# Technical note on ‘green upside’ model [internal use only]

**This note sets out the ‘green upside’ modelling methodology, used in the low carbon portfolio tool, including a mapping between available financial and green data lines, and the model. Please ensure this note reflects the latest green upside modelling methodology before review (date of last edit in filename).**

**This note is structured as follows:**

* Section 1.1.1 provides the motivation for, and a brief summary of the green upside model
* Section 1.1.2 sets out the full modelling methodology for the green upside tool
* Section 1.1.3 is an outline of the steps used in the model (TBC)

### Abstract

**The ‘green upside’ is an important feature of climate policy scenarios which is often omitted by attempts to quantify the financial impacts of 2DS.** The ‘green upside’ approach complements the profit impact valuation tool, by modelling climate policy upside potential, beyond low emissions intensity:

* Producers of goods and technologies involved in the low carbon transition will **benefit** **indirectly** from carbon pricing policies through **higher demand** for their products;
* For instance, in the renewable energy equipment sector, wind turbine and solar panel manufacturers will face higher demand in a 2DS world than under business as usual;
  + To curb CO2 emissions while meeting demand for power from a rising population, power producers will need to deploy more low carbon generation capacity
  + This will include greater wind and solar deployment;
  + Similar arguments can be made for many other sectors, as set out in Table 1.
* The ‘green upside’ impacts are analogous to oil and gas demand destruction impacts – in the latter case, companies were indirectly affected by a contraction in demand for their products;
* These impacts will vary across 2DS scenarios, for instance, wind turbine manufacturers will perform better in a renewable-led 2DS scenario, than in a CCS-led 2DS scenario;
* The profit impact valuation tool does not capture this ‘green upside’ potential, as it is not reflected in company CO2 emissions, or oil and gas demand destruction.

### Green upside methodology

**X sectors were identified as being both materially significant in the MSCI World index, and having significant exposure to different climate policy scenarios.** The sectors identified are presented in Table 1. Firms which are active in these sectors are identified based on FTSE Russell’s Green Revenue data series. Their profits are then modelled under different climate scenarios, based on how the sector performs, and how the firm’s market share evolves over time. Future market share is determined based on existing market share and the value of relevant patents the firm owns, an indicator for market share growth (decline).

The key data sources used in analysis are set out below, with the categories used set out in Table 1:

1. **FTSE Russell Green Revenues series**:
   1. Proportion of each MSCI World company’s revenue which is attributable to each of 60 green activities;
   2. Covers all major industries and technologies involved in the transition to a low carbon economy;
   3. Time series dataset covering 98.5% of global market capitalization;
   4. Reflects company revenue shares to a granularity of 0.01% of total revenue.
2. **Orbis Patent data:**
   1. Number of patents filled under green patent categories as part of the International Patent Classification (IPC) system;
   2. Details on how green patent categories were mapped to FTSE Russell revenue categories.
3. **TIAM (Times Integrated Assessment Model) scenario data**:
   1. Volume of key green sector variables under each climate policy scenario, based on policy simulations using the Imperial TIAM energy systems model;
   2. Each data line is fully consistent with other key variables such as the carbon price, fossil fuel use, and demand for energy services;
   3. Example data lines include: new renewable generation capacity deployment, electric vehicles, battery production, and heat pump production.
4. ‘Green upside’ sectors identified as part of the Low Carbon portfolio tool

| Activity | Sector product | FTSE Russell category | Orbis patent category | TIAM model variable(s) | Comments |
| --- | --- | --- | --- | --- | --- |
| Low carbon energy equipment | Wind turbines | Energy Equipment – Wind | TBC | New wind generation capacity (GW) | E.g. Vestas, Siemens |
| Low carbon energy equipment | Solar panels | Energy Equipment – Solar | TBC | New solar generation capacity (GW) | E.g. Mitsubishi Electric |
| Low carbon energy equipment | Hydroelectric turbines | Energy Equipment – Hydro | TBC | New hydro generation capacity (GW) | E.g. General Electric |
| Low carbon energy equipment | Carbon capture, utilisation and storage equipment | Energy Equipment – Clean Fossil Fuels | TBC | New CCS generation capacity (GW) |  |
| Low carbon energy equipment | All other low carbon energy equipment | Energy Equipment – all other categories | TBC | Other new zero / low carbon generation capacity (GW) |  |
| Low carbon transport | Electric vehicles | Modal Shift – Road Vehicles | TBC | Electric vehicle usage (bn passenger km) | Do we want to add fuel cell vehicles to this? E.g. Tesla |
| Battery and fuel cell manufacturing | Batteries and fuel cells for EVs and grid-scale storage | Energy Management – Fuel Cells | TBC | Electric vehicle usage (bn passenger km) Grid-scale battery capacity (GW) | Unclear whether we have the data to do this E.g. Panasonic |
| Mining / minerals | Minerals and metals for battery manufacture | Env. Res. – Mining  Env. Res.– Minerals and Metals | TBC | Electric vehicle usage (bn passenger km) Grid-scale battery capacity (GW) | E.g. BHP Billiton |
| Biofuel growth | Biofuels | Env. Res – Agriculture | TBC | Biofuels in power generation, road transport (TJ) | Is this important enough to warrant inclusion? |
| Heating services equipment | Heat pumps | TBC | TBC | Heating services from heat pumps (TJ) |  |

Note: To be filled after discussion, and cross-checking against FTSE Russell, Orbis and TIAM energy model data  
Generation from renewable sources omitted intentionally – we should reflect this in the power utilities sector directly (through lower carbon intensity of generation)

Source: Vivid Economics

**Current revenue and market share in green sectors is calculated for each company, and each sector listed in Table 1.** Green revenue in each sector is identified based on FTSE Russell green revenue shares, and total revenue, as reported in Thomson Reuters financial data.

**Market size under each policy scenario is estimated based on growth in product demand, as modelled under the TIAM energy system model.** Market quantity is scaled by the ratio of demand under the climate policy scenario relative to demand under the reference scenario, where there is no climate policy. For instance, the market quantity for wind turbines under 2DS in 2020 will depend on the business as usual market quantity, demand under BAU, and demand under 2DS as shown in Figure 1.

1. New wind generation capacity grows much more quickly under the 2DS climate scenario than under business as usual



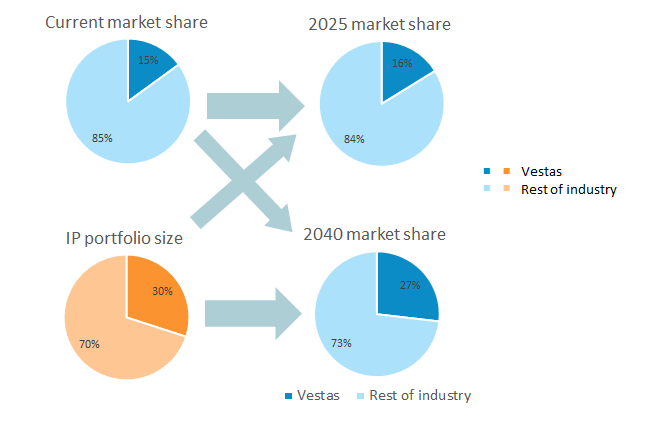
Note: Excel link below; data shown is new capacity added per annum (all regions, by scenario) <https://vivideconomics.sharepoint.com/:x:/s/projects/171211HSB/EadSu9Uee0BAv76VhGoHILEBoM5BQlr3AucmYCxaODmKlg?e=QXtwlP>

Source: Vivid Economics

**Future market share is modelled based on current market share and company intellectual property (IP) portfolios.** IP portfolio size is a leading indicator for market share growth in green technology sectors as evidenced by X. The effect of patent portfolios on market share is greater Y years into the future, than it is today, as innovations take time to reach market. This does vary across green sectors to reflect the length of different technology life-cycles. For instance, in non-green sectors semiconductor chips have a much shorter development cycle than new cancer treatments.

**Figure 2 shows the effect of Vestas’s greater than industry average patent portfolio on its market share from 2016 to 2040.** In 2025, Vestas’ market share is slightly higher than its current market share, at 16%, while in 2040, it is considerably higher at 27%. Current market share has a large impact on market share in 2025, but only a moderate effect in 2040. Conversely, the leading indicator, IP portfolio, has little effect on market share in 2025, but a significant effect in 2040. The size of each company’s IP asset base is defined as the number of patents a company owns under relevant IPC categories.

1. The effect of IP portfolio size on market share strengthens over time, while that of current market share diminishes



Note: Dubious Excel-based chart at the link below:  
<https://vivideconomics.sharepoint.com/:x:/s/projects/171211HSB/EadSu9Uee0BAv76VhGoHILEBoM5BQlr3AucmYCxaODmKlg?e=QXtwlP>

Source: Vivid Economics

**Future market size and market share allows company revenue to be modelled under each scenario, from 2017 – 2050.** Profits are then estimated by assuming that quantity growth has no effect on company profit margins (standard economic assumption of constant marginal (and unit) cost. The net present value of these profits compared to each company’s market capitalisation yields the value impairment (gain) index for companies active in green sectors.

**Note the following:**

* No assessment or adjustments for existing pricing in of climate scenarios has been made  
  This may be more problematic for green sectors relative to traditional sectors, as the market valuation of these companies will vary more between BAU and 2DS
* Patent portfolio-market share story must be consistent with BAU (reference) scenario profits equalling market cap in net present value terms (as in the ‘downside’ model):
  + Market share varies over time, but not *across* scenarios
  + The only difference between scenarios is from market size growth as in Figure 1
  + Having a large patent portfolio may still benefit companies, because a larger proportion of their profits occur in the future, where change in market size from 2DS is higher
  + However, this is an indirect channel, and the effects on valuation may be small
  + Either resolve or drop patent data methodology
* Cannot assess the extent to which MSCI companies take market share from the wider industry (based on IP portfolio), as we do not know initial MSCI quantity relative to the industry

### Model steps

1. TBC (once we have a model)