Charting Functionality

Author	Version	Date
Gary Huish	1.0	25-Oct-2107

Figures

Charting Principles

On top of our data warehouse we have created our own charting application.

Real life data sets are imperfect; expected data points can be missing; 'bad' data (e.g. zeroes, #NA values, questionable outliers) are published and find their way into archived data sets. Often exchanges use a local holiday conventions to define trading days, so when trying to compare data sets across these source they do not naturally align.

It is our own experience that ensuring data sets are consistent can take a large amount of time, requires considerable skill in e.g. Excel or a similar application; this not only slows downs analysis, but introduces significant operational risks.

We have developed this charting application to manage these issues, and to support a suite of charts whose meaning is very clear. No more lining up starts dates, and dates, or extrapolating values.

Many assets are price in different units and currencies. If you want to plot 2 assets that do not share a common unit or currency, our engine provides functionality to convert to a common currency and unit automatically - so it is clear that you are comparing like with like.

Data model

The underlying data model is very flexible. The data warehouse contains collections of raw 'basic' data; as well as being able to plot that data, it is simple to combine 'basic' data into more complicated data sets. A simple example would be an 'asset spread' time series, which is the difference between series 'A' and series 'B': series C= 'A-B'. We can rich combinations of data sets to get new data sets.

The data model is 'data agnostic'; there is constraint on the way that data sets can be combined.

The data model is also ' frequency agnostic'; you can pair (say) weekly data sets with daily data sets (once you have defined the rules that pull the data together).

Data cleaning

To support a consistent format the charting application can automatically clean data, to ensure data points are aligned. So, say, you would like a chart to start on 1-jan-2015, and end on 31-Dec-2015, working days only, that is exactly what you will get, for whatever set of data you would like to charts.

Where there is (say) a missing data point, in a particular series, the application will create a value for that point and 'bootstrap' the series.

We have a set of rules to clean data embedded in the application, and it is easy to add new rules as required.

Data extraction

Any data set displayed on a chart cab be saved to a csv with a button click.

Chart Images extraction

Any chart image can saved to a variety of formats with a click of a button.

Currency and units consistency

If you want to plot 2 assets that do not share a common unit or currency, our engine provides functionality to convert to a common currency and asset unit.

Chart Styles

In this document line type charts are generally shown, but the application supports many chart types, broadly exactly as you would find in Excel.

Application Charting Types

We support the following at this point in time, and will be extending the set over time.

- **Asset Price Forward curves**
    - represents the traded value of an asset for consumption at a future point in time (usually monthly periods)

- **Composite Asset Price Forward curves**

- these are ‘user bespoke’ charts; the user may define the future time points for the value of the asset. For example, we might have monthly data for an asset but want the Quarter and Season forward price for the asset. This chart will build such ‘composite’ prices

+ **Asset time series**
  - shows the time series of value for an asset. For example, the price of crude oil for December 2015 delivery, daily close

+ **Asset time series continuations**
  - if you are looking at futures price data, then you need to deal with the ‘expiry’ event – the point at which a contract ceases to trade. One way to do this is to ‘glue’ together consecutive futures contracts in a defined way, and this creates a synthetic but continuous series of data

+ **Asset seasonal**
  - the idea of a ‘seasonal’ chart is to overlay different years of a series onto the same generic x-axis. For example, you want to look at the 1st nearby oil contract over the year 2005 with the same contract in 2010 and 2015, because you think that the price evolution is similar

Charting Examples

Here are some examples of charts that we can produce.

Forward Curves

Date Axis convention

We start with a simple 'classic' forward curve. Here we have a single asset (US Crude Oil) on a single date. Generally the left axis does not display units of the asset, you can see the units in the chart legend; here WTI is in units is [USD bbl] i.e. US dollars and barrels.

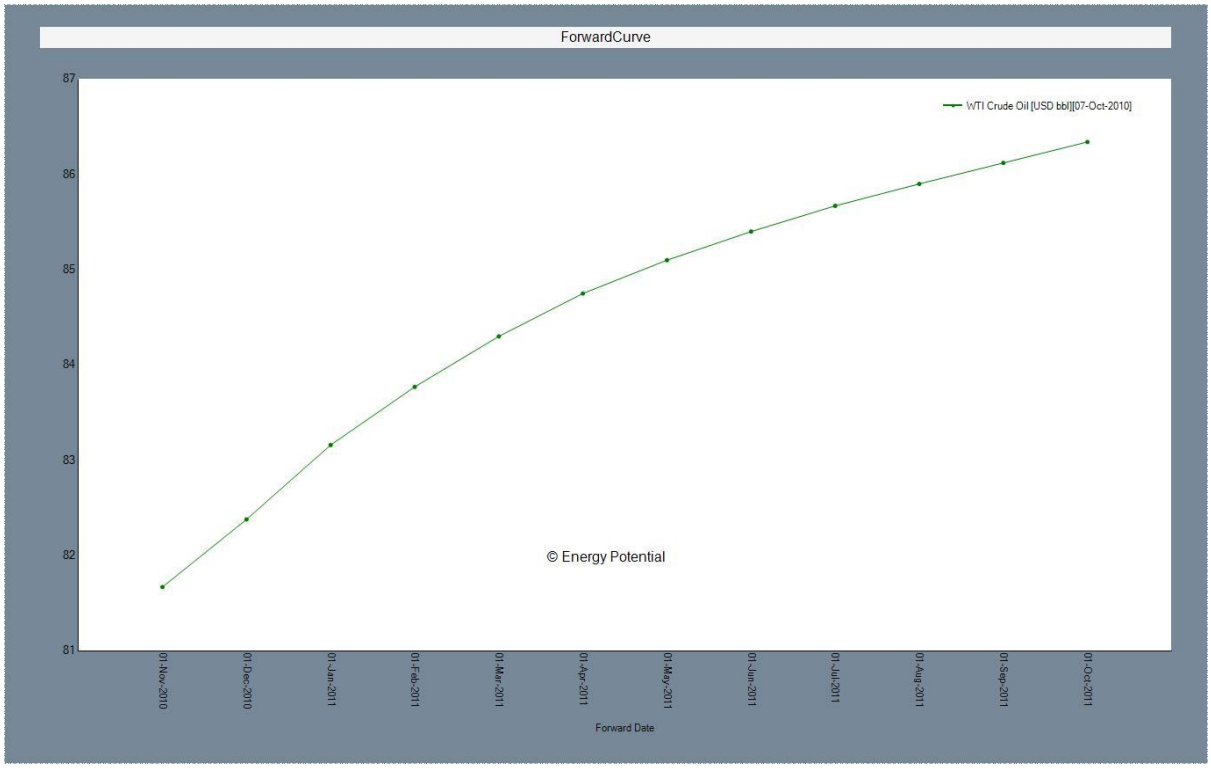

Figure 1 - WTI Crude Oil Forward Curve 12 Months forward from 7-Oct-2010

Next, a single asset on 2 different dates.

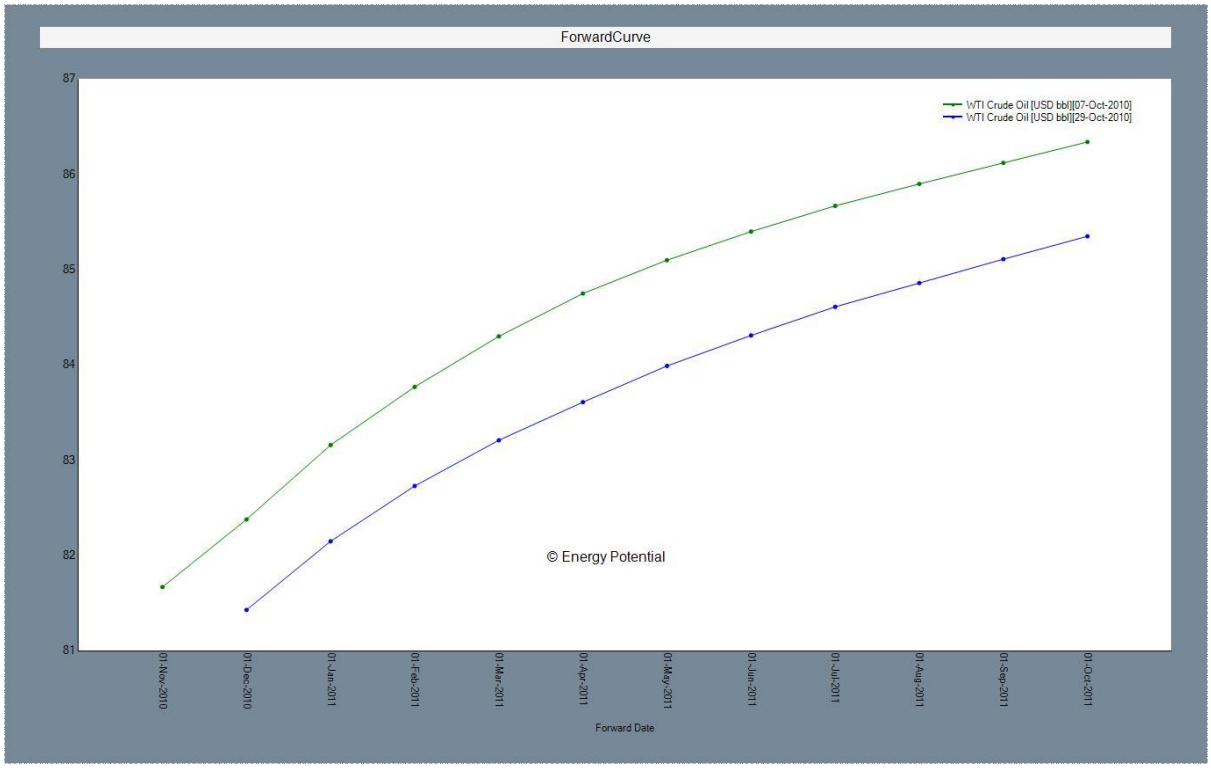

Figure 2 - WTI Crude Oil Forward Curve 12 Months forward on 2 dates; note that on the 2nd date (29-Oct-2010) the near Nov contract has expired, so there is no data point on the chart.

Now 2 different assets on the same date:

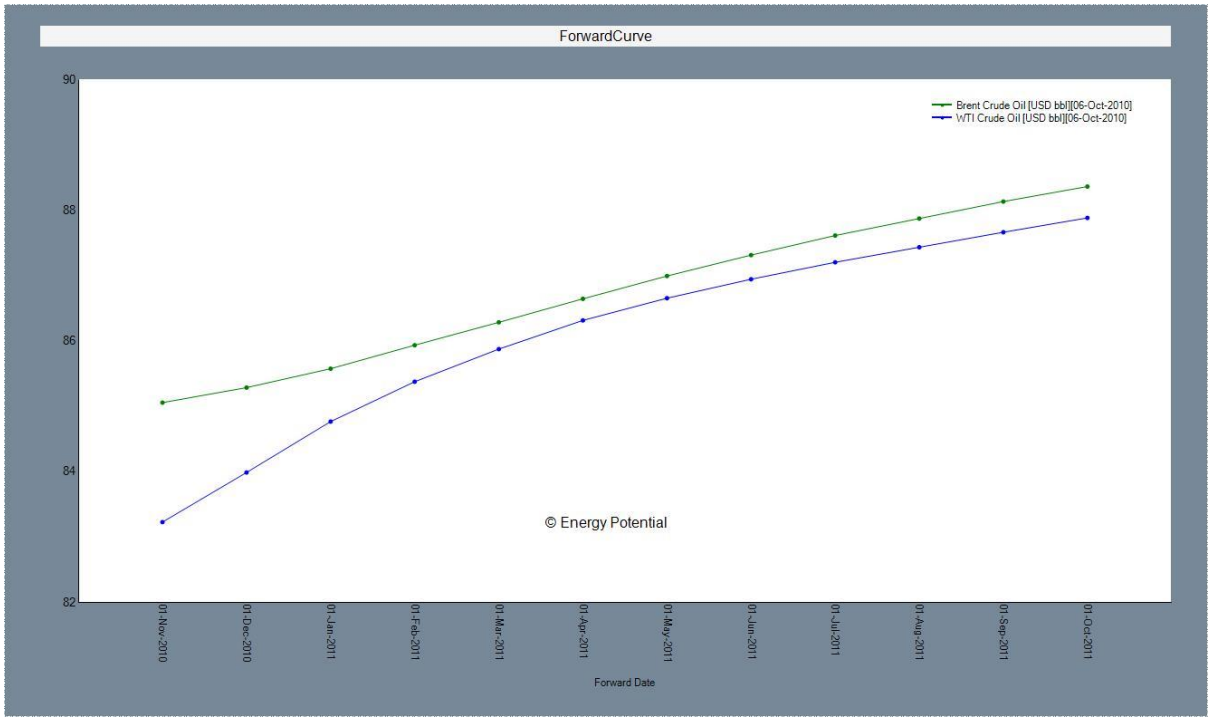

Figure 3 - WTI and Brent Crude Oil Forward Curves 12 Months forward on 1 date

Finally , 2 assets on 2 dates:

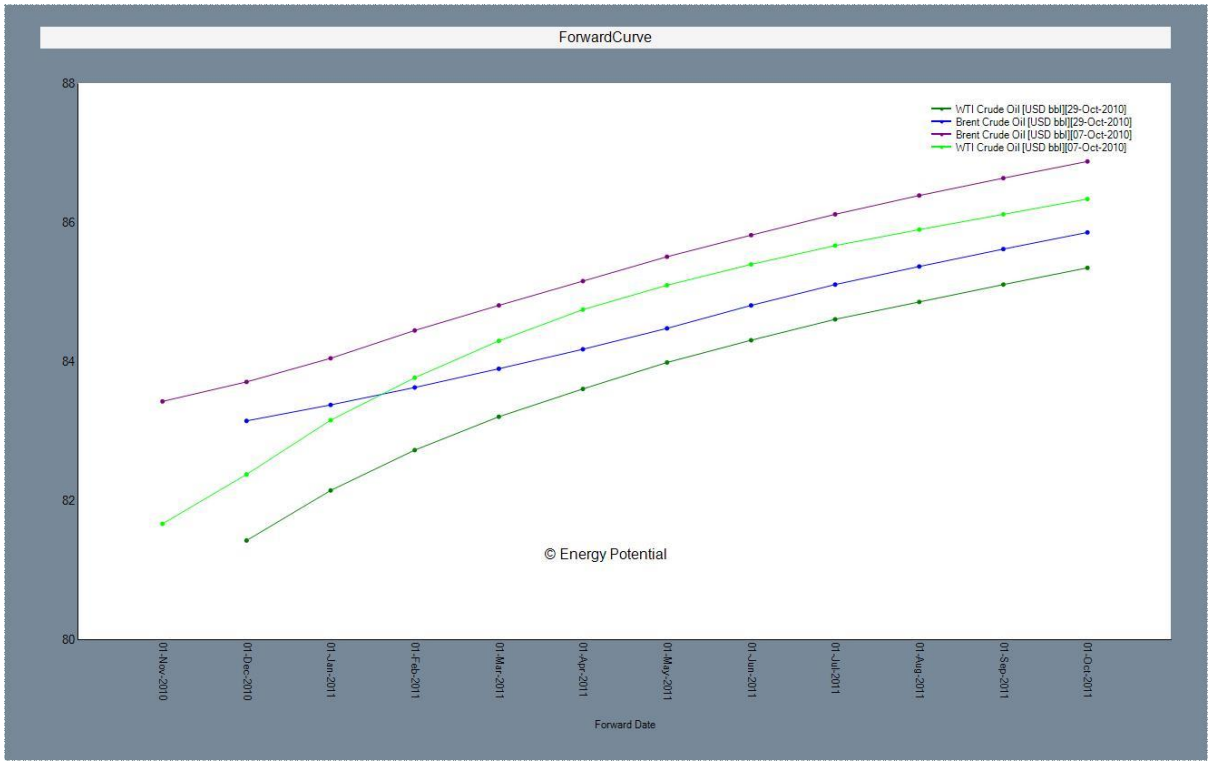

Figure 4 - WTI and Brent Crude Oil Forward Curves 12 Months forward on 2 dates

You can iterate these charts to any number of assets on any number of dates. Note that the first series added defines the left most contract date (here Nov-2010); if you tried to add a series that has no data on the chart nothing will happen.

Currency and Unit conversions

When forming new curves from 'base' ones it is vital to keep track of the currency and units of the base curves. All curves (base curves and derived curves) are associated with its currency and unit, and there is logic to ensure that curves have a consistent currency and unit.

The chart below, UK power spark spreads, shows a prototype example. Curves in different units are internally converted to a target ccy/unit pair (here, GBP ad MWh), ensuring consistent outputs.

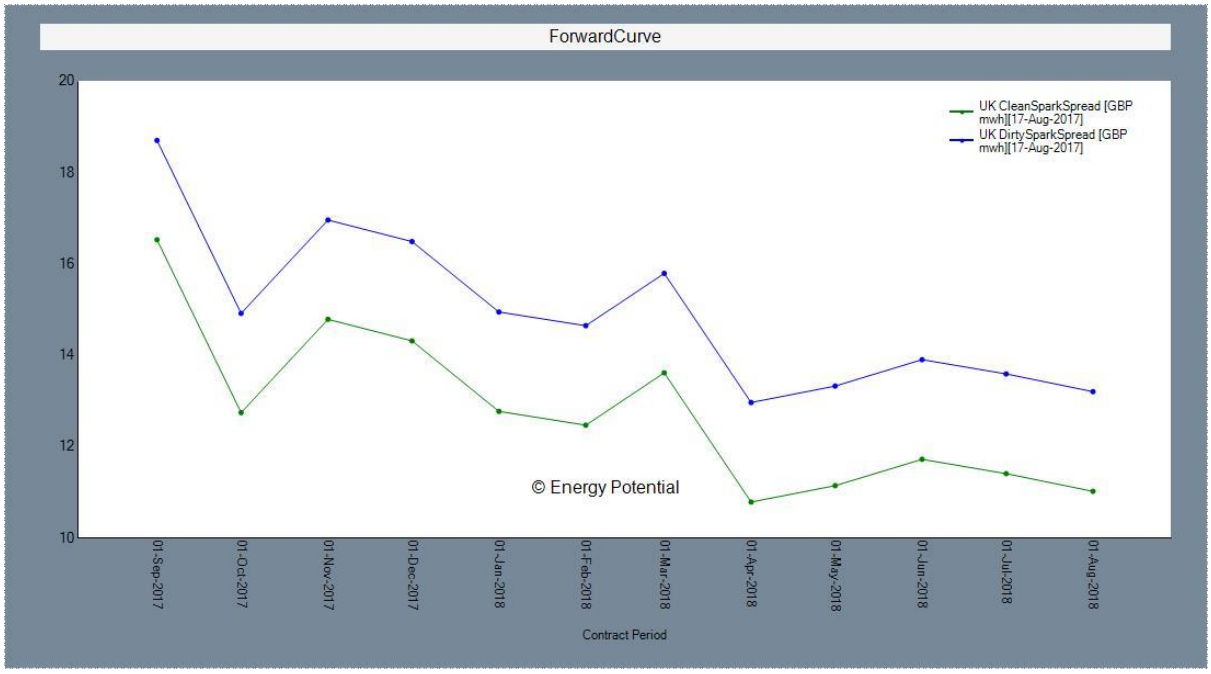

Figure 5 – UK Power spark clean and dirty. This chart use 3 base curves; Power (GBP/MWh); UK Gas (GPpence/therm); EUA (EUR/MT). The displayed output curve is displayed in GBP/MWH, with all conversions internalised.

Contracts to delivery Axis Convention

A second way to plot forward curve sets is to use 'contracts to delivery' to order the data rather than the date of the contract itself. In this scheme for each forward curve date the contract delivering in the next month period is indexed '1', the next contract is '2', the next '3'.

The chart below shows a crude oil forward curve in this notation:

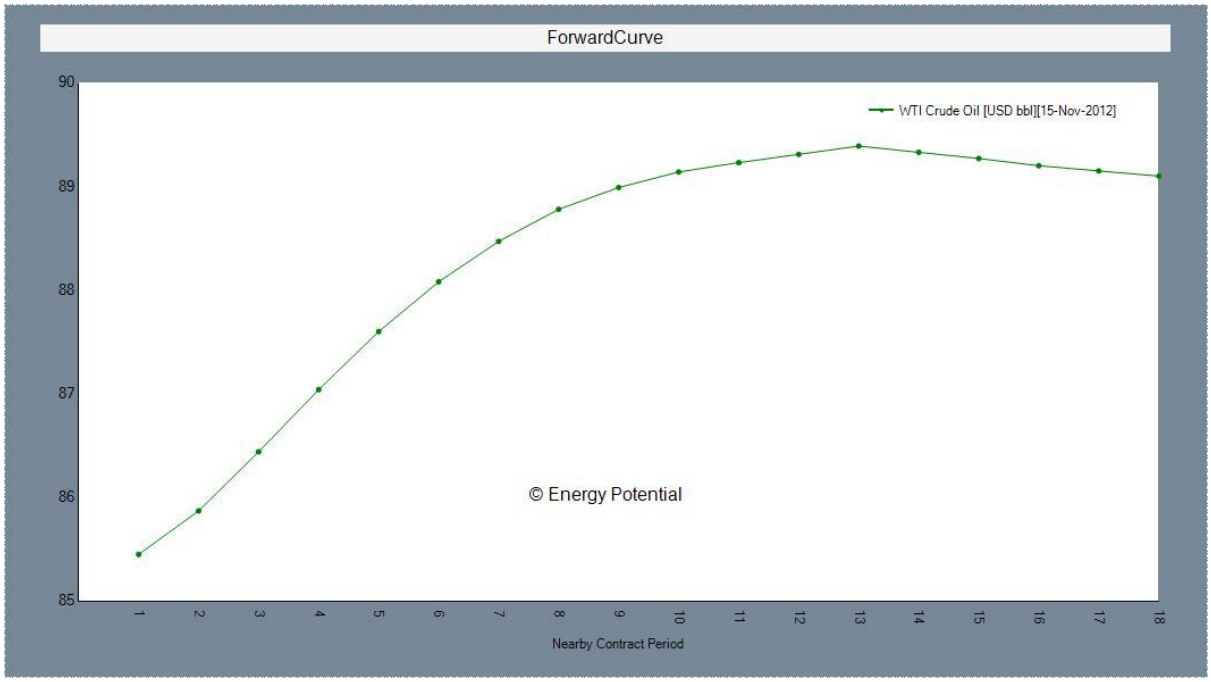

Figure 6 - Oil Forward Curves 18 Months forward, indexed in contracts to delivery

This representation is useful because it uses a relative axis; so it is simple to compare any forward curve with others. In the chart below the crude oil curve is compare in the opening trading days in 2003 to 2006.

If an asset is highly seasonal the user should be cautious with this representation. The relative notation hides the underlying absolute contract, so on a 'summer' date the 1st nearby will be a summer contract, while on a winter date the 1st nearby will be a winter contract; the natural seasonal spreads will be embedded in the series.

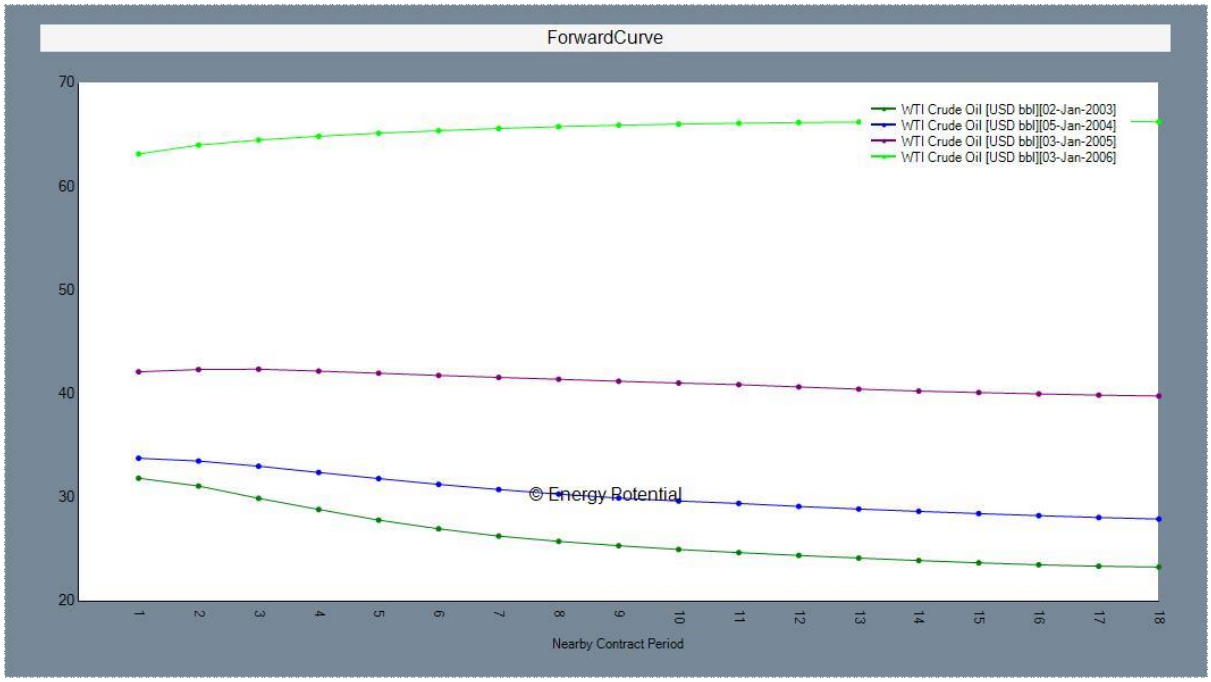

Figure 7 - Oil Forward curves indexed in contracts to delivery over multiple years

The next chart demonstrates the seasonality issue using UK power as an example. Here for the date 2-Jun-2015 the 1st contract is 'July-15'; for the curve on 1-Dec-15, the 1st contract is Dec-16.

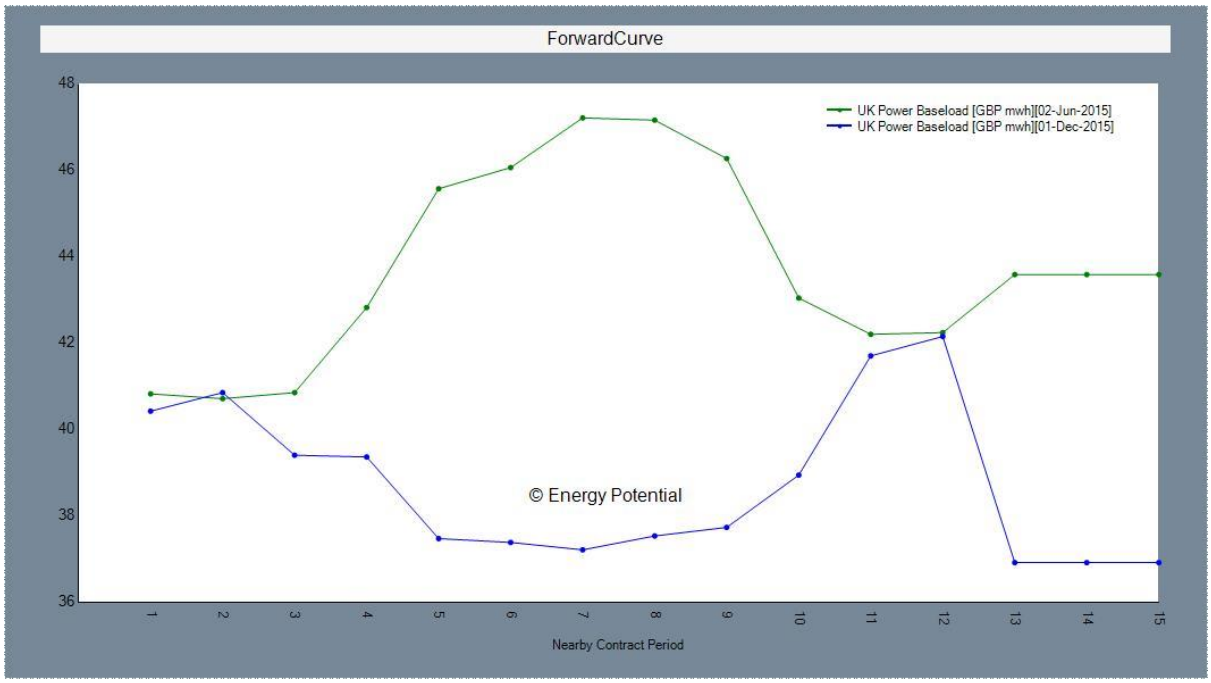

Figure 8 – Power forward curves in summer and winter indexed in contracts to delivery

Composite Forward Curves

Composite curve charts are inspired by the typical traded market structure Power Markets, which tend to be built from monthly, quarterly and seasonal, and sometimes calendar contracts; compare that with fuel markets which may have a month structure.

These curves are defined by a user who must specify how many months, quarters, seasons and calendar periods they would like to see. In the chart below we use months =2, quarters = 3, seasons = 2; there is logic underlying these charts to make sure that that the representation is continuous. For example, if the user specified 3 months then the final month would be Jan-18, but the next quarter period would then be 1-April start, and so the chart would contain the Feb and Mar periods are months, to 'fill the gap'. The same process happens with quarters and seasons.

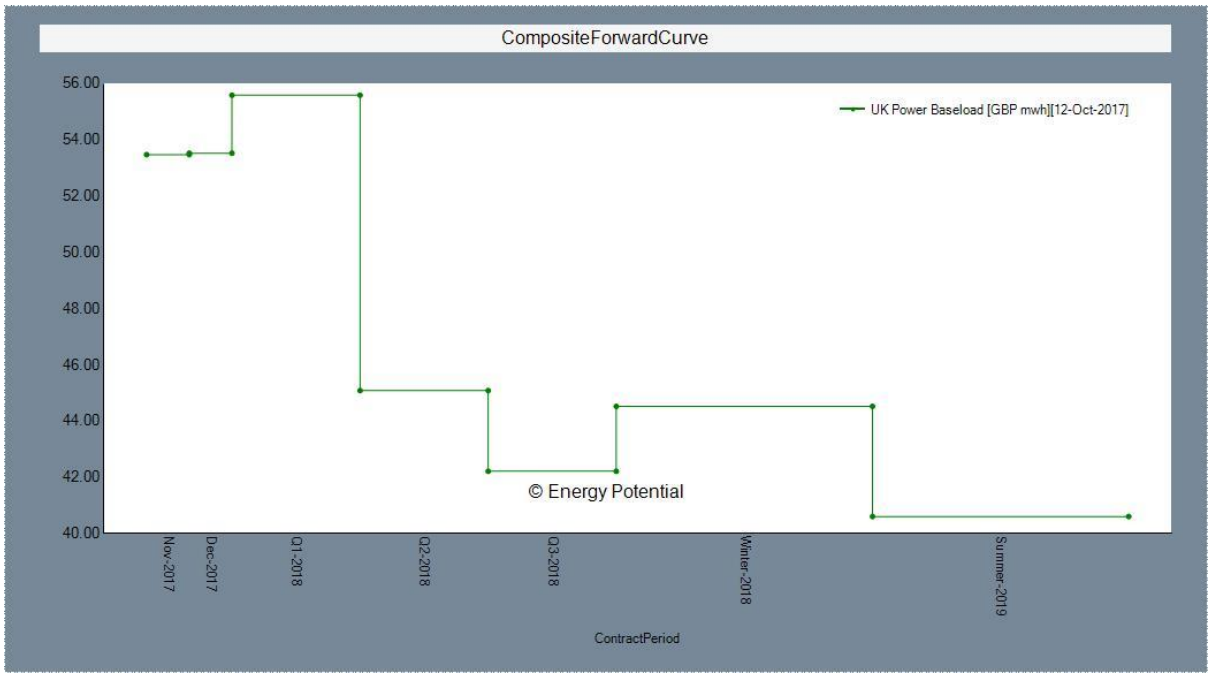

Figure 9 – UK Power Curve Composite, built on this format: M=2,Q=2,S=2; which means 2 Months, then 2 Quarters then 2 Seasons

These charts are useful if you want to combine assets that do not share the same traded market periods.

The next chart shows UK Power and input 'fuels' (for simplicity using Brent Crude as the oil complex fuel proxy)

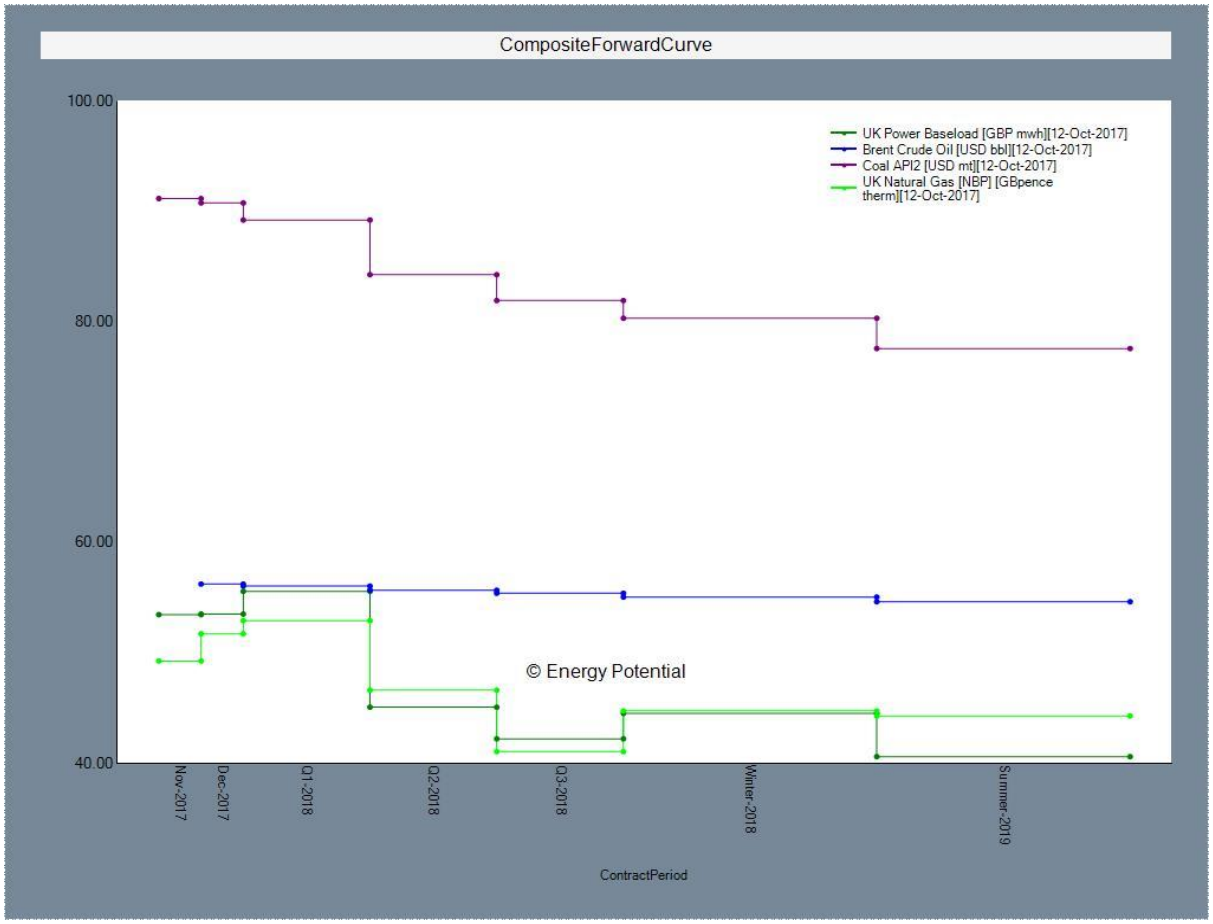

Figure 10 – UK Power Curve, UK Gas, Brent Oil, Rotterdam Coal, in a composite representation

You can also compare multiple dates on the same chart:

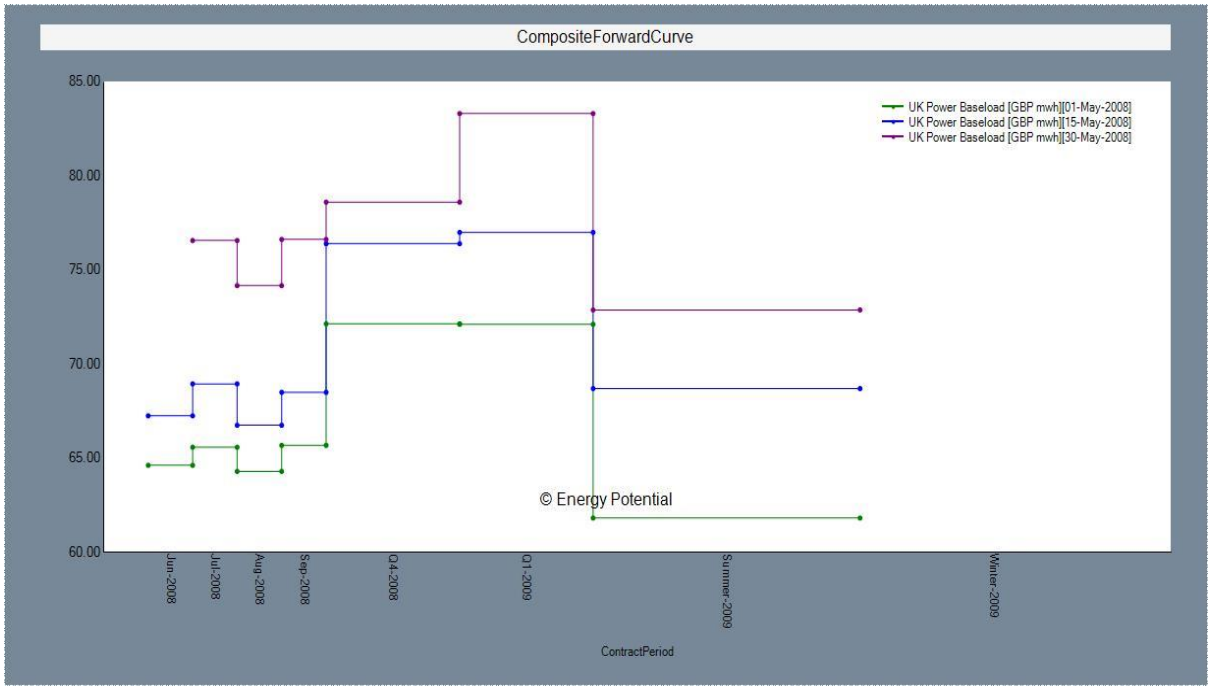

Figure 11 – UK Power Curves in start, mid, end May 2008: the winter contract is not quoted and does not display

Asset time series

These charts plot show the values of an asset over time and are similar to normal 'stock price' chart. For many asset price data sets we have open-high-low-close type data, and these can be viewed on the same chart.

The first below shoes the opening and closing prices for the Dec 1985 US Crude contract, over its lifetime.

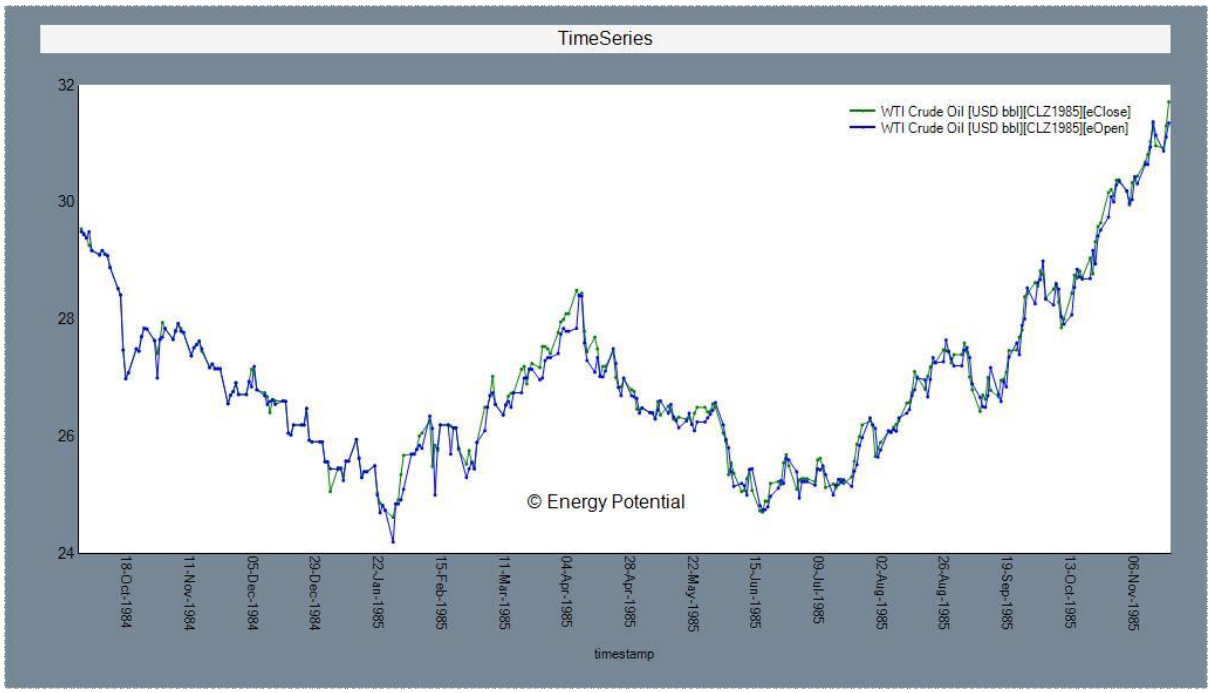

Figure 12 – Open and close price for WTI oil Dec 1995 contract, open and close prices over the contract lifetime.

We can have multiple different contracts plotted on the same chart. The next chart shows Dec 1996 and Dec 1996 closing prices over each contract lifetime.

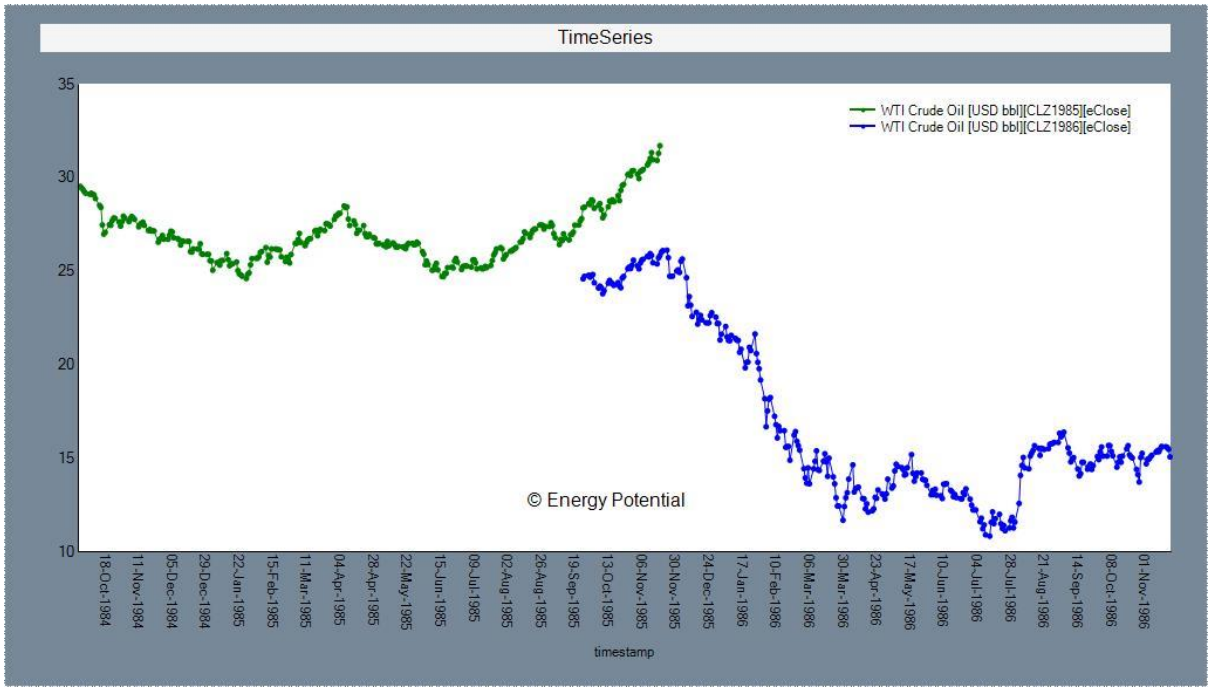

Figure 13 – Close prices for WTI oil Dec 1995 and Dec 1996 contracts, over each contract lifetime

To examine the area of overlap in the chart above simply zoom in:

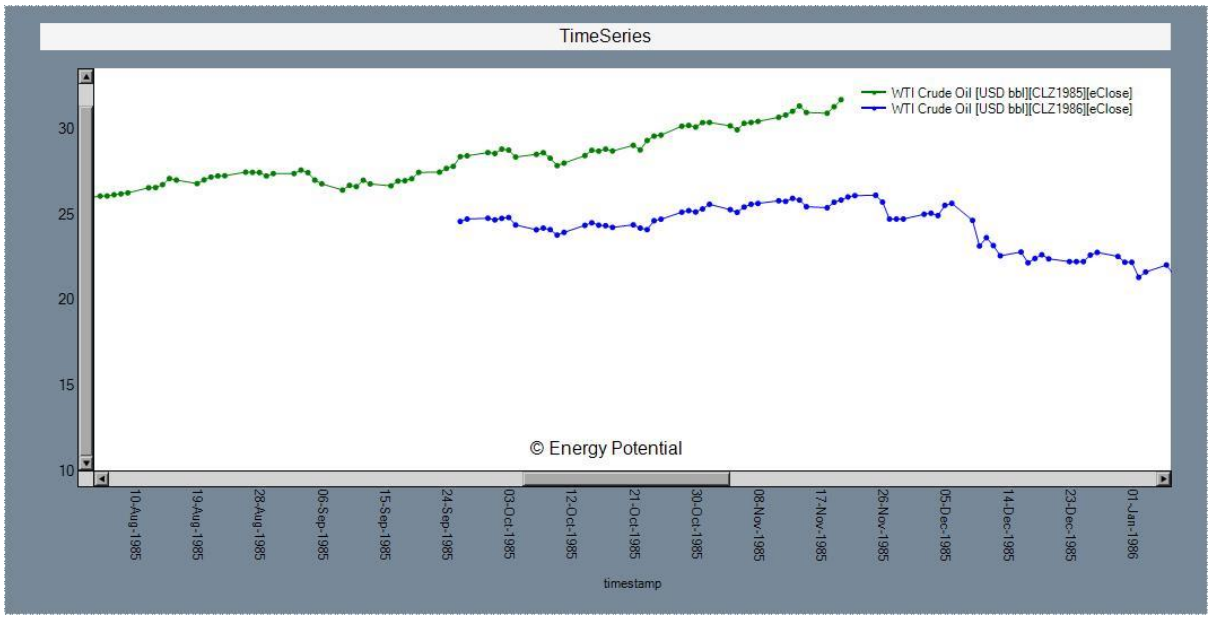

Figure 14 – Close prices for WTI oil Dec 1995 and Dec 1996 contracts, zoomed to overlap period

You can plot many assets on the same chart, in the below we show the 'joint' behaviour of power with coal and gas prices at the close, for the Jan 2014 contract (note we have switched data point market off in this chart, it can make the chart easier on the eye).

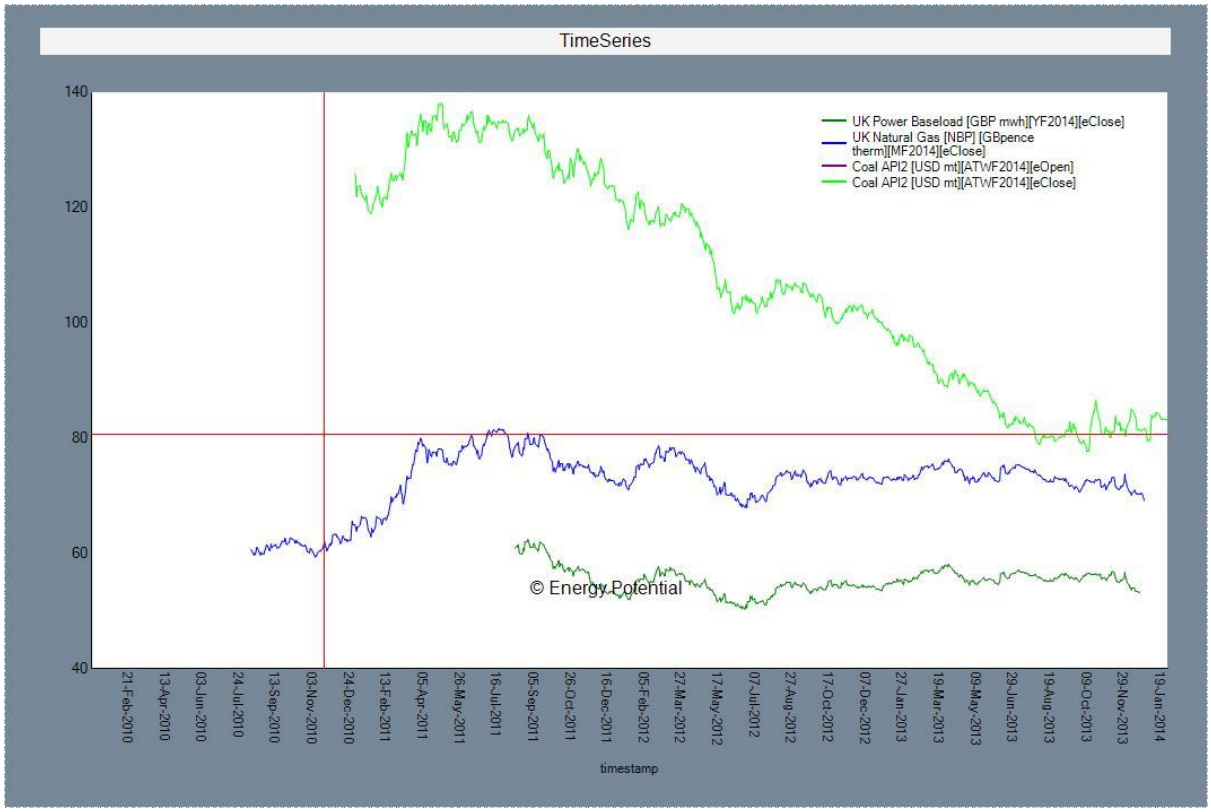

Figure 15 – Power, Gas, Coal (Rotterdam) close prices for Feb 14 contract

Continuation Series

Price Continuations

Continuation series are created from futures price type data sets. While each future expires, the continuation does not expire, it is in some sense a 'perpetual' future. The charts here show a simple 'c1' series; this is a series built like this:

- at time t the contract price is the 1st nearby contract price

Implicit in this definition is the idea of the 'contract roll' – this is the point in time where the 1st nearby contract expires and the 2nd nearby 'rolls' into the 1st nearby position.

There are many ways to create continuation series, and the underlying data model supports an arbitrary continuation definition.

Continuations are used to create a commodity analogue of a 'spot price'. Continuations are typically very long dated, starting from the very first contract traded to the present day. To illustrate below is the c1 for WTI Crude Oil. Note the chart legend tells you it is a continuation rather than a real contract.

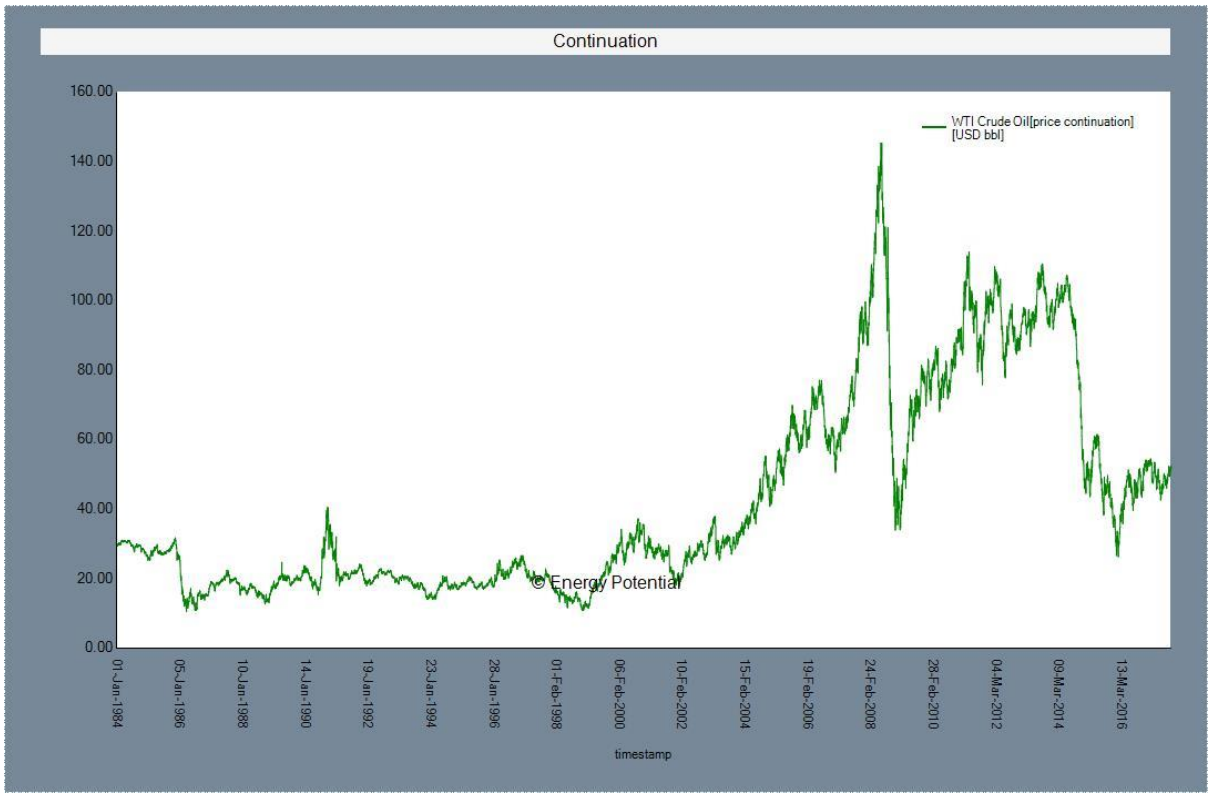

Figure 16 – Crude Oil Front Contract Continuation, lifetime to date [1984 to 2017]

As for other charts we overlay other continuations to an existing one. In the next chart the Brent Oil c1 is added, as is the UK NBP gas c1 contract. Each has a different first contract date, as can be seen the start point of the chart changes with asset.

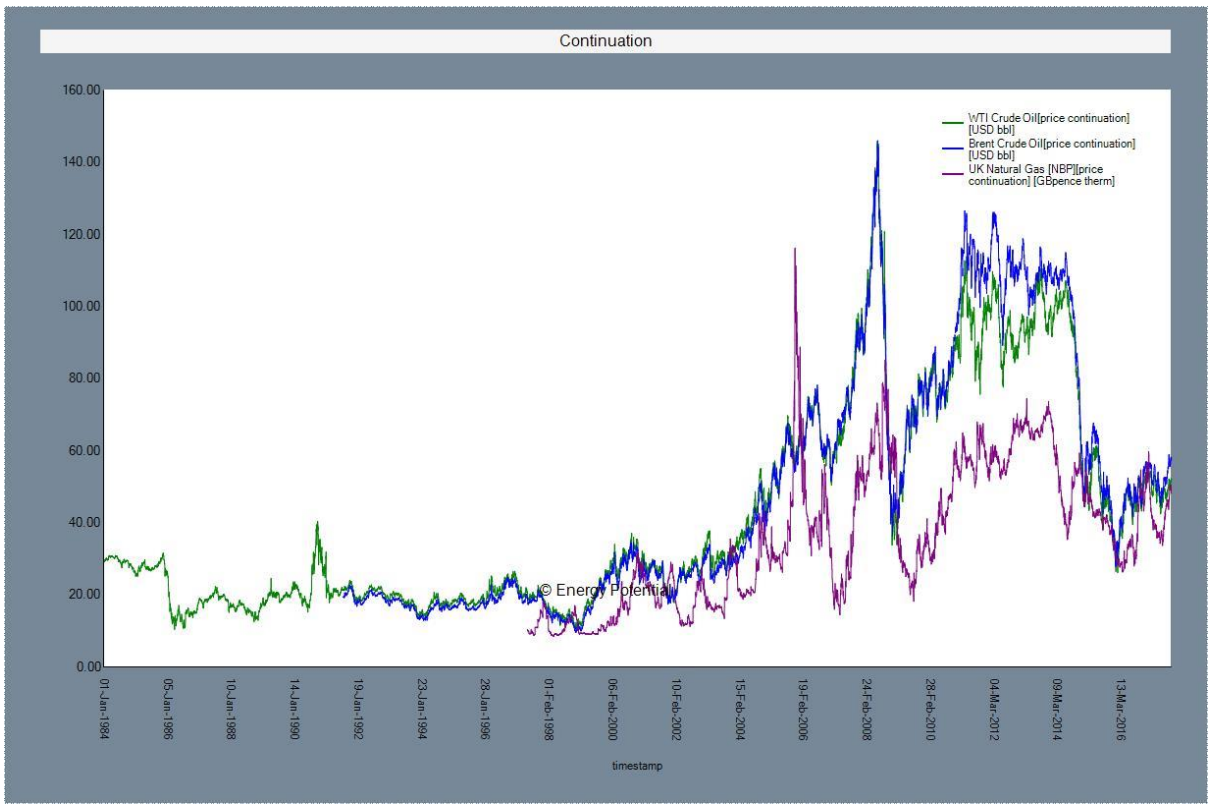

Figure 17 –c1 for WTI, Brent, NBP Continuation, lifetime to date

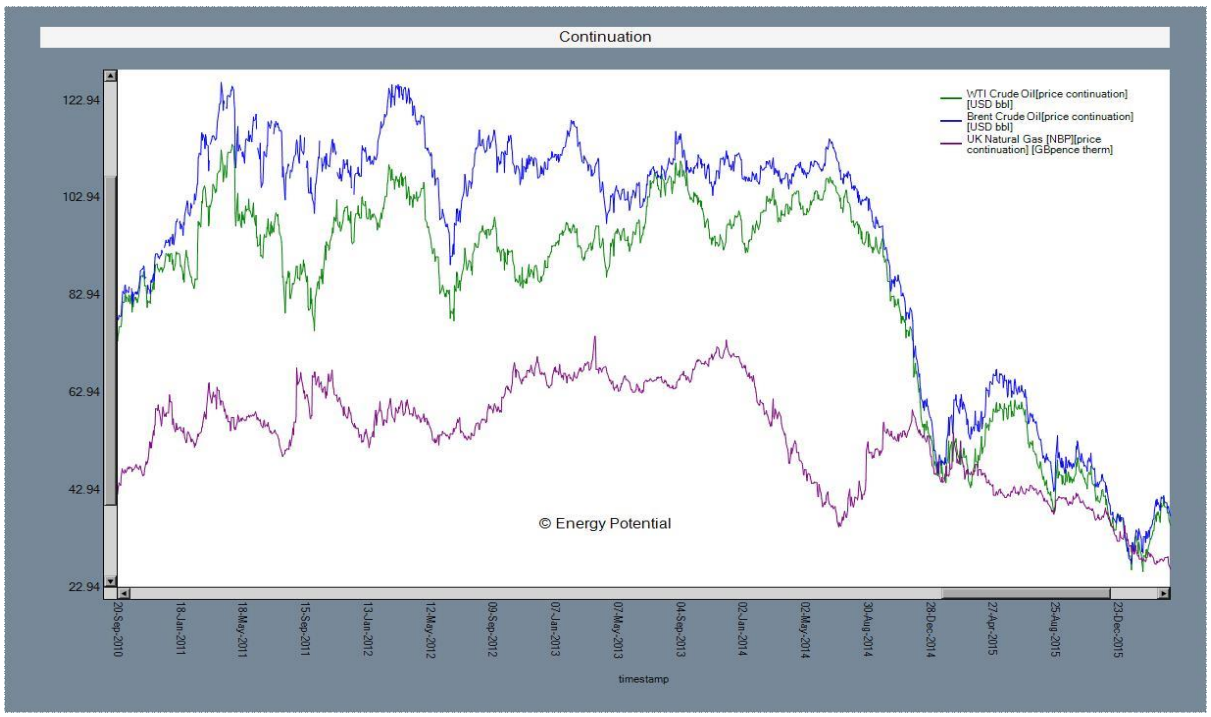

Figure 18 –c1 for WTI, Brent, NBP Continuation, lifetime to date, zoomed

Return Continuations

The data warehouse also stores return continuation series. A return represents a proportional change in price, for example we might write, with t time

$$return(t) \sim \frac{p(t)}{p(t-1)} - 1$$

Return continuations follow the price continuation definition, but are constructed to be contract continuous over a contract roll, this ensure that there are no 'jumps' in return series.

Return series continuations are important to measure the relative performance of assets over long time periods. Though not as easy to interpret as price ones, an example in provided below for completeness:

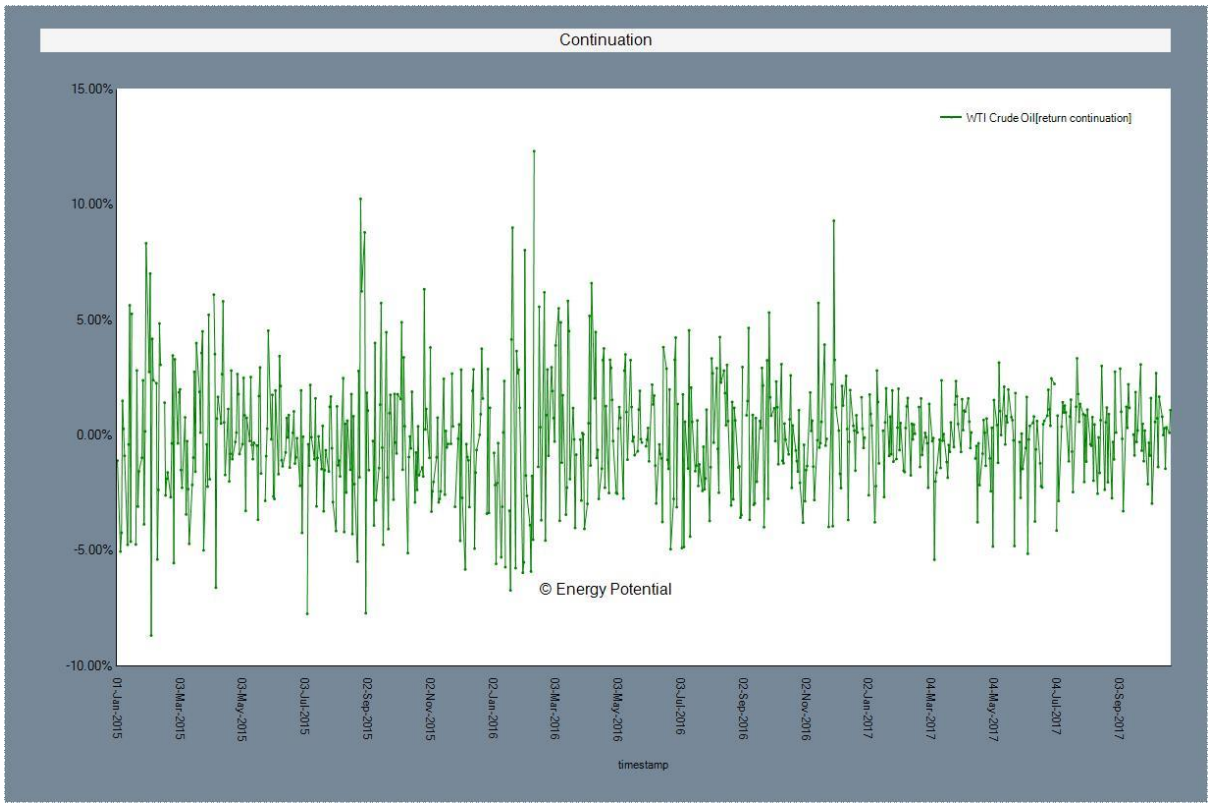

Figure 19 – c1 return continuation for WTI

Seasonal charts

Seasonal charts take series and slice them into 'pieces' that you can overlay onto a single, generic axis. That way you can see the evolution of the same asset over the same periods but ordered by (say) the time series year. Consider a 'summer' seasonal; for a series available (say) from 2000 to 2005, in each year period we take the summer slice (say, 1-June to 30-Sep). We then map each slice to the same 'generic' axis, and use that axis to align the data.

Below is an example of this for UK NBP gas using the c1 continuation. The first chart shows data on a generic axis of 1 year: 1-Jan to 31-Dec. The second chart zooms into the summer period for more detail.

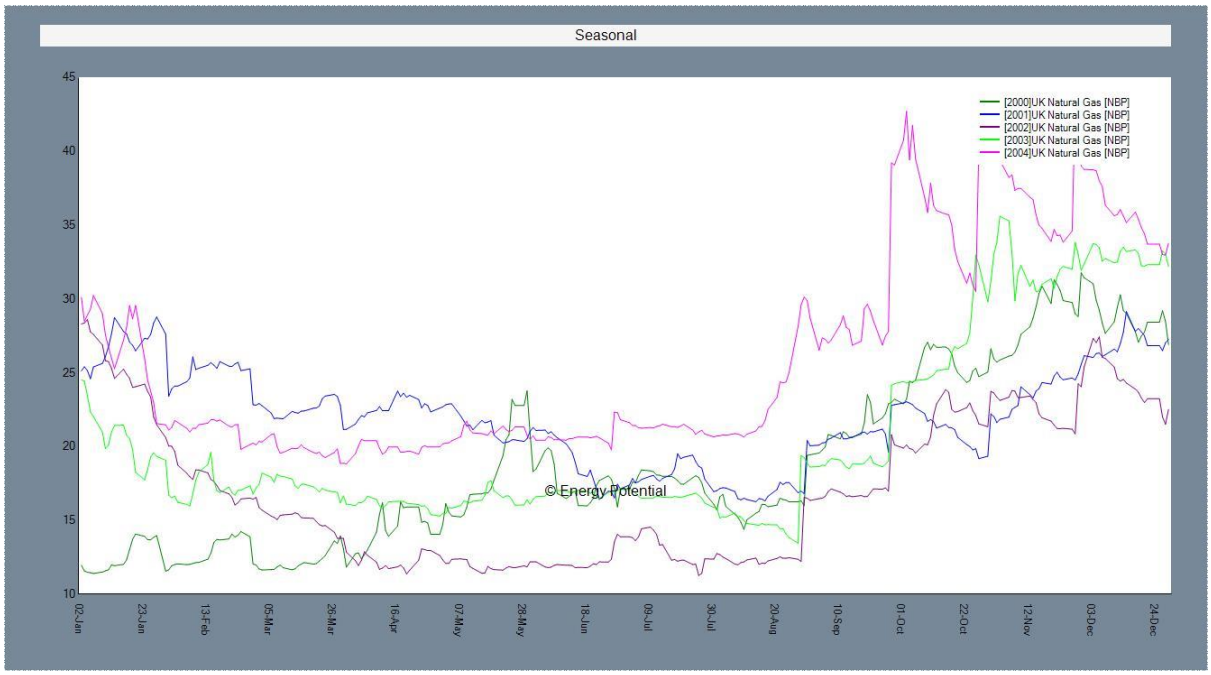

Figure 20 – c1 seasonal for UK Gas (NBP)

Below is the same chart 'zoomed', showing the summer period in more detail.

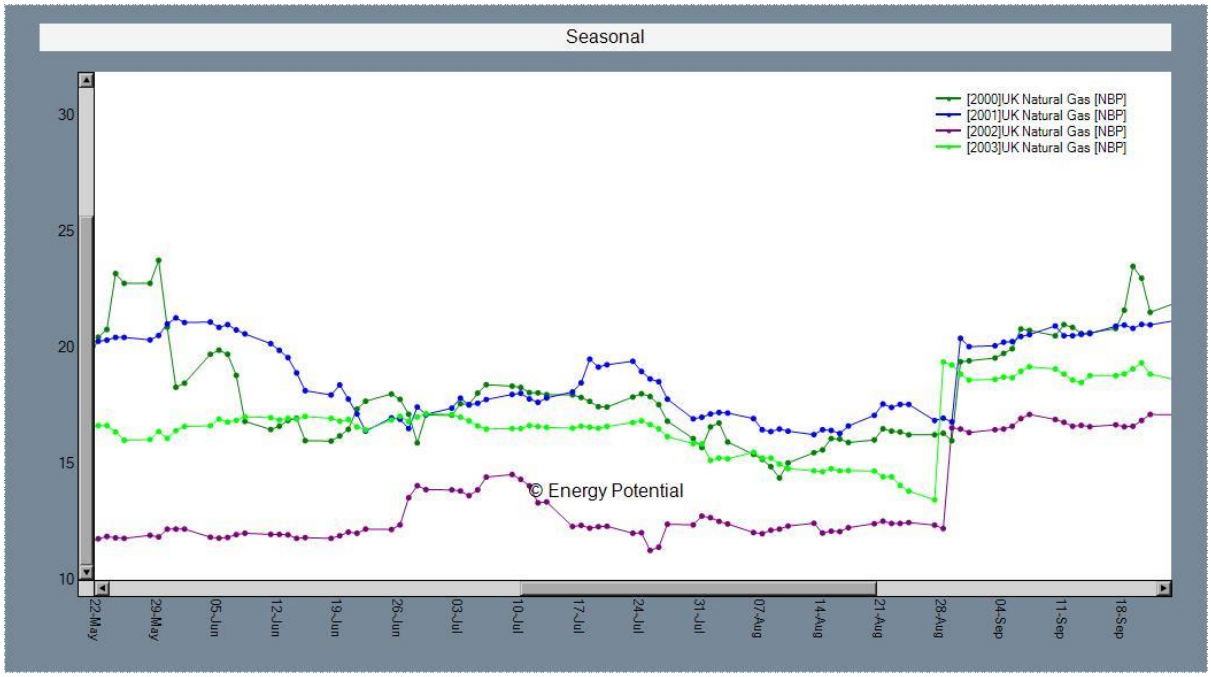

Figure 21 – c1 seasonal for UK Gas (NBP) – summer period

More generally, the charting tool can create multi asset seasonal charts, across different multi-year selections; for example the more complex chart below.

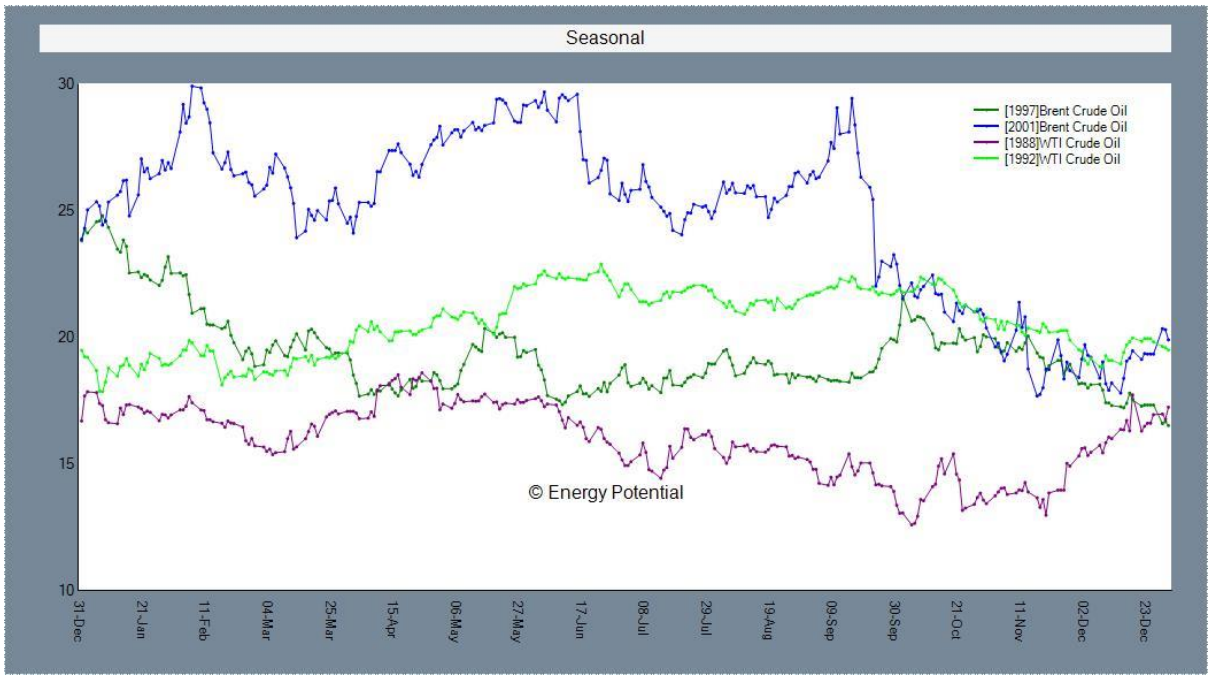

Figure 22 – c1 seasonal, WTI and Brent oil, multi years