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Island Finance Forum 2023

A Quantitative Framework for Doubling the Energy Efficiency by 2030 For Small Island Nations

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1. What can you tell us about Energy Efficiency at national level?

Answer: the main data tools are 1) an Energy balance and 2) an economic and investment framework of indicators. You need both to be able to join the discussion on Energy efficiency at national level.

Key: small island nations need to invest in both, so they can design policies. Foreign and private investors need these data systems to make investment decisions when they are looking for an island to invest in.

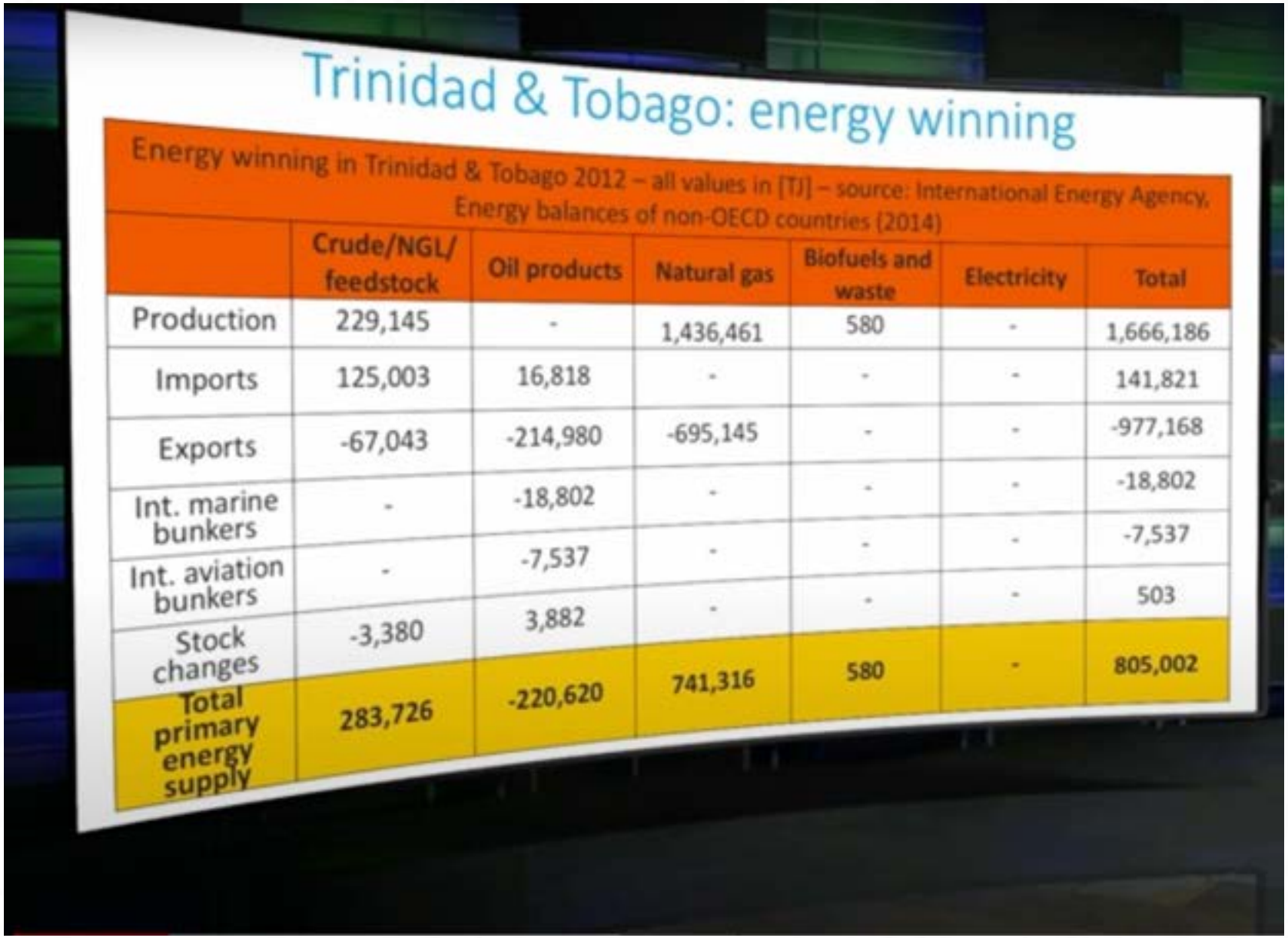
2. Can you show us a case study how this is used?

Yes: here is how an energy balance of Trinidad and Tobago looks like. You get the fuels used in the economy as columns and you get the production, transformation and consumption of these fuels down the rows.

	Crude/NGL/feedstock	Oil products	Natural gas	Biofuels and waste	Electricity	Total
Production	229,145	-	1,436,461	580	-	1,666,186
Imports	125,003	16,818	-	-	-	141,821
Exports	-67,043	-214,980	-695,145	-	-	-977,168
Int. marine bunkers	-	-18,802	-	-	-	-18,802
Int. aviation bunkers	-	-7,537	-	-	-	-7,537
Stock changes	-3,380	3,882	-	-	-	503
TPES	**283,726**	**-220,620**	**741,316**	**580**	**-**	**805,002**
Transfers	-52,796	58,233	-	-	-	5,437
Statistical differences	2,135	-39	-	-	-4	2,093
power plants	-	-217	-110,314	-	32,881	-77,649
Oil refineries	-233,066	226,603	-	-	-	-6,462
Other transformation	-	-	-	-75	-	-75
Energy industry own use	-	-11,281	-131,509	-	-1,195	-143,986
Losses	-	-	-22,454	-	-861	-23,315
TFC	**-**	**52,680**	**477,039**	**505**	**30,822**	**561,044**
Industry	-	6,352	68,806	-	18,633	93,792
Iron and steel	-	-	39,190	-	-	39,190
Non-metallic minerals	-	-	3,629	-	-	3,629
Non-specified (industry)	-	6,352	25,987	-	18,633	50,973
Transport	-	43,619	-	-	-	43,619
Domestic aviation	-	4,415	-	-	-	4,415
Road	-	39,203	-	-	-	39,203
Other	-	1,539	3,991	505	12,188	18,223
Residential	-	1,236	3,991	505	8,829	14,560
services	-	303	-	-	3,359	3,662
Non-energy use	-	1,170	404,241	-	-	405,411
Electricity and Heat generation						
Electricity output (GWh)	-	24	9,108	-	-	9,132
power plants	-	24	9,108	-	-	9,132

Source: Professor Kornelis Blok
Technical University Delft

https://youtu.be/zLEOASP1VVU

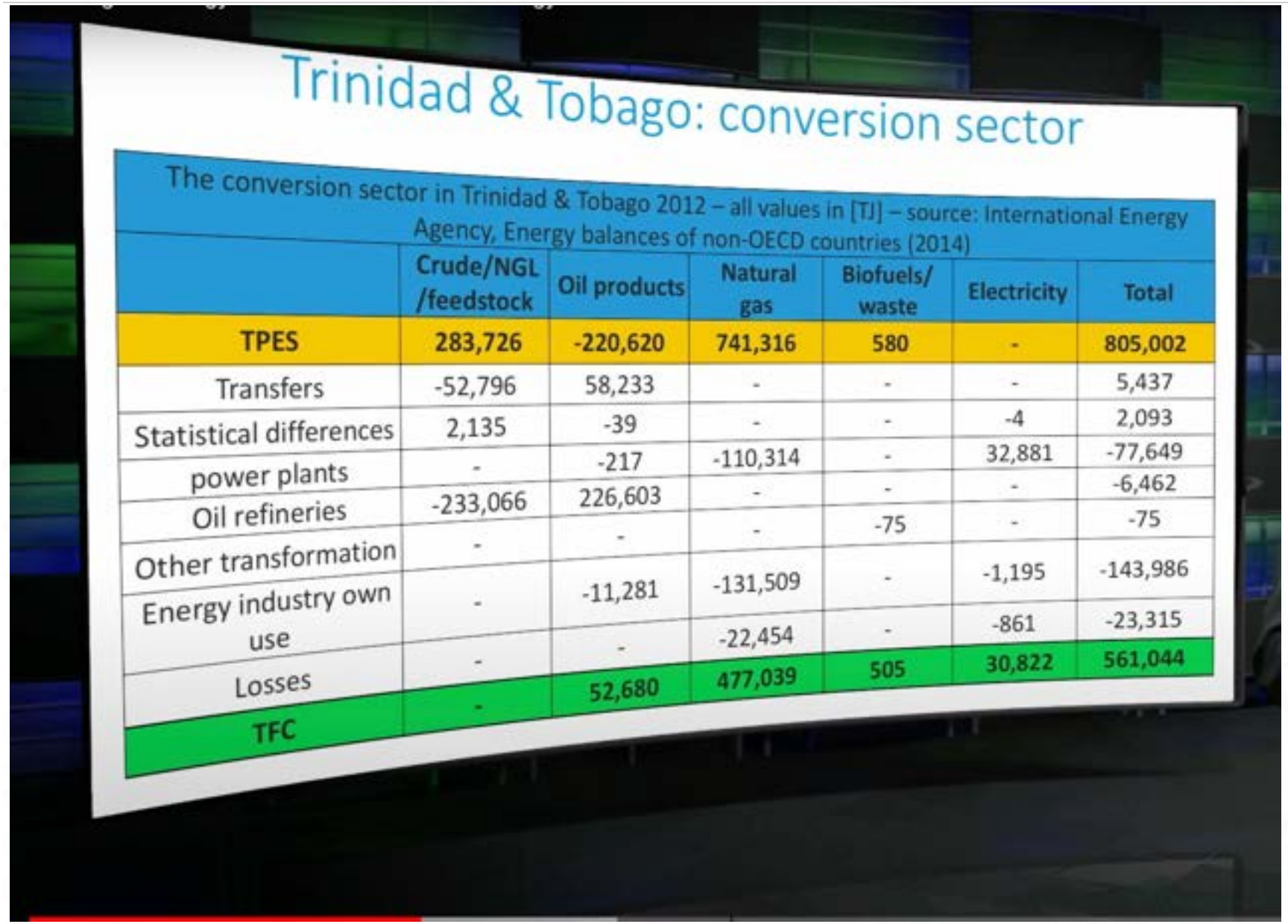


Trinidad & Tobago: energy winning

Energy winning in Trinidad & Tobago 2012 – all values in [TJ] – source: International Energy Agency, Energy balances of non-OECD countries (2014)

	Crude/NGL/ feedstock	Oil products	Natural gas	Biofuels and waste	Electricity	Total
Production	229,145	-	1,436,461	580	-	1,666,186
Imports	125,003	16,818	-	-	-	141,821
Exports	-67,043	-214,980	-695,145	-	-	-977,168
Int. marine bunkers	-	-18,802	-	-	-	-18,802
Int. aviation bunkers	-	-7,537	-	-	-	-7,537
Stock changes	-3,380	3,882	-	-	-	503
Total primary energy supply	**283,726**	**-220,620**	**741,316**	**580**	**-**	**805,002**

Source: Professor Kornelis Blok https://youtu.be/zLEOASP1VVU
Technical University Delft



Trinidad & Tobago: conversion sector

The conversion sector in Trinidad & Tobago 2012 – all values in [TJ] – source: International Energy Agency, Energy balances of non-OECD countries (2014)

	Crude/NGL /feedstock	Oil products	Natural gas	Biofuels/ waste	Electricity	Total
TPES	**283,726**	**-220,620**	**741,316**	**580**	**-**	**805,002**
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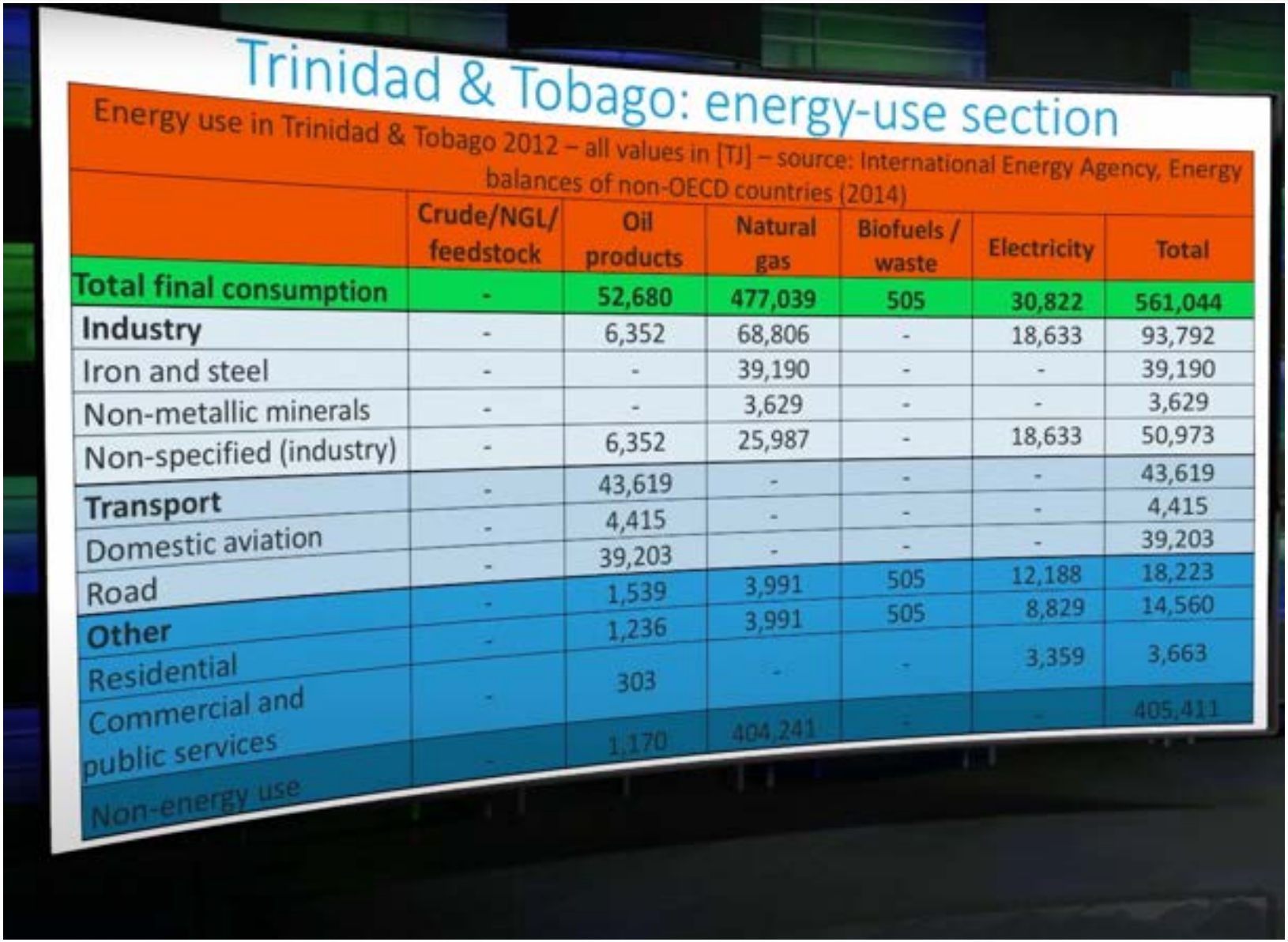
Other transformation	-	-	-	-75	-	-75
Energy industry own use	-	-11,281	-131,509	-	-1,195	-143,986
Losses	-	-	-22,454	-	-861	-23,315
TFC	**-**	**52,680**	**477,039**	**505**	**30,822**	**561,044**

Source: Professor Kornelis Blok https://youtu.be/zLEOASP1VVU
Technical University Delft



Trinidad & Tobago: energy-use section

Energy use in Trinidad & Tobago 2012 – all values in [TJ] – source: International Energy Agency, Energy balances of non-OECD countries (2014)

	Crude/NGL/ feedstock	Oil products	Natural gas	Biofuels / waste	Electricity	Total
Total final consumption	-	**52,680**	**477,039**	**505**	**30,822**	**561,044**
Industry	-	6,352	68,806	-	18,633	93,792
Iron and steel	-	-	39,190	-	-	39,190
Non-metallic minerals	-	-	3,629	-	-	3,629
Non-specified (industry)	-	6,352	25,987	-	18,633	50,973
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Commercial and public services	-	303	-	-	3,359	3,663
Non-energy use	-	1,170	404,241	-	-	405,411

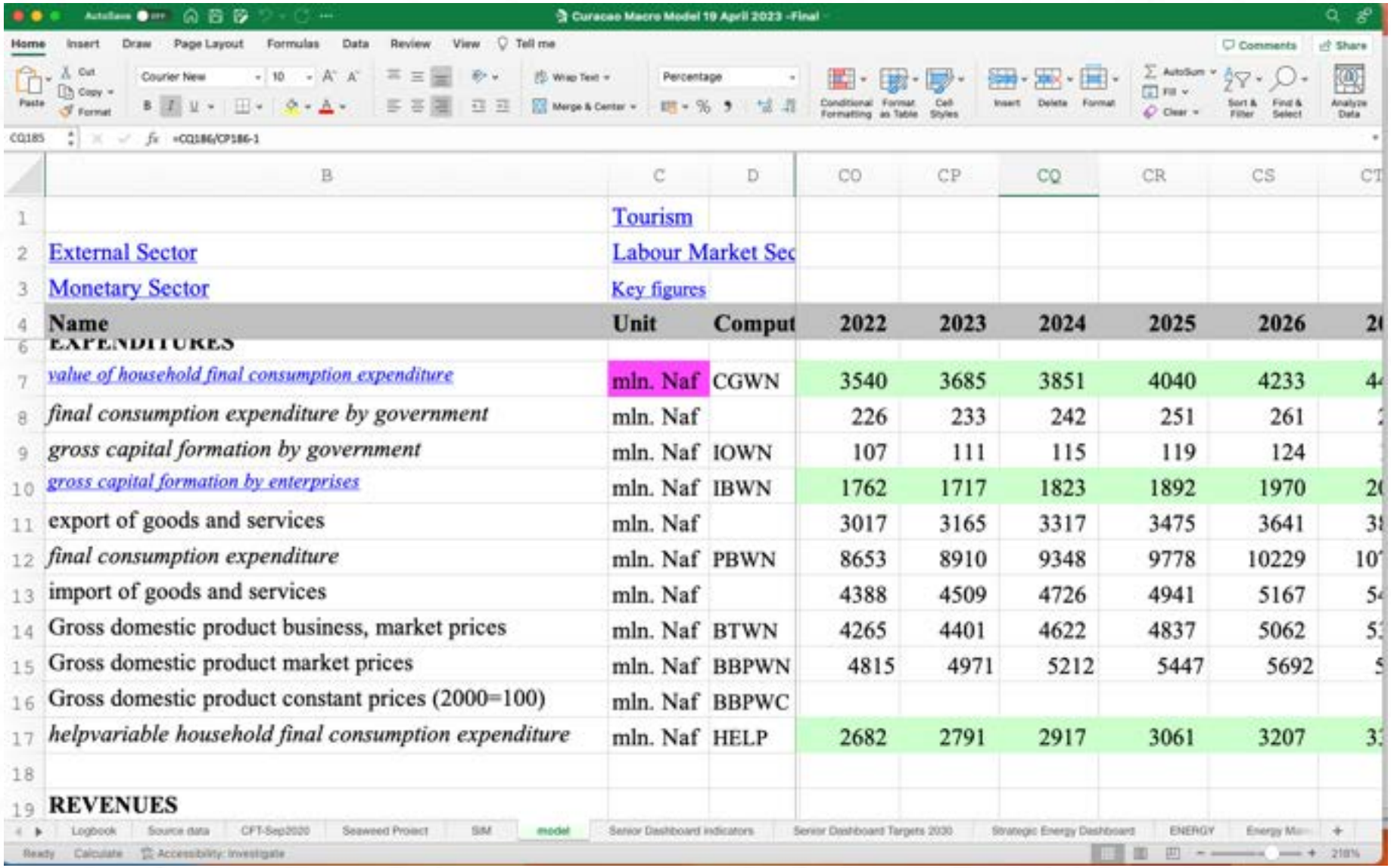
Source: Professor Kornelis Blok https://youtu.be/zLEOASP1VVU
Technical University Delft

Here is an example of an economic and investment framework at national level for Curacao. I have created this for 12 small islands in the Caribbean.

Here you see some of the main indicators, with Gross Domestic Product a main indicator to calculate Energy Intensity. (1 USD = 1.78 NAF)

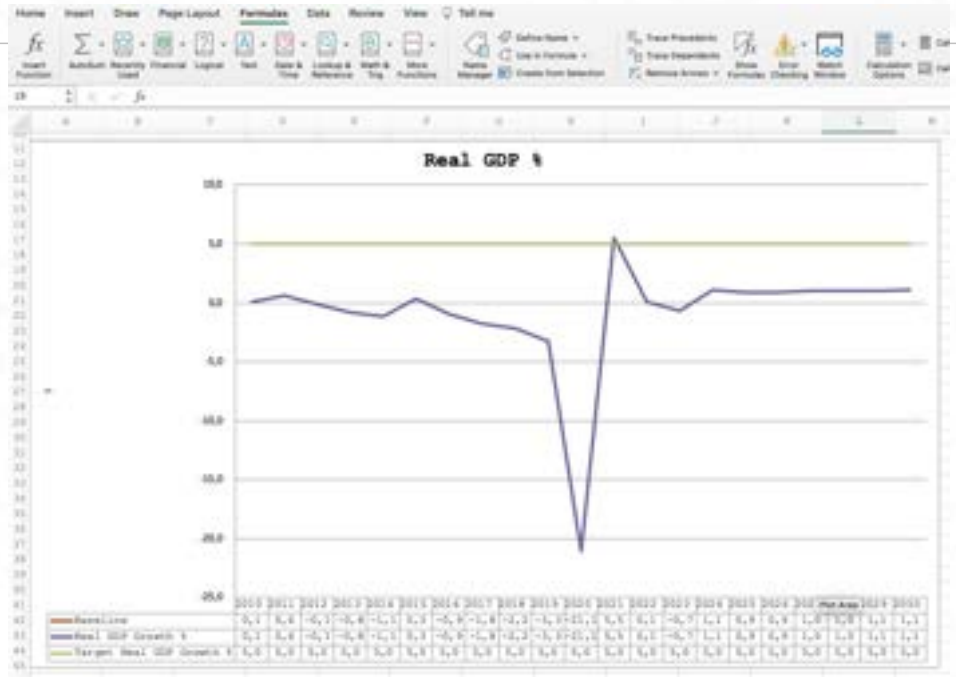
But also a lot of other economic indicators are calculated.

Macro Economic and Investment Framework



Curacao Macro Model 19 April 2023 -Final

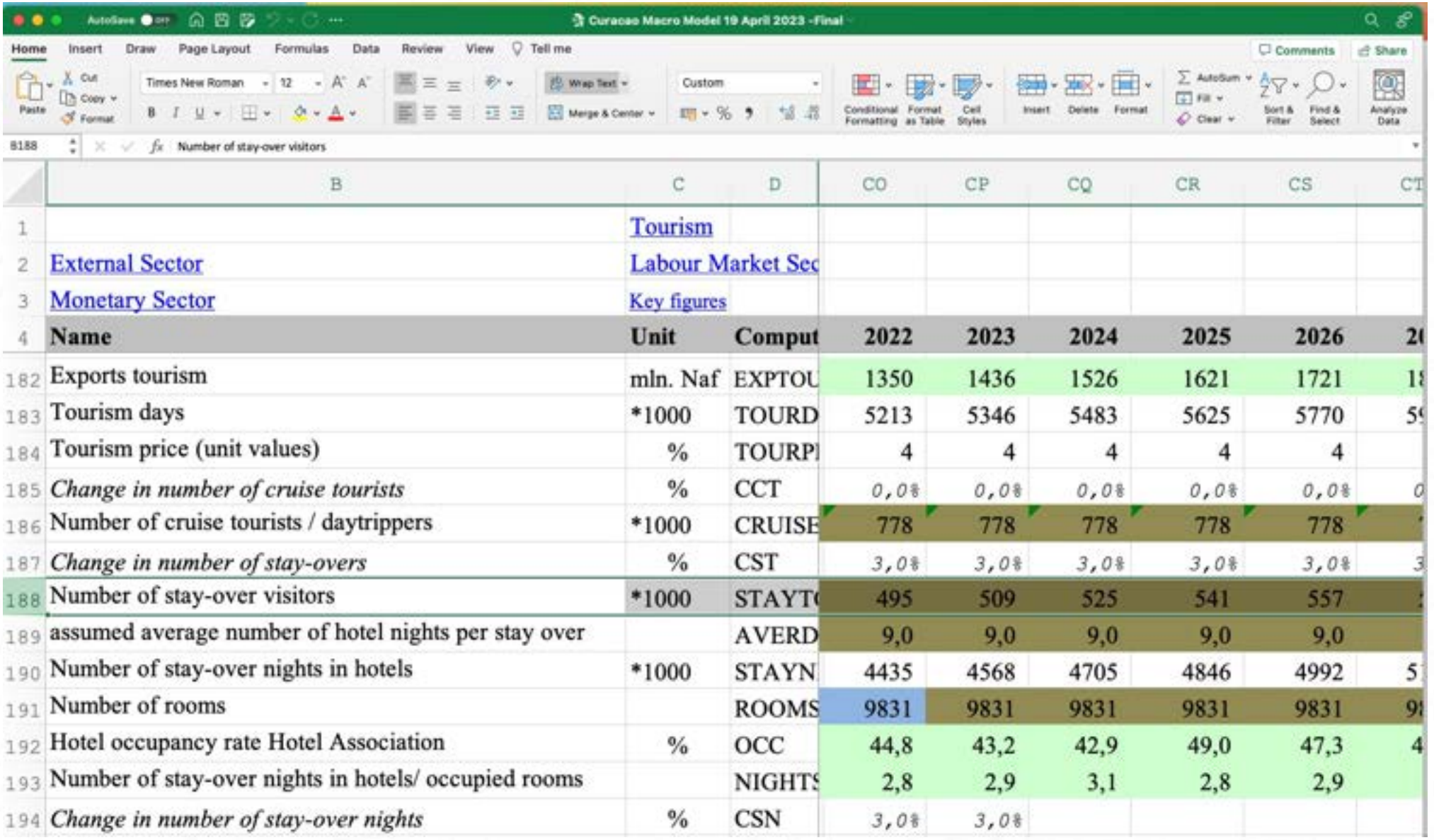
	B	C	D	CO	CP	CQ	CR	CS
1		Tourism						
2	External Sector	Labour Market Sec						
3	Monetary Sector	Key figures						
4	**Name**	**Unit**	**Comput**	**2022**	**2023**	**2024**	**2025**	**2026**
6	**EXPENDITURES**							
7	*value of household final consumption expenditure*	mln. Naf	CGWN	3540	3685	3851	4040	4233
8	*final consumption expenditure by government*	mln. Naf		226	233	242	251	261
9	*gross capital formation by government*	mln. Naf	IOWN	107	111	115	119	124
10	*gross capital formation by enterprises*	mln. Naf	IBWN	1762	1717	1823	1892	1970
11	export of goods and services	mln. Naf		3017	3165	3317	3475	3641
12	*final consumption expenditure*	mln. Naf	PBWN	8653	8910	9348	9778	10229
13	import of goods and services	mln. Naf		4388	4509	4726	4941	5167
14	Gross domestic product business, market prices	mln. Naf	BTWN	4265	4401	4622	4837	5062
15	Gross domestic product market prices	mln. Naf	BBPWN	4815	4971	5212	5447	5692
16	Gross domestic product constant prices (2000=100)	mln. Naf	BBPWC					
17	*helpvariable household final consumption expenditure*	mln. Naf	HELP	2682	2791	2917	3061	3207
18								
19	**REVENUES**							


Real GDP %


Inflation %
Purchasing power %
Unemployment %
Population*1000

Here you see some of the indicators for the tourism sector.

Indicators Tourism Sector



Curacao Macro Model 19 April 2023 -Final

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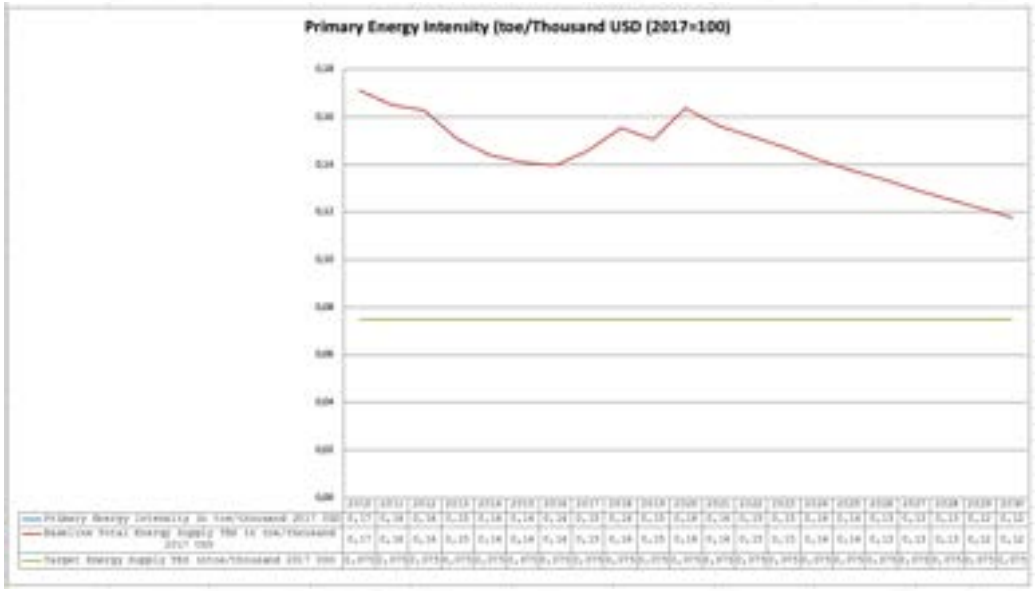
B188 Number of stay-over visitors

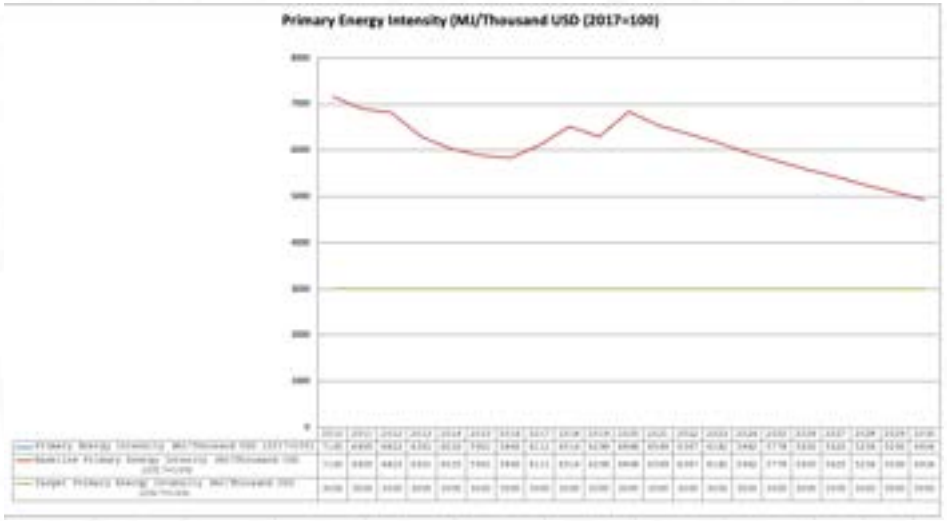
	B	C	D	CO	CP	CQ	CR	CS	CT
1		Tourism							
2	External Sector	Labour Market Sec							
3	Monetary Sector	Key figures							
4	**Name**	**Unit**	**Comput**	**2022**	**2023**	**2024**	**2025**	**2026**	**2(**
182	Exports tourism	mln. Naf	EXPTOU	1350	1436	1526	1621	1721	1
183	Tourism days	*1000	TOURD	5213	5346	5483	5625	5770	5
184	Tourism price (unit values)	%	TOURPI	4	4	4	4	4	
185	*Change in number of cruise tourists*	%	CCT	0,0%	0,0%	0,0%	0,0%	0,0%	0
186	Number of cruise tourists / daytrippers	*1000	CRUISE	778	778	778	778	778	
187	*Change in number of stay-overs*	%	CST	3,0%	3,0%	3,0%	3,0%	3,0%	3
188	Number of stay-over visitors	*1000	STAYT	495	509	525	541	557	
189	assumed average number of hotel nights per stay over		AVERD	9,0	9,0	9,0	9,0	9,0	
190	Number of stay-over nights in hotels	*1000	STAYN	4435	4568	4705	4846	4992	5
191	Number of rooms		ROOMS	9831	9831	9831	9831	9831	9
192	Hotel occupancy rate Hotel Association	%	OCC	44,8	43,2	42,9	49,0	47,3	4
193	Number of stay-over nights in hotels/ occupied rooms		NIGHTS	2,8	2,9	3,1	2,8	2,9	
194	*Change in number of stay-over nights*	%	CSN	3,0%	3,0%				

We added a demo Energy module to this economic and investment framework and Strategic Energy Dashboard.

Using info from an energy balance and the economic and investment Framework. And here you see the history and forecast of energy intensity for Curacao calculated from the indicators.

Indicators and Strategic Dashboad Energy Module





Primary Energy Intensity (MJ/Thousand USD (2 MJ/Thousand USD	7165	6965	6823	6301	6053	5901	5845
Baseline Primary Energy Intensity (MJ/Thousand USD (2017=100)	7165	6965	6823	6301	6053	5901	5845
Diffference from base line	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Target Primary Energy Intensity (MJ/Thousand USD (2017=100)	5000	5000	5000	5000	5000	5000	5000
Change in Primary Energy Intensity MJ/Thousan MJ/USD	0,1%	-3,6%	-1,2%	-7,6%	-4,3%	-2,2%	-0,9%
Baseline Change in Primary Energy Intensity MJ/Thousand USD (2017=1	0,1%	-3,6%	-1,2%	-7,6%	-4,3%	-2,2%	-0,9%
Diffference from base line	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tonnes of Oil Equivalent Conversion 1 MJ=toe							
In toe/thousand 2010 USD 2,388460E-05							
Primary Energy Intensity in toe/thousand 2017 USD	0,17	0,16	0,16	0,15	0,14	0,14	0,14
Baseline Total Energy Supply TES in toe/thousand 2017 USD	0,17	0,16	0,16	0,15	0,14	0,14	0,14
Target Energy Supply TES toe/thousand 2017 USD	0,075	0,075	0,075	0,075	0,075	0,075	0,075
Conversion GJ = 1 mln t							
In GJ/thousand 2017 USD							
Primary Energy Intenity in GJ per thousand 2017 USD	0,007	0,007	0,007	0,006	0,006	0,006	0,006
Baseline Total Energy Supply TES in GJ per thousand 2017 USD	0,007	0,007	0,007	0,006	0,006	0,006	0,006
Target Energy Supply TES in GJ per thousand 2010 USD	0,0033	0,0033	0,0033	0,0033	0,0033	0,0033	0,0033
Conversion 1 MJ= 0,00							
In MWh/thousand 2017 USD 0,000277778							
Primary Energy Intenity in MWh per thousand 2017 USD	2,0	1,9	1,9	1,8	1,7	1,6	1,6
Baseline Total Energy Supply TES in MWh per thousand 2017 USD	2,0	1,9	1,9	1,8	1,7	1,6	1,6
Target Energy Supply TES in MWh per thousand 2017 USD	0,85	0,85	0,85	0,85	0,85	0,85	0,85

ENERGY CONSUMPTION							
Module of Macro Economic Model							
Explanation, as now 2x2 and beyond.							
SECTOR	SUBSECTOR	2010	2011	2012	2013	2014	
	2010	1	1	1	1	1	
GASOIL SECTOR END-USE (TJ)							
	12010	646	626	640	609	575	
	2010	189	190	189	188	186	
TOURISM							
	HOTELS	1	1	1	1	1	
INDUSTRY							
	GENERAL	264	266	266	263	261	
	EXPORT	53	68	72	64	65	
	IMPORT	65	65	65	64	64	
	NEW PIPE	0	0	0	0	0	
COMM & GOV							
	COMM+SERVICES	71	71	71	70	70	
	GOVERNMENT	4	3	3	2	4	
LPG SECTOR END-USE (TJ)							
TOURISM							
	HOTELS	21	27	28	28	28	
	APARTMENTS	2	3	3	3	3	
	RESTAURANTS	27	32	34	30	31	

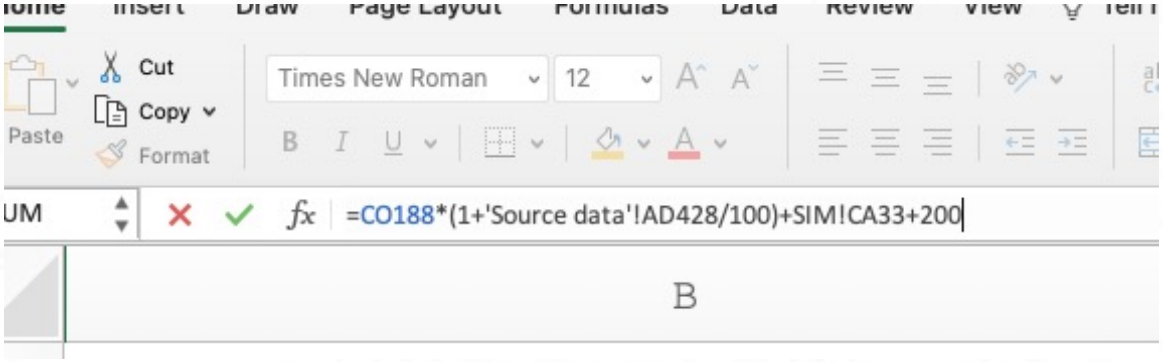
3. What can you do with it? Can you show us an example?

Answer yes: just to show you one simulation: lets grow the number of stayover tourists to 1 million. That might be a policy the policy makers want to achieve.

You can run many simulations and play with many economic indicators and also the energy indicators.

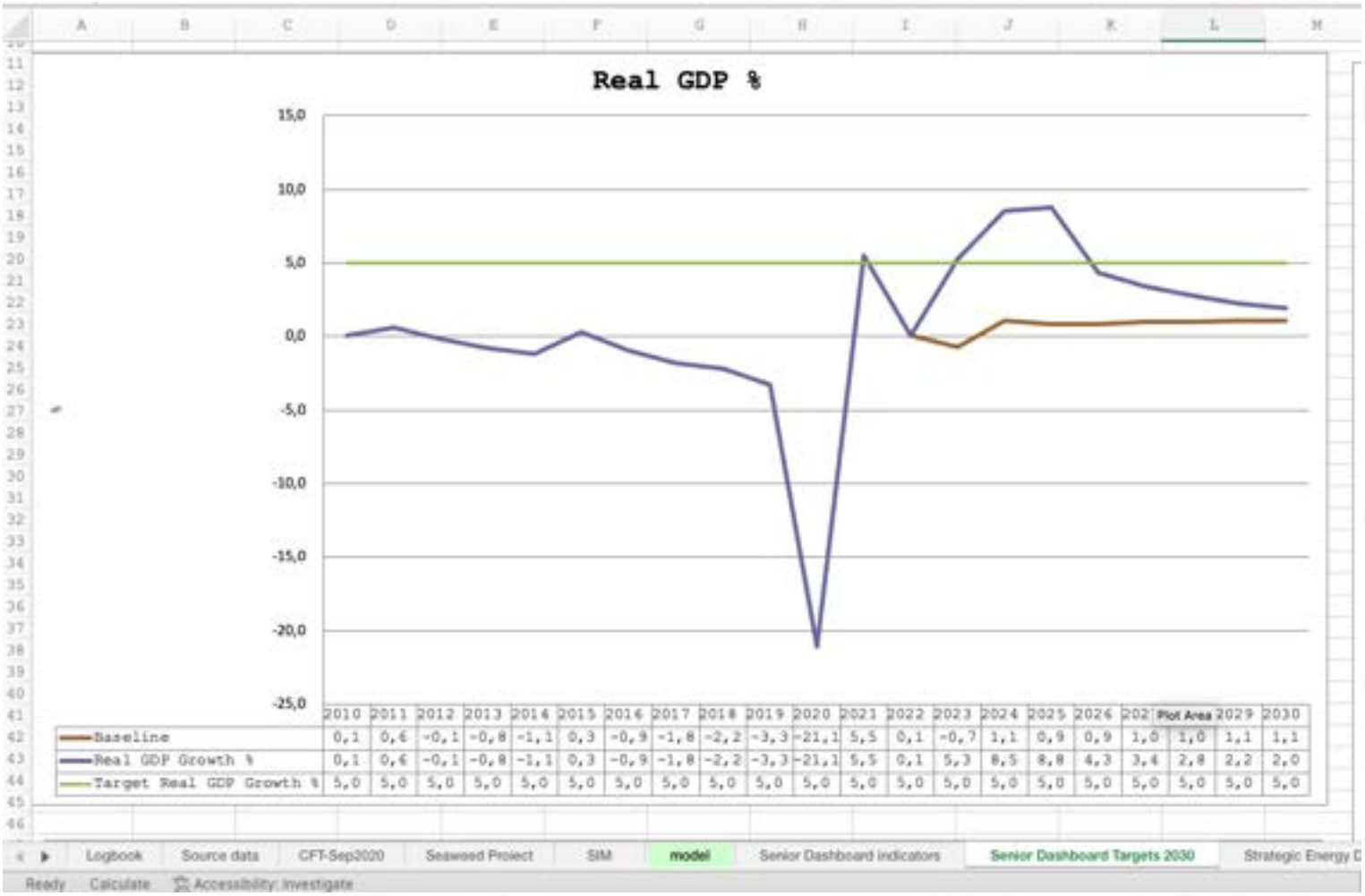
Simulation: increase number of stayover tourists to 1 million to calculate effect on Energy Intensity

Here I increase the tourists and look at the effects on the Strategic Dashboards:



3	Monetary Sector		Key figures			
4	**Name**	**Unit**	**Comput**	**2023**	**2024**	**2025**
82	Exports tourism	mln. Naf	EXPTOU	1918	2541	3225
83	Tourism days	*1000	TOURD	7139	9123	11167
84	Tourism price (unit values)	%	TOURP	4	4	4
85	*Change in number of cruise tourists*	%	CCT	*0,0%*	*0,0%*	*0,0%*
86	Number of cruise tourists / daytrippers	*1000	CRUISE	778	778	778
87	*Change in number of stay-overs*	%	CST	*43,4%*	*31,2%*	*24,5%*
88	Number of stay-over visitors	*1000	STAYT	709	931	1159
89	assumed average number of hotel nights per stay over		AVERD	9,0	9,0	9,0

Economic Impact of 1 million stayover tourists



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	0,1	0,6	-0,1	-0,8	-1,1	0,3	-0,9	-1,8	-2,2	-3,3	-21,1	5,5	0,1	-0,7	1,1	0,9	0,9	1,0	1,0	1,1	1,1
Real GDP Growth %	0,1	0,6	-0,1	-0,8	-1,1	0,3	-0,9	-1,8	-2,2	-3,3	-21,1	5,5	0,1	5,3	8,5	8,8	4,3	3,4	2,8	2,2	2,0
Target Real GDP Growth %	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0

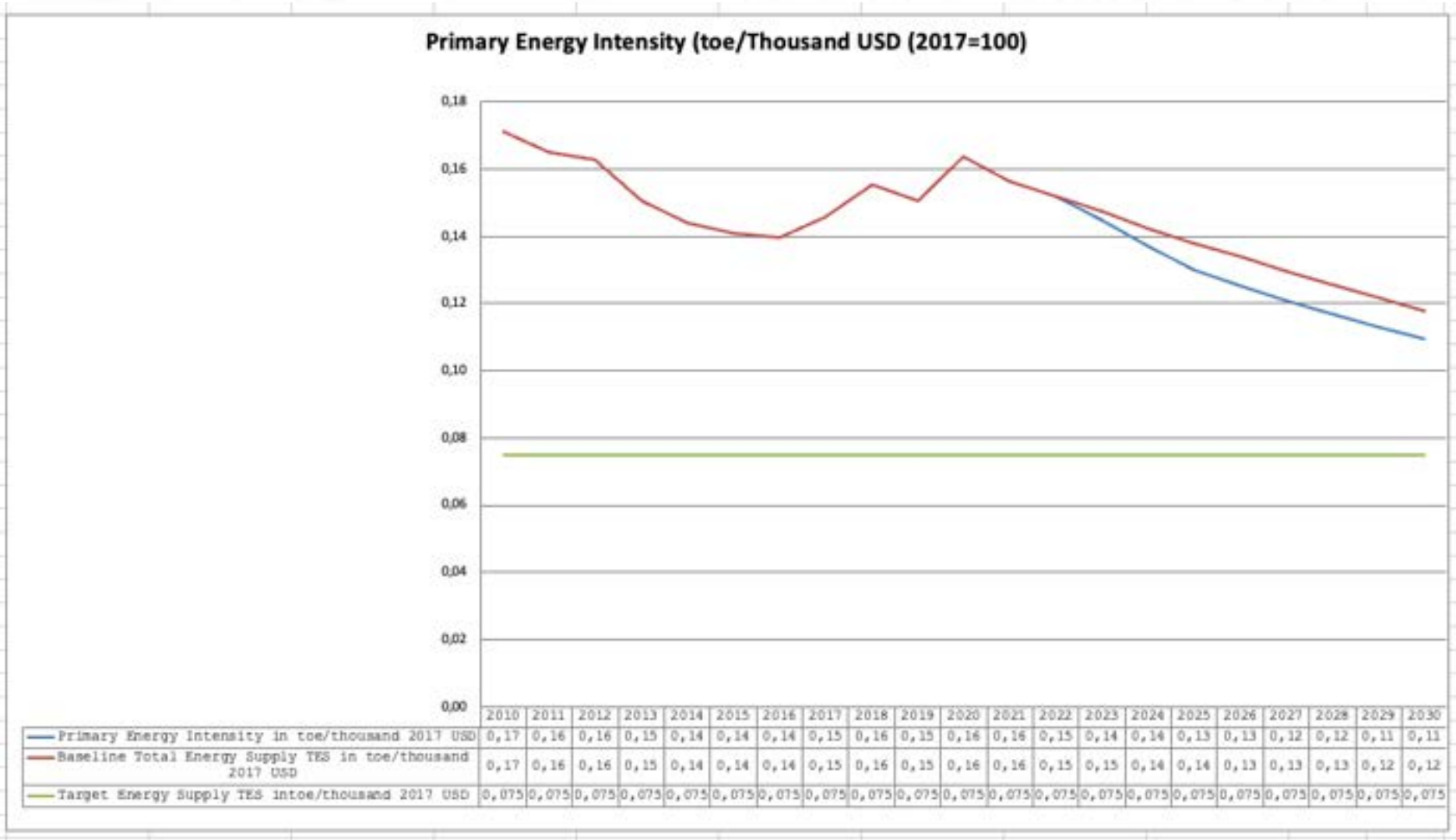
Logbook | Source data | CFT-Sep2020 | Seaweed Project | SIM | model | Senior Dashboard indicators | Senior Dashboard Targets 2030 | Strategic Energy

Ready | Calculate | Accessibility: Investigate

Above you see the brown line was the baseline before the simulation and the blue line the effect on the Gross Domestic Product (growth of the economy) after we increase the number of stayovers to 1 million.

So the economy grows significantly in this simulation scenario.

Impact on the Energy Intensity of simulation



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Primary Energy Intensity in toe/thousand 2017 USD	0,17	0,16	0,16	0,15	0,14	0,14	0,14	0,15	0,16	0,15	0,16	0,16	0,15	0,14	0,14	0,13	0,13	0,12	0,12	0,11	0,11
Baseline Total Energy Supply TES in toe/thousand 2017 USD	0,17	0,16	0,16	0,15	0,14	0,14	0,14	0,15	0,16	0,15	0,16	0,16	0,15	0,15	0,14	0,14	0,13	0,13	0,13	0,12	0,12
Target Energy Supply TES intoe/thousand 2017 USD	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075	0,075

In the dashboard above you see the impact on energy intensity of this specific simulation:

energy demand goes up but the economy also increases. The impact on energy intensity in this scenario is the energy intensity decreases. As you can see here (blue line below brown line.

4 ok thanks Runy: where can people find more about you?

If you want to know more we have put a short pdf together with:

- some resources and info about energy balances,
- the basic 7 steps to create such an economic and investment framework and
- what are the 54 economic indicators you need to focus on to create this economic and investment framework.
- Also what data you need and where to find that data .

You can get these valuable resources here by leaving your name, email and social media (linked in) in the form below (scan qr or click the link)

As a group working on Energy Efficiency and Energy Intensity, we plan to organize some sessions after Island Finance Forum and building towards Island Innovation Forum at the end of this year.

If you are an investor or policy maker or practitioner who care about data, planning to make decision stay in contact by leaving your info. Thanks

Extra questions: 5 How do you define Energy Intensity?

Great question: when analyzing processes like Energy Efficiency you always need to get the indicator: here you see how it is defined. Like I said before you take the total energy supply (or demand) and you divide it by an economic indicator. For national level it is the Gross Value Added of the country. For Curacao you see here how we calculated these indicators.

METHODOLOGY

Total energy supply (TES) in megajoules (MJ)	This represents the amount of energy available in the national territory during the reference period. It is calculated as follows: Total energy supply = Primary energy production + Import of primary and secondary energy – Export of primary and secondary energy – International (aviation and marine) bunkers – Stock changes. (Definition consistent with International Recommendations for Energy Statistics.) *Data sources:* Energy balances from the International Energy Agency (IEA), supplemented by the United Nations Statistics Division (UNSD) for countries not covered by IEA as of 2017.
Gross domestic product (GDP) in 2017 U.S. dollars (USD) at purchasing power parity (PPP)	Sum of gross value-added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. GDP is measured in constant 2017 USD PPP. *Data source:* World Development Indicators database: http://datatopics.worldbank.org/world-development-indicators/).
Primary energy intensity in MJ/2017 USD PPP	$$Primary\ energy\ intensity = \frac{TES\ (MJ)}{GDP\ (USD\ 2017\ PPP)}$$ Ratio between TES and GDP is measured in MJ per 2017 USD PPP. Energy intensity (EI) indicates how much energy is used to produce one unit of economic output. A lower ratio indicates that less energy is used to produce one unit of economic output.

For sectoral level, say tourism which is an important service sector on most small island nations you take the Energy demand/production for the tourism sector and divide it by the gross value added of that sector.

Daniel will show you how to go further in hotels and restaurants and calculate it even and lower level.

Loreto will show you some calculations for specific areas of cooling even. So, stay with us.

Energy Intensity at Sectoral level (e.g. Services: Tourism)

Industrial energy intensity in MJ/2017 USD PPP	$$\textit{Industrial energy intensity} = \frac{\textit{Industrial TFEC (MJ)}}{\textit{Industrial value added (USD 2017 PPP)}}$$ Ratio between industry TFEC and industry value-added, measured in MJ per 2017 USD PPP. *Data sources:* Energy balances from IEA and value-added from WDI.
Services energy intensity in MJ/2017 USD PPP	$$\textit{Services energy intensity} = \frac{\textit{Services TFEC (MJ)}}{\textit{Services value added (USD 2017 PPP)}}$$ Ratio between services TFEC and services value-added measured in MJ per 2017 USD PPP. *Data sources:* Energy balances from IEA and value-added from WDI.
Agriculture energy intensity in MJ/2017 USD PPP	$$\textit{Agriculture energy intensity} = \frac{\textit{Agriculture TFEC (MJ)}}{\textit{Agriculture value added (USD 2017 PPP)}}$$ Ratio between agriculture TFEC and agriculture value-added measured in MJ per 2017 USD PPP. *Data sources:* Energy balances from IEA and value-added from WDI.

Focus on economic indicators and Energy Balances for your small island nation

Extra question 6: Runy you said that you found Energy balances for Malta and Cyprus, we have many small island nations here: what's going on?

Answer: I advice small island nations to focus on producing data. If we don't have data, we cannot join the discussion and attract foreign investments.

How to do it? We might collaborate with Malta and Cyprus who probably have received European funds to create these Energy Balances. And ensure we build capacity. We can send our students and professionals and educate ourselves remotely and collaborate on data gathering etc. After this webinar: go to your power company and your statistical office and ask what they are doing on creating energy balances. And please let us know.

www.linkedin.com/in/calmera

Please mention **#iff** when you request to connect with me so I know you are member of the Island Finance Forum community

Stay in contact by filling in the form and we send you some valuable additional resources

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