**Cell-Oriented Report: Deriving Concept B’s Formula Using Excel Solver**

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**1. Introduction**

In this report, I document the step-by-step process of reverse-engineering the relationship between raw e-car data and Concept B’s reported consumption (kWh/100 km). The goal was to find a linear formula of the form:

Bmodel=α×(calc\_cons)  +  βB\_{\text{model}} = \alpha \times (\text{calc\\_cons}) \;+\; \beta

where:

* **α\alpha** and **β\beta** are constants to be determined by Excel’s Solver.
* **calc\_cons** is the baseline consumption derived from raw data (time, distance, power).

**2. Baseline Calculations**

1. **Time in Hours (Column I)**

time\_h=sec3600\text{time\\_h} = \frac{\text{sec}}{3600}

1. **Distance in Kilometers (Column J)**

dist\_km=meter1000\text{dist\\_km} = \frac{\text{meter}}{1000}

1. **Energy in kWh (Column K)**

energy\_kWh=kW×time\_h\text{energy\\_kWh} = \text{kW} \times \text{time\\_h}

1. **Baseline Consumption (Column L, calc\_cons)**

calc\_cons=(energy\_kWhdist\_km)×100\text{calc\\_cons} = \left(\frac{\text{energy\\_kWh}}{\text{dist\\_km}}\right) \times 100

These columns (I, J, K, L) were added to the original dataset in Excel. Each row contains formulas referencing the raw data columns (A: sec, B: kW, C: meter, etc.).

**3. Setting Up the Model for Concept B**

1. **Hypothesized Formula**
We assume Concept B can be approximated by:

Bmodel=α×calc\_cons+βB\_{\text{model}} = \alpha \times \text{calc\\_cons} + \beta

1. **Cells for α\alpha and β\beta**
	* **Q1:** α\alpha (initial guess: 1)
	* **R1:** β\beta (initial guess: 0)
2. **Modeled Column for B (Column P)**
In cell **P2** (and copied down):
3. =($Q$1 \* L2) + $R$1
	* L2L2 is the baseline consumption (calc\_cons).
	* $Q$1 and $R$1 are absolute references to the guess cells for \(\alpha and β\beta.
4. **Error Metric (Objective Cell)**
	* In cell **S1**, I defined a **sum of squared differences** between B\_model (Column P) and B\_consumption (Column G).
	* For example:
	* =SUMXMY2(P2:P39, G2:G39)
	* This cell becomes the **Objective Cell** that we want to **minimize** in Solver.

**4. Why Focus on Concept B?**

Several key observations led us to focus exclusively on Concept B:

* **Closer Initial Match to the Baseline:** Concept B exhibited the lowest average difference (residuals) between the computed baseline consumption and the reported values, making it the most statistically aligned model.
* **Improved Fit with Linear Adjustment:** A linear relationship of the form:

was applied using Solver. Concept B responded well to this transformation, significantly reducing error, whereas Concepts A and C showed inconsistent trends.

* **Reproducibility and Transparency:** The relationship derived for Concept B was mathematically straightforward and repeatable. It allowed clear parameter tuning (α and β) with an interpretable adjustment, unlike other models that lacked clear patterns.
* **Benchmark Feedback:** Early benchmarking and validation tests highlighted Concept B as the most accurate, reinforcing our decision to refine it further.

**5. Using Excel’s Solver**

1. **Solver Parameters**
	* **Set Objective:** $S$1 (Minimize)
	* **By Changing Variable Cells:** $Q$1:$R$1
	* **Constraints:** None (or remove any leftover defaults)
	* **Solving Method:** GRG Nonlinear (or Evolutionary, depending on preference)
2. **Running Solver**
	* Initially, $Q$1 = 1 and $R$1 = 0, leading to a high error (over 13,000 in the example).
	* After clicking “Solve,” Solver iterated until it found values that minimize $S$1.
3. **Solver Results**
	* **Final α\alpha** ≈0.018\approx 0.018
	* **Final β\beta** ≈4.5746\approx 4.5746
	* **Objective Cell** (sum of squared errors) reduced from 13,378 to ~22.96.

**6. Interpretation of the Results**

The best-fit linear formula is:

Bmodel  =  0.018059217×(calc\_cons)  +  4.574561668B\_{\text{model}} \;=\; 0.018059217 \times (\text{calc\\_cons}) \;+\; 4.574561668

1. **Physical Meaning:**
	* A small multiplier (α≈0.018\alpha \approx 0.018) indicates the baseline consumption contributes only a small amount to Concept B.
	* A larger constant offset (β≈4.57\beta \approx 4.57) suggests there’s a fixed overhead or base consumption in the B concept.
2. **Residuals Check:**
	* After applying this formula, the differences between B\_model and B\_consumption are much smaller than before.
	* Any remaining outliers could indicate speed-dependent factors or other nuances.

**7. Conclusion**

By employing a **cell-oriented** approach in Excel—where each step is explicitly laid out in columns and formulas—we successfully used Solver to derive a linear approximation for Concept B from the raw e-car data. The resulting formula significantly lowers the sum of squared differences between the modeled and actual B\_consumption values, offering insight into how Concept B might be calculated.