

The role of decentralised mathematical algorithms in operating the entire energy ecosystem

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Can you picture 2030?

NETELIX

THE BOFFINS' BAFFLING MATHS... AND WHAT IT MEANS

- The formula for the correct thickness of cream and jam:
 $r = \text{radius of scone}$

Thickness of clotted cream:

$$\frac{r^3}{8(r-1)^2}$$

Thickness of jam:

$$\frac{3r^3}{40(r-1/2)^2}$$

Ideal scone thickness:
28mm

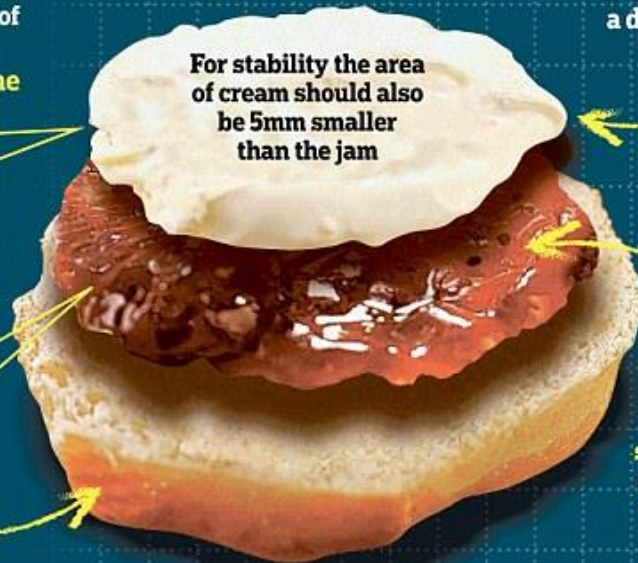
For stability the area of cream should also be 5mm smaller than the jam

- Using a scone with a diameter of 60mm

Ideal thickness of cream is:
4mm

Ideal thickness of jam is:
2.3mm

- To prevent dripping there should be a 5mm rim of scone left visible after the jam and cream cover the base



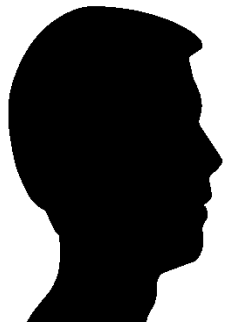
2004



2030



2030 as a customer



Energy Choices

Reliability

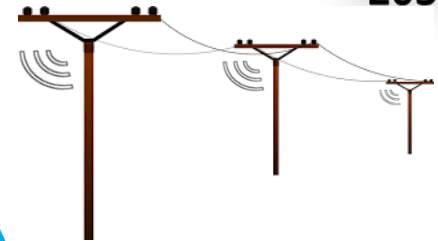
Decarbonise

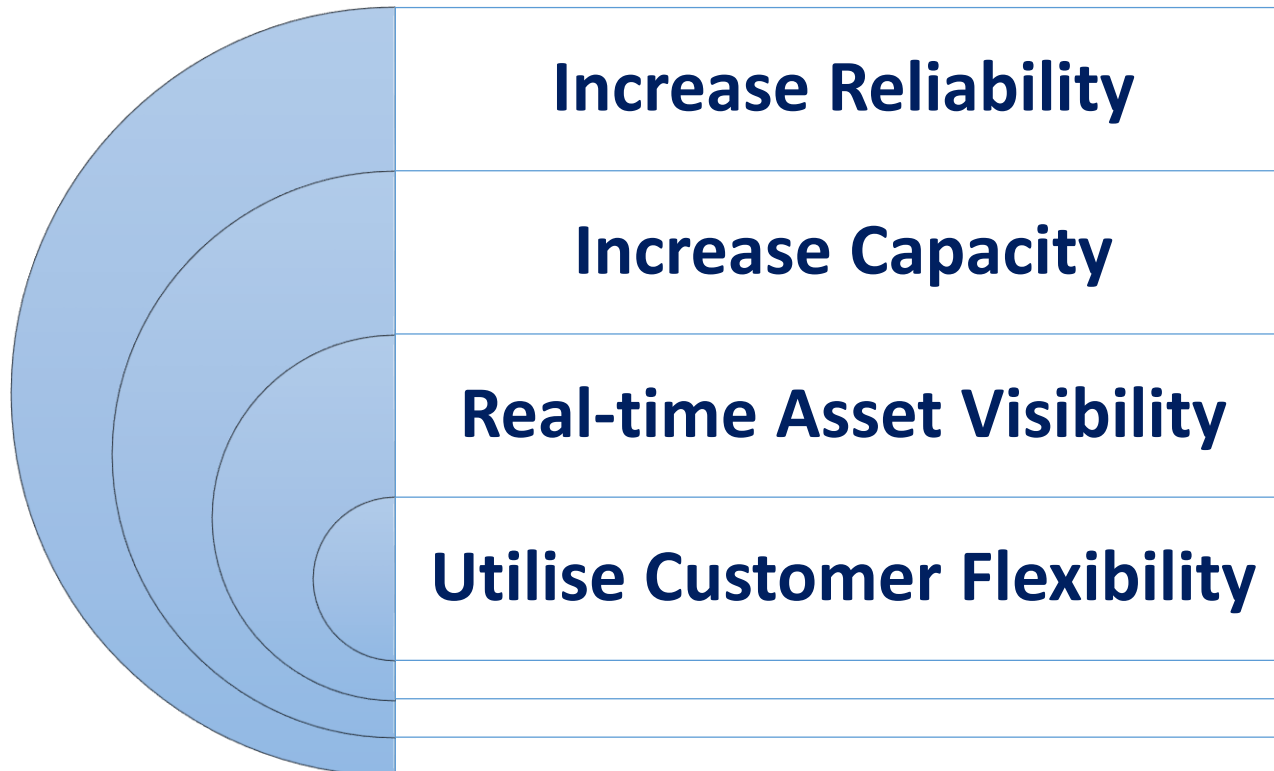
Affordability

2017

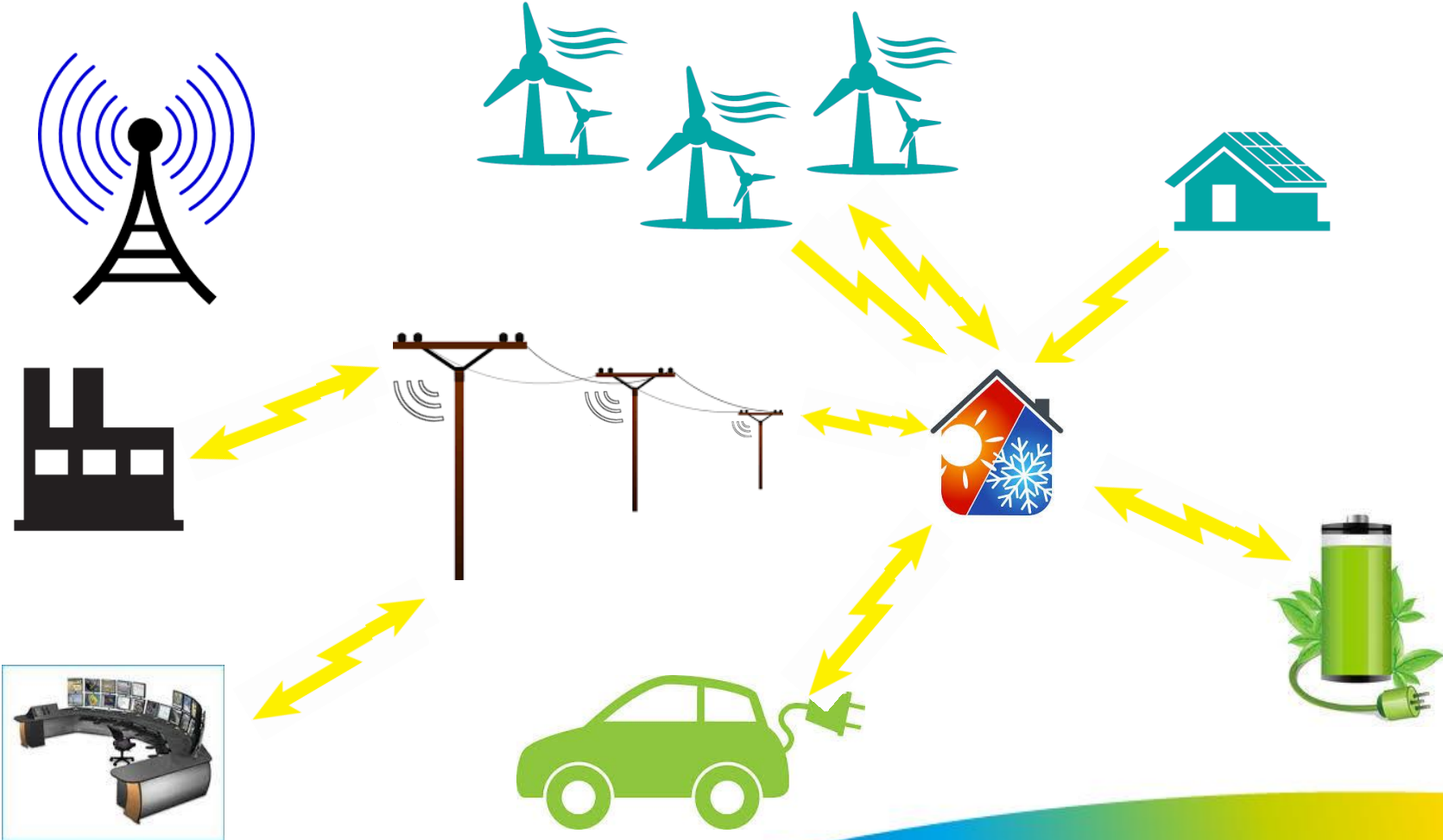


2030

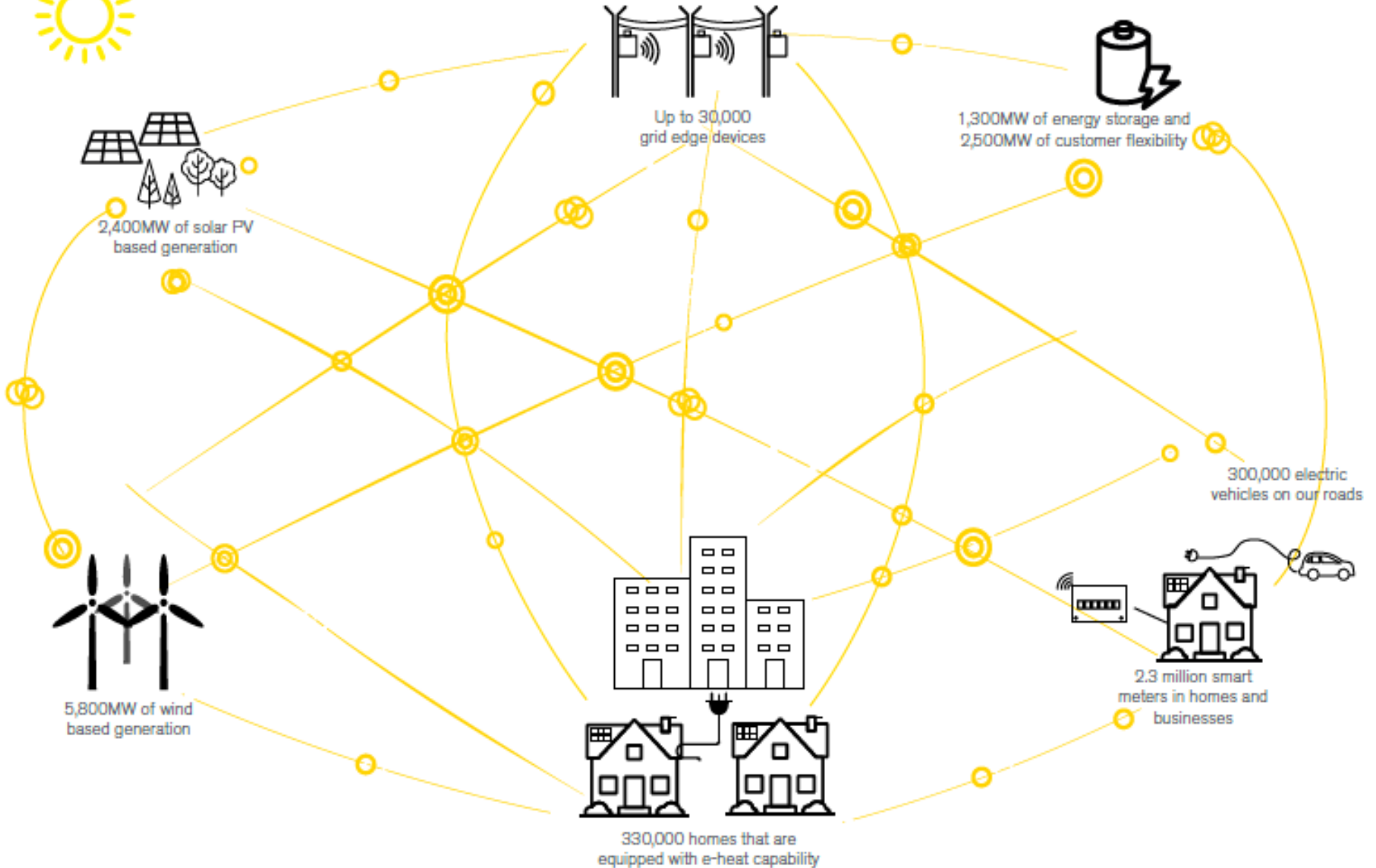




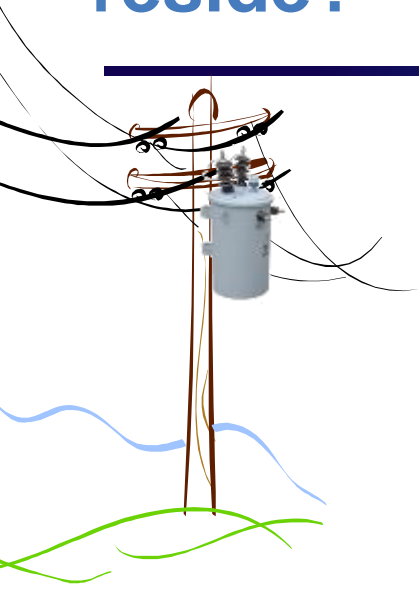
Smart Grid



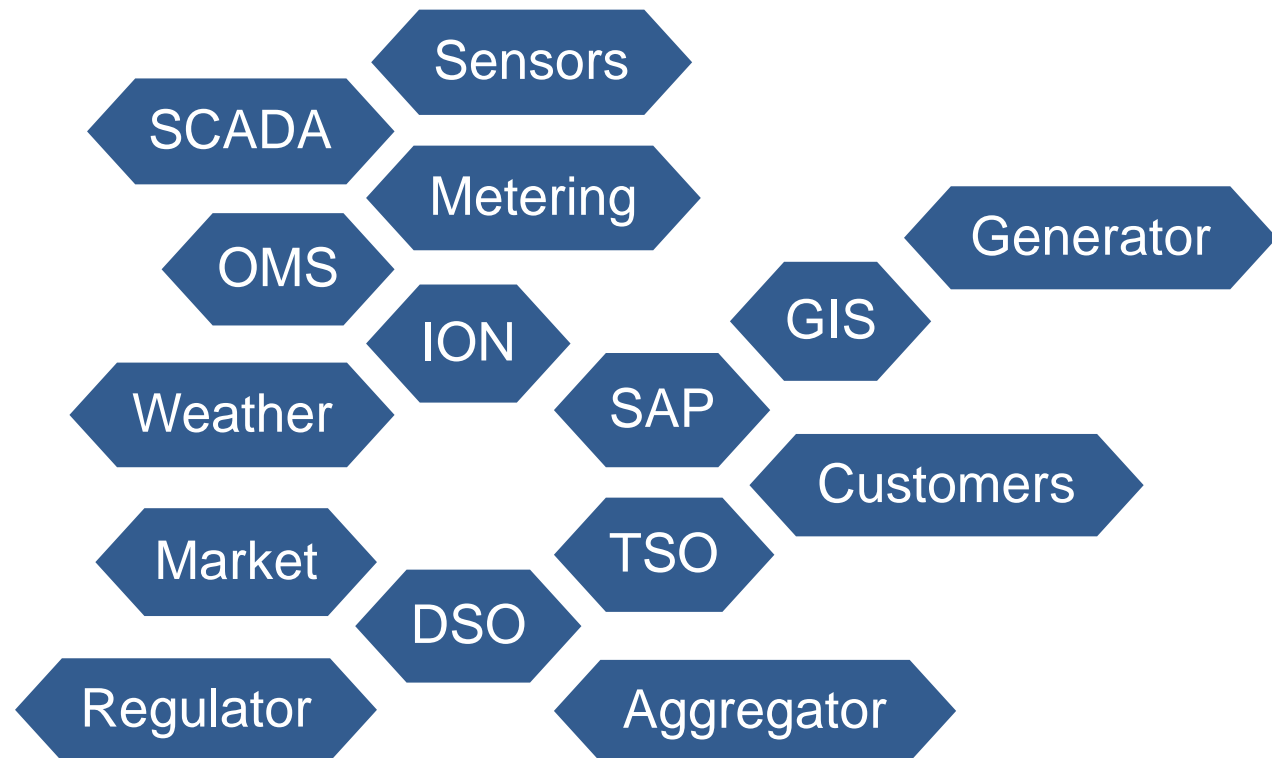
By 2030, our Network will Support



What and where do algorithms reside?



On and between energy actors using numerous data sets and from around the business/industry in multiple locations and formats.



Think of the scale...

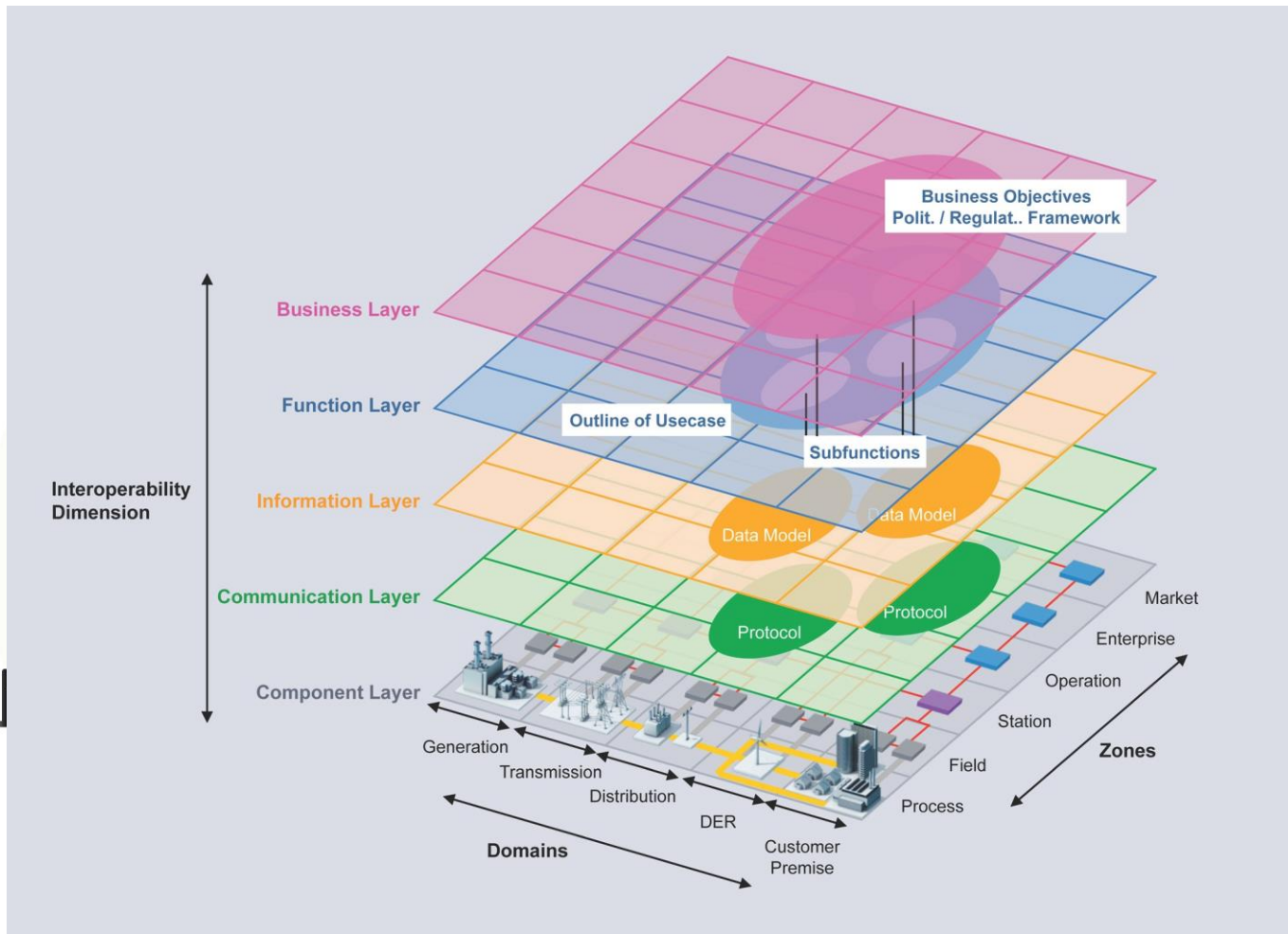
Europe:

- 43 TSO's
- 2400 DSO's
- 260M Customers
- 2700 TWh of distribution connected Generation
- €400,000,000,000 of investment by 2020

Ireland:

- 2.3M Customers
- 270,000 transformers
- 230,000km of network
- 80/20 and 99/1

Energy's overall vision



Architecture is key to informing approach

TSO

DSO/DNO

DAO/TAO

ISO

Urban /
Rural

Business Specific Layer::

1. Accommodate Dist DER for 0% carbon targets
 2. Decrease Customer minutes lost per annum
 3. Demonstrate flexibility to host future service
- Demonstrate vision into the ability of the network in

Functional layer per actor::

Demonstrate real-time state estimation and m
real-time sectionalisation of HV/MV/LV s
ICT platform and comms to enable D
nodal view of active/reactive pow

**Citizen
Needs**

**Markets
Weather
Politics
Agendas**

Integration

S

S

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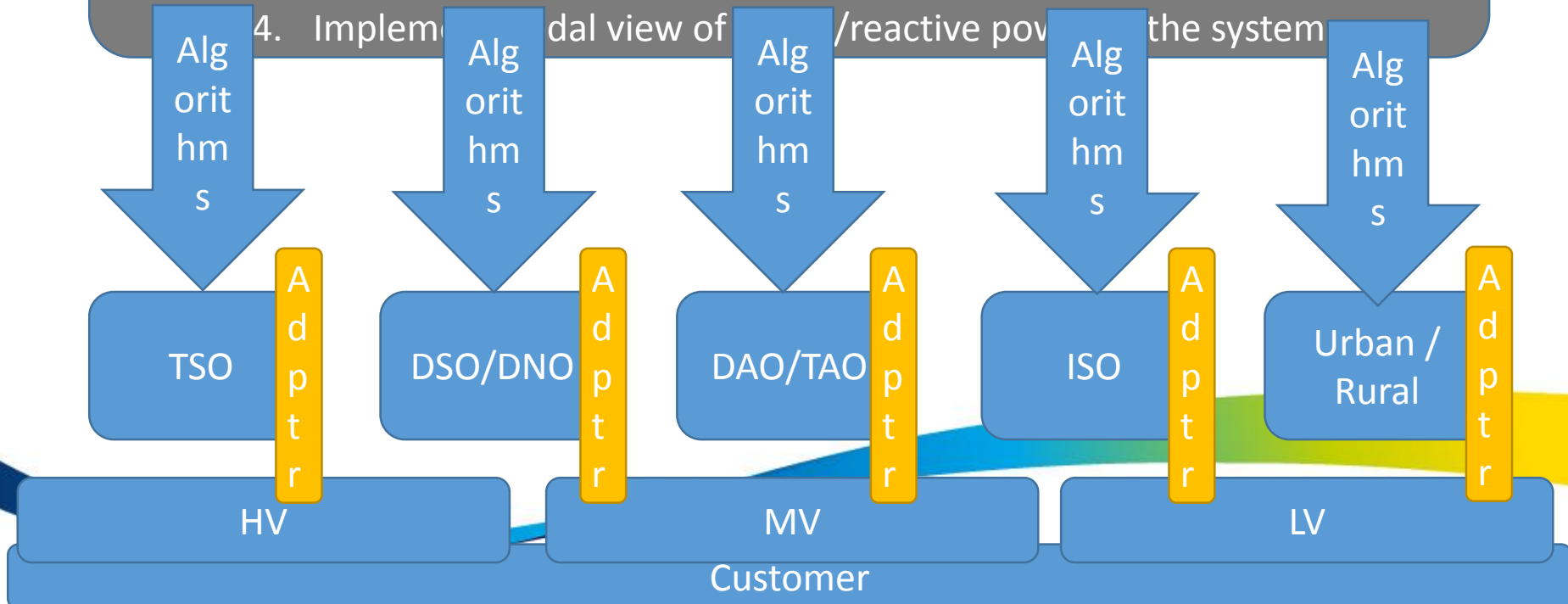
An alternate approach

Energy Ecosystem Layer::

1. Accommodate Dist DER for 0% carbon targets
2. Decrease Customer minutes lost per annum
3. Demonstrate flexibility to host future service
4. Demonstrate vision into the ability of the network in realtime

Functional layer per actor::

1. Demonstrate real-time state estimation and modelling
2. Real-time sectionalisation of HV/MV/LV system
3. Set up ICT platform and comms to enable DER adoption
4. Implement a global view of /reactive power the system



FIELD TRIALS IN IRELAND



Superhomes Project:
Homes with ASHP – 32 Homes +
Most also have Solar PV
Install Interval Meter and RE-SERVE Control Device



MV/LV Unit Subs
LV Monitoring Trials
Possible RE-SERVE Control
Device Installation



Commercial Scale Rooftop Solar



eStore Project
Domestic Battery Storage – Tesla 13kWh
5 customers primarily rural some with PV



SMA Solar Inverter
Install in NTC for testing



V2G –
NTC and Leopardstown Rd
Provide Voltage Support

Dingle's electrical infrastructure

Dingle town is connected on a tail fed 38kV line from a 110kV substation in Killarney

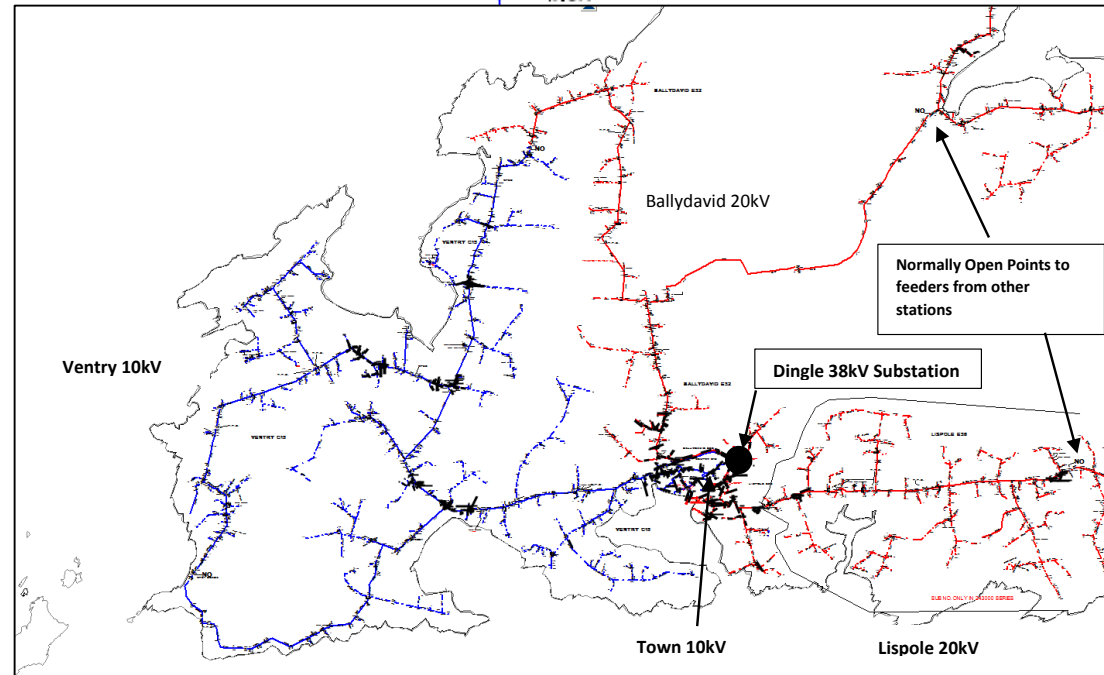
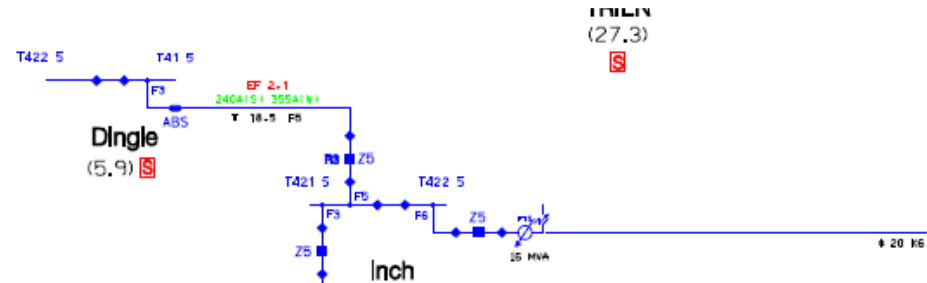
All of the customers in Dingle are connected to a 132km of 10kV and 20kV overhead network

There are 4,772 customers connected to Dingle 38kV station

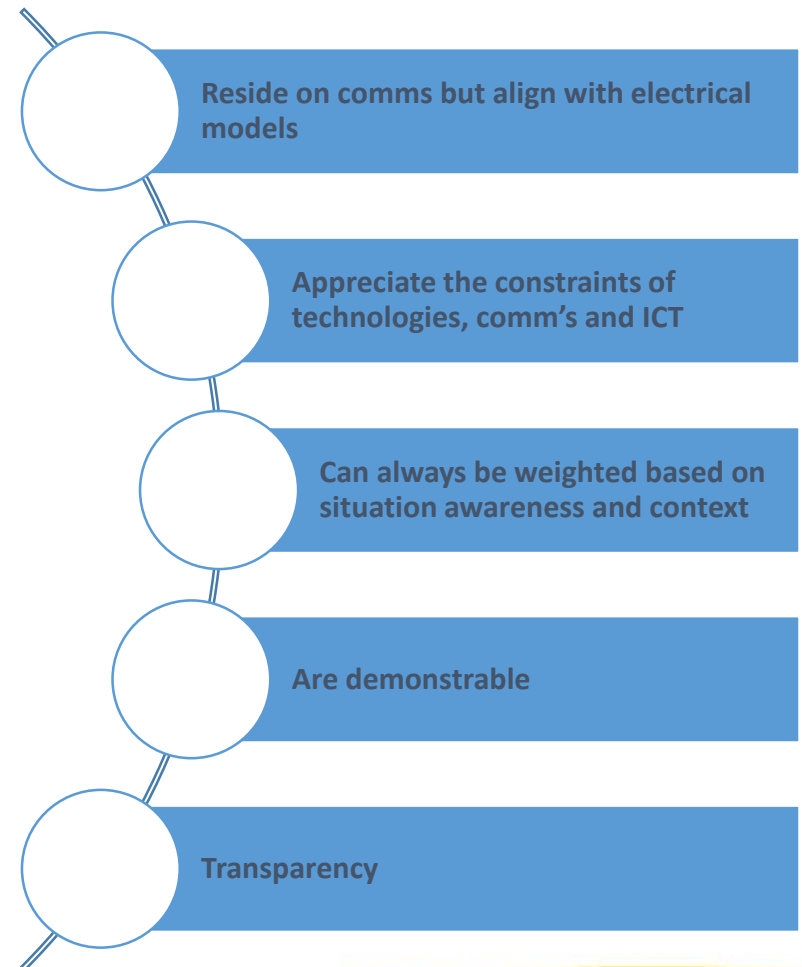
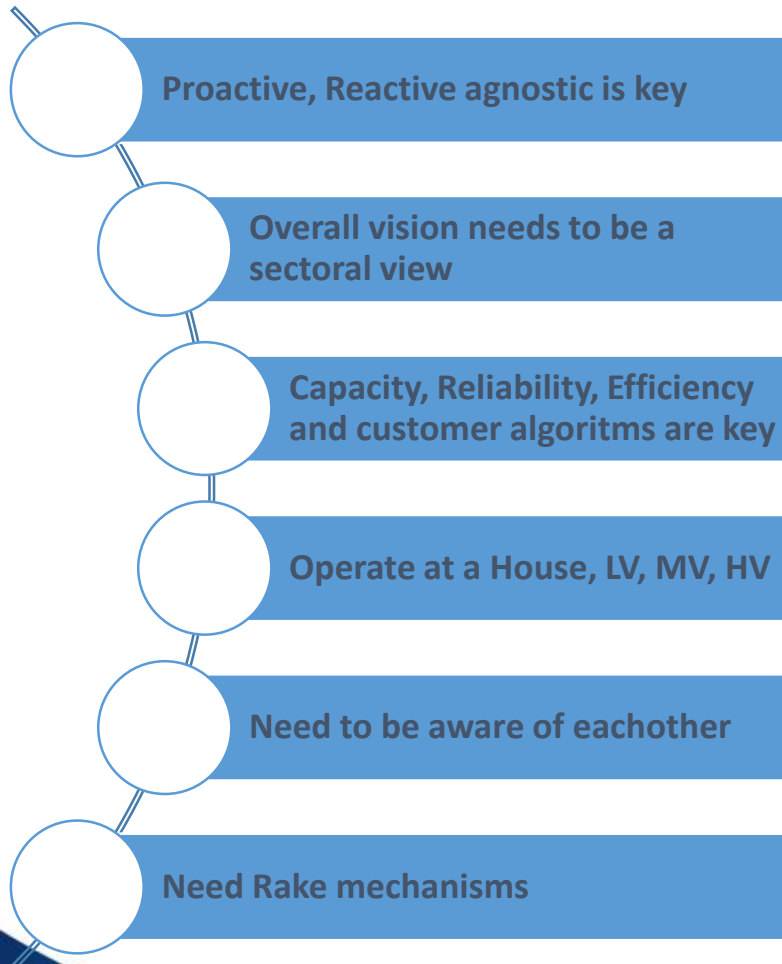
Peak Demand in Dingle is 6MW with a peak transformer capacity of 10MW

1.5MW of available load growth available

ESB Networks has significant control and visibility of this network through our Operational Technology systems



A view on algorithms



Thank You

