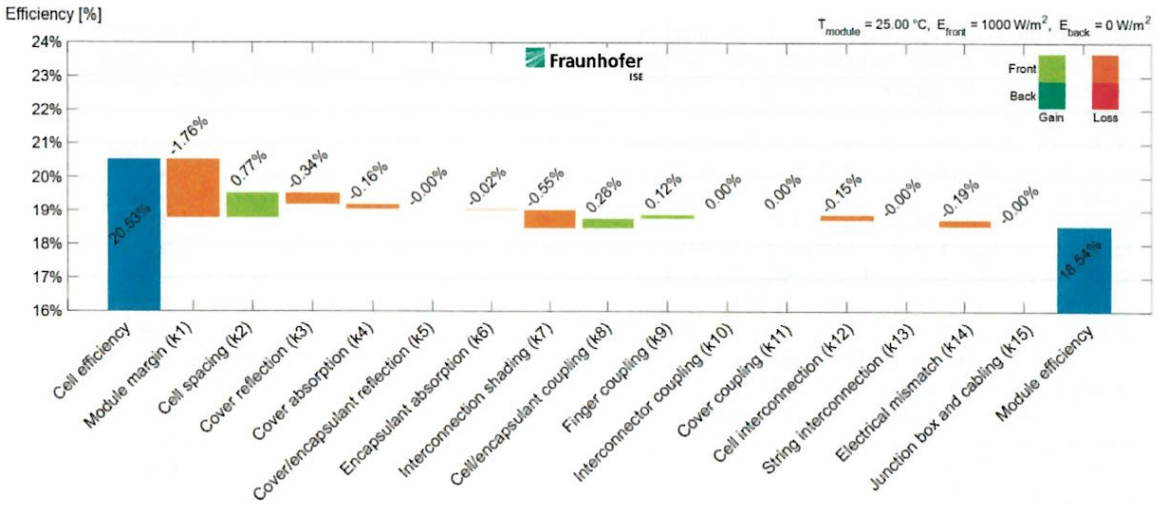

Figure 8: Shingle to module gains and losses diagram for a full-size shingle matrix module as depicted in ***Fehler! Verweisquelle konnte nicht gefunden werden.*** with G1 1/5th LSMC cut FSQ shingles as input. The factors relevant to the matrix technology are discussed in section 3.2. A detailed description of all factors can be found in [20].

4 CONCLUSION AND OUTLOOK

In this work matrix shingling was analyzed. This technology brings many advantages for BIPV. The absence of ribbons and the bricked wall like arrangement ensure a very homogeneous appearance. High power outputs during partial shading compared to conventional modules ensure high energy yields. Scalability makes integration into predefined glass sizes easy and maintains excellent area efficiency. Fraunhofer ISE has developed and tested this technology while an industrial stringer was brought to the market by M10 Solar Equipment. The key points for designing of high efficiency matrix modules are a low damage laser cutting process, optimized glass margins and reduced shingle overlap. A comparison between a common half-cell module and matrix modules shows that either module area or number of host cells must be adjusted for an optimized matrix module. The matrix technology reaches higher module efficiency (19.3%). However, more silicon is used per module. This shows that – simply speaking – shingle matrix technology does not get the best out of the host wafer but out of the module area. Therefore, shingle matrix modules are attractive for applications with limited space such as BIPV.

Seven matrix modules were built on a glass area of 1700 × 1000 mm². They feature a power up to 322 W_p and an efficiency of up to 18.8%. In experiment as well as in a detailed shingle-cell-to-module simulation, a relative power loss of −4.5% is obtained. The most important points in order to build highly efficient matrix modules, namely low glass margins, low damage cut shingles and small shingle overlap are presently under development at Fraunhofer ISE.

Long-term stability for modules with similar material was already shown for linear shingled modules by Fraunhofer ISE [17]. A batch of 10 modules is currently under test to show the same for matrix interconnected shingles. The test sequences according to IEC 61215 [23] includes TC200, humidity freeze, DH1000, mechanical load and hot-spot endurance.

Matrix integrated into a MorphoColor® façade element was presented which shows the aesthetic attractiveness of such modules. Technology wise matrix shingling offers a solution for upscaling flexible BIPV productions with high design leeway.

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