

SFRA-Assessing the application bandwidth of inductive voltage transformers

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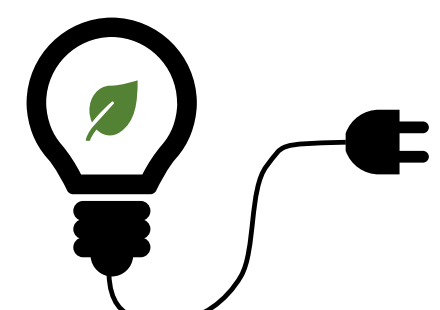
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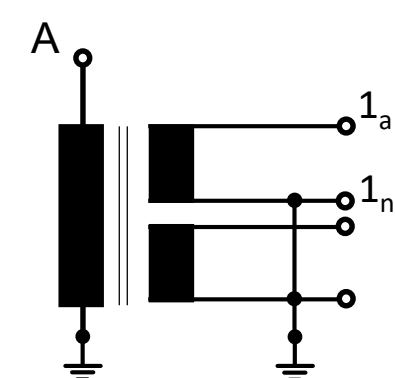
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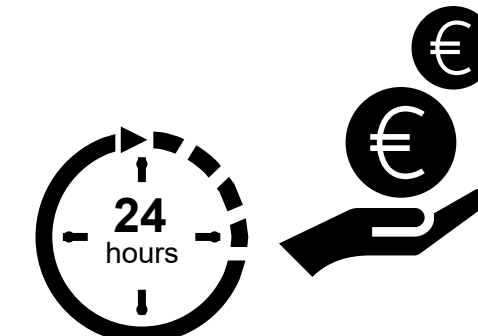
Motivation



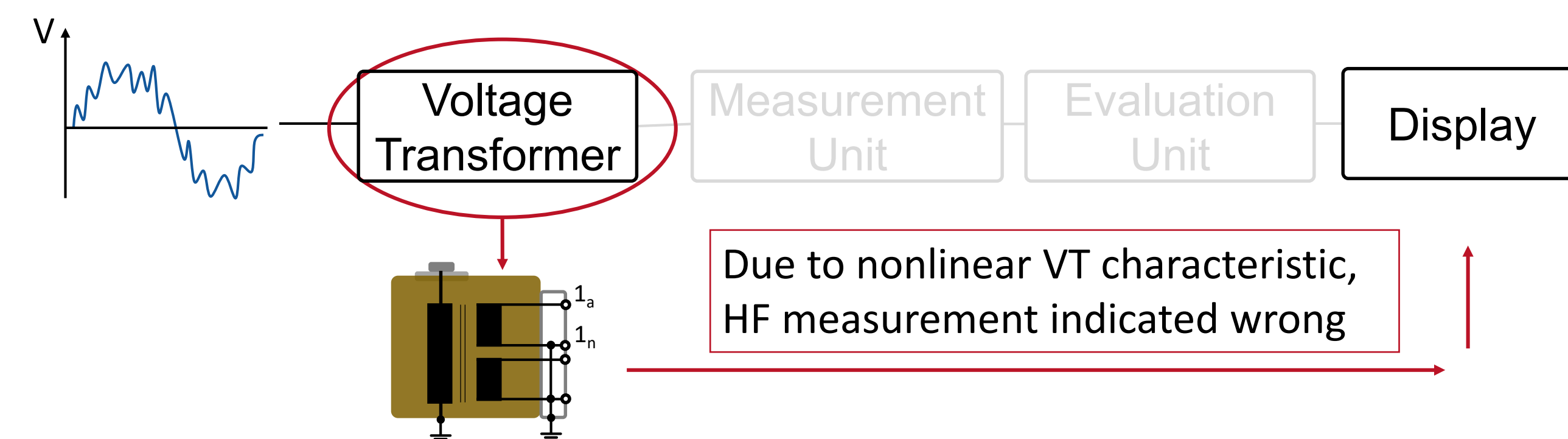
Share of renewables more than doubled (2004-2019) [1]
→ **more harmonic frequencies in the system voltage**



Primarily inductive VTs are used to measure PQ
→ **Limited bandwidth**
→ **High frequency on-site ratio tests required**



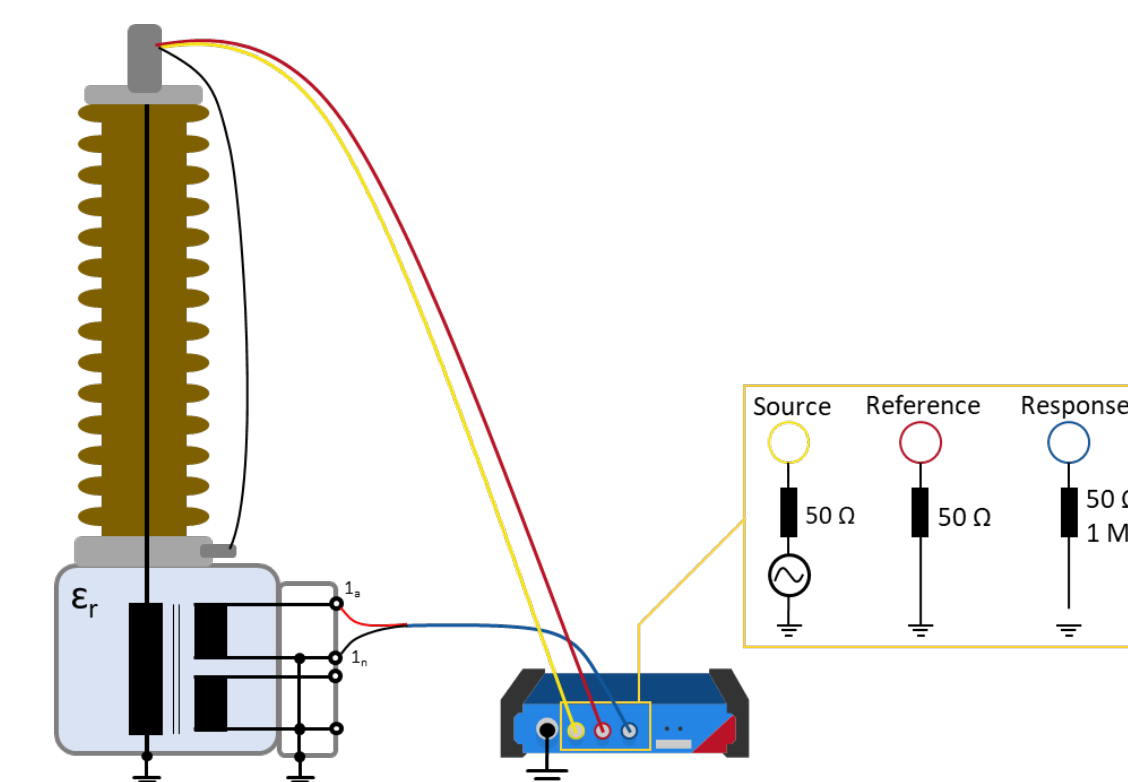
Availability of (on-site) test technology and cost effectiveness of test
→ **Reliable, mobile and accurate test methods required**
→ **Qualification parameters for VTs needed**



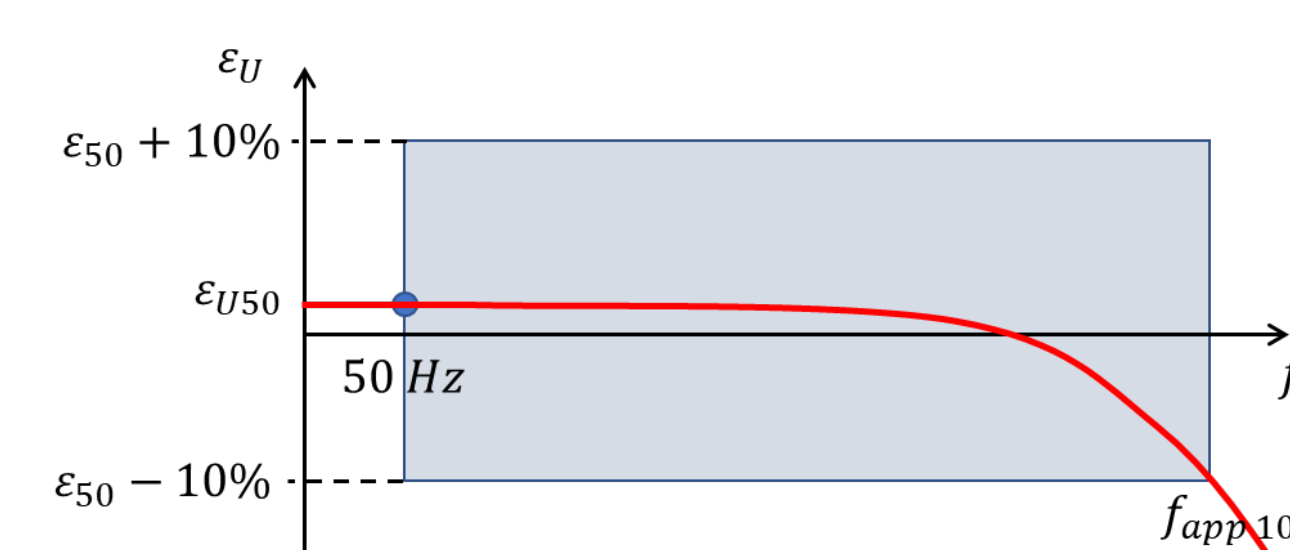
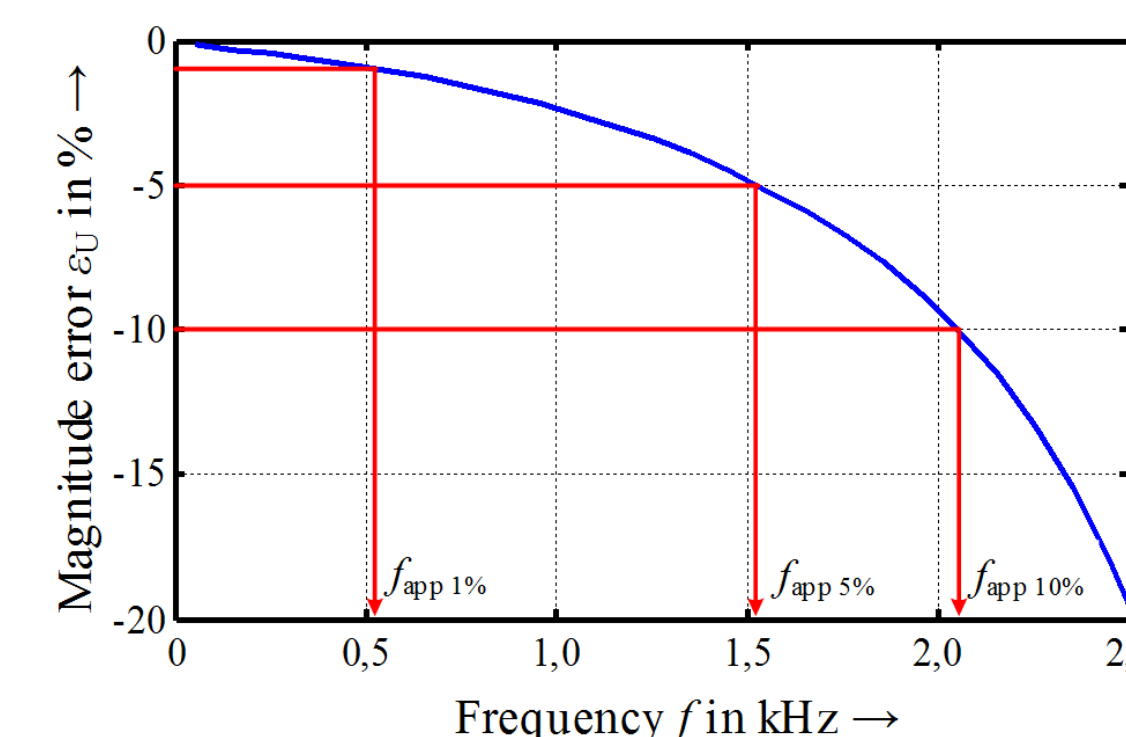
Methodology

Qualification of SFRA technology for VT high frequency transfer characteristic

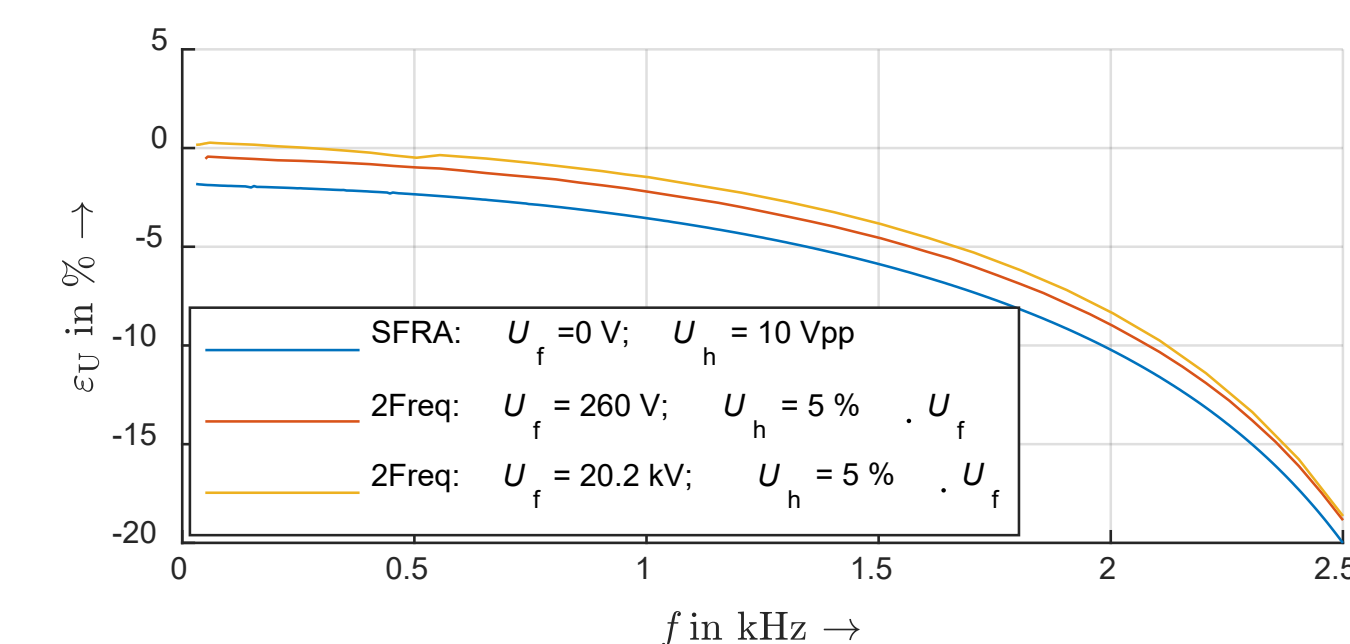
Application bandwidth for the purpose of VT high frequency performance qualification



- **Absolute application bandwidth** (left) – voltage ratio error (IEC 61869) exceeds limit
- **Relative application bandwidth** (right) – independent on absolute ratio error at 50/60 Hz, the deviation from measured 50/60 Hz ratio is considered



Results



- The qualitative frequency response characteristic are comparable with all used technologies

DUT	Appl. Bandwidth	Meas. System	No burden			Rated burden		
			1%	5%	10%	1%	5%	10%
10 kV IVT	Abs.	SFRA	2140	10519	11742	269	3192	5143
		Ref.-Sys	9453	>10000	>10000	1429	3518	5285
	Rel.	SFRA	2742	10503	11744	950	3457	5319
		Ref.-Sys	4148	>10000	>10000	1440	3524	5290
20 kV IVT 1	Abs.	SFRA	-	2987	4149	-	1621	2629
		Ref.-Sys	1760	3381	4313	730	1911	2778
	Rel.	SFRA	1564	3358	4318	893	2034	2882
		Ref.-Sys	1445	3268	4258	793	1938	2796

- **Relative and absolute application Bandwidth** are compared
- The **absolute application bandwidth with reference setup** is the reference

- >1% are comparable (SFRA compared to reference)
- 1% application bandwidth worst-case determination
- SFRA can be used to qualify the VT high frequency measurement performance