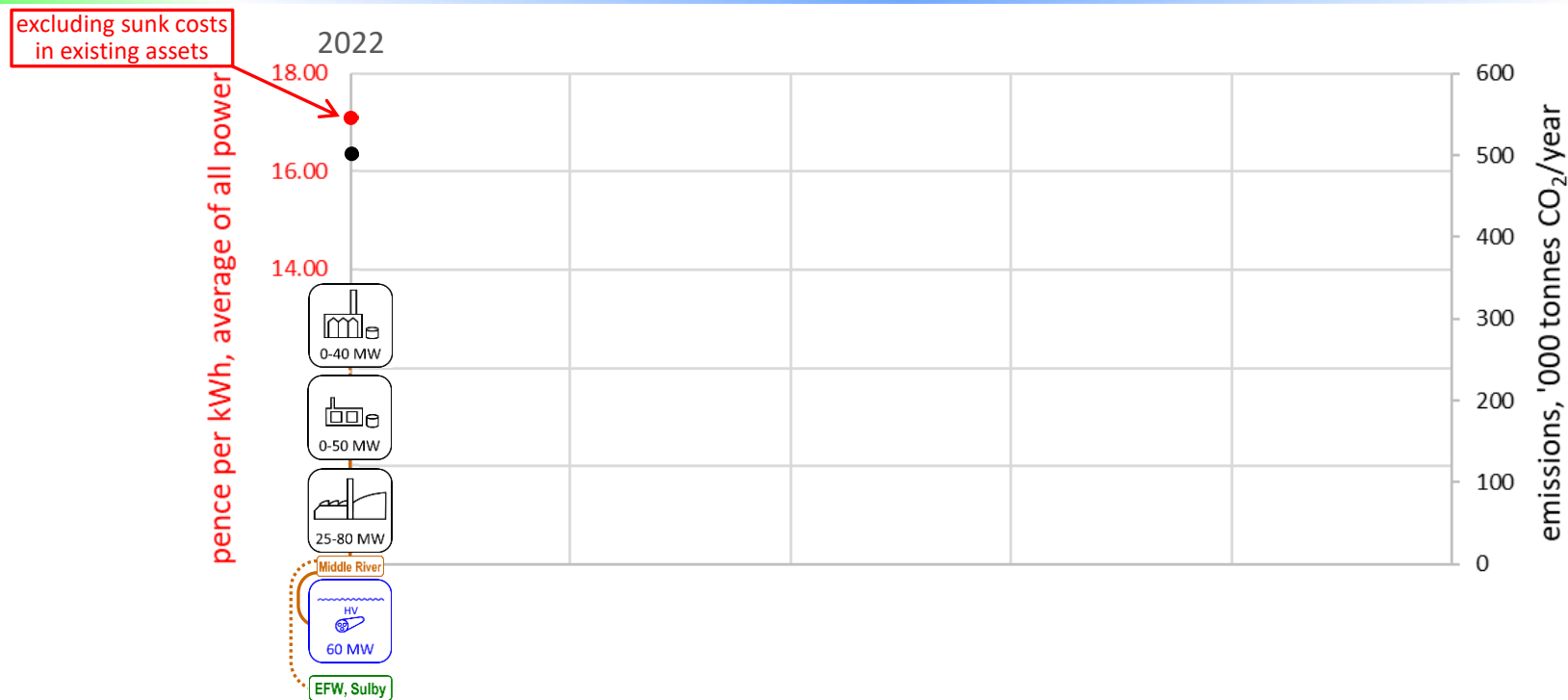
Parameter	Value	Unit	Action	File/Source
Electricity demand*	0.36	TWh/year	Change distribution	IoM_MUA_electricity_demand_2021_JB_24_Aug_22.txt
Additional electricity demand	0	TWh/year	Change distribution	const.txt
Electric heating (IF included)	0	TWh/year	Subtract electric heating using distribution from 'individual' window	
Electric cooling (IF included)	0	TWh/year	Subtract electric cooling using distribution from 'cooling' window	
Elec. for Biomass Conversion	0.00	TWh/year	(Transferred from Biomass Conversion TabSheet)	
Elec. for Transportation	0.00	TWh/year	(Transferred from Transport TabSheet)	
Sum (excluding electric heating and cooling)	0.36	TWh/year		
Electric heating (individual)	0.00	TWh/year		
Electricity for heat pumps (individual)	0.00	TWh/year		
Electric cooling	0.00	TWh/year		
Flexible demand (1 day)	0	TWh/year	Max-effect	0 MW
Flexible demand (1 week)	0	TWh/year	Max-effect	0 MW
Flexible demand (4 weeks)	0	TWh/year	Max-effect	0 MW
Fixed Import/Export	0	TWh/year	Change distribution	DK 2013 Fixed import export.txt
Total electricity demand*	0.36	TWh/year		

The schematic diagram on the right shows a box labeled "Import/Export fixed and variable" with arrows pointing to and from a box labeled "Electricity demand".

* Including generation, transmission, demand & cost data from MUA

Stepwise pathway to Manx self-sufficiency in renewable energy

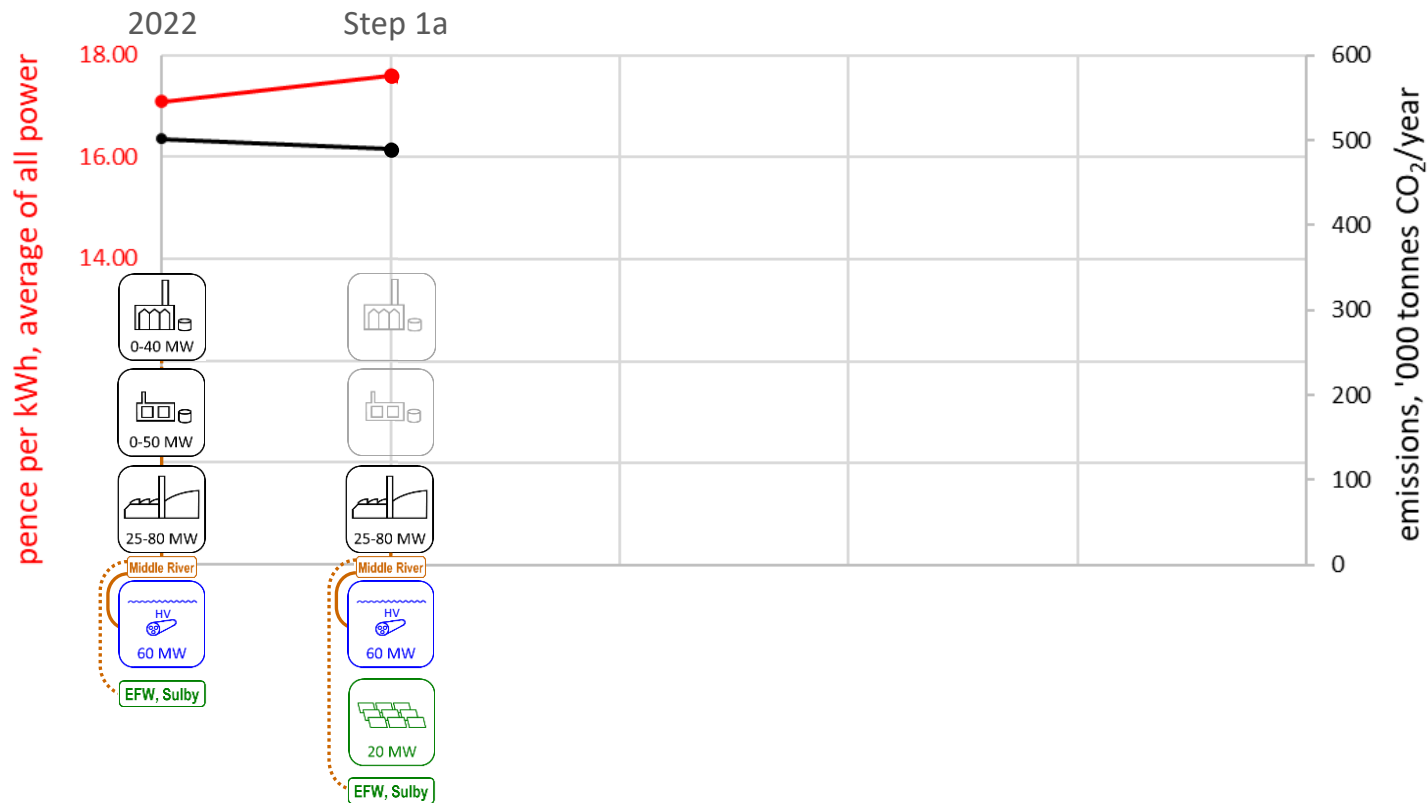
29



Data courtesy of MUA

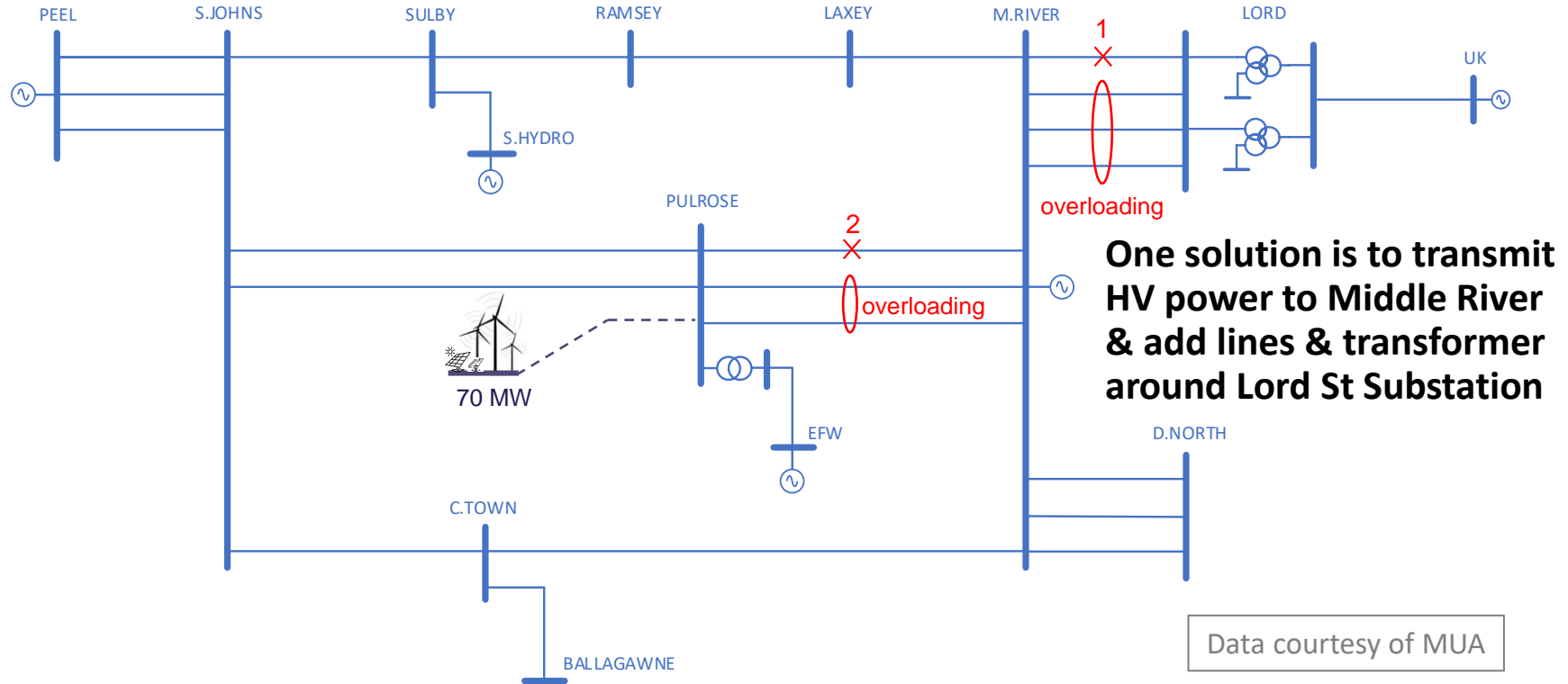
Stepwise pathway to Manx self-sufficiency in renewable energy

30



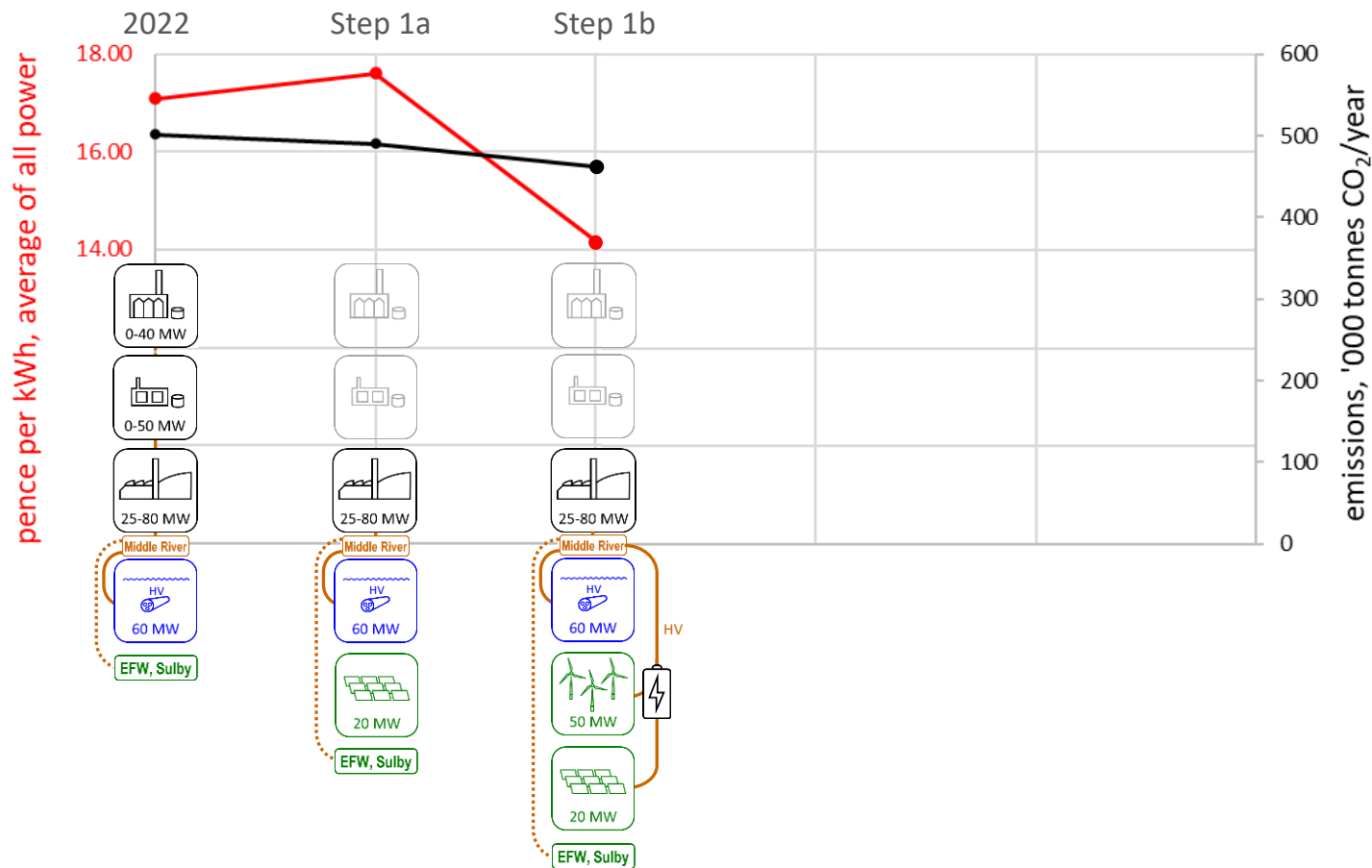
33 kV grid is rapidly overloaded by new supply... or rising demand

31



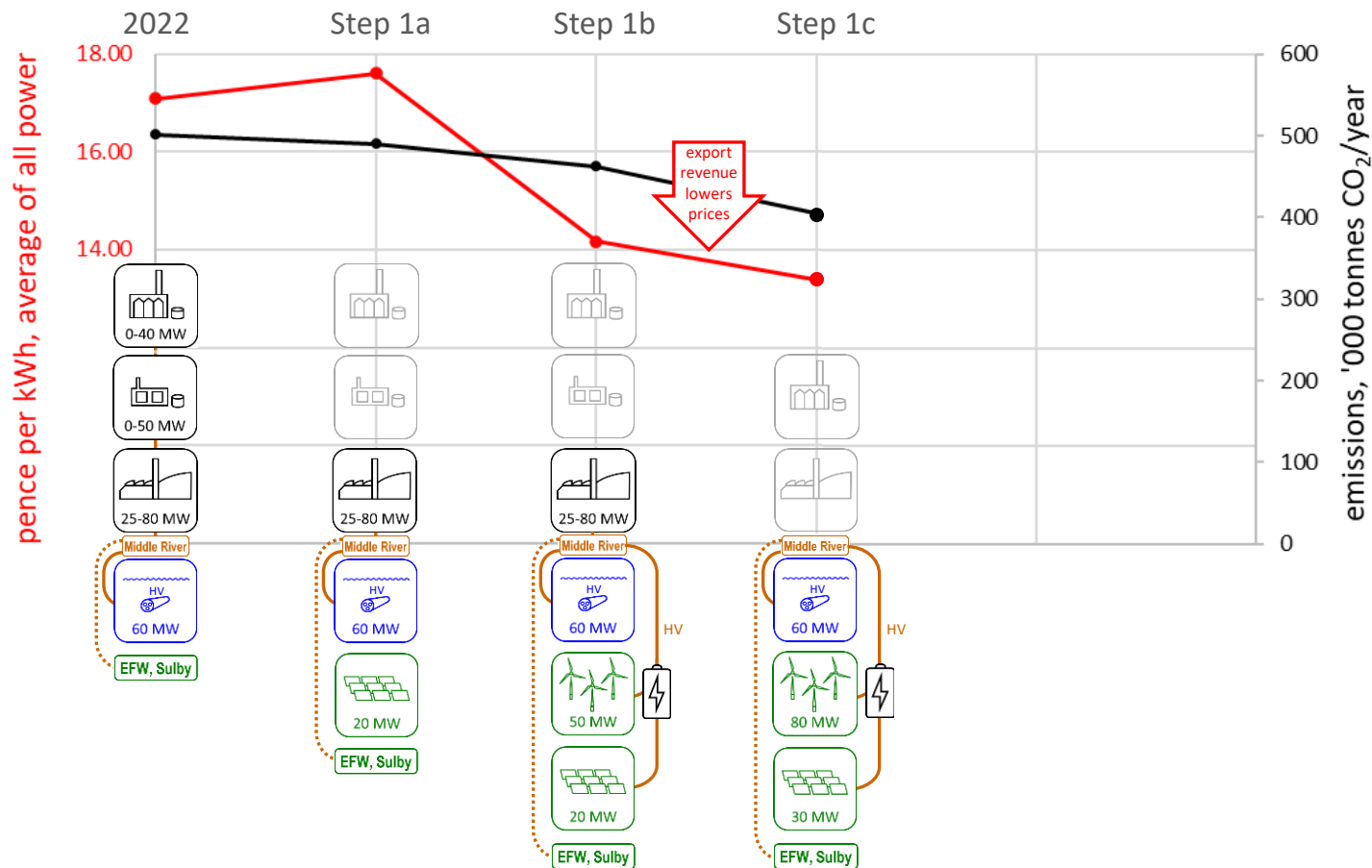
Stepwise pathway to Manx self-sufficiency in renewable energy

32



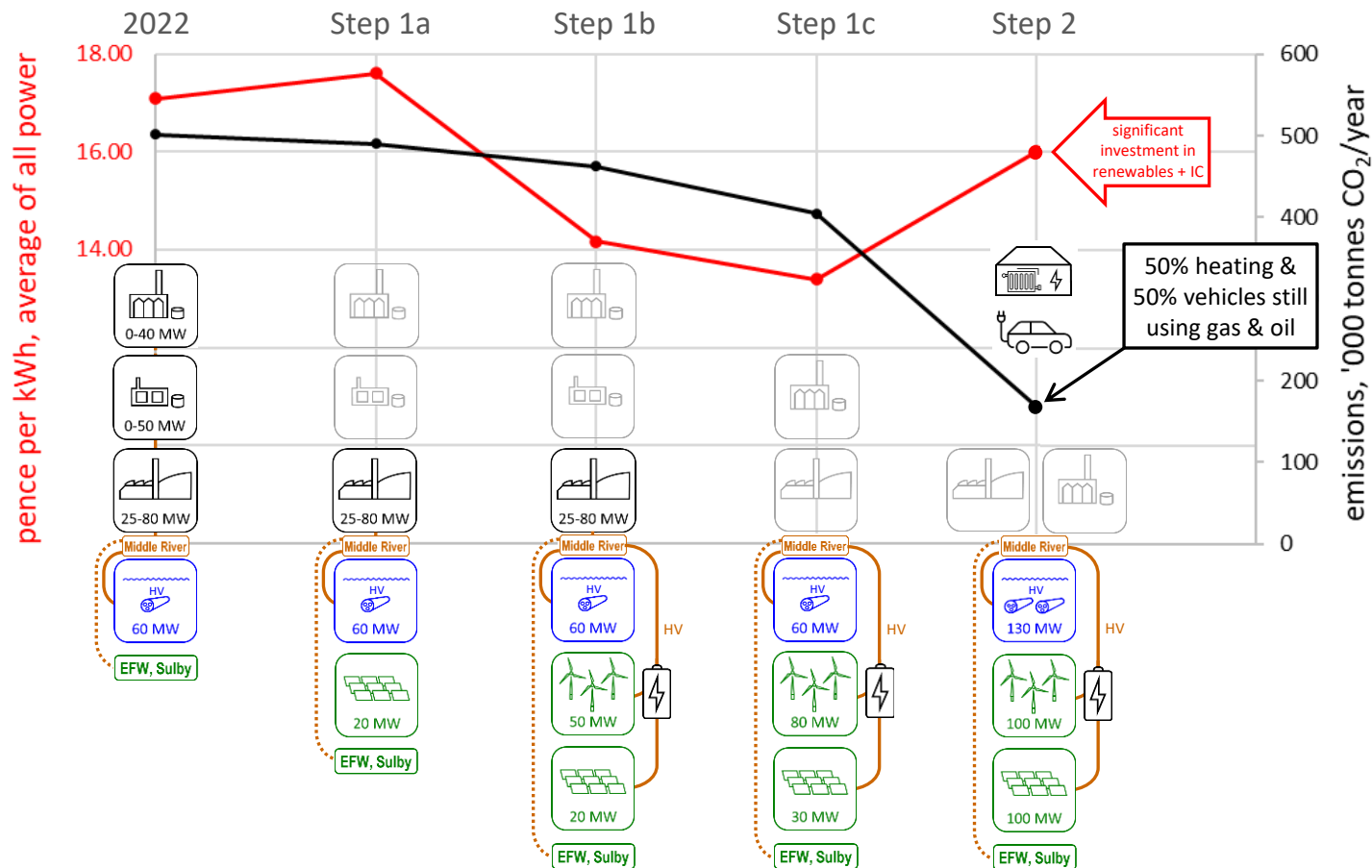
Stepwise pathway to Manx self-sufficiency in renewable energy

33



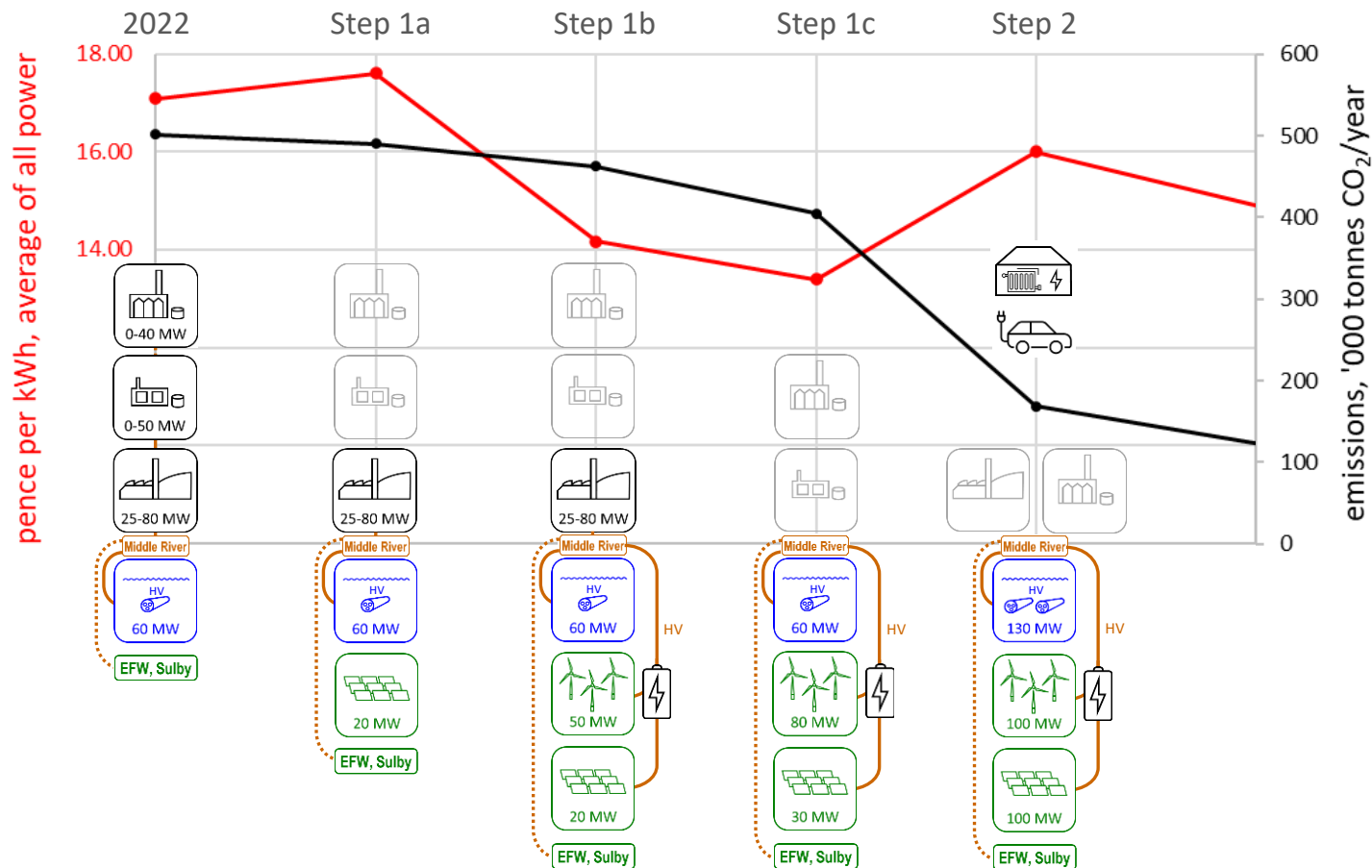
Stepwise pathway to Manx self-sufficiency in renewable energy

34



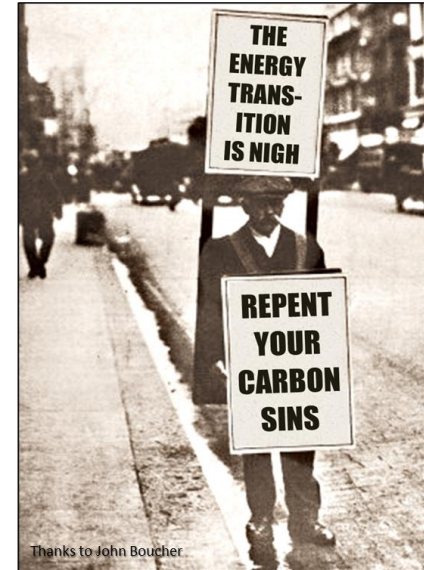
Stepwise pathway to Manx self-sufficiency in renewable energy

35



Conclusions

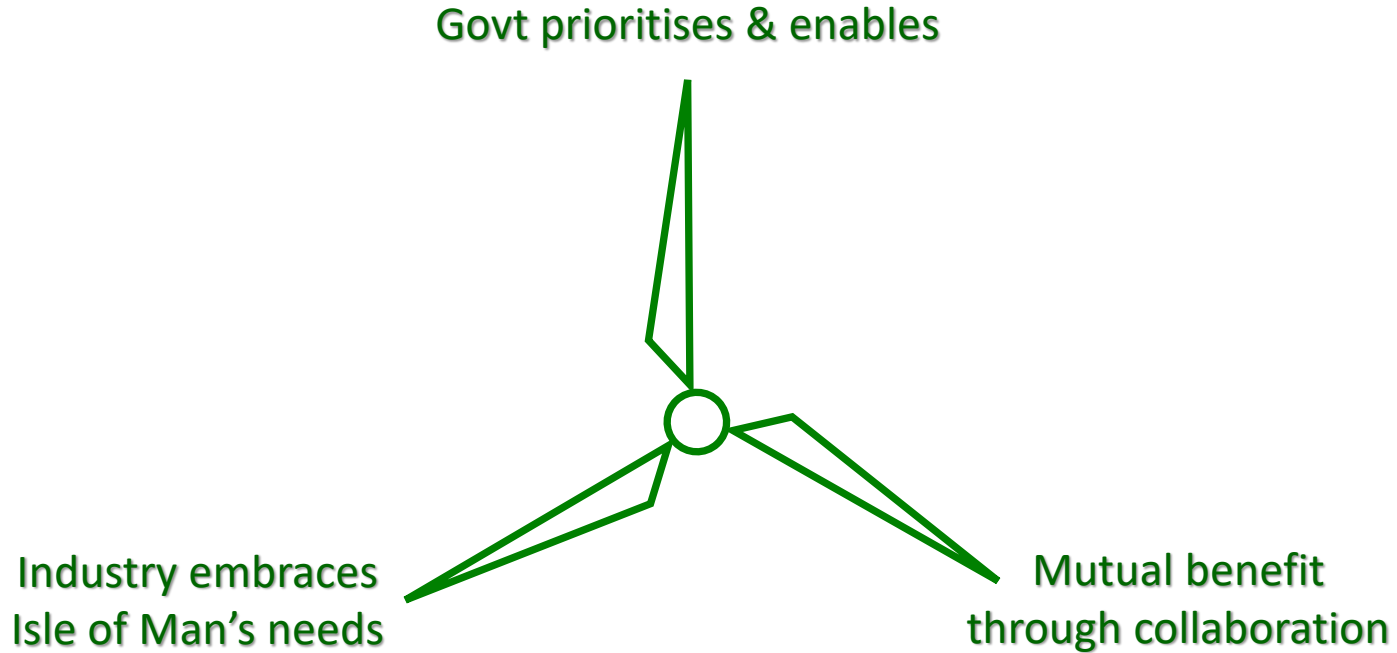
- We are committed to net zero emissions – most benefit in doing it now
- What fantastic assets we have
 - Just a question of choosing, facilitating & accommodating an optimum path
 - Need to move quickly to secure 1) affordable energy and 2) private funding
- Yes it is doable... even with a 33 kV grid at current demand
- Gas prices are unpredictable, unlike renewables
- At grid scale, renewable energy is affordable
- A larger interconnector adds more value
- Energy storage improves value & export sales



- Risk of avoiding losing revenue & business
- All the technology is available & companies are ready to invest
- Permitting needs to be streamlined
- The grid will need to be reinforced, flexible & smart
- District heating, biofuels & H₂ should be added to our options
- Alignment is critical – time to collaborate
- Let's work this out on 16 November
- IoM will get colder if climate change continues unabated
 - visit www.energysustainabilitycentre.im



15 years since first iPhone



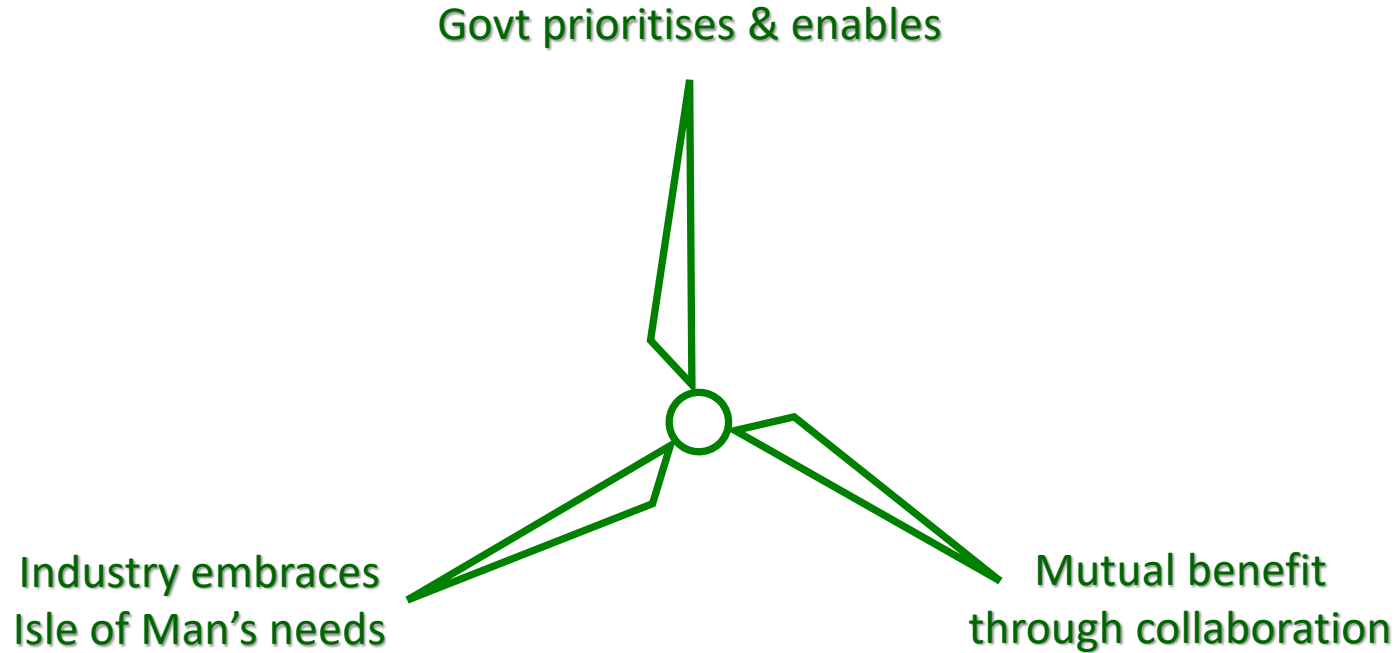


www.energysustainabilitycentre.im - Empowering a green future

ESC's Role:

To act as a pathfinder & intermediary between Government and Industry, sharing ideas and knowledge to promote the development of a secure, reliable & economic transition to low-carbon energy on the Isle of Man

Thank you
Gura mie ayd



Changing climate

