Technological & Societal Changes and their Impacts on Resource Use

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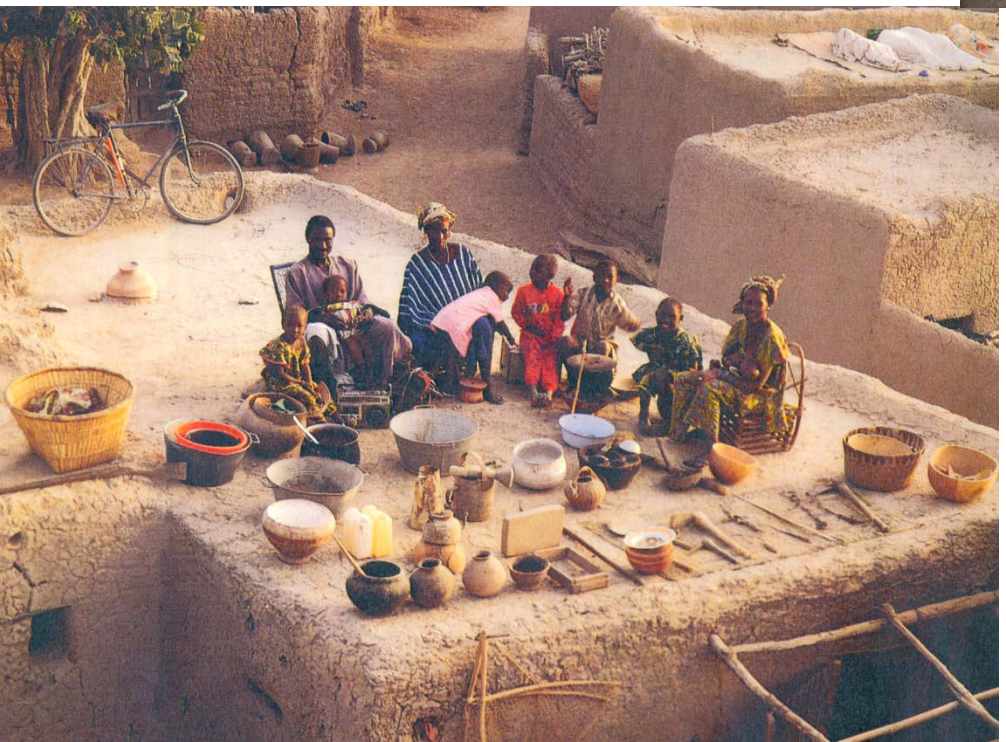
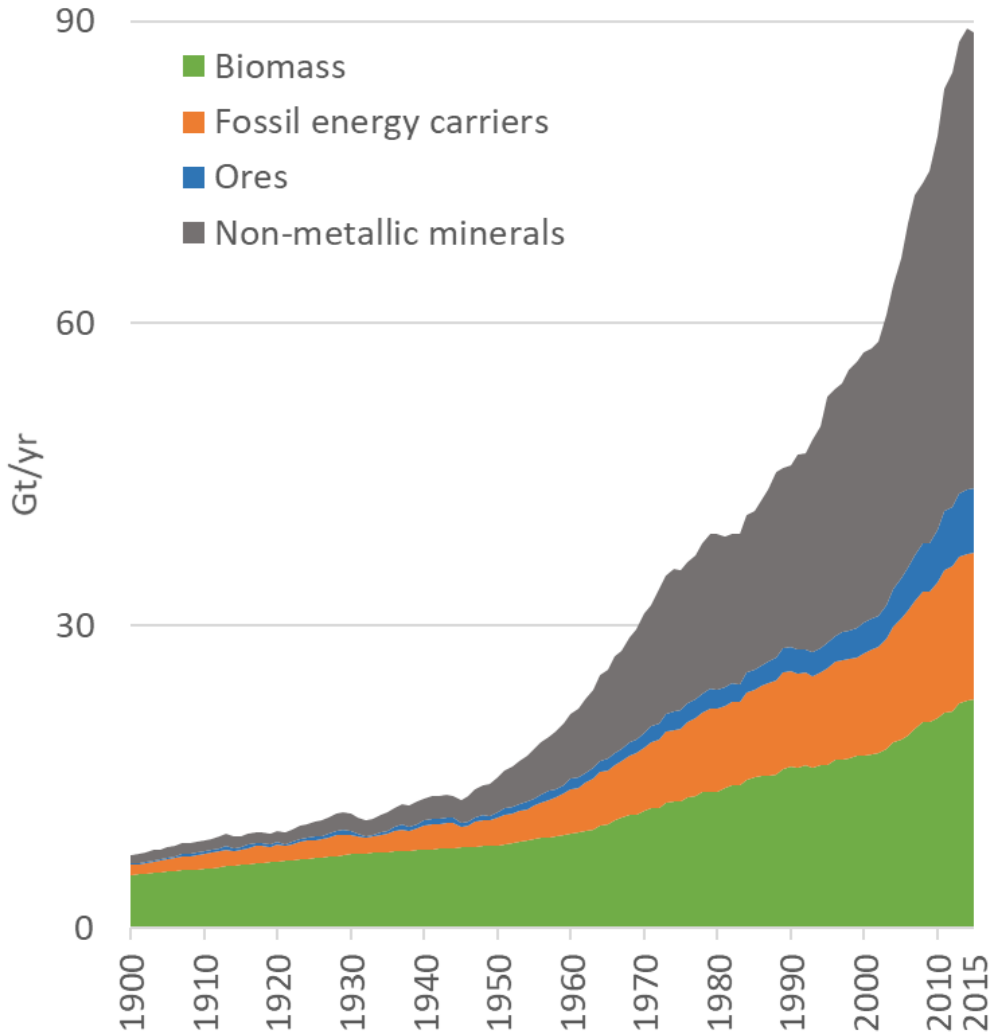
10th ESEE Dialogue Conference Leoben, March 27-29, 2019

Material Worlds



Peter Menzel, Material World
http://menzelphoto.com/galleries/material-world/

Global Materials Extraction (Gt/yr)



Source: Krausman et al., *Global Env. Change*, 2018

New Trends in Social and Technological Change

- Changing consumer preferences (e.g. diets)
- Generational change in materialism (service rather than ownership)
- New business models (sharing & circular economy)
- Pervasive digitalization and ICT convergence (Society 5.0)
- Rapid innovation in granular technologies and integrated digital services

Social Change:
Change in Car Driving Licenses Held by Young
Trends: near-term: <50%, long-term: ~0?

Location	year a	year b	age group	% of age group with drivers license		change
				year a	year b	%-points
Austria 2	2010	2015	17-18	39	28	-11
Germany	2008	2017	18-24	71	66	-5
Great Britain	1995	2008	17-20	43	36	-7
Great Britain	1995	2008	21-29	74	63	-11
Israel 2	2005	2015	17-18	34	30	-4
Israel 2	2009	2016	19-24	65	64	-1
Japan	2001	2009	16-19	19	17	-2
Japan	2001	2009	20-24	79	75	-4
Norway	1991	2009	19	74	55	-19
Norway	1991	2009	20-24	85	67	-18
Sweden	1983	2008	19	70	49	-21
Sweden	1983	2008	20-24	78	63	-15
Switzerland	1994	2015	18-24	71	61	-10
USA	1983	2014	18	80	60	-20
USA	1983	2014	19	86	69	-17
USA	1983	2014	20-24	91	77	-14

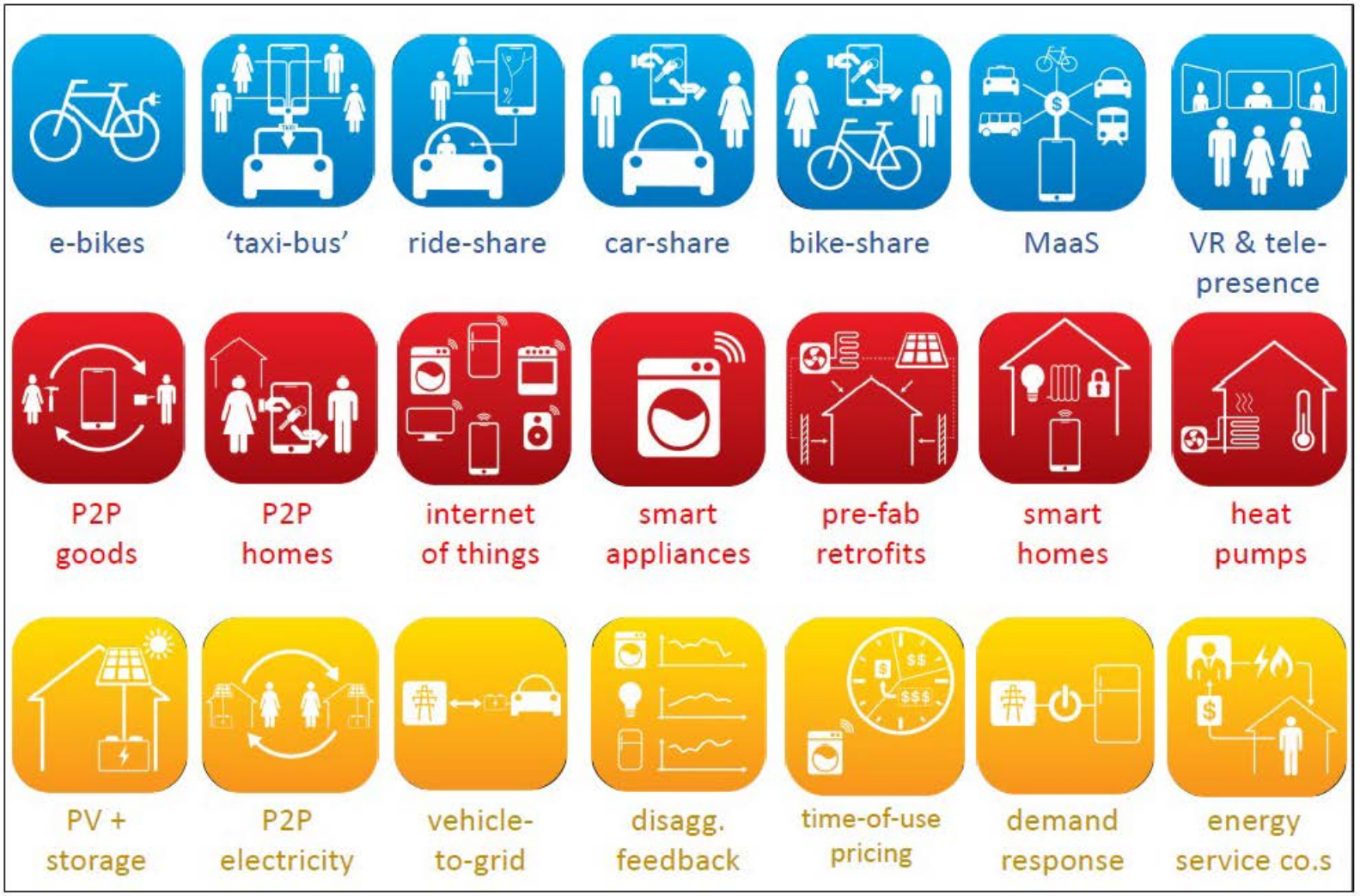
Location	year a	year b	age group	% of age group with drivers license		change
				year a	year b	%-points
Austria 1	2006	2010	17-18	32	39	7
Finland	1983	2008	18-19	37	68	31
Finland	1983	2008	20-29	51	82	31
Israel 1	1983	2008	19-24	42	64	22
Israel 1	1983	2008	25-34	62	78	16
Netherlands	1985	2008	18-19	25	45	20
Netherlands	1985	2008	20-24	64	64	0
Spain	1999	2009	15-24	37	50	13

Lowest: <19 year old in Stockholm: <10% with drivers licenses

Note in particular much larger prevalence of declining driving license ownership and shift from growth to decline trends in Austria and Israel around 2008/2010 (for Finland, Netherlands, Spain no more recent data available to uncover similar trend breaks)

Data sources: Sivak & Schottle, 2011; Delbosc & Currie, 2013; Nat.Stats, 2017 for Austria, Germany, Israel, Switzerland

Disruptive End-User Innovations



(1) From ownership to usership – (2) Sharing Economy -- (3) From atomized to connected

lumpy
large unit size
high unit cost
indivisible
high risk

Technology
Unit Size

granular
small unit size
low unit cost
modular
low risk

Innovation Dynamics: Cost Improvements by Technology Size

	today	initial	costs	factor
	$	$	%/year	improvement
Car battery (25 kWh)	5000	33000	-15	7
Solar PV (1 kW unit)	1000	350000	-12	350
3D-printing	100	40000	-58	400
Drones	100	100000	-50	1000
Biotech (DNA profile)	100	10000000	-65	100000
Sensors (ex Lidar)	3.5	20000	-66	5714

Data: IRENA, 2019, derStandard, 2019

Resource Impacts of Digital Convergence

Operational Peak Power / 90

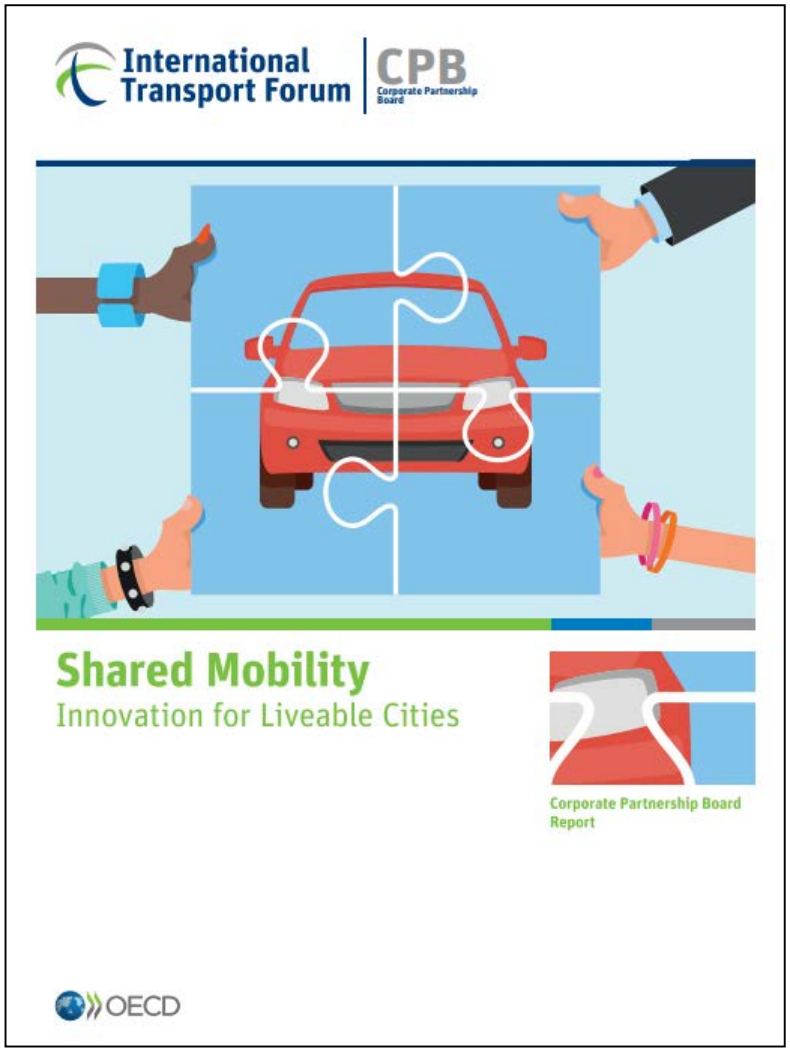
Weight /260

Operational Energy /30

Embodied Energy /23

Bento 2019; Grubler et al *Nature Energy* 2018

The “Sharing Economy”: Mobility Case Studies



Reductions (%) in shared mobility scenario compared to status quo

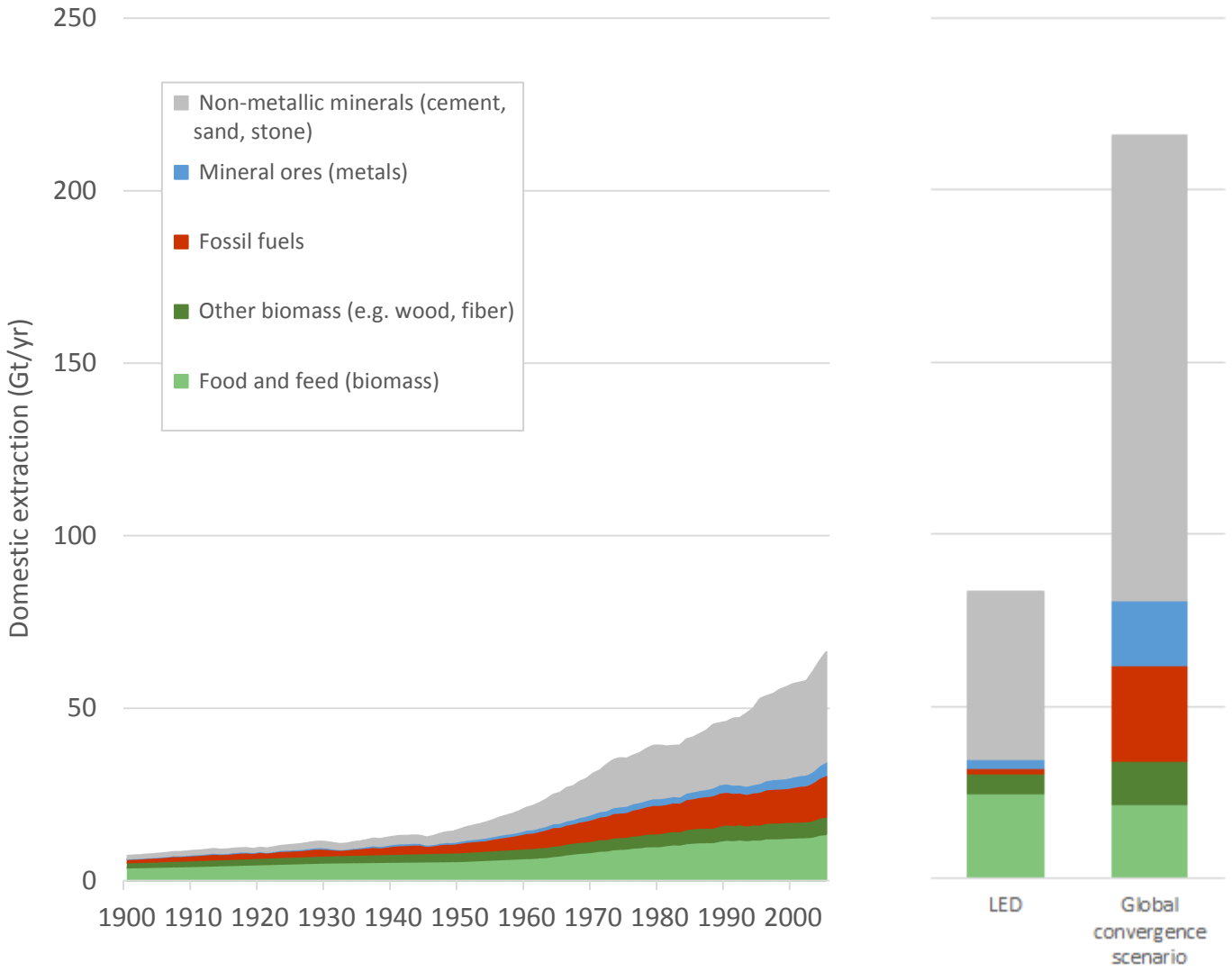
	vehicle fleet	con-gestion	mobility costs	CO2 emissions
Auckland	-95%	-49%	-43%	-54%
Dublin	-98%	-43%	-50%	> -31% *
Helsinki	-96%	-37%	-43%	> -34% *
Lisbon	-97%	-30%	-50%	-62%

* IC vehicle fleets, no electrification

Same mobility @ 2-5% of vehicle fleet!

OECD ITF, 2018 & 2019

Global Materials Use: Past and 2 Scenarios by 2050



Gruebler et al., *Nature Energy, 2018*
Krausmann, F., et al., *Global Environmental Change,* 2018

Meeting the 17 SDGs

Our Common Challenge