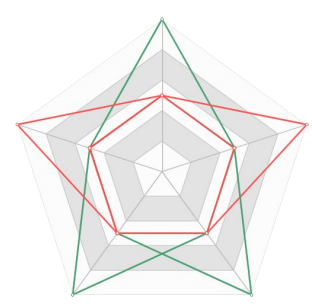# LG.Philips is looking to invest in a 6th generation TFT-LCD production facility

- LG.Philips is the market leader in large scale thin-film transistor liquid crystal display (TFT-LCD) panels, with almost 24% of the market share and a widespread presence with 49,000 employees. To retain this, you are looking into innovating your production by utilising the 6th generation TFT-LCD panels for televisions, monitors, and notebooks.

- The question you asked Penta Consultants is:
**Should the investment in a 6th gen TFT-LCD production facility be made?**

  Due to many uncertain factors and multiple product options, it is not directly clear whether to invest and how to divide production. A complex approach is necessary.
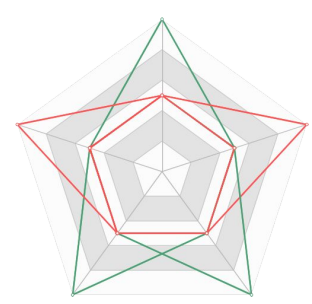
# An investment decision is worth considering when the associated Net Present Value (NPV) is positive, indicating profitability

- The NPV flowchart gives an overview of what influences the NPV, with highlighted differences between the decision variables (blue) and the fixed but somewhat uncertain parameters (green)
- This will be optimized with different risk measurements such that the degree of risk could be considered by making a good decision.
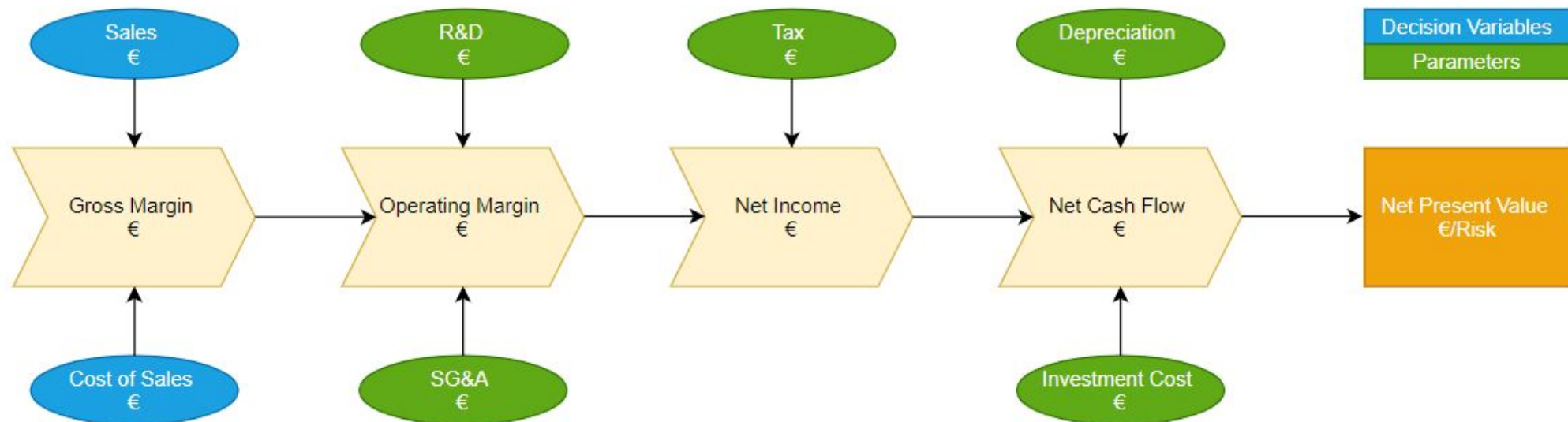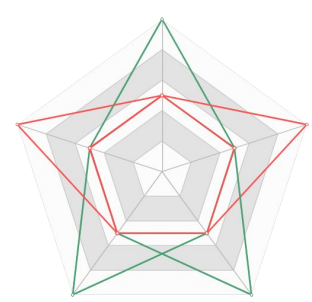
# The data indicates that the profitability* of televisions will increase over time, until 2012, and as such the optimal solution should reflect this

Initial data analysis suggests that the **profitability** of televisions will **increase** over time, until 2012. In large part this is due to the rising yield rate. After 2012, however, the initial data analyses suggests that the profitability of TV's will decrease, as a result of falling prices.

Indeed, a particular product becomes more profitable over time when the rise in yield rate is greater than the decrease in price.

The profitability of notebooks and monitors, as opposed to televisions, is expected to **suffer** as the yield rate grows at a slower rate than the decrease in price.

As such, one would expect the optimal solution of products to change over time according to their respective profitability.



Profitability per product type
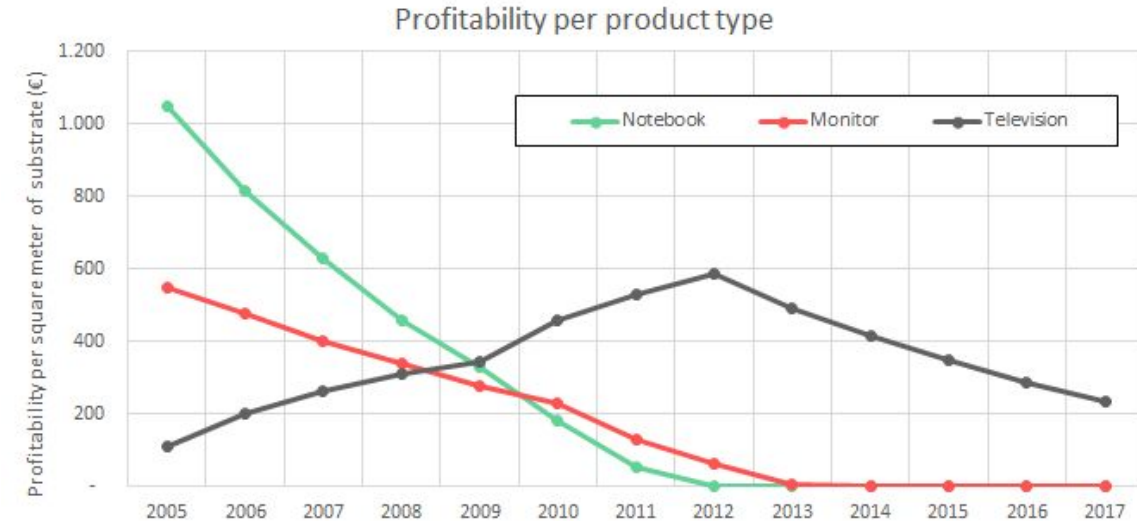
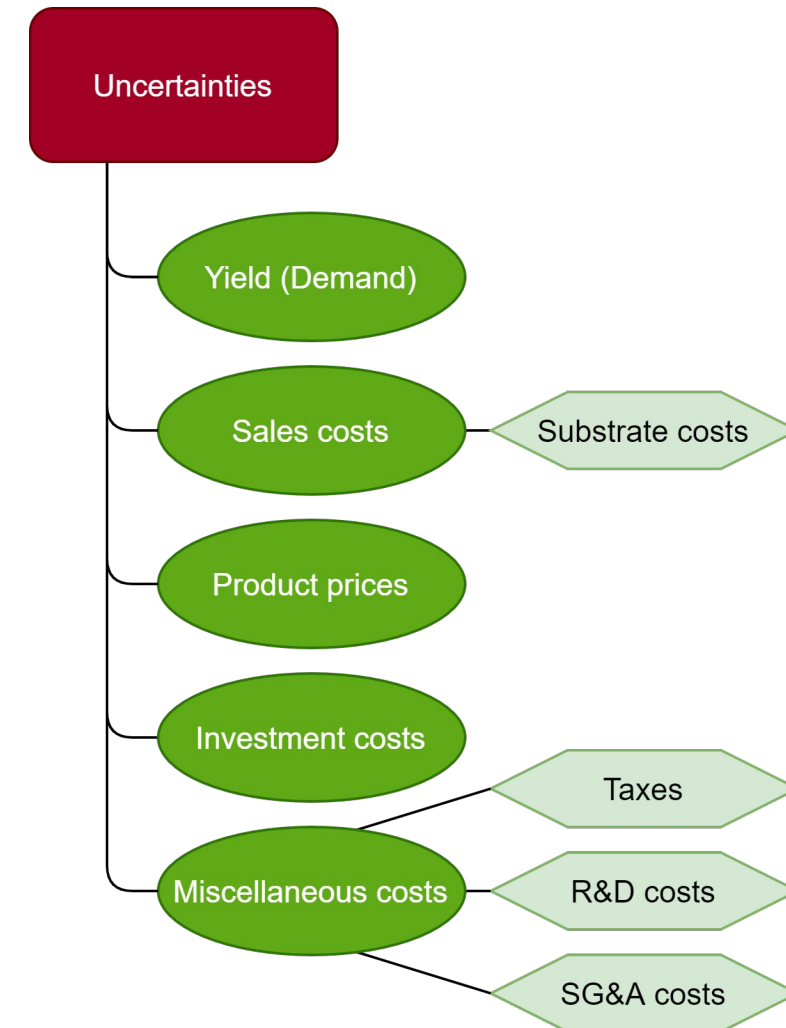| | % Δ Yield Rate 2005- | % Δ Price 2005-2017 |
|---|---|---|
| Notebook | +20% | -93% |
| Monitor | +25% | -86% |
| Television | +50% | -75% |

*Profitability per square meter of substrate for each product category over time, assuming that the number of products that can fit on a meter squared of substrate is 1/area per product (i.e. not accounting for any constraints and/or uncertainties).
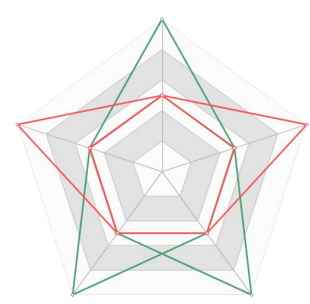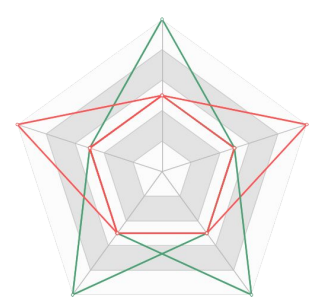
# There are, however, many uncertainties to take into account when determining the optimal solution which maximizes the NPV

Uncertainties that may influence our calculations of the Net Present Value are:

⬟ **Demand yield**: How much of our production can we actually sell?
  *E.g. 2017 for TVs: 65% to 82%*

⬟ **Television demand**: What size of televisions will be in-demand in the future?
  *HDreadyTV or FullHDTV? 40 or 43 inch?*

⬟ **Product prices**: What will be the market prices for our products?
  *E.g. FullHDTV 37 inch in 2006: €911,20 to €1366.80*

⬟ **Sales costs**: How high are the costs per substrate?
  *E.g. in 2017: €357,- to €447,-*

⬟ **Investment costs**: How much do we need to invest?
  *E.g. in 2004: €1.125 billion to €1.375 billion*

⬟ **Miscellaneous costs**: How much tax do we need to pay? How much do we spend on R&D and SG&A? Etcetera.
  *E.g. R&D: 4% to 11% - tax from 20% to 30%*

Uncertainties
- Yield (Demand)
- Sales costs
  - Substrate costs
- Product prices
- Investment costs
- Miscellaneous costs
  - Taxes
  - R&D costs
  - SG&A costs

# Different uncertainty scenarios, regarding substrate costs, product selling price and yield, will be used to produce the optimal solution

Maximizing the total profit comes down to performing a lot of calculations and making important decisions. The calculations can be performed in the best way possible using a simulation model. The model will be optimized numerous times with each time different values as input.

This results in different scenarios that will be used to simulate a clear overview of the choices and possibilities to eventually provide the best advice on investment.
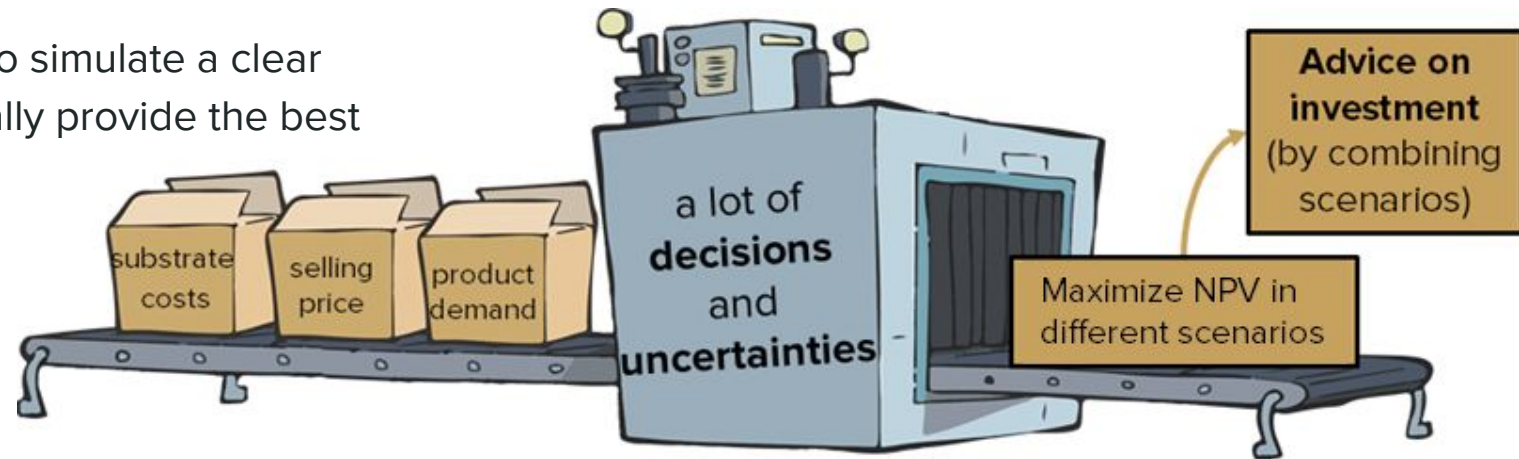


| There are three factors that influence how we maximize the different scenarios | | |
| --- | --- | --- |
| Maximizing the number of products per substrate by choosing the optimal direction in which the products are cut out | Choosing the optimal substrate size in such a way that glass loss is minimized. Taking into account TV sizes are uncertain | Choosing the optimal composition of products knowing the maximum production capacity of the facility while maintaining a diverse product portfolio (some products are more profitable than others) |
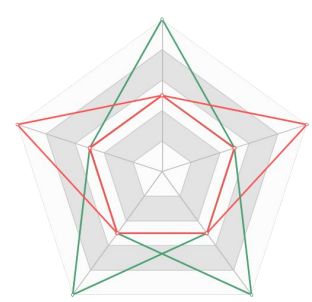
# Penta Consultants will deliver all necessary information so that that you can make the best investment decision



Net Present Value ($ millions)

| | | |
|---|---|---|
| 2017 Notebook Yield | 85% | 97% |
| Tax | 30% | 20% |
| 2017 Television Yield | 65% | 82% |
| 2017 Costs per Substrate | $437 | $357 |
| 2004 Investment Costs | $1375 | $1125 |
| R&D Costs | 11% | 4% |
| 2017 Monitor Yield | 85% | 97% |
| 2008 40 Inch Television Price | $1016 | $1524 |
| 43 Inch FullHDTV Television Size | 44 inch | 41 inch |
| SG&A Costs | 3% | 5% |

Base Value = 75

| Option | Positive NPV | Remain Market Leader | Minimal Risk |
|---|---|---|---|
| **Invest and accept more risk** *E.g. allocate more substrates to TVs or assume tax won't be too high.* | Yes | Yes | No |
| **Invest and accept less risk** *E.g. allocate substrates in a more balanced way and consider a possibly high tax.* | Yes | Yes | Yes |
| **Do not invest** | Yes | No | Yes |

## Tornado chart
How does uncertainty affect your investment opportunity?
- ⬟ 2017 Notebook Yield has the largest effect: if we can sell 97% of our notebooks, the NPV more than doubles compared to the base value.
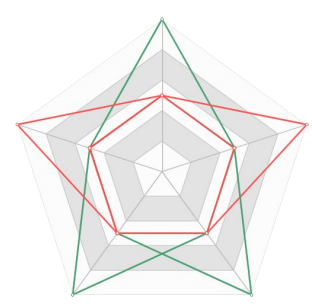- ⬟ If the costs per substrate rise by $50, the NPV almost halves compared to the base value.

## Decision matrix
How do different alternatives satisfy your requirements?
- ⬟ If you do not invest, you retain a positive NPV and have minimal risk. However, you will no longer be market leader.
- ⬟ By investing conservatively, you can produce 6th generation TFT-LCD screens with minimal risk and a positive NPV while retaining your position as market leader.

NB: These charts are made for illustration purposes and are not based on calculations or other analyses

# The optimization process will be based on many different assumptions

## General assumptions

- The market research conducted on the price and demand projections for each product, as well the projections on the costs of the substrate, are an accurate representation of what will actually happen.
- Production of 6th generation is essential to stay market leader.
- Investment costs will be paid from 2003 to 2005. There are no costs like facility deconstruction costs after 2017 which have to be taken into account.
- There are uncertainty bandwidths around certain values, where the high and low values are both attained 25% of the time and the base value is attained 50% of the time. Moreover, these uncertainties are independent over time.

## Sales assumptions

- There are no political, economical, or competitive factors that influences the demand for LG.Philips. In general, under uncertainties, the yield percentage of production can always be sold. Hence, there is always enough demand to satisfy this.
- Sales of other generations (before or after the 6th) are not influenced by the 6th gen products and the 6th generation products are not influenced by their sales and will therefore not be taken into consideration.
- If a different television screen size become the standard, the price can be scaled by the area change.

## Production assumptions

- Machines cut the substrates correctly, up to an exclusion.
- Machines can only handle one size of substrate.
- Products can only be placed in either horizontal or vertical direction on a substrate.
- Out of one substrate, only one product type can produced.
- The maximum substrate size is constrained as 1.55 by 1.85 meters.
- The capacity is constrained by 60,000 substrates per month.
- There will be no logistical issues (i.e. transport or construction delays). Moreover, no supply disruptions will happen, i.e. there are always enough resources to produce 60,000 substrates per month.
- There will be no extraordinary political/labor/environmental influences on the production rate.

## Product assumptions

- Television sizes remain constant over the years.
- There will be no other 6th generation products than known in 2003 produced by LG.Philips up to 2017.
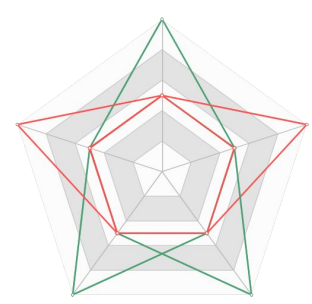
# Penta Consultants will run several optimization scenarios, enabling you to make the best possible investment decision

## Overview

- LG.Philips is looking to **invest** in a 6th generation TFT-LCD production facility.

- The **Net Present Value** will determine whether the investment is profitable.

- Initial data analysis suggests that the profitability of televisions will be higher than that of notebooks and monitors.

- **Many uncertainties** influence the Net Present Value.

- Different uncertainty scenarios will be analyzed to produce the **optimal weighted solution**.

- We will enable **you** to make the best decision.

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