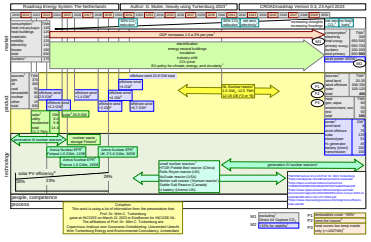
Constructing a Roadmap

by *Gerrit Muller* USN-SE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

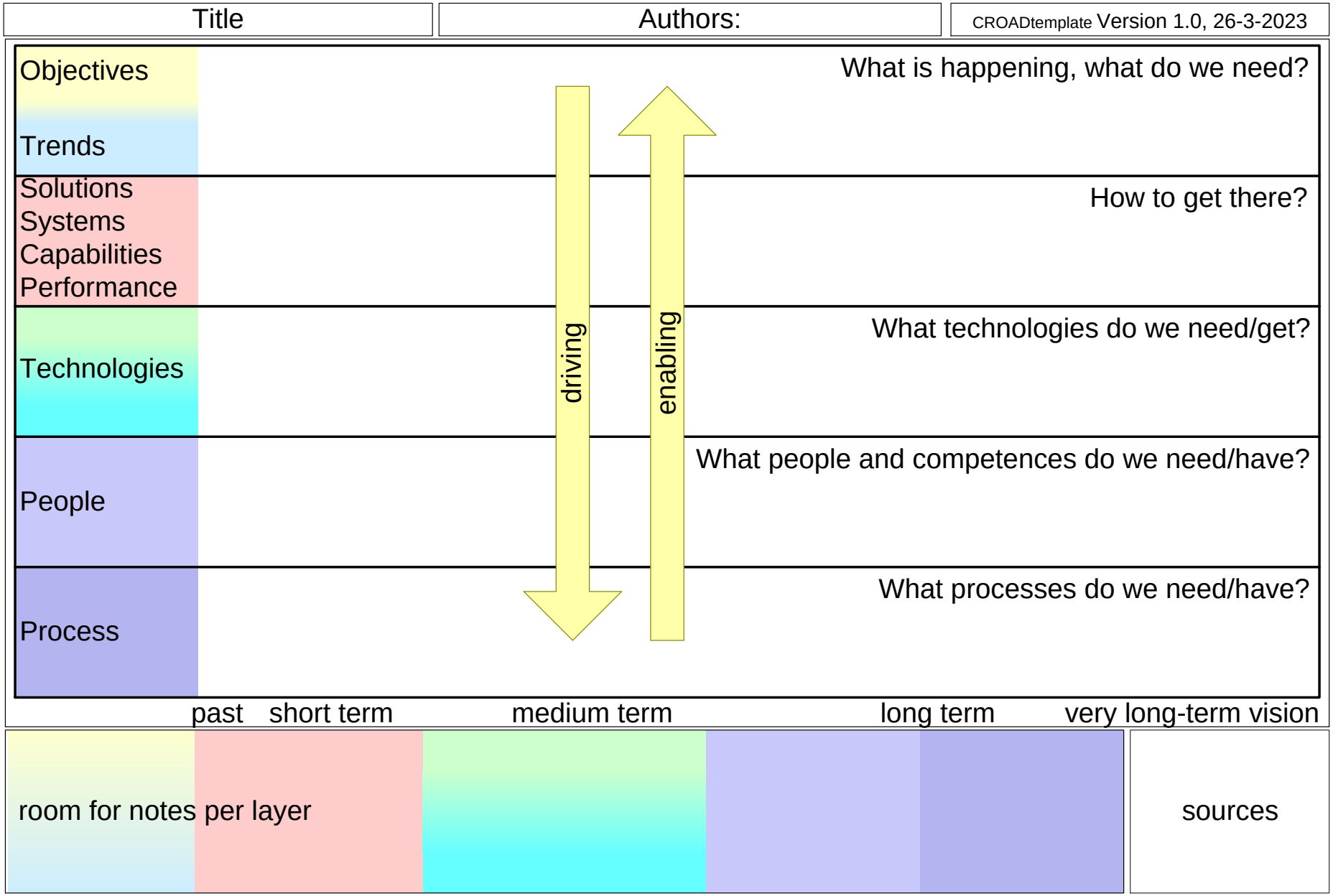
Abstract

In this presentation, we show how to construct a roadmap. The Dutch energy system is taken as an example.

July 9, 2023
status: preliminary draft
version: 0.1



A Roadmap Provides a Single Page Overview



Colophon

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This work is using a lot of information from the presentation that

Prof. Dr. Wim C. Turkenburg

gave at INCOSE on March 21 2023 in Eindhoven for INCOSE-NL.

The affiliations of Prof. Dr. Wim C. Turkenburg are

Copernicus Instituut voor Duurzame Ontwikkeling ,Universiteit Utrecht

(Copernicus Institure for Sustainable Development, University Utrecht)

and

Wim Turkenburg Energy and Environmental Consultancy, Amsterdam

Roadmap Energy System The Netherlands

Author: G. Muller, heavily using Turkenburg 2023[1]

CROADroadmap Version 0.3, 23 April 2023

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market

consumption[1]	TWh
heat industry&agro	140
heat buildings	120
materials	145
mobility	125
electricity	110
losses	190
total	830
bunkers[1]	170

60% CO_2 reduction[1]

80% CO_2 reduction[1] | net zero electricity[1]

increasing droughts
increasing floodings

net zero CO_2[1] | no fossil fuels[1]

GDP increasea 1.5 a 2% per year[1]

M1

consumption[1]	TWh[1]
electricity	300
final energy	450-500
primary energy	650-700
bunkers	150-200
total primary	800-**900**
peak power 45GW[1]	

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electrification
energy neutral buildings
insulation
industry shift
CO_2 price
EU policy for climate, energy, and circularity[1]

product

sources[1]	TWh
gas	370
oil	300
coal	50
renewable	85
nuclear	10
other	15
total	830

offshore wind 22.8 GW total

offshore wind 2.5 GW[2]

offshore wind +2.2 GW[3]

offshore wind +1,4 GW[3]

offshore wind +4 GW[3]

offshore wind +2 GW[3]

offshore wind +4 GW[3]

offshore wind +6.7 GW[3]

NL Nuclear reactor[1]
1.6 GW_e, 12.5 TWh
12-15 G€ (*2 or *8)

P1
P2
P3

sources[1]	TWh[1]
wind land	20-25
wind offshore	308-330
solar	100-120
total	**450**

heat	TWh
geo, aqua	80
environment, sun	50
rest	50
total	**180**

solar[4]	GW
utility	8.6
residential	5.8
total	14.4
11.3 TWh	

solar[4] 25.9 GW

power[1]	GW[1]
wind land	8
wind offshore	75
solar	125
electrolyser	51
H_2 generator	45
battery (short)	200
transmission	100

technology

generation III nuclear reactors[1]

nuclear waste storage Finland[1]

Areva Nuclear EPR[1] Finland 1.6 GWe, 11G€

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Areva Nuclear EPR[1] France 1.6 GWe, 19G€

solar PV efficiency[5]
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generation IV nuclear reactors[1]

[1] INCOSE lecture 21-3-23 Prof. Dr. Wim Turkenburg
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people, competence

process

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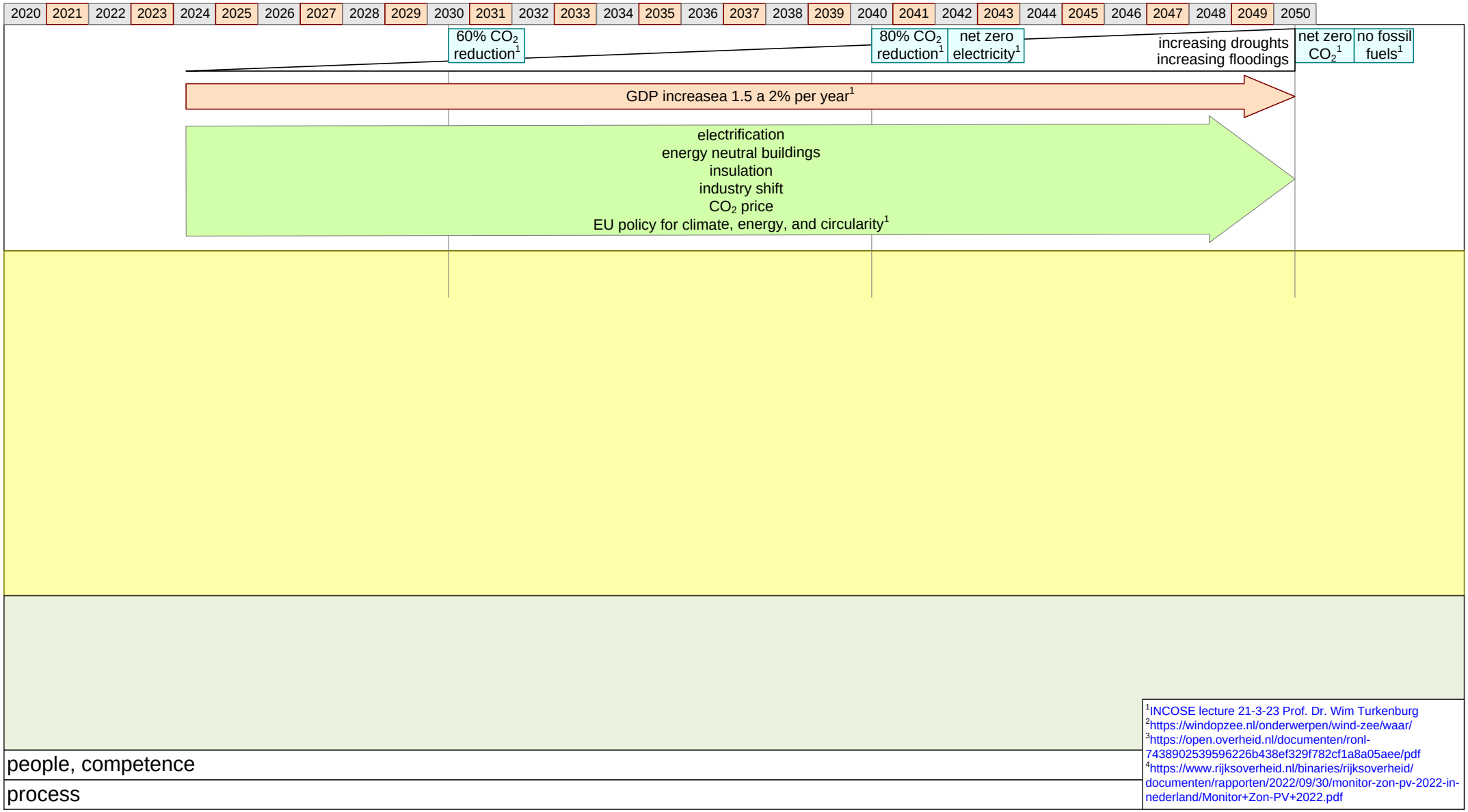
M1	excluding[1] Direct Air Capture CO_2
M2	+15% for stability[1]

P1	renewables cover ~50%[1]
P2	mind the losses![1]
P3	heat covers low temp needs only (<<100TWh)[1]

Roadmap Energy System The Netherlands

Author: G. Muller, heavily using Turkenburg 2023[1]

CROADtrendsAndObjectives Version 0.1, 25 March 2023



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[4]https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2022/09/30/monitor-zon-pv-2022-in-nederland/Monitor+Zon-PV+2022.pdf

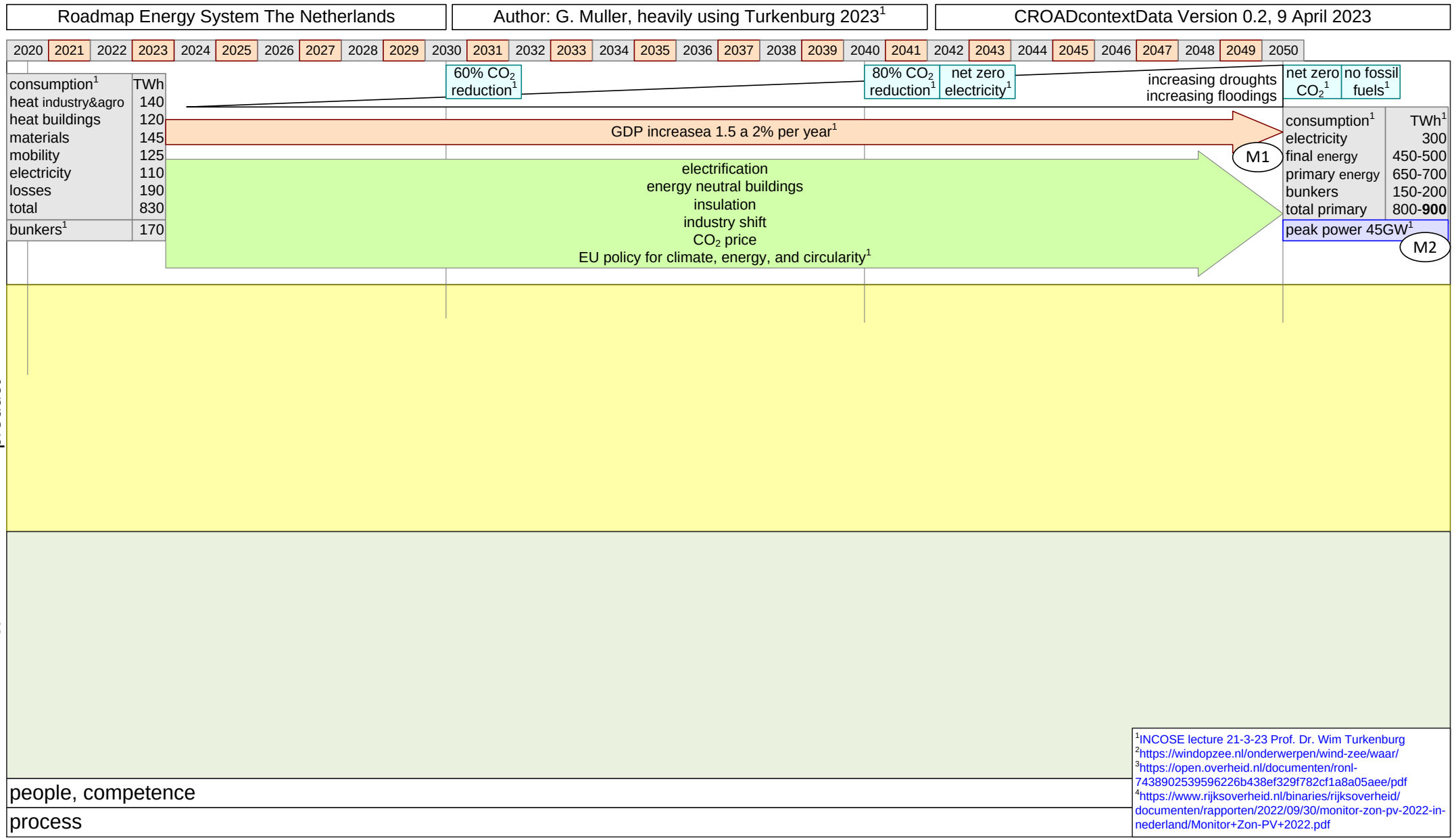
Step 1: Market Layer

Determine the long-term objectives

List the major relevant trends in the context

Make them specific

Quantify them (order of magnitude), as-is and to-be


Roadmap Energy System The Netherlands
Author: G. Muller, heavily using Turkenburg 2023[1]
CROADcontextData Version 0.2, 9 April 2023
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consumption[1] TWh
heat industry&agro 140
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materials 145
mobility 125
electricity 110
losses 190
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bunkers[1] 170
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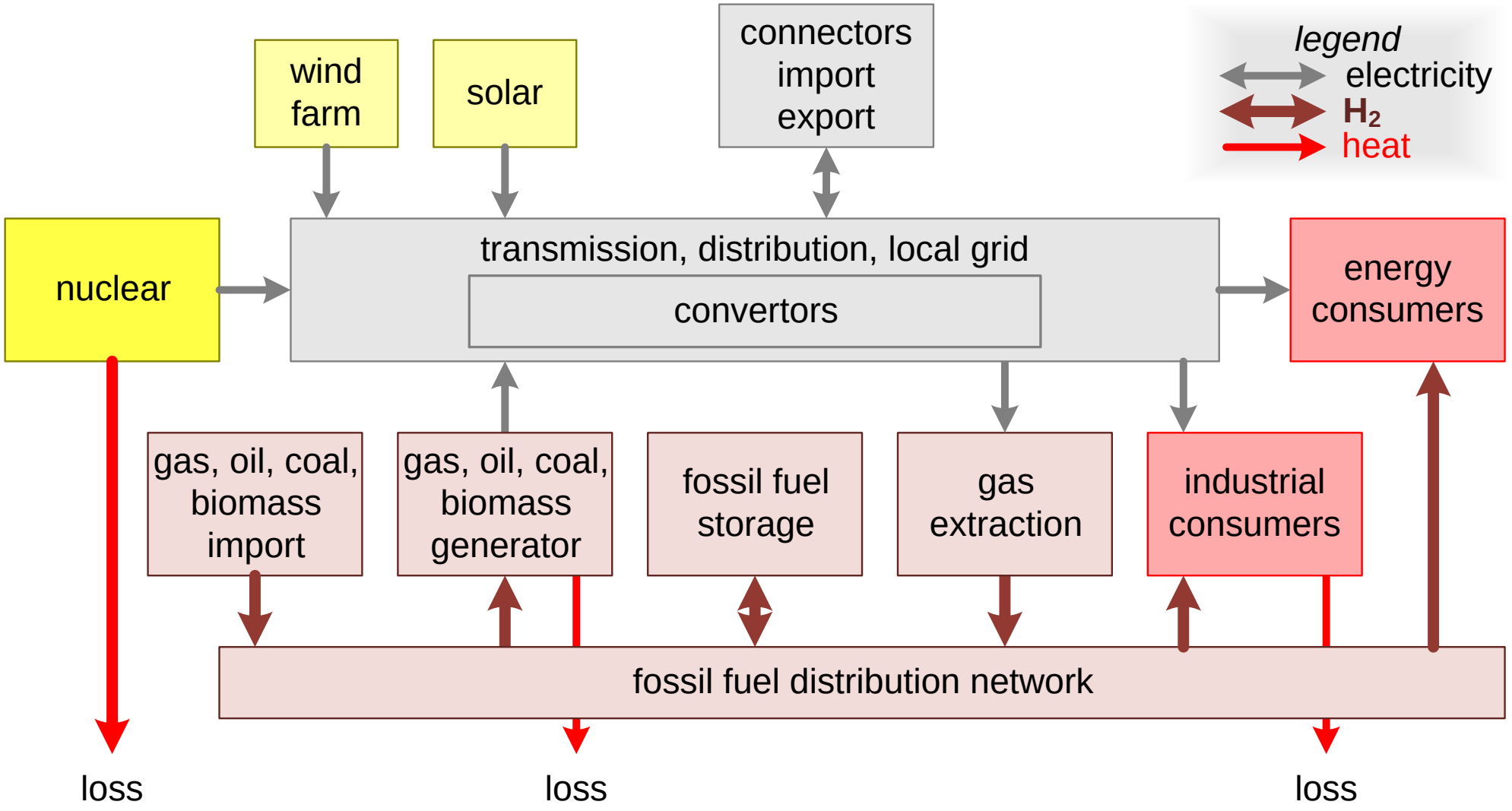
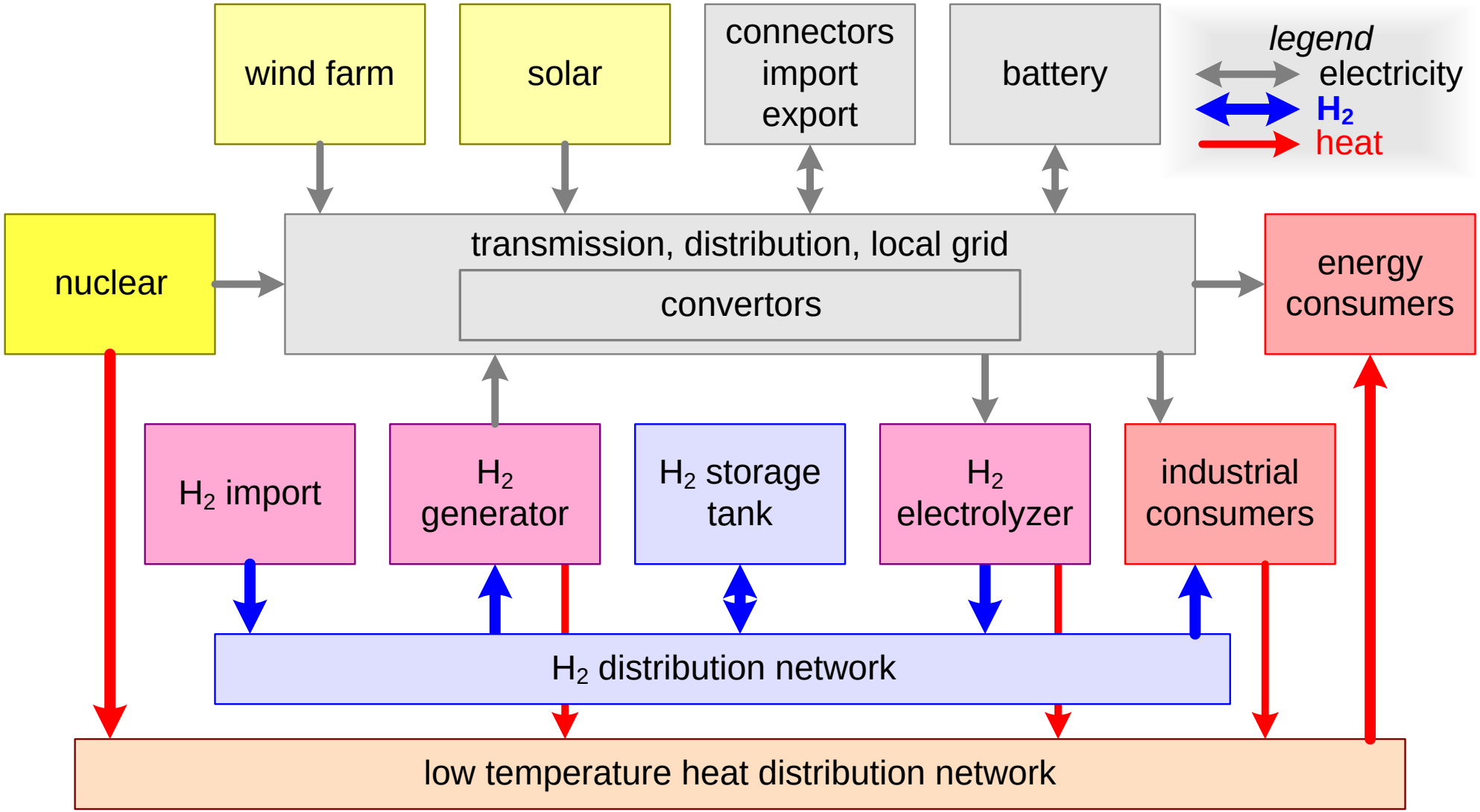
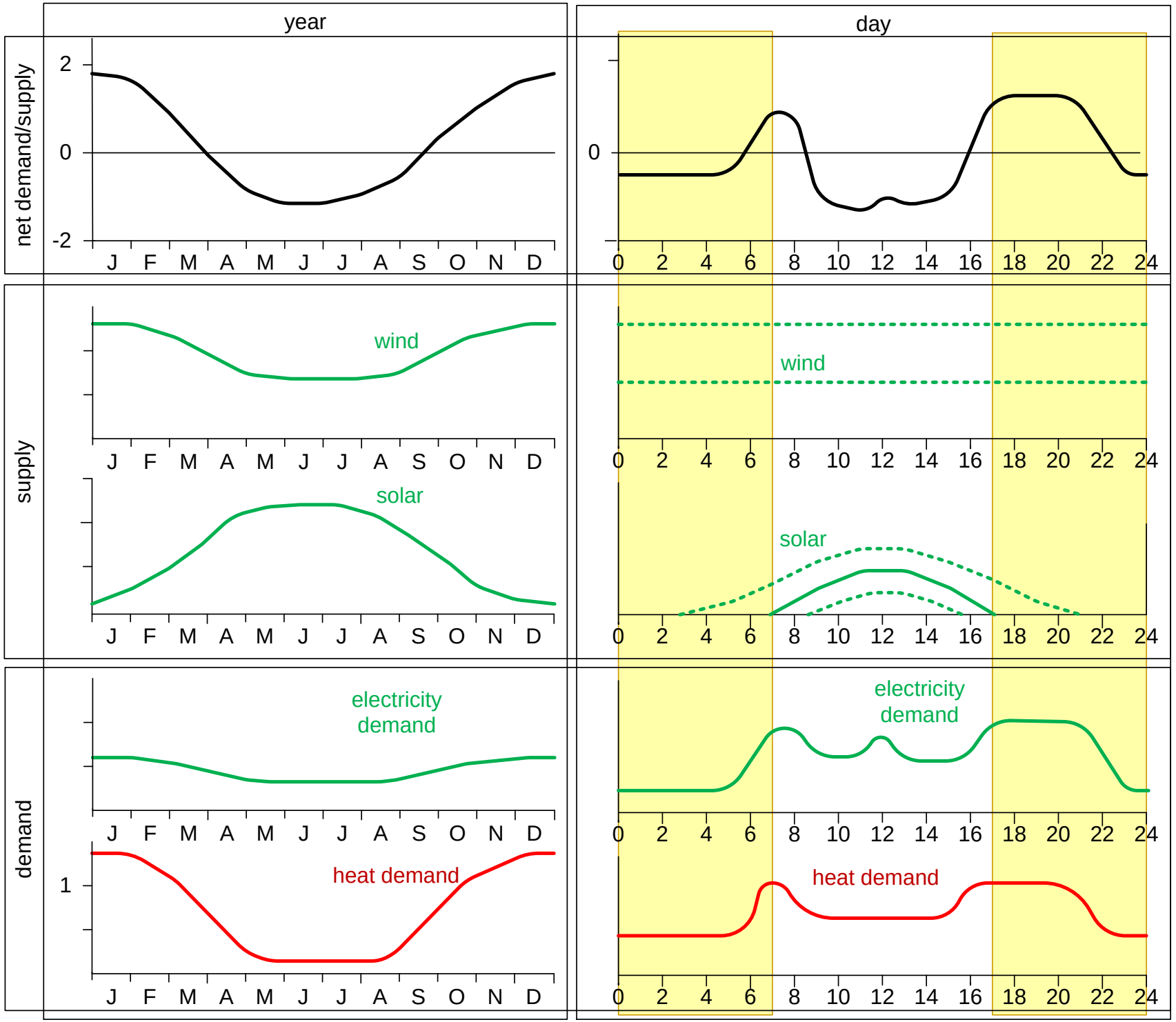
Block Diagram Past Energy System



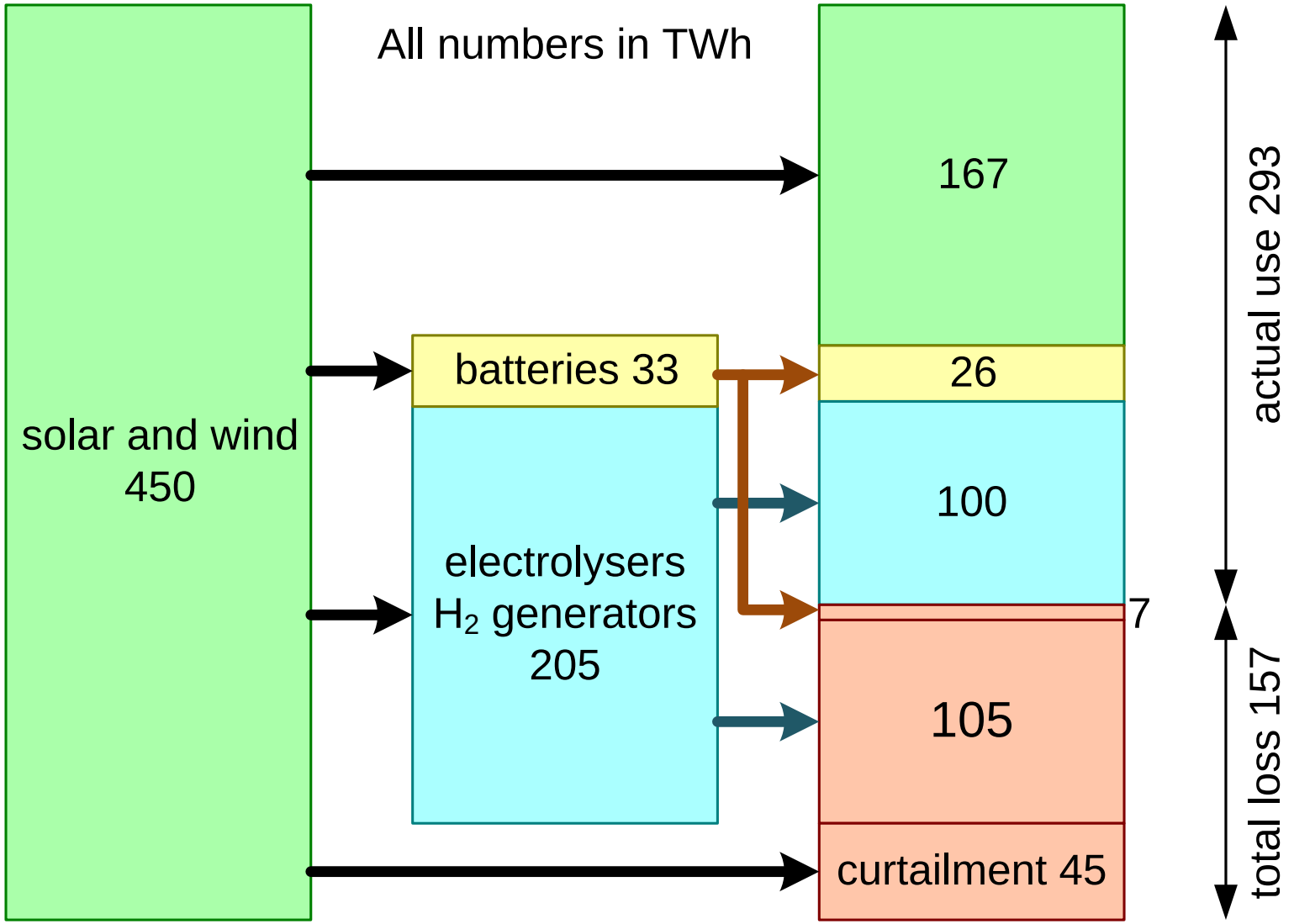
Block Diagram Future Energy System



Schematic Typical Energy Demand and Supply Dynamics | Author: Gerrit Muller | CROADdynamics Version 0, March 26, 2023



Local Energy; 30% Loss!



data from INCOSE lecture 21-3-23 Prof. Dr. Wim Turkenburg

Roadmap Energy System The Netherlands | Author: G. Muller, heavily using Turkenburg 2023[1] | CROADroadmapTechnology Version 0.2, 9 April 2023

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Step 2: Technology Layer

List the major relevant trends in the technology

Make them specific

Quantify them (order of magnitude), as-is and to-be

When stuck start sketching solutions and how they work.

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Step 3: Product/Solutions Layer

List the solutions that the organization is working on or is planning (short-term)

Make them specific (features, performance, qualities)

Identify future solutions that fit the trends and objectives

Make them specific