



Energy Technologies Area

Lawrence Berkeley National Laboratory

Models Used for Transmission Planning

Their Focus, Strengths, and Limitations for Various Purposes, and How They Can be Improved

Models to Inform Planning for the Future of Electric Power in the US

Committee on Future of Electric Power in the US

National Academies of Sciences, Engineering, Medicine

Irvine, CA

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“Plans are worthless, but planning is everything”

Dwight Eisenhower

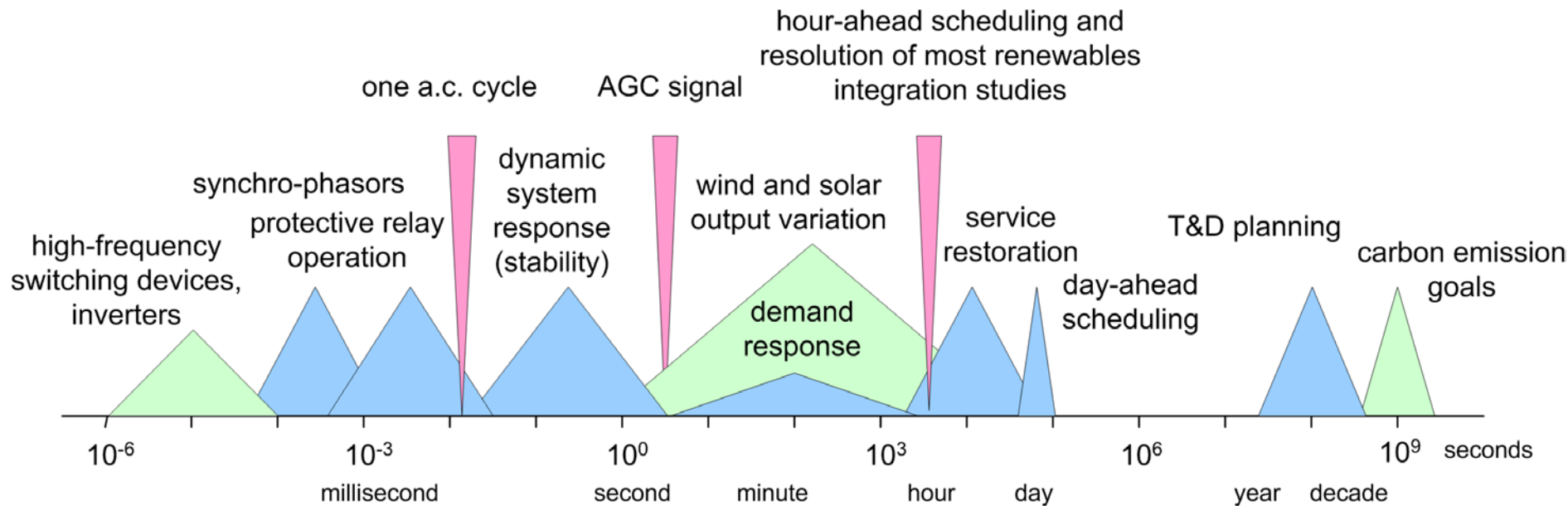
“Plans are worthless, but planning is everything”

Dwight Eisenhower

“For utility CEO’s, blackouts considered fire events, because when blackouts occur, the CEO gets fired”

Terry Boston

Reliable Operation of the Electric Transmission System Involves Management Over Multiple Time Scales

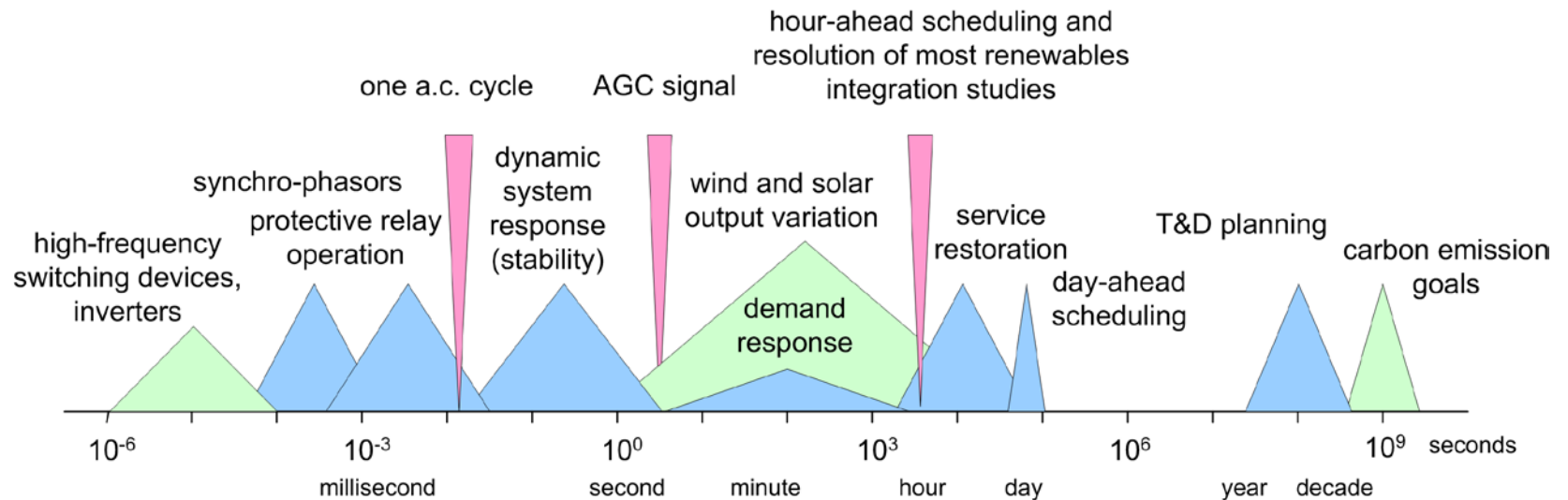


Distinct classes of planning tools are used to support operations over each of these time scales – most are used “off-line” long in advance of operations; some are used “on-line” during real-time operations

Source: A. von Meier, “Challenges to the Integration of Renewable Resources at High System Penetration,” California Energy Commission, May 2014

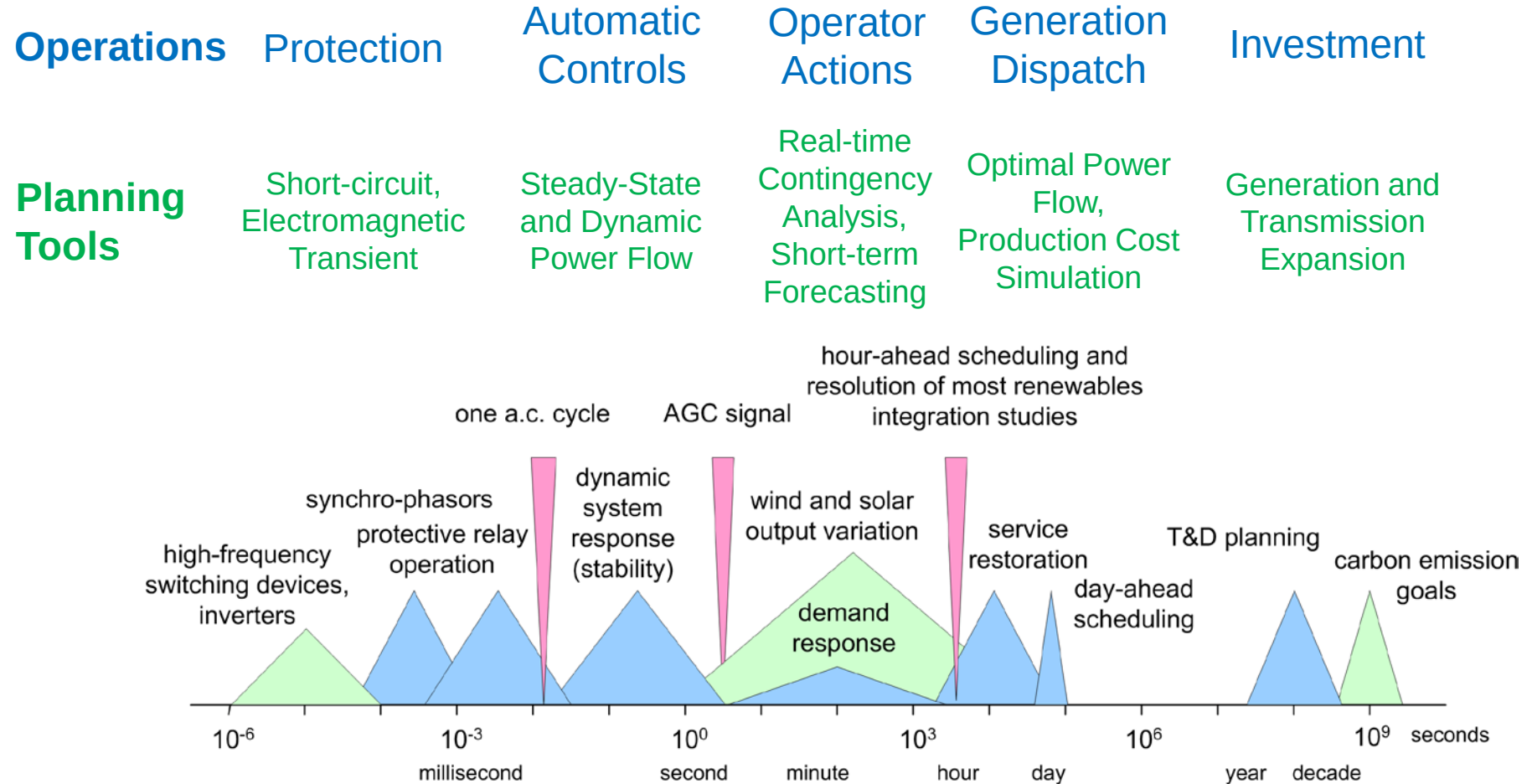
Transmission operations

Operations Protection Automatic Controls Operator Actions Generation Dispatch Investment



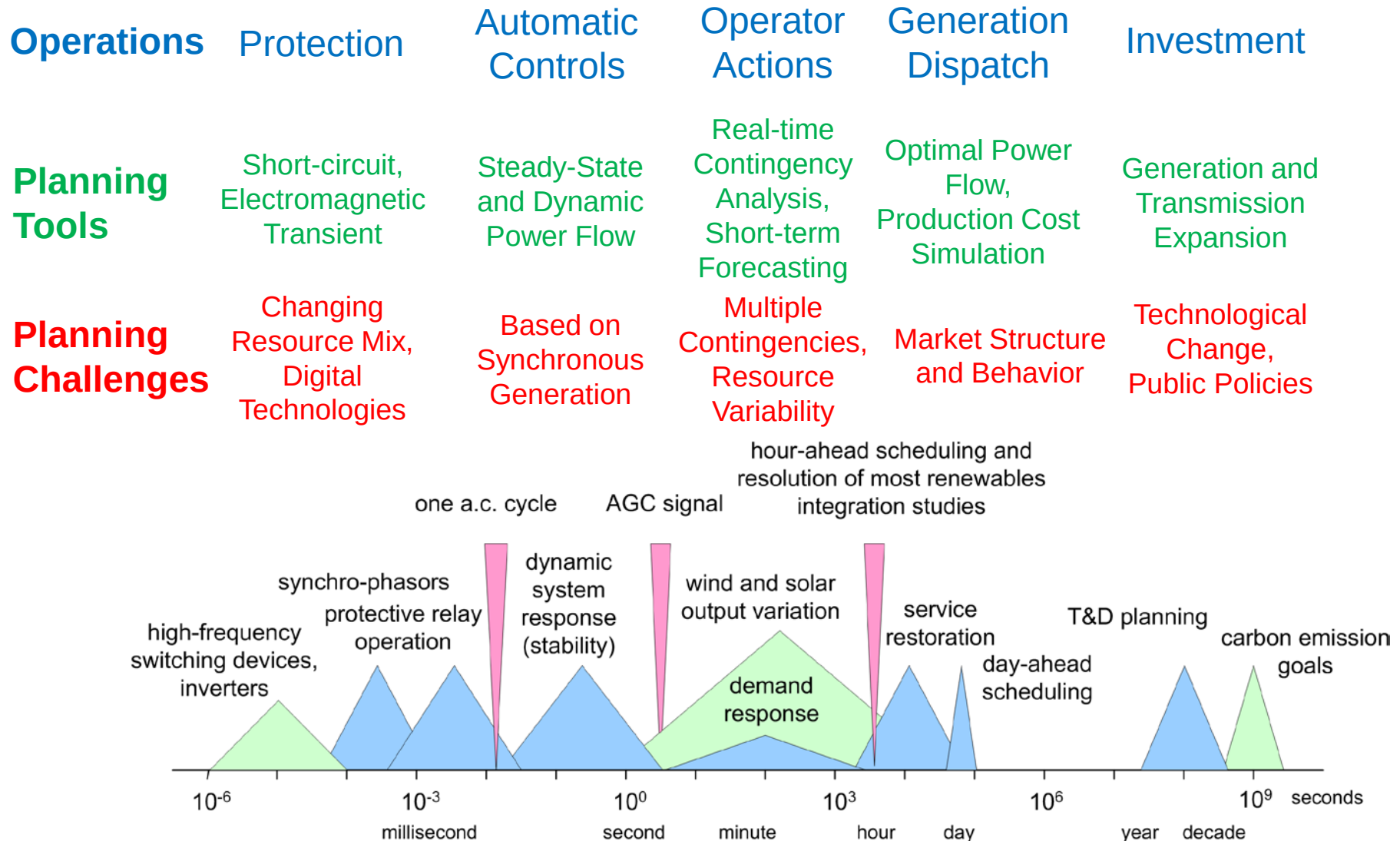
Source: A. von Meier, "Challenges to the Integration of Renewable Resources at High System Penetration," California Energy Commission, May 2014

Transmission planning tools



Source: A. von Meier, "Challenges to the Integration of Renewable Resources at High System Penetration," California Energy Commission, May 2014

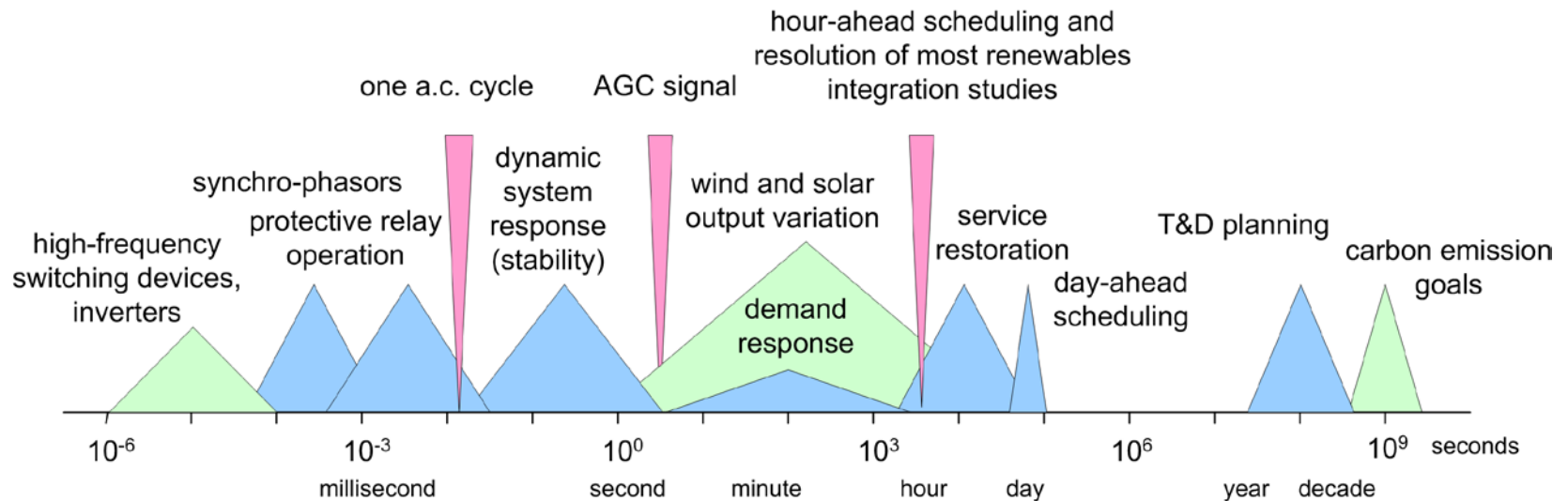
Transmission planning challenges



Source: A. von Meier, "Challenges to the Integration of Renewable Resources at High System Penetration," California Energy Commission, May 2014

Cross-cutting transmission planning issues

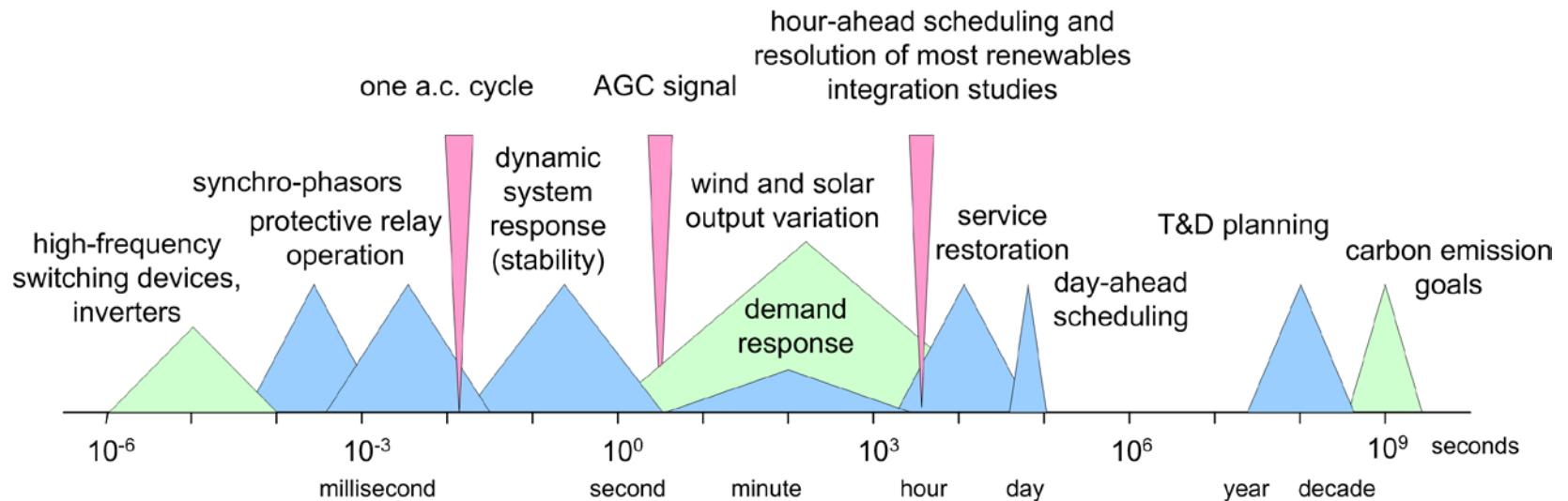
- Variable Renewable Generation



Source: A. von Meier, "Challenges to the Integration of Renewable Resources at High System Penetration," California Energy Commission, May 2014

Cross-cutting transmission planning issues

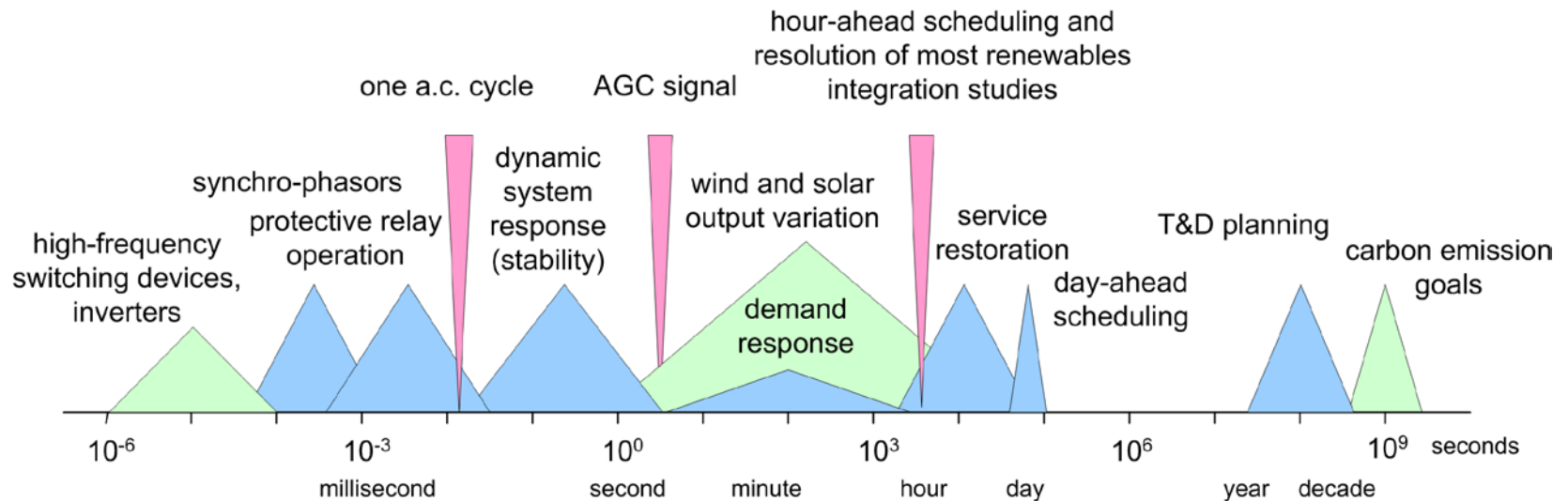
- Variable Renewable Generation
- Integrated Transmission and Distribution System Planning



Source: A. von Meier, "Challenges to the Integration of Renewable Resources at High System Penetration," California Energy Commission, May 2014

Cross-cutting transmission planning issues

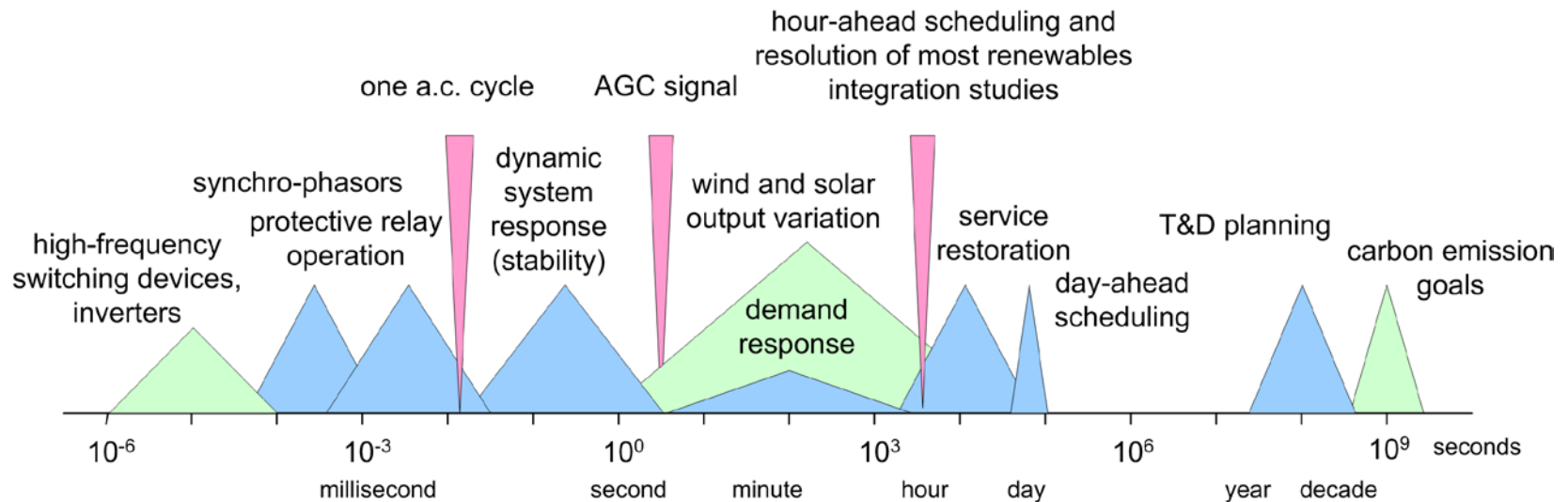
- Variable Renewable Generation
- Integrated Transmission and Distribution System Planning
- Cyber and Physical Security



Source: A. von Meier, "Challenges to the Integration of Renewable Resources at High System Penetration," California Energy Commission, May 2014

Cross-cutting transmission planning issues

- Variable Renewable Generation
- Integrated Transmission and Distribution System Planning
- Cyber and Physical Security
- Interdependencies with Natural Gas and Communications



Source: A. von Meier, "Challenges to the Integration of Renewable Resources at High System Penetration," California Energy Commission, May 2014