

Concepts for SF₆-free Transmission and Distribution of Electricity

Project background, overview and interim results

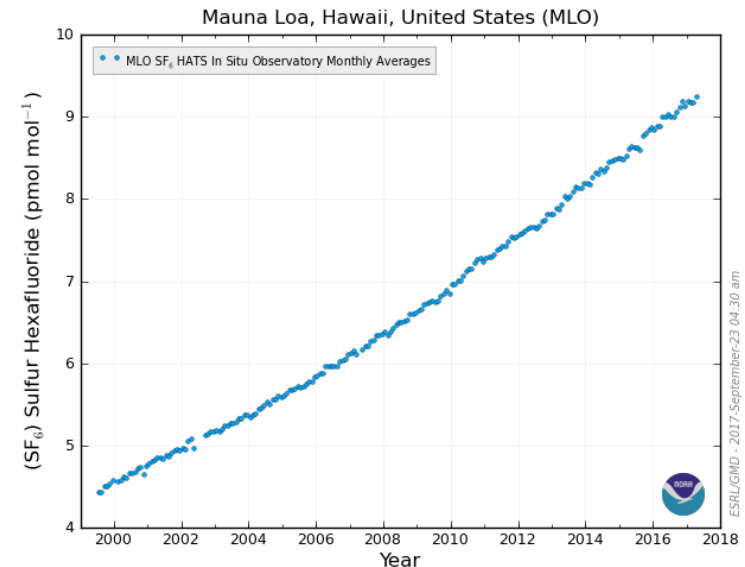
September 2017

ETH zürich **HVL** | High Voltage Laboratory **ECOFYS**

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SF_6 is the industrially used gas with the highest global warming potential (GWP): 23,500¹

- SF_6 has an extremely long life in atmosphere of 3200 years²⁾ → atmospheric concentration increases linearly with emissions
- EU F-Gas regulation and reports of the Commission:
 - Regulation (EC) 842/2006 | Report on application, effects and adequacy COM (2011) 581
 - Regulation (EC) 517/2014 | Assessment of alternatives for new medium voltage (MV) switchgear due 2020 | Report on effects due 2022

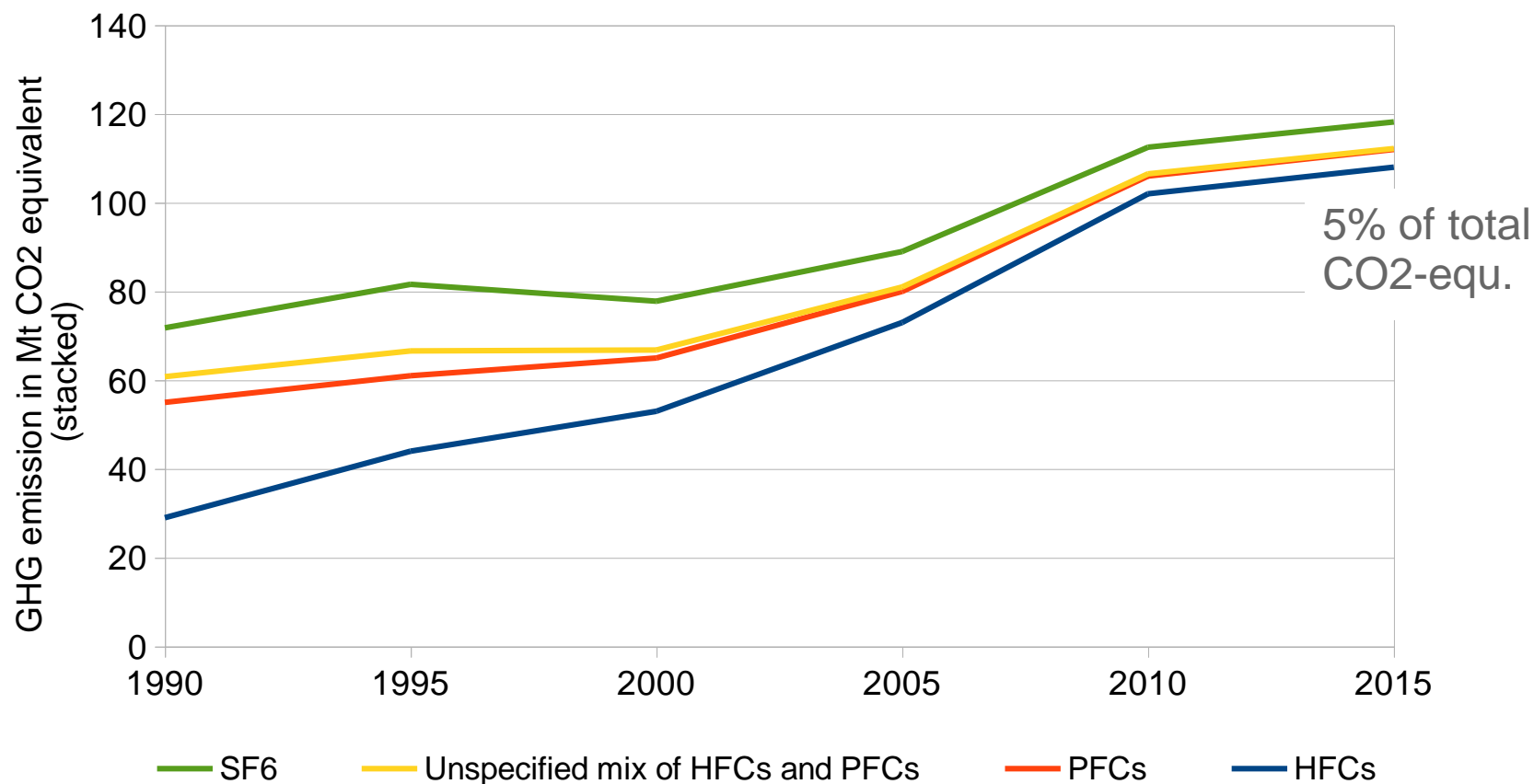


1) Time horizon 100 years

2) Source: Climate Change 1995, The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group I Report, page 22.

Source graph: <https://www.esrl.noaa.gov/gmd/dv/iadv/graph.php?code=MLO&program=hats&type=ts>

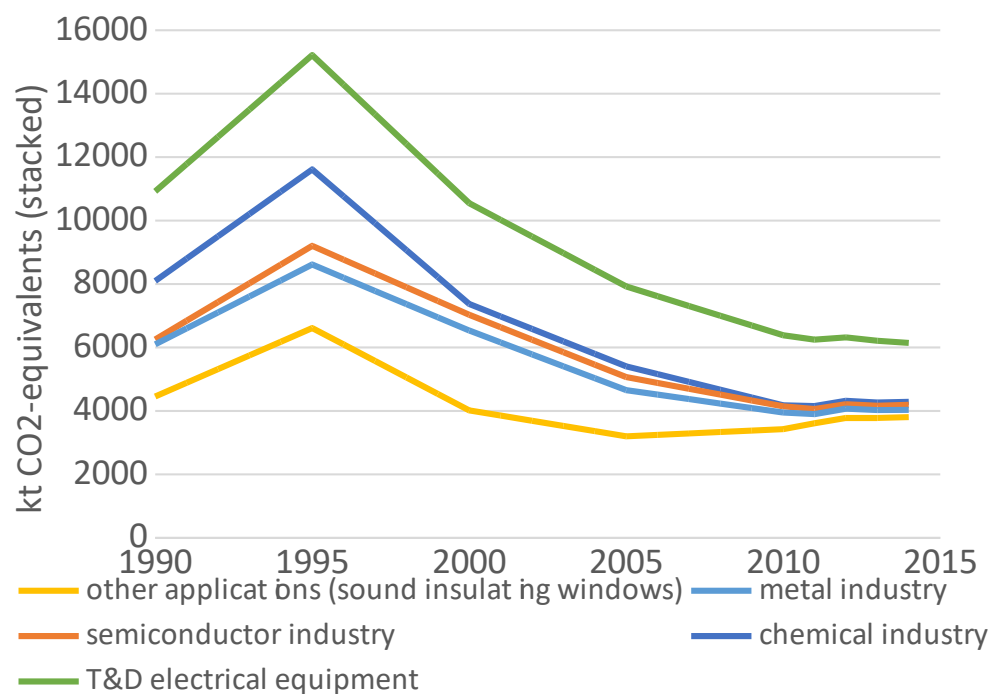
SF6 represents a significant share of the EU's GHG emissions related to F-gases.



Source: European Environment Agency: Annual European Union greenhouse gas inventory 1990–2015 and inventory report 2017 Submission to the UNFCCC Secretariat

In the EU, equipment for Power Transmission and Distribution (T&D) is one of the last eligible applications for SF₆.

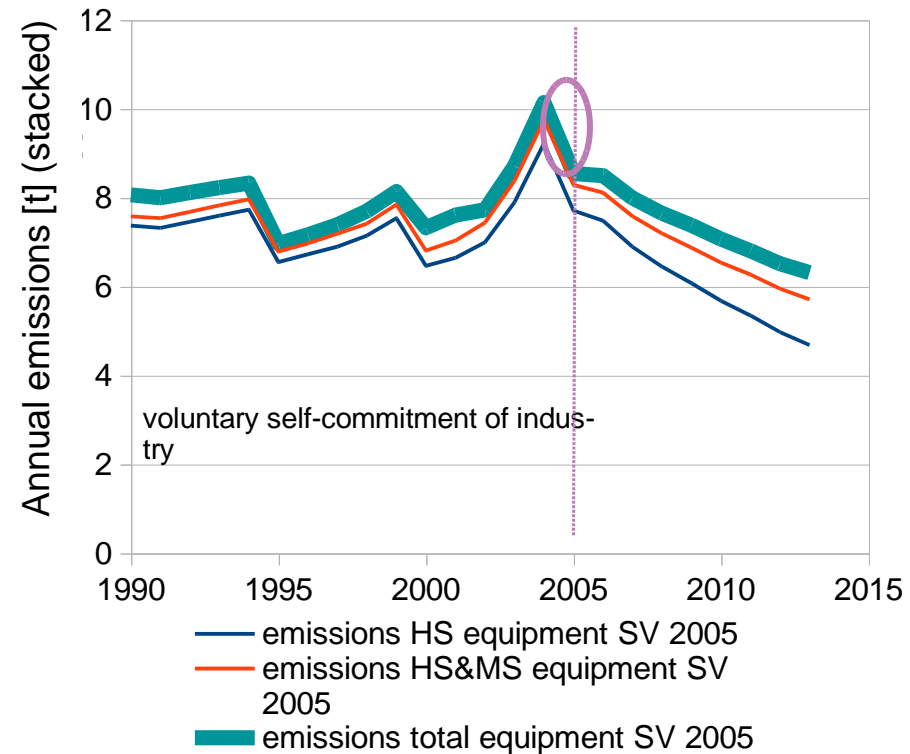
- SF₆ emissions from electrical industry are a major component in the total
- EU regulation (EC) 517/2014
 - does not yet restrict application of SF₆ in equipment for power T&D;
 - defines requirements for handling, training of staff, labeling of equipment and reporting.



Source: Monitoring Umweltbundesamt / German Environment Agency

German SF₆ emissions from T&D industry currently account for about 30...40% of EU emissions in this sector. Legal restrictions have not been implemented.

- The voluntary self-commitment of electrical industry (users and manufacturers, 2005) aims on emission reduction, monitoring and research for alternatives.
- Substantial emission reductions have been reported, despite increasing use of SF₆.



Source: Monitoring Umweltbundesamt / German Environment Agency

The Project – objective and key facts

- In preparation of the 2020 report the German Ministry for the Environment (BMU) wanted to get an informed position on:
 - State of the art of T&D equipment and alternatives to SF6
 - Existing developments and expected progress

BMU contracted the study „Concepts for SF6-free transmission and distribution of electrical energy“. Contractors are Ecofys and ETH Zurich, High Voltage Laboratory (Prof. Chr. Franck).

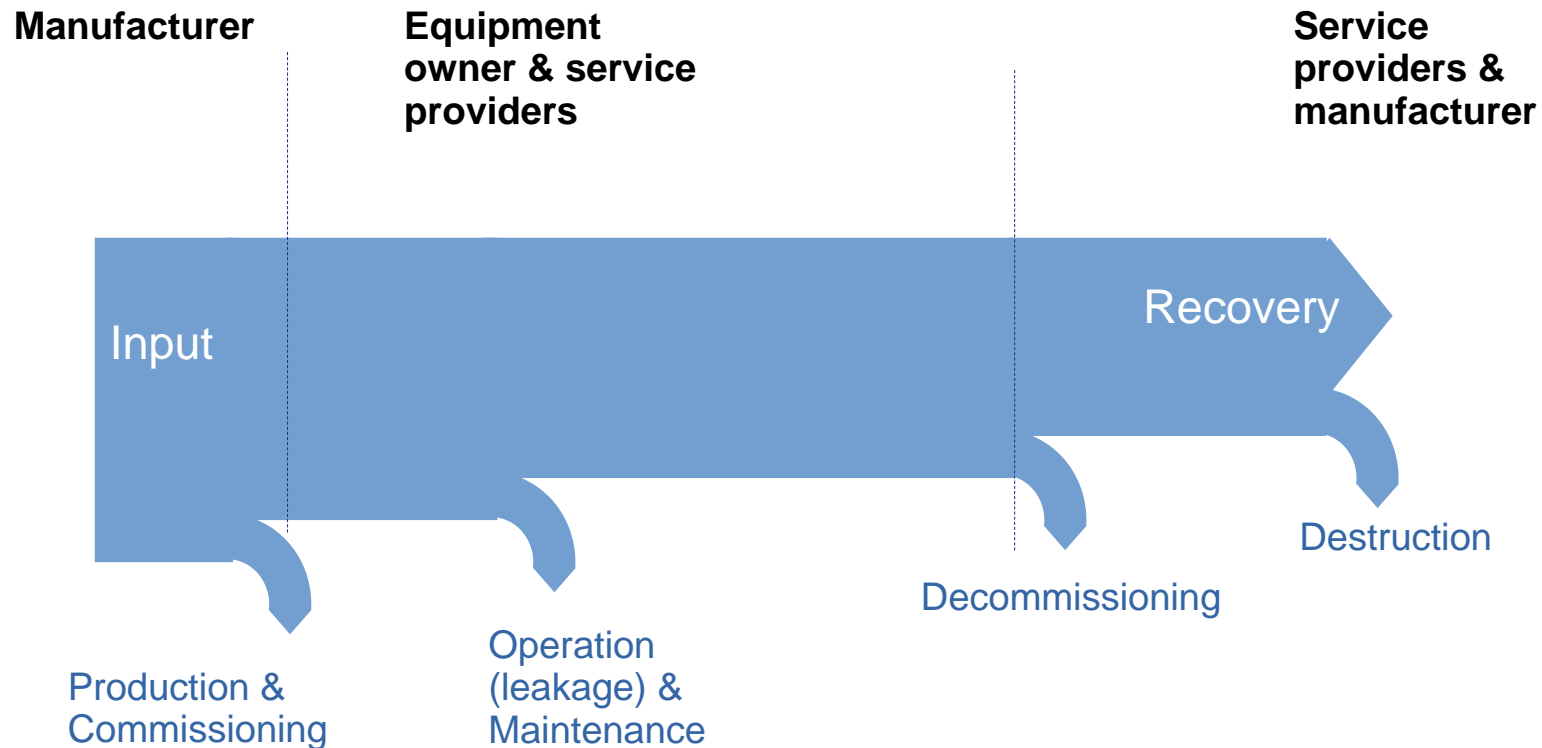
- An intense stakeholder involvement was a dedicated purpose of the project.
- Running from February 2016 (kick off) until February 2018. (Draft technical report available at website Umweltbundesamt¹⁾. Final report to be published in early 2018.

1) <http://www.umweltbundesamt.de/en/topics/economics-consumption/products/fluorinated-greenhouse-gases-fully-halogenated-cfcs/application-domains-emission-reduction/switchgear#textpart-2>

The project – some remarks on the scope of the contract

- ‘SF6 free Transmission and distribution’ in our view means considering:
 - Progress allowing emission reduction,
 - Progress reducing specific amounts of SF6 per application and
 - Progress allowing to completely replace SF6 where possible
- Only new equipment.
 - Measures focusing on existing assets are highly important and effective. Still we cannot ignore the potential associated with new equipment.
- MV and HV dedicatedly addressed.
 - These categories are a simplification of reality and we need to be careful in today's discussion. Anyways we have to consider one AND the other, not one OR the other.
- Focus is on Germany.
 - Knowing that any future regulation will not be a national one.
- Propose concepts. (Not immediate legislative actions.)

Over the complete life cycle, various stakeholders have their specific responsibility.



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Discussion of Policy options

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Reduction of SF6 use in and emissions from transmission and distribution equipment is possible. Ambitious targets are justified.

- As a consequence of technology progress, SF6 emissions from transmission and distribution components can be further reduced. Future targets extrapolating achieved reductions during the last decade seem to be reasonable.

The 'easy wins' are not the 'big wins'. Both need appropriate attention and effort.

- There is no single application or technology justifying immediate or disruptive changes in regulation because of major gains in reducing use of SF6 or related emissions. ... An integrated approach covering the industry as a whole, promises to avoid these limitations and complexities (see next thesis).

Emissions differ per voltage level AND per application.

Medium voltage switchgear (primary and secondary distribution)

- Various commercial alternatives exist for secondary, to a lesser extent for primary distribution

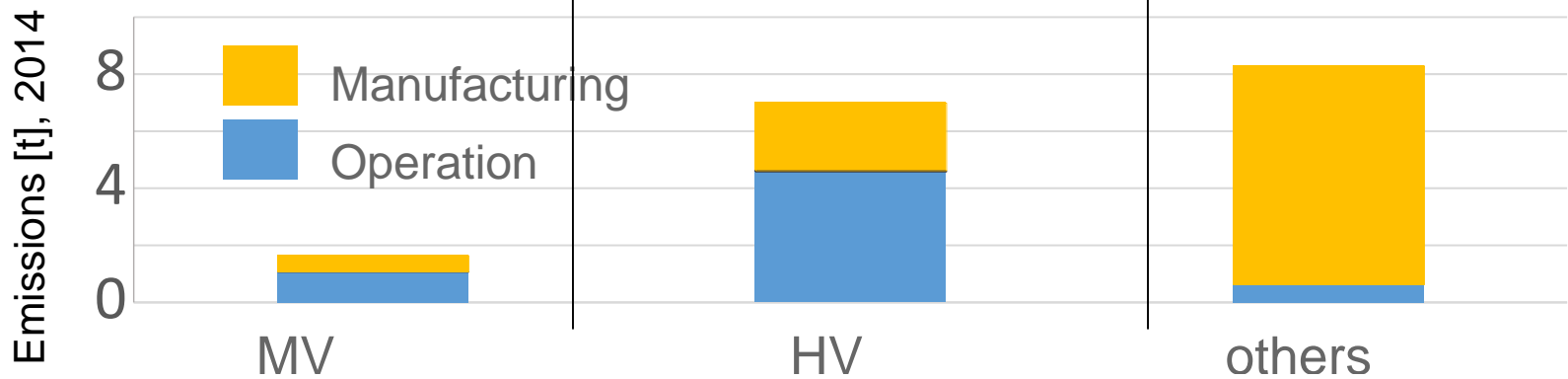
High voltage switchgear

- Prototype solutions are being demonstrated
- Open questions (± 5 years)

Others

(voltage and current transformers, MV capacitors etc.)

- Alternatives and measures depend on application



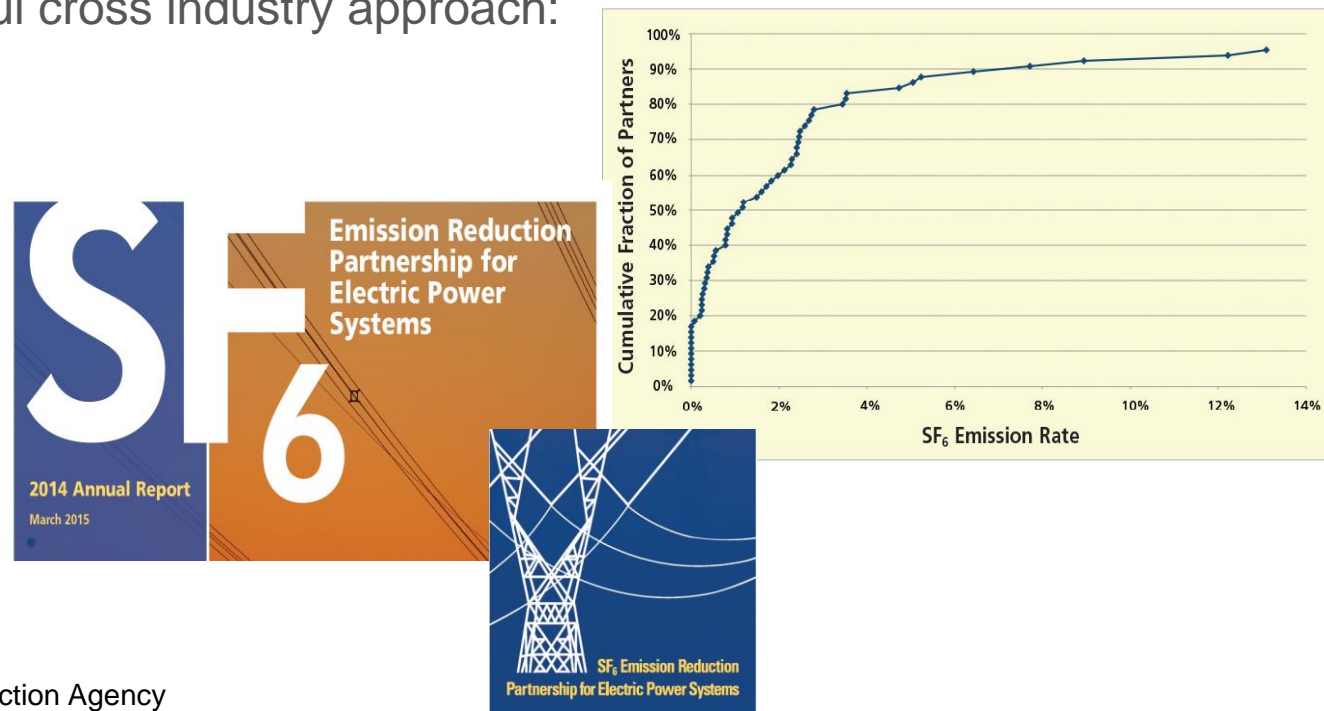
Source: Monitoring Umweltbundesamt / German Environment Agency

Policy should provide a binding and reliable framework. Industry knows the way to meet the objectives.

- Legal regulation of specific applications neither is necessary nor particularly promising. However, setting binding limits on the SF₆ emissions across the industry as a whole may be required in order to keep momentum. ... Industry benchmarks and best practice guidelines may support further progress.

Example of successful cross industry approach:

Figure 2: SF₆ Emission Rate Trends



Source: US Environmental Protection Agency

Further improving monitoring is a precondition for effective and efficient policies.

- Current methodologies and aggregation levels of the monitoring in the framework of the industry obligation insufficiently support an independent evaluation and comparison of achieved performance levels. Major indicators for making informed choices are hidden in cumulative reporting.
 - Implement a SF6 register.
 - Increase granularity of reported data. (e.g. per age data, per technology).
 - Combine generalized modeling with empirical samples. Describe methodologies.
- In the end we need a consistent monitoring framework across Europe.

Improving monitoring is a precondition for effective and efficient policies.

- In addition to the existing bottom up inventory performed by the industry associations, we recommend implementing a process of top down monitoring by atmospheric measurements and reverse modelling. This potentially helps verifying achieved progress in emission reduction, refining emission modelling for the bottom up inventory and identifying major sources requiring attention.

Old equipment is an 'easy win' and should be addressed.

- The study focused exclusively on new equipment. Nevertheless, emissions from stock deserve special attention, because of their assumed volume and because of the possible achievements gained by straight forward measures. Selectively replacing parts of the existing equipment population makes sense.
- If the volume of SF6 is substantially and sustainably reduced, incentives and socialization of cost might be justified. However, we recommend not to allow compensating future targets by accounting gains in emission reduction from stock.

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